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CRASH COURSE

SAMPLE

PHYSICS

ELECTROMAGNETIC INDUCTION

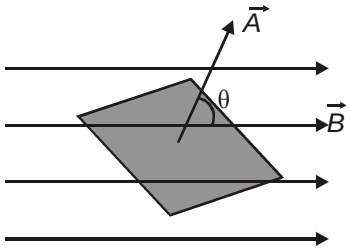
THIS CHAPTER COVERS :

- Magnetic flux & Faraday's Law
- Lenz's Law
- Methods of inducing emf & applications
- Mutual and self inductance
- Inductor
- LR circuit with dc source
- Eddy current
- Induced electric field
- Transformer
- LC oscillations

MAGNETIC FLUX & FARADAY'S LAW

$\phi = \vec{B}.\vec{A} = BA\cos\theta$

Units : weber (SI)
Maxwell (CGS)
1 maxwell = 10^{-8} Wb



Faraday's Laws of Electromagnetic Induction :

1. An emf is induced in a loop when the number of magnetic field lines i.e., magnetic flux passing through the loop is changing.
2. Magnitude of the emf 'e' induced in a conducting loop is equal to the rate at which the magnetic flux ϕ_B through that loop changes with time.

$\Rightarrow \quad e = -\frac{d\phi_B}{dt}$ (for a loop), for a plane coil having N turns

$e = -\frac{Nd\phi_B}{dt} = -\frac{d(N\phi_B)}{dt}$

Note : Negative sign indicates opposition (explained by Lenz's law).

LENZ'S LAW

The flux of the magnetic field due to the induced current opposes the change in flux that causes the induced current.

Application of Lenz's Law

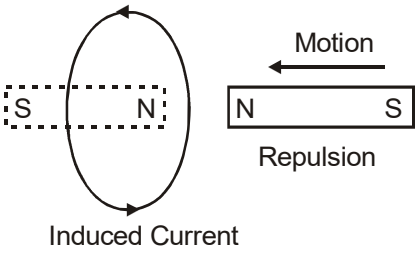


Fig. 1

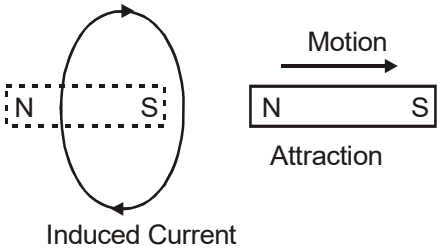
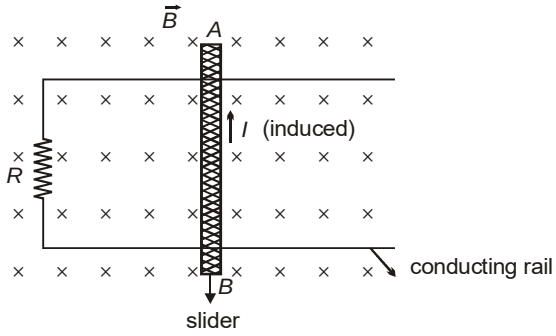


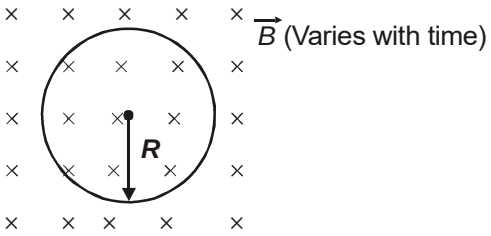
Fig. 2

1. If loop ABCD is brought closed, anticlockwise current is induced. (Fig. 1)
2. If ABCD is moved away, clockwise current is induced. (Fig. 2)
3. As shown, if magnetic field starts increasing, an anticlockwise current starts flowing. Due to this, slider AB moves leftward.



METHODS OF INDUCING EMF AND APPLICATIONS

Methods of Inducing EMF :



(1) By Changing $\vec{B}$

$\phi = BA = B \times \pi R^2$

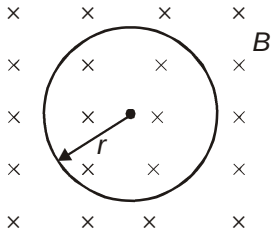
$$\frac{d\phi}{dt} = \pi R^2 \frac{dB}{dt} \quad \Rightarrow e = -\pi R^2 \frac{dB}{dt}$$

(a) If $\vec{B}$ increases, current is in anticlockwise direction producing outward magnetic field.

(b) If $\vec{B}$ decreases, current is in clockwise direction.

(2) By Changing Area

(a) Let area changes from A_1 to A_2 in time t



$\phi_1 = BA_1$

$\phi_2 = BA_2$

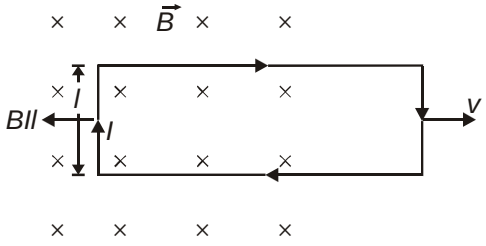
$$e = -\frac{(\phi_2 - \phi_1)}{t}$$

$$e = \frac{B(A_1 - A_2)}{t}$$

(b) Radius of the loop starts increasing at rate $\frac{dr}{dt}$

$$e = -\frac{d}{dt}(B \times \pi r^2) = -B \times 2\pi r \frac{dr}{dt}$$

(c) Moving a loop in/out of a uniform field.



e = Bvl, R = resistance of loop, $I = \frac{e}{R}$ (clockwise)

Some Important Points :

(a) Force required to pull the loop with constant velocity

$$F = BIl = \frac{Bl \times e}{R} = \frac{B^2l^2v}{R}$$

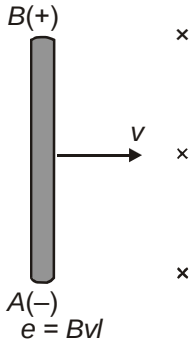
(b) Power of external force = $Fv = \frac{B^2l^2v^2}{R}$

(c) Rate of heat loss = $I^2R = \frac{B^2l^2v^2}{R}$

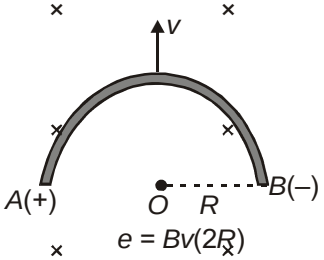
$\therefore$ External power = thermal power dissipated

If the loop is pushed inside, current will be anticlockwise.

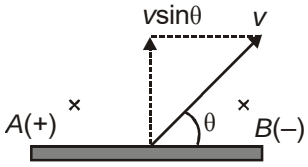
Applications :

1. 

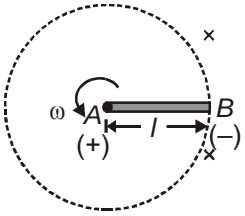
$e = Bvl$

2. 

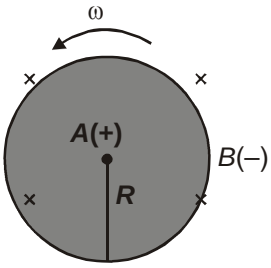
$e = Bv(2R)$

3. 

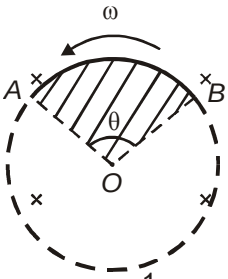
$e = Bvl \sin\theta$

4. 

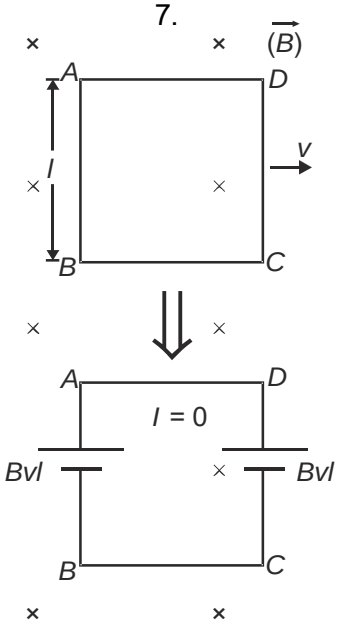
$e = \frac{1}{2} Bl^2\omega$

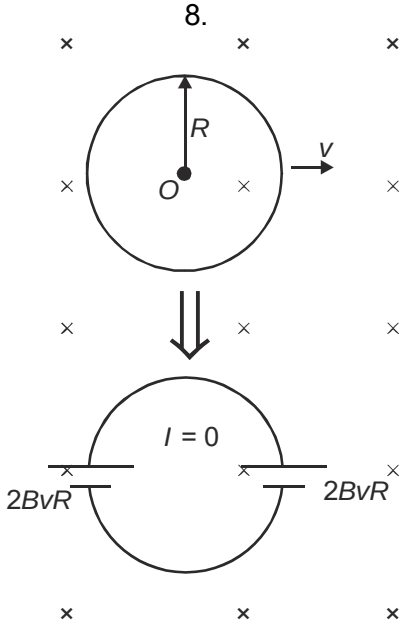
5. 

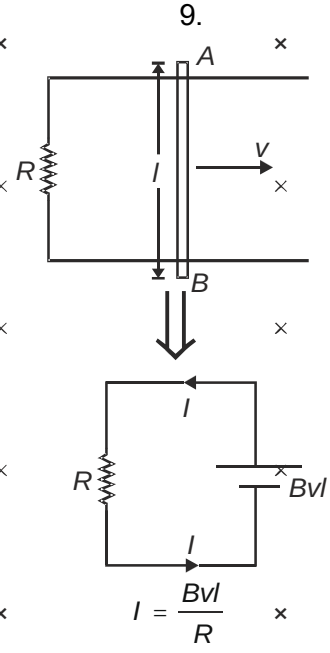
$e = \frac{1}{2} Br^2\omega$
Disc

6. 

$\varepsilon_{AB} = 0 \quad e_{OA} = \frac{1}{2} Br^2\omega$
Part of Disc

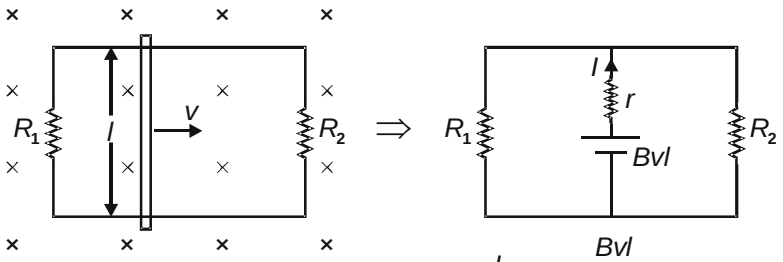
7. 

8. 

9. 

$I = \frac{Bvl}{R}$

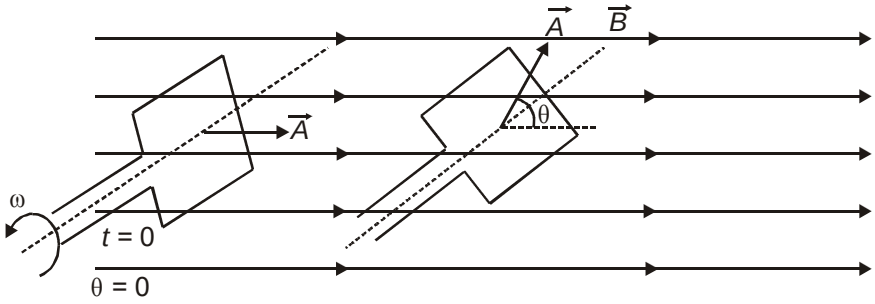
10.

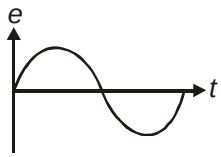


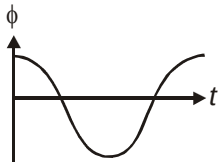
Sliding rod also has a resistance '*r*'

$$I = \frac{Bvl}{r + \frac{R_1R_2}{R_1 + R_2}}$$

(3) A.C. Generator







$e = e_0 \sin\omega t$

Alternating emf is produced in the coil, given by

$e = NBA\omega.\sin\omega t$

[N = No. of turns, B = magnetic field,

A = Area of loop, ω = angular speed of rotation]

MUTUAL AND SELF INDUCTANCE

Mutual Induction :

Property of two coils by virtue of which each opposes any change in the magnitude of current flowing through the other by inducing an emf in itself provided magnetic flux of one coil is linked with other.

Let I_1 is current through one coil, ϕ_2 is flux linked with other coil, then

$\phi_2 \propto I_1$

$\Rightarrow$ $\phi_2 = MI_1$, where M is mutual induction

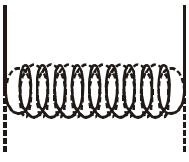
$$\Rightarrow \quad e = \frac{-d\phi_2}{dt} = -M\frac{dI_1}{dt}$$

Important cases :

1. Mutual inductance of two solenoids :

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$

N_1 = Number of turns in one solenoid



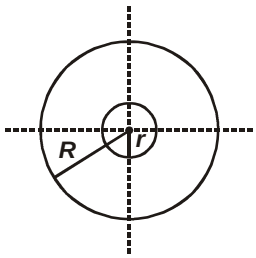
N_2 = Number of turns in other solenoid

A = Area of cross-section of narrower solenoid

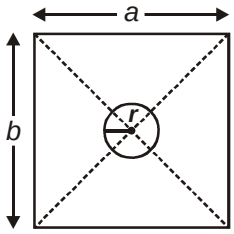
l = Length of solenoid

2. Two loops :

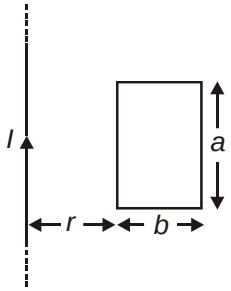
R >> r



(a) $M = \frac{\mu_0 \pi r^2}{2R}$



(b) $M = \frac{\mu}{4\pi} \frac{8\sqrt{a^2+b^2}}{ab} \pi r^2$



(c) $M = \frac{\mu_0}{2\pi} a \log\left(\frac{r+b}{r}\right)$

Self Induction :

Property of a coil by which it opposes any change in the magnitude of current flowing through it by inducing an emf in itself.

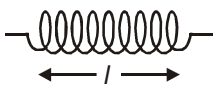
Here $\phi = LI$, $e = \frac{-L dI}{dt}$, L = Coefficient of self-induction.

Both M and L have unit Henry. 1 Henry = $\frac{1 \text{ Volt - sec}}{\text{Ampere}}$ = 1 Joule/(Amp)^2

INDUCTOR

Ideal Inductor : A part of long solenoid having zero resistance, inductance or coefficient of self induction

$L = \mu_0 n^2 Al = \frac{\mu_0 N^2 A}{l}$

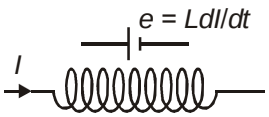


l = length, A = area of cross-section

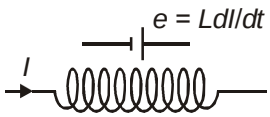
n = number of turns/length, N = total number of turns

Direction of Induced emf

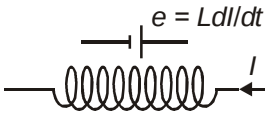
(a) I is increasing



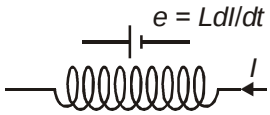
(b) I is decreasing



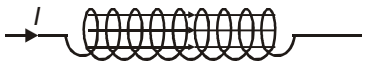
(c) I is increasing



(d) I is decreasing



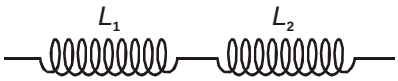
Energy in Inductor



Energy $U_B = \frac{1}{2}LI^2$, Energy Density = $\frac{1}{2}\frac{B^2}{\mu_0}$

Combination of Inductors :

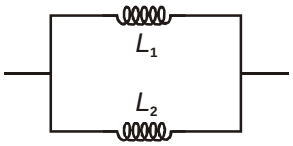
1. **Inductor in series**



(a) $L = L_1 + L_2$

(b) $L = L_1 + L_2 \pm 2M$ (If mutual inductance is also considered)

2. **Inductor in parallel**



$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$ (Neglecting mutual induction)

Relation between Self Inductance and Mutual Inductance :

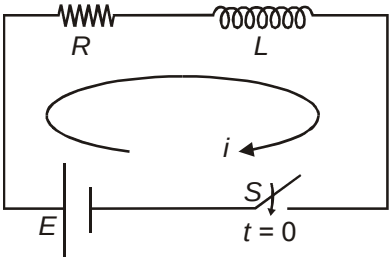
$M = K\sqrt{L_1 L_2}$

M = Mutual inductance of two inductors L_1 and L_2, K = Coefficient of coupling.

For a tight (perfect) coupling K = 1, otherwise K < 1.

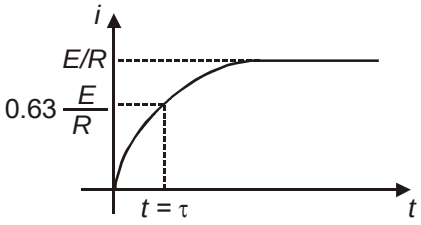
L-R- CIRCUIT WITH D.C. SOURCE

Growth of Current :



At $t = 0$ the switch S is closed

$$i = \frac{E}{R}\left(i - e^{-t/\tau}\right).$$

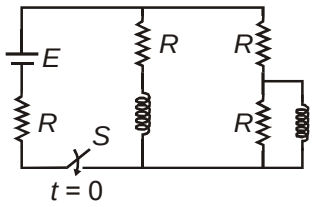


Graph for variation of current (i) with time (t) is shown here.

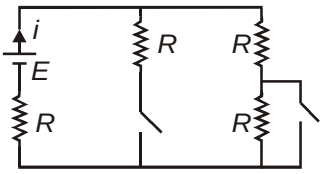
(1) Inductor behaves like open circuit. No current through it, as t = 0, i = 0.

(2) After long time, as $t \to \infty$, $i_0 = \frac{E}{R}$. (Inductor behaves as closed switch)

Illustration :

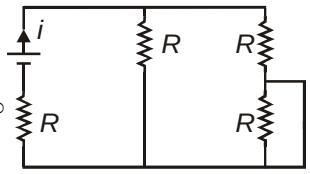


at t = 0



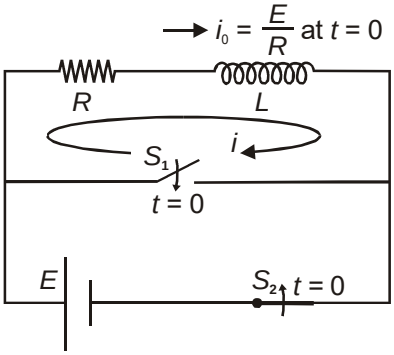
$i = \frac{E}{3R}$

at t = ∞



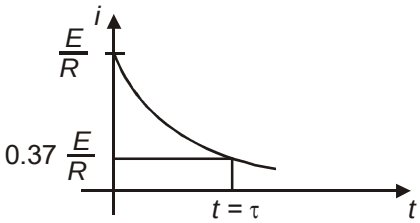
$i = \frac{2E}{3R}$

Decay of Current :



At $t = 0$, $i = \frac{E}{R}$ is flowing through the inductor. Now S_1 is closed and S_2 is opened.

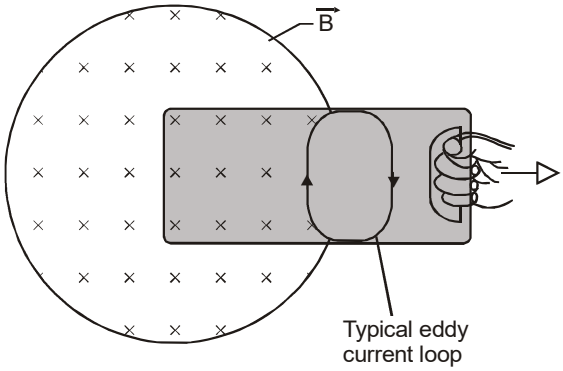
$$i = \frac{E}{R}\left(e^{-t/\tau}\right)$$



Graph for variation of current (i) with time (t) is shown here.

EDDY CURRENTS

When the magnetic flux through a large piece of conducting material changes, induced currents appear in the material. These current are called eddy currents.



The magnitude of eddy currents is given by $i = \frac{-\varepsilon}{R} = \frac{d\phi/dt}{R}$ where R is resistance of the conductor.

The direction of eddy currents is given by Lenz's law or Flemming's right hand rule.

Some of the important applications of eddy currents are: Induction motor and in diathermy i.e., deep heat treatment of parts of human body.

Some of the undesirable effects of eddy currents are that they oppose the relative motion, involve loss of energy in the form of heat and reduce the life of electrical devices. To minimise eddy currents, we use laminated cores.

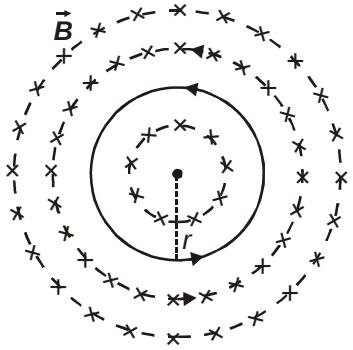
Uses of Eddy Currents :

Induction furnace, magnetic brakes, speedometers, damping in galvanometers, dead beat galvanometer.

INDUCED ELECTRIC FIELD

A changing magnetic field produces an electric field. This field is non-conservative and always forms closed lop. Consider a region of magnetic field. The magnetic field strength is increasing at a rate $\frac{d\vec{B}}{dt}$. This creates anticlockwise electric field lines. Electric field strength at distance r from point O is given by

$$E = \frac{dB}{dt} \times \frac{r}{2}.$$



TRANSFORMER

1. A transformer is a device for converting high voltage into low voltage and vice versa, without change in power.
2. There are two types of transformers.

   (a) Step up Transformer : It converts low voltage into high voltage.

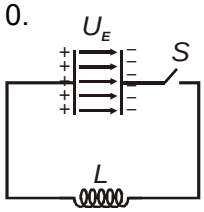
   (b) Step down transformer : It converts high voltage into low voltage.
3. The principle of a transformer is based on mutual induction and a transformer always works on AC. The input is applied across primary terminals and output is obtained across secondary terminals.
4. The ratio of number of turns in secondary and primary is called the turn ratio i.e., $\frac{n_s}{n_p}$ = turn ratio n.
5. If E_p and E_s are alternating voltage, I_p and I_s the alternating currents across primary and secondary terminals respectively, then for ideal transformer

   $$\frac{E_s}{E_p} = \frac{I_p}{I_s} = \frac{n_s}{n_p} = n .$$
6. Efficiency of practical transformer

   $$\eta = \frac{\text{output power}}{\text{input power}} = \frac{P_{out}}{P_{in}} = \frac{E_s I_s}{E_p I_p} < 1$$

LC OSCILLATIONS

A charged capacitor is connected to an inductor and switch is closed at t = 0.

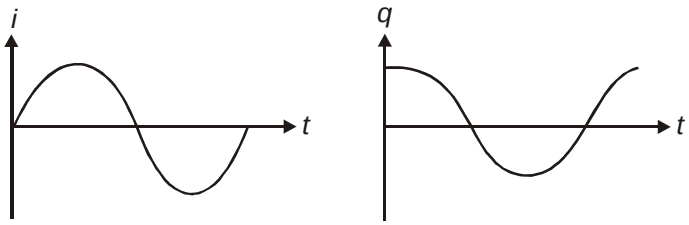


The charge and current vary sinusoidally as,

$q = q_0 \cos \omega t$ [$\because$ at t = 0, $q = q_0$]

$i = i_0 \sin \omega t$ [$\because$ at t = 0, i = 0]

Graphical representation of this variation is as shown.



$i_0 = \frac{q_0}{\sqrt{LC}}, \omega = \frac{1}{\sqrt{LC}}, \nu = \frac{1}{2\pi\sqrt{LC}}$ is frequency of LC oscillations

Some Important Points :

1. If there is some resistance, there is a continuous loss of energy. $\therefore$ Amplitude of charge or current decays with time.
2. During oscillations, voltage across capacitor at any instant = emf induced in the inductor.
3. Energy stored in capacitor or inductor oscillates with frequency 2ν.

EXERCISE-1

1. Dimensional formula of magnetic flux is
(1) $[M L^2 T^{-2} A^{-1}]$ (2) $[M L^1 T^{-1} A^{-2}]$ (3) $[M L^2 T^{-3} A^{-1}]$ (4) $[M L^{-2} T^{-2} A^{-2}]$

2. An emf can be induced in stationary coil if it is kept in
(1) Stationary uniform magnetic field (2) Stationary nonuniform magnetic field
(3) Time varying magnetic field (4) Not possible

3. The induced e.m.f. in a coil does not depend on
(1) The number of turns in the coil (2) The rate of change of magnetic flux
(3) Time of rotation (4) The resistance of the circuit

4. Flux ϕ (in weber) in a closed circuit of resistance 10 ohm varies with time t (in second) according to the equation $\phi = 6t^2 - 5t + 1$. What is the magnitude of the induced current at $t = 0.25$ s?
(1) 1.2A (2) 0.2A (3) 0.6A (4) 0.8A

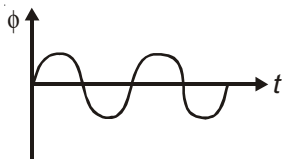
5. A cylindrical magnet is kept along the axis of a circular coil. On rotating the magnet about its axis, the coil will have induced in it
(1) No current (2) A current
(3) Only an e.m.f. (4) Both an e.m.f. and a current

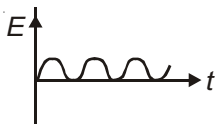
6. A magnet is brought near a coil in two ways (i) rapidly (ii) slowly. The induced charge will be
(1) More in case (i) (2) More in case (ii)
(3) Equal in both the cases (4) More or less according to the radius of the coil

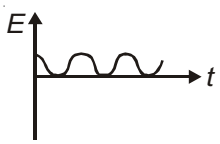
7. A circular loop of flexible conducting material is kept in a magnetic field directed perpendicularly into its plane. By holding the loop at diametrically opposite points its is suddenly stretched outwards, then
(1) No current is induced in the loop (2) Anti-clockwise current is induced
(3) Clockwise current is induced (4) Only e.m.f. is induced

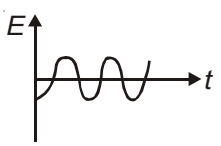
8. An aeroplane is flying horizontally with a velocity of 360 km/h. The distance between the tips of the wings of aeroplane is 25 m. The vertical component of earth's magnetic field is 4×10^{-4} Wb/m^2. The induced e.m.f. is
(1) 1 V (2) 100 V (3) 1 kV (4) Zero

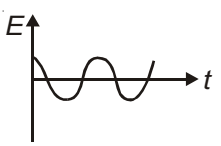
9. The magnetic flux through a coil varies with time t as shown in the diagram. Which graph best represents the variation of the e.m.f. E induced in the coil with time t?



(1) 

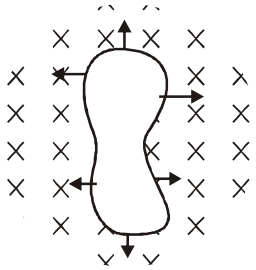
(2) 

(3) 

(4) 

10. A coil having 500 square loops each of side 10 cm is placed with its plane perpendicular to a magnetic field which increases at a rate of 1.0 tesla/s. The induced e.m.f. (in volts) is
(1) 0.5 (2) 0.1 (3) 1.0 (4) 5.0

11. A loop of irregular shape of conducting wire *PQRS* (as shown in figure) placed in a uniform magnetic field perpendicular to the plane of the paper changes into a circular shape. The direction of induced current will be



(1) Clockwise (2) Anti-clockwise (3) No current (4) None of these

12. A copper rod of length l is rotated about one end perpendicular to the uniform magnetic field B with constant angular velocity ω. The induced e.m.f. between its two ends is

(1) $B\omega l^2$ (2) $\frac{3}{2}B\omega l^2$ (3) $\frac{1}{2}B\omega l^2$ (4) $2\,B\omega l^2$

13. A coil having number of turns N and area A is rotated in a uniform magnetic field B with angular velocity ω about its diameter. Maximum e.m.f. induced in it is given by

(1) $NAB\omega$ (2) $\frac{NAB}{\omega}$ (3) $\frac{NA\omega}{B}$ (4) $\frac{B\omega}{NA}$

14. A flat coil of 500 turns, each of area 50 cm^2, rotates in a uniform magnetic field of 0.14 Wb/m^2 about an axis normal to the field at an angular speed of 150 rad/s. The coil has a resistance of 5 Ω. The induced e.m.f. is applied to an external resistance of 10 Ω. The peak current through the resistance is

(1) 1.5 A (2) 2.5 A (3) 3.5 A (4) 4.5 A

15. The current passing through a choke coil of self inductance 5 H is decreasing at the rate of 2 A/s. The e.m.f. developed across the coil is

(1) 10 V (2) – 10 V (3) – 2.5 V (4) 2.5 V

16. When the number of turns in a solenoid are doubled without any change in the length of the solenoid, its self inductance becomes

(1) Half (2) Double (3) Four times (4) Eight times

17. A coil of resistance 20 ohms and inductance 5 H has been connected to a 100 volt battery. The energy stored in the coil is

(1) 31.25 J (2) 62.5 J (3) 125 J (4) 250 J

18. The magnetic energy stored in a long solenoid of area of cross-section A in a small region of length L is

(1) $\frac{B^2AL}{2\mu_0^2}$ (2) $\frac{AL}{2\mu_0}$ (3) $\frac{1}{2}\mu_0 B^2 AL$ (4) $\frac{B^2AL}{2\mu_0}$

19. A long solenoid has self inductance L. If its length is doubled keeping total number of turns constant then its new self inductance will be

(1) $\frac{L}{2}$ (2) $2L$ (3) L (4) $\frac{L}{4}$

20. If L and R denote inductance and resistance respectively, then the dimension of L/R is

(1) $[M^0L^0T^{-1}]$ (2) $[M^0L^0T^1]$ (3) $[M^0L^0T^2]$ (4) $[MLT^2]$

21. A solenoid has 2000 turns wound over a length of 0.3 m. The area of its cross section is 1.2×10^{-3} m^2. Around its central section a coil of 300 turns is wound. If an initial current of 2 A is reversed in 0.25 s, the e.m.f. induced in the coil is equal to

(1) 6×10^{-4} V (2) 4.8×10^{-2} V (3) 2.4×10^{-2} V (4) 48 kV

22. With the decrease of current in the primary coil from 2 A to zero in 0.01s, the e.m.f. generated in the secondary coil is 1000 V. The mutual inductance of the two coil is

(1) 1.25 H (2) 2.50 H (3) 5.00 H (4) 10.00 H

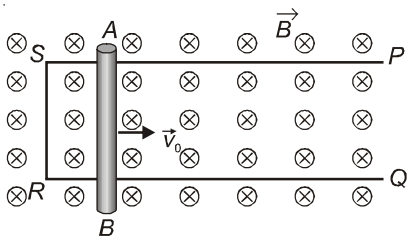
23. Two coaxial coils are very close to each other and their mutual inductance is 5 mH. If a current 50 sin 500t is passed in one of the coils then the peak value of induced e.m.f. in the secondary coil will be

(1) 5000 V (2) 500 V (3) 150 V (4) 125 V

24. The coefficient of self induction of two inductor coils are 20 mH and 40 mH respectively. If the coils are connected in series so as to support each other and the resultant inductance is 80 mH then the value of mutual inductance between the coils will be

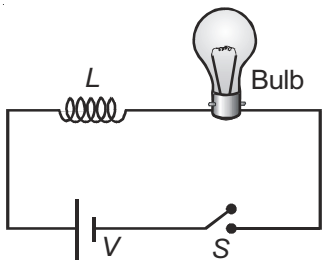
(1) 5 mH (2) 10 mH (3) 20 mH (4) 40 mH

25. A conducting rod AB of length l is projected on a frictionless frame $PSRQ$ with velocity v_0 at any instant. The velocity of the rod after time t is



(1) $v = v_0$ (2) $v > v_0$ (3) $v < v_0$ (4) None of these

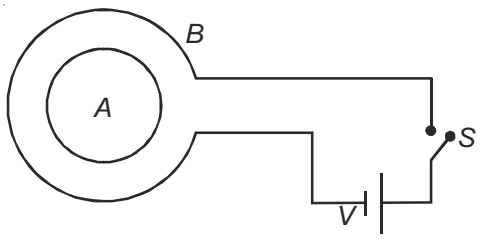
26. In the given circuit, bulb will become suddenly bright, if



(1) Switch is closed or opened (2) Switch is closed

(3) Switch is opened (4) None of these

27. What will be the direction of current in the coil *A* as the switch *S* is closed?



(1) Clockwise
(2) Anticlockwise
(3) Anticlockwise and then clockwise
(4) Clockwise and then anticlockwise

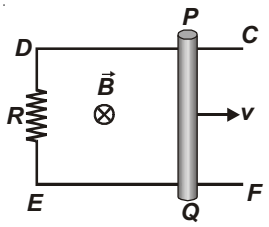
28. The armature of a generator of resistance 1 Ω is rotated at its rated speed and produces 125 V without load and 115 V with full load. The current in the armature coil is

(1) 240 A (2) 10 A (3) 1 A (4) 2 A

29. A copper disc of radius 0.1 m is rotated about its centre with 10 rev/s in a uniform magnetic field of 0.1T with its plane perpendicular to field. The emf induced across the radius of disc is

(1) $\frac{\pi}{10}$ volt (2) $\frac{\pi}{100}$ volt (3) $\frac{\pi}{1000}$ volt (4) Zero

30. A frame *CDEF* is placed in a region where a magnetic field $\vec{B}$ is present. A rod of length one metre moves with constant velocity 20 m/s and strength of magnetic field is one tesla. The power spent in the process is (take R = 0.2 Ω and all other wires and rod have zero resistance)

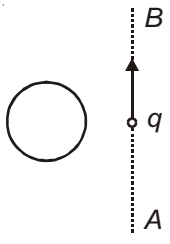


(1) 1 kW (2) 2 kW (3) 3 kW (4) 4 kW

31. An ideal solenoid of cross-sectional area 10^{-4} m^2 has 500 turns per metre. At the centre of this solenoid, another coil of 100 turns is wrapped closely around it. If the current in the coil changes from 0 to 2 A in 3.14 ms, the emf developed in the second coil is

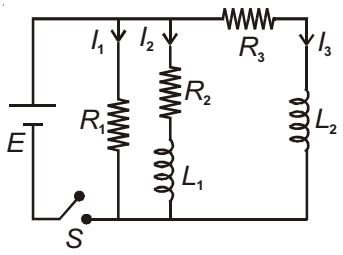
(1) 1 mV (2) 2 mV (3) 3 mV (4) 4 mV

32. A positive charge *q* moves along the line *AB*, which lies in the same plane as a circular loop of conducting wire as shown in the figure. The direction of current induced in the loop is



(1) Clockwise
(2) First anticlockwise then clockwise
(3) First clockwise then anticlockwise
(4) No current is induced

33. Figure shows an L-R circuit. When the switch S is closed, the current through resistor R_1, R_2 and R_3 are I_1, I_2 and I_3 respectively. The value of I_1, I_2 and I_3 at $t = 0$ s is



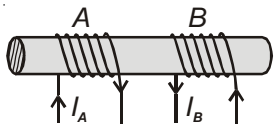
(1) $I_1 = I_2 = I_3 = 0$

(2) $I_1 = \frac{E}{R_1}, I_2 = I_3 = 0$

(3) $I_1 = 0, I_2 = \frac{E}{R_2}, I_3 = \frac{E}{R_3}$

(4) $I_1 = \frac{E}{R_1}, I_2 = \frac{E}{R_2 + L_1}, I_3 = \frac{E}{R_3 + L_3}$

34. Two coils A and B are wound on the same iron core as shown in figure. The number of turns in the coil A and B are N_A and N_B respectively. Identify the correct statement



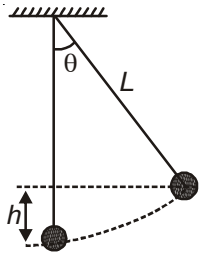
(1) Both the coils have same magnitude of magnetic flux

(2) The magnetic flux linked are in the ratio $\frac{\phi_A}{\phi_B} = \frac{N_A}{N_B}$

(3) The induced emf across each coil are in the ratio $\frac{E_A}{E_B} = \left(\frac{N_A}{N_B}\right)^2$

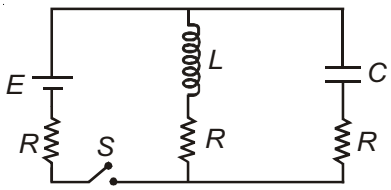
(4) Both the coils have same magnitude of induced emf

35. A simple pendulum with bob of mass m and conducting wire of length L swings under gravity through an angle 2θ. The earth's magnetic field component in the direction perpendicular to swing is B. The maximum potential difference induced across the pendulum is



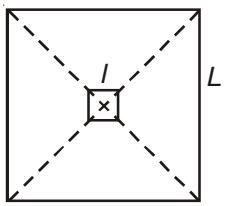
(1) $2BL\sin\left(\frac{\theta}{2}\right).\sqrt{gL}$ (2) $BL\sin\left(\frac{\theta}{2}\right)\sqrt{(gl)}$ (3) $BL\sin\left(\frac{\theta}{2}\right).(gL)^{3/2}$ (4) $BL\sin\left(\frac{\theta}{2}\right).(gL)^2$

36. The switch shown in the circuit is closed at $t = 0$. The current drawn from the battery by the circuit at $t = 0$ and $t = \infty$ are in the ratio



(1) 2 : 1 (2) 1 : 2 (3) 1 : 1 (4) 1 : 4

37. A small square loop of wire of side l is placed inside a large square loop of wire of side L (>>l). The loops are coplanar and their centres coincide. The mutual inductance of the system is

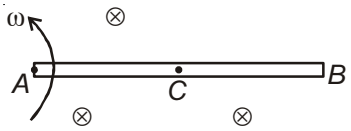


(1) $\frac{2\sqrt{2}\mu_0 L}{\pi l}$ (2) $\frac{2\sqrt{2}\mu_0 L^2}{\pi l}$ (3) $\frac{2\sqrt{2}\mu_0 l}{\pi L}$ (4) $\frac{2\sqrt{2}\mu_0 l^2}{\pi L}$

38. A uniform magnetic field exists in the region given by $\vec{B} = 3\hat{i} + 4\hat{j} + 5\hat{k}$. A rod of length 5 m placed along y-axis is moved along x-axis with constant speed 1 ms^{-1}. Then induced e.m.f. in the rod is

(1) Zero (2) 25 V (3) 5 V (4) 10 V

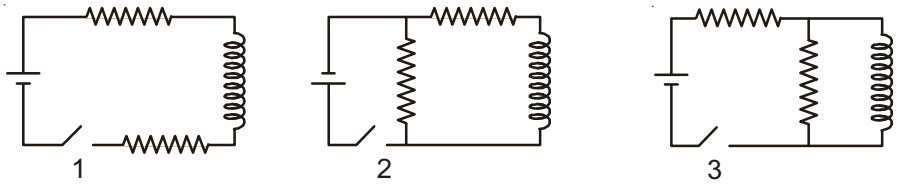
39. A copper rod AB of length l, pivoted at one end A, rotates at constant angular velocity ω, at right angles to a uniform magnetic field of induction B. The emf, developed between the mid point C of the rod and end B is



(1) $\frac{B\omega l^2}{8}$ (2) $\frac{3}{4}B\omega l^2$ (3) $\frac{B\omega l^2}{4}$ (4) $\frac{3}{8}B\omega l^2$

40. Radius of a circular loop placed in a perpendicular uniform magnetic field is increasing at a constant rate of r_0 ms^{-1}. If at any instant radius of the loop is r, then emf induced in the loop at that instant will be

(1) $-2Brr_0$ (2) $-2B\pi r$ (3) $-B\pi r_0 r$ (4) $-2B\pi r_0 r$

41. 

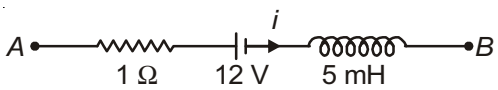
The figure shows three circuits with identical batteries, inductors and resistances. Rank the circuits according to the currents through the battery just after the switch is closed, greatest first

(1) $I_2 > I_3 > I_1$ (2) $I_2 > I_1 > I_3$ (3) $I_1 > I_2 > I_3$ (4) $I_1 > I_3 > I_2$

42. In an inductor, the current I varies with time t as $I = 5A + 16$ (A/s) t. If induced emf in the inductor is 5 mV, the self inductance of the inductor is

(1) 3.75×10^{-3} H (2) 3.75×10^{-4} H (3) 3.125×10^{-3} H (4) 3.125×10^{-4} H

43. The network shown in figure is a part of a complete circuit. If at a certain instant, the current i is 4 A and is increasing at a rate of 10^3 A/s. Then $V_B - V_A$ will be



(1) –11 V (2) 11 V (3) –21 V (4) 21 V

44. The magnetic flux through a stationary loop with resistance R varies during interval of time T as $\phi = at\,(T - t)$. The heat generated during this time neglecting the inductance of loop will be

(1) $\frac{a^2T^3}{3R}$ (2) $\frac{a^2T^2}{3R}$ (3) $\frac{a^2T}{3R}$ (4) $\frac{a^3T^2}{3R}$

45. A short-circuited coil is placed in a time-varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the number of turns were to be quadrupled and the wire radius halved, the electric power dissipated would be

(1) Halved (2) The same (3) Doubled (4) Quadrupled

46. A small square loop of wire of side l is placed inside a large circular loops of radius r. The loop are coplanar and their centre coincide. The mutual inductance of the system is proportional to

(1) $\frac{l^2}{r}$ (2) $\frac{l^2}{r^2}$ (3) $\frac{r}{l^2}$ (4) $\frac{r^2}{l}$

47. In which of the following situations, the magnetic field can accelerate a charge particle at rest?

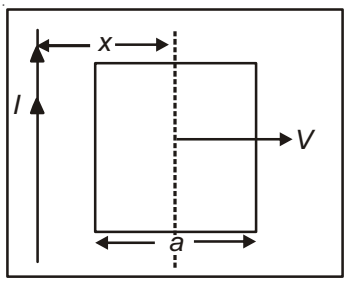
I. When the magnetic field is uniform with respect to time as well as position

II. When the magnetic field is time varying but uniform w.r.t. position

III. When the magnetic field is time independent but position dependent

(1) I, II & III (2) III only (3) II only (4) None of these

48. A conducting square frame of side a and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity V. The emf induced in the frame will be proportional to

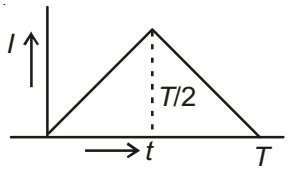


(1) $\frac{1}{(2x-a)\,(2x+a)}$ (2) $\frac{1}{x^2}$ (3) $\frac{1}{(2x-a)^2}$ (4) $\frac{1}{(2x+a)^2}$

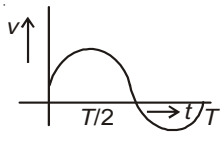
49. A coil of resistance 400 Ω is placed in a magnetic field. if the magnetic flux ϕ (Wb) linked with the coil varies with times t (s) as $\phi = 50t^2 + 4$. The current in the coil at $t = 2$ s is

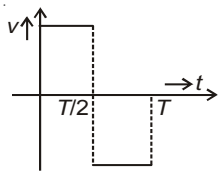
(1) 2 A (2) 1 A (3) 0.5 A (4) 0.1 A

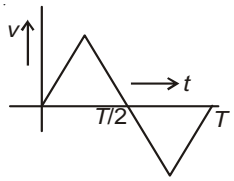
50. The current (I) in the inductance is varying with time according to the plot shown in figure.

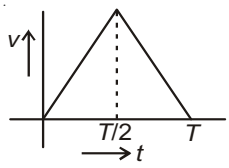


Which one of the following is the correct variation of voltage with time in the coil?

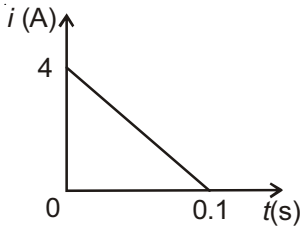
(1) 

(2) 

(3) 

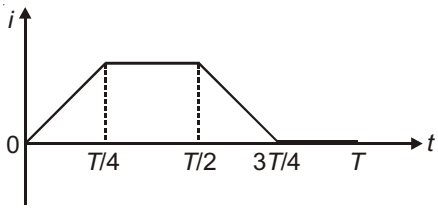
(4) 

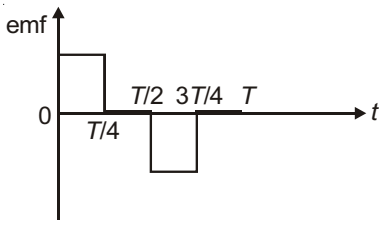
51. In a coil of resistance of 10 Ω, the induced current developed by changing magnetic flux through it,is shown in figure as a function of time. The magnitude of change in flux through the coil in Weber is

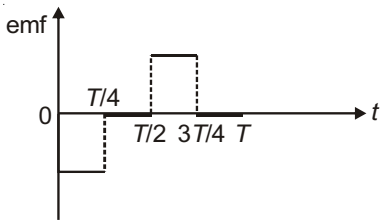


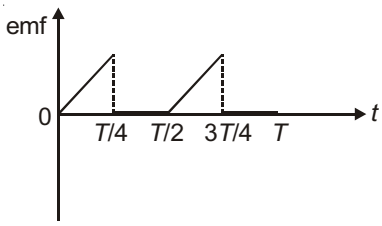
(1) 8) (2) 2 (3) 6 (4) 4

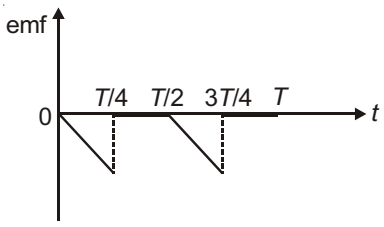
52. The current i in a coil varies with time as shown in the figure. The variation of induced emf with time would be



(1) 

(2) 

(3) 

(4) 

53. A long solenoid has 500 turns. When a current of 2 A is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self-inductance of the solenoid is

(1) 4.0 H (2) 2.5 H (3) 2.0 H (4) 1.0 H

54. Two coils of self-inductances 2 mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is

(1) 10 mH (2) 6 mH (3) 4 mH (4) 16 mH

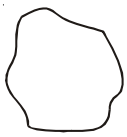
55. A metal ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is

(1) More than g (2) Equal to g (3) Less than g (4) Either (1) or (3)

56. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by

(1) $Q = \frac{1}{R}.\frac{\Delta\phi}{\Delta t}$ (2) $Q = \frac{\Delta\phi}{R}$ (3) $Q = \frac{\Delta\phi}{\Delta t}$ (4) $Q = R.\frac{\Delta\phi}{\Delta t}$

57. As a result of change in the magnetic flux linked to the closed loop as shown in the figure, an e.m.f V volt is induced in the loop. The work done (in joule) in taking a charge Q coulomb once along the loop is



(1) QV (2) $2QV$ (3) $\frac{QV}{2}$ (4) Zero

58. A rectangular, a square, a circular and an elliptical loop, all in the (x-y) plane, are moving out of a uniform magnetic field with a constant velocity $\vec{V} = v\hat{i}$. The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for

(1) Any of the four loops (2) The rectangular, circular and elliptical loops
(3) The circular and the elliptical loops (4) Only the elliptical loop

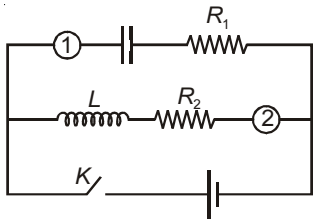
59. A conductor of 3 m length is moving perpendicular to its length as well as a magnetic field of 10^{-3} T with a speed of 10^2 m/s, then the force required to move it with this constant speed is

(1) 0. 3 N (2) 0.9 N (3) 0 (4) 3×10^{-3} N

60. In a circular conducting coil, when current increases from 2 A to 18 A in 0.05 s, the induced emf is 20 V. The self inductance of the coil is

(1) 62.5 mH (2) 6.25 mH (3) 50 mH (4) 0

61. In the circuit given in figure, 1 and 2 are ammeters. Just after key K is pressed to complete the circuit, the reading will be



(1) Zero in 1, maximum in 2 (2) Maximum in both 1 and 2
(3) Zero in both 1 and 2 (4) Maximum in 1, zero in 2

62. For a coil having L = 2 mH, current flowing through it is $I = t^2 e^{-t}$ then the time at which emf become zero

(1) 2 s (2) 1 s (3) 4 s (4) 3 s

63. When the number of turns and the length of a solenoid both are doubled, its self inductance becomes

(1) Four times (2) Doubled (3) Halved (4) Unchanged

64. The time constant of L-R circuit is doubled if

(1) Both L and R become two times

(2) L becomes four times and R becomes two times

(3) L becomes two times and R becomes four times

(4) L becomes two times and R becomes eight times

65. Two neighbouring coils *A* and *B* have a mutual inductance of 20 mH. The current flowing through *A* is given by, $i = 3t^2 - 4t + 6$. The induced emf at $t = 2$ s is

(1) 160 mV (2) 200 mV (3) 260 mV (4) 300 mV

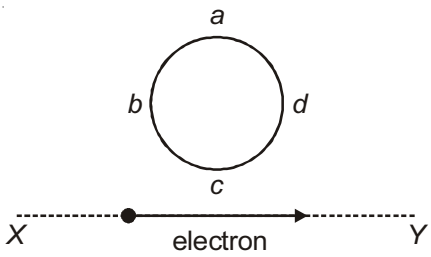
66. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 10$ A and $\omega = 100\ \pi$ radian per second. The maximum value of e.m.f. (in volt) in the second coil is

(1) π (2) 5π (3) 2π (4) 4π

67. Two coils have self inductance $L_1 = 4$ mH and $L_2 = 1$ mH respectively. The currents in the two coils are increased at the same rate. At a certain instant of time both coils are given the same power. If I_1 and I_2 are the currents in the two coils, at that instant of time respectively, then the value of $\frac{I_1}{I_2}$ is

(1) $\frac{1}{8}$ (2) $\frac{1}{4}$ (3) $\frac{1}{2}$ (4) 1

68. An electron moves on a straight line path *XY* as shown. The abcd is a coil adjacent to the path of electron. What will be the direction of current, if any, induced in the coil?



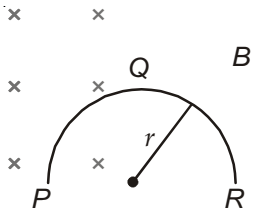
(1) No current induced

(2) *abcd*

(3) *adcb*

(4) The current will reverse its direction as the electron goes past the coil

69. A thin semicircular conducting ring (*PQR*) of radius *r* is falling with its plane vertical in a horizontal magnetic field *B*, as shown in figure. The potential difference developed across the ring when its speed is *v* is



(1) Zero (2) $Bv\pi r^2/2$ and *P* is at higher potential

(3) πrBv and *R* is at higher potential (4) $2rBv$ and *R* is at higher potential

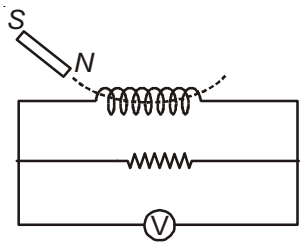
70. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced e.m.f. is

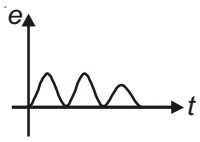
(1) Twice per revolution
(2) Four times per revolution
(3) Six times per revolution
(4) Once per revolution

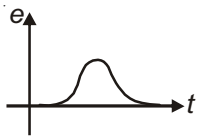
71. A transformer has 500 primary turns and 10 secondary turns. If the secondary has resistive load of 15 Ω, the currents in the primary and secondary respectively, are

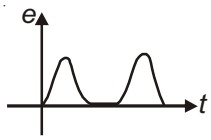
(1) 0.16 A, 3.2×10^{-3} A
(2) 3.2×10^{-3} A, 0.16 A
(3) 0.16 A, 0.16 A
(4) 3.2×10^{-3} A, 3.2×10^{-3} A

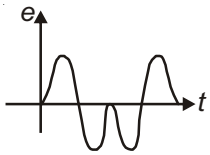
72. A magnet is made to oscillate with a particular frequency through a coil as shown in figure. The time variation of magnitude of emf generated across the coil during one cycle is



(1) 

(2) 

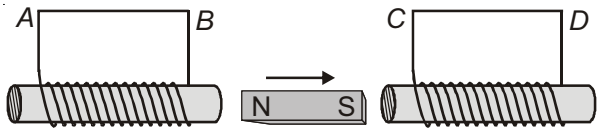
(3) 

(4) 

73. Two coils of self inductance L_1 and L_2 are placed near each other so that the total flux in one coil is completely linked with the other. Their mutual inductance (M) will be given by

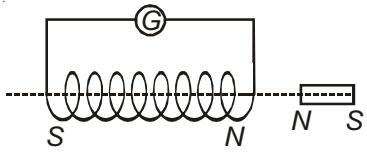
(1) $M = L_1 L_2$
(2) $M = \sqrt{L_1 L_2}$
(3) $M < \sqrt{L_1 L_2}$
(4) $M > L_1 L_2$

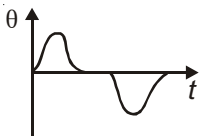
74. A magnet is moved in the direction indicated by an arrow between two coils AB and CD as shown in figure. The direction of induced current in the straight wire is

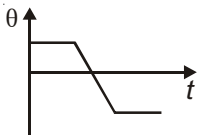


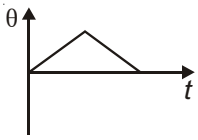
(1) A to B and C to D
(2) B to A and C to D
(3) A to B and D to C
(4) B to A and D to C

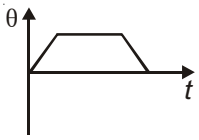
75. A short bar magnet passes at a steady speed right through a long solenoid. A galvanometer is connected across the solenoid. Which graph best represents the variation of the galvanometer deflection θ with time t?



(1) 

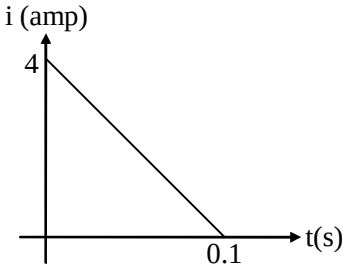
(2) 

(3) 

(4) 

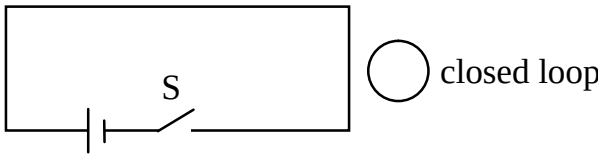
EXERCISE-2

Q.1 Some magnetic flux is changed from a coil of resistance 10 ohm. As a result an induced current is developed in it, which varies with time as shown in figure. The magnitude of change in flux through the coil in Webers is-



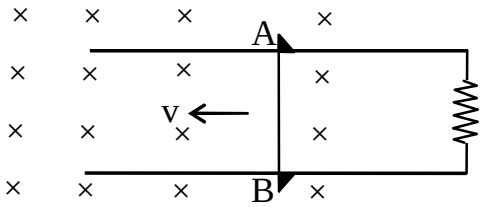
(A) 2 (B) 4 (C) 6 (D) 8

Q.2 Consider the situation shown in figure. If the switch is closed and after some time it is opened again, the closed loop will show-



(A) an anticlockwise current-pulse
(B) a clockwise current-pulse
(C) an anticlockwise current-pulse and then a clockwise current-pulse
(D) a clockwise current-pulse and then an anticlockwise current-pulse

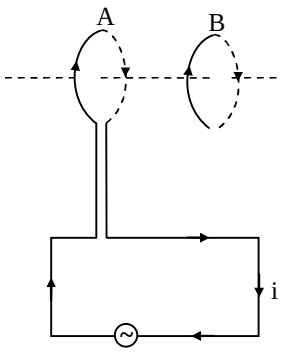
Q.3 Consider the situation shown in figure. The wire AB is slid on the fixed rails with constant velocity v. If the wire AB is replaced by a semi-circular wire, the magnitude of the induced current will-



(A) increase
(B) remain the same
(C) decrease
(D) increase or decrease depending on whether the semicircle bulges towards the resistance or away from it.

Q.4 A metallic ring is held horizontal and a magnet is allowed to fall vertically through it withN-pole pointing upwards. The acceleration of magnet near the ring is **a**. Then-
(A) a = g
(B) a < g while approaching but a > g while receding
(C) a < g while approaching as well as receding
(D) a > g while approaching but a < g while receding

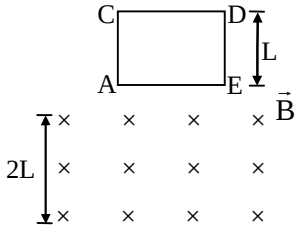
Q.5 Two circular coils A and B are facing each other as shown in figure. The current 'i' through A can be altered-



(A) there will be repulsion between A and B if i is increased
(B) there will be attraction between A and B if i is increased
(C) there will be neither attraction nor repulsion when i is changed
(D) attraction or repulsion between A and B depends on the direction of current, it does not depend whether the current is increased or decreased

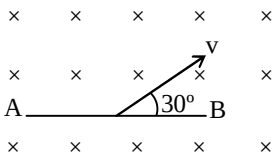
Q.6 Two identical coaxial circular loops carry a current i each circulating in the same direction. If the loops approach each other-
(A) the current in each loop will decrease
(B) the current in each loop will increase
(C) the current in each loop will remain the same
(D) the current in one loop will increase and in the other loop will decrease

Q.7 A square coil ACDE with its plane vertical is released from rest in a horizontal uniform magnetic field $\vec{B}$ of length 2L. The acceleration of the coil is-



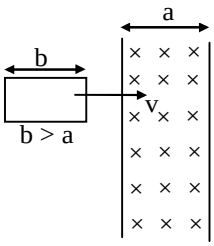
(A) less than g for all the time till the loop crosses the magnetic field completely
(B) less than g when it enters the field and greater than g when it comes out of the field
(C) g all the time
(D) less than g when it enters and comes out of the field but equal to g when it is within the field

Q.8 A conducting rod AB of length ℓ = 1 m is moving at a velocity v = 4 m/s making an angle 30º with its length. A uniform magneticfield B = 2T exists in a direction perpendicular to the plane of motion. Then-



(A) $V_A - V_B = 8V$ (B) $V_A - V_B = 4V$ (C) $V_B - V_A = 8V$ (D) $V_B - V_A = 4V$

Q.9 In the given arrangement, the loop is moved with constant velocity v in a uniform magnetic field B in a restricted region of width 'a'.The time for which the emf is induced in the circuit is -



(A) $\frac{2b}{v}$ (B) $\frac{2a}{v}$ (C) $\frac{(a+b)}{v}$ (D) $\frac{2(a-b)}{v}$

Q.10 A uniform magnetic field exists in region given by $\vec{B} = 3\hat{i} + 4\hat{j} + 5\hat{k}$. A rod of length 5 m is placed along y-axis is moved along x-axis with constant speed 1 m/sec. Then induced e.m.f. in the rod will be-

(A) zero (B) 25 volt (C) 20 volt (D) 15 volt

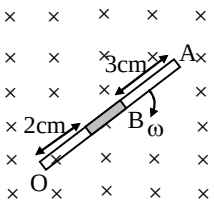
Q.11 A solid conducting sphere of radius R is moved with a velocity V in a uniform magnetic field of strength B such that $\vec{B}$ is perpendicular to $\vec{V}$. The maximum e.m.f. induced between two points of the sphere is-

(A) 2 RBV (B) RBV (C) $\sqrt{2}$ RBV (D) $\frac{RBV}{2}$

Q.12 A vertical rod of length ℓ is moved with constant velocity v towards East. The vertical component of the earth's magnetic field is B and the angle of dip is θ. The induced e.m.f. in the rod is-

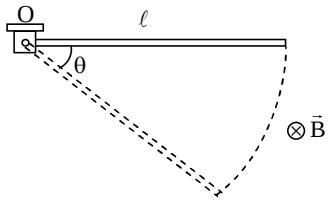
(A) Bℓv cot θ (B) Bℓv sin θ (C) Bℓv tan θ (D) Bℓv cos θ

Q.13 A rod of length 10 cm made up of conducting and non-conducting material (shaded part is non-conducting). The rod is rotated with constant angular velocity 10 rad/sec about point O, in constant magnetic field of 2 tesla as shown in the figure. The induced emf between the point A and B of rod will be-



(A) 0.029 volt (B) 0.1 volt (C) 0.051 volt (D) 0.064 volt

Q.14 A conducting rod of length ℓ is hinged at point O.It is free to rotate in a vertical plane. The rod is released from the position shown. The potential difference between the two ends of the rod is proportional to-



(A)ℓ^2 (B) ℓ (C) sin θ (D) (sin θ)$^{1/2}$

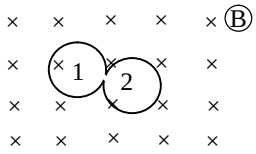
Q.15 A closed coil consists of 500 turns on a rectangular frame of area 4.0 cm^2 and has a resistance of 50 ohm. The coil is kept with its plane perpendicular to a uniform magnetic field of 0.2 weber/$meter^2$. The amount of charge flowing through the coil if it is turned over (rotated through 180°) will be-

(A) 1.6×10^{-19} C (B) 1.6×10^{-9} C (C) 1.6×10^{-3} C (D) 1.6×10^{-2} C

Q.16 A rod of length ℓ rotates with a small but uniform angular velocity ω about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the two ends of the rod is-

(A) zero (B) $\frac{1}{2}\omega B\ell^2$ (C) $\omega B\ell^2$ (D) $2\,\omega B\ell^2$

Q.17 The induced emf in a circular conducting loop is E, when placed in a magnetic field decreasing at a steady rate of x tesla/sec. If two such loops identical in all respect are cut and connect as shown in figure then the induced emf in the combined circuit will be-

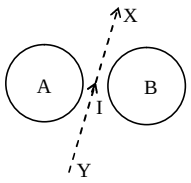


(A) E (B) 2E (C) E/2 (D) 0

Q.18 5.5×10^{-4} magnetic flux lines are passing through a coil of resistance 10 ohm and number of turns 1000. If the number of flux lines reduces to 5×10^{-5} in 0.1 sec. The electromotive force and the current induced in the coil will be respectively-

(A) 5 V, 0.5 A (B) 5×10^{-4} V, 5×10^{-4}A
(C) 50 V, 5 A (D) none of the above

Q.19 Consider the situation shown in figure. If the current I in the long straight wire XY is increased at a steady rate then the induced emf's in loops A and B will be-



(A) clockwise in A, anticlockwise in B (B) anticlockwise in A, clockwise in B
(C) clockwise in both A and B (D) anticlockwise in both A and B

Q.20 A thin copper wire of length 100 metres is wound as a solenoid of length ℓ and radius r. Its self-inductance is found to be L. Now if the same length of wire is wound as a solenoid of length ℓ but of radius r/2, then its self-inductance will be-

(A)4 L (B) 2 L (C) L (D) L/2

Q.21 Two coils are at fixed locations. When coil 1 has no current and the current in coil 2 increases at the rate 15.0 A/s the e.m.f. in coil 1 in 25.0 mV, when coil 2 has no current and coil 1 has a current of 3.6 A, flux linkage in coil 2 is-

(A) 16 mWb (B) 10 mWb (C) 4 mWb (D) 6 mWb

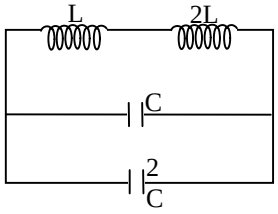
Q.22 Two coils A and B have coefficient of mutual inductance M = 2H. The magnetic flux passing through coil A change by 4 Weber in 10 seconds due to the change in current in B. Then-

(A) change in current in B in this time interval is 0.5 A
(B) the change in current in B in this time interval is 2A
(C) the change in current in B in this time interval is 8 A
(D) a change in current of 1 A in coil A will produce a change in flux passing through B by 4 Weber

Q.23 A long straight wire is placed along the axis of a circular ring of radius R. The mutual inductance of this system is-

(A) $\frac{\mu_0 R}{2}$ (B) $\frac{\mu_0 \pi R}{2}$ (C) $\frac{\mu_0}{2}$ (D) 0

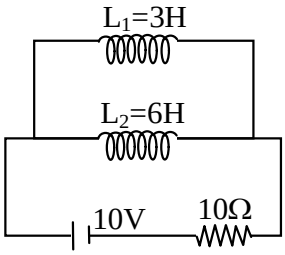
Q.24 The frequency of oscillation of current in the inductor is-



(A) $\frac{1}{3\sqrt{LC}}$ (B) $\frac{1}{6\pi\sqrt{LC}}$

(C) $\frac{1}{\sqrt{LC}}$ (D) $\frac{1}{2\pi\sqrt{LC}}$

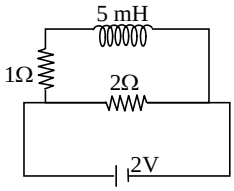
Q.25 Two inductor coils of self-inductance 3H and 6H respectively are connected with a resistance 10 Ω and a battery 10 V as shown in figure. The ratio of total energy stored in the inductors to that of heat developed in resistancein 10 seconds at the steady state is-



(A) $\frac{1}{10}$ (B) $\frac{1}{100}$

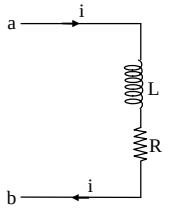
(C) $\frac{1}{1000}$ (D) 1

Q.26 When induced emf in inductor coil is 50% of its maximum value then stored energy in inductor coil in the given circuit will be-



(A) 2.5 mJ (B) 5 mJ (C) 15 mJ (D) 20 mJ

Q.27 When the current in the portion of the circuit shown in the figure is 2A and increasing at the rate of 1 A/s, the measured potential difference V_{ab} = 8V. However, when the current is 2A and decreasing at the rate of 1 A/s, the measured potential difference V_{ab} = 4V. The values of R and L are-



(A) 3 ohm and 2 henry respectively (B)2 ohm and 3 henry respectively
(C) 10 ohm and 6 henry respectively (D)6 ohm and 1 henry respectively

Q.28 An inductor L and a resistor R are connected in series with a direct current source of emf ε. The maximum rate at which energy is stored in the magnetic field is-

(A) $\frac{\varepsilon^2}{4R}$ (B) $\frac{\varepsilon^2}{R}$ (C) $\frac{4\varepsilon^2}{R}$ (D) $\frac{2\varepsilon^2}{R}$

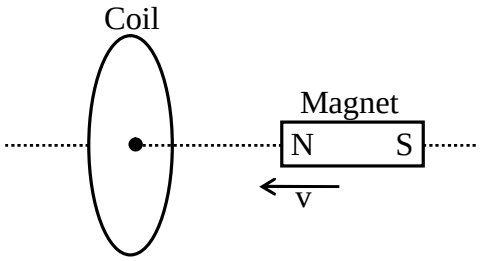
Q.29 When a solenoid of self-inductance 1.8×10^{-4} Henry and resistance 6Ω is broken in two equal parts. If these two solenoids are connected in parallel with a 12-volt battery and negligible internal resistance. Then the time constant for the circuit is ..... sec, and the constant current through the battery is ..... ampere.

(A) 6×10^{-5},4 (B) 6×10^{-5}, 8 (C) 3×10^{-5},4 (D) 3×10^{-5}, 8

Q.30 An infinitesimally small bar magnet of dipole moment is pointing and moving with the speed v in the - direction. A small closed circular conducting loop of radius a and negligible self-inductance lies in the y-z plane with its centre at x = 0, and its axis coinciding with the x-axis. Find the force opposing the motion of the magnet, if the resistance of the loop is R. Assume that the distance x of the magnet from the centre of the loop is much greater than a.

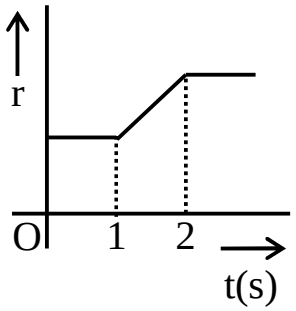
(A) $\frac{17}{4}\frac{\mu_0^2 M^2 a^4 v}{R\ x^8}$ (B) $\frac{17}{4}\frac{\mu_0^2 M^2 a^4 v}{R\ x^6}$ (C) $\frac{21}{4}\frac{\mu_0^2 M^2 a^4 v}{R\ x^8}$ (D) $\frac{21}{4}\frac{\mu_0^2 M^2 a^4 v}{R\ x^6}$

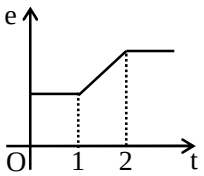
Q.31 In the figure the magnet is moved along the axis of coil from one position to another position in 10^{-3} sec. Now magnet is at rest for 2 sec. in its new position. The duration of induced emf in the coil is –

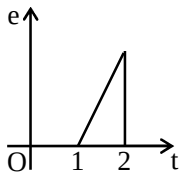


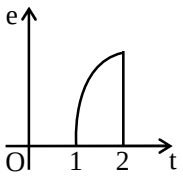
(A) 10^{-3} sec (B) 2 sec (C) 2×10^{-3} sec (D) 0.5×10^{-3} sec

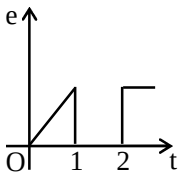
Q.32 A circular coil is placed in uniform magnetic field such that its plane is perpendicular to field. The radius of coil changes with time as shown in the figure. Then which of the following graph represent the induced emf in the coil with time –



(A) 

(B) 

(C) 

(D) 

Q.33 The magnetic field in a region is given by $\vec{B} = B_0\left(1+\frac{x}{a}\right)\hat{k}$. A square loop of edge-length d is placed with its edge along x & y axis. The loop is moved with constant velocity $\vec{v} = v_0\hat{i}$. The emf induced in the loop is –

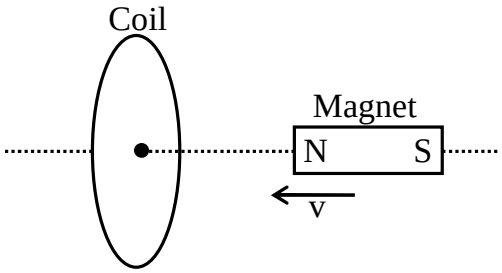
(A) $\frac{v_0B_0d^2}{a}$ (B) $\frac{v_0B_0d^2}{2a}$

(C) $\frac{v_0B_0a^2}{d}$ (D) none of these

Q.34 A circular coil of n turns and radius r is placed in a uniform magnetic field B. Initially the plane of the coil is perpendicular to the field. Now the coil is rotated by 90°. If its resistance is R then quantity of charge passing through the coil is –
(Neglect the inductance of coil)

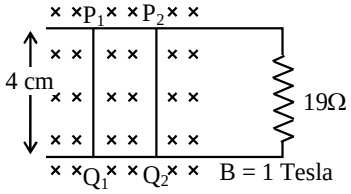
(A) zero (B) $\frac{\pi n^2 rB}{R}$ (C) $\frac{\pi nr^2B}{R}$ (D) $\frac{2\pi nr^2B}{R}$

Q.35 In the figure, the magnet is moved towards the coil with a speed **v** and induced emf is **e**. If magnet and coil recede away from one another each moving with speed v the induced emf of the coil will be-



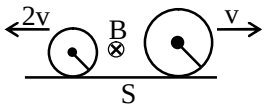
(A) e. (B) 2e (C) e/2 (D) 4e

Q.36 In figure, wires P_1Q_1 and P_2Q_2, both are moving towards right with speed 5 cm/sec. Resistance of each wire is 2Ω. Then current through 19Ω resistor is –



(A) 0 (B) 0.1 mA (C) 0.2 mA (D) 0.3 mA

Q.37 Two conducting rings of radii r and 2r move in opposite directions with velocities 2v and v respectively on a conducting surface S. There is a uniform magnetic field of magnitude B perpendicular to the plane of the rings. The potential difference between the highest points of the two rings is

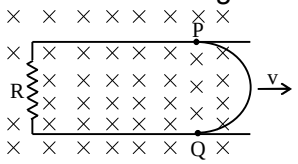


(A) zero (B) 2rv B (C) 4rv B (D) 8rv B

Q.38 A closed circuit consists of a source of emf E and an inductor coil of inductance L connected in series. The active resistance of whole circuit is R. At the moment t = 0 the inductance of coil abruptly decreased to $\frac{L}{n}$. Then current in the circuit immediately after is -

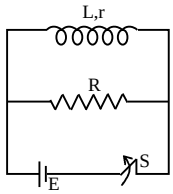
(A) 0 (B) $\frac{E}{R}$ (C) $\frac{nE}{R}$ (D) $\frac{E}{nR}$

Q.39 A metallic wire PQR in the shape of a semicircle of radius a slides with constant velocity **v** in a uniform magnetic field of induction B as shown in figure. Induced current in resistance R is –



(A) $\frac{Bva}{R}$ (B) $\frac{2Bva}{R}$ (C) $\frac{\pi Bva}{R}$ (D) zero

Q.40 A solenoid of inductance L and resistance r is connected in parallel to a resistance R and a battery of emf E. Initially the switch is closed for long time and at t = 0 , switch S is opened. Then which of the following is wrong-



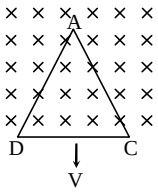
(A) Current through solenoid at any time t, after opening the switch is $\frac{E}{r}\, e^{-\frac{(R+r)}{L}t}$

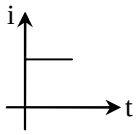
(B) Induced emf across solenoid at time t = 0^+ is $\frac{E(R+r)}{r}$

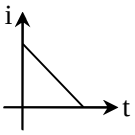
(C) Amount of heat generated in solenoid is $\frac{E^2L}{2r(r+R)}$

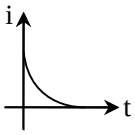
(D) Potential difference across solenoid at t = 0^+ is E

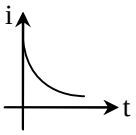
Q.42 An equilateral triangular loop ADC of some finite magnetic field $\vec{B}$ as shown in the figure. At time t = 0, side DC of loop is at edge of the magnetic field. Magnetic field is perpendicular to the paper inwards (or perpendicular to the plane of the coil). The induced current versus time graph will be as -



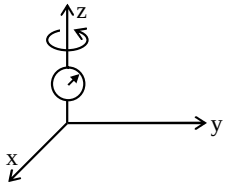
(A) 

(B) 

(C) 

(D) 

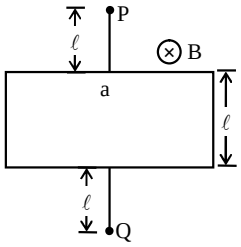
Q.43 A circular loop of wire of radius r rotates about z-axis with angular velocity ω. The normal to the loop is always perpendicular to z axis. Att =0 , normal parallel to y axis. An external magnetic field $\vec{B} = B_y\hat{j} + B_z\hat{k}$ is applied. The EMF induced in the loop at time 't' -



(A) $\pi r^2 \omega B_y \sin\omega t$ (B) $\pi r^2\omega B_z \cos\omega t$

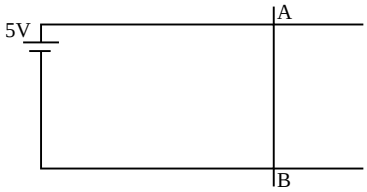
(C) $\pi r^2\omega B_z \sin\omega t$ (D) $\pi r^2\omega B_y \cos\omega t$

Q.44 A wire frame PQ, shaped in the form shown in fig. is placed in a magnetic field B (as shown). The wire frame is moving towards left with a uniform velocity v. Then the induced emf between the end P and Q is –



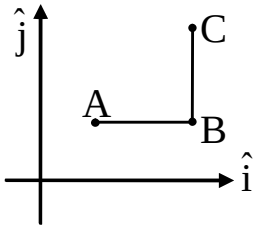
(A) $B\ell v$ (B) $2B\ell v$ (C) $3B\ell v$ (D) zero

Q.45 A conductor AB can slide freely on two long parallel horizontal smooth wires separated by 1 meter. The two wires are connected to the terminals of a 5voltbattery. There is a uniform magnetic field of induction 0.1 wb/m^2 acting vertically downward (into the paper normally). Find the terminal velocity of AB.



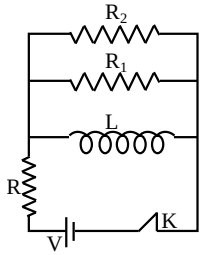
(A) 50 m/s (B) 55 m/s (C) 45 m/s (D) 0 m/s

Q.46 There is a uniform magnetic field B normal to the xy plane. A conductor ABC has length AB = ℓ_1, parallel to the x-axis, and length BC = ℓ_2,parallel to the y-axis. ABC moves in the xy plane with velocity $v_x\hat{i} + v_y\hat{j}$. The potential difference between A and C is proportional to –



(A) $v_x\ell_1 + v_y\ell_2$ (B) $v_x\ell_2 + v_y\ell_1$ (C) $v_x\ell_2 - v_y\ell_1$ (D) $v_x\ell_1 - v_y\ell_2$

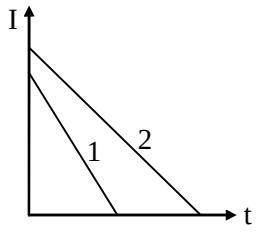
Q.47 In the circuit shown, initially switch K is closed for long time. At time t = 0, switch K is open. Then total heat produced in resistor R_1 after opening the switch K is –



(A) $\frac{1}{2}\frac{LV^2}{R^2}$ (B) $\frac{1}{2}\left(\frac{R_1}{R_1+R_2}\right)\frac{LV^2}{R^2}$

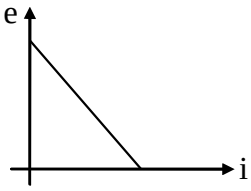
(C) $\frac{1}{2}\left(\frac{R_2}{R_1+R_2}\right)\frac{LV^2}{R^2}$ (D) 0

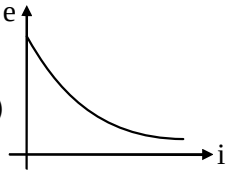
Q.48 Two identical inductance carry currents that vary with time according linear laws (as shown in figure). In which of two inductance is the self-induction emf greater ?

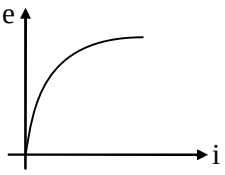


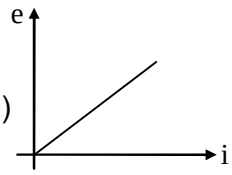
(A) 1 (B) 2
(C) same (D) data are insufficient to decide

Q.49 In an L-R circuit connected to a battery of constant e.m.f. E switch S is closed at time t = 0. If e denotes the magnitude of induced e.m.f. across inductor and i the current in the circuit at any time t. Then which of the following graphs shows the variation of e with i?

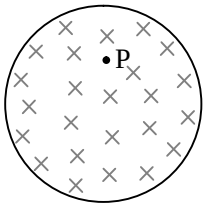
(A) 

(B) 

(C) 

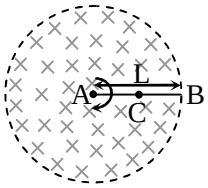
(D) 

Q.50 Figure shows a uniform magnetic field B confined to a cylindrical volume and is increasingat a constant rate. The instantaneous acceleration experienced by an electron placed at P is –



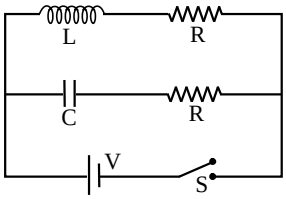
(A) zero (B) towards right (C) towards left (D) upwards

Q.51 A copper rod AB of length L, pivoted at one end A, rotates at constant angular velocity ω, at right angles to a uniform magnetic field of induction B. The e.m.f. developed between the midpoint C of the rod and end B is –



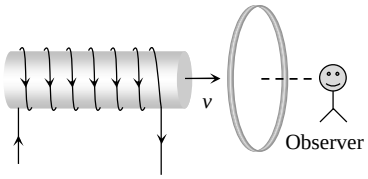
(A) $\frac{B\omega\ell^2}{4}$ (B) $\frac{B\omega\ell^2}{2}$ (C) $\frac{3B\omega\ell^2}{4}$ (D) $\frac{3B\omega\ell^2}{8}$

Q.52 In the circuit shown in the figure, $R = \sqrt{\frac{L}{C}}$. Switch S is closed at time t = 0. The current through C and L would be equal after a time t equal to –



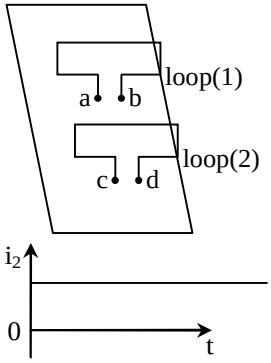
(A) CR (B) CR ln (2) (C) $\frac{L}{E\ln(2)}$ (D) LR

Q.53 A current carrying solenoid is approaching a conducting loop as shown in the figure. The direction of induced current as observed by an observer on the other side of the loop will be

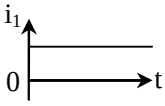


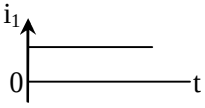
(A) Anticlockwise (B) Clockwise (C) East (D) West

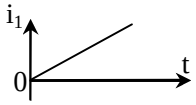
Q.54 An electric current i_1 can flow either direction through loop (1) and induced current i_2 in loop (2). Positive i_1 is when current is from 'a' to 'b' in loop (1) and positive i_2 is when the current is from 'c' to 'd' in loop (2). In an experiment, the graph of i_2 against time 't' is as shown below

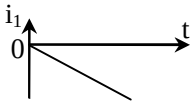


Which one(s) of the following graphs could have caused i_2 to behave as given above.

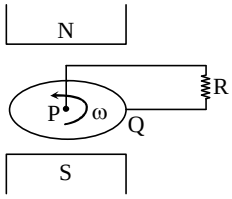
(A) 

(B) 

(C) 

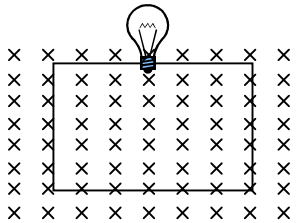
(D) 

Q.55 A metal disc rotates freely, between the poles of a magnet in the direction indicated. Brushes P and Q make contact with the edge of the disc and the metal axle. What current, if any, flows through R?



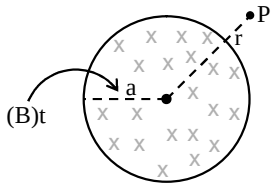
(A) a current from P to Q
(B) a current from Q to P
(C) no current, because the emf in the disc is opposed by the back emf
(D) no current, because no radial emf is induced in the disc

Q.56 A square wire loop of 10.0 cm side lies at right angles to a uniform magnetic field of 20T. A 10 V light bulb is in a series with the loop as shown in the figure. The magnetic field is decreasing steadily to zero over a time interval Δt. The bulb will shine with full brightness if Δt is equal to -



(A) 20 ms (B) 0.02 ms (C) 2 ms (D) 0.2 ms

Q.57 A uniform but time-varying magnetic field B(t) exists in a circular region of radius 'a' and is directed into the plane of the paper, as shown. The magnitude of the induced electric field at point P at a distance r from the centre of the circular region –



(A) Is zero (B) Decreases as 1/r

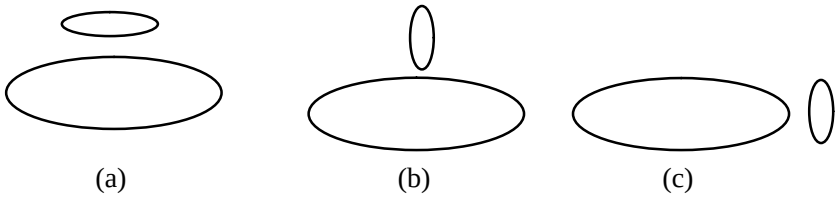
(C) Increases as r (D) Decreases as $1/r^2$

Q.58 A coil of wire having finite inductance and resistance has a conducting ring placed coaxially within it. The coil is connected to a battery at time t=0, so that a time dependent current I_1 (t) starts flowing through the coil. If I_2 (t) is the current induced in the ring, and B(t) is the magnetic field at the axis of the coil due to I_1 (t), then as a function of time (t>0), the product I_2 (t). B(t) –

(A) Increase with time (B) Decrease with time

(C) Does not vary with time (D) Passes through a maximum

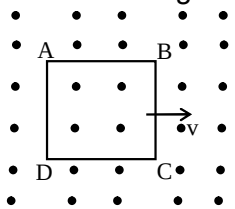
Q.59 Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be –



(A) Maximum in situation (a) (B) Maximum in situation (b)

(C) Maximum in situation (c) (D) the same in all situation

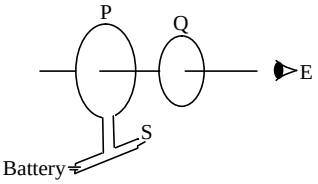
Q.60 A metallic square loop ABCD is moving in its own plane with velocity v in a uniform magnetic field perpendicular to its plane as shown in the figure. An electric field is induce



(A) in AD, but not in BC (B) in BC, but not in AD

(C) neither in AD nor in BC (D) in both AD and BC

Q.61 As shown in the figure, P and Q are two coaxial conducting loops separated by some distance. When the switch S is closed, a clockwise current I_P flows in P (as seen by E) and an induced current I_{Q1} flows in Q. The switch remains closed for a long time. When S is opened, a current I_{Q2} flows in Q. Then the directions of I_{Q1} and I_{Q2} (as seen by E) are –



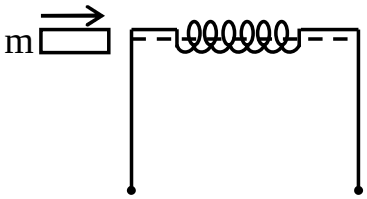
(A) Respectively clockwise and anti-clockwise (B) Both clockwise

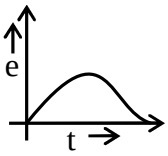
(C) Both anti-clockwise (D) Respectively anti-clockwise and clockwise

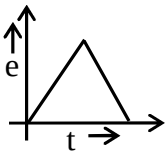
Q.62 A short-circuited coil is placed in a time varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the wire is stretch to increase its length such that number of turns become quadrupled and the wire radius halved, the electrical power dissipated would be –

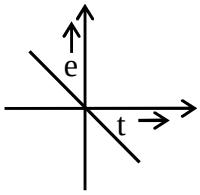
(A) Halved (B) The same (C) Doubled (D) Quadrupled

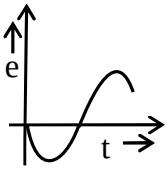
Q.63 A small magnet is moving with constant velocity along the axis of a coil as shown in the figure. Then correct graph between induced emf and time is



(A) 

(B) 

(C) 

(D) 

Q.64 A long hollow cylindrical wire placed parallel to the direction of uniform magnetic field which is directed along + Z axis. Then induced current on the surface of cylinder -

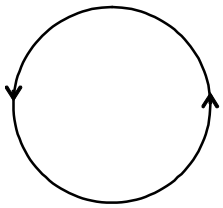
(A) in the direction of magnetic field

(B) 0

(C) clockwise as seen from + Z axis

(D) Anticlockwise as seen from + Z axis

Q.65 The given figure shows lines of force of a particular field. Out of the following option, the field line cannot represent.



(A) An electrostatic field (B) A magneto static field

(C) An induced electric field (D) None of these

Q.66 The magnetic flux through a coil varies with time as $\phi = 5t^2 + 6t + 9$. The ratio of emf at t = 3s to t = 0s will be –

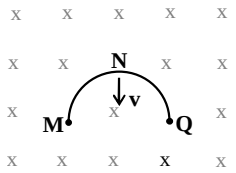
(A) 9:1 (B)1:6 (C) 6 : 1 (D) 1 : 9

Q.67 Two inductances L_1 and L_2 are placed far apart and in parallel. Their combined inductance is–

(A) $L_1 + L_2$ (B) $(L_1 + L_2)\frac{L_1}{L_2}$

(C) $(L_1 - L_2)\frac{L_2}{L_1}$ (D) $\frac{L_1 L_2}{L_1 + L_2}$

Q.68 A thin semi-circular conducting ring of radius R is falling with its plane vertical in a horizontal magnetic induction B (Figure). At the position MNQ the speed of the ring is V, and the potential difference developed across the ring is–



(A) Zero

(B) $Bv\pi R^2/2$ and M is at higher potential

(C) πRBv and Q is at higher potential

(D) 2RBv and Q is at higher potential

Q.69 A metal rod moves at a constant velocity in a direction perpendicular to its length. A constant, uniform magnetic field exists in space in a direction perpendicular to the rod as well as its velocity. Select the correct statement (s) from the following

(A) The entire rod is at the same electric potential

(B) There is an electric field in the rod.

(C) The electric potential is highest at the centre of the rod and decreases towards its ends.

(D) The electric potential is lowest at the centre of the rod, and increases towards its ends.

Q.70 A small square loop of side ℓ is placed inside a large square loop of side L (>>ℓ). The loops are coplanar and their centres coincide. The mutual inductance of the system is proportional to –

(A) (ℓ/L) (B) (ℓ^2/L) (C) (L/ℓ) (D) (L^2/ℓ)

Q.71 Two identical circular loops of metal wire are lying on a table without touching each other. Loop - A carries a current which increases with time. In response, the loop – B

(A) Remains stationary (B) Is attracted by the loop -A

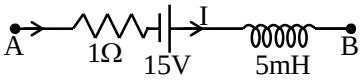
(C) Is repelled by the loop-A (D) Rotates about its CM, with CM fixed

Q.72 A coil of inductance 8.4 mH and resistance 6Ω is connected to a 12V battery. The current in the coil is 1.0 A at approximately the time–

(A) 500s (B) 20s (C) 35 ms (D) 1 ms

Q.73 The network shown in Fig. is part of a complete circuit. If at a certain instant the current (I) is 5 A, and is decreasing at a rate of 10^3 A/s, then $V_B - V_A$ is-

(A) 15 V (B) 20 V (C) 5 V (D) 10V



Q.74 A solenoid has an inductance of 10 henry and a resistance of 2 ohm. It is connected to a 10-volt battery. How long will it take for the magnetic energy to reach 1/4 of its maximum value?

(A) 3.20 sec (B) 2.87 sec (C) 3.47 sec (D) 2.38 sec

Q.75 The two rails of a railway track, insulated from each other and the ground, are connected to a millivoltmeter. What is the reading of the millivoltmeter when a train travels at a speed of 18 km/h along the track given that the vertical components of earth's magnetic field is 0.2×10^{-4} weber/m^2 and the rails are separated by 1 m? Track is south to north.

(A) 1.0 mv (B) 5.0 mv (C) 0.5 mv (D) 0.1 mv

ANSWER KEY

EXERCISE-1

1	A	**2**	C	**3**	D	**4**	B	**5**	A	**6**	C	**7**	C
8	A	**9**	C	**10**	D	**11**	B	**12**	C	**13**	A	**14**	C
15	A	**16**	C	**17**	B	**18**	D	**19**	A	**20**	B	**21**	B
22	C	**23**	D	**24**	B	**25**	C	**26**	C	**27**	A	**28**	B
29	B	**30**	B	**31**	D	**32**	C	**33**	B	**34**	B	**35**	B
36	C	**37**	D	**38**	B	**39**	D	**40**	D	**41**	A	**42**	D
43	C	**44**	A	**45**	B	**46**	A	**47**	C	**48**	A	**49**	C
50	B	**51**	B	**52**	B	**53**	D	**54**	C	**55**	C	**56**	B
57	A	**58**	C	**59**	C	**60**	A	**61**	D	**62**	A	**63**	B
64	B	**65**	A	**66**	B	**67**	B	**68**	D	**69**	D	**70**	A
71	B	**72**	C	**73**	B	**74**	C	**75**	A				

EXERCISE-2

1	A	**2**	D	**3**	B	**4**	C	**5**	A	**6**	A	**7**	D
8	B	**9**	B	**10**	B	**11**	A	**12**	A	**13**	C	**14**	D
15	C	**16**	A	**17**	B	**18**	B	**19**	A	**20**	C	**21**	D
22	B	**23**	D	**24**	B	**25**	B	**26**	A	**27**	D	**28**	A
29	D	**30**	C	**31**	A	**32**	B	**33**	A	**34**	C	**35**	B
36	B	**37**	D	**38**	C	**39**	B	**40**	D	**41**	C	**42**	B
43	A	**44**	C	**45**	A	**46**	C	**47**	C	**48**	A	**49**	A
50	B	**51**	D	**52**	B	**53**	B	**54**	D	**55**	A	**56**	A
57	B	**58**	D	**59**	A	**60**	D	**61**	D	**62**	B	**63**	D
64	B	**65**	A	**66**	C	**67**	D	**68**	D	**69**	B	**70**	B
71	C	**72**	D	**73**	A	**74**	C	**75**	D				

SOLUTIONS

EXERCISE-1

1. (1)

Sol. $\phi = BA$

and $F = ilB \Rightarrow B = \frac{F}{il}$

So dimensional formula will be $ML^2T^{-2}A^{-1}$

2. (3)

Sol. Time varying $\vec{B}$ will induce emf as

$$\varepsilon = -\frac{d\phi}{dt}$$

3. (4)

Sol. ε does not depend on resistance.

4. (2)

Sol. $\phi = 6t^2 - 5t + 1$

$$\varepsilon = -\frac{d\phi}{dt} = -12t + 5$$

$$I = \frac{\varepsilon}{R} = \frac{-12\left(\frac{1}{4}\right) + 5}{10} = 0.2 \text{ A}$$

5. (1)

Sol. No change in flux, so no current will be induced.

6. (3)

Sol. Induced charged is independent of speed of magnet.

7. (3)

Sol. Flux will increase by stretching outwards so by Lenz's law clockwise current will be induced to oppose the change.

8. (1)

Sol. $\varepsilon = Bvl$

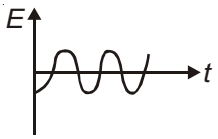
$$= 4 \times 10^{-4} \times 360 \times \frac{5}{18} \times 25$$

$= 1$ V

9. (3)

Sol. $\phi \quad A\sin\omega t$

$$\varepsilon = -\frac{d\phi}{dt} = -A\omega\cos\omega t$$



10. (4)

Sol. $$\varepsilon = NA\frac{dB}{dt}$$

$$= (500)(0.1)^2(1) = 5 \text{ V}$$

11. (2)

Sol . Using Lenz's law, inward flux is increasing. So to oppose this change current will be anticlockwise.

12. (3)

Sol . $$\varepsilon = \frac{1}{2}B\omega l^2$$

13. (1)

Sol . $$\phi = NBA\cos\theta = NBA\cos\omega t$$

$$\varepsilon = -\frac{d\phi}{dt}$$

$$\varepsilon = NBA\omega\sin\omega t$$

$$\varepsilon_{max} = NBA\omega$$

14. (3)

Sol . N = 500, A = 50 cm^2, B = 0.14 Wb/m^2

ω = 150 rad/s, R = 5 Ω

$$\varepsilon_{max} = NBA\omega$$

$$I_{max} = \frac{\varepsilon_{max}}{R} = 3.5 \text{ A}$$

15. (1)

Sol . L = 5 H, $\frac{di}{dt} = 2$ A/s

$$\varepsilon = \frac{Ldi}{dt} = 5(2) = 10 \text{ V}$$

16. (3)

Sol. $L \propto n^2$

So if $n' = 2n$

$L' = 4L$

17. (2)

Sol. $I = \frac{100}{20} = 5 \text{ A}$

$\varepsilon = \frac{1}{2}LI^2 = \frac{1}{2}5(5)^2 = 62.5 \text{ J}$

18. (4)

Sol. $\frac{\text{Energy}}{\text{Volume}} = \frac{B^2}{2\mu_0} \Rightarrow \text{Energy} = \frac{B^2(AL)}{2\mu_0}$

19. (1)

Sol. $L = \mu_0 n^2 Al$

$L = \mu_0 \left(\frac{N}{l}\right)^2 Al$

$L = \frac{\mu_0 N^2}{l} A \Rightarrow L \propto \frac{1}{l}$

$\Rightarrow L' = \frac{L}{2}$

20. (2)

Sol. $\tau = \frac{L}{R}$ represents time constant hence will have dimension of time.

21. (2)

Sol. $\phi = NBA \Rightarrow \varepsilon = \frac{d\phi}{dt} \Rightarrow \varepsilon = NA\frac{dB}{dt} = \left(NA\mu_0 n \frac{\Delta i}{\Delta t}\right)$

$\frac{\Delta i}{\Delta t} = \frac{4}{0.25}$, So $\varepsilon = 4.8 \times 10^{-2}$ V

22. (3)

Sol. $\phi = Mi$

$\frac{d\phi}{dt} = \frac{Mdi}{dt}$

$1000 = \frac{M(2)}{0.01}$

$M = \frac{1}{2}(10) = 5.00 \text{ H}$

23. (4)

Sol. $\phi = Mi$

$$\frac{d\phi}{dt} = \frac{Mdi}{dt}$$

$$\varepsilon = 5 \times 10^{-3} (50)(500)\cos \omega t$$

$$\varepsilon_{max} = 125 \text{ V}$$

24. (2)

Sol $L_1 = 20$ mH, $L_2 = 40$ mH

$$L = L_1 + L_2 \pm 2 \text{ M}$$

80 = 20 + 40 + 2 M

M = 10 mH

25. (3)

Sol The rod will experience magnetic force in the direction opposite to initial force. So velocity will decrease with time.

26. (3)

Sol Sudden decrease in current due to circuit breaking (opening) will be compensated by sudden induced current flow (as per Lenz's law) and hence sudden brightness.

27. (1)

Sol Using Lenz's law, current in *A* will be clockwise.

28. (2)

Sol $$I = \frac{125 - 115}{1} = 10 \text{ A}$$

29. (2)

.Sol $\varepsilon = \frac{1}{2} B\omega R^2$, $R = 0.1$ m, $B = 0.1$ T, $W = 20\frac{\pi}{s}$

$$\varepsilon = \frac{1}{2}(0.1)(0.1)^2 (20\pi)$$

$$= \frac{\pi}{100} \text{ volt}$$

30. (2)

Sol. $P = F.V = \frac{B^2 l^2 v^2}{R}$

$= \frac{1(1)^2 (20)^2}{0.2}$

$= 2 \text{ kW}$

31. (4)

Sol. $M = \mu_0 n_1 n_2 A$

$= 4\pi \times 10^{-7} (500)(100) \times 10^{-4}$

$\varepsilon = -\frac{Mdi}{dt} = \frac{M(2)}{3.14} = 4 \text{ mV}$

32. (3)

Sol. $B = \frac{\mu_0}{4\pi} \frac{qv}{r^2}$

when q approaches the loop 'r' decreases when q goes away from the loop 'r' increases so using Lenz law induced current will be first clockwise then anticlockwise.

33. (2)

Sol At t = 0, inductor offers infinite resistance

So , $I_1 = \frac{E}{R_1}$, $I_2 = I_3 = 0$

34. (2)

Sol $\frac{\phi_A}{\phi_B} = \frac{N_A}{N_B}$

35. (2)

Sol. Using conservation of energy

$mgl(1-\cos\theta) = \frac{1}{2} I\omega^2$

$mgl(1-\cos\theta) = \frac{1}{2} ml^2\omega^2$

$2gl\left(2\sin^2\left(\frac{\theta}{2}\right)\right) = l^2\omega^2$

$\omega = 2\sqrt{\frac{g}{l}} \sin\frac{\theta}{2}$

$\varepsilon = \frac{1}{2} B\omega l^2 = \frac{1}{2} \times \left(2\sqrt{\frac{g}{l}} \sin\frac{\theta}{2}\right) l^2 \times B$

$\varepsilon = Bl \sin\frac{\theta}{2} \sqrt{gl}$

36. (3)

Sol. At $t = 0$, L offers infinite resistance

At $t \to \infty$, C offers infinite resistance

So, in both the cases, $I = \frac{\varepsilon}{2R}$

Hence ratio is 1 : 1.

37. (4)

Sol. $M = \frac{\phi}{I}$

ϕ due to outer loop in the smaller loop will be due to magnetic field Vector sum of all the four sides of bigger square.

So $M = \frac{2\sqrt{2}\mu_0 l^2 i}{\pi L(i)}$

38. (2)

Sol. $\varepsilon = (\vec{v} \times \vec{B}).\vec{l}$

$= \left[(1\hat{i}) \times \left(3\hat{i} + 4\hat{j} + 5\hat{k}\right)\right].5\hat{j}$

$= \left[4\hat{k} - 5\hat{j}\right].5\hat{j}$

$= 25$ V

39. (4)

Sol. $\varepsilon = \int_{l/2}^{l} B\omega x dx$

$= B\omega\left(\frac{x^2}{2}\right)_{l/2}^{l}$

$= \frac{B\omega}{2}\left(l^2 - l^2/4\right)$

$= \frac{3}{8}B\omega l^2$

40. (4)

Sol. $\frac{dr}{dt} = r_0 \Rightarrow \phi = B\pi r^2$

$\varepsilon = \frac{-d\phi}{dt} = -B\pi(2r)\frac{dr}{dt}$

$\varepsilon = -2\pi B r r_0$

41. (1)

Sol. $I_1 = 0,\ I_2 = \frac{\varepsilon}{R},\ I_3 = \frac{\varepsilon}{2R}$

$\Rightarrow\ I_2 > I_3 > I_1$

42. (4)

Sol. $I = 5 + 16t \ \Rightarrow \frac{di}{dt} = 16$

$\varepsilon = 5 \times 10^{-3}$ V

$|\varepsilon| = \frac{Ldi}{dt} = L(16) = 5 \times 10^{-3}$

So, $L = 3.125 \times 10^{-4}$ H

43. (3)

Sol. $\frac{di}{dt} = +10^3$

So, $V_A - (4)(1) - 12 - 5 \times 10^{-3}(10^3) = V_B$

$\Rightarrow V_B - V_A = -21$ V

44. (1)

Sol. $\phi = at(T - t) = aTt - at^2$

$\varepsilon = -\frac{d\phi}{dt} = -(aT - 2at)$

$P = -\frac{\varepsilon^2}{R} = \frac{(aT - 2at)^2}{R}$

$H = \int_0^T P dt = \int_0^T \frac{(aT - 2at)^2}{R}$

$= \frac{a^2T^3}{3R}$

45. (2)

Sol. $\varepsilon = nB\pi r^2 \frac{dB}{dt}$

$\varepsilon' = 4nB\pi\left(\frac{r}{2}\right)^2 \frac{dB}{dt}$

$\varepsilon' = nB\pi r^2 \frac{dB}{dt} = \varepsilon$

$P' = \frac{(\varepsilon')^2}{R} = \frac{\varepsilon^2}{R}$

46. (1)

Sol. Using $\phi = Mi$

$$M = \frac{\phi}{i} = \left(\frac{\mu_0 i}{2r}\right).\frac{l^2}{i} \propto \frac{l^2}{r}$$

47. (3)

Sol. When magnetic field is time varying, an induced electric field is produced which can accelerate charge.

48. (1)

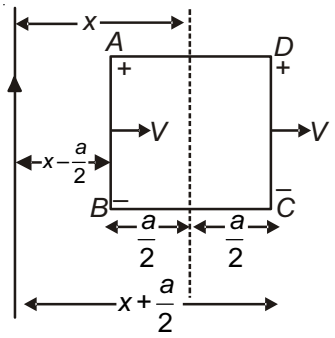
Sol. $e_{ABCD} = e_{AB} + e_{CD}$

$$= \frac{\mu_0 I}{2\pi\left(x - \frac{a}{2}\right)}av - \frac{\mu_0 I}{2\pi\left(x + \frac{a}{2}\right)}av$$

$$= \frac{\mu_0 Iav}{2\pi}\left[\frac{2}{2x-a} - \frac{2}{2x+a}\right]$$

$$= \frac{\mu_0 Iav}{\pi}\left[\frac{2x+a-2x+a}{(2x-a)(2x+a)}\right]$$

$$= \frac{2\mu_0 Ia^2 v}{\pi(2x-a)(x+a)}$$



49. (3)

Sol. $\phi = 50t^2 + 4$

$$|\varepsilon| = \left|\frac{d\phi}{dt}\right| = 100t$$

$$\varepsilon\big|_{t=2} = 100(2) = 200 \text{ V}$$

$$I = \frac{\varepsilon}{R} = \frac{200}{400} = 0.5 \text{ A}$$

50. (2)

Sol. Use $|\varepsilon| = \frac{Ldi}{dt}$

for 0 to $\frac{T}{2}$, $\frac{di}{dt}$ is constant and positive

and from $\frac{T}{2}$ to T, $\frac{di}{dt}$ is constant and negative.

51. (2)

Sol. $I = \left(\frac{\Delta\phi}{\Delta t.R}\right)$

$\Delta\phi = I\Delta tR$

or $d\phi = (Idt)R$

Total flux $\phi = R\int Idt$

$\int idt$ represents area under $i - t$ curve

So $\phi = R\left[\frac{1}{2}(0.1)(4)\right] = 2$

52. (2)

Sol. $\varepsilon = \frac{-Ldi}{dt}$

$\frac{di}{dt}$ is slope of $I - t$ curve.

53. (4)

Sol. $N = 500$, $I = 2$

$L = \frac{N\phi}{i} = \frac{500(4\times10^{-3})}{2}$

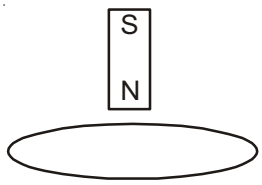
54. (3)

Sol. $L_1 = 2\text{mH}$, $L_2 = 8\text{ mH}$

$M = \sqrt{L_1L_2} = \sqrt{16} = 4\text{ mH}$

55. (3)

Sol.



due to Lenz's law $a < g$

56. (2)

Sol. $I = \frac{\Delta\phi}{\Delta tR} \Rightarrow \frac{\Delta Q}{\Delta t} = \frac{\Delta\phi}{\Delta tR}$

$\Rightarrow \Delta Q = \frac{\Delta\phi}{R}$

57. (1)

Sol. $W = QV$

(By the defination of e.m.f)

58. (3)

Sol. For circular and elliptical loop, area coming out from the field per unit time is not constant

i.e., $\frac{dA}{dt} \neq$ constant

59. (3)

Sol. Motional emf will induce ($\varepsilon = Bvl$). But loop is not closed so no current will flow, hence no magnetic field force will act upon it.

60. (1)

Sol. $\varepsilon = \left|\frac{Ldi}{dt}\right| = \frac{L(18-2)}{0.05} = 20$

So $L = 62.5 \times 10^{-3}$ H

61. (4)

Sol. At $t = 0$, C offers zero resistance

L offers infinite resistance

So reading of Ammeter (1) $\rightarrow$ max

Ammeter (2) $\rightarrow$ Zero

62. (1)

Sol. $\varepsilon = \frac{Ldi}{dt}$

When $\frac{di}{dt}$ becomes zero, ε will becom zero.

$\frac{di}{dt} = -t^2(e^{-t}) + e^{-t}(2t) = 0$

$\Rightarrow t = 2$

63. (2)

Sol. $L = \mu_0 n^2 Al$

$L = \mu_0 \frac{N^2}{l^2} Al = \frac{\mu_0 N^2 A}{l}$

So, on doubling N and l

$L' = \frac{\mu_0 (2N)^2 A}{2l} = \frac{2\mu_0 N^2 A}{l}$

$\Rightarrow L' = 2L$

64. (2)

Sol. $\tau = \frac{L}{R}$

$\tau' = 2\tau = \frac{4L}{2R}$

65. (1)

Sol. M = 20 mH

$I = 3t^2 - 4t + 6$

$\frac{di}{dt} = 6t - 4$

$\varepsilon = \left.\frac{Mdi}{dt}\right|_{t=2} = 20 \times 10^{-3}(6(2) - 4) = 160 \text{ mV}$

66. (2)

Sol. $M = 0.005$ H

$I = I_0 \sin\omega t = 10\sin\omega t$

$\omega = 1\omega\pi$ rad/s

$\varepsilon = \frac{Mdi}{dt} = (0.005)[(10)(100\pi)\cos\omega t] = (0.005)(1000\pi) = 5\pi$

67. (2)

Sol. $L_1 = 4$ mH, $L_2 = 1$ mH

$\frac{di_1}{dt} = \frac{di_2}{dt}$

$\frac{I_1}{I_2} = \frac{\varepsilon_2}{\varepsilon_1} \quad \left(\because P = \varepsilon i \Rightarrow \frac{\varepsilon_1}{\varepsilon_2} = \frac{I_2}{I_1}\right)$

$\frac{I_1}{I_2} = \frac{L_2\frac{di_2}{dt}}{L_1\frac{di_1}{dt}} \Rightarrow \frac{I_1}{I_2} = \frac{L_2}{L_1} = \frac{1}{4}$

68. (4)

Sol. When electron goes in straight line electric flux first increases then decreases.

69. (4)

Sol. $\varepsilon = BL_{eff}v$ (L_{eff} = Diameter)

$= B\,2Rv$

70. (1)

Sol. $\phi = BA\cos\omega t$

$$\varepsilon = \frac{d\phi}{dt} = BA\omega\sin\omega t$$

71. (2)

Sol. Use $\frac{i_P}{i_S} = \frac{n_P}{n_S}$

72. (3)

Sol. emf induced will be zero when magnet will be inside coil. Use Lenz's law.

73. (2)

Sol. $M = \sqrt{L_1 L_2}$

74. (3)

Sol. Using Lenz's law

75. (1)

Sol. Using Lenz's law

EXERCISE-2

1. **[A]**

Sol. $(dq) = \frac{d\phi}{R} = idt$

$= $ Area under i – t graph

$\therefore d\phi$ = (Area under i – t graph) (R)

$= \frac{1}{2}(4)(0.1)(10)$

$= 2$ Wb

2. **[D]**

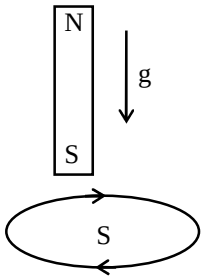
Sol. When switch is closed then current increase in circuit we know as per lenz's Law when current increase, inverse current induced in the loop so clockwise current flow in loop. When switch is open after some time then current reduced in circuit as per Lenz's law current induced loop is flow same direction of circuit.
So current flow in loop in anti clockwise direction.

3. **[B]**

Sol. Induced current does not depends on shape of wire so magnitude of induced current same as before.

4. **[C]**

Sol.



As magnet falling flux increases & from Lenz law coil in horizontal plane will develop S polarity so as to oppose, due to repulsive force a < g while approaching as well as receding.

5. **[A]**

Sol. When current increased in A, magnetic flux passing through B will increase. So according to Lenz's law direction of induced current in B will be such as there is repulsion between A and B.

6. **[A]**

Sol. When the coils approach each other the flux linked with each coils will increase.
So in accordance with Lenz's law a current will be induced in each coil which will try to decrease the flux, i.e. the induced current in each coil will decrease as the coil approach each other

7. **[D]**

Sol. When the coil is within the field there is no change is magnetic flux passing through it. Those, no current will be induced and the acceleration will be g. But according to Lenz's law the induced current will oppose its motion when it enters or leaves the field. Therefore, acceleration will be less through

8. **[B]**

Sol. The emf induced across the rod AB is

$e = B(\vec{V} \times \vec{\ell})$

here, $V_\perp = V \sin 30^\circ$

= component of velocity perpendicular of length

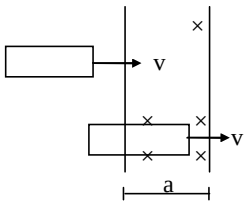
$e = Bvl \sin 30^\circ$

$= 2 \times 4 \times 1 \times \frac{1}{2} = 4V$

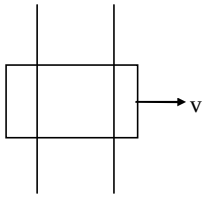
The free electrons of the rod shifts towards right due to the force $q(\vec{V} \times \vec{B})$. Thus, the left side of the rod is at higher potential or $V_A - V_B = 4V$

9. [B]

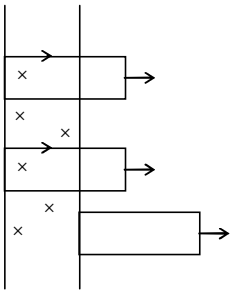
Sol.



Emf induced till loop front edge reach at the right boundary of B. Because of ϕ change during that time.



No emf as No change in ϕ.



Emf induced till loop come out of B.

$\therefore$ total time = $t_1 + t_2$

Time = $\frac{a}{V} + \frac{a}{V} = \frac{2a}{V}$ (B)

10. [B]

$E = (\vec{v} \times \vec{B}).\vec{\ell}$

$= \vec{v} = 1\hat{i}$

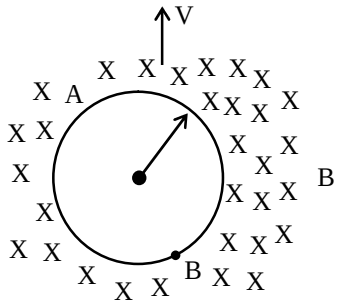
$\hat{\ell} = 5\hat{j}$

$$|e| = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 5 & 0 \\ 3 & 4 & 5 \end{vmatrix}$$

$|e| = 25$ volt

11. [A]

Sol.

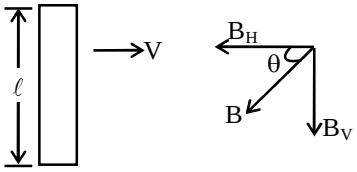


Emf of two points of sphere $E_A - E_B = B\ell V$

Here (ℓ = 2R) = 2RBV

12. [A]

Sol.



⇒From the above figure, are conclude that magnetic force which is responsible for induction of emf is horizontal component of magnetic field only.

Formula $\Delta e = \left(\overline{V} \times \overline{B}\right) l$ = Vbl sin 90° = VBl

Now $\tan\theta = \frac{B_H}{B} \Rightarrow B_H = B\cot\theta$

Now, emf induced =

$e = V(B_H l)$

$e = VBl\cot\theta$

$\Rightarrow e = Blv\cot\theta$

13. [C]

Sol. $de_{AB} = B\ell V$ (V = wr, ℓ = dr)

$de_{AB} = Bwrdr$

Integration both side for calculate.

E.M.F. between point A and D of rod

$$\int de_{AB} = \int_{0.07}^{0.1} Bwrdr$$

Here B = 2 tesla

w = 10 rad/sec.

$$e_{AB} = \int_{0.07}^{0.1} 2\times(10r)dr$$

$$= 20\left(\frac{r^2}{2}\right)_{0.07}^{0.1}$$

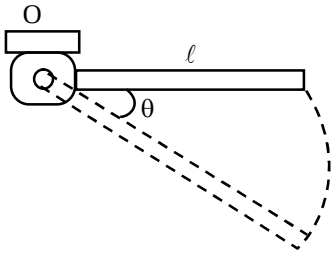
$= 10\ [(0.01)^2 - (0.07)^2]$

$= 10 \times .0051$

$e_{AB} = 0.051$ Volt

14. [D]

Sol.



from energy conservation

$$mg\frac{\ell}{2}\sin\theta = \frac{1}{2}Iw^2$$

Here I for one end of rod = $\frac{m\ell^3}{3}$

$$mg\frac{\ell}{2} = \sin\theta = \frac{1}{2}\left(\frac{m\ell^3}{3}\right)\omega^2$$

$$w = \frac{\sqrt{3g\sin\theta}}{\ell}$$

Potential difference = $\frac{1}{2}Bw\ell^2$

$$= \frac{1}{2}B \times \frac{\sqrt{3g\sin\theta}}{t} \times \ell^2$$

So, Potential difference $\alpha \sqrt{\sin\theta}$

or Potential difference α $(\sin\theta)^{1/2}$

Hence, correct option is (D)

15. [C]

Sol. $q = \frac{\Delta\phi}{R}$

$$q = -\frac{NBA\cos\theta}{R}$$

$$= -\frac{NBA(\cos\theta - \cos 180^\circ)}{R}$$

$$q = \frac{2NBA}{R}$$

Given N = 500 Through,

$A = 4.0\ cm^2, = 4 \times 10^{-4}\ m^2$

$B = 0.2$ weber / meter^2, $R = 500$ ohm

Put values

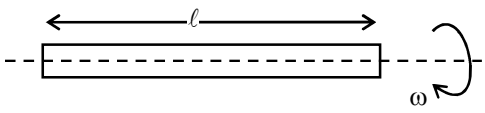
$$q = \frac{2\times 500\times 0.2\times 4\times 10^{-4}}{50}$$

$q = 2 \times 10 \times 0.2 \times 4 \times 10^{-4}$

$q = 16 \times 10^{-4} = 1.6 \times 10^{-3}$ C

16. [A]

Sol.



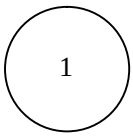
$E = B\ (\vec{V} \times \vec{\ell})$

$= B\ r\ (\vec{\omega} \times \vec{\ell})$ $\quad (\theta = 0)$

So $E = 0$

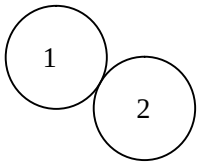
17. [B]

Sol.



$Emf = E = \frac{d\phi}{dt} = \frac{dB}{dt} \times A = xA$

Where A is area of loop.



$Emf = E' = 2A\ \frac{dB}{dt} = 2xA$

In combined circuit

$E' = 2E$

18. [B]

Sol. Given $\phi_1 = 5.5 \times 10^{-4}$, $\phi_2 = 5 \times 10^{-5}$

$t = 0.1$ sec., $N = 1000$

$R = 0.10$ ohm

Electromotive force

$$e = -N\ \frac{d\phi}{dt}$$

$$= -N\ \frac{(\phi_2 - \phi_1)}{dt}$$

$$= -1000 \frac{(5\times10^{-5} - 5.5\times10^{-4})}{0.1}$$

$$= \frac{1000\times5\times10^{-4}}{0.1}$$

$e = 5V$

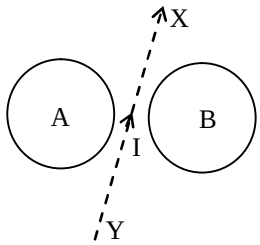
Induced current $I = -\frac{N}{R}\frac{d\phi}{dt}$

$$I = \frac{e}{R} = \frac{5}{10}$$

$I = 0.5$ A

19. **[A]**

Sol.



Loops A and B oppose change in flux in straight wine

So In loops A current will be flow in clockwise and loops B current will be flow anticlockwise direction.

20. **[C]**

Sol. Self-inductance of solenoid of length and radius r

$$L = \mu_0 n^2 A / l$$

$$L_1 = \mu_0 A^2 (\pi r^2) \ell$$

When Length l and radius r / 2 then self inductance

$$L_2 = \mu_0 n^2 (\pi r^2)\, \ell$$

Here $n^2 = \frac{N}{L} = \frac{1}{2\pi r}$

$$L_2 = \mu_0 \left(\frac{1}{2\pi r}\right)^2 \times \pi r^2 \times \ell$$

$$= \frac{\mu_0}{4\pi r^2} \times \pi r^2 \times \ell$$

No effect of reducing r'

So L_2 is also equal to L

21. **[D]**

Sol.

Coil 1	Coil 2
$I_1 = 0$	$\frac{dI_2}{dt} = 15$ A/s
$e_1 = 25.0$ mV	$I_2 = 0$
$I_1 = 3.6$A	$\phi_2 = ?$

First $e_1 = -M \frac{dI_2}{dt}$

$$M = \frac{-e_1}{\frac{dI_2}{dt}} = \frac{25\times10^{-3}}{15}$$

$$M = \frac{5}{3} \times 10^{-3}$$

flux linkage in coil 2

$$\phi_2 \propto I_1$$

$$\phi_2 = MI_1$$

$$\phi_2 = \frac{5}{3} \times 10^{-3} \times 3.6$$

$$= 6 \times 10^{-3}$$

$$\phi_2 = 6 \text{ mwb}$$

22. **[B]**

Sol. Given M = 2H, ϕ = 4 weber t_1 = 10 seconds

$I_2 = 7$

$\phi_1 \propto I_2$

$\phi_1 = MI_2$

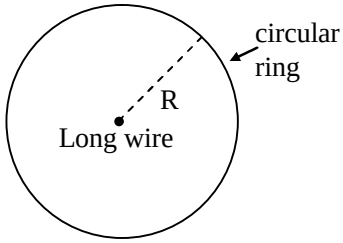
$I_2 = \frac{\phi}{M} = \frac{4}{2}$

$I_2 = 2$

So correct option is (B)

23. **[D]**

Sol.



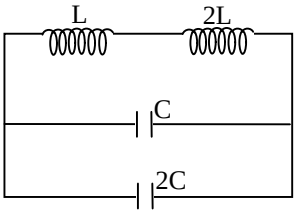
Taking primary coil as a long wire. Magnetic lines of force due to wire does not pass through circular ring.

Coupling coefficient = 0

$\therefore$ M = 0

24. **[B]**

Sol.

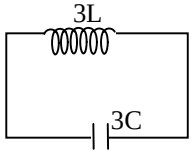


L and 2L are in series,

So Leq = L + 2L = 3L

C and 2C are in parallel

So C_{eq} = C + 2C = 3 C



$f = \frac{1}{2\pi\sqrt{LC}}$

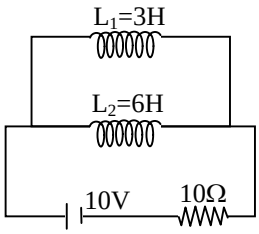
Here L = 3L and C = 3C

So, $f = \frac{1}{2\pi\sqrt{3L \times 3C}}$

$f = \frac{1}{2\pi \times 3\sqrt{LC}} = \frac{1}{6\pi\sqrt{LC}}$

25. **[B]**

Sol.

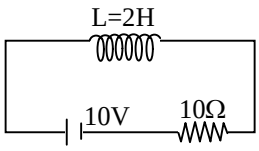


$L_1$and L_2 are in parallel

So,equilibrium of L_1 and L_2

$$L = \frac{L_1 \times L_2}{L_1 + L_2} = \frac{3 \times 6}{3 + 6}$$

$$L = 2H$$



Total energy stored in inductor is

$$U = \frac{1}{2} LI^2$$

After long time put

$$I = \frac{V}{R} = \frac{10}{10} = 1 \text{ Amp.}$$

Then $U = \frac{1}{2} \times 2 \times (1)^2$

$$U = 1 \text{ J}$$

Heat developed in resistance in 10 sec. is

$$H = \frac{V^2}{R} t$$

$$H = \frac{(10)^2}{10} \times 10$$

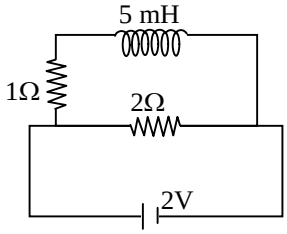
$$H = 100 \text{ J}$$

Ratio of $\frac{U}{H}$ is equal to $\frac{1}{100}$

SoCorrect option is (B)

26. **[A]**

Sol.



At to = 0, Inductor behaves like a inflate resistance

So $I_2 = 0$ and $I_1 = \frac{2}{2} = 1$ Amp.

After long time inductor behaves as a conductor wire

then current $I = \frac{2}{\frac{2\times 2}{2+1}} = 3A$

$I_{max} = 0.36\ I_0$

50% I_{max}.

So, $I = 0.63 \times \frac{50}{100} \times I_{max}$

$$I = \frac{0.63}{2} \times I_2$$

$$I = 1\ A$$

Stored energy in inductor

$$U = \frac{1}{2}LI^2$$

Here $L = 5 \times 10^{-3}$ H

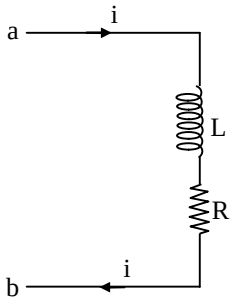
$I = 1$ A

$$U = \frac{1}{2} \times 5 \times 10^{-3} \times (1)^2$$

$$U = 2.5$$

27. [D]

Sol.



$V_{ab} = V_L + V_R$

$$= L\frac{dI}{dt} + IR \Rightarrow 8 = L \times 1 + 2R$$

$$8 = L + 2R \quad \text{.....(I)}$$

When $V_{ab} = 4V$

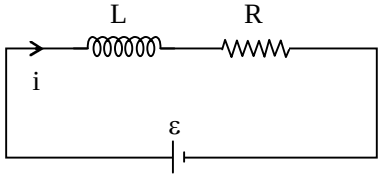
$$4 = -L + 2R \Rightarrow 4 = 2R - L \quad \text{.....(II)}$$

From equation (I) and (II)

$$4R = 12 \Rightarrow R = 3\Omega \text{ and } L = 2\ H$$

28. [A]

Sol.



$U = \frac{1}{2}Li^2$

$\frac{dU}{dt} \rightarrow$ Rate at which energy is stored in magnetic field.

$$\frac{dU}{dt} = Li\frac{di}{dt}$$

Applying Kirchoff $\frac{Ldi}{dt} + iR = \varepsilon$

Multiply by i both

$Li\frac{di}{dt} + i^2R = \varepsilon i$

$Li\frac{di}{dt} = \varepsilon i - i^2R = f(i)$

For Maxima of $\frac{dU}{dt}$

$f'(i) = 0$

$\varepsilon - 2iR = 0$

$i = \frac{\varepsilon}{2R}$

$\left(\frac{dU}{dt}\right)_{max} = \varepsilon i - i^2R = \frac{\varepsilon^2}{2R} - \left(\frac{\varepsilon}{2R}\right)^2 \times R \Rightarrow \frac{\varepsilon^2}{4R}$

29. **[D]**

Sol. $L = 1.8 \times 10^{-4}$ H & $R = 6\Omega$.

Broken in two parts

$L_1 = 0.9 \times 10^{-4}$ H, $L_2 = 0.9 \times 10^{-4}$ If

$R_1 = 3\Omega$, $R_2 = 3\Omega$.

$L = \frac{L_1L_2}{L_1+L_2} = \frac{9\times10^{-5}\times9\times10^{-5}}{9\times10^{-5}+9\times10^{-5}} = 4.5 \times 10^{-5}$

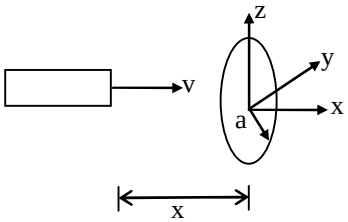
$R = \frac{3\times3}{3+3} = 1.5$; $\tau = \frac{L}{R} = \frac{4.5\times10^{-5}}{1.5}$

$\tau = 3\times 10^{-5}$

$i = \frac{V}{R} = \frac{12}{1.5} = 8$ Amp.

30. **[C]**

Sol. Given x >> a



magnetic field at the centre of coil due to bar magnet is

$$B = \frac{\mu_0}{4\pi}\frac{2M}{x^3}$$

Flux linked with the coil

$$\phi = BA = \frac{\mu_0 M}{2\pi x^3} \times \pi a^2$$

$$\phi = \frac{\mu_0 M a^2}{2x^3}$$

$\therefore$ Induced emf in the coil

$$e = -\frac{d\phi}{dt} = \frac{\mu_0 M a^2}{2}\frac{d}{dt}(x^{-3})$$

$$= \frac{\mu_0 M a^2}{2}\left(\frac{3}{x^4}\right)\frac{dx}{dt}$$

$$\left(v = \frac{dx}{dt}\right)$$

$$e = \frac{3\mu_0 M a^2}{2x^4}\, v$$

Magnetic moment of coil.

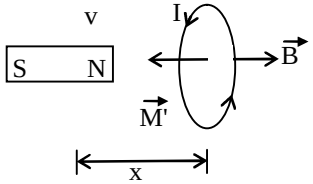
$$M' = i \times \pi a^2 = \frac{3}{2}\,\frac{\mu_0 \pi M a^4 v}{R x^4}$$

PE of $\vec{M}$ and $\vec{B}$ $U = \vec{M'} . \vec{B}$

$$U = -M' B \cos 180$$

$$U = M'B$$

$$U = \frac{3}{2}\,\frac{\mu_0 \pi M a^4 v}{R x^4}\left(\frac{\mu_0}{2\pi}\frac{M}{x^3}\right)$$



$$U = \frac{3}{4}\,\frac{\mu_0^2 M^2 a^4 v}{R\, x^7}$$

$$F = -\frac{dU}{dx} = \frac{21}{4}\,\frac{\mu_0^2 M^2 a^4 v}{R\, x^8}$$

Positive sign of F shows repulsion between magnet & coil.

31. **[A]**

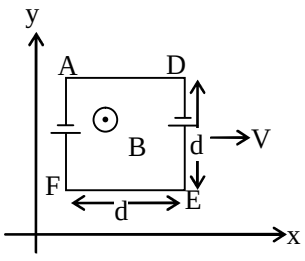
Sol. Since induced emf is present only during time interval flux keeps on changing flux changes during 10^{-3}s.

32. **[B]**

Sol. Radius of coil in magnetic field changes during interval is to 2s. Hence emf is represented by graph (B)

33. **[A]**

Sol.

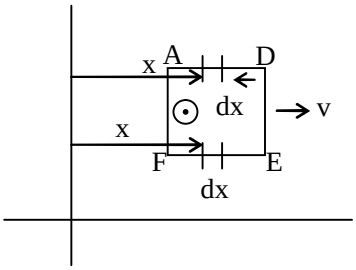


$$B = B_0\left(1+\frac{x}{a}\right)\hat{k}$$

Using motional emf

Emf in AF = $V \times B_0\left(1+\frac{x}{a}\right) \times d$

Emf in DE = $V \times B_0\left(1+\frac{x+d}{a}\right) \times d$



In AD & EF emf is zero because $\vec{v}$ and $\vec{dx}$ are parallel.

$\therefore$ emf in loop

$= v \times B_0\left(1+\frac{x+d}{a}\right) \times d - v \times B_0\left(1+\frac{x}{a}\right) d$

$= \frac{v \times B.d^2}{a}$

34. [C]

Sol. $\phi_1 = nBA = nB(\pi r^2)$

$\phi_2 = 0,$

$\therefore \quad I = \frac{\phi_2 - \phi_1}{dt}$

$I = \frac{n\pi r^2 B}{R.dt}$

$\frac{dq}{dt} = \frac{n\pi r^2 B}{R.dt}$

or $q = \frac{n\pi r^2 B}{R}$

35. [B]

Sol. When coil is also receding away with speed v from the magnet, the rate of change of flux is doubled so emf induced. Will be (2e).

36. [B]

Sol. $\vec{B} = 1T$

$v = 5$ cm/s

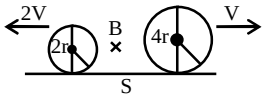
rate of charge of Area = $\frac{dA}{dt} = 5 \times 10^{-2} \times 4 \times 10^{-2} = 2 \times 10^{-3}$ m^2/s

since $e = -\frac{BdA}{dt} = 1 \times 2 \times 10^{-3}$ volt.

$i = \frac{2\times10^{-3}V}{20\Omega} = 0.1$ mA.

37. [D]

Sol.



Given radius = r and 2r. so diameters are 2r and 4r
area swept in 1sec. = 2r × 2v + 4r × v.

or $\frac{dA}{dt} = 8\ rv$

$$e = \left|\frac{d\phi}{dt}\right| = B\ \frac{dA}{dt} = 8Brv$$

So emf induced or P.D. between height point of two rings in 8 rvB

38. [C]

Sol. As flux remains conserved just before and after the change so that

$$\phi = L \times \frac{e}{R} = \frac{L}{n}\ I$$

$$\therefore \quad I = \frac{ne}{R}$$

39. [B]

Sol. Refer to given figure in question

PQ = 2a

As the wire slides e = Bv2a

Hence induced current $i = \frac{e}{R}$

$$i = \frac{2Bva}{R}$$

40. [D]

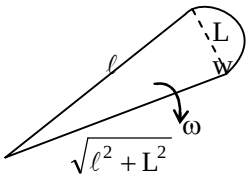
Sol. Refer to given figure in question

When S is closed for long time, circuit is in steady state, at t = 0 switch S is opened Then decay current takes place through R and P.D. across solenoid L at t = 0, is E

41. [C]

Sol. Using the concept of motional emf

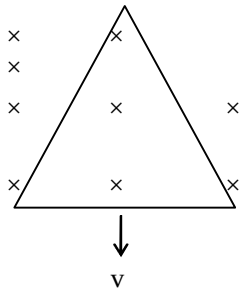
join the end P & Q



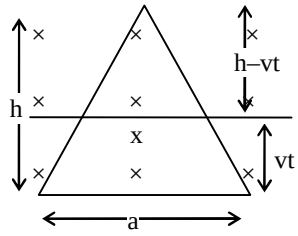
$$e = \frac{B\omega(\ell^2 + L^2)}{2}$$

42. [B]

Sol.



At time t



Emf in $\Delta = -\frac{d\phi}{dt} = -\frac{d}{dt}\left[\frac{1}{2}x(h-vt)\right]$

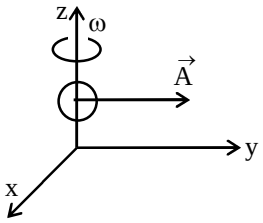
$\Rightarrow \frac{h-vt}{x} = \frac{h}{a}$

$e = -\frac{1}{2}\left[(h-vt)^2 \times \frac{a}{h}\right] \Rightarrow (h - vt) \times \frac{v_0}{h}$

e = (h–vt) $\frac{v_0}{h}$ straight line with negative slope

43. [A]

Sol.



r = radius

$\vec{B} = B_y\hat{j} + B_z\hat{k}$

at t = 0, $\vec{A}$ is parallel to y axis

$\vec{A} = Ar^2\hat{j}$

$\phi = \vec{B} \cdot \vec{A} = BA\cos\theta$

$= BA\cos\omega t$

$\phi = B_y(\pi r^2)\cos\omega t$

$e = -\frac{d\phi}{dt} = \pi r^2 B_y \omega \sin\omega t$

44. [C]

Sol. $e = B\,v\,(3\ell)$

$e = 3Bv\ell.$

45. [A]

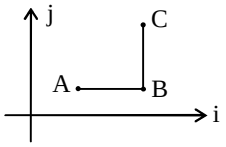
Sol. Induced emf = 5 volt

$Bv\ell = 5$ volt

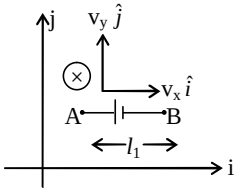
$v = \frac{5}{0.1\times 1} = 50$ m/s

46. **[C]**

Sol.

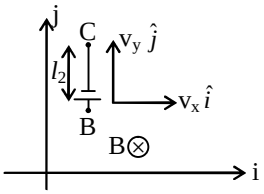


Emf in AB:

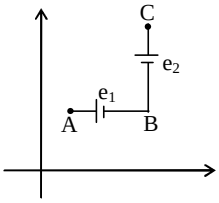


$e_1 = emf_{AB} = Bv_y l_1$ [e due to v_x is zero as $v_x \parallel l_1$]

emf in BC:



$e_2 = emf_{BC} = Bv_x l_2$ [e due to v_y is zero as $v_y \parallel l_2$]



$V_A - V_C = e_1 - e_2 \Rightarrow B\,[v_y l_1 - v_x l_2]$

$V_c - V_A = B\,[v_x l_2 - v_y l_1]$

47. **[C]**

Sol. Since initially switch is closed for long time the circuit is in steady state and current through inductor $I = \frac{V}{R}$.

Energy stored in inductor

$= \frac{1}{2} LI^2$

$U = \frac{1}{2} L \frac{V^2}{R^2} = \frac{LV^2}{2R^2}$

at time t = 0 witch K open, decay will start and heat produced in R_1

$= \frac{LV^2}{2R^2} \times \frac{1}{R_1}\left(\frac{R_1 R_2}{R_1 + R_2}\right)$

Heat produced in $R_1 = \frac{LV^2 R_2}{R^2(R_1 + R_2)}$

48. **[A]**

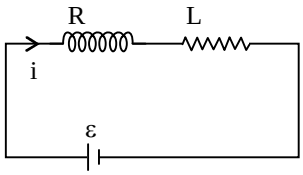
Sol. $\varepsilon = -\frac{Ldi}{dt}$

$\therefore \frac{dI_1}{dt} > \frac{dI_2}{dt}$; and L is same

$\varepsilon_1 > \varepsilon_2$

49. [A]

Sol.



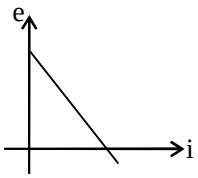
$iR + \frac{Ldi}{dt} - \varepsilon = 0$

$\frac{Ldi}{dt} = \varepsilon - iR$

e = emf in Inductor = $\frac{Ldi}{dt}$

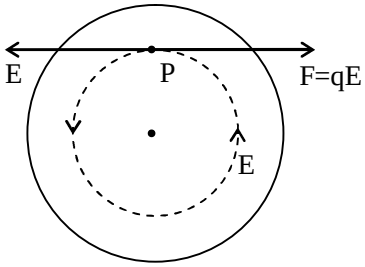
$e = \varepsilon - iR$

Straight line graph with negative slope



50. [B]

Sol.

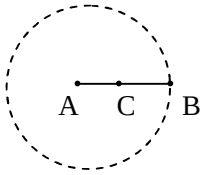


Induced electric field in the direction of induced current. Force on e^- is in opposite direction to E.

$\therefore$ a is toward right.

51. [D]

Sol.



$e_{CB} = e_{AB} - e_{AC}$

Motional EMF induced in a conductor of length L moving in magnetic field is given by equation

EMF = vBL

now lets take a small part of length "dx" which is at distance"x" from the hinge point

the speed of the point is given by

$v = x\omega$

now the motional emf in that small part of the rod will be

$EMF = \int_{x=L/2}^{x=L} vBdx$

$$EMF = \int_{x=L/2}^{x=L} xwBdx$$

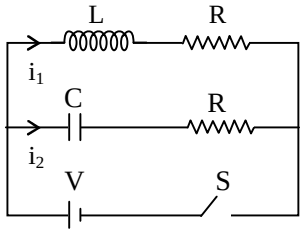
$$= \frac{B\omega L^2}{2} - \frac{B\omega}{2}\left(\frac{L}{2}\right)^2$$

$$EMF = \frac{\left(L^2 - (L/2)^2\right)}{2}\omega B$$

$$= 3\ \frac{B\omega L^2}{8}$$

52. [B]

Sol.



L-R & RC circuit have potential difference V.

$\therefore i_1 = \frac{V}{R}[1 - e^{-\frac{R}{L}t}]$

$i_2 = \frac{V}{R}e^{-\frac{t}{RC}}$

$i_1 = i_2$

$\frac{V}{R}[1 - e^{-\frac{R}{L}t}] = \frac{V}{R}e^{-\frac{t}{RC}}$

Put $R = \sqrt{\frac{L}{C}}$

$1 - e^{-\frac{\sqrt{L}t}{\sqrt{C}L}} = e^{-\frac{t\sqrt{C}}{\sqrt{LC}}}$

$1 - e^{-\frac{t}{\sqrt{LC}}} = e^{-\frac{t}{\sqrt{LC}}}$

$1 = 2e^{-\frac{t}{\sqrt{LC}}}$

$\ln 2 = \frac{t}{\sqrt{LC}}$

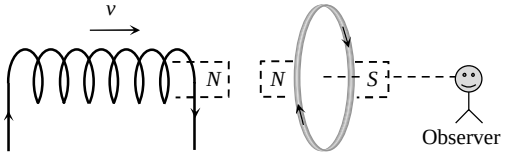
$t = \sqrt{LC}\ \ln 2$

as $\sqrt{L} = R\sqrt{C}$

$\therefore t = RC \ln 2$

53. [B]

The direction of current in the solenoid is anti-clockwise as seen by observer. On displacing it towards the loop a current in the loop will be induced in a direction so as to oppose the approach of solenoid. Therefore the direction of induced current as observed by the observer will be clockwise.



54. **[D]**

Sol. Induced current i_2 is due to mutual induction

$$e = \frac{Mdi_1}{dt}$$

$$i_2 = \frac{e}{R}$$

$$i_2 = \frac{M}{R}\frac{di_1}{dt}$$

As i_2 is constant

$\therefore \frac{di_1}{dt}$ = constant

So i_1 v/s time graph is straight line

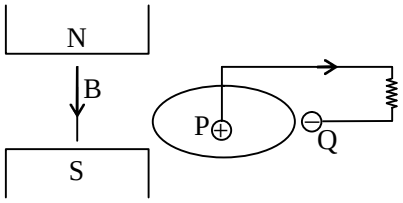
In graph (C) & (D) i_1 is increasing

In graph (C) i_1 is clockwise, in graph (D) i_1 is anticlockwise, i_2 is clockwise as shown in graph.

$\therefore$ i_1 should be anticlockwise [Lenz law]

55. **[A]**

Sol. $\vec{F} = q(\vec{v} \times \vec{B})$



56. **[A]**

Sol. $e = -\frac{d\phi}{dt} = \frac{-\Delta\phi}{\Delta t} = A\frac{dB}{dt}$

$10\ V = (0.1)^2 \times \frac{20}{\Delta t}$

$\Delta t = 2 \times .01 = 20 \times 10^{-3}$

57. **[B]**

Sol. $\int \vec{E}.\vec{d\ell} = \left|\frac{d\phi}{dt}\right|$

or $E\,(2\pi r) = \pi a^2\left|\frac{dB}{dt}\right|$ for $r \geq a$

$$E = \frac{a^2}{2r}\left|\frac{dB}{dt}\right|$$

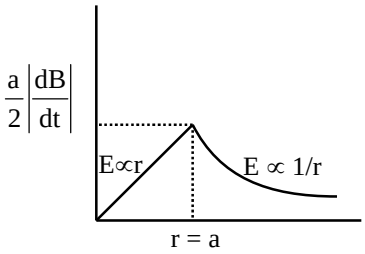
Induced $E \propto \frac{1}{r}$

for $r \leq a$

$$E(2\pi r) = \pi r^2\left|\frac{dB}{dt}\right|$$

$$E = \frac{r}{2}\left|\frac{dB}{dt}\right| \text{ or } E \propto r$$

At $r = a$, $E = \frac{a}{2}\left|\frac{dB}{dt}\right|$



58. **[D]**

Sol. Equations of $I_1(t)$, $I_2(t)$ and B(t)

$I_1(t) = k_1(1 - e^{-k_2 t})$

current growth in L – R

$B(t) = k_3 (1 - e^{-k_2 t})$

$\Rightarrow$ $B(t) \propto I_1$

$B = \mu_0 nI$ in case of solenoid

and $B = \frac{\mu_0 nI}{2R}$ in case of circular coil

i.e. $B \propto I$

$I_2(t) = k_4 e^{-k_2 t}$

$[I_{2_{(t)}} = \frac{e_2}{R}$ and $e_2 \propto \frac{dI_1}{dt}$; $e_2 = -M\frac{dI_1}{dt}]$

Therefore, product $I_{2(t)}$ $B_{2(t)}$

$I_2(t)\, B_2(t) = k_5 e^{-k_2 t}(1 - e^{-k_2 t})$

and value of this product is zero

at t = 0 and t = ∞

Therefore, product will pass through maximum value

59. **[A]**

Sol. Mutual induction $\propto$ flux linkage between coils

1) Flux linkage in coil (a) is maximum because both coils have same axis.

2) Flux linkage between coil (b & c) is 0 because thus axis are perpendicular to each other.

The mutual inductance between two coils depends on their degree of flux linkage, i.e., the fraction of flux linked with one coil which is also linked to the other coil. Here, the two coils in arrangement (a) are placed with their planed parallel. This will allow maximum flux linkage.

60. **[D]**

Sol. The square loop ABCD is a metallic loop. So it consists of the free electrons. When the loop moves in a magnetic field, the free electrons in the AD and BC rod will experience the Lorentz force and they will move towards the ends creating a potential difference in the rods.
This induced emf leads to the electric field induced in the rods AD and BC of the square loop. But there will be no current flowing in the loop as ned potential difference is zero.

61. **[D]**

Sol. Refer to figure given in question, when switch S is closed, magnetic field lines passing through Q increases in the direction from right to left according to Lenz' law induced current in Q (I_{Q1}) will flow in such a direction, so that magnetic field lines due to (I_{Q1}) passes from left to right through Q means (I_{Q1}) anti clock wise as seen by E,
Opposite will be the case when switch S opened, means IQ_2 clockwise as sheen by E.

62. **[B]**

Sol. $P = \frac{e^2}{R}$ e = induced emf

$e = -\frac{d\phi}{dt} = -NA\frac{dB}{dt}$

R (resistance) = $\rho\frac{\ell}{\pi r^2}$

$P \propto \frac{N^2r^2}{\ell}$

When radius is halved length increases 4 times

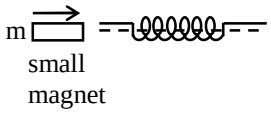
$$\frac{P_2}{P_1} = \left(\frac{N_2}{N_1}\right)^2 \times \left(\frac{r_2}{r_1}\right)^2 \times \frac{\ell_1}{\ell_2}$$

$$= \left(\frac{4}{1}\right)^2 \times \left(\frac{1}{2}\right)^2 \times \left(\frac{1}{4}\right) = 1$$

electrical power dissipated will be same

63. **[D]**

Sol.



Induced emf $e = -\frac{d\phi}{dt} = -\frac{d}{dt}(BA)$

$e = -A\frac{dB}{dt} = -A\frac{dB}{dx}\frac{dx}{dt}$

$e = -Av\frac{dB}{dx}$

The magnetic flux linked with the coil initially increases, hence induced emf is initially negative, then magnetic flux linked with the coil is constant so $\frac{dB}{dx} = 0$, then magnet flux begins to decreases, and induced emf is positive.

This shown by graph D.

64. **[B]**

Sol. In uniform magnetic field change in flux is zero. therefore, induced current is zero.

65. **[A]**

Sol. Electrostatic and gravitational field do not make closed loops.

66. **[C]**

Sol. $\phi = 5t^2 + 6t + 9$

$e = -\frac{d\phi}{dt} = -(10t + 6)$

e_1(at t = 0s) = 6 volt

e_2 (at t = 3s) = 36 volt

$\therefore \quad \frac{e_2}{e_1} = \frac{36}{6}$

= 6 : 1

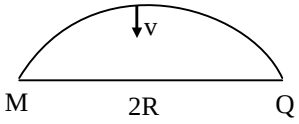
67. **[D]**

Sol. $\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$

or $L = \frac{L_1 L_2}{L_1 + L_2}$

68. **[D]**

Sol. The rate of decrease of area in semi-circular ring in magnetic field is



$$-\frac{dA}{dt} = (2R)v$$

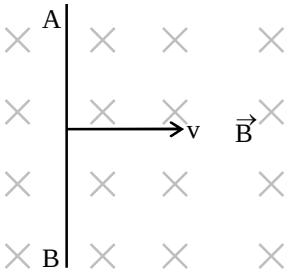
since $e = -\frac{d\phi}{dt} = -B\frac{dA}{dt} = B(2R)\,v$

So emf induced is e = 2RBv and Q is at higher potential

As direction of induced emf is Q to M. So Q is at higher potential.

69. **[B]**

Sol.



Motional emf is induced in rod $e = Bv\ell$.

or potential difference is induced between two ends of the rod AB with end A at higher potential and B at lower potential (there will be lower number of electrons at end B and higher number of electrons at end A) . Due to this P.D., there is electric field in the rod.

70. **[B]**

Sol. Magnetic field produced by current i in a large square loop at its centre

$$B \propto \frac{i}{L} \qquad \text{say } B = \frac{Ki}{L}$$

$\therefore$ Magnetic flux limited with smaller loop

$$\phi = B\,A$$

$$\phi = \frac{Ki}{L}(\ell^2)$$

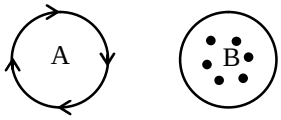
and mutual inductance

$$M = \frac{\phi}{i} = \frac{k\ell^2}{L}$$

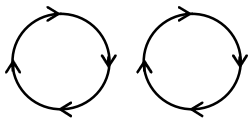
or $$M \propto \frac{\ell^2}{L}$$

71. **[C]**

Sol.



The current in loop one (A) will produce ⊙ magnetic field in loop (B), therefore increase in current in loop (A) will produce ⊗ magnetic field passing through it i.e. induced current in loop (B) clockwise



The loops now repel each other as the current at the nearest and farthest points of the two loops flow in the opposite directions.

72. **[D]**

Sol. Growth current in L–R circuit

Given L = 8.4 mH; R = 6Ω ;V = 12 V

$i = i_0 (1 - e^{-tR/L})$

$i_0 = \frac{V}{R} = \frac{12}{6} = 2\ A$

$\tau = \frac{L}{R} = \frac{8.4\times10^{-3}}{6}$

$\tau = 1.4 \times 10^{-3}$ s.

$\frac{i}{i_0} = 1 - e^{-t/\tau}$

$i = i_0\left(1 - e^{-\frac{t}{\tau}}\right)$

$i = 1A$

or $i_0 = 2A$ or $\frac{1}{2} = e^{-t/t}$

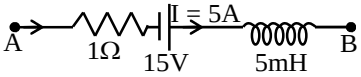
$\log_e 2 = \frac{t}{\tau}$ or $t = 693 \times 1.4 \times 10^{-3}$

$= 0.97 \times 10^{-3}$ s

or0.97 ms ≈ 1ms

73. **[A]**

Sol.



$V_A - iR + E + L\frac{dI}{dt} = V_B.,\quad V_B - V_A$

$V_A - 5 + 15 + 5 \times 10^{-3} \times 10^3 = V_B$

or $V_B - V_A = -5 + 15 + 5$

or $V_B - V_A = 15$ volt

74. **[C]**

Sol. Given L = 10 H, R = 2Ω.

$U = \frac{1}{2} Li_0^2$

or $U \propto i_0^2$

U will reach $\left(\frac{1}{4}\right)$ of its value when current reaches half its max. value in L – R circuit

Growth current

$i = i_0 (1 - e^{-t/\tau})$ $\quad (\because \tau = \frac{L}{R})$

$$\tau = \frac{L}{R} = \frac{10}{2} = 5$$

therefore $i = \frac{i_0}{2}$

$$\frac{i_0}{2} = i_0(1 - e^{-t/5})$$

$$\frac{1}{2} = 1 - e^{-t/5}$$

or $\frac{1}{2} = e^{-t/5}$ or $e^{t/5} = 2$

$$\frac{t}{5} = \log_e 2$$

$t = 0.693 \times 5 = 3.465$ second $= 3.47$ sec

75. [D]

Sol. Given V = 18 km/h

$V = 18 \times \frac{5}{18} = 5$ m/s

$B = 0.2 \times 10^{-4}$ weber/m^2

$\ell = 1$ m

A × ℓe of train will cut vertical component of earth's magnetic field.

$\varepsilon = V B \ell$

$= 5 \times 0.2 \times 10^{-4} \times 1$

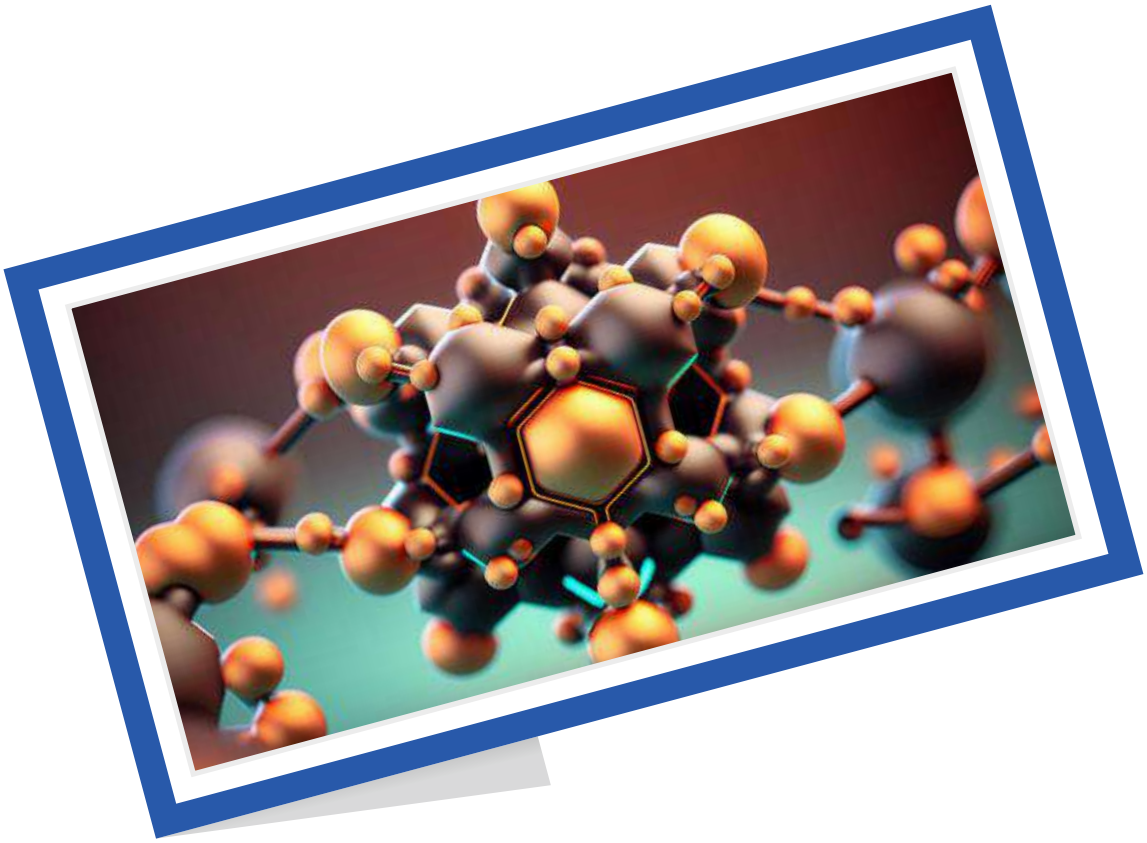
$= 10^{-4}$ v

= 0.1 mv

CRASH COURSE

SAMPLE

CHEMISTRY



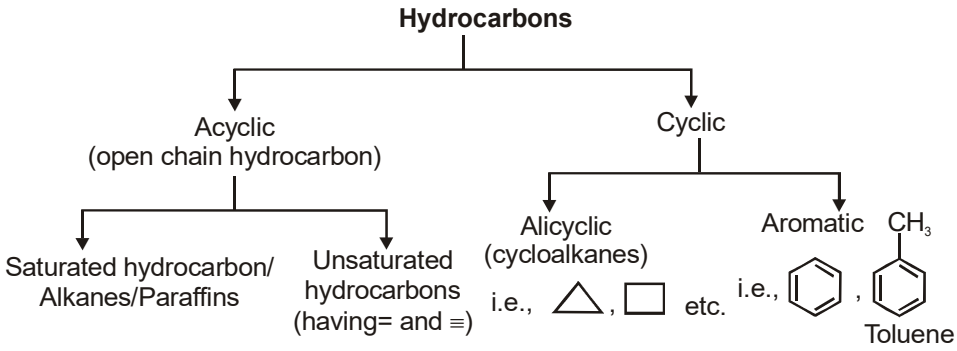
HYDROCARBONS

THIS CHAPTER INCLUDES

- Alkane
- Alkene
- Alkyne
- Aromatic hydrocarbons

HYDROCARBONS AND THEIR CLASSIFICATIONS

Compounds of only Carbon and Hydrogen are called hydrocarbons. They are parent organic compounds and all other organic compounds have been derived by replacing one or more H atoms from hydrocarbon.



ALKANES

Methods of Preparation :

I. Reactions where number of carbon atoms are increased

1. Wurtz Reaction

$$2R-X+2Na \xrightarrow{\text{dry ether}} R-R+NaX$$

Here other metals in the finely divided state may also be used such as Cu, Ag etc.

(i) Methane cannot be prepared by this method.

(ii) Only symmetrical alkane can be prepared by this method in good yield.

2. Corey-House Synthesis:

$$R\text{-}X+Li \longrightarrow RLi+LiX$$

$$RLi+CuI \longrightarrow R_2LiCu$$

(a) $R_2LiCu+2R-X \longrightarrow 2R-R+LiX+CuX$

(b) $R_2LiCu+2R'-X \longrightarrow 2R-R'+LiX+CuX$ etc.

It can be used for preparing both symmetrical and unsymmetrical alkanes.

3. Kolbe's Electrolytic Decarboxylation

$$2RCOONa\,(aq) \xrightarrow{\text{electrolytic}} R\text{-}R+2NaOH+2CO_2+H_2$$

Mechanism :

$RCOONa \rightleftharpoons RCOO^- + Na^+$

$2H_2O \rightleftharpoons 2H^+ + 2OH^-$

Anodic Reaction

$2RCOO^- \longrightarrow 2RCOO^{\cdot} + 2e^-$

$2RCOO^{\cdot} \longrightarrow R - R + 2CO_2$

Cathodic Reaction

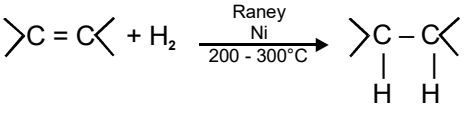
$2H^+ + 2e^- \longrightarrow H_2$

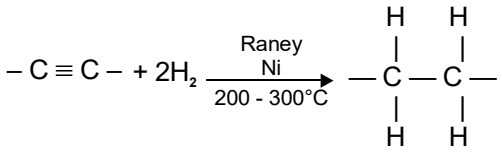
(i) Methane cannot be prepared by this method

(ii) Unsymmetrical hydrocarbon (alkane) cannot be prepared

II. Reactions where number of carbon atoms are retained

1. Sabatier - Sanderen's Reduction





2. Reduction of Alkyl Halides

(a) $R-X+Zn \xrightarrow{HCl} R-H+HX$

Zn – Cu and C_2H_5OH or Na and alcohol can also be used

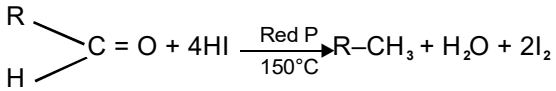
(b) $4R–X + LiAlH_4 \longrightarrow 4RH + LiX + AlX_3$

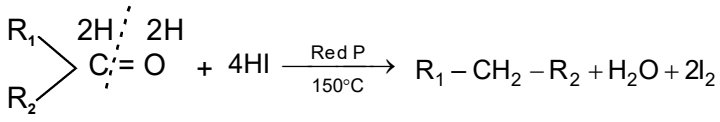
This is a nucleophilic substitution reaction with the nucleophilic H^- coming from $LiAlH_4$.

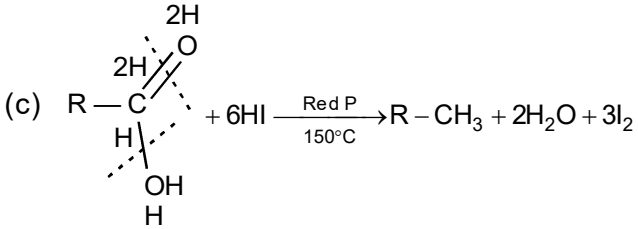
(c) $R – X + (n – C_4H_9)_3SnH \longrightarrow R – H + (n –C_4H_9)_3SnX.$

3. Reduction of Alcohols, Aldehydes, Ketones and Carboxylic Acids with HI/Red P.

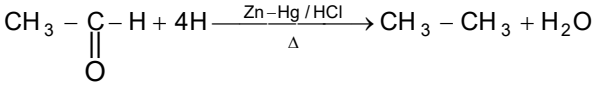
(a) $ROH + 2HI \xrightarrow[150°C]{Red\ P} R-H+I_2+H_2O$

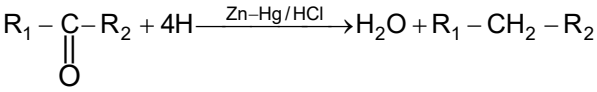
(b) 



(c) 

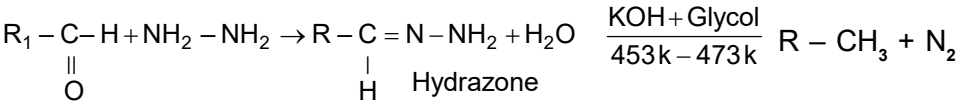
(d) Clemmensen's Reduction

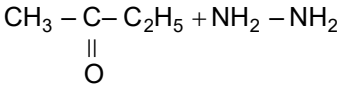


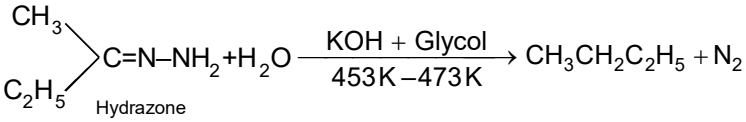


Clemmensen's reduction should not be used when the carbonyl compound has a basic end in it.

(e) Wolf-Kishner's Reduction:

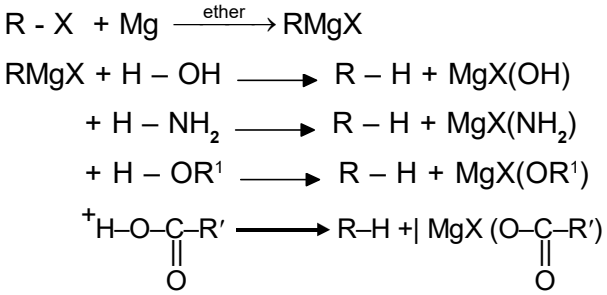




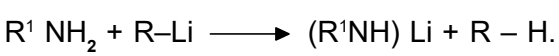


This reaction should not be used when the carbonyl compound has an acidic end in it.

4. (a) Using Grignard's Reagent

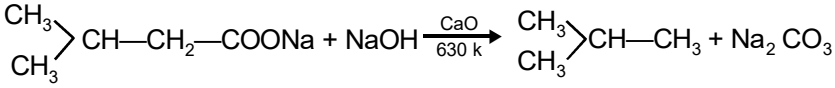


(b) Using Alkyl lithium compound



III. Reaction where number of carbon atom are decreased

Sodalime Decarboxylation



IV. Some other methods of preparation

(1) Preparation of Methane from carbides

(a) $Al_4C_3 + 12H_2O \longrightarrow 4Al(OH)_3 + 3CH_4$

(b) $Be_2C + 4H_2O \longrightarrow 2Be(OH)_2 + CH_4$

(2) Methane from carbon monoxide

$$CO + 3H_2 \xrightarrow[250^\circ C]{Ni+C} CH_4 + H_2O$$

This is also called Sabatier Sanderen's reduction

Physical Properties :

Boiling Point (B.P.)

B.P. increases with the increase of molecular mass. Among the isomers, straight chain alkane have higher b.p. than branched chain alkane.

Melting Point (M.P.)

The melting points do not show regular variation with increase in molecular size. The even number members have higher m.p. as compared to next alkanes with odd number of carbon atoms (ALTERATION EFFECT).

Solubility

They are soluble in non polar solvents but insoluble in polar solvents such as water.

Chemical Properties :

Alkanes are generally inert towards acids, bases, oxidising and reducing agents but they give following reactions:

(1) Halogenation. Alkanes undergoes substitution reaction with halogen. Cl_2 and Br_2 only in presence of ultra violet light or high temperature (573 – 773K). But in presence of direct sunlight reaction is as

$$CH_4 + 2Cl_2 \xrightarrow{\text{direct sunlight}} C + 4HCl$$

$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$$

$$CH_3Cl + Cl_2 \xrightarrow{h\nu} CH_2Cl_2 + HCl$$

$$CH_2Cl_2 + Cl_2 \xrightarrow{h\nu} CHCl_3 + HCl$$

$$CHCl_3 + Cl_2 \xrightarrow{h\nu} CCl_4 + HCl$$

Decreasing order of reactivity of halogens towards alkanes.

$F_2 > Cl_2 > Br_2 > I_2$

$$CH_3-CH_2-CH_3 + Cl_2 \xrightarrow[\text{Light}]{298\ K} \underset{\displaystyle Cl}{\overset{\displaystyle |}{CH_3CH}}-CH_3 + CH_3CH_2CH_2-Cl$$

$$\begin{array}{l} CH_3 \\ | \\ CH_3-C-H \\ | \\ CH_3 \end{array} + Cl_2 \xrightarrow[\text{Light}]{298\ K} (CH_3)_3C-Cl + (CH_3)_2CHCH_2Cl$$

Similarly

$$\begin{array}{l} CH_3 \\ | \\ CH_3-C-H \\ | \\ CH_3 \end{array} + Br_2 \xrightarrow[\text{Light}]{298\ K} \underset{99\%}{(CH_3)_3C-Br} + \underset{1\%}{(CH_3)_2CH-CH_2Br}$$

Note : The reaction with iodine is extremely slow and reversible

$$CH_4 + I_2 \rightleftharpoons CH_3I + HI$$

So iodination is carried out in presence of oxidising agent such as iodic acid or HNO_3.

$$HI + HIO_3 \longrightarrow 3I_2 + 3H_2O$$

(2) General mechanism : Halogenation of alkanes takes place in 3 steps :

(i) Chain initiation steps : $X-X \xrightarrow[\text{sunlight}]{} X^\bullet + X^\bullet$

(ii) Propagation :

$$R-H + X^\bullet \longrightarrow R^\bullet + HX$$

$$R^\bullet + X-X \longrightarrow RX + X^\bullet$$

(iii) Termination

$$X^\bullet + X^\bullet \longrightarrow X-X$$

$$R^\bullet + R^\bullet \longrightarrow R-R$$

$$R^\bullet + X^\bullet \longrightarrow R-X$$

Among these three steps, propagation step is rate determing step.

The relative rates of abstraction of various types of hydrogen follow the order :

$3^oC : 2^oC : 1^oC$

Chlorination $\rightarrow$ 5 : 3.8 : 1

Bromination $\rightarrow$ 1600 : 82 : 1

(3) Nitration :

Liquid phase $\longrightarrow$ For higher alkanes – Fuming HNO_3, at 413 K

e.g., : $C_6H_{13}-H + HONO_2 \longrightarrow C_6H_{13}NO_2 + H_2O$

Vapour phase $\longrightarrow$ For lower alkanes – conc. HNO_3, at 670-750 K

e.g., : $CH_3 - \boxed{H+HO}NO_2 \longrightarrow CH_3NO_2 + H_2O$

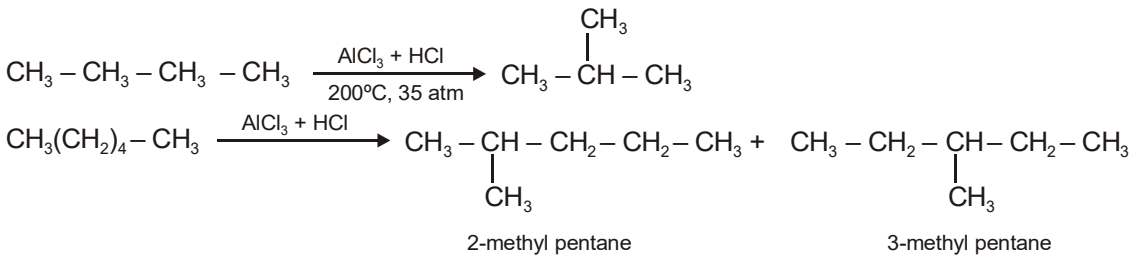
(4) Oxidation : Alkanes undergo oxidation under special conditions to yield a variety of products.

(a) $2CH_4 + O_2 \xrightarrow[573/1100\ atm]{Cu} 2CH_3OH$

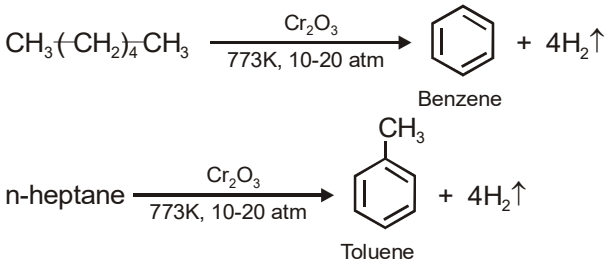
(b) $CH_4 + O_2 \xrightarrow[Mo_2O_3]{} HCHO + H_2O$

(c) $2R-CH_3 + 3O_2 \xrightarrow[\text{373-430 K or } Ag_2O]{\text{Manganese acetate}} 2R-\overset{\overset{O}{\|}}{C}-OH + 2H_2O$

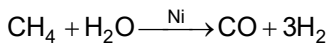
(5) Isomerization : In presence of Anhy. $AlCl_3$ + HCl or $AlBr_3$ + HBr, straight chain alkanes, get converted in branched alkane.



(6) Aromatization : Alkanes having minimum 6 or more carbons when heated at 773 K under high pressure (10-20 atm) in presence of Cr_2O_3, V_2O_3, Mo_2O_3 supported on Alumina gets converted into aromatic hydrocarbon.



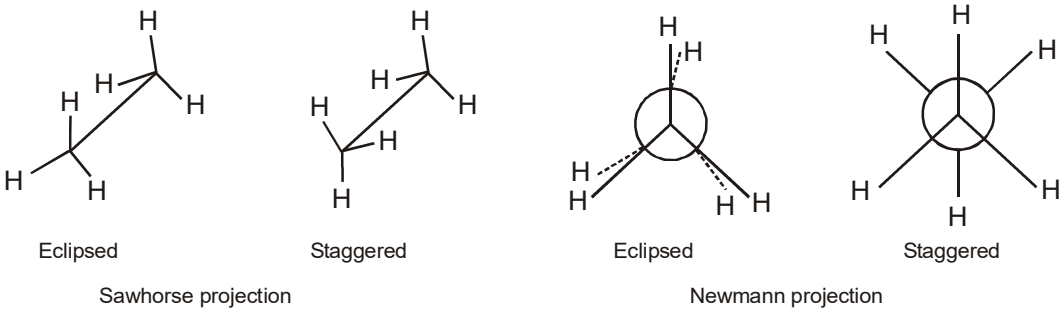
(7) Reaction with steam :



Conformations of Alkanes :

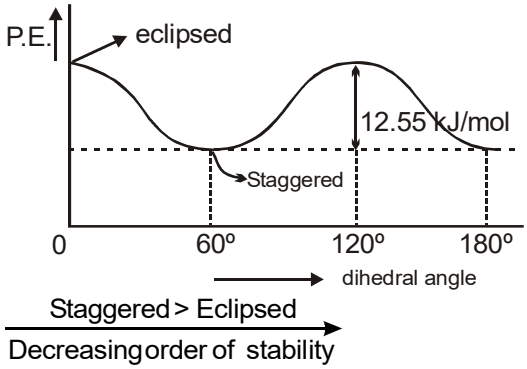
Conformations isomers/conformers are compounds which arises due to rotation around C–C. In fact C–C rotation is hindered by an energy barrier of **1 to 20 kJ × mol^{-1}**. There are infinite number of conformers possible. Out of infinite number of conformers extremes can be discussed as

Conformers of ethane :

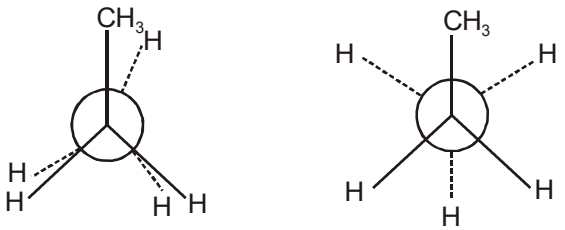


(i) It may be noted that one extreme conformation of ethane can be converted into other extreme conformer by rotation of 60° about C–C bond.

(ii) Conformers lying between two extreme are called **skew conformations**.

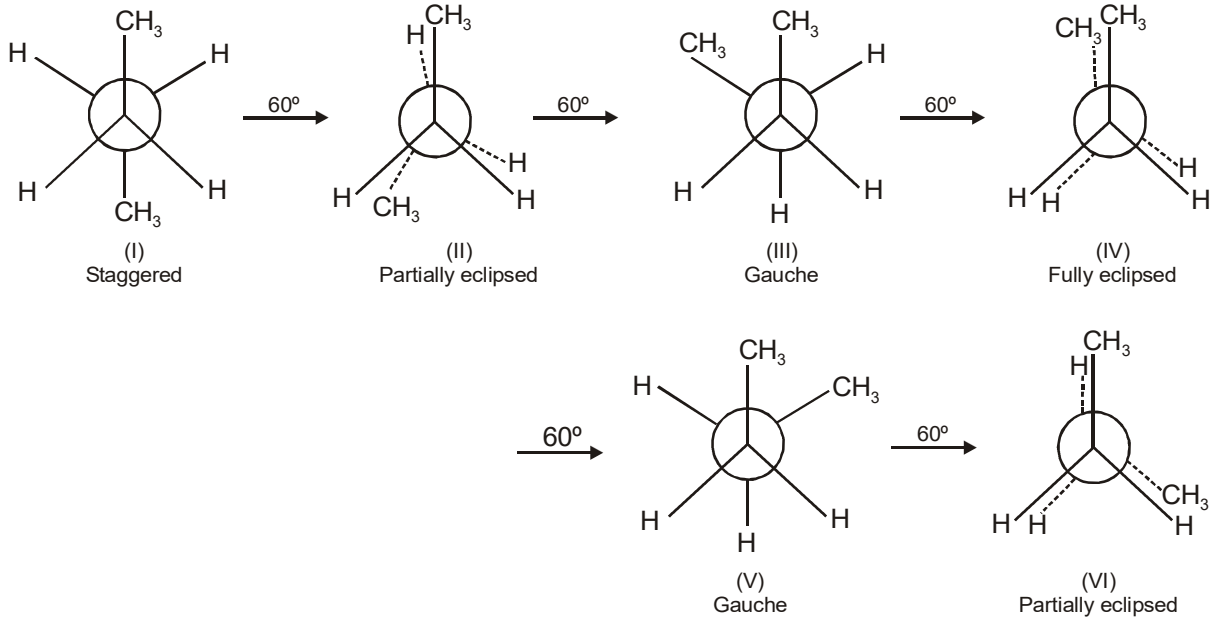


Conformers of propane :



Eclipsed Staggered

Conformers of Butane :



(I) Staggered (II) Partially eclipsed (III) Gauche (IV) Fully eclipsed

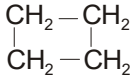
(V) Gauche (VI) Partially eclipsed

Stability order : I > III ≈ V > II ≈ VI > IV

ALKENES

Alkene have the structural unit $\rangle C = C \langle$. The carbon atoms carrying the unsaturation are sp^2 hybridized with the p orbital laterally overlaping to form π-bonds. They have the general formula C_nH_{2n}. They are isomeric with cycloalkanes e.g. – C_4H_8

$CH_3 - CH_2 - CH = CH_2$
Butene



Cyclobutane

Nomenclature :

The IUPAC rules for naming alkenes are similar in many respects to those for naming alkanes. Hence few solved examples are taken.

(i) $\overset{1}{CH_3} - \overset{2}{CH} = \overset{3}{CH} - \overset{4}{CH_2} - \overset{5}{CH_3}$ 2 - pentene

(ii) $CH_3-\underset{2}{\overset{CH_3}{C}}=\underset{3}{CH}-\underset{4}{CH_2}-\underset{5}{\overset{C_2H_5}{CH}}-\underset{6}{CH_2}-\underset{7}{CH_2}-\underset{8}{CH_3}$
1

5-Ethyl–2–methyl–2–octene

(iii) Alkene – H = Alkenyl

e.g., $CH_2 = CH–$ ethenyl (Vinyl group); $CH_2 = CH – CH_2 –$ propenyl (Allyl group)

e.g., $CH_2 = CH – Cl$ - Vinyl chloride; $CH_2 = CH–CH_2–OH$ Allyl alcohol

Preparations of Alkenes :

From Alcohols

By heating alcohol with H_2SO_4 or H_3PO_4 at 170°C.

$$CH_3 – CH_2 – OH \xrightarrow[170°C]{95\%\ H_2SO_4} CH_2 = CH_2$$

Mechanism :

1st step : $H_2SO_4 \longrightarrow H^+ + HSO_4^-$

2nd step : $CH_3 – CH_2 – OH + H^+ \rightleftharpoons CH_3 – CH_2 – \overset{+}{O}H_2$

3rd step : $CH_3 – CH_2 – \overset{\oplus}{O}H_2 \rightarrow CH_3 – \overset{\oplus}{C}H_2 + H_2O$

4th step : $CH_2 – \overset{+}{C}H_2 \longrightarrow CH_2 = CH_2 + H_2SO_4$ (H and HSO_4 shown)

Here the 3rd step i.e. formation of carbocation is rate determining step.

The ease of dehydration of alcohols depends on the stability of carbocations formed. Hence the order of reactivity of alcohols is ter–> sec–> pri–> $CH_3 – OH$ because the incipient carbonium ion stability is ter–> sec–> pri–> CH_3^+.

Note : Since the carbocation stability is the primary criteria so the initally formed carbocation undergoes molecular rearrangement by either to give more stable carbocation.

Hydride shift or

Example (Hydride shift)

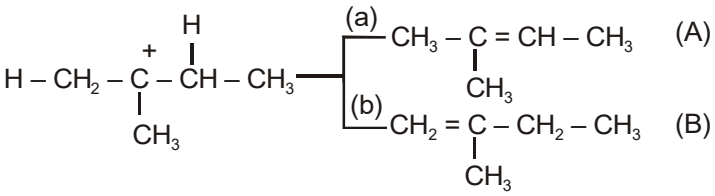
$$CH_3 – \underset{\displaystyle CH_3}{\underset{|}{CH}} – \underset{\displaystyle OH}{\underset{|}{CH}} – CH_3 \xrightarrow[170°c]{H_2SO_4} CH_3 – \underset{\displaystyle CH_3}{\underset{|}{C}} = CH_2 – CH_3 \ (\text{Major}) \ + \ CH_2 = \underset{\displaystyle CH_3}{\underset{|}{C}} – CH_2 – CH_3 \ (\text{Minor})$$

Mechanism :

$$CH_3 – \underset{\displaystyle CH_3}{\underset{|}{CH}} – \underset{\displaystyle :\ddot{O}H}{\underset{|}{CH}} – CH_3 + \overset{+}{H} \longrightarrow CH_3 – \underset{\displaystyle CH_3}{\underset{|}{CH}} – \underset{\displaystyle \overset{+}{O}H_2}{\underset{|}{CH}} – CH_2$$

$$CH_3 – \underset{\displaystyle CH_3 \quad \overset{+}{O}H_2}{\overset{H}{\overset{|}{C}}} – CH – CH_3 \longrightarrow CH_3 – \underset{\displaystyle CH_3}{\overset{H}{\overset{|}{C}}} – \overset{+}{C}H – CH_3 \longrightarrow CH_3 – \underset{\displaystyle CH_3}{\overset{+}{C}} – CH_2 – CH_3$$

sec-carbocation (Less stable) ter-carbocation (More stable)

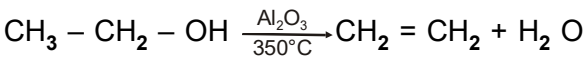


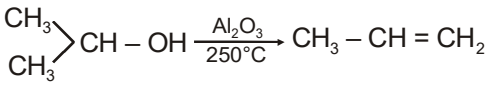
(i) Dehydration of alcohols follow Saytzeff's rule.

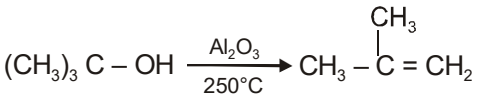
Hence (B) product is maximum.

Saytzeff's Rule: It states that "During dehydration of alcohols and dehydrohalogenation of alkyl halides the product formed is preferentially the one in which maximum number of alkyl groups are attached to the doubly bonded carbon atoms.

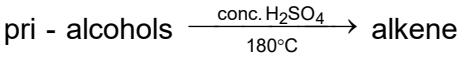
(ii) Dehydration by passing over alumina (Lewis Acid)

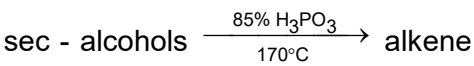


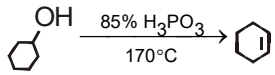


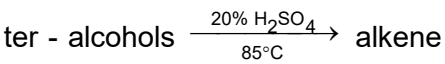


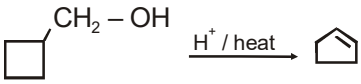
The experimental conditions change with the structure of alcohols



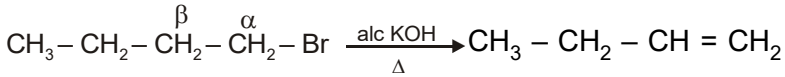


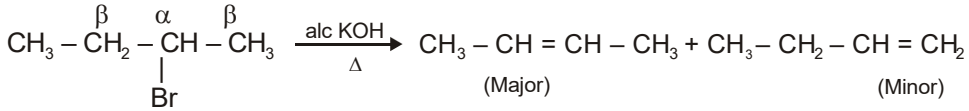
e.g., 

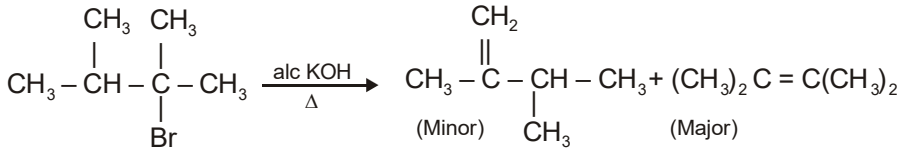




I. Dehydrohalogenation of alkyl halides

1. 

2. 

3. 

(i) The base used may be strongly basic anions like OH^-, RO^-, $C_2H_5O^-$.... $(CH_3)_3CO^-$ etc.)

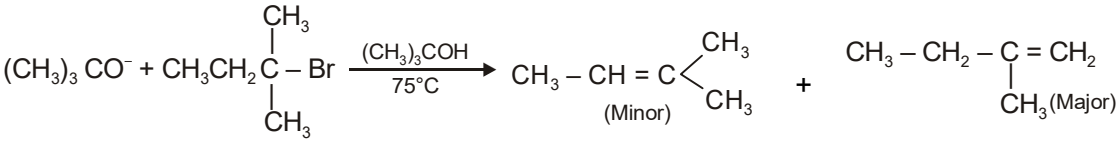
(ii) The group leaving (i.e., halogen) is a good leaving group if it is the conjugate base of a strong acid. (i.e., weakly basic halide ion).

(iii) One may also use sulphonates.

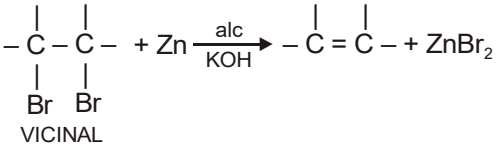
(iv) Dehydrohalogenation of 2° and 3° alkyl halides follow Saytzeff's Rule.

II. Exception to Saytzeff's Rule (Hofmann Rule)

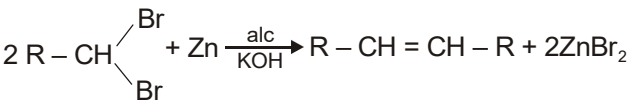
When dehydrohalogenation is carried out with potassium, tertiary butoxide there is formation of less substituted alkene.



III. Dehalogenation Reactions

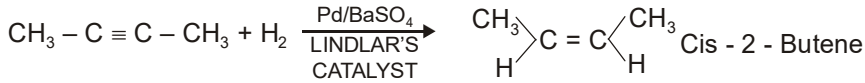


VICINAL

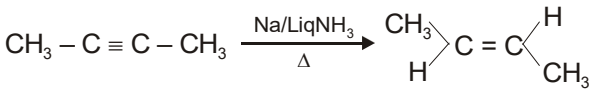


GEMINAL

IV. By controlled hydrogenation of alkynes

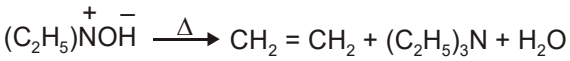
(i) 

Here we may use small amounts of sulphur or quinoline also.

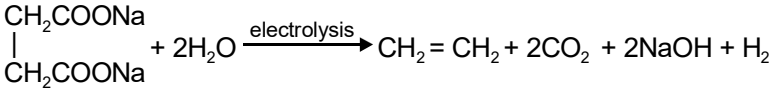


trans-2-Butene

V. By heating Quaternary Ammonium hydroxide



VI. Kolbe's Electrolysis



Sodium succinate

Mechanism is similar to preparation of alkanes.

VII. Pyrolysis

$$CH_3CH_2CH_2CH_3 \xrightarrow[770K]{\Delta} CH_3–CH=CH_2 + CH_4$$

$$CH_3CH_2CH_2CH_2CH_2CH_3 \xrightarrow[770K]{\Delta} CH_3CH=CH_2 + CH_3CH_2CH_3$$

VIII. By heating saturated hydrocarbon with SiO_2

$$C_6H_5 – CH_2 – CH_2 – C_6H_5 \xrightarrow[\Delta]{SiO_2} C_6H_5–CH=CH–C_6H_5 + H_2$$

Physical Properties :

Solubility

They are insoluble in water but soluble in organic solvents.

Boiling point

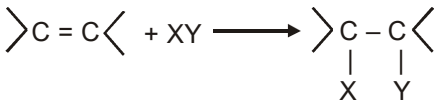
The boiling point of cis–alkenes is usually higher than corresponding trans–alkenes (More polarity).

Melting point

The melting point of trans-alkenes is usually greater than cis-alkene. (trans form is more symmetrical).

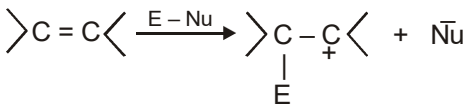
Chemical Properties :

In alkenes C = C bond is made of stable σ-bond and reactive π-bond. As π-bond can easily be broken, alkenes undergo addition reactions.

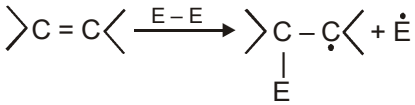


Being electron rich species they react with electrophiles in three ways.

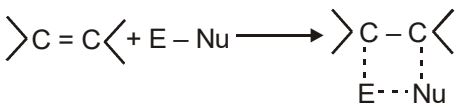
1. Ionic Mechanism



2. Free Radical Mechanism

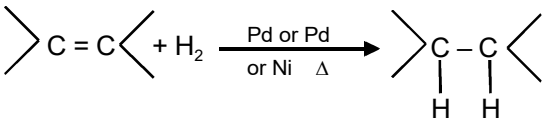


3. Transition State



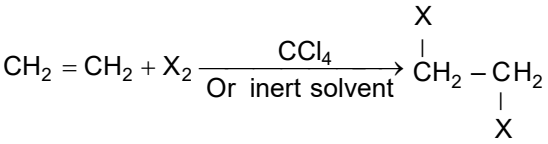
Reactions :

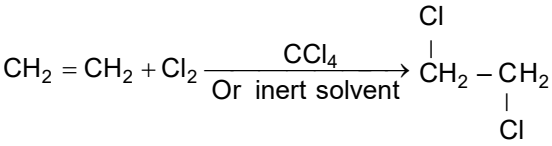
1. Hydrogenation :



The relative rates of hydrogenation is $CH_2 = CH_2 > RCH = CH_2 > R_2C = CH_2 > RCH = CHR > R_2C = CR_2$. This is due to the fact that as number of alkyl groups increase the steric hindrance increases and there by rate decreases.

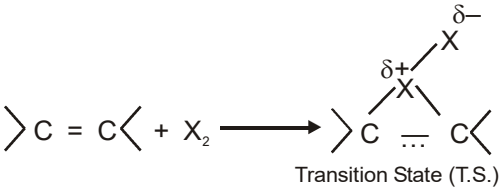
2. Halogenation :

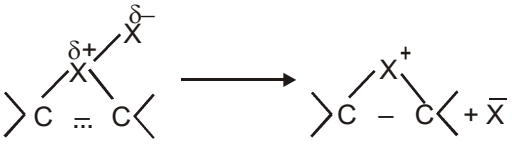


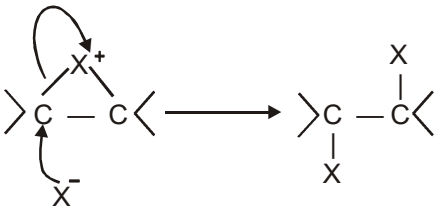


The addition always leads to the formation of trans addition product.

Mechanism :

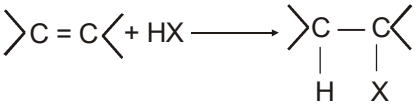






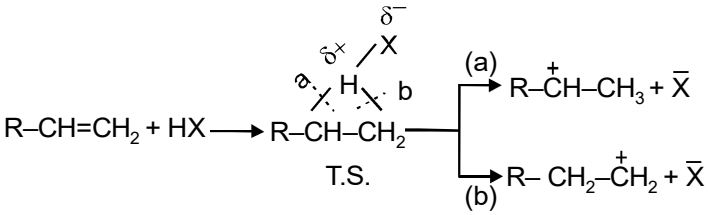
e.g., $CH_3 – CH = CH – CH_3 + Cl_2 \xrightarrow{-9°C} CH_3 – \underset{Cl}{CH} – \underset{Cl}{CH} – CH_3$

3. Addition of Halogen Acid

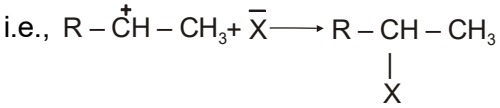


The reactivity order of halogen acid is HI > HBr > HCl

Mechanism :

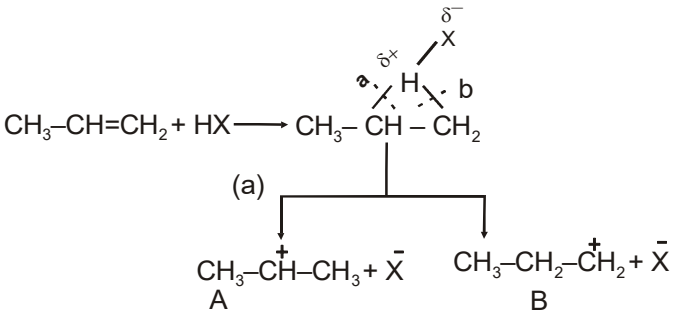


Here the transition state cleaves to from the most stable carbocation hence (a) cleavage takes place and hence, $R-\overset{+}{C}H_2-CH_3+\bar{X}$ are formed

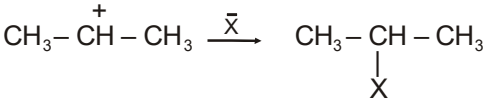
i.e., 

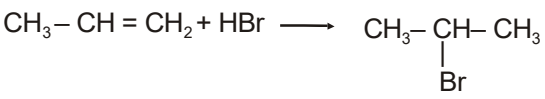
Markownikoff's Rule may therefore be applied. It states that, "During the addition of unsymmetrical reagents to unsymmetrical alkenes, the negative part of the addendum goes to carbon of double bond with least number of atoms".

Example :



Since A is more stable than B. Hence A is formed and we get





Kharasch - Mayo Effect :

If the above reaction is carried out in the presence of some peroxide then addition takes place contrary to Markownikoff's Rule

$CH_3 - CH = CH_2 + HBr \xrightarrow{\text{Peroxide}} CH_3 - CH_2 - CH_2 - Br$

Explanation

This can be explained on the basis of free radical formation

Step 1 : $R - O - O - R \longrightarrow 2R - \dot{O}$

Step 2 : $R - \dot{O} + HBr \longrightarrow ROH + \dot{B}r$

Step 3 : $CH_3 - CH = CH_2 + \dot{B}r$ → $CH_3 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_2^{\bullet}$ (A) 1° Carbon free radical

→ $CH_3 - \dot{C}H - CH_2 - Br$ (B)

(B) is more stable than (A). 2° Carbon free radical

Hence (B) is formed.

$R - \dot{C}H - CH_2 - Br + HBr \longrightarrow R - CH_2 - CH_2 - Br + \dot{B}r$

Note : Only HBr adds on by Anti Markownikoff's Rule (in presence of organic peroxide) not HCl or HI.

4. Addition of Hypohalous Acid

$>C = C< + HOX \longrightarrow >\underset{\displaystyle OH}{\underset{|}{C}} - \underset{\displaystyle X}{\underset{|}{C}}<$

$CH_2 = CH_2 + HOCl \longrightarrow \underset{\displaystyle OH}{\underset{|}{CH_2}} - \underset{\displaystyle Cl}{\underset{|}{CH_2}}$

$CH_2 - CH = CH_2 + HOBr \longrightarrow CH_2 - \underset{\displaystyle OH}{\underset{|}{CH}} - \underset{\displaystyle Br}{\underset{|}{CH_2}}$

5. Addition of Water

This reaction also takes place via carbocation mechanism (Rearrangement possible).

$(CH_3)_2 C = CH_2 + H_2O \xrightarrow[10\%\ H_2SO_4]{H^+} CH_3 - \underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}} - OH$

6. Addition of cold and conc. H_2SO_4

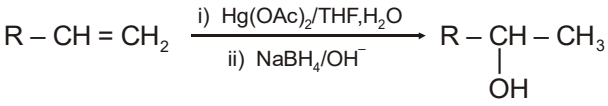
Carbocation Mechanism Followed, (Rearrangement Possible)

$R - CH = CH_2 + H_2SO_4 \longrightarrow R - \underset{\displaystyle HSO_4}{\underset{|}{CH}} - CH_3 \xrightarrow[Heat]{H_2O} R - \underset{\displaystyle OH}{\underset{|}{CH}} - CH_3$

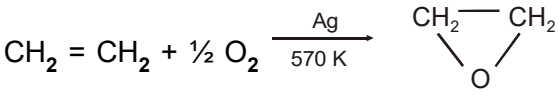
7. Oxy-Mercuration - Demercuration

Synthesis of alcohols from alkenes is in accordance with Markownikoff's Rule

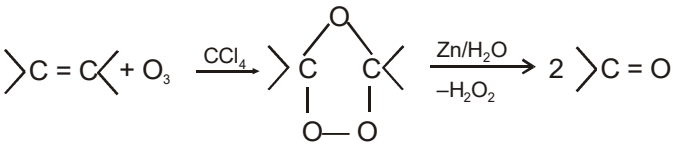
(No carbocation formed)



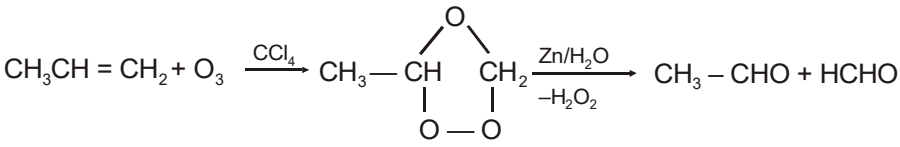
8. Addition of Oxygen:

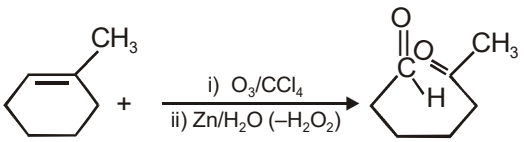


9. Ozonolysis:



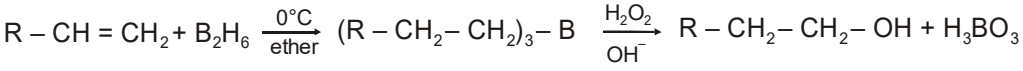
Example :





Ozonalysis helps to locate the positions of double bonds in alkene.

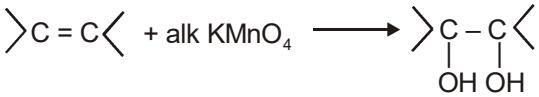
10. Hydroboration Oxidation



(Product is Antimarkownikov product.)

11. Oxidation Reactions

(a) Reaction with Baeyer's Reagent (Cold dilute Alkaline $KMnO_4$, Hydroxylation)



The addition is a syn addition to form vicinal dihydroxy compounds.

Note : Decolorization of Baeyer's reagent is also used as a test for unsaturation.

(b) With hot $KMnO_4$ or acidic $KMnO_4$

$$CH_2 = CH_2 \xrightarrow[\text{Hot } KMnO_4]{[O]} 2HCOOH \longrightarrow 2CO_2 + 2H_2O$$

$$CH_3 - CH = CH_2 \xrightarrow[H^+]{KMnO_4} CH_3COOH + CO_2 + H_2O$$

$$(CH_3)_2C = C(CH_3)_2 \xrightarrow[KMnO_4]{Hot} 2\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!C = O$$

12. Substitution Reaction

$$CH_3–CH = CH_2 + Cl_2 \xrightarrow{500-600°C} Cl–CH_2–CH=CH_2 + HCl$$

This type of reaction takes place at a carbon atom attached to double bond carbon. This is called allylic substitution.

Mechanism

Step - 1 : $Cl - Cl \xrightarrow{500-600°C} 2Cl^{\bullet}$

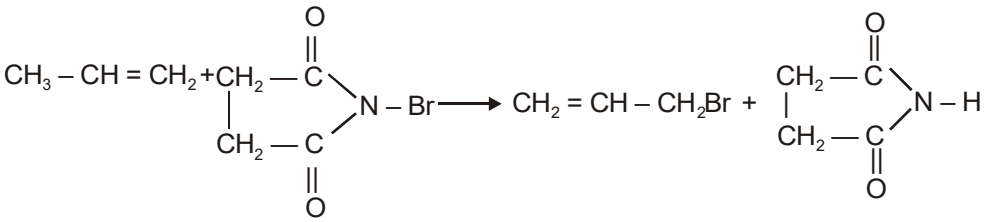
Step - 2 : $CH_2=CH–CH_3 \xrightarrow{+Cl^{\bullet}} HCl + CH_2 = CH– \dot{C}H_2$

Step - 3 : $CH_2 = CH - \dot{C}H_2 + Cl_2 \longrightarrow CH_2 = CH – CH_2 – Cl + Cl^{\bullet}$

13. Wohl Zeigler Reaction

$$CH_3 – CH = CH_2 + Br_2 \xrightarrow{\text{Low conc. of } Br_2} CH_2 = CH–CH_2–Br$$

The low concentration of Br_2 is obtained from NBS



14. Addition of Carbenes

(i) $\overset{-}{C}H_2 – \overset{+}{N} \equiv N \xrightarrow{h\nu} \ddot{C}H_2 + N_2$

(ii) $CH_3 – CH = CH_2 + \ddot{C}H_2 \xrightarrow{h\nu} CH_3 – CH(CH_2)CH_2$

15. Isomerization :

$$CH_2– CH_2– CH_2– CH = CH_2 \xrightarrow[\text{or } Al_2(SO_4)_3;\ 470\ K]{700 - 970\ atm} CH_3– CH_2– CH = CH – CH_3$$

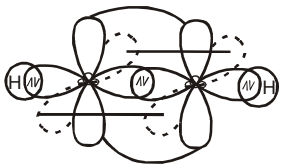
16. Polymerization :

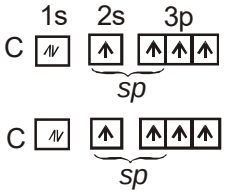
$$CH_2 = CH_2 \xrightarrow[O_2]{\text{Pressure}} -(CH_2 – CH_2)_n-$$

$$CF_2 = CF_2 \xrightarrow[O_2]{\text{Trans}} -(F_2C – CF_2)_n-$$

ALKYNES

Compounds containing the structural unit – C≡C– are called Alkynes. Like the double bond it is unsaturated and highly reactive towards the reagent that double bonds react with and also towards others. The simplest member of the alkyne family is acetylene, C_2H_2.Each of the carbon atoms carrying the triple bond are **sp** hybridized.





Alkynes the compounds having general formula C_nH_{2n-2} where $n \geq 2$ it can be categorize by two ways.

1. **Terminal alkynes :** Alkynes having triple bond at one end of the carbon attached to H
   e.g. $CH_3–C \equiv C–H$, $CH_3 – CH_2–C\equiv CH$. Terminal hydrogen is acidic in nature.
2. **Non-terminal alkynes :** Alkynes in which both triple bonded carbons are attached to alkyl group.

Preparation of Alkynes :

1. From Dehydrohalogenation of vicinal or geminal dihalides

$$CH_2(Br)–CH_2(Br) \xrightarrow[\Delta]{\text{alc. KOH}} CH \equiv CH + 2H_2O + KBr$$

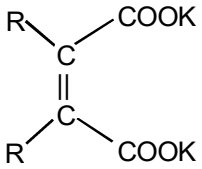
$$R–CH(Br)–CH_2(Br) \xrightarrow[\Delta]{\text{alc. KOH}} R – C \equiv CH + 2H_2O + KBr$$

2. Dehalogenation Reaction

(a) $$–C(X)(X)–C(X)(X)– \xrightarrow[\Delta]{\text{Zn dust}} –C \equiv C + 2ZnX_2$$

(b) $$2R–C(X)(X)(X) \xrightarrow[\Delta]{\text{Zn dust}} R – C \equiv C – R + 3ZnX_2$$

3. Kolbe's Electrolytic Decarboxylation



$$+ 2H_2O \xrightarrow{\text{Electrolysis}} R – C \equiv C – R + 2KOH + CO_2 + H_2$$

cis or trans

4. Formation of Higher alkyne

(i) $$CH \equiv CH \xrightarrow[\Delta]{NaNH_2} CH \equiv \bar{C}\,\overset{+}{Na} + NH_3$$

$$CH \equiv \bar{C}\,\overset{+}{Na} + CH_3Cl \longrightarrow CH \equiv C – CH_3 + NaCl$$

(ii) $R\text{–}C \equiv CH + NaNH_2 \longrightarrow RC \equiv \bar{C}\overset{+}{Na} + NH_3$

$R\text{–}C \equiv \bar{C}\,\overset{+}{Na} + R'X \longrightarrow R\text{–}C \equiv C\text{–}R' + NaX$

Chemical Properties :

Alkynes undergo electrophilic addition generally but in the presence of salt of heavy metals which forms complexes with multiple bonds it undergo nucleophilic addition reaction.

1. Addition Reaction

A. Electrophilic addition reaction :

(i) Addition of halogen

$$\underset{CH}{\overset{CH}{|||}} + Cl_2 \longrightarrow \underset{\text{acetylene dichloride}}{CHCl = CHCl} \xrightarrow{Cl_2} \underset{\substack{\text{acetylene tetrachloride}\\ \text{(westron)}}}{\underset{CHCl_2}{\overset{CHCl_2}{|}}}$$

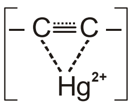
$$CH_3 - C \equiv CH \xrightarrow{Br_2/CCl_4} \underset{\text{Trans-1, 2-dibromopropene}}{CH_3 - \underset{Br}{\underset{|}{C}} = C\begin{matrix} \diagup Br \\ \diagdown H \end{matrix}} \xrightarrow{Br_2/CCl_4} \underset{\text{1, 1, 2, 2-tetra bromo propane}}{CH_3 - \underset{Br}{\underset{|}{\overset{Br}{\overset{|}{C}}}} - \underset{Br}{\underset{|}{\overset{Br}{\overset{|}{C}}}} - H}$$

(ii) Addition of halogen acids

$$HC \equiv CH \xrightarrow[CH_3COOH]{HCl} \underset{\text{Vinyl chloride}}{CH_2 = CHCl} \xrightarrow[CH_3COOH]{HCl} \underset{\text{Ethylidene chloride}}{CH_3CHCl_2}$$

$$CH \equiv CH \xrightarrow[\substack{\text{or}\\ HOCl}]{Cl_2/H_2O} \underset{Cl}{\underset{|}{CH}} = CHOH \xrightarrow{HOCl} CHCl_2 - \overset{OH}{\overset{|}{CH}} - OH \xrightarrow{-H_2O} \underset{\text{Dichloro acetaldehyde}}{HCCl_2 - CHO}$$

B. Nucleophilic addition reaction :

Because of greater electronegativity of sp hybridized C as compared to sp^2 hybridized carbons, Alkynes are more susceptible to nucleophilic addition reactions than alkenes. It is due to formation of some sort of complex of heavy metal ion with π electrons like 

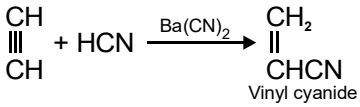
and this results decrease in electron density around triply bonded carbon atoms and this can be attacked by nucleophiles.

(i) Addition of H_2O or hydration of alkyne or Kucherov reaction

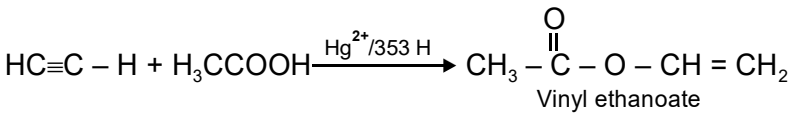
$$\underset{CH}{\overset{CH}{|||}} + H_2O \xrightarrow[333\ K]{H^+,\ Hg^{2+}} \underset{\text{Vinyl alcohol}}{H - \overset{H}{\overset{|}{C}} = \overset{OH}{\overset{|}{C}} - H} \underset{}{\xrightleftharpoons{\text{tautomerise}}} \underset{\text{Acetaldehyde}}{CH_3 - \overset{O}{\overset{||}{C}} - H}$$

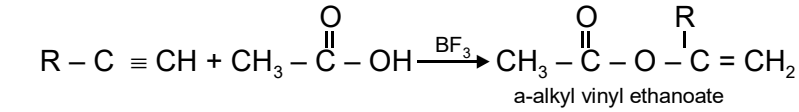
$$R - C \equiv C - H + H_2O \xrightarrow{H^+,\ Hg^{2+}} R - \overset{OH}{\overset{|}{C}} = CH_2 \xrightarrow{\text{tautomerise}} \underset{\text{Ketone}}{R - \overset{O}{\overset{||}{C}} - CH_3}$$

(ii) Addition of HCN



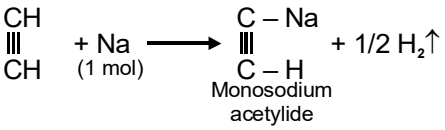
Similarly alkynes adds acids in presence of lewis acid catalyst or Hg^{2+} give vinyl ester.

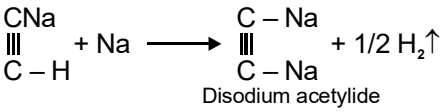


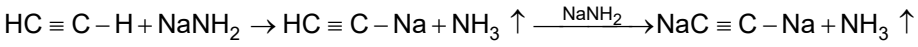


2. Reaction of Acidic H Atom

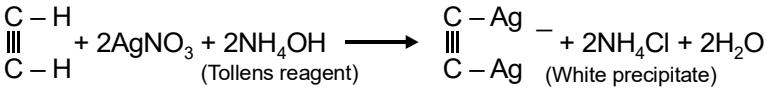
(i) Alkynes having acidic H atom reacts with metals like Na, K, evolves H_2 gas.



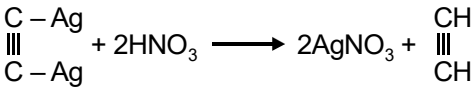


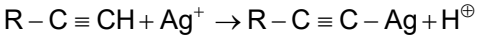


(ii) **Reaction with Tollens reagent :** When alkyne reacts with tollens reagent (Ammonical $AgNO_3$ solution) at forms white precipitate of silver acetylide.

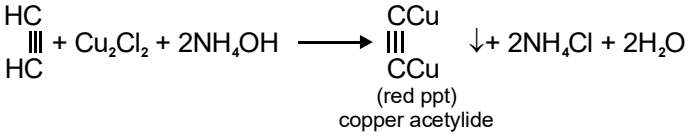


These acetylide are not decomposed by H_2O like acetylide of Na but by mineral acids like dil HNO_3.





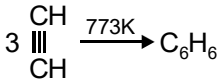
(iii) **Reaction with Ammonical Cuprous Chloride :**



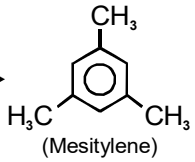
These reactions are used to distinguish terminal alkynes from other alkynes.

3. Polymerization Reaction

(i) When acetylene is passed in red hot cutube or retube. It converted into benzene.



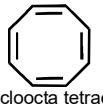
Similarly $CH_3 - C \equiv CH$ —red hot Cu or Fe tube→ (Mesitylene)



(ii) 2 $HC \equiv CH$ —$CuCl/NH_4Cl$ or Cu_2Cl_2/NH_4Cl→ $CH_2 = CH - C \equiv CH$ (Vinyl acetylene) —HCl→ $CH_2 = CH - \underset{Cl}{C} = CH_2$ (Chloroprene)

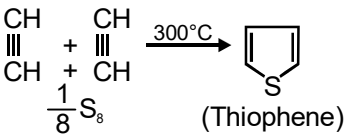
Chloroprene on polymerization gives polymer called neoprene; used as artificial rubber.

(iii) Under high pressure and in presence $Ni(CN)_2$ acetylene tetramerises.

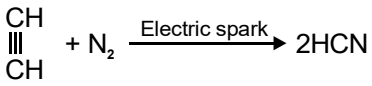
4 $CH \equiv CH$ —$Ni(CN)_2$→  Cycloocta tetraene

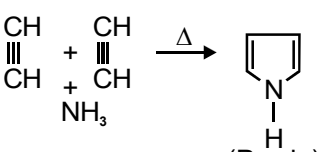
4. Reaction with S_8, N_2, NH_3 and HCN

Acetylene reacts with S_8, N_2, NH_3 and HCN to form different heterocyclic compounds.

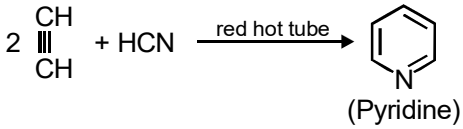
(i) 

(Thiophene)

(ii) 

(iii) 

(Pyrole)

(iv) 

(Pyridine)

AROMATIC HYDROCARBONS

Hydrocarbons which follow Huckel rule are termed as Aromatic hydrocarbons.

Huckel's rule :

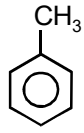
A planar molecule having complete delocalisation of (4n + 2) π electrons is termed as aromatic hydrocarbon (where n is any integer)

e.g.,

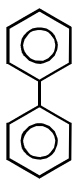

4n + 2 = 6
n = 1

4n + 2 = 2
n = 0

4n + 2 = 6
n = 1

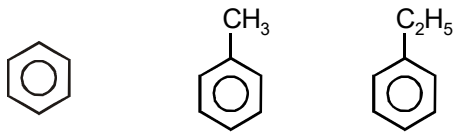


4n + 2 = 6
n = 1


4n + 2 = 6
n = 1

Homologues of Benzene :

They are all aromatic hydrocarbons. Aromaticity is present due to benzene ring.

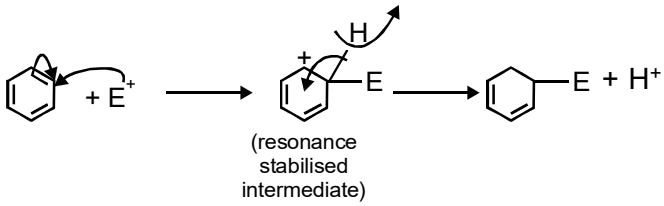


etc.

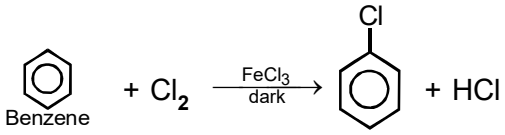
1. Electrophilic Aromatic substitution reactions in Benzene : (EAS)

Benzene and its homologues readily undergo EAS. As a consequence of complete delocalization of π electrons in benzene, it has π electron cloud over benzene ring which makes electrophile attack over it.

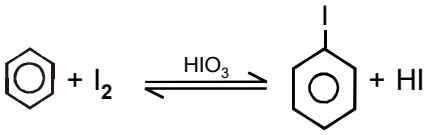
General Mechanism :



(i) Halogenation

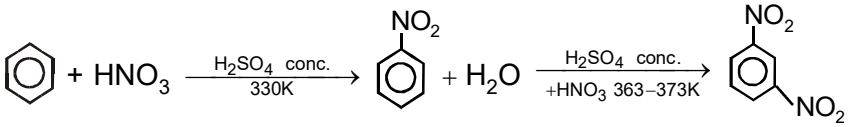


Reaction with I_2 is reversible.



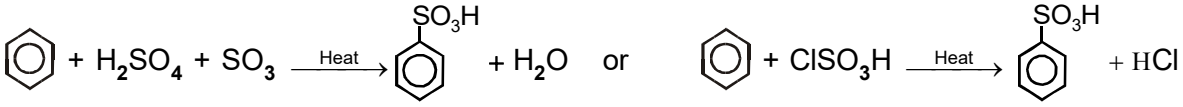
Hence it is carried out in the presence of conc. nitric acid to oxidise the Hydrogen Iodide formed.

(ii) Nitration



Nitro benzene

(iii) Sulphonation

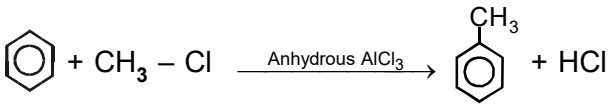


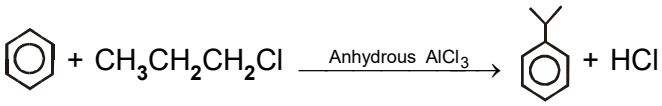
Chloro Sulphuric Acid

Benzene sulphonic acid

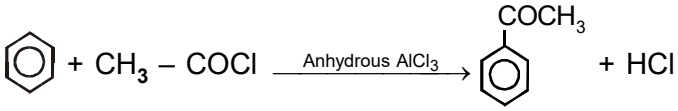
(iv) Friedel Crafts Reaction

Alkylation : Reactive intermediate is carbocation which can undergo rearrangement.





Acylation : Reactive intermediate is acylium ion $\left(R-\overset{\overset{O:}{\|}}{C}+\right)$ which cannot undergo rearrangement.

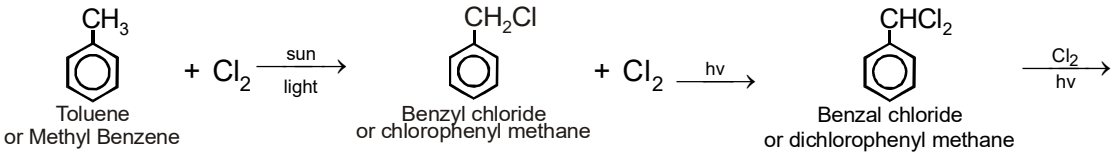


Acetyl chloride Acetophenone

Ortho and para substitution : Electron releasing groups like - R (alkyl) — $\ddot{O}H$, —$\ddot{O}R$, — $\ddot{N}H$ H R , —$\ddot{N}$HCOR are activating groups i.e., they increase electron density at ortho and para position, therefore, are ortho and para directing towards electrophilic substitution reactions.

Meta substitution : Electron withdrawing groups such as – NO_2, – CHO, – COOH, – $COCH_3$, – CN, – SO_3H, – COOR are called deactivating groups. They decrease electron density at ortho and para-position, therefore, electrophillic substitution takes place at meta-position.

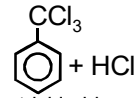
2. Halogenation of side chain :



Toluene
or Methyl Benzene

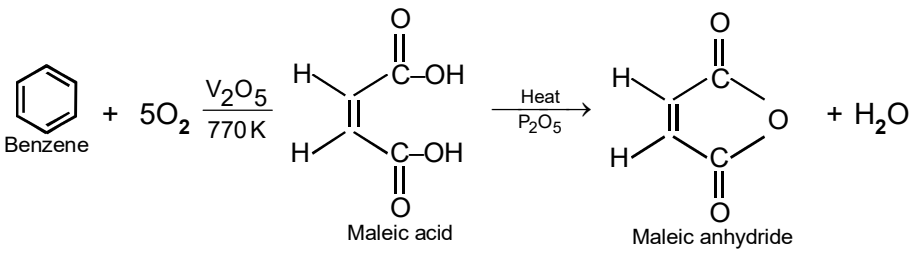
Benzyl chloride
or chlorophenyl methane

Benzal chloride
or dichlorophenyl methane



Benzotrichloride
or trichlorophenyl methane

3. Oxidation :



Maleic acid

Maleic anhydride

2-Butene-1,4-dioic acid

EXERCISE-1

1. The difference in potential energy between eclipsed and staggered form of ethane is

(1) 4 kJ/mol (2) 12.55 kJ/mol (3) 2 kJ/mol (4) 44 kJ/mol

2. Eclipsed form of ethane has higher energy due to

(1) Torsional strain (2) Steric strain (3) Angle strain (4) Both (1) & (2)

3. The angle strain in cyclopentane is

(1) 72° (2) 1°28′ (3) 44′ (4) 108°

4. Which one is most stable?

(1) Cyclopropane (2) Cyclobutane (3) Cyclopentane (4) Cyclohexane

5. The chair form is _____ stable than boat form by potential energy _____ kJ/mol.

(1) More, 44 kJ/mol (2) Less, 44 kJ/mol (3) More, 12.55 kJ/mol (4) Less, 4 kJ/mol

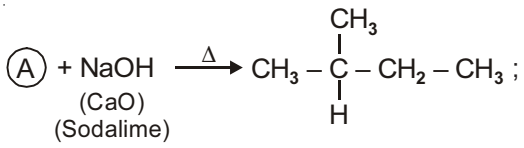
6. Which one of the following statement is not correct for sigma- and pi-bonds formed between two carbon atoms?

(1) Sigma-bond is stronger than a pi-bond

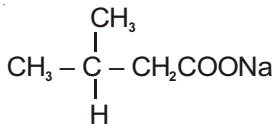
(2) Bond energies of sigma- and pi-bonds are of the order of 264 kJ/mol and 347 kJ/mol, respectively

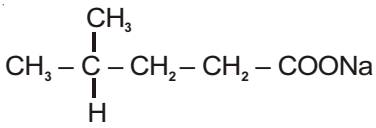
(3) Free rotation of atoms about a sigma-bond is allowed but not in case of a pi-bond

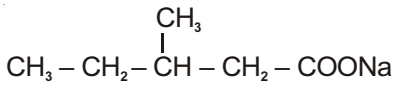
(4) Sigma-bond determines the direction between carbon atoms but a pi-bond has no primary effect in this regard

7. 

The possible compound (A) is

(1) 

(2) 

(3) 

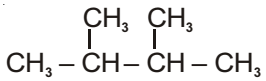
(4) Both (2) & (3)

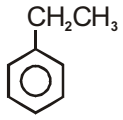
8. On electrolysis of sodium succinate, the alkene obtained is _____ and nature of solution after electrolysis is _____.

(1)  and acidic (2)  and basic (3)  and acidic (4)  and basic

9. Which one is not prepared by Wurtz reaction?

(1) C_2H_6 (2) n-C_4H_{10}

(3) CH_4 (4) 

10.  can be prepared by

(1) Wurtz reaction (2) Fittig reaction (3) Wurtz Fittig reaction (4) Frankland reaction

11. $Mg_2C_3 + H_2O \longrightarrow \textcircled{A} \xrightarrow{Na} \textcircled{B} \xrightarrow{CH_3Br} \textcircled{C}$;

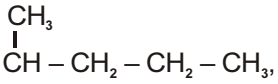
The incorrect statement for C is

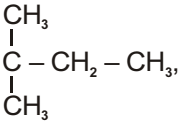
(1) Compound Ⓒ is $CH_3 - C \equiv C - CH_3$ (2) Ⓒ gives positive Tollen's test

(3) In compound Ⓒ all four carbon are linearly present (4) Compound Ⓒ on ozonolysis gives diketone

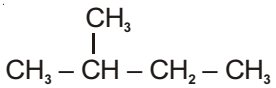
12. In the following compounds the decreasing order of B.P. is

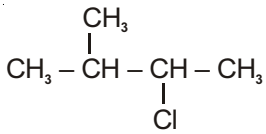
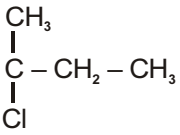
(I) $CH_3 - CH_2 - CH_2 - CH - CH_2 - CH_3$,

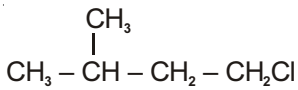
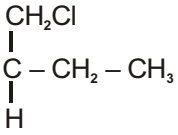
(II)  ,

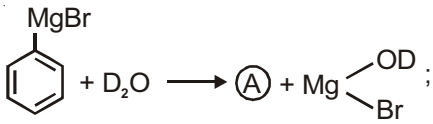
(III)  ,

(1) (I) > (II) > (III) (2) (I) > (III) > (II) (3) (II) > (III) > (I) (4) (III) > (II) > (I)

13.  ; The compound "A" is

(1)  (2) 

(3)  (4) 

14.  ;

The compound Ⓐ is

(1) Benzene (2) Duetero benzene (3) Duetero toluene (4) Both (2) & (3)

15. In iodination ; for preparation of iodomethane compound used is

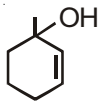
(1) HIO_3 (2) HgO (3) Both (1) & (2) (4) HI

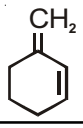
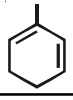
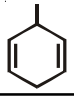
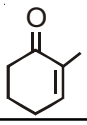
16. In chlorination the relation rate of abstraction of H in 3°, 2° and 1°C atom respectively

(1) 5 : 3.8 : 2 (2) 5 : 3.8 : 1 (3) 1600 : 82 : 1 (4) 1600 : 5 : 82

17. In which alkane isomerization will not occur?

(1) C_2H_6 (2) C_4H_{10} (3) C_5H_{10} (4) C_6H_{14}

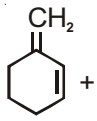
18. In  ; compound "A" is

(1)  (2)  (3)  (4) 

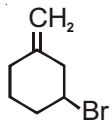
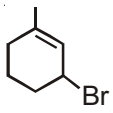
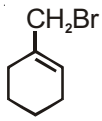
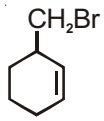
19. $CH_3 - C \equiv C - CH_3 \xrightarrow{Na/liq.\ NH_3} (A)$;
$\xrightarrow[(CH_3COO)_2Pb]{Pd/CaCO_3} (B)$;

The minimum heat of hydrogenation is in

(1) (A) (2) (B) (3) Both have equal (4) Cannot predict

20.  + HBr $\xrightarrow[\text{High temperature}]{CCl_4}$ "A" ;

The compound A is

(1)  (2)  (3)  (4) 

21. In which of the following reactions Markovnikov's rule is not observed ?

(1) $CH_3CH = CH_2 + HCl \longrightarrow$

(2) $CH_3CH = CH_2 + HBr \xrightarrow{\text{organic peroxide, h}\nu}$

(3) $CH_3CH = CH_2 + HBr \xrightarrow{H_2O_2,\ h\nu}$

(4) Both (2) & (3)

22. The reaction of $CH_3CH = CH_2$ with HOCl will yield

(1) 2-chloro-1-propanol (2) 3-chloro-2-propanol

(3) 1-chloro-2-propanol (4) 1-chloro-1-propanol

23. $C_6H_5CH_2CH_2CH_3$ is when oxidised in the presence of alk. $KMnO_4$, the product obtained is

(1) C_6H_5CHO (2) C_6H_5COOH (3) $C_6H_5CH_2CH_2CHO$ (4) $C_6H_5COCH_3$

24. What is X in the following sequence of reactions?

$X \xrightarrow[-1/2H_2]{Na} Z \xrightarrow{NaOH/CaO} CH_4$

(1) Methane (2) Ethanoic acid (3) Propane (4) None of these

25. Addition of HBr to propene

(1) Follows Markovnikov's rule

(2) Does not follow Markovnikov's rule

(3) Follows Markovnikov's rule but the product rearranges to give anti–Markovnikov's product

(4) Follows free radical mechanism

26. In an attempt to prepare propane by Wurtz reaction 1 mole of methyl bromide and 1 mole of ethyl bromide are treated with sodium. Assuming equal probability for all possible reaction. How many g of propane will be obtained?

(1) 44 g (2) 22 g (3) 33 g (4) 14.67 g

27. Addition of HBr to 2-methyl-1-propene in the presence of hydrogen-peroxide produces

(1) 1-Bromobutane (2) 2-Bromopropane

(3) 2-Bromo-2-methylpropane (4) 1-Bromo-2-methylpropane

28. Toluene $\xrightarrow[H_2SO_4]{K_2Cr_2O_7}$ Y . Here Y is

(1) Benzaldehyde (2) Toluene (3) Benzoic acid (4) Ethylbenzene

29. $C_6H_6 + Z \xrightarrow{AlCl_3}$ Toluene, Z is

(1) Acetic acid (2) Acetic anhydride (3) Acetone (4) Chloromethane

30. $C_6H_6 \xrightarrow[V_2O_5/\Delta]{\text{Oxidation}}$ X . Here, X is

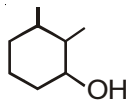
(1) Maleic anhydride (2) Acetic acid (3) Propanoic acid (4) Succinic acid

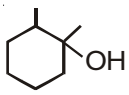
31. In Kharasch effect; reaction follows

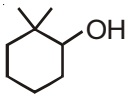
(1) Free radical substitution (2) Electrophilic addition

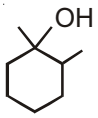
(3) Free radical addition (4) Nucleophilic addition

32.  $\xrightarrow[(2)\ H_2O_2/\bar{O}H]{(1)\ B_2H_6}$ "A" (Major) ; "A" is

(1) 

(2) 

(3) 

(4) 

33. $CH_3-\underset{Cl}{\underset{|}{CH}}-CH_2-CH_3 \xrightarrow{\text{Potassium tert. butoxide}}$ "A" is Major

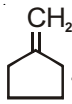
(1) $CH_3-CH=CH-CH_3$ (2) $CH_2=CH-CH_2-CH_3$

(3) $CH_3-\underset{CH_3}{\underset{|}{C}}=CH_2$ (4) Both (2) & (3)

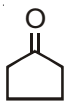
34. $\underset{CH}{\overset{CH_3}{\overset{|}{C}\equiv}}$ $\xrightarrow{KMnO_4 + H_2SO_4}$ (A) $\xrightarrow[CaO]{NaOH}$ (B) ;

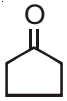
Compound (B) is

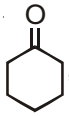
(1) C_2H_6 (2) CH_4 (3) CH_3COOH (4) CH_3COONa

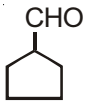
35.  $\xrightarrow[(2)\ H^+]{(1)\ KMnO_4/\Delta}$ (A) + (B) + (C) ; (C) → Turns $CuSO_4$ crystal to blue; (B) → Turns lime H_2O milky

Compound (A), (B) and (C) are respectively

(1) CH_2O, H_2O and 

(2)  , CO_2, H_2O

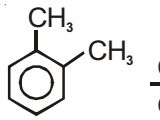
(3)  , SO_2, H_2O

(4)  , CO_2, H_2O

36. $(CH_3)_2C = C(CH_3) - CH = CH_2 \xrightarrow[(2)\ Zn/H_2O]{(1)\ O_3} (A) + (B) + (C)$;

Which one is not (A), (B), (C)?

(1) $CH_3 - \overset{O}{\overset{\|}{C}} - CH_3$ (2) CH_2O (3) $CH_3 - \overset{O}{\overset{\|}{C}} - CHO$ (4) CH_3CHO

37.  $\xrightarrow[(2)\ Zn/H_2O]{(1)\ O_3}$ (A) + (B) + (C) ;

(A), (B) and (C) can be

(1) $CH_3 - \overset{O}{\overset{\|}{C}} - \overset{O}{\overset{\|}{C}} - CH_3$ (2)  (3) $CH_3 - \overset{O}{\overset{\|}{C}} - CHO$ (4) All of these

38. Baeyer's reagent is

(1) 1% Alkaline $KMnO_4$ (2) Acidic $KMnO_4$ (3) Neutral $KMnO_4$ (4) Aq. Br_2 solution

39. Acetylene when oxidized with chromic acid gives

(1) Ethylene glycol (2) Oxalic acid (3) Formic acid (4) Acetic acid

40. The catalyst used to reduce an alkyne to alkene is

(1) Raney Nickel (2) Palladium (3) Lindlar's catalyst (4) Iron

41. Benzene undergoes substitution reaction more easily than addition because

(1) It has a cyclic structure (2) It has three double bonds

(3) Of delocalization of π-electrons (4) It has six hydrogen atoms

42. A mixture of C_2H_6, C_2H_4 and C_2H_2 is bubbled through alkaline solution of copper (I) chloride, contained in Woulf's bottle. The gas coming out is

(1) Original mixture (2) C_2H_6 (3) C_2H_6 and C_2H_4 mixture (4) C_2H_4 and C_2H_2

43. Ethylene + $S_2Cl_2 \rightarrow$ "A" ; The compound "A" is

(1) Lewisite (2) Mustard oil (3) Mustard gas (4) Insecticide

44. $Ph - C \equiv CH \xrightarrow{Hg^{2+},\ H^+/H_2O}$ "A".

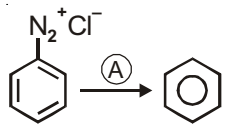
Addition of H_2O in the reaction is an example of

(1) Electrophilic addition (2) Nucleophilic addition

(3) Free radical addition (4) Electrophilic substitution

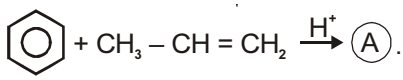
45. Monomer of neoprene is

(1) Chloroprene (2) Acetylene (3) Vinyl acetylene (4) Both (2) & (3)

46.  $\xrightarrow{(A)}$ $+ N_2\uparrow + HCl\uparrow$

Compound "A" is

(1) H_3PO_2 (2) H_3PO_3 (3) H_3PO_4 (4) Both (1) & (2)

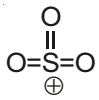
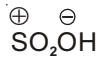
47.  .

Compound "A" is

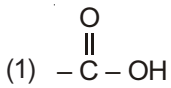
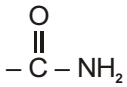
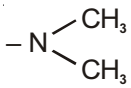
(1) Isopropyl benzene (2) Cumene

(3) An alkyl derivative of benzene (4) All of these

48. In sulphonation of benzene; electrophilic reagent used is

(1)  (2) SO_3 (3)  (4) 

49. Which one is o, p-directing group for electrophilic substitution reaction?

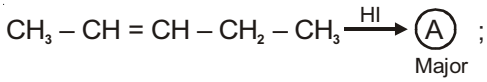
(1)  (2)  (3)  (4) $-NO_2$

50. In Chlorobenzene (I), 2,4 - dinitrochlorobenzene (II),

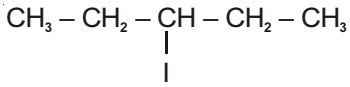
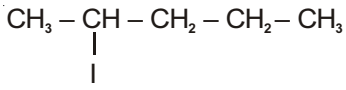
p - nitrochlorobenzene (III)

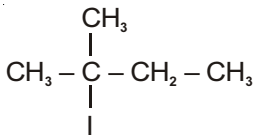
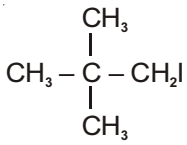
The decreasing order of reactivity towards electrophilic substitution reaction is

(1) (I) > (II) > (III) (2) (I) > (III) > (II) (3) (II) > (I) > (III) (4) (III) > (I) > (II)

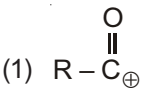
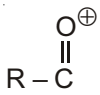
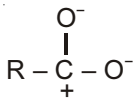
51.  ;

Compound (A) is

(1)  (2) 

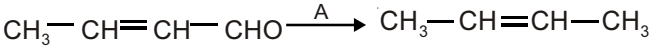
(3)  (4) 

52. The electrophile which attacks in Friedel-Craft acylation is

(1)  (2)  (3)  (4) Both (1) & (3)

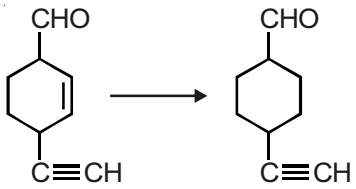
53. Which of the following shows geometrical isomerism?

(1) But-1-ene (2) But-2-ene (3) Prop-1-ene (4) Pent-1-ene

54. 

The best suitable reagent 'A' is

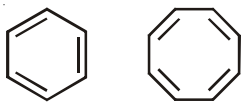
(1) $C_3H_8S_2/H_2/Ni$ (2) N_2H_4/KOH (3) Zn–Hg/conc. HCl (4) HI/P(red)

55. 

The most suitable reagent for given conversion is

(1) Diimide (2) H_2/Ni_2B (3) Zn/dil. HCl (4) $LiAlH_4$

56. Consider the following two structures

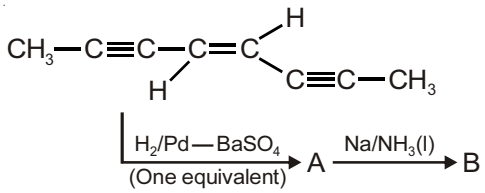


(i) (ii)

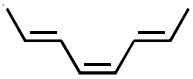
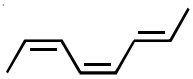
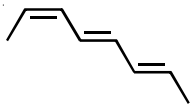
Choose the correct statement

(1) Both (i) & (ii) are conjugated system (2) (i) & (ii) both show resonance

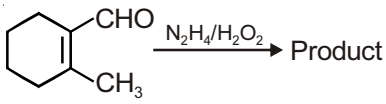
(3) (i) & (ii) both are aromatic (4) (i) is less stable than (ii)

57. 

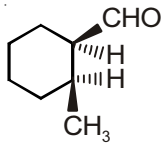
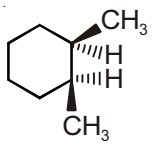
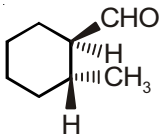
In above reaction product (B) is

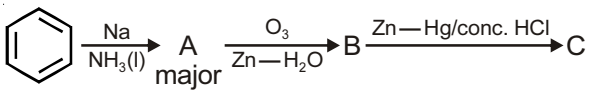
(1)  (2)  (3)  (4) 

58. In the given reaction



The product will be

(1)  (2)  (3)  (4) Mixture of (1) & (2)

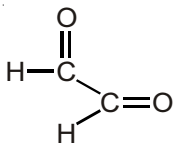
59. 

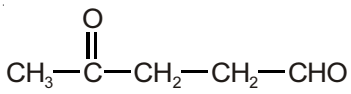
Product (C) is

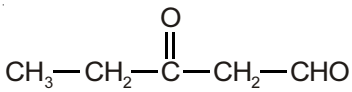
(1) Mixture of n-butane, ethane (2) Only propane

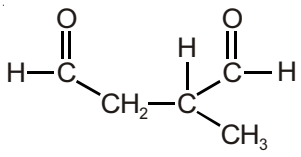
(3) Only ethane (4) n-hexane

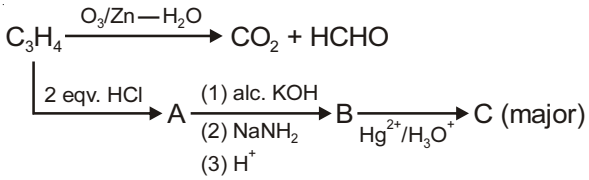
60. Natural rubber is a polymer of isoprene (2-methyl buta-1, 3-diene). If natural rubber is treated with O_3 followed by Zn/H_2O, the final product will be

(1) 

(2) 

(3) 

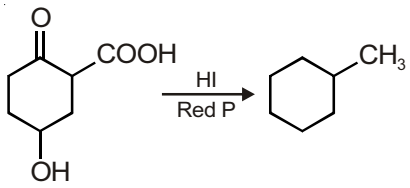
(4) 

61. 

Product (C) is

(1) Propanal (2) Butanal (3) 2-pentanone (4) Propanone

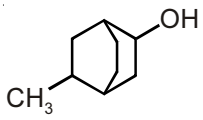
62. In the given reaction

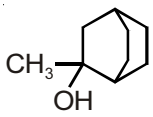


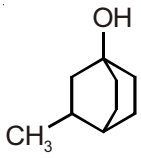
The number of moles of HI required for conversion is

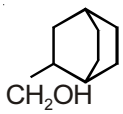
(1) 12 (2) 8 (3) 14 (4) 10

63. Dehydration by conc. H_2SO_4 is the most difficult in

(1) 

(2) 

(3) 

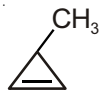
(4) 

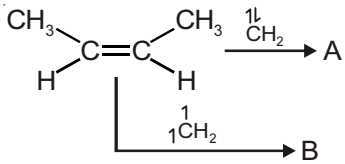
64. Which of the following can form methane gas with methyl magnesium bromide?

(1) 

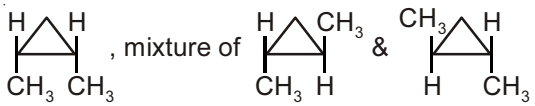
(2) 

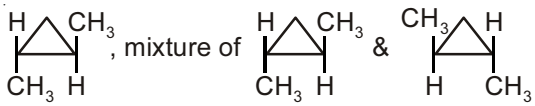
(3) 

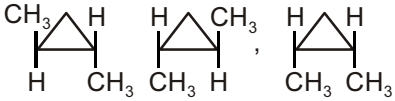
(4) 

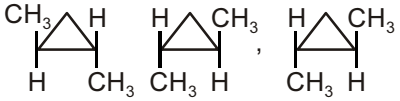
65. 

A & B are respectively

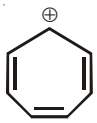
(1) 

(2) 

(3) Mixture of 

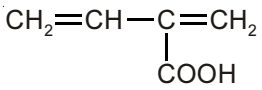
(4) Mixture of 

66. Which of the following compound is paramagnetic?

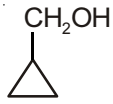
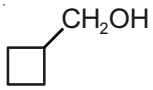
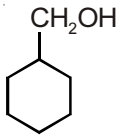
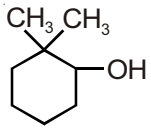
(1) 
(2) 
(3) 
(4) 

67. $CaC_2 \xrightarrow{H_2O} A \xrightarrow[NH_4Cl]{Cu_2Cl_2} B \xrightarrow[(2)\ Mg/ether\ (3)\ CO_2/H_2O/H^+]{(1)\ 1\ eqv.\ HCl} C$

In above reaction product (C) is

(1) $CH_2{=}CH{-}COOH$
(2) $HC{\equiv}C{-}COOH$
(3) $HOOC{-}C{\equiv}C{-}COOH$
(4) 

68. In which of the following dehydration by conc. H_2SO_4 no rearrangement is favourable?

(1) 
(2) 
(3) 
(4) 

69. Which is maximum stable?

(1) But-1-ene
(2) *cis*-but-2-ene
(3) *trans*-but-2-ene
(4) All have equal

70. Geometrical isomers differ in

(1) Position of functional group
(2) Position of atoms
(3) Spatial arrangement of atoms
(4) Length of carbon chain

71. The correct order of reactivity towards the electrophilic substitution of the compounds aniline (I), benzene (II) and nitrobenzene (III) is

(1) III > II > I
(2) II > III I
(3) I < II > III
(4) I > II > III

72. The reactive species in the nitration of benzene is

(1) NO_3
(2) NHO_3
(3) NO_2^+
(4) NO_2^-

73. Which of the following compounds will exhibit *cis-trans* (geometrical) isomerism?

(1) But-2-enol
(2) But-2-ene
(3) Butanol
(4) But-2-yne

74. The IUPAC name of the compound $CH_3CH{=}CHC{\equiv}CH$ is

(1) Pent-4-yn-2-ene
(2) Pent-3-en-1-yne
(3) Pent-2-en-4-yne
(4) Pent-1-yn-3-ene

75. Which of the following reagents will be able to distinguish between 1-butyne and 2-butyne?

(1) $NaNH_2$
(2) HCl
(3) O_2
(4) Br_2

76. $H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH=CH_2 + HBr \rightarrow A$

A (predominantly) is

(1) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3$

(2) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_2Br$

(3) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle Br}{\overset{|}{\underset{|}{C}}}}-CH_2CH_3$

(4) $CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$

77. The alkene R–CH = CH_2 reacts readily with B_2H_6 and the product on oxidation with alkaline hydrogen peroxides produces

(1) $R-\underset{\displaystyle CH_3}{\underset{|}{C}}=O$

(2) $R-\underset{\displaystyle OH}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH_2}}$

(3) R–CH_2–CHO

(4) R–CH_2–CH_2–OH

78. Electrophile in the case of chlorination of benzene in the presence of $FeCl_3$ is

(1) Cl

(2) $FeCl_3$

(3) Cl^+

(4) Cl^-

79. The bond length between central carbon atom and other carbon atom is minimum in

(1) Propene

(2) Propyne

(3) Propane

(4) Pentane

80. Which of the following is used as an anti-knocking material?

(1) Glyoxal

(2) Freon

(3) T.E.L.

(4) Ethyl alcohol

81. Which of the following reaction is expected to readily give a hydrocarbon product in good yields?

(1) $CH_3CH_3 \xrightarrow[\nu]{Cl_2}$

(2) $(CH_3)_3CCl \xrightarrow{C_2H_5OH}$

(3) $RCOOK \xrightarrow[\text{Oxidation}]{\text{Electrolysis}}$

(4) $RCOOAg \xrightarrow[h\nu]{I_2}$

82. In a reaction : $CH_2 = CH_2 \xrightarrow[\text{acid}]{\text{Hypochlorous}} M \xrightarrow{R} \underset{\displaystyle CH_2OH}{\overset{\displaystyle CH_2OH}{\overset{|}{\underset{|}{\quad}}}}$, where M = Molecule and R = Reagent. M and R are

(1) CH_3CH_2OH and HCl

(2) CH_3–CH_3 and heat

(3) CH_3CH_2Cl and NaOH

(4) CH_2Cl–CH_2OH and aq. $NaHCO_3$

83. The cylindrical shape of alkyne is due to

(1) Two sigma C–C and one π C–C bonds

(2) One sigma C–C and two π C–C bonds

(3) Three sigma C–C bonds

(4) Three π C–C bonds

84. In the commercial gasolines, the type of hydrocarbons which are more desirable is

(1) Linear unsaturated hydrocarbon

(2) Toluene

(3) Branched hydrocarbon

(4) Straight-chain hydrocarbon

85. The most stable conformation of n-butane is

(1) Gauche

(2) Staggered

(3) Skew boat

(4) Eclipsed

86. Which one of these is not compatible with arenes?

(1) Electrophilic additions

(2) Delocalisation of π-electrons

(3) Greater stability

(4) Resonance

87. When acetylene is passed through dil. H_2SO_4 in the presence of $HgSO_4$, the compound formed is
(1) Acetic acid (2) Ketone (3) Ether (4) Acetaldehyde

88. In Friedel-Craft's alkylation, besides $AlCl_3$ the other reactants are
(1) $C_6H_6 + CH_3Cl$ (2) $C_6H_6 + CH_4$
(3) $C_6H_6 + NH_2 - NH_2$ (4) $C_6H_6 + CH_3COCl$

89. Gammexane is
(1) Bromobenzene (2) Benzyl Chloride
(3) Chlorobenzene (4) Benzene hexachloride

90. In Friedel-Crafts reaction, toluene can be prepared by
(1) $C_6H_6 + CH_3Cl$ (2) $C_6H_5Cl + CH_4$ (3) $C_6H_6 + CH_2Cl_2$ (4) $C_6H_6 + CH_3COCl$

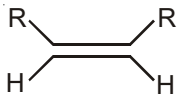
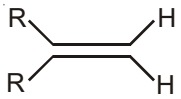
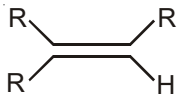
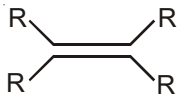
91. 2-butene shows geometrical isomerism due to
(1) Restricted rotation about double bond (2) Free rotation about double bond
(3) Free rotation about single bond (4) Chiral carbon

92. Dihedral angle in staggered form of ethane is
(1) 0° (2) 120° (3) 60° (4) 180°

93. Which alkene on ozonolysis gives 'CH_3CH_2CHO and $CH_3\overset{\overset{O}{\|}}{C}CH_3$?
(1) $CH_3CH_2CH=C<^{CH_3}_{CH_3}$ (2) $CH_3CH_2CH = CHCH_2CH_3$
(3) $CH_3CH_2CH = CHCH_3$ (4) $CH_3-\underset{\underset{CH_3}{|}}{C}=CHCH_3$

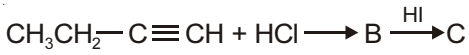
94. In preparation of alkene from alcohol using Al_2O_3 which is the effective factor?
(1) Porosity of Al_2O_3 (2) Temperature
(3) Concentration (4) Surface area of Al_2O_3

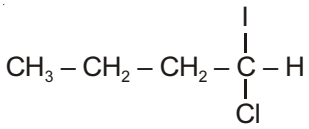
95. The compound $CH_3-\overset{\overset{CH_3}{|}}{C}=CH-CH_3$ on reaction with $NaIO_4$ in the presence of $KMnO_4$ gives
(1) CH_3COCH_3 (2) $CH_3COCH_3 + CH_3COOH$
(3) $CH_3COCH_3 + CH_3CHO$ (4) $CH_3CHO + CO_2$

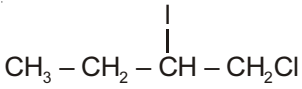
96. Which one of the following alkenes will react faster with H_2 under catalytic hydrogenation conditions?
(1)  (2)  (3)  (4) 

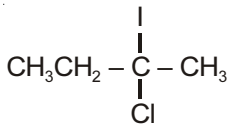
97. Products of the following reaction $CH_3C\equiv CCH_2CH_3 \xrightarrow[(ii)\ H_2O/Zn]{(i)\ O_3/\text{ether}}$ are
(1) $CH_3-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$ (2) $CH_3COOH + HOOC.CH_2CH_3$
(3) $CH_3CHO + CH_3CH_2CHO$ (4) $CH_3COOH + CH_3COCH_3$

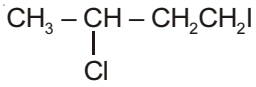
98. Predict the product C obtained in the following reaction of but-1-yne



(1) 

(2) 

(3) 

(4) 

99. Which of the compounds with molecular formula C_5H_{10} yields acetone on ozonolysis?

(1) 3-methylbut-1-ene
(2) Cyclopentane
(3) 2-methylbut-1-ene
(4) 2-methylbut-2-ene

100. One of the following which does not observe the anti-Markownikoff's addition of HBr, is

(1) Pent-2-ene
(2) Propene
(3) But-2-ene
(4) But-1-ene

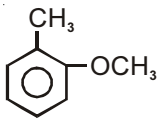
101. Benzene reacts with CH_3Cl in the presence of anhydrous $AlCl_3$ to form

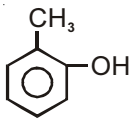
(1) Xylene
(2) Toluene
(3) Chlorobenzene
(4) Benzylchloride

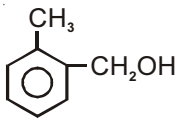
102. Liquid hydrocarbons can be converted to a mixture gaseous hydrocarbons by

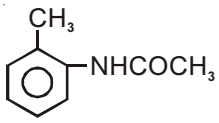
(1) Hydrolysis
(2) Oxidation
(3) Cracking
(4) Distillation under reduced pressure

103. Which one is most reactive towards electrophilic reagent?

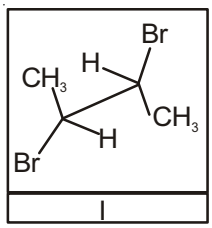
(1) 

(2) 

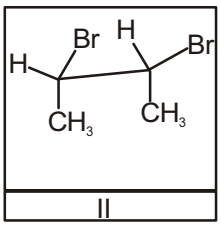
(3) 

(4) 

104. Given



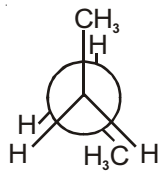
and

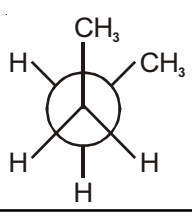


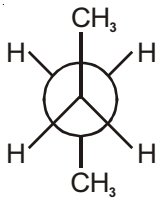
I and II are

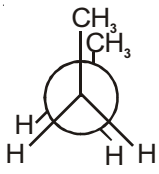
(1) A pair of optical isomers
(2) Identical
(3) A pair of conformers
(4) A pair of geometrical isomers

105. In the following the most stable conformation of *n*-butane is

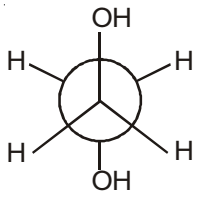
(1) 

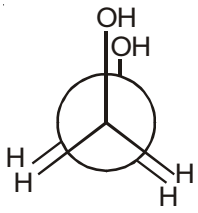
(2) 

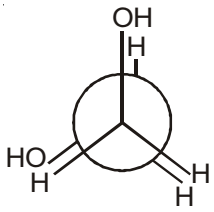
(3) 

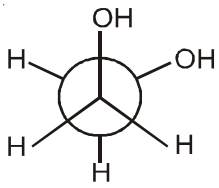
(4) 

106. Which of the following conformers for ethylene glycol is most stable?

(1) 

(2) 

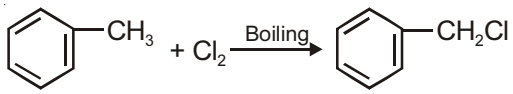
(3) 

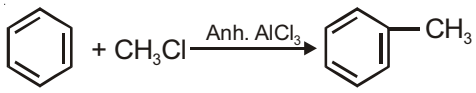
(4) 

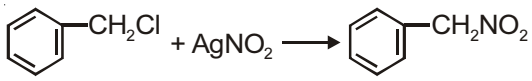
107. Reaction of HBr with propene in the presence of peroxide gives

(1) Isopropyl bromide (2) 3-bromo propane (3) Allyl bromide (4) n-propyl bromide

108. Which one of the following is a free-radical substitution reaction?

(1) 

(2) 

(3) 

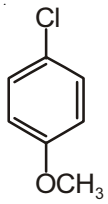
(4) $CH_3CHO + HCN \rightarrow CH_3CH(OH)CN$

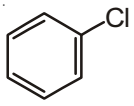
109. Using anhydrous $AlCl_3$ as catalyst, which one of the following reactions produces ethylbenzene (PhEt)?

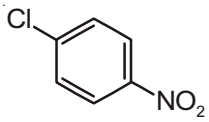
(1) $H_3C - CH_2OH + C_6H_6$ (2) $CH_3 - CH = CH_2 + C_6H_6$

(3) $H_2C = CH_2 + C_6H_6$ (4) $H_3C - CH_3 + C_6H_6$

110. Which of the following compounds undergoes nucleophilic substitution reaction most easily?

(1) 

(2) 

(3) 

(4) 

ANSWER KEY

EXERCISE-1

1	B	2	D	3	C	4	D	5	A	6	B	7	D
8	B	9	C	10	C	11	B	12	A	13	A	14	B
15	C	16	B	17	A	18	B	19	A	20	B	21	D
22	C	23	B	24	B	25	A	26	D	27	C	28	C
29	D	30	A	31	C	32	A	33	B	34	B	35	B
36	D	37	D	38	A	39	C	40	C	41	C	42	C
43	C	44	B	45	B	46	D	47	D	48	B	49	C
50	B	51	B	52	A	53	B	54	B	55	A	56	A
57	D	58	A	59	B	60	B	61	D	62	A	63	C
64	B	65	A	66	A	67	D	68	A	69	C	70	C
71	D	72	C	73	B	74	B	75	A	76	C	77	D
78	C	79	B	80	C	81	C	82	D	83	B	84	C
85	B	86	A	87	D	88	A	89	D	90	A	91	A
92	C	93	A	94	B	95	B	96	A	97	A	98	C
99	D	100	C	101	B	102	D	103	B	104	C	105	C
106	D	107	D	108	A	109	C	110	C				

SOLUTIONS

EXERCISE-1

1. (2)

Sol. The energy difference between the eclipsed and staggered term of ethane is 12.55 kJ/mol

2. (4)

Sol. The eclipsed form of ethane possess higher energy and hence unstable. This is due to the torsional strain and steric strain due to the repulsion between the electron clouds of the C-H bond.

3. (3)

Sol. Angle strain $\propto$ d $= \frac{1}{2}(109.5 - \alpha)$

$= \frac{1}{2}(109^\circ 28' - 108^\circ)$ [for cyclopentane a = 108° a = inner angle]

$= \frac{1^\circ 28'}{2} = 44'$

4. (4)

Sol. Cyclohexane is most stable because the ring is not planar but it is puckered in which all angles are tetrahedral and thus cyclohexane ring is strainless.

5. (1)

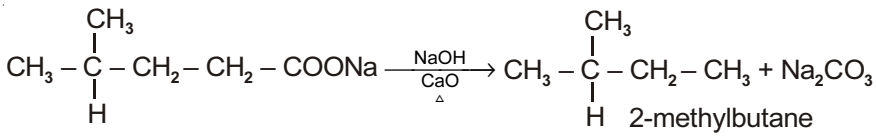
Sol. The chair form is more stable than boat form because in boat form, there is steric repulsion between flagpole hydrogen and chain form is more stable by potential energy of 44 kJ/mol.

6. (2)

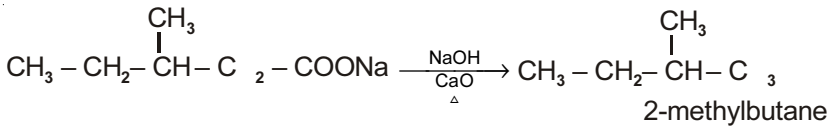
Sol. The bond energy of sigma bond is about 397 kJ/mol, where as the bond energy for pi bond is about 284 kJ/mol sigma bond is stronger than pi bond.

7. (4)

Sol.



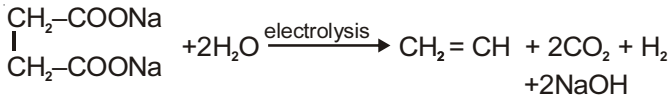
2-methylbutane



2-methylbutane

8. (2)

Sol.



Sodium succinate

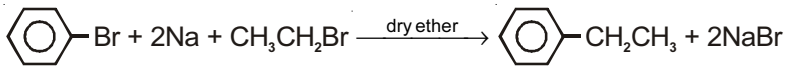
The hydrocarbon formed is ethene and solution is basic due to the formation of NaOH.

9. (3)

Sol. In Wurtz reaction the simplest alkane which can be prepared is C_2H_6, and it gives product with even number of carbon atoms $CH_3Br + 2Na + BrCH_3 \xrightarrow{\text{dry ether}} \underset{\text{ethane}}{CH_3 - CH_3} + 2NaBr$

10. (3)

Sol. The reaction of an aromatic halide with aliphatic halide in presence of Na and dry ether to give alkyl benzenes is called Wurtz fittig reaction



11. (2)

Sol. $Mg_2C_3 + H_2O \longrightarrow \underset{(A)}{CH_3-C\equiv CH} \xrightarrow{Na} CH_3-C\equiv \bar{C}\,Na \,(B) \xrightarrow{CH_3Br} \underset{(C)}{CH_3-C\equiv C-CH_3}$

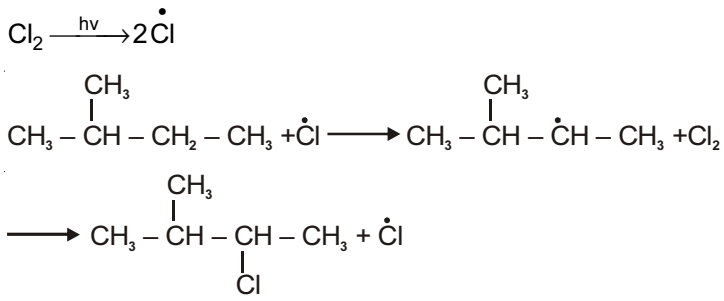
Since compound (C) is not a terminal alkyne and does not contain acidic H.

12. (1)

Sol. With increase in branching boiling point decreases. This is due to decrease in the magnitude of van der Waals forces with increase in branching. Therefore boiling point of n-hexane is higher than 2-methyl pentane and 2,2-dimethylbutane.

13. (1)

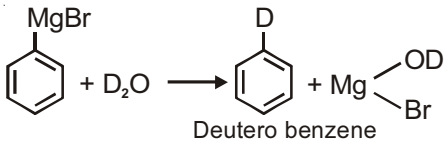
Sol. Mechanism



Selectivity for Cl_2 is 1 : 3. 8 : 5 for 1º : 2º : 3º

14. (2)

Sol.



Deutero benzene

15. (3)

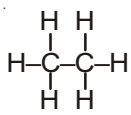
Sol. Both HNO_3 and HgO can be used for preparation of iodomethane because these oxidizes the HI formed as one of the product to shift the reaction in the forward direction $CH_4 + I_2 \underset{}{\overset{\Delta}{\rightleftharpoons}} CH_3I + HI$

16. (2)

Sol. The chlorination of alkanes proceeds through the formation of alkyl free radical and the order of stability of free radical is 3º>2º>1º, 3º radical is more stable because it has more number of Hyper conjugative structures. Therefore the relative rate of abstraction of H in 3º, 2º and 1º C atom is 5 : 3.8 : 1.

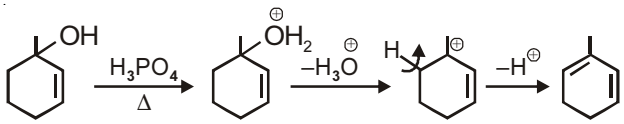
17. (1)

Sol.

In ethane, isomerization is not possible because it contains only two carbon atoms 

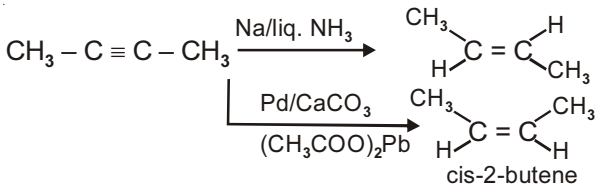
18. (2)

Sol.



19. (1)

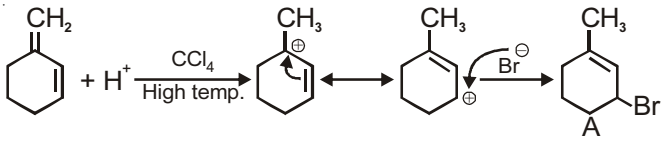
Sol.



Trans 2-butene will show minimum heat of hydrogenation because trans 2-butene is more stable as compared to cis 2-butene.

20. (2)

Sol.



21. (4)

Sol. Markovnikov's rule is not followed when free radical additon of HBr takes place to an unsymmetrical alkene

$$CH_3–CH = CH_2 + HBr \xrightarrow[h\nu]{\text{organic peroxide}} CH_3 - CH_2 - CH_2 - Br$$

$$CH_3–CH = CH_2 + HBr \xrightarrow{H_2O_2,\ h\nu} CH_3 - CH_2 - CH_2 - Br$$

Both these reactions follow free radical mechanism and hence Markovnikov's addition is not observed.

22. (3)

Sol.

$$CH_3 - CH = CH_2 + HOCl \longrightarrow \underset{\text{1-chloro-2-propanol}}{CH_3 - \overset{OH}{\overset{|}{C}}H - CH_2 - Cl}$$

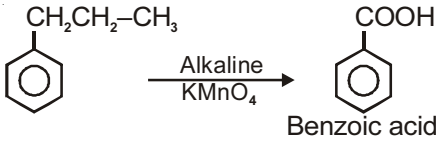
Mechanism

$$HOCl \rightleftharpoons HO^{\ominus} + Cl^{\oplus}$$

$$CH_3 - CH = CH_2 + Cl^{\oplus} \longrightarrow CH_3 - \overset{\oplus}{C}H - CH_2 - Cl + OH^{\ominus} \longrightarrow CH_3 - \overset{OH}{\overset{|}{C}}H - CH_2 - Cl$$

23. (2)

Sol.



Alkaline $KMnO_4$ is a strong oxidizing agent and oxidizes alkyl benzenes to benzoic acid.

24. (2)

Sol. $CH_3COOH \xrightarrow[-1/2H_2]{Na} CH_3COONa \xrightarrow[\text{Decarboxylation}]{NaOH/CaO} CH_4 + Na_2CO_3$

25. (1)

Sol. $CH_3 - CH = CH_2 + HBr \longrightarrow CH_3 - \underset{Br}{\overset{|}{C}}H - CH_3$

When HBr is adds to propene, Markovnikov's rule is obeyed. However in the presence of peroxide, free radical addition of HBr to propene takes place which does not follow Markovnikov's rule.

26. (4)

Sol. The possible reacts are

(i) $CH_3Br + 2Na + CH_3Br \rightarrow CH_3 - CH_3 + 2NaBr$

(ii) $CH_3Br + 2Na + CH_3CH_2Br \rightarrow CH_3CH_2CH_3 + 2NaBr$

(iii) $CH_3CH_2Br + 2Na + CH_3CH_2Br \rightarrow CH_3-CH_2-CH_2-CH_3 + 2NaBr$

1 mol of $CH_3CH_2CH_3$ weight = 44g

Grams of CH_3CH_2CH obtained $= \frac{44}{3}$

$= 14.67g$

Since 3 reactions of possible, the probability of formation of propane is $\frac{1}{3}$ and mass of propane obtained is $\frac{1}{3}$ of mass of mass of 1 mol of propane *i.e*, 14.67 g

27. (3)

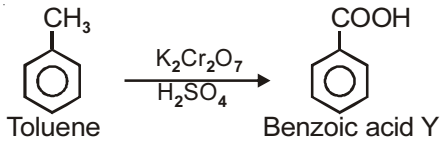
Sol. Mechanism

$R-O-O-R \xrightarrow{UV} 2R-\dot{O}$ $\quad HBr + R\dot{O} \longrightarrow R-OH + \dot{Br}$

$$CH_3 - \underset{CH_3}{\overset{|}{C}} - CH_2 + Br \longrightarrow CH_3 - \underset{Br}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}} - CH_2 + HBr \longrightarrow CH_3 - \underset{Br}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}} - CH_2 - Br$$

28. (3)

Sol.

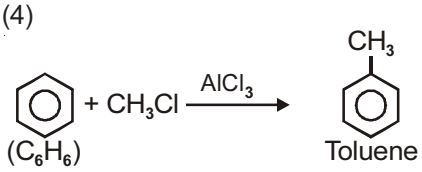


Toluene Benzoic acid Y

Acidified $K_2Cr_2O_7$ is an strong oxidizing agent and its oxidizes $-CH_3$ group of toluene to –COOH group

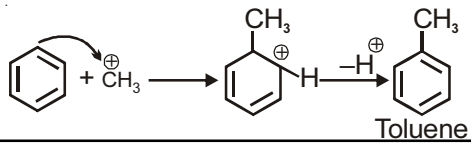
29. (4)

Sol.



(C_6H_6) Toluene

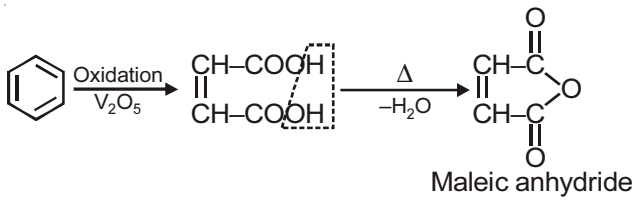
$CH_3Cl + AlCl_4 \rightarrow \overset{+}{C}H_3 + AlCl_4^-$



Toluene

30. (1)

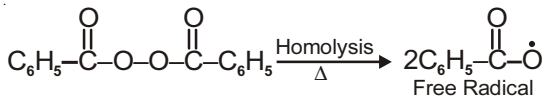
Sol.



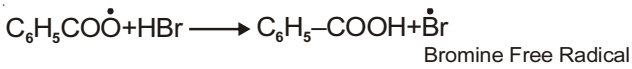
Maleic anhydride

31. (3)

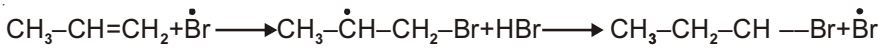
Sol. Kharasch effect is the anti-Markovnikov's addition of HBr to an unsymmetrical alkene in the presence of peroxide. This reaction follows free radical addition.



Free Radical

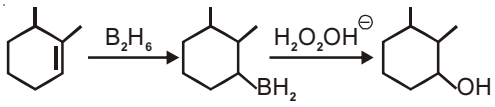


Bromine Free Radical



32. (1)

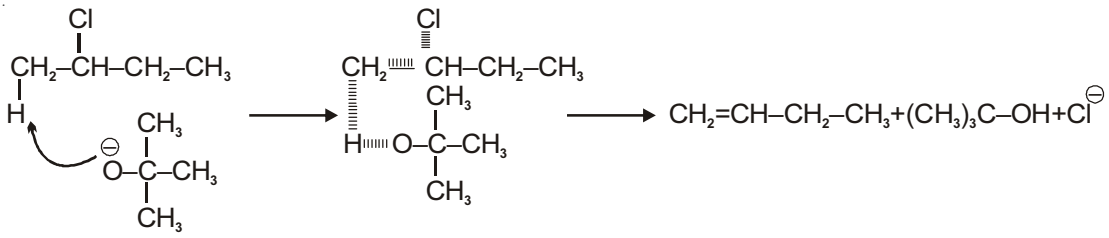
Sol.



Hydrobaration oxidation results in the anti-Markownikov's additon of water to alkene.

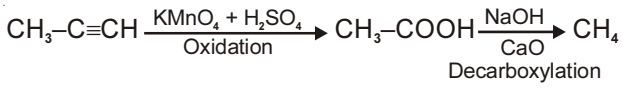
33. (2)

Sol.



34. (2)

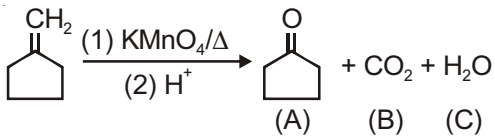
Sol.



Decarboxylation

35. (2)

Sol.

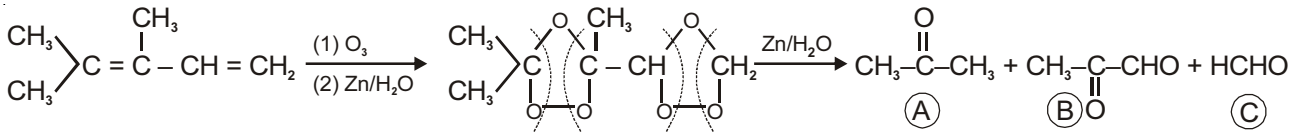


(A) (B) (C)

CO_2 turns lime water milky and H_2O turns $CuSO_4$ crystals to blue due to formation of hydrated salt.

36. (4)

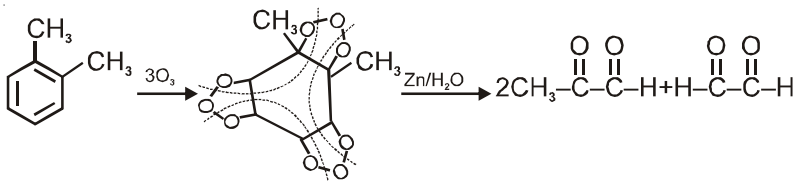
Sol. Ozonolysis of alkene results in oxidative cleavage

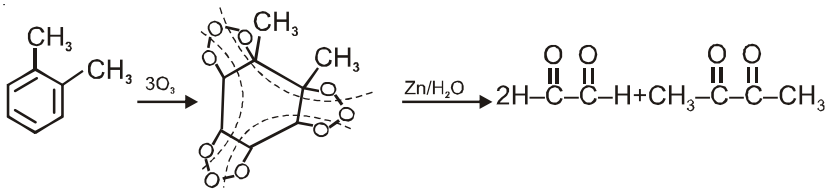


Hence CH_3CHO is not formed.

37. (4)

Sol.





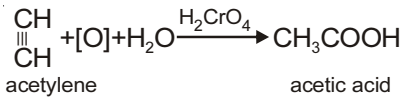
$CH_3-\overset{O}{\overset{\|}{C}}-CHO$, $CH_3-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-CH_3$ and $\begin{matrix}CHO\\|\\CHO\end{matrix}$ are formed.

38. (1)

Sol. 1% alkaline solution of $KMnO_4$ is known as Baeyer's reagent.

39. (4)

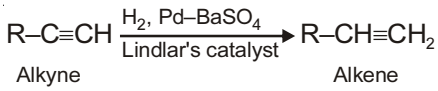
Sol.



acetylene acetic acid

40. (3)

Sol. Lindlar's catalyst is palladium deposited on $CaCO_3/BaSO_4$ which is poisoned with lead or sulpher compounds. It is used for the hydrogenation of alkyne to alkene in suitable solvent.



Alkyne Alkene

41. (3)

Sol. Benzene consist of sp_2 hybridized carbon atoms whose π-charge cloud is delocalized over the ring.

Because of the high stability of benzene due to aromaticity, it does not show addition reaction but since it contain electron charge cloud, it shows electrophilic substitution reaction.

42. (3)

Sol. Out of C_2H_6, C_2H_4 and C_2H_2, C_2H_2 will react with alkaline Cu_2Cl_2. Therefore only C_2H_6 and C_2H_4 will come out of the bottle.

$$CH\equiv CH+Cu_2Cl_2 \xrightarrow[NH_4OH]{\text{alkaline}} C_2Cu_2+2NH_4Cl+2H_2O$$

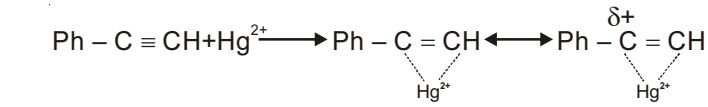
43. (3)

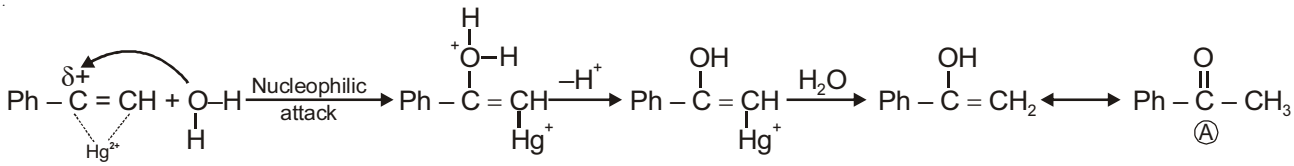
Sol. $S_2Cl_2+2C_2H_4 \rightarrow Cl–CH_2–CH_2–S–CH_2–CH_2–Cl+S$

Mustard gas

44. (2)

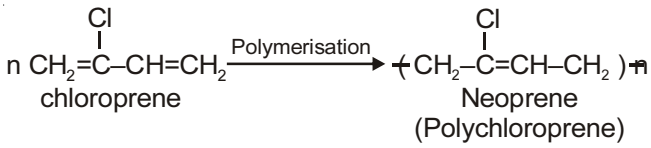
Sol.





45. (2)

Sol.



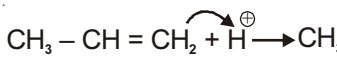
chloroprene — Neoprene (Polychloroprene)

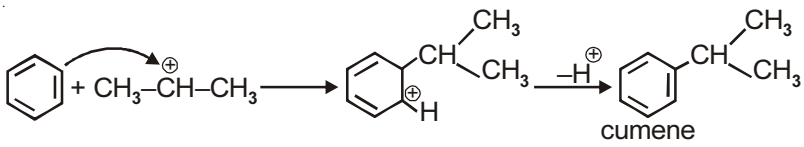
46. (4)

Sol. Both H_3PO_2 and H_3PO_3 can be used to convert benzene diazonium chloride to benzene.

47. (4)

Sol.

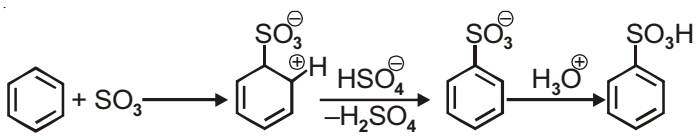




cumene is also known as isopropyl benzene which is an alkyl benzene.

48. (2)

Sol.

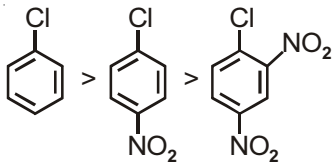


49. (3)

Sol. $-N(CH_3)_2$ is an electron donation group. It is an ortho and para directing group for electrophilic substitution reaction. $-\overset{O}{\overset{\|}{C}}-NH_2$, $-\overset{O}{\overset{\|}{C}}-OH$ and $-NO_2$ are electron withdrawing group. They are meta directing group for electrophilic substitution reaction.

50. (2)

Sol. Reactivity



$-NO_2$ group is an electron withdrawing group and its decreases the electron density on benzene ring due to its –R and –I effect. Since chlorobenzene does not contain nitro group it is most reactive towards electrophilic substitution, since p-nitrochlorobenzene contains only one nitro group, it is more reactive towards electrophilic substitution reaction as compared to 2, 4-dinitrochlorobenzene.

51. (2)

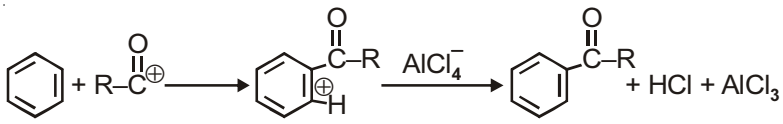
Sol. $CH_3 - CH = CH - CH_2 - CH_3 \xrightarrow{H^{\oplus}} \underset{(I)}{CH_3 - \overset{\oplus}{C}H - CH_2 - CH_2 - CH_3}$ (major) + $\underset{(II)}{CH_3 - CH_2 - \overset{\oplus}{C}H - CH_2 - CH_3}$ (minor)

$CH_3 - \overset{\oplus}{C}H - CH_2 - CH_2 - CH_3 + I^{\ominus} \longrightarrow CH_3 - \underset{I}{CH} - CH_2 - CH_2 - CH_3$

Carbocation (I) is more stable than carbocation II because I has more number of hyperconjugating structures.

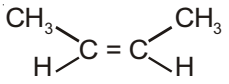
52. (1)

Sol. $R - \overset{O}{\overset{\|}{C}} - Cl + AlCl_3 \longrightarrow R - \overset{O}{\overset{\|}{C}}^{\oplus} + AlCl_4^{\ominus}$

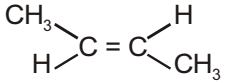


53. (2)

Sol.



Cis. but-2-ene



Trans. but-2-ene

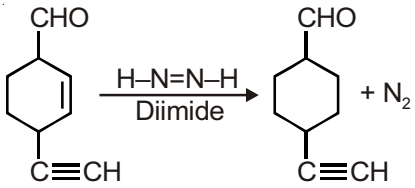
54. (2)

Sol. $CH_3-CH=CH-CHO \xrightarrow[KOH]{N_2H_2} CH_3-CH=CH-CH_3$

This is known as Wolff-kishner reduction it specifically converts/reduces carbonyl group to $-CH_2$ or CH_3 group without affecting the double bond.

55. (1)

Sol. Dimide are specifically used to hydrogenate the alkenes. The advantage of using diimide is that they does not react with triple bond or functional group present with the double bond.

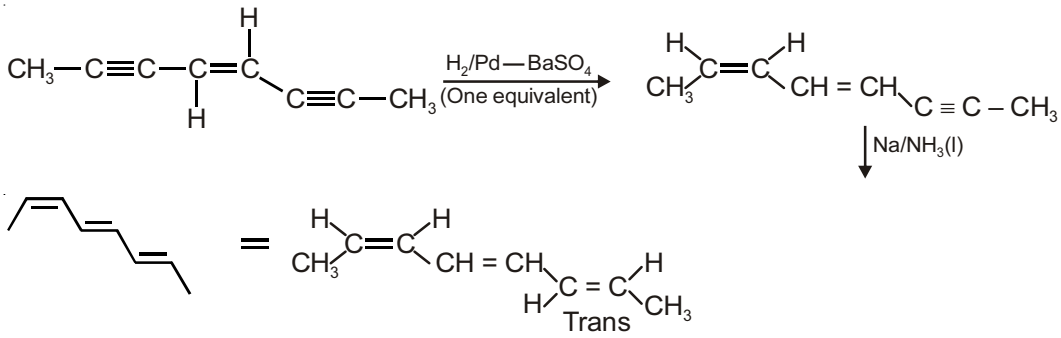


56. (1)

Sol. Benzene is an aromatic compound having conjugated double bonds and it is highly stable due to resonance. Cyclooctatetraene (stucture ii) on the other hand is a non-aromatic compound which is not planar and hence it does not exihibit resonance despite of having conjugated double bonds.

57. (4)

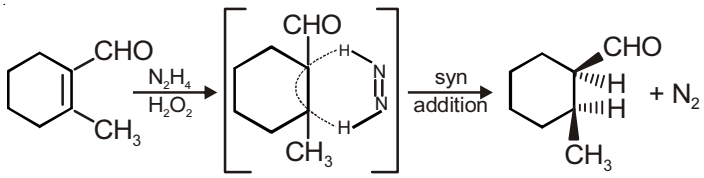
Sol.



H_2/Pd-$BaSO_4$ (Lindlar's catalyst) reduces/hydrogenates alkyne to give cis-alkene whereas Na/NH_3 (liquid) hydrogenates alkyne to give trans alkene.

58. (1)

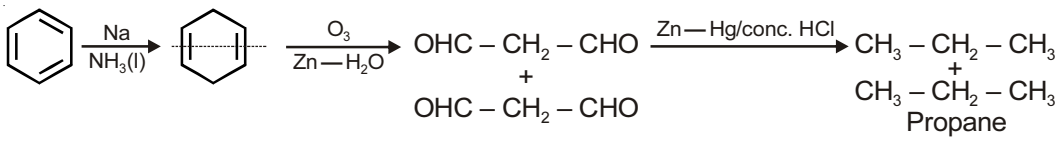
Sol. When N_2H_4 is treated with an oxidizing agent, it produces diimide which hydrogenates double bond and follows syn addition.



Overall result is the syn addition of H_2 to the double bond.

59. (2)

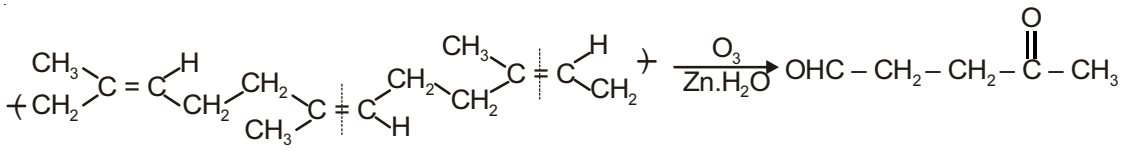
Sol.



The end product of this reaction sequence is propane only.

60. (2)

Sol.

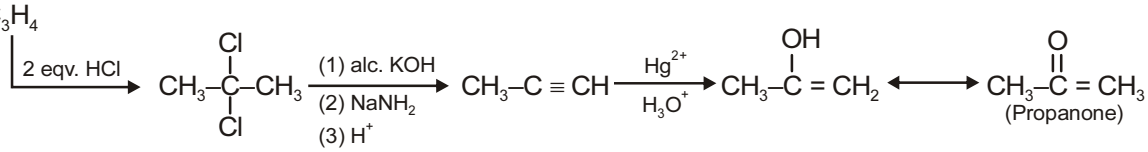


61. (4)

Sol.

$$CH_2 = C = CH_2 \xrightarrow{O_3/Zn-H_2O} 2HCHO + CO_2$$

C_3H_4



62. (1)

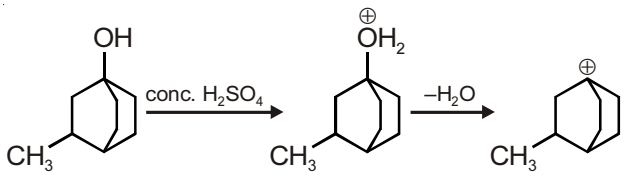
Sol. 1 mole of carbonyl or –OH group utilizes 4 moles of HI for their conversion into hydrocarbon

$$R - \overset{O}{\overset{\|}{C}} - R' + 4HI \xrightarrow[\Delta]{\text{Red P}} R - CH_2 - R' + H_2O + 2I_4$$

Since the given compound contain 3 group which can undergo reduction, It will require 12 moles of HI for the given conversion.

63. (3)

Sol. The dehydration of alcohols by conc. H_2SO_4 involves the formation of carbocation.

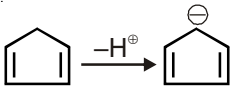


The above compound gives a bridgehead carbocation on dehydration. Since bridgehead carbocations are very unstable because of their non-planar structure, the dehydration of this compound with H_2SO_4 is very difficult.

64. (2)

Sol. Methyl magnesium bromide reacts with compound having acidic hydrogen to form methane gas for example $CH_3MgBr + AH \rightarrow CH_4 + AMgBr$ [AH = Aad]

Cyclopentadiene can loose a proton and acts as an acid, because cyclopentadienyl anion formed after loosing a proten is avite stable because of its aromatic nature.

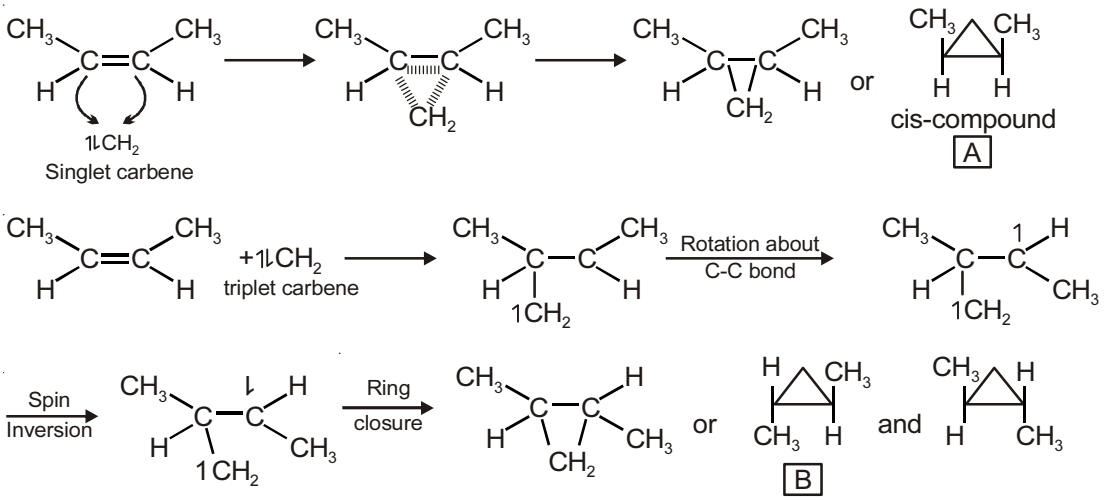


Cyclopentadienyl anion (Aromatic)

Since the conjugate base is stable, cyclopentadiene can loose a proton and will give methane gas on reaction with CH_3MgBr.

65. (1)

Sol.

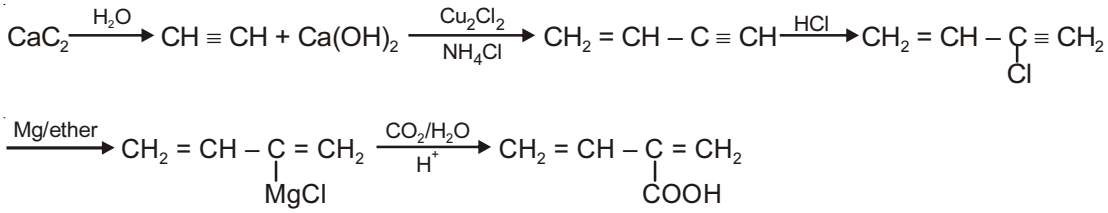


66. (1)

Sol. Antiaromatic compounds are paramagnetic in nature cyclobutadiene is an antiaromatic compound because it has cyclic planar structure but has 4π electrons.

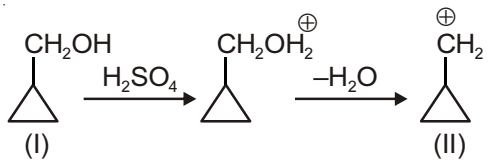
67. (4)

Sol.



68. (1)

Sol. Dehydration of alcohols with conc. H_2SO_4 involves the formation of carbocation. In the dehydration of compound I rearrangement is not possible because cyclopropyl ring strongly stabilizes the carbocation (II) and rearrangement is not favourable because of high stability of carbocation (II)

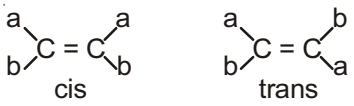


69. (3)

Sol. More substituted alkene are more stable among as and trans isomer, trans isomer is more stable due to less steric hindrance. Hence trans-but-2ene is more stable than cis-but-2ene and but-1-ene which is less substituted.

70. (3)

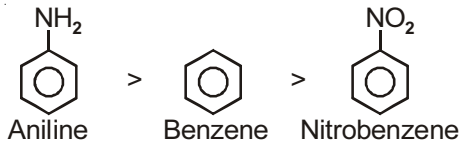
Sol. Geometrical isomer have same molecular formula but different spatial arrangement by atoms/groups.



71. (4)

Sol. Presence of electron donating group increases the reactivity of benzene towards electrophilic substitution while electron withdrawing groups decreases the reactivity of benzene towards electrophilic substitution.

Among aniline (I), benzene (II) and nitrobenzene, aniline is most reactive because of the presence of electron releasing $-NH_2$ group while nitrobenzene is least reactive due to the presence of electron withdrawing $-NO_2$ group.



72. (3)

Sol.

$$HNO_3 + H_2SO_4 \longrightarrow HSO_4^{\ominus} + NO_2^{\oplus} + H_2O$$

This $NO_2^{\oplus}$ ion acts as electrophile during the nitration of benzene.

73. (2)

Sol. But-2-ene exhibits geometrical isomerism and form cis-but-2-ene and trans-but-2-ene.

74. (2)

Sol. Generally double bond is given preference over triple bond during the numbering. Since double bond is getting 2nd position from both the ends, lowest sum rule is followed and numbering is done from alkyne end.

$$\overset{5}{C}H_3 - \overset{4}{C}H = \overset{3}{C}H - \overset{2}{C} \equiv \overset{1}{C}H$$

75. (1)

Sol. Terminal alkynes are acidic in nature and reacts with base because they contain acidic hydrogen.

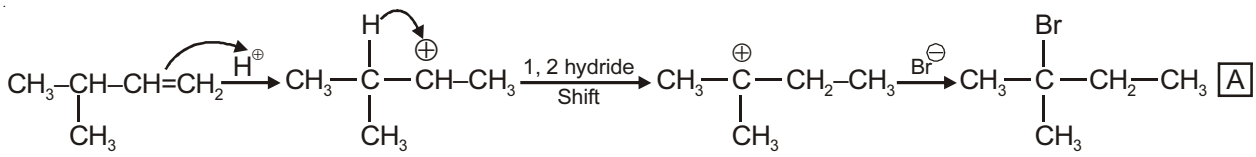
$CH_3 - C \equiv C - CH_3 + NaNH_2 \rightarrow$ No reaction.

$CH_3 - CH_2 - C \equiv CH + NaNH_2 \rightarrow CH_3 - CH_2 - C \equiv CNa + NH_3$

Since 2-butyne does not contain acidic hydrogen, it will not react with base ($NaNH_2$)

76. (3)

Sol.



77. (4)

Sol.

$$R-CH=CH_2 \xrightarrow[THF]{B_2H_6} R-CH_2-CH_2-BH_2 \xrightarrow{H_2O_2, OH^{\ominus}} R-CH_2-CH_2-OH$$

This is hydroboration of alkene which results in anti Markovnikov's additon of water to the alkene.

78. (3)

Sol. $Cl_2 + FeCl_2 \longrightarrow \overset{\delta+\ \delta-}{Cl\text{–}Cl}\ldots\ldots FeCl_3 \longrightarrow Cl^+ + FeCl_4^-$

The Cl^+ generated acts as electrophile during chlorination.

79. (2)

Sol. The C–C bond length is strotest when both carbon atoms are bonded with a triple bond.
Since propyne contains a triple bond, it has minimum C–C bond length.

80. (3)

Sol. T.E.L. is tetraethyl lead which is used as anti knocking additive for petrol $(C_2H_5)_4Pb$ - T.E.L.

81. (3)

Sol. Electrolysis of sodium or pottasium salt of carboxylic acid gives hydrocarbon in good yield. This method is known as kolbe's electrolytic method

$$2\ R\text{-}COOK + 2H_2O \xrightarrow{\text{Electrolysis}} R\text{-}R + 2CO_2 + H_2 + 2KOH$$

82. (4)

Sol. $CH_2 = CH_2 \xrightarrow[HOCl]{\text{Hypochlorous acid}} \underset{\boxed{M}}{CH_2Cl\text{–}CH_2\text{–}OH} \xrightarrow[\boxed{R}]{\text{Aq. } Na_2CO_3} CH_2(OH)\text{–}CH_2(OH)$

83. (2)

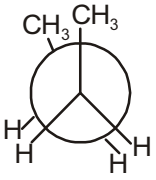
Sol. R – C ≡ C – R (Alkyne)
The cylindrical shape of the alkyne is due to triple bond which consist of one sigma and two π bonds.
The electron cloud between two carbon atoms is cylindrically symmetrical about the internuclear axis.

84. (3)

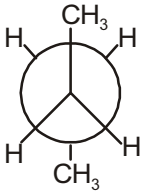
Sol. For commercial gasolines branched hydrocarbons are more desirable because they react more rapidly with oxygen and undergo combustion easily.

85. (2)

Sol.



Eclipsed form of n-butane



staggered form of n-butane

Staggered form of n-butane is more stable because of minimum repulsion between the electron charge clouds of C–H bond due to maximum distance between the groups.

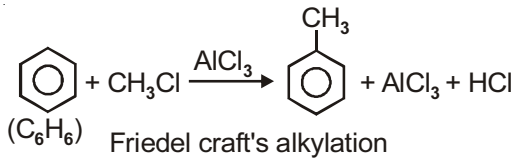
86. (1)

Sol. Arenes are aromatic compound which are very stable due to their aromaticity. In arenes electrophilic substitution is possible because substitution does not affect their aromaticity but addition will lead to disturbance of aromaticity. Arenes show delocalization of π-electron and are stable because of resonance but they will not undergo electrophilic additions.

87. (4)

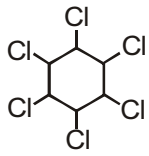
Sol. $HC \equiv CH + H_2O \xrightarrow[H_2SO_4]{Hg^{2+}} CH_2 = \underset{|}{\overset{H}{C}} - OH \longleftrightarrow CH_3 - CHO$

88. (1)

Sol. 

(C_6H_6) Friedel craft's alkylation

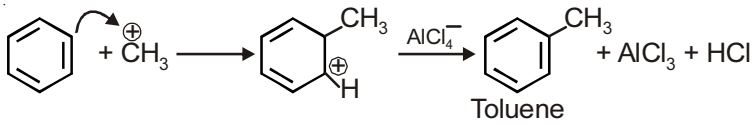
89. (4)

Sol. 

Benzene hexachloride (gammexane)

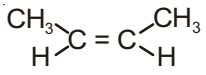
90. (1)

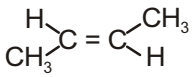
Sol. $CH_3–Cl + AlCl_3 \longrightarrow \overset{\oplus}{C}H_3 + \overset{\ominus}{AlCl_4}$



Toluene

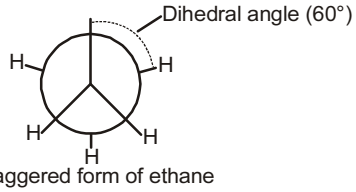
91. (1)

Sol. 
cis-but-2-ene


trans-but-2-ene

In alkene geometrical isomerism is possible due to restricted rotation about the double bond. Due to this restricted rotation, cis and trans form are not readily convertible into other and exist as pair of geometrical isomers.

92. (3)

Sol. 

Staggered form of ethane

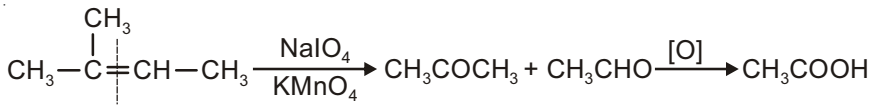
93. (1)

Sol. $CH_3–CH_2–CH=C\begin{matrix}CH_3\\CH_3\end{matrix} \xrightarrow{O_3} CH_3–CH_2–CH\begin{matrix}O\\|\\C(CH_3)_2\\|\\O\end{matrix}O \xrightarrow{Zn/H_2O} CH_3CH_2CHO + CH_3COCH_3$

94. (2)

Sol. Dehydration of alcohol in presence of Al_2O_3 gives alkene. Al_2O_3 acts as a catalyst and rate of the reaction of affected by the temperature.

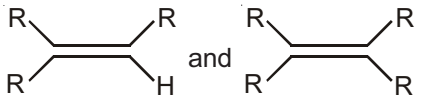
95. (2)

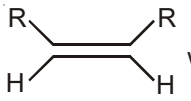
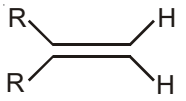
Sol. 

Initially CH_3CHO is formed but since $KMnO_4$ is a strong oxidizing agent, it oxidizes CH_3CHO to CH_3COOH. Therefore products are CH_3COCH_3 and CH_3COOH.

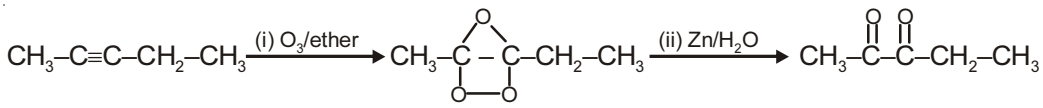
96. (1)

Sol. Lesser the stability of alkene, higher is rate of hydrogenation also less substituted alkenes undergo hydrogenation faster because steric hundrance is less.

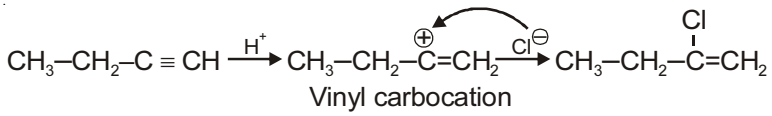
 are highly substituted, so they will undergo hydrogenation slowly.

 will undergo hydrogenation faster than  because one end of $R_2C = CH_2$ contains two alkyl group and it will hinder the approach of hydrogen involved in the hydrogenation.

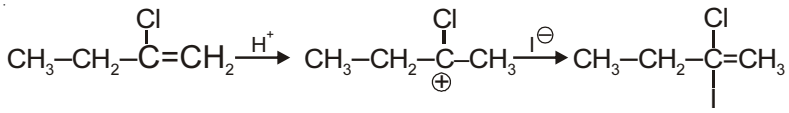
97. (1)

Sol. 

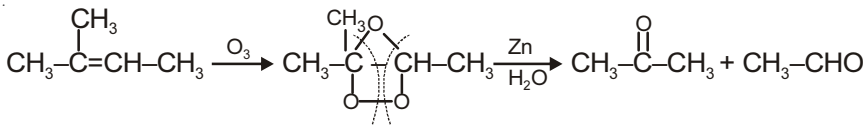
98. (3)

Sol. 

Vinyl carbocation

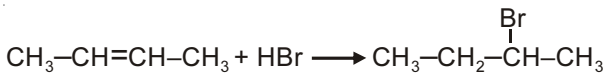


99. (4)

Sol. 

Hence 2-methyl but-2-ene will give acetone on ozonolysis

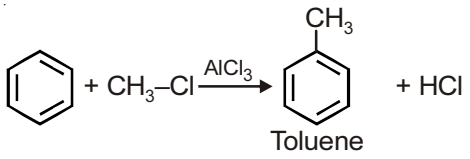
100. (3)

Sol. 

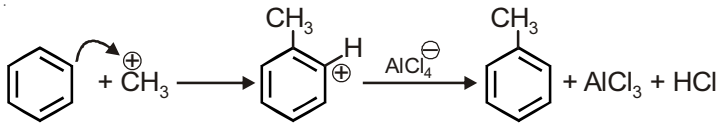
Symmetrical alkenes do not show anti-markovnikov's addition

101. (2)

Sol.



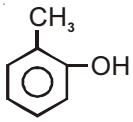
Mechanism $CH_3 - Cl + AlCl_3 \rightarrow \overset{+}{C}H_3 + AlCl_4^-$



102. (4)

Sol. Distillation is a process of purification of liquids. The mixture of two liquid hydrocarbons can be seperated by using distillation under reduced pressure. The reduced pressure allows the mixture to boil at lower temperature which prevent the degradation of hydrocarbon.

103. (2)

Sol. Those substituents which increases electron density on benzene ring increases its reactivity towards electrophilic reagent. In the given compounds, CH_3^- is common but –OH group has maximum +R effect which increases the electron density on benzene ring. Therefore 

will be most reactive towards electrophilic reagent.

104. (3)

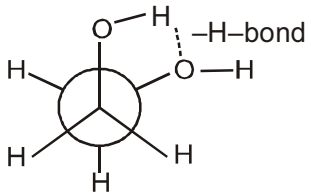
Sol. Compound I and II are a pair of conformers. They are not geometrical isomers because they do not contain double bond also not optical isomers because carbon-2 and 3 contain same groups. These are a pair of conformers because they are redaily interconvertible into one another just by the rotation about C–C bond.

105. (3)

Sol. The anti conformer of n-butane is the most stable conformation, In anti conformation, the distance between the two –CH3 groups is maximum and repulsion between electron charge cloud is minimum stability.

106. (4)

Sol. The gauche conformers of ethylene glycol is the most stable conformation because of intramolecular H-bonding



Gauche conformer

This type of hydogen bonding is possible only in gauche conformer. Therefore it is the most stable conformation of ethylene glycol.

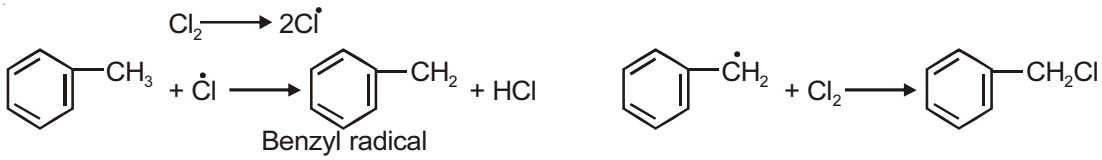
107. (4)

Sol. $CH_3 - CH = CH_2 + HBr \xrightarrow{\text{peroxide}} CH_3 - CH_2 - CH_2 - Br$ (n-propyl bromide)

In the presence of peroxide, addition of HBr to unsymmetrical alkene follows anti markovnikov's rule. Due to the free radical addition. In presence of peroxide HBr dissociates into radicals.

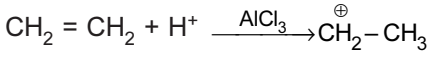
108. (1)

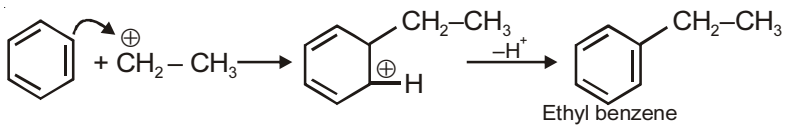
Sol.



109. (3)

Sol.





110. (3)

Sol. Benzene undergoes nucleophilic substitution reaction when a strong electron withdrawing groups are attached to it. p-chloro nitrobenzene has one – Cl and – NO_2 group which are electron withdrawing groups. Hence p-chloronitrobenzene will undergo nucleophilic substitution because of the presence of – NO_2 group which is a strong electron withdrawing group due to its –I and –R effect.

CRASH COURSE

SAMPLE

MATHEMATICS

VECTORS

THIS CHAPTER INCLUDES :

- Vectors and Scalars
- Representation of vectors
- Magnitude of a vectors
- Types of vectors
- Angle between vectors
- Addition of vectors
- Subtraction of vectors
- Section formulae
- Resolution of vectors
- Linearly dependent & independent system of vectors
- Multiplication of a vectors by a scalar
- Scalar (dot) product of two vectors
- Vectors (cross) product of two vectors
- Scalar triple product
- Vector triple product
- Application of vectors to geometry

Vector algebra deals with addition / subtraction / product of vector quantities. Application of vectors to many geometrical problems cuts short the procedure. Hence geometrical significance of vectors should be well understood.

VECTORS AND SCALARS

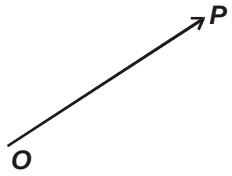
The physical quantities (we deal with) are generally of two types:

Scalar Quantity: A quantity which has magnitude but no sense of direction is called Scalar quantity (or scalar), e.g., mass, volume, density, speed etc.

Vector Quantity: A quantity which has magnitude as well as a sense of direction in space is called a vector quantity, e.g., velocity, force, displacement etc.

NOTATION AND REPRESENTATION OF VECTORS

Vectors are represented by $\vec{a}, \vec{b}, \vec{c}$ and their magnitude (modulus) is represented by a, b, c, or $|\vec{a}|, |\vec{b}|, |\vec{c}|$,..... The vectors are represented by directed line segments.



For example, line segment $\overrightarrow{OP}$ represents a vector with magnitude OP (length of line segment), arrow denotes its direction. O is initial point and P is terminal point.

SOME SPECIAL VECTORS

1. **Null vectors:** A vector with zero magnitude and indeterminate direction, denoted by $\vec{O}$.
2. **Unit vector:** A vector with unit magnitude (one unit), denoted by $\hat{a}$ where $|\hat{a}| = 1$ unit.
3. **Equal vectors:** Two vectors $\vec{a}$ and $\vec{b}$ are said to be equal if they have same sense of direction and $|\vec{a}| = |\vec{b}|$, denoted by $\vec{a} = \vec{b}$.
4. **Like and unlike vectors:** Vectors having same sense of directions are called Like vector and opposite sense of directions are called Unlike vector.
5. **Negative of a vector:** Negative of a vector $\vec{a}$, denoted by $-\vec{a}$, is a vector whose magnitude is $|\vec{a}|$ and direction is opposite of $\vec{a}$.
6. **Collinear vectors:** Vectors having same line of action.

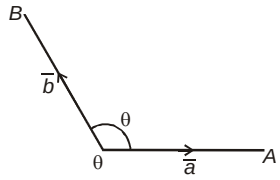
7. **Parallel vectors:** Vectors having same line of action or are parallel to a fixed straight lines.
8. **Coplanar vectors:** The vectors which lie in the same plane. At least three coplanar unequal vectors are required to make the sum zero and at least four if non-coplanar.
9. **Free vectors:** A vector not restricted to pass through a fixed point.
10. **Localized vectors:** A vector restricted to pass through a fixed point.
11. **Co-initial vectors:** Vectors having same initial point.
12. **Position vectors:** Let O be fixed point in space, then vector $\overrightarrow{OP}$ (P is any point in space) is called position vector of P w.r.t. O. If A and B are any two point in space then

$\overrightarrow{AB}$ = p.v. of B – p.v. of A = $\overrightarrow{OB}-\overrightarrow{OA}$.

ANGLE BETWEEN TWO VECTORS

The angle between two vectors $\bar{a}$ and $\bar{b}$ represented by OA and OB is $\angle AOB = \theta$

$0 \le \theta \le \pi$

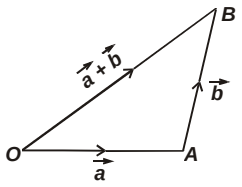


If $\theta = \frac{\pi}{2}$, then vectors are called orthogonal or perpendicular vectors

if θ = 0 or π then vectors are called parallel or coincident vectors.

ADDITION OF VECTORS

Let $\vec{a}$ and $\vec{b}$ be two vectors. Draw $\overrightarrow{OA}$ representing vector $\vec{a}$. Taking terminal point of $\vec{a}$ as initial point of vector $\vec{b}$, draw $\overrightarrow{AB}$ representing vector $\vec{b}$. Then vector $\overrightarrow{OB}$ is called sum of vectors $\vec{a}$ and $\vec{b}$, denoted by $\vec{a}$ + $\vec{b}$ (triangle law of addition)



Triangle Law of Addition

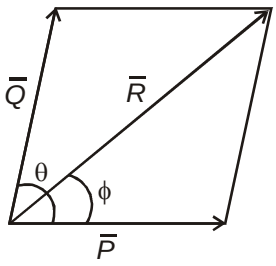
Three vectors are in equilibrium if represented by, three sides of a closed triangle taken in order, (in magnitude and direction).

Converse of triangle law is also true.

Law of polygons : If several vectors, when added, form a closed polygon, their resultant is zero.

Parallelogram law of addition – If two vectors are represented in magnitude and direction, by the two adjacent sides of a parallelogram, their resultant is represented in magnitude and direction, by the co-initial diagonal of that parallelogram.

$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$ and $\tan\phi = \frac{Q\sin\theta}{P + Q\cos\theta}$



If θ = 0° then R = P + Q (maximum)

$\theta = \pi$ then R = P ~ Q (minimum)

If $\theta = \frac{\pi}{2}$ then $R = \sqrt{P^2 + Q^2}$ and $\tan\phi = \frac{Q}{P}$

Properties of Vector Addition :

1. Vector addition is commutative.

   $\bar{a}+\bar{b}=\bar{b}+\bar{a}$

2. Vector addition is associative

   $(\bar{a}+\bar{b})+\bar{c}=\bar{a}+(\bar{b}+\bar{c})$

3. $\bar{O}$ or null vector is additive identity.

   $\bar{A}+\bar{O}=\bar{A}=\bar{O}+\bar{A}$

4. Additive inverse of $\bar{A}$ is $(-\bar{A})$, Since

   $\bar{A}+(-\bar{A})=\bar{O}$

SUBTRACTION OF TWO VECTORS

The subtraction of two vectors $\bar{a}$ and $\bar{b}$ is defined as $\bar{a}-\bar{b}=\bar{a}+(-\bar{b})$

i.e. the vector to be subtracted is reversed and added to other vector.

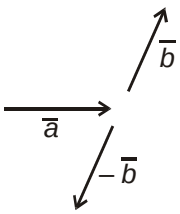
$\bar{a}-\bar{b}\neq\bar{b}-\bar{a}$ not commutative

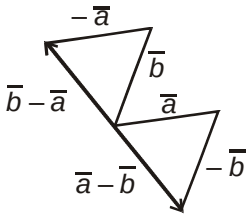
$\bar{a}-\bar{b}=-(\bar{b}-\bar{a})$ i.e. directions are opposite but magnitudes are same

For non - zero vectors $\bar{a}$ & $\bar{b}$

$\bar{a}+\bar{b}\neq\bar{a}-\bar{b}$

$|\bar{a}+\bar{b}|=|\bar{a}-\bar{b}|$ mean $\bar{a}\perp\bar{b}$





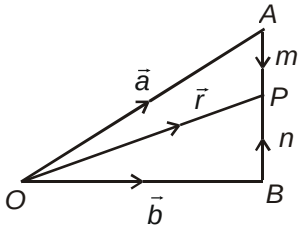
SECTION FORMULAE

Let $\overrightarrow{OA}=\vec{a},\overrightarrow{OB}=\vec{b}$ then p.v. of point P which divides AB internally in the ratio m : n given by

$\overrightarrow{OP}=\vec{r}=\dfrac{m\vec{b}+n\vec{a}}{m+n}$ (m ≠ – n)

If P divides AB externally in the ratio m : n then

$\overrightarrow{OP}=\dfrac{n\vec{a}-m\vec{b}}{n-m}$



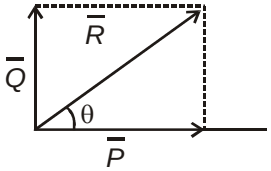
VECTOR RESOLUTION OF A VECTOR (COMPONENTS OF A VECTOR)

A vector $\vec{r}=a\hat{i}+b\hat{j}+c\hat{k}$ has its x, y and z components as a, b & c respectively.

The vector resolution can be orthogonal or non-orthogonal. Orthogonal resolution means the components of the vector are mutually perpendicular otherwise non-orthogonal. Orthogonal components of vector $\bar{R}$ are as shown.

P = Rcosθ $\qquad \vec{R} = \bar{P} + \bar{Q}$

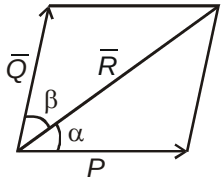
Q = Rsinθ



Non-orthogonal components of $\bar{R}$ are as shown

$$P = \frac{R\sin\beta}{\sin(\alpha+\beta)}$$

$$Q = \frac{R\sin\alpha}{\sin(\alpha+\beta)}$$



LINEAR COMBINATION OF VECTORS

If $\vec{a}$ and $\vec{b}$ are two non-collinear vectors, then any vector $\vec{r}$ in the plane of $\vec{a}$ and $\vec{b}$ is uniquely expressed as $\vec{r} = x\vec{a} + y\vec{b}$, where x and y are scalars. (Similar linear combination (unique) exists for three non-coplanar vectors, $\vec{r} = x\vec{a} + y\vec{b} + z\vec{c}$).

LINEARLY DEPENDENT AND INDEPENDENT VECTORS

Vectors $\vec{a}_1, \vec{a}_2, ..., \vec{a}_n$ are said to be linearly dependent if for scalars x_1, x_2,....x_n (not all zero), $x_1\vec{a}_1 + x_2\vec{a}_2 + ... + x_n\vec{a}_n = \vec{0}$. If $x_1\vec{a}_1 + ... + x_n\vec{a}_n = \vec{0} \Rightarrow x_1 = x_2 = ... x_n = 0$ then vectors are called linearly independent.

Note :

1. If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are three non-coplanar vectors, then the vectors are linearly independent.
2. If $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, $\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$ and $\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$ are linearly dependent then

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = 0$$

3. If $\vec{a}$, $\vec{b}$, $\vec{c}$ are non-coplanars, then $x_1\bar{a} + y_1\bar{b} + z_1\bar{c}$, $x_2\bar{a} + y_2\bar{b} + z_2\bar{c}$ and $x_3\bar{a} + y_3\bar{b} + z_3\bar{c}$ are coplanar iff.

$$\begin{vmatrix} x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \\ z_1 & z_2 & z_3 \end{vmatrix} = 0$$

4. Two non-zero, non-collinear vectors, or any three non-coplanar vectors are linearly independent.
5. Two collinear or any three coplanar or any four vectors in 3-D are linearly dependent.
6. Three points with position vectors $\vec{a}, \vec{b}$ and $\vec{c}$ are collinear iff there exist scalars x, y and z (not all zero) such that $x\vec{a} + y\vec{b} + z\vec{c} = \vec{0}$ where x + y + z = 0.

7. Four points with position vectors $\vec{a}, \vec{b}, \vec{c}$ and $\vec{d}$ are said to be coplanar iff there exist scalars x, y, z and w (not all zero) such that $x\vec{a}+y\vec{b}+z\vec{c}+w\vec{d}=\vec{0}$ where x + y + z + w = 0

Multiplication of a Vector by a Scalar :

If m is a scalar and $\vec{a}$ is a vector, then $m\vec{a}$ (scalar multiple) is a vector whose magnitude is $|m||\vec{a}|$ and direction is same as of $\vec{a}$ (if m +ve) and opposite that of $\vec{a}$ if m is –ve.

Properties

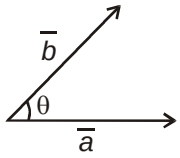
1. $m(\vec{a}+\vec{b})=m\vec{a}+m\vec{b}$ 2. $(mn)\vec{a}=m(n\vec{a})=n(m\vec{a})$ 3. $(m+n)\vec{a}=m\vec{a}+n\vec{a}$

Scalar (dot) Product of Two Vectors :

The scalar product of vectors $\vec{a}$ and $\vec{b}$, denoted by $\vec{a}.\vec{b}$, is defined as $\vec{a}.\vec{b}=|\vec{a}||\vec{b}|\cos\theta$, θ is angle between two vectors.

Properties :

1. $\vec{a}.\vec{b}=\vec{b}.\vec{a}$
2. $\vec{a}.(\vec{b}+\vec{c})=\vec{a}.\vec{b}+\vec{a}.\vec{c}$
3. $(m\vec{a}).\vec{b}=m(\vec{a}.\vec{b})=\vec{a}.(m\vec{b})$



4. If $\theta = 0 \Rightarrow \vec{a}.\vec{b}=|\vec{a}||\vec{b}|$ (like vectors)
5. If $\theta = \pi \Rightarrow \vec{a}.\vec{b}=-|\vec{a}||\vec{b}|$ (unlike vectors)
6. If $\hat{a}$ and $\hat{b}$ are unit vectors then $\hat{a}.\hat{b}$ = cosθ (where θ is angle between them).
7. $\vec{a}.\vec{a}=|\vec{a}|^2 \Rightarrow |\vec{a}|=\sqrt{\vec{a}.\vec{a}}$
8. If $\vec{a}\perp\vec{b} \Rightarrow \vec{a}.\vec{b}=0$ but $\vec{a}.\vec{b}=0 \Rightarrow \vec{a}=\vec{0}$ or $\vec{b}=\vec{0}$ or $\vec{a}\perp\vec{b}$.
9. If $\hat{i}, \hat{j}$ and $\hat{k}$ are unit vectors along the rectangular coordinate are OX, OY and OZ then $\hat{i}.\hat{i}=\hat{j}.\hat{j}=\hat{k}.\hat{k}=1$, $\hat{i}.\hat{j}=\hat{j}.\hat{k}=\hat{k}.\hat{i}=0$.
10. If $\vec{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}$ and $\vec{b}=b_1\hat{i}+b_2\hat{j}+b_3\hat{k}$ then

    $\vec{a}.\vec{b}=a_1b_1+a_2b_2+a_3b_3$

    and $\cos\theta=\dfrac{a_1b_1+a_2b_2+a_3b_3}{\sqrt{a_1^2+a_2^2+a_3^2}\sqrt{b_1^2+b_2^2+b_3^2}}$
11. Components of a vector $\vec{r}$ in the direction of vector $\vec{a}$ is $\left(\dfrac{\vec{r}.\vec{a}}{|\vec{a}|^2}\right)\vec{a}$ and $\perp$ to $\vec{a}$ is $\vec{r}-\left(\dfrac{\vec{r}.\vec{a}}{|\vec{a}|^2}\right)\vec{a}$.
12. Work done by a force $\vec{F}$ in displacing a particle from A to B $(\overrightarrow{AB}=\vec{d})$

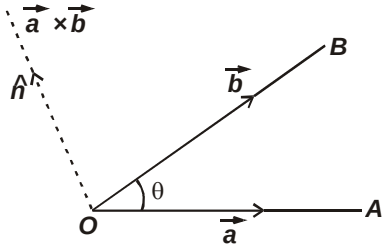
    $W=\vec{F}.\overrightarrow{AB}=\vec{F}.\vec{d}$

VECTOR (CROSS) PRODUCT OF TWO VECTORS

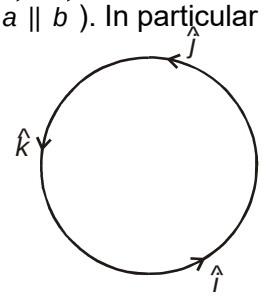
Vector product of two vectors $\vec{a}$ and $\vec{b}$ is defined as $\vec{a}\times\vec{b}=|\vec{a}||\vec{b}|\sin\theta\hat{n}$ where θ is the angle between $\vec{a}$ and $\vec{b}$ whose direction is that of unit vector $\hat{n}$ which is $\perp$ to both $\vec{a}$ and $\vec{b}$ in such away that $\vec{a},\vec{b},\hat{n}$ form a right handed triad (right handed screw system).

Properties :

1. In general, $\vec{a}\times\vec{b}\neq\vec{b}\times\vec{a}$. In fact $\vec{a}\times\vec{b}=-\vec{b}\times\vec{a}$.
2. For scalar m, $m\vec{a}\times\vec{b}=m(\vec{a}\times\vec{b})=\vec{a}\times m\vec{b}$.



3. $\vec{a}\times(\vec{b}+\vec{c})=\vec{a}\times\vec{b}+\vec{a}\times\vec{c}$
4. If $\vec{a}\,||\vec{b}$ then $\theta=0$ or $\pi\Rightarrow\vec{a}\times\vec{b}=\vec{0}$ (but $\vec{a}\times\vec{b}=\vec{0}\Rightarrow\vec{a}=\vec{0}$ or $\vec{b}=\vec{0}$ $\vec{a}\parallel\vec{b}$). In particular $\vec{a}\times\vec{a}=0$.
5. If $\vec{a}\perp\vec{b}$ then $\vec{a}\times\vec{b}=|\vec{a}||\vec{b}|\hat{n}$ (or $|\vec{a}\times\vec{b}|=|\vec{a}||\vec{b}|$)
6. $\hat{i}\times\hat{i}=\hat{j}\times\hat{j}=\hat{k}\times\hat{k}=0$ and $\hat{i}\times\hat{j}=\hat{k},\ \hat{j}\times\hat{k}=\hat{i}$ and $\hat{k}\times\hat{i}=\hat{j}$ (use cyclic system)



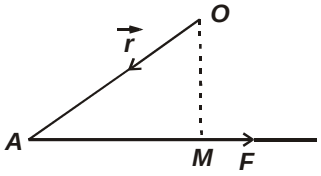
7. Unit vector perpendicular to $\vec{a}$ and $\vec{b}$ is given by $\pm\dfrac{\vec{a}\times\vec{b}}{|\vec{a}\times\vec{b}|}$
8. If θ is angle between $\vec{a}$ and $\vec{b}$ then $\sin\theta=\dfrac{|\vec{a}\times\vec{b}|}{|\vec{a}||\vec{b}|}$
9. If $\vec{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}$ and $\vec{b}=b_1\hat{i}+b_2\hat{j}+b_3\hat{k}$ then

$$\vec{a}\times\vec{b}=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\a_1&a_2&a_3\\b_1&b_2&b_3\end{vmatrix}$$

10. (i) If $\vec{a}$ and $\vec{b}$ are adjacent sides of a parallelogram, then

    Area of parallelogram = $|\vec{a}\times\vec{b}|$

    (ii) If diagonals of parallelogram are $\vec{a}$ and $\vec{b}$, then area of parallelogram = $\dfrac{1}{2}|\vec{a}\times\vec{b}|$
11. Vector moment of a force about a point:



The vector moment or torque $\vec{M}$ of a force $\vec{F}$ acting at A about the point O is given by $\vec{M}=\vec{r}\times\vec{F}$

SCALAR TRIPLE PRODUCT

Scalar triple product : If $\vec{a},\vec{b}$ and $\vec{c}$ are three vectors then $\vec{a}.(\vec{b}\times\vec{c})$ is called scalar triple product of $\vec{a},\vec{b}$ and $\vec{c}$ denoted $[\vec{a}\,\vec{b}\,\vec{c}]$.

Properties :

1. If $\vec{a},\vec{b}$ and $\vec{c}$ are adjacent sides of a parallelopiped then volume = $[\vec{a}\,\vec{b}\,\vec{c}]$
2. $[\vec{a}\,\vec{b}\,\vec{c}]=[\vec{b}\,\vec{c}\,\vec{a}]=[\vec{c}\,\vec{a}\,\vec{b}]$ (cyclic permutations of $\vec{a},\vec{b}$ and $\vec{c}$ makes no change in value) but $[\vec{a}\,\vec{b}\,\vec{c}]=-[\vec{a}\,\vec{c}\,\vec{b}]$ etc.

   i.e., Dot and cross can be interchanged, keeping the same cyclic order i.e. $\vec{a}.(\vec{b}\times\vec{c})=(\vec{a}\times\vec{b}).\vec{c}$
3. For scalar m, $[m\vec{a}\,\vec{b}\,\vec{c}]=[\vec{a}\,m\vec{b}\,\vec{c}]=[\vec{a}\,\vec{b}\,m\vec{c}]=m[\vec{a}\,\vec{b}\,\vec{c}]$
4. The value of scalar triple product is zero if any two vectors are equal or parallel
5. If $\vec{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}$, $\vec{b}=b_1\hat{i}+b_2\hat{j}+b_3\hat{k}$ and $\vec{c}=c_1\hat{i}+c_2\hat{j}+c_3\hat{k}$ then $[\vec{a}\,\vec{b}\,\vec{c}]=\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$
6. Condition of coplanarity: Three non-colinear, non-zero vectors $\vec{a},\vec{b}$ and $\vec{c}$ are called coplanar iff $[\vec{a}\,\vec{b}\,\vec{c}]=0$

Vector Triple Product :

Vector triple product : If $\vec{a},\vec{b}$ and $\vec{c}$ are three vectors their vector triple product is defined by $\vec{a}\times(\vec{b}\times\vec{c})=(\vec{a}.\vec{c})\vec{b}-(\vec{a}.\vec{b})\vec{c}$ and $(\vec{a}\times\vec{b})\times\vec{c}=(\vec{a}.\vec{c})\vec{b}-(\vec{b}.\vec{c})\vec{a}$

Note : $\vec{a}\times(\vec{b}\times\vec{c})\neq(\vec{a}\times\vec{b})\times\vec{c}$

APPLICATION OF VECTORS TO GEOMETRY

1. Vector Equation of Straight Line :

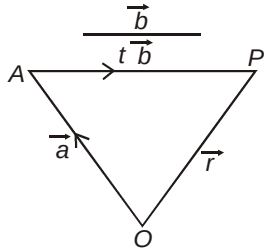
Case I : Vector equation of a straight line passing through a point $\vec{a}$ and parallel to vector $\vec{b}$. Let O be the origin and $\overrightarrow{OA}=\vec{a}$. Let P be any point on the line with $\overrightarrow{OP}=\vec{r}$.

Since $\overrightarrow{AP}\parallel\vec{b}$, for some scalar t,

$\overrightarrow{AP}=t\vec{b}$

$\Rightarrow\ \vec{r}-\vec{a}=t\vec{b}$

$\Rightarrow\ \boxed{\vec{r}=\vec{a}+t\vec{b}}$ (required equation)



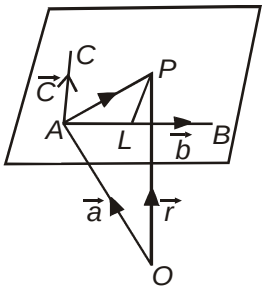
Case II : Vector equation of a straight line passing through two points $\vec{a}$ and $\vec{b}$.

$\boxed{\vec{r}=\vec{a}+t(\vec{b}-\vec{a})}$

2. Vector Equation of a Plane :

Case I : Vector equation of a plane passing through the point $\vec{a}$ and parallel to two given vectors $\vec{b}$ and $\vec{c}$. Let O be the origin, $\overrightarrow{OA} = \vec{a}$. Let AB and AC be the lines on the plane | | to vectors $\vec{b}$ and $\vec{c}$. Let $P(\vec{r})$ be any point on the plane, draw PL | | AC, (AL | | AB).

Now $\overrightarrow{AL} = s\vec{b}$ and $\overrightarrow{LP} = t\vec{c}$ (s, t are scalars)



Now $\overrightarrow{AP} = \overrightarrow{AL} + \overrightarrow{LP} = s\vec{b} + t\vec{c}$

and $\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP} = \vec{a} + s\vec{b} + t\vec{c}$

Required equation $\boxed{\vec{r} = \vec{a} + s\vec{b} + t\vec{c}}$

Another form : $\boxed{[\vec{r}\ \vec{b}\ \vec{c}] = [\vec{a}\ \vec{b}\ \vec{c}]}$

Case II : Vector equation of a plane passing through the point $\vec{a}$, $\vec{b}$, $\vec{c}$ is given by

$\boxed{\vec{r} = (1-s-t)\vec{a} + s\vec{b} + t\vec{c}}$ (where s, t are scalars)

Another form : $\boxed{\vec{r}.(\vec{b}\times\vec{c} + \vec{c}\times\vec{a} + \vec{a}\times\vec{b}) = [\vec{a}\ \vec{b}\ \vec{c}]}$

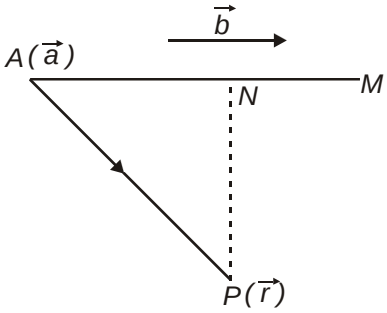
Case III: Vector equation of plane passing through a point $\vec{a}$ and perpendicular to vector $\vec{n}$:

$\boxed{(\vec{r} - \vec{a}).\vec{n} = 0}$

3. Perpendicular distance of a point from a line :

Let straight line passes through $A(\vec{a})$ and is | | to $\vec{b}$. Then perpendicular distance of point $(\vec{r})$ from the

line = $\boxed{\dfrac{|(\vec{r} - \vec{a})\times\vec{b}|}{|\vec{b}|}}$



Another form : $\boxed{\left[(\vec{r} - \vec{a})^2 - \left\{\dfrac{(\vec{r} - \vec{a}).\vec{b}}{|\vec{b}|}\right\}^2\right]^{1/2}}$

4. Perpendicular distance of a point from a plane :

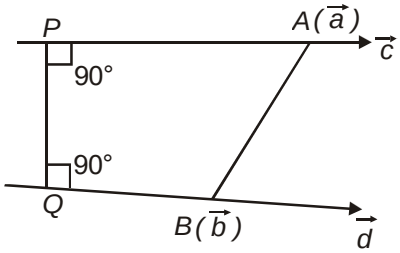
Case I : When plane passes through a point $\vec{a}$ and is | | to $\vec{b}$ and $\vec{c}$. Distance of point $P(\vec{r})$ from the plane $\boxed{\dfrac{(\vec{r} - \vec{a}).(\vec{b}\times\vec{c})}{|\vec{b}\times\vec{c}|}}$

Case II : When plane passes through the points $\vec{a},\vec{b}$ and $\vec{c}$.

$$\frac{(\vec{r}-\vec{a}).(\vec{b}\times\vec{c}+\vec{c}\times\vec{a}+\vec{a}\times\vec{b})}{|\vec{b}\times\vec{c}+\vec{c}\times\vec{a}+\vec{a}\times\vec{b}|}$$

5. <u>Shortest distance between two non-intersecting lines</u> :

Let there be two non-intersecting lines passing through $\vec{a}$ and $\vec{b}$ and are || to $\vec{c}$ and $\vec{d}$. If PQ be the shortest distance between them, then



PQ = projection of $\overrightarrow{AB}$ on the vector $\vec{n}$ (where $\vec{n}=\vec{c}\times\vec{d}$)

Then $$PQ=\frac{(\vec{b}-\vec{a}).(\vec{c}\times\vec{d})}{|\vec{c}\times\vec{d}|}$$

6. <u>Vector equation of the bisector of the angle between two straight lines</u> :

Let the two lines AB and AC meet at A whose p.v. is $\vec{a}$. Let $\vec{b}$ and $\vec{c}$ be vectors || to AB and AC respectively. Also let P be a point on internal bisector of $\angle$BAC where $\overrightarrow{OP}=\vec{r}$.

From P draw line || AB which meets AC at M.

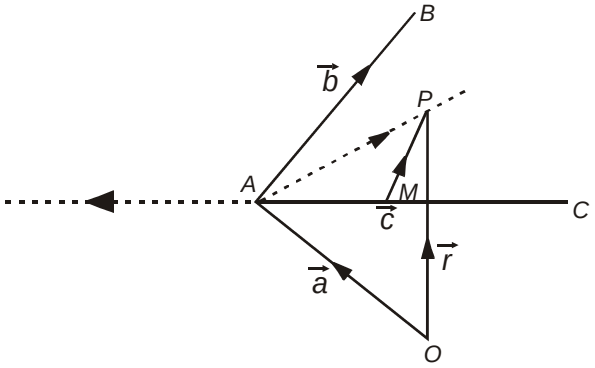
Now $\angle$PAM = $\angle$PAB = $\angle$APM

$\Rightarrow$ AM = PM = t (say)

$\overrightarrow{AM}$ is collinear with $\vec{c}$ and $\overrightarrow{MP}$ is collinear with $\vec{b}$.

Then $\overrightarrow{AM}=t\frac{\vec{c}}{|\vec{c}|},\overrightarrow{MP}=t\frac{\vec{b}}{|\vec{b}|}$

Now in ΔAPM, $\overrightarrow{AP}=\overrightarrow{AM}+\overrightarrow{MP}=t\left(\frac{\vec{c}}{|\vec{c}|}+\frac{\vec{b}}{|\vec{b}|}\right)$,



In ΔOAP, $\overrightarrow{OP}=\overrightarrow{OA}+\overrightarrow{AP}$

$\Rightarrow$ $\vec{r}=\vec{a}+t\left(\frac{\vec{b}}{|\vec{b}|}+\frac{\vec{c}}{|\vec{c}|}\right)$, required equation of internal bisector

Equation of external bisector is given by $\vec{r}=\vec{a}+t\left(\frac{\vec{b}}{|\vec{b}|}-\frac{\vec{c}}{|\vec{c}|}\right)$

EXERCISE - 1

Q.1 If ABCDE is a pentagon then the resultant of forces $\overrightarrow{AB}$, $\overrightarrow{AE}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{ED}$ and $\overrightarrow{AC}$ in terms of $\overrightarrow{AC}$ is-

(A) $2\overrightarrow{AC}$ (B) $3\overrightarrow{AC}$ (C) $5\overrightarrow{AC}$ (D) None of these

Q.2 Points $\vec{a}+\vec{b}+\vec{c}$, $4\vec{a}+3\vec{b}$, $10\vec{a}+7\vec{b}-2\vec{c}$ are-

(A) collinear (B) coplanar (C) non-collinear (D) None of these

Q.3 If Five forces $\overrightarrow{AB}, \overrightarrow{AC}, \overrightarrow{AD}, \overrightarrow{AE}, \overrightarrow{AF}$ act at the vertex A of a regular hexagon ABCDEF. then their resultant is (where O is the centroid of the hexagon)-

(A) $2\overrightarrow{AO}$ (B) $3\overrightarrow{AO}$ (C) $5\overrightarrow{AO}$ (D) $6\overrightarrow{AO}$

Q.4 If D, E, F are the mid points of the sides BC, CA and AB respectively of a triangle ABC and 'O' is any point then $\overrightarrow{AD}+\overrightarrow{BE}+\overrightarrow{CF}$ is-

(A) 1 (B) 0 (C) 2 (D) None of these

Q.5 If the vector $\vec{b}$ is collinear with the vector $\vec{a}=(2\sqrt{2},-1,4)$ and $|\vec{b}|=10$, then

(A) $\vec{a}\pm\vec{b}=0$ (B) $\vec{a}\pm2\vec{b}=0$ (C) $2\vec{a}\pm\vec{b}=0$ (D) None of these

Q.6 If points A(1, 2, 3), B(3, 4, 7), C(– 3, – 2, – 5) are collinear then the ratio in which B divides ACis-

(A) – 1 : 3 (B) 1 : 3 (C) 3 : 1 (D) None of these

Q.7 The position vectors of points A, B, C are respectively $\vec{a}, \vec{b}, \vec{c}$. If L divides AB in 3 : 4 & M divides BC in 2 : 1 both externally, then $\overrightarrow{LM}$ is-

(A) $4\vec{a}-2\vec{b}+2\vec{c}$ (B) $4\vec{a}+2\vec{b}+2\vec{c}$ (C) $-4\vec{a}+2\vec{b}+2\vec{c}$ (D) $4\vec{a}-2\vec{b}-2\vec{c}$

Q.8 If A(4, 7, 8), B(2, 3, 4), C(2, 5, 7) are the position vectors of the vertices of ΔABC. Then length of angle bisector of angle A is -

(A) $\frac{3}{2}\sqrt{34}$ (B) $\frac{2}{3}\sqrt{34}$ (C) $\frac{1}{2}\sqrt{34}$ (D) $\frac{1}{3}\sqrt{34}$

Q.9 If $\vec{e}_1$ & $\vec{e}_2$ are non collinear unit vectors, such that $|\vec{e}_1+\vec{e}_2|=\sqrt{3}$ then $(2\vec{e}_1-5\vec{e}_2).(3\vec{e}_1+\vec{e}_2)$ is equal to-

(A) $-\frac{11}{2}$ (B) $\frac{13}{2}$ (C) $\frac{2}{11}$ (D) $\frac{11}{2}$

Q.10 The vector $\vec{p}$ perpendicular to the vectors $\vec{a}=2\hat{i}+3\hat{j}-\hat{k}$ and $\vec{b}=\hat{i}-2\hat{j}+3\hat{k}$ and satisfying the condition $\vec{p}.(2\hat{i}-\hat{j}+\hat{k})=-6$ is

(A) $-\hat{i}+\hat{j}+\hat{k}$ (B) $3(-\hat{i}+\hat{j}+\hat{k})$ (C) $2(-\hat{i}+\hat{j}+\hat{k})$ (D) $\hat{i}-\hat{j}+\hat{k}$

Q.11 Vectors $\vec{a}$ and $\vec{b}$ make an angle $\theta=\frac{2\pi}{3}$.If $|\vec{a}|=1$, $|\vec{b}|=2$, then $\{(\vec{a}+3\vec{b})\times(3\vec{a}-\vec{b})\}^2$ is equal to

(A) 225 (B) 250 (C) 275 (D) 300

Q.12 Unit vector perpendicular to the plane of the triangle ABC with position vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ of the vertices A, B, C is

(A) $\frac{(\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a})}{\Delta}$ (B) $\frac{(\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a})}{2\Delta}$

(C) $\frac{(\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a})}{4\Delta}$ (D) None of these

Q.13 Given the three vectors $\vec{a} = -2\hat{i} + \hat{j} + \hat{k}, \vec{b} = \hat{i} + 5\hat{j}$ and $\vec{c} = 4\hat{i} + 4\hat{j} - 2\hat{k}$. The projection of the vector $3\vec{a} - 2\vec{b}$ on the vector $\vec{c}$ is

(A) 11 (B) –11 (C) 13 (D) None of these

Q.14 For three vectors $\vec{u}, \vec{v}, \vec{w}$ which of the following expressions is not equal to any of the remaining three?

(A) $\vec{u} . (\vec{v} \times \vec{w})$ (B) $(\vec{v} \times \vec{w}) . \vec{u}$ (C) $\vec{v} . (\vec{u} \times \vec{w})$ (D) $(\vec{u} \times \vec{v}) . \vec{w}$

Q.15 For any three vectors $\vec{a}, \vec{b}$ and $\vec{c}$, $(\vec{a} - \vec{b}) . (\vec{b} - \vec{c}) \times (\vec{c} - \vec{a}) =$

(A) 0 (B) $\vec{a} . \vec{b} \times \vec{c}$ (C) $2\ \vec{a} . \vec{b} \times \vec{c}$ (D) None of these

Q.16 $\vec{A}, \vec{B}$ and $\vec{C}$ are three non coplanar vectors, then $(\vec{A} + \vec{B} + \vec{C}) . ((\vec{A} + \vec{B}) \times (\vec{A} + \vec{C})) =$

(A) 0 (B) $[\vec{A}, \vec{B}, \vec{C}]$ (C) $2\ [\vec{A}, \vec{B}, \vec{C}]$ (D) $-[\vec{A}, \vec{B}, \vec{C}]$

Q.17 If $\vec{A}, \vec{B}, \vec{C}$ are three non-coplanar vectors, then $\frac{\vec{A}.\vec{B} \times \vec{C}}{\vec{C} \times \vec{A}.\vec{B}} + \frac{\vec{B}.\vec{A} \times \vec{C}}{\vec{C}.\vec{A} \times \vec{B}} =$

(A) 0 (B) 1 (C) 2 (D) None of these

Q.18 The value of $[(\vec{a} + 2\vec{b} - \vec{c}), (\vec{a} - \vec{b}), (\vec{a} - \vec{b} - \vec{c})]$ is equal to the box product:

(A) $[\vec{a}\ \vec{b}\ \vec{c}]$ (B) $2[\vec{a}\ \vec{b}\ \vec{c}]$ (C) $3\ [\vec{a}\ \vec{b}\ \vec{c}]$ (D) $4\ [\vec{a}\ \vec{b}\ \vec{c}]$

Q.19 If $\vec{a} = \hat{i} + \hat{j} + \hat{k}, \vec{b} = \hat{i} - \hat{j} + \hat{k}, \vec{c} = \hat{i} + 2\hat{j} - \hat{k}$, then the value of $\begin{vmatrix} \vec{a}.\vec{a} & \vec{a}.\vec{b} & \vec{a}.\vec{c} \\ \vec{b}.\vec{a} & \vec{b}.\vec{b} & \vec{b}.\vec{c} \\ \vec{c}.\vec{a} & \vec{c}.\vec{b} & \vec{c}.\vec{c} \end{vmatrix}$ is equal to

(A) 2 (B) 4 (C) 16 (D) 64

Q.20 Let $\vec{a} = x\hat{i} + 12\hat{j} - \hat{k}, \vec{b} = 2\hat{i} + 2x\hat{j} + \hat{k}$ and $\vec{c} = \hat{i} + \hat{k}$. If the ordered set $[\vec{b}\ \vec{c}\ \vec{a}]$ is left handed, then:

(A) $x \in (2, \infty)$ (B) $x \in (-\infty, -3)$ (C) $x \in (-3, 2)$ (D) $x \in \{-3, 2\}$

Q.21 If $\vec{a}, \vec{b}, \vec{c}$ be the unit vectors such that $\vec{b}$ is not parallel to $\vec{c}$ and $\vec{a} \times (2\vec{b} \times \vec{c}) = \vec{b}$, then the angle that $\vec{a}$ makes with $\vec{b}$ and $\vec{c}$ are respectively

(A) $\frac{\pi}{3}$ & $\frac{\pi}{4}$ (B) $\frac{\pi}{3}$ & $\frac{2\pi}{3}$ (C) $\frac{\pi}{2}$ & $\frac{2\pi}{3}$ (D) $\frac{\pi}{2}$ & $\frac{\pi}{3}$

Q.22 Given unit vectors $\vec{m}, \vec{n}$ & $\vec{p}$ such that angle between $\vec{m}$ & $\vec{n}$ = angle between $\vec{p}$ and $(\vec{m} \times \vec{n}) = \frac{\pi}{6}$ then $[\vec{n}\ \vec{p}\ \vec{m}] =$

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{\sqrt{3}}{4}$ (C) $\frac{\sqrt{3}}{5}$ (D) None of these

Q.23 Let $\vec{u}, \vec{v}, \vec{w}$ be vectors such that $\vec{u} + \vec{v} + \vec{w} = 0$. If $|\vec{u}| = 3, |\vec{v}| = 5, |\vec{w}| = 4$. Then the value of the $\vec{u} . \vec{v} + \vec{v} . \vec{w} + \vec{w} . \vec{u}$ is-

(A) 47 (B) – 25 (C) 0 (D) 25

Q.24 Let $\vec{a} = \hat{i} + \hat{j}$ and $\vec{b} = 2\hat{i} - \hat{k}$. The point of intersection of the lines $\vec{r} \times \vec{a} = \vec{b} \times \vec{a}$ and $\vec{r} \times \vec{b} = \vec{a} \times \vec{b}$ is

(A) $-\hat{i} + \hat{j} + 2\hat{k}$ (B) $3\hat{i} - \hat{j} + \hat{k}$ (C) $3\hat{i} + \hat{j} - \hat{k}$ (D) $\hat{i} - \hat{j} - \hat{k}$

Q.25 The perpendicular distance of $\vec{A}$ (1, 4, – 2) from the segment BC where $\vec{B}$ = (2, 1, – 2) and $\vec{C}$ = (0, – 5, 1) is-

(A) $\frac{3}{7}\sqrt{26}$ (B) $\frac{6}{7}\sqrt{26}$ (C) $\frac{4}{7}\sqrt{26}$ (D) $\frac{2}{7}\sqrt{26}$

Q.26 If line $\vec{r} = (\hat{i} - 2\hat{j} - \hat{k}) + \lambda(2\hat{i} + \hat{j} + 2\hat{k})$ is parallel to the plane $\vec{r} \cdot (3\hat{i} - 2\hat{j} - m\hat{k}) = 14$, then the value of m is

(A) 2 (B) –2

(C) 0 (D) cannot be predicted with these information

Q.27 Shortest distance between the lines:

$\vec{r} = (4\hat{i} - \hat{j}) + \lambda(\hat{i} + 2\hat{j} - 3\hat{k})$ and $\vec{r} = (\hat{i} - \hat{j} + 2\hat{k}) + \mu(2\hat{i} + 4\hat{j} - 5\hat{k})$ is

(A) $6/\sqrt{5}$ (B) $12/\sqrt{5}$ (C) $18/\sqrt{5}$ (D) None of these

Q.28 Equation of a line which passes through a point with position vector $\vec{c}$, parallel to the plane $\vec{r} \cdot \vec{n} = 1$ & perpendicular to the line $\vec{r} = \vec{a} + t\vec{b}$ is-

(A) $\vec{r} = \vec{c} + \lambda(\vec{c} - \vec{a}) \times \vec{n}$ (B) $\vec{r} = \vec{c} + \lambda(\vec{a} \times \vec{n})$

(C) $\vec{r} = \vec{c} + \lambda(\vec{b} \times \vec{n})$ (D) $\vec{r} = \vec{c} + \lambda(\vec{b} \cdot \vec{n})\vec{a}$

Q.29 The vectors $\vec{a} = -4\hat{i} + 3\hat{k}$, $\vec{b} = 14\hat{i} + 2\hat{j} - 5\hat{k}$ are co-initial. The vector $\vec{d}$ which is bisecting the angle between the vectors $\vec{a}$ and $\vec{b}$, is having the magnitude $\sqrt{6}$, is

(A) $\hat{i} + \hat{j} + 2\hat{k}$ (B) $\hat{i} - \hat{j} + 2\hat{k}$ (C) $\hat{i} + \hat{j} - 2\hat{k}$ (D) None of these

Q.30 The set of values of 'm' for which the vectors $\vec{a} = m\hat{i} + (m+1)\hat{j} + (m+8)\hat{k}$, $\vec{b} = (m+3)\hat{i} + (m+4)\hat{j} + (m+5)\hat{k}$ and $\vec{c} = (m+6)\hat{i} + (m+7)\hat{j} + (m+8)\hat{k}$ are non-coplanar is

(A) R (B) R – {1} (C) R – {1, 2} (D) ϕ

Q.31 Which of the following system is linearly dependent-

(A) $\vec{a} = \hat{i} + \hat{j}, \vec{b} = \hat{i} + \hat{k}, \vec{c} = 3\hat{i} + 3\hat{j} + 2\hat{k}$ (B) $\vec{a} = -2\hat{i} - 4\hat{k}, \vec{b} = \hat{i} - 2\hat{j} - \hat{k}, \vec{c} = \hat{i} - 4\hat{j} + 3\hat{k}$

(C) $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}, \vec{b} = 3\hat{i} - 6\hat{j} + 9\hat{k}$ (D) $\vec{a} = -2\hat{i} - 4\hat{k}, \vec{b} = \hat{i} - 2\hat{j} - \hat{k}, \vec{c} = \hat{i} - 4\hat{j} + 3\hat{k}$

Q.32 If $\vec{a}, \vec{b}, \vec{c}$ are linearly independent vectors, then which one of the following set of vectors is linearly dependent?

(A) $\vec{a} + \vec{b}, \vec{b} + \vec{c}, \vec{c} + \vec{a}$ (B) $\vec{a} - \vec{b}, \vec{b} - \vec{c}, \vec{c} - \vec{a}$

(C) $\vec{a} \times \vec{b}, \vec{b} \times \vec{c}, \vec{c} \times \vec{a}$ (D) None of these

Q.33 Vector $\vec{x}$ satisfying the relation $\vec{A} \cdot \vec{x} = c$ and $\vec{A} \times \vec{x} = \vec{B}$ is

(A) $\frac{c\vec{A} - (\vec{A} \times \vec{B})}{|\vec{A}|}$ (B) $\frac{c\vec{A} - (\vec{A} \times \vec{B})}{|\vec{A}|^2}$ (C) $\frac{c\vec{A} + (\vec{A} \times \vec{B})}{|\vec{A}|^2}$ (D) $\frac{c\vec{A} - 2(\vec{A} \times \vec{B})}{|\vec{A}|^2}$

Q.34 For a non- zero vector $\vec{A}$ if the equation $\vec{A} \cdot \vec{B} = \vec{A} \cdot \vec{C}$ and $\vec{A} \times \vec{B} = \vec{A} \times \vec{C}$ hold simultaneously, then:

(A) $\vec{A}$ is perpendicular to $\vec{B} - \vec{C}$ (B) $\vec{A} = \vec{B}$

(C) $\vec{B} = \vec{C}$ (D) $\vec{C} = \vec{A}$

Q.35 Let $\vec{A}$ and $\vec{B}$ be two non-parallel unit vectors in a plane. If $(\alpha\vec{A} + \vec{B})$ bisects the internal angle between $\vec{A}$ and $\vec{B}$, then α is equal to-

(A) 1/2 (B) 1 (C) 2 (D) 4

Q.36 Given a parallelogramDOACB. The length of the vectors $\vec{OA}$, $\vec{OB}$ and $\vec{AB}$ are a, b and c respectively. The scalar product of the vectors $\vec{OC}$ and $\vec{OB}$ is -

(A) $(a^2 - 3b^2 + c^2)/2$ (B) $(3a^2 + b^2 - c^2)/2$

(C) $(3a^2 - b^2 + c^2)/2$ (D) $(a^2 + 3b^2 - c^2)/2$

Q.37 The vertices of triangle have the position vectors $\vec{a}, \vec{b}, \vec{c}$ and P($\vec{r}$) is a point in the plane of Δ such that : $\vec{a}.\vec{b} + \vec{c}.\vec{r} = \vec{a}.\vec{c} + \vec{b}.\vec{r} = \vec{b}.\vec{c} + \vec{a}.\vec{r}$ then for the Δ, P is the

(A) circumcentre (B) centroid (C) orthocentre (D) incentre

Q.38 If A, B, C, D are four points in space satisfying $\overrightarrow{AB}.\overrightarrow{CD} = K[|\overrightarrow{AD}|^2 + |\overrightarrow{BC}|^2 - |\overrightarrow{AC}|^2 - |\overrightarrow{BD}|^2]$ then the value of K is –

(A) 2 (B) 1/3 (C) 1/2 (D) 1

Q.39 If in a right-angled triangle ABC, the hypotenuse AB = p, then $\vec{AB}.\vec{AC} + \vec{BC}.\vec{BA} + \vec{CA}.\vec{CB}$ is -

(A) $2p^2$ (B) $\frac{p^2}{2}$ (C) p^2 (D) None

Q.40 Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three non–zero and non-coplanar vectors and $\vec{p}, \vec{q}$ and $\vec{r}$ be three vectors given by $\vec{p} = \vec{a} + \vec{b} - 2\vec{c}$,

$\vec{q} = 3\vec{a} - 2\vec{b} + \vec{c}$, $\vec{r} = \vec{a} - 4\vec{b} + 2\vec{c}$.

If the volume of the parallelopiped determined by $\vec{a}, \vec{b}$ and $\vec{c}$ is v_1 and that of the parallelopiped determined by $\vec{p}, \vec{q}$ and $\vec{r}$ is v_2, then $v_2 : v_1$ =

(A) 3 : 1 (B) 7 : 1 (C) 11 : 1 (D) 15 :1

Q.41 A vector $\vec{x}$ is coplanar with vectors

$\vec{a} = -\hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = 2\hat{i} + \hat{k}$ and is orthogonal to the vector $\vec{b}$. If $\vec{x}.\vec{a} = 7$ then the vector $\vec{x}$ is equal to-

(A) $(-3\hat{i} + 5\hat{j} + 6\hat{k})$ (B) $\frac{1}{2}(-3\hat{i} + 5\hat{j} + 6\hat{k})$

(C) $(3\hat{i} - 5\hat{j} - 6\hat{k})$ (D) none of these

Q.42 If $\vec{b}$ is a vector whose initial point divides the join of $5\hat{i}$ and $5\hat{j}$ in the ratio k : 1 and terminal point is origin and $|\vec{b}| \le \sqrt{37}$, then k lies in the interval -

(A) $\left[-6, -\frac{1}{6}\right]$ (B) $(-\infty, -6] \cup \left[-\frac{1}{6}, \infty\right)$

(C) [0, 6] (D) None of these

Q.43 Let co-ordinates of a point 'p' with respect to the system non-coplanar vectors $\vec{a}, \vec{b}$ and $\vec{c}$ is (3, 2, 1). Then, co-ordinates of 'p' with respect to the system of vectors $\vec{a} + \vec{b} + \vec{c}$, $\vec{a} - \vec{b} + \vec{c}$ and $\vec{a} + \vec{b} - \vec{c}$ is -

(A) $\left(\frac{3}{2}, \frac{1}{2}, 1\right)$ (B) $\left(\frac{3}{2}, 1, \frac{1}{2}\right)$ (C) $\left(\frac{1}{2}, \frac{3}{2}, 1\right)$ (D) none of these

Q.44 The position vectors of the points P and Q are $\vec{p}$ and $\vec{q}$ respectively. If O is the origin and R is a point in the interior of $\angle POQ$ such that OR bisects the $\angle POQ$ then unit vector along OR is

(A) $\frac{\vec{p} + \vec{q}}{|\vec{p}||\vec{q}|}$ (B) $\frac{\vec{p}}{|\vec{p}|} - \frac{\vec{q}}{|\vec{q}|}$ (C) $\frac{\left(\frac{\vec{p}}{|\vec{p}|} + \frac{\vec{q}}{|\vec{q}|}\right)}{\left|\frac{\vec{p}}{|\vec{p}|} + \frac{\vec{q}}{|\vec{q}|}\right|}$ (D) none of these

Q.45 If $\overrightarrow{AD} = \vec{a}$, $\overrightarrow{AB} = \vec{b}$ and $\overrightarrow{BC} = \overrightarrow{ka}$ where k > 0 and X, Y are the mid-points of DB & AC respectively, such that $|\vec{a}| = 17$ & $|\overrightarrow{XY}| = 4$, then k equal to -

(A) $\frac{8}{17}$ (B) $\frac{13}{17}$ (C) $\frac{25}{17}$ (D) $\frac{4}{17}$

Q.46 Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three non-zero vectors, no two of which are collinear. If the vector $3\vec{a} + 7\vec{b}$ is collinear with $\vec{c}$ and $3\vec{b} + 2\vec{c}$ is collinear with $\vec{a}$, then $9\vec{a} + 21\vec{b} + 14\vec{c}$ is equal to -

(A) $\lambda\vec{a}$ (B) $\lambda\vec{c}$ (C) 0 (D) none of these

Q.47 Let $\vec{a}$ be a unit vector and $\vec{b}$ a non-zero vector not parallel to $\vec{a}$. The angles of the triangle, two of whose sides are represented by $\sqrt{3}(\vec{a} \times \vec{b})$ and $\vec{b} - (\vec{a}.\vec{b})\vec{a}$ are -

(A) $\pi/4, \pi/4, \pi/2$ (B) $\pi/4, \pi/3, 5\pi/12$ (C) $\pi/6, \pi/3, \pi/2$ (D) None of these

Q.48 Let $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, $\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$ and $\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$ be three non-zero vectors such that $\vec{c}$ is a unit vector perpendicular to both the vectors $\vec{a}$ and $\vec{b}$. If the angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{6}$, then $\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}^2$ is equal to-

(A) 0

(B) 1

(C) $\frac{1}{4}(a_1^2 + a_2^2 + a_3^2)(b_1^2 + b_2^2 + b_3^2)$

(D) $\frac{3}{4}(a_1^2 + a_2^2 + a_3^2)(b_1^2 + b_2^2 + b_3^2) \times (c_1^2 + c_2^2 + c_3^2)$

Q.49 Let $\vec{a} = \hat{i} - \hat{j}$, $\vec{b} = \hat{j} - \hat{k}$, $\vec{c} = \hat{k} - \hat{i}$. If $\vec{d}$ is a unit vector such that $\vec{a} \cdot \vec{d} = 0 = [\vec{b}, \vec{c}, \vec{d}]$, then $\vec{d}$ equals

(A) $\pm\frac{\hat{i} + \hat{j} - 2\hat{k}}{\sqrt{6}}$ (B) $\pm\frac{\hat{i} + \hat{j} - \hat{k}}{\sqrt{3}}$ (C) $\frac{\hat{i} + \hat{j} + \hat{k}}{\sqrt{3}}$ (D) $\pm\hat{k}$

Q.50 If $\vec{p}, \vec{q}, \vec{r}$ be three mutually perpendicular vectors of the same magnitude. If a vector $\vec{x}$ satisfies the equation $\vec{p} \times ((\vec{x} - \vec{q}) \times \vec{p}) + \vec{q} \times ((\vec{x} - \vec{r}) \times \vec{q}) + \vec{r} \times ((\vec{x} - \vec{p}) \times \vec{r}) = \vec{0}$ then $\vec{x}$ is given by-

(A) $\frac{1}{2}(\vec{p} + \vec{q} - 2\vec{r})$ (B) $\frac{1}{2}(\vec{p} + \vec{q} + \vec{r})$ (C) $\frac{1}{3}(\vec{p} + \vec{q} + \vec{r})$ (D) $\frac{1}{3}(2\vec{p} + \vec{q} - \vec{r})$

Q.51 If $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = 4\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{c} = \hat{i} + \alpha\hat{j} + \beta\hat{k}$ are linearly dependent vectors and $|\vec{c}| = \sqrt{3}$, then-

(A) $\alpha = 1, \beta = -1$ (B) $\alpha = 1, \beta = \pm 1$ (C) $\alpha = -1, \beta = \pm 1$ (D) $\alpha = \pm 1, \beta = 1$

Q.52 Let $\vec{a} = 2\hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - \hat{k}$ and a unit vector $\vec{c}$ be coplanar. If $\vec{c}$ is perpendicular to $\vec{a}$, then $\vec{c}$ =

(A) $\frac{1}{\sqrt{2}}(-\hat{j} + \hat{k})$ (B) $\frac{1}{\sqrt{3}}(-\hat{i} - \hat{j} - \hat{k})$ (C) $\frac{1}{\sqrt{5}}(\hat{i} - 2\hat{j})$ (D) $\frac{1}{\sqrt{3}}(\hat{i} - \hat{j} - \hat{k})$

Q.53 The scalar $\vec{A}.(\vec{B} + \vec{C}) \times (\vec{A} + \vec{B} + \vec{C})$ equals

(A) 0 (B) $[\vec{A}\ \vec{B}\ \vec{C}] + [\vec{B}\ \vec{C}\ \vec{A}]$

(C) $[\vec{A}\ \vec{B}\ \vec{C}]$ (D) None of these

Q.54 If $\vec{a}$, $\vec{b}$ and $\vec{c}$ be unit coplanar vectors then the scalar triple product $[2\vec{a}-\vec{b}, 2\vec{b}-\vec{c}, 2\vec{c}-\vec{a}]$=

(A) 0 (B) 1 (C) $-\sqrt{3}$ (D) $\sqrt{3}$

Q.55 Let $\vec{a} = \hat{i} - \hat{k}$, $\vec{b} = x\hat{i} + \hat{j} + (1-x)\hat{k}$ and $\vec{c} = y\hat{i} + x\hat{j} + (1+x-y)\hat{k}$. Then $[\vec{a}\ \vec{b}\ \vec{c}]$ depends on-

(A) only x (B) only y (C) neither x nor y (D) both x and y

Q.56 If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are unit vectors, then $|\vec{a}-\vec{b}|^2+|\vec{b}-\vec{c}|^2+|\vec{c}-\vec{a}|^2$ does not exceed-

(A) 4 (B) 9 (C) 8 (D) 6

Q.57 If $\vec{a}$ and $\vec{b}$ are two unit vectors such that $\vec{a}+2\vec{b}$ and $5\vec{a}-4\vec{b}$ are perpendicular to each other then the angle between $\vec{a}$ and $\vec{b}$ is –

(A) 45º (B) 60º (C) $\cos^{-1}(1/3)$ (D) $\cos^{-1}(2/7)$

Q.58 Let $\vec{V} = 2\hat{i}+\hat{j}-\hat{k}$ and $\vec{W} = \hat{i}+3\hat{k}$. If $\vec{U}$ is a unit vector; then the maximum value of the scalar triple product $[\vec{U}\ \vec{V}\ \vec{W}]$ is–

(A) – 1 (B) $\sqrt{10}+\sqrt{6}$ (C) $\sqrt{59}$ (D) $\sqrt{60}$

Q.59 If $\vec{a} = \hat{i}+\hat{j}+\hat{k}$ & $\vec{a}\cdot\vec{b} = 1$ & $\vec{a}\times\vec{b} = \hat{j}-\hat{k}$ then $\vec{b}$ is equal to -

(A) $2\hat{i}$ (B) $\hat{i}-\hat{j}+\hat{k}$ (C) $\hat{i}$ (D) $2\hat{j}-\hat{k}$

Q.60 A unit vector is orthogonal to $3\hat{i}+2\hat{j}+6\hat{k}$ and is coplanar to $2\hat{i}+\hat{j}+\hat{k}$ & $\hat{i}-\hat{j}+\hat{k}$ then the vector is -

(A) $\frac{3\hat{j}-\hat{k}}{\sqrt{10}}$ (B) $\frac{2\hat{i}+5\hat{j}}{\sqrt{29}}$ (C) $\frac{6\hat{i}-5\hat{k}}{\sqrt{61}}$ (D) $\frac{2\hat{i}+2\hat{j}-\hat{k}}{3}$

Q.61 If $\vec{a}$, $\vec{b}$, $\vec{c}$ are three non-zero, non-coplanar vectors and

$\vec{b}_1 = \vec{b} - \frac{\vec{b}\cdot\vec{a}}{|\vec{a}|^2}\vec{a}$, $\vec{b}_2 = \vec{b} + \frac{\vec{b}\cdot\vec{a}}{|\vec{a}|^2}\vec{a}$, $\vec{c}_1 = \vec{c} - \frac{\vec{c}\cdot\vec{a}}{|\vec{a}|^2}\vec{a} + \frac{\vec{b}\cdot\vec{c}}{|\vec{c}|^2}\vec{b}_1$,

$\vec{c}_2 = \vec{c} - \frac{\vec{c}\cdot\vec{a}}{|\vec{a}|^2}\vec{a} - \frac{\vec{b}_1\cdot\vec{c}}{|\vec{b}_1|^2}\vec{b}_1$, $\vec{c}_3 = \vec{c} - \frac{\vec{c}\cdot\vec{a}}{|\vec{c}|^2}\vec{a} + \frac{\vec{b}\cdot\vec{c}}{|\vec{c}|^2}\vec{b}_1$,

$\vec{c}_4 = \vec{c} - \frac{\vec{c}\cdot\vec{a}}{|\vec{c}|^2}\vec{a} - \frac{\vec{b}\cdot\vec{c}}{|\vec{b}|^2}\vec{b}_1$, then the set of orthogonal vectors is -

(A) $\{\vec{a}, \vec{b}_1, \vec{c}_3\}$ (B) $\{\vec{a}, \vec{b}_1, \vec{c}_2\}$ (C) $\{\vec{a}, \vec{b}_1, \vec{c}_1\}$ (D) $\{\vec{a}, \vec{b}_2, \vec{c}_2\}$

Q.62 Let $\vec{a} = \hat{i}+2\hat{j}+\hat{k}$, $\vec{b} = \hat{i}-\hat{j}+\hat{k}$ & $\vec{c} = \hat{i}+\hat{j}-\hat{k}$. A vector in the plane of $\vec{a}$ and $\vec{b}$ whose projection on $\vec{c}$ is of length $\frac{1}{\sqrt{3}}$ unit is-

(A) $4\hat{i}+\hat{j}-4\hat{k}$ (B) $4\hat{i}-\hat{j}+4\hat{k}$ (C) $2\hat{i}+\hat{j}-\hat{k}$ (D) $3\hat{i}+\hat{j}-3\hat{k}$

Q.63 The number of distinct real values of λ, for which the vectors $-\lambda^2\hat{i}+\hat{j}+\hat{k}$, $\hat{i}-\lambda^2\hat{j}+\hat{k}$ and $\hat{i}+\hat{j}-\lambda^2\hat{k}$ are coplanar, is -

(A) zero (B) one (C) two (D) three

Q.64 Let $\vec{a}$, $\vec{b}$, $\vec{c}$ be unit vectors such that $\vec{a}+\vec{b}+\vec{c} = \vec{0}$. Which one of the following is correct ?

(A) $\vec{a}\times\vec{b} = \vec{b}\times\vec{c} = \vec{c}\times\vec{a} = \vec{0}$ (B) $\vec{a}\times\vec{b} = \vec{b}\times\vec{c} = \vec{c}\times\vec{a} \neq \vec{0}$

(C) $\vec{a}\times\vec{b} = \vec{b}\times\vec{c} = \vec{a}\times\vec{c} \neq \vec{0}$ (D) $\vec{a}\times\vec{b}$, $\vec{b}\times\vec{c}$, $\vec{c}\times\vec{a}$ are mutually $\perp$.

Q.65 The edges of a parallelopiped are of unit length and are parallel to non-coplanar unit vectors $\hat{a}, \hat{b}, \hat{c}$ such that $\hat{a}.\hat{b} = \hat{b}.\hat{c} = \hat{c}.\hat{a} = 1/2$. Then, the volume of the parallelopiped is

(A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{2\sqrt{2}}$ (C) $\frac{\sqrt{3}}{2}$ (D) $\frac{1}{\sqrt{3}}$

Q.66 A particle P starts from the point $z_0 = 1 + 2i$, where $i = \sqrt{-1}$. It moves first horizontally away from origin by 5 units and then vertically away from origin by 3 units to reach a point z_1. From z_1 the particles moves $\sqrt{2}$ units in the direction of the vector $\hat{i} + \hat{j}$ and then it moves through an angle $\frac{\pi}{2}$ in anticlockwise direction on a circle with centre at origin, to reach a point z_2. The point z_2 is given by-

(A) $6 + 7\hat{i}$ (B) $-7 + 6\hat{i}$ (C) $7 + 6\hat{i}$ (D) $-6 + 7\hat{i}$

Q. 67 If $\vec{a}, \vec{b}, \vec{c}$ and $\vec{d}$ are unit vectors such that $(\vec{a}\times\vec{b}).(\vec{c}\times\vec{d}) = 1$ and $\vec{a}.\vec{c} = \frac{1}{2}$, then

(A) $\vec{a}, \vec{b}, \vec{c}$ are non-coplanar (B) $\vec{b}, \vec{c}, \vec{d}$ are non-coplanar
(C) $\vec{b}, \vec{d}$ are non- parallel (D) $\vec{a}, \vec{d}$ are parallel and $\vec{b}, \vec{c}$ are parallel

Q.68 Let P, Q, R and S be the points on the plane with position vectors $-2\hat{i} - \hat{j}$, $4\hat{i}$, $3\hat{i} + 3\hat{j}$ and $-3\hat{i} + 2\hat{j}$ respectively. The quadrilateral PQRS must be a -

(A) parallelogram, which is neither a rhombus nor a rectangle
(B) square
(C) rectangle, but not a square (D) rhombus, but not a square

Q.69 Two adjacent sides of a parallelogram ABCD are given by $\overrightarrow{AB} = 2\hat{i} + 10\hat{j} + 11\hat{k}$ and $\overrightarrow{AD} = -\hat{i} + 2\hat{j} + 2\hat{k}$. The side AD is rotated by an acute angle α in the plane of the parallelogram so that AD becomes AD′. If AD′makes a right angle with the side AB, then the cosine of the angle α is given by

(A) $\frac{8}{9}$ (B) $\frac{\sqrt{17}}{9}$ (C) $\frac{1}{9}$ (D) $\frac{4\sqrt{5}}{9}$

Q.70 Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} - \hat{k}$ be three vectors. A vector $\vec{v}$ in the plane of $\vec{a}$ and $\vec{b}$, whose projection on $\vec{c}$ is $\frac{1}{\sqrt{3}}$, is given by

(A) $\hat{i} - 3\hat{j} + 3\hat{k}$ (B) $-3\hat{i} - 3\hat{j} - \hat{k}$ (C) $3\hat{i} - \hat{j} + 3\hat{k}$ (D) $\hat{i} + 3\hat{j} - 3\hat{k}$

Q.71 If $\vec{a}$ and $\vec{b}$ are vectors such that $|\vec{a} + \vec{b}| = \sqrt{29}$ and $\vec{a}\times(2\hat{i} + 3\hat{j} + 4\hat{k}) = (2\hat{i} + 3\hat{j} + 4\hat{k})\times\vec{b}$, then a possible value of $(\vec{a} + \vec{b}).(-7\hat{i} + 2\hat{j} + 3\hat{k})$ is

(A) 0 (B) 3 (C) 4 (D) 8

Q.72 The number of vectors of unit length perpendicular to vectors $\vec{a}$ = (1, 1, 0) and $\vec{b}$ = (0, 1, 1) is-

(A) one (B) two (C) three (D) infinite

Q.73 Let $\vec{a}, \vec{b}, \vec{c}$ be three non-coplanar vectors and $\vec{p}$, $\vec{q}$, $\vec{r}$ are vectors defined by the relations $\vec{p} = \frac{\vec{b}\times\vec{c}}{[\vec{a}\,\vec{b}\,\vec{c}]}, \vec{q} = \frac{\vec{c}\times\vec{a}}{[\vec{a}\,\vec{b}\,\vec{c}]}, \vec{r} = \frac{\vec{a}\times\vec{b}}{[\vec{a}\,\vec{b}\,\vec{c}]}$ then the value of the expression $(\vec{a} + \vec{b}).\vec{p} + (\vec{b} + \vec{c}).\vec{q} + (\vec{c} + \vec{a}).\vec{r}$ is equal to

(A) 0 (B) 1 (C) 2 (D) 3

Q.74 Let a, b, c be distinct non-negative numbers. If the vectors $a\hat{i}+a\hat{j}+c\hat{k}$, $\hat{i}+\hat{k}$ and $c\hat{i}+c\hat{j}+b\hat{k}$ lie in a plane, then c is-

(A) the arithmetic mean of a and b (B) the geometric mean of a and b
(C) the harmonic mean of a and b (D) equal to zero

Q.75 Let $\vec{p}$ and $\vec{q}$ be the position vectors of P and Q respectively, with respect to O and $|\vec{p}|$ = p, $|\vec{q}|$ = q. The points R and S divide PQ internally and externally in the ratio 2 : 3 respectively. If OR and OS are perpendicular then

(A) $9p^2 = 4q^2$ (B) $4p^2 = 9q^2$ (C) 9p = 4q (D) 4p = 9q

Q.76 Let α, β, γ be distinct real numbers. The points with position vectors $\alpha\hat{i}+\beta\hat{j}+\gamma\hat{k}$, $\beta\hat{i}+\gamma\hat{j}+\alpha\hat{k}$, $\gamma\hat{i}+\alpha\hat{j}+\beta\hat{k}$

(A) are collinear (B) form an equilateral triangle
(C) form a scalene triangle (D) form a right angled triangle

Q.77 Let $\vec{a}=2\hat{i}+\hat{j}-2\hat{k}$ and $\vec{b}=\hat{i}+\hat{j}$. If $\vec{c}$ is vector such that $\vec{a}.\vec{c}=|\vec{c}|, |\vec{c}-\vec{a}|=2\sqrt{2}$ and the angle between $(\vec{a}\times\vec{b})$ and $\vec{c}$ is 30º, then $|(\vec{a}\times\vec{b})\times\vec{c}|$ =

(A) 2/3 (B) 3/2 (C) 2 (D) 3

Q.78 Let the vector $\vec{a}$, $\vec{b}$, $\vec{c}$ and $\vec{d}$ be such that $(\vec{a}\times\vec{b})\times(\vec{c}\times\vec{d})=\vec{0}$. Let P_1 and P_2 be planes determined by the pairs of vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ and $\vec{d}$ respectively. Then the angle between P_1 and P_2 is-

(A) 0 (B) $\pi/4$ (C) $\pi/3$ (D) $\pi/2$

Q.79 Any four non-zero vector will always be:

(A)Linearly dependent (B)Linearly independent
(C)Either 'A' or 'B' (D)None of these

Q.80 If $\vec{a}$ and $\vec{b}$ are reciprocal vectors, then:

(A) $\vec{a}.\vec{b}=0$ (B) $\vec{a}.\vec{b}=-1$ (C) $\vec{a}.\vec{b}=1$ (D)None of these

Q.81 If $\vec{a}+\vec{b}=\vec{p}$ and $\vec{a}-\vec{b}=\vec{q}$, then:

(A) $|\vec{a}|^2+|\vec{b}|^2=|\vec{p}|^2+|\vec{q}|^2$ (B) $|\vec{a}|^2-|\vec{b}|^2=|\vec{p}|^2-|\vec{q}|^2$
(C) $2(|\vec{a}|^2+|\vec{b}|^2)=|\vec{p}|^2+|\vec{q}|^2$ (D) $2(|\vec{a}|^2-|\vec{b}|^2)=|\vec{p}|^2-|\vec{q}|^2$

Q.82 If three unit vectors $\vec{a}, \vec{b}, \vec{c}$ satisfy $\vec{a}+\vec{b}+\vec{c}=\vec{0}$, then angle between $\vec{a}$ and $\vec{b}$ is:

(A) $\frac{\pi}{3}$ (B) $\frac{2\pi}{3}$ (C) $\frac{\pi}{6}$ (D) $\frac{5\pi}{6}$

Q.83 Projection of $\hat{i}+2\hat{j}+3\hat{k}$ on $\hat{i}-2\hat{j}-2\hat{k}$ is equal to:

(A)3 (B)-3 (C)9 (D)-9

Q.84 If $\vec{a}$ and $\vec{b}$ are two non-collinear unit vectors, then projection of $\vec{a}+\vec{b}$ on $\vec{a}-\vec{b}$ is equal to:

(A)2 (B)-2 (C)1 (D)None of these

Q.85 ABCD is a parallelogram with $\vec{AC}=\hat{i}-2\hat{j}+\hat{k}$ and $\vec{BD}=-\hat{i}+2\hat{j}-5\hat{k}$. Area of this parallelogram is equal to:

(A) $\sqrt{5}/2$ sq. units (B) $2\sqrt{5}$ sq. units (C) $4\sqrt{5}$ sq. units (D) $\sqrt{5}$ sq. units

Q.86 If $\vec{a}=x\hat{i}+(x-1)\hat{j}+\hat{k}$ and $\vec{b}=(x+1)\hat{i}+\hat{j}+a\hat{k}$ always make an acute angle with each other for every value of $x\in R$, then:

(A) $a\in(-\infty, 2)$ (B) $a\in(2, \infty)$ (C) $a\in(-\infty, 1)$ (D) $a\in(1, \infty)$

Q.87 Let $\vec{a}, \vec{b}, \vec{c}$ be three non zero vectors such that $\vec{a}+\vec{b}+\vec{c}=\vec{0}$ Then $\lambda\vec{b}\times\vec{a}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a}=\vec{0}$, where λ is equal to:

(A)1 (B)2 (C)-1 (D)-2

Q.88 If $\vec{a}\times\vec{b}=\vec{c}$, $\vec{b}\times\vec{c}=\vec{a}$ where $\vec{c}\neq\vec{0}$, then:

(A)$|\vec{a}|=|\vec{c}|,|\vec{b}|=1$ (B)$|\vec{a}|=|\vec{b}|,|\vec{c}|=1$ (C)$|\vec{b}|=|\vec{c}|,|\vec{a}|=1$ (D)$|\vec{a}|=|\vec{b}|,|\vec{c}|=1$

Q.89 Let $\vec{a}, \vec{b}, \vec{c}$ be unit vectors such that $\vec{a}+\vec{b}+\vec{c}=\vec{x}$, $\vec{a}\,.\,\vec{x}=1$, $\vec{b}\,.\,\vec{x}=\frac{3}{2}$, $|\vec{x}|=2$ Then angle between $\vec{c}$ and $\vec{x}$ is :

(A)$\cos^{-1}\left(\frac{1}{4}\right)$ (B)$\cos^{-1}\left(\frac{3}{4}\right)$ (C)$\cos^{-1}\left(\frac{3}{8}\right)$ (D)$\cos^{-1}\left(\frac{5}{8}\right)$

Q.90 Let $\vec{a}, \vec{b}, \vec{c}$ be pair wise mutually perpendicular vectors, such that $|\vec{a}|=1,|\vec{b}|=2,|\vec{c}|=2$. Then length of $\vec{a}+\vec{b}+\vec{c}$ is equal to:

(A)2 (B)4 (C)3 (D)6

Q.91 Let $\vec{a}, \vec{b}, \vec{c}$ be three unit vectors such that $\vec{a}+5\vec{b}+3\vec{c}=\vec{0}$ Then $\vec{a}.(\vec{b}\times\vec{c})$ is equal to:

(A)$\vec{a}.\vec{b}$ (B)$\vec{a}.(\vec{b}+2\vec{c})$ (C)$\vec{b}.(\vec{a}+\vec{c})$ (D)None of these

Q.92 ABCD is a parallelogram A_1 and B_1 are the midpoints of side BC and CD respectively. If $\vec{AA_1}+\vec{AB_1}=\lambda\vec{AC}$, then λ is equal to:

(A)1/2 (B)1 (C)3/2 (D)2

Q.93 Two constant force $\vec{F}_1=2\hat{i}-5\hat{j}+6\hat{k}$ and $\vec{F}_2=-\hat{i}+2\hat{j}-\hat{k}$ act on a particle. If particle is displaced from a point A with position vector $4\hat{i}-3\hat{j}-2\hat{k}$ to the point B with position vector $6\hat{i}+\hat{j}-3\hat{k}$ Then work done in the process is equal to:

(A)15 units (B)10 units (C)-15 units (D)-10 units

Q.94 A, B, C and D are any four points in the space. If $|\vec{AB}\times\vec{CD}+\vec{BC}\times\vec{AD}+\vec{CA}\times\vec{BD}|=\lambda\Delta_{ABC}$, where Δ_{ABC} is the area of triangle ABC, then λ is equal to:

(A)2 (B)1/2 (C)4 (D)1/4

Q.95 The position vector of the points A, B, C and D are $3\hat{i}-2\hat{j}-\hat{k}$, $2\hat{i}+3\hat{j}-4\hat{k}$, $-\hat{i}+\hat{j}+2\hat{k}$ and $4\hat{i}+5\hat{j}+\lambda\hat{k}$. It is known that these points are coplanar, then λ is equal to:

(A)$-\frac{146}{17}$ (B)$-\frac{137}{17}$ (C)$-\frac{154}{17}$ (D)None of these

Q.96 Let $\vec{a}, \vec{b}, \vec{c}$ be any three vectors. Then $\left[\vec{a}+\vec{b},\vec{b}+\vec{c},\vec{c}+\vec{a}\right]$ is always equal to:

(A)$[\vec{a}, \vec{b}, \vec{c}]$ (B)$2[\vec{a}, \vec{b}, \vec{c}]$ (C)Zero (D)None of these

Q.97 The perimeter of the triangle whose vertices have the position vectors $(\mathrm{i}+\mathrm{j}+\mathrm{k}), (5\mathrm{i}+3\mathrm{j}-3\mathrm{k})$ and $(2\mathrm{i}+5\mathrm{j}+9\mathrm{k})$, is given by

(A)$15+\sqrt{157}$ (B)$15-\sqrt{157}$ (C)$\sqrt{15}-\sqrt{157}$ (D)$\sqrt{15}+\sqrt{157}$

Q.98 $\hat{i}\times(\vec{a}\times\hat{i})+\hat{j}\times(\vec{a}\times\hat{j})+\hat{k}\times(\vec{a}\times\hat{k})$ is always equal to:

(A)$\vec{a}$ (B)$-\vec{a}$ (C)$2\vec{a}$ (D)$-2\vec{a}$

Q.99 Value of $[\vec{a}\times\vec{b},\vec{a}\times\vec{c},\vec{d}]$ is always equal to:

(A)$(\vec{a}.\vec{d})[\vec{a}\ \vec{b}\ \vec{c}]$ (B)$(\vec{a}.\vec{c})[\vec{a}\ \vec{b}\ \vec{c}]$ (C)$(\vec{a}.\vec{b})[\vec{a}\ \vec{b}\ \vec{c}]$ (D)None of these

Q.100 For any four vectors $\vec{a}, \vec{b}, \vec{c}, \vec{d}$, the expression $(\vec{b}\times\vec{c}).(\vec{a}\times\vec{d})+(\vec{c}\times\vec{a}).(\vec{b}\times\vec{d})+(\vec{a}\times\vec{b}).(\vec{c}\times\vec{d})$ is always equal to:

(A)$[\vec{a}\ \vec{b}\ \vec{c}]$ (B)$[\vec{a}\ \vec{c}\ \vec{d}]$ (C)$[\vec{b}\ \vec{c}\ \vec{d}]$ (D)None of these

ANSWER KEY

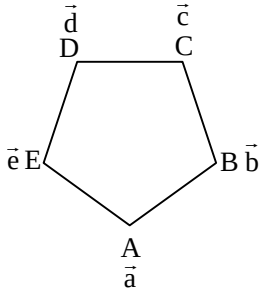
1	B	**2**	A	**3**	D	**4**	B	**5**	C	**6**	A	**7**	C
8	B	**9**	A	**10**	B	**11**	D	**12**	B	**13**	B	**14**	C
15	A	**16**	D	**17**	A	**18**	C	**19**	C	**20**	C	**21**	D
22	B	**23**	B	**24**	C	**25**	A	**26**	A	**27**	A	**28**	C
29	A	**30**	A	**31**	C	**32**	B	**33**	B	**34**	C	**35**	B
36	D	**37**	C	**38**	C	**39**	C	**40**	D	**41**	B	**42**	B
43	A	**44**	C	**45**	C	**46**	C	**47**	C	**48**	C	**49**	A
50	B	**51**	D	**52**	A	**53**	A	**54**	A	**55**	C	**56**	B
57	B	**58**	C	**59**	C	**60**	A	**61**	B	**62**	B	**63**	C
64	B	**65**	A	**66**	D	**67**	C	**68**	A	**69**	B	**70**	C
71	C	**72**	B	**73**	D	**74**	B	**75**	A	**76**	B	**77**	B
78	A	**79**	A	**80**	C	**81**	C	**82**	B	**83**	B	**84**	D
85	B	**86**	B	**87**	D	**88**	A	**89**	B	**90**	C	**91**	D
92	C	**93**	C	**94**	C	**95**	A	**96**	B	**97**	A	**98**	C
99	A	**100**	D										

SOLUTIONS

EXERCISE-1

Q.1 [B]

Sol.



$\overrightarrow{AB}+\overrightarrow{AE}+\overrightarrow{BC}+\overrightarrow{DC}+\overrightarrow{ED}+\overrightarrow{AC}$

$=(\vec{b}-\vec{a})+(\vec{e}-\vec{a})+(\vec{c}-\vec{b})+(\vec{c}-\vec{d})+(\vec{d}-\vec{e})+(\vec{c}-\vec{a})$

$=3(\vec{c}-\vec{a})=3\overrightarrow{AC}$

Q.2 [A]

Sol. $\vec{a}+\vec{b}+\vec{c}$ = Position Vector of A

$4\vec{a}+3\vec{b}$ = P.V. of B

$\overrightarrow{AB}=3\vec{a}+2\vec{b}-\vec{c}$

$\overrightarrow{AC}=9\vec{a}+6\vec{b}-3\vec{c}=3(3\vec{a}+2\vec{b}-\vec{c})$

$10\vec{a}+7\vec{b}-2\vec{c}$ = P.V. of C

$\overrightarrow{AB}=\lambda\overrightarrow{AC}$

Collinear

Q.3 [D]

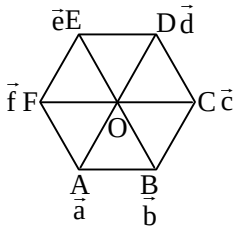
Sol. $\overrightarrow{AB}+\overrightarrow{AC}+\overrightarrow{AD}+\overrightarrow{AE}+\overrightarrow{AF}$

$=(\vec{b}-\vec{a})+(\vec{c}-\vec{a})+(\vec{d}-\vec{a})+(\vec{e}-\vec{a})+(\vec{f}-\vec{a})$

Let centre is $\vec{O}$

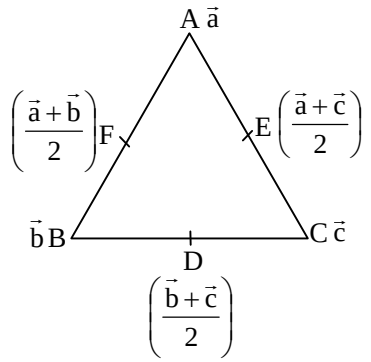
$=\vec{a}+\vec{b}+\vec{c}+\vec{d}+\vec{e}+\vec{f}-6\vec{a}$

$=\vec{0}-6\vec{a}=6\overrightarrow{AO}$



Q.4 **[B]**

Sol.



$$\overrightarrow{AD}+\overrightarrow{BE}+\overrightarrow{CF}=\left(\frac{\vec{b}+\vec{c}}{2}-\vec{a}\right)+\left(\frac{\vec{a}+\vec{c}}{2}-\vec{b}\right)+\left(\frac{\vec{a}+\vec{b}}{2}-\vec{c}\right)$$

$$=(\vec{a}+\vec{b}+\vec{c})-(\vec{a}+\vec{b}+\vec{c})=0$$

Q.5 **[C]**

Sol. $\vec{b}=\lambda(2\sqrt{2}\,\hat{i}-\hat{j}+4\hat{k})$

$|\vec{b}|=|\lambda|\ \sqrt{8+1+16}$

$10=5\,|\lambda| \Rightarrow \lambda=\pm 2$

$\vec{b}=\pm 2\vec{a} \Rightarrow 2\vec{a}\pm\vec{b}=0$

Q.6 **[A]**

Sol. A(1, 2, 3) C(– 3, – 2, –5)

let B divides AC in ratio of λ : 1

$$\left(\frac{-3\lambda+1}{\lambda+1},\frac{-2\lambda+2}{\lambda+1},\frac{-5\lambda+3}{\lambda+1}\right)$$

compare as in 'B' (3, 4, 7)

$\frac{-3\lambda+1}{\lambda+1}=3$	$\frac{-2\lambda+2}{\lambda+1}=4$	$\frac{-5\lambda+3}{\lambda+1}=7$
$-3\lambda+1=3\lambda+3$	$-2\lambda+2=4\lambda+4$	$\lambda=\frac{-1}{3}$
$6\lambda=-2$	$6\lambda=-2$	
$\lambda=\frac{-1}{3}$	$\lambda=\frac{-1}{3}$	

Hence –1 : 3

Q.7 **[C]**

Sol. $\vec{L}=\frac{4\vec{a}-3\vec{b}}{1}$, $\vec{M}=\frac{2\vec{c}-\vec{b}}{1}$

then $\overrightarrow{LM}$ = P.V of $\vec{M}$ – P.V of C

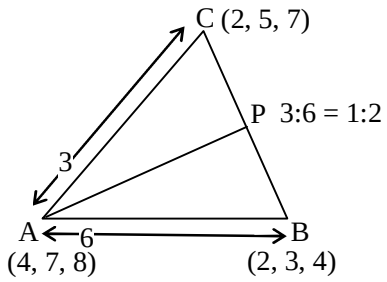
$\overrightarrow{LM}=(2\vec{c}-\vec{b})-(4\vec{a}-3\vec{b})$

$\overrightarrow{LM}=2\vec{c}-\vec{b}-4\vec{a}+3\vec{b}$

$\overrightarrow{LM}=-4\vec{a}+2\vec{b}+2\vec{c}$

Q.8 [B]

Sol.



Length $\overrightarrow{AB} = \sqrt{4+16+16} = \sqrt{36} = 6$

Length $\overrightarrow{AC} = \sqrt{4+4+1} = \sqrt{9} = 3$

So point P divides $\overrightarrow{BC}$ in

Ratio of 2 : 1

B(2, 3, 4) C(2, 5, 7)

So point P

$$\left(\frac{4+2}{3}, \frac{10+3}{3}, \frac{18}{3}\right)$$

$$\left(2, \frac{13}{3}, 6\right)$$

So AP = $\sqrt{(4-2)^2 + \left(7-\frac{13}{3}\right)^2 + (8-6)^2}$

$= \sqrt{4+\frac{64}{9}+4}$

$= \frac{\sqrt{136}}{3} = \frac{2\sqrt{34}}{3}$

Q.9 [A]

Sol.

$|\vec{e}_1 + \vec{e}_2| = \sqrt{3}$

$|\vec{e}_1|^2 + |\vec{e}_2|^2 + 2(\vec{e}_1.\vec{e}_2) = 3$

$1 + 1 + 2(\vec{e}_1.\vec{e}_2) = 3$

$\vec{e}_1.\vec{e}_2 = \frac{1}{2}$

Now

$(2\vec{e}_1 - 5\vec{e}_2).(3\vec{e}_1 + \vec{e}_2)$

$= 6|\vec{e}_1|^2 + 2\vec{e}_1.\vec{e}_2 - 15\vec{e}_1.\vec{e}_2 - 5|\vec{e}_2|^2$

$= 6 + 2 \times \frac{1}{2} - 15 \times \frac{1}{2} - 5$

$= 2 - \frac{15}{2} = \frac{-11}{2}$

Q.10 [B]

Sol.

$$\vec{a}\times\vec{b}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 3 & -1\\ 1 & -2 & 3\end{vmatrix}$$

$\vec{a}\times\vec{b}=\hat{i}(9-2)-\hat{j}(6+1)+\hat{k}(-4-3)$

$=7(\hat{i}-\hat{j}-\hat{k})$

$\vec{p}=\lambda(\hat{i}-\hat{j}-\hat{k})$

$\vec{p}\,.(2\hat{i}-\hat{j}+\hat{k})=\lambda(\hat{i}-\hat{j}-\hat{k})\,.(2\hat{i}-\hat{j}+\hat{k})=-6$

$\lambda(2+1-1)=-6$

$\Rightarrow\lambda=-3$

So $\vec{p}=-3(\hat{i}-\hat{j}-\hat{k})$

$\vec{p}=3(-\hat{i}+\hat{j}+\hat{k})$

Q.11 [D]

Sol. $\{(\vec{a}+3\vec{b})\times(3\vec{a}-\vec{b})\}^2=\{-\vec{a}\times\vec{b}+9\vec{b}\times\vec{a}\}^2$

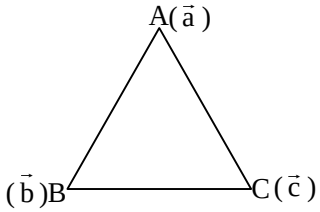
$=\{10(\vec{b}\times\vec{a})\}^2=(10)^2|\vec{b}|^2\,|\vec{a}|^2\sin^2\theta$

$=100\times4\times1\times\sin^2\left(\frac{2\pi}{3}\right)$

$=100\times4\times\frac{3}{4}=300$

Q.12 [B]

Sol.



$$=\frac{(\vec{a}-\vec{b})\times(\vec{a}-\vec{c})}{|(\vec{a}-\vec{b})\times(\vec{a}-\vec{c})|}$$

$$=\frac{-\vec{a}\times\vec{c}-\vec{b}\times\vec{a}+\vec{b}\times\vec{c}}{2\Delta}$$

$$=\frac{\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a}}{2\Delta}$$

Q.13 [B]

Sol. Projection of $(3\vec{a}-2\vec{b})$ at $\vec{c}=\frac{(3\vec{a}-2\vec{b}).\vec{c}}{|\vec{c}|}=-11$

Q.14 [C]

Sol. **(A)** $\vec{u}.(\vec{v}\times\vec{w}) = [\vec{u}\ \vec{v}\ \vec{w}]$

(B) $(\vec{v}\times\vec{w}).\vec{u} = -\vec{v}.(\vec{u}\times\vec{w})$

$= -(\vec{v}\times\vec{u}).\vec{w}$

$= \vec{u}.(\vec{v}\times\vec{w}) = [\vec{u}\ \vec{v}\ \vec{w}]$

(C) $\vec{v}.(\vec{u}\times\vec{w}) = -(\vec{u}\times\vec{v}).\vec{w}$

$= -\vec{u}.(\vec{v}\times\vec{w}) = -[\vec{u}\ \vec{v}\ \vec{w}]$

(D) $(\vec{u}\times\vec{v}).\vec{w} = \vec{u}.(\vec{v}\times\vec{w}) = [\vec{u}\ \vec{v}\ \vec{w}]$

Clearly C is not equal

Q.15 [A]

Sol. $(\vec{a}-\vec{b}).(\vec{b}-\vec{c})\times(\vec{c}-\vec{a})$

$= (\vec{a}-\vec{b}).(\vec{b}\times\vec{c} - \vec{b}\times\vec{a} + \vec{c}\times\vec{a})$

$= \vec{a}.(\vec{b}\times\vec{c}) - \vec{b}.(\vec{c}\times\vec{a})$

$= \vec{a}.(\vec{b}\times\vec{c}) + \vec{b}.(\vec{a}\times\vec{c})$

$= \vec{a}.(\vec{b}\times\vec{c}) - (\vec{a}\times\vec{b}).\vec{c}$

$= \vec{a}.(\vec{b}\times\vec{c}) - \vec{a}.(\vec{b}\times\vec{c})$

$= 0$

Q.16 [D]

Sol. $(\vec{A}+\vec{B}+\vec{C}).((\vec{A}+\vec{B})\times(\vec{A}+\vec{C}))$

$= (\vec{A}+\vec{B}+\vec{C}).(\vec{A}\times\vec{C}+\vec{B}\times\vec{A}+\vec{B}\times\vec{C})$

$= \vec{A}.(\vec{B}\times\vec{C}) + \vec{B}.(\vec{A}\times\vec{C}) + \vec{C}.(\vec{B}\times\vec{A})$

$= \vec{A}.(\vec{B}\times\vec{C}) - \vec{B}.(\vec{C}\times\vec{A}) - \vec{C}.(\vec{A}\times\vec{B})$

$= [\vec{A}\ \vec{B}\ \vec{C}] - [\vec{A}\ \vec{B}\ \vec{C}] - [\vec{A}\ \vec{B}\ \vec{C}]$

$= -[\vec{A}\ \vec{B}\ \vec{C}]$

Q.17 [A]

Sol. $\because \vec{A}, \vec{B}, \vec{C}$ are non coplanar vector

$\Rightarrow [\vec{A}\ \vec{B}\ \vec{C}] \neq 0$

we know that

$\vec{A}.\vec{B}\times\vec{C} = [\vec{A}\ \vec{B}\ \vec{C}]$

$\vec{B}.\vec{A}\times\vec{C} = -[\vec{A}\ \vec{B}\ \vec{C}]$

$\vec{C}.\vec{A}\times\vec{B} = [\vec{A}\ \vec{B}\ \vec{C}]$

$$\Rightarrow \frac{\vec{A}.\vec{B}\times\vec{C}}{\vec{C}\times\vec{A}.\vec{B}} + \frac{\vec{B}.\vec{A}\times\vec{C}}{\vec{C}.\vec{A}\times\vec{B}}$$

$$= \frac{[\vec{A}\,\vec{B}\,\vec{C}]}{[\vec{A}\,\vec{B}\,\vec{C}]} + \frac{-[\vec{A}\,\vec{B}\,\vec{C}]}{[\vec{A}\,\vec{B}\,\vec{C}]} = 0$$

Q.18 [C]

Sol. $[(\vec{a} + 2\vec{b} - \vec{c})\,(\vec{a} - \vec{b})\,(\vec{a} - \vec{b} - \vec{c})]$

$= (\vec{a} + 2\vec{b} - \vec{c}).\{(\vec{a} - \vec{b}) \times (\vec{a} - \vec{b} - \vec{c})\}$

$= (\vec{a} + 2\vec{b} - \vec{c}).\{(\vec{a} \times \vec{a}) - (\vec{a} \times \vec{b}) - (\vec{a} \times \vec{c}) - (\vec{b} \times \vec{a}) + (\vec{b} \times \vec{b}) + (\vec{b} \times \vec{c})$

$= (\vec{a} + 2\vec{b} - \vec{c})\{0 - (\vec{a} \times \vec{b}) - (\vec{a} \times \vec{c}) + (\vec{a} \times \vec{b}) + 0 + (\vec{b} \times \vec{c})\}$

$= (\vec{a} + 2\vec{b} - \vec{c})\{(\vec{b} \times \vec{c}) - (\vec{a} \times \vec{c})\}$

$= a.(\vec{b} \times \vec{c}) + 2\vec{b}.(\vec{b} \times \vec{c}) - \vec{c}.(\vec{b} \times \vec{c}) - \vec{a}\,(\vec{a} \times \vec{c}) - 2\vec{b}.(\vec{a} \times \vec{c}) + \vec{c}.(\vec{a} \times \vec{c})$

$= [\vec{a}\ \vec{b}\ \vec{c}] - 2[\vec{b}\ \vec{a}\ \vec{c}] = [\vec{a}\ \vec{b}\ \vec{c}] + 2[\vec{a}\ \vec{b}\ \vec{c}] = 3[\vec{a}\ \vec{b}\ \vec{c}]$

Q.19 [C]

Sol. Given $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$,

$\vec{c} = \hat{i} + 2\hat{j} - \hat{k}$

then $\begin{vmatrix} \vec{a}.\vec{a} & \vec{a}.\vec{b} & \vec{a}.\vec{c} \\ \vec{b}.\vec{a} & \vec{b}.\vec{b} & \vec{b}.\vec{c} \\ \vec{c}.\vec{a} & \vec{c}.\vec{b} & \vec{c}.\vec{c} \end{vmatrix} = \begin{vmatrix} 3 & 1 & 2 \\ 1 & 3 & -2 \\ 2 & -2 & 6 \end{vmatrix}$

$= 3(18 - 4) - 1(6 + 4) + 2(-2 - 6) = 16$

Q.20 [C]

Sol. $[\vec{b}\ \vec{c}\ \vec{a}] < 0$

$$\begin{vmatrix} 2 & 2x & 1 \\ 1 & 0 & 1 \\ x & 12 & -1 \end{vmatrix} < 0$$

$R_1 \to R_1 + R_3$

$R_2 \to R_2 + R_3$

$$\begin{vmatrix} 2+x & 2x+12 & 0 \\ 1+x & 12 & 0 \\ x & 12 & -1 \end{vmatrix} < 0$$

$-1[(24 + 12x) - (1 + x)(2x + 12)] < 0$

$[24 + 12x - 2x - 12 - 2x^2 - 12x] > 0$

$-2x^2 - 2x + 12 > 0$

$x^2 + x - 6 < 0$

$(x + 3)(x - 2) < 0$

$x \in (-3, 2)$

Q.21 [D]

Sol. $\vec{a} \times (2\vec{b} \times \vec{c}) = \vec{b}$

$(\vec{a}.\vec{c})2\vec{b} - (\vec{a}.2\vec{b})\vec{c} = \vec{b}$

$\vec{b}(2\vec{a}.\vec{c} - 1) - (\vec{a}.2\vec{b})\vec{c} = 0$

$2\vec{a}.\vec{c} - 1 = 0$, $\vec{a}.2\vec{b} = 0$

so $\vec{a}.\vec{c} = \frac{1}{2}$ & $\vec{a}.2\vec{b} = 0$, $\vec{a}.\vec{b} = 0$

angle between

$\vec{a}$ & $\vec{c}$ $= \frac{\pi}{3}$ angle between $\vec{a}$ & $\vec{b} = \frac{\pi}{2}$

Q.22 [B]

Sol. $[\vec{n}\ \vec{p}\ \vec{m}] = [\vec{p}\ \vec{m}\ \vec{n}] = \vec{p}.(\vec{m} \times \vec{n})$

$= |\vec{p}|\ |\vec{m} \times \vec{n}| \cos\frac{\pi}{6}$

$= |\vec{p}|\ |\vec{m}|\ |\vec{n}|\ \sin\frac{\pi}{6}\cos\frac{\pi}{6}$

$= \frac{1}{2} \times \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{4}$

Q.23 [B]

Sol. $\therefore \vec{u} + \vec{v} + \vec{w} = 0$

$\Rightarrow |\vec{u} + \vec{v} + \vec{w}|^2 = 0$

$\Rightarrow |\vec{u}|^2 + |\vec{v}|^2 + |\vec{w}|^2 + 2(\vec{u}.\vec{v} + \vec{v}.\vec{w} + \vec{w}.\vec{u}) = 0$

$\Rightarrow 9 + 25 + 16 + 2(\vec{u}.\vec{v} + \vec{v}.\vec{w} + \vec{w}.\vec{u}) = 0$

$\Rightarrow \vec{u}.\vec{v} + \vec{v}.\vec{w} + \vec{w}.\vec{u} = -25$

Q.24 [C]

Sol.

$\vec{r} \times \vec{a} = \vec{b} \times \vec{a}$	$\vec{r} \times \vec{b} = \vec{a} \times \vec{b}$
$(\vec{r} - \vec{b}) \times \vec{a} = 0$	$(\vec{r} - \vec{a}) \times \vec{b} = 0$
$\vec{r} - \vec{b} = \lambda\vec{a}$	$\vec{r} - \vec{a} = \mu\vec{b}$
$\vec{r} = \vec{b} + \lambda\vec{a}$	$\vec{r} = \vec{a} + \mu\vec{b}$
….(i)	….(ii)

First line

$\vec{r}_1 = (2\hat{i} - \hat{k}) + \lambda(\hat{i} + \hat{j})$ $\quad$ $\vec{r}_2 = \hat{i} + \hat{j} + \mu(2\hat{i} - \hat{k})$

$\vec{r}_1 = \hat{i}(2 + \lambda) + \lambda\hat{j} - \hat{k}$ $\quad$ $\vec{r}_2 = \hat{i}(1 + 2\mu) + \hat{j} - \mu\hat{k}$

compare $\quad$ $2 + \lambda = 1 + 2\mu$

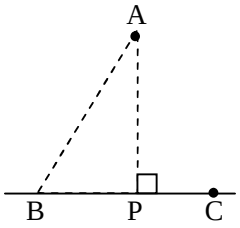
$\lambda = 1$

$\mu = 1$

So point of intersection $3\hat{i} + \hat{j} - \hat{k}$

Q.25 [A]

Sol. equation of line $\vec{r} = \vec{b} + \lambda(\vec{c} - \vec{b})$



So $|\overrightarrow{AP}| = \left|\frac{\overrightarrow{AB} \times (\vec{C} - \vec{B})}{(\vec{C} - \vec{B})}\right|$

$\Rightarrow \frac{3}{7}\sqrt{26}$

Q.26 [A]

Sol. Direction ratios of line (2, 1, 2)

Direction ratios of normal to plane (3, –2, – m)

So. Dot present will be zero

$(2\hat{i} + \hat{j} + 2\hat{k}) \cdot (3\hat{i} - 2\hat{j} - m\hat{k}) = 0$

$6 - 2 - 2m = 0 \Rightarrow 2m = 4 \Rightarrow m = 2$

Q.27 [A]

Sol. $\vec{r}_1 = \vec{a}_1 + \lambda\vec{b}_1$

$\vec{r}_2 = \vec{a}_2 + \lambda\vec{b}_2$

line are not parallel and doesn't have any intersection point (lines are skew line)

shortest distance = $\left|\frac{(\vec{a}_1 - \vec{a}_2)(\vec{b}_1 \times \vec{b}_2)}{|\vec{b}_1 \times \vec{b}_2|}\right|$

$\Rightarrow 6/\sqrt{5}$

Q.28 [C]

Sol. line $\perp$ to $\vec{n}$

line $\perp$ to $\vec{b}$

and line passes through $\vec{c}$

Then equation of line $\vec{r} = \vec{c} + \lambda(\vec{b} \times \vec{n})$

Q.29 [A]

Sol. angle Bisector = $\sqrt{6}\,\frac{(\hat{a} + \hat{b})}{|\hat{a} + \hat{b}|}$

Q.30 [A]

Sol. Vector are non-coplanar $\begin{vmatrix} m & m+1 & m+8 \\ m+3 & m+4 & m+5 \\ m+6 & m+7 & m+8 \end{vmatrix}$ because determinant is - 18 for all in $m \in R$

Q.31 [C]

Sol. $\vec{a} = \lambda \vec{b}$

Q.32 [B]

Sol. $[\vec{a}-\vec{b}, \vec{b}-\vec{c}, \vec{c}-\vec{a}] = 0$ in all condition. So $\vec{a}-\vec{b}$, $\vec{b}-\vec{c}$, $\vec{c}-\vec{a}$ are coplanar. (linearly dependent)

Q.33 [B]

Sol. $\vec{A} \times (\vec{A} \times \vec{x}) = \vec{A} \times \vec{B}$

$(\vec{A}.\vec{x})\vec{A} - (\vec{A}.\vec{A})\vec{x} = \vec{A} \times \vec{B}$

$c\vec{A} - |\vec{A}|^2 \vec{x} = \vec{A} \times \vec{B}$

$\vec{x} = \dfrac{c\vec{A} - (\vec{A} \times \vec{B})}{|\vec{A}|^2}$

Q.34 [C]

Sol.

$\vec{A} . (\vec{B} - \vec{C}) = 0$	$\vec{A} \times (\vec{B} - \vec{C}) = 0$
then $\vec{A} = 0$	$\vec{A} = 0$
or $\vec{B} = \vec{C}$	or $\vec{B} = \vec{C}$
or $\vec{A} \perp (\vec{B} - \vec{C})$	or $\vec{A} \parallel (\vec{B} - \vec{C})$

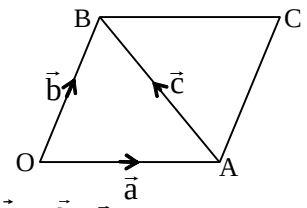
But A is non zero and common $\vec{B} = \vec{C}$

Q.35 [B]

Sol. $\vec{A}$ and $\vec{B}$ are unit vector so vector bisects the internal angle is $\alpha(\vec{A}+\vec{B})$ so $\alpha = 1$

Q.36 [D]

Sol.



$\vec{c} = \vec{b} - \vec{a}$ ……..(1)

square on both side

$c^2 = b^2 + a^2 - 2\vec{a}.\vec{b}$

$\vec{a}.\vec{b} = \dfrac{b^2 + a^2 - c^2}{2}$ …….(2)

$\overrightarrow{OC}.\overrightarrow{OB} = (\vec{a}+\vec{b}) . b = a.b + b^2$

$= \dfrac{b^2 + a^2 - c^2}{2} + b^2$

$= \dfrac{a^2 + 3b^2 - c^2}{2}$

Q.37 [C]

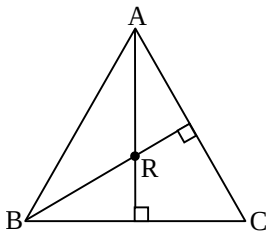
Sol. $\vec{a}.\vec{b} - \vec{a}.\vec{c} = \vec{b}.\vec{r} - \vec{c}.\vec{r}$ $\quad \vec{a}.\vec{b} - \vec{b}.\vec{c} = \vec{a}.\vec{r} - \vec{c}.\vec{r}$

$\vec{a}.(\vec{b}-\vec{c}) - (\vec{b}-\vec{c})\vec{r} = 0$ $\quad \vec{b}(\vec{a}-\vec{c}) - \vec{r}.(\vec{a}-\vec{c}) = 0$

$(\vec{b}-\vec{c}).(\vec{a}-\vec{r})=0$ $(\vec{a}-\vec{c}).(\vec{b}-\vec{r})=0$

$\overrightarrow{CB}.\overrightarrow{RA}=0$ $\overrightarrow{CA}.\overrightarrow{RB}=0$

$\overrightarrow{CB}\perp\overrightarrow{RA}$ $\overrightarrow{AC}\perp\overrightarrow{RB}$



So R is orthocenter

Q.38 [C]

Sol. Let $\vec{A}$ be the origin and position vector of $\vec{B},\vec{C},\vec{D}$ are $\vec{b},\vec{c},\vec{d}$ respectively

Then L.H.S

$\overrightarrow{AB}.\overrightarrow{CD}=\vec{b}.(\vec{d}-\vec{c})$

Taking R.H.S we have

$K[|\overrightarrow{AD}|^2+|\overrightarrow{BC}|^2-|\overrightarrow{AC}|^2-|\overrightarrow{BD}|^2]$

$=K[|\vec{d}|^2+|\vec{c}-\vec{b}|^2-|\vec{c}|^2-|\vec{d}-\vec{b}|^2]$

$=K[\vec{d}.\vec{d}+\vec{c}.\vec{c}+\vec{b}.\vec{b}-2\vec{c}.\vec{b}-\vec{c}.\vec{c}-\vec{d}.\vec{d}$

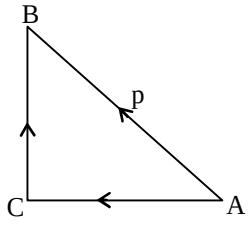
$-\vec{b}.\vec{b}+2\vec{d}.\vec{b}]$

$=K[2(\vec{d}.\vec{b}-\vec{c}.\vec{b})]=2K\,\vec{b}.(\vec{d}-\vec{c})$

$\Rightarrow K=\frac{1}{2}$

Q.39 [C]

Sol.



Given $\vec{AB}=p$

$\therefore \vec{CA}\perp\vec{CB}\Rightarrow\vec{CA}.\vec{CB}=0$ .....(i)

$\Rightarrow\vec{AB}.\vec{AC}+\vec{BC}.\vec{BA}+\vec{CA}.\vec{CB}$

$=\vec{AB}.\vec{AC}+\vec{BC}.\vec{BA}+0$using (i)

$=\vec{AB}.(\vec{AC}-\vec{BC})$

$=\vec{AB}.(\vec{AC}+\vec{CB})$

$=\vec{AB}.\vec{AB}=p^2$

Q.40 [D]

Sol. $v_1 = [\vec{a}\ \vec{b}\ \vec{c}]$ and $v_2 = [\vec{p}\ \vec{q}\ \vec{r}]$

$\because [\vec{p}\ \vec{q}\ \vec{r}] = \vec{p}.(\vec{q} \times \vec{r})$

$= (\vec{a} + \vec{b} - 2\vec{c}).\{(3\vec{a} - 2\vec{b} + \vec{c})$

$\times (\vec{a} - 4\vec{b} + 2\vec{c})\}$

$= (\vec{a} + \vec{b} - 2\vec{c}).\{-12(\vec{a} \times \vec{b}) + 6(\vec{a} \times \vec{c}) - 2(\vec{b} \times \vec{a}) - 4(\vec{b} \times \vec{c}) + (\vec{c} \times \vec{a}) - 4(\vec{c} \times \vec{b})\}$

$= (\vec{a} + \vec{b} - 2\vec{c}).\{-10(\vec{a} \times \vec{b}) + 5(\vec{a} \times \vec{c})\}$

$= 5\vec{b}.(\vec{a} \times \vec{c}) + 20\vec{c}.(\vec{a} \times \vec{b})$

$= -5\vec{a}.(\vec{b} \times \vec{c}) + 20\vec{a}.(\vec{b} \times \vec{c})$

$= 15[\vec{a}\ \vec{b}\ \vec{c}]$

$\Rightarrow \frac{v_2}{v_1} = \frac{[\vec{p}\ \vec{q}\ \vec{r}]}{[\vec{a}\ \vec{b}\ \vec{c}]} = \frac{15}{1}$

Q.41 [B]

Sol. $\vec{a} = -1, 1, 1,\ \vec{b} = 2, 0, 1$

Since $\vec{x}$ is coplanar with $\vec{a}$ and $\vec{b}$

$\vec{x} = \lambda\vec{a} + \mu\vec{b}$

$\Rightarrow \vec{x} = \lambda(-\hat{i} + \hat{j} + \hat{k}) + \mu(2\hat{i} + \hat{k})$

$= \vec{x} = (-\lambda + 2\mu, \lambda, \lambda + \mu)$

$\vec{x}$ is orthogonal to $\vec{b}$

$\Rightarrow \vec{x}.\vec{b} = 0$

$\Rightarrow 2(-\lambda + 2\mu) + 0 + (\lambda + \mu) = 0$

$\Rightarrow -\lambda + 5\mu = 0$ .....(i)

Given $\vec{x}.\vec{a} = 7$

$-1(-\lambda + 2\mu) + \lambda + \lambda + \mu = 7$

$3\lambda - \mu = 7$ .....(ii)

Solving (i) & (ii) we get

$\lambda = \frac{5}{2}, \mu = \frac{1}{2}$

$\Rightarrow \vec{x} = \left(-\frac{5}{2} + \frac{2}{2}\right)\hat{i} + \frac{5}{2}\hat{j} + \left(\frac{5}{2} + \frac{1}{2}\right)\hat{k}$

$\vec{x} = \frac{1}{2}(-3\hat{i} + 5\hat{j} + 6\hat{k})$

Q.42 [B]

Sol. $\vec{b}$ is a vector whose initial point divides the join to $5\hat{i}$ and $5\hat{j}$ in the ratio k : 1

$\Rightarrow$ Point = $\frac{5\hat{i}+5k\hat{j}}{k+1}$

terminal point is origin

$\Rightarrow \vec{b} = \frac{5\hat{i}+5k\hat{j}}{k+1}$

Given that $|\vec{b}| \le \sqrt{37}$

$\Rightarrow \frac{\sqrt{25+25k^2}}{k+1} \le \sqrt{37}$

$\Rightarrow 25 + 25k^2 \le 37 (k + 1)^2$

$\Rightarrow 6k^2 + 37k + 6 \ge 0$

$\Rightarrow (k + 6) (6k + 1) \ge 0$

$\Rightarrow k \in (-\infty, -6] \cup \left[-\frac{1}{6}, \infty\right)$

Q.43 [A]

Sol. Coordinate of P in first column

$$\vec{P} = 3\vec{a} + 2\vec{b} + \vec{c} \qquad \text{.....(1)}$$

coordinate of P in second column

$\vec{P} = \lambda(\vec{a}+\vec{b}+\vec{c}) + \mu(\vec{a}-\vec{b}+\vec{c}) + \gamma(\vec{a}+\vec{b}-\vec{c})$

$\vec{P} = \vec{a}(\lambda + \mu + \gamma) + \vec{b}(\lambda - \mu + \gamma) + \vec{c}(\lambda + \mu - \gamma)$

.....(2)

compare (1) & (2)

$\lambda + \mu + \gamma = 3$ so $\lambda = 3/2$

$\lambda - \mu + \gamma = 2$ $\quad \mu = 1/2$

$\lambda + \mu - \gamma = 1$ $\quad \gamma = 1$

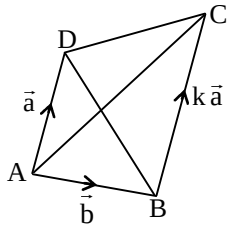
Q.44 [C]

Sol. Unit vector along OR is

$$\frac{\hat{p}+\hat{q}}{|\hat{p}+\hat{q}|} = \frac{\frac{\vec{p}}{|\vec{p}|}+\frac{\vec{q}}{|\vec{q}|}}{\left|\frac{\vec{p}}{|\vec{p}|}+\frac{\vec{q}}{|\vec{q}|}\right|}$$

Q.45 [C]

Sol.



Let A is origin

P.V of Bis $\vec{b}$

P.V of Cis $k\vec{a} + \vec{b}$

P.V of D is $\vec{a}$

P.V of X = $\frac{\vec{a}+\vec{b}}{2}$

P.V of Y = $\frac{\vec{b}+k\vec{a}}{2}$

$(\overrightarrow{XY}) = \left|\frac{(k-1)}{2}\right| |\vec{a}| = 4$

$\left|\frac{(k-1)}{2}\right| = \frac{4}{17} \Rightarrow k - 1 = \pm\frac{8}{17}$

$k = 1 + \frac{8}{17} = \frac{25}{17}$

$k = 1 - \frac{8}{17} = \frac{9}{17}$

Q.46 [C]

Sol. $3\vec{a} + 7\vec{b} = \lambda\vec{c}$ .....(1)

$3\vec{b} + 2\vec{c} = \mu\vec{a}$ .....(2)

eliminate 'c' from (1) & (2)

$6\vec{a} + 14\vec{b} = \lambda(\mu\vec{a} - 3\vec{b})$

$\vec{a}(6 - \lambda\mu) + \vec{b}(14 + 3\lambda) = 0$

$\vec{a}$ and $\vec{b}$ are not collinear

$6 - \lambda\mu = 0$ $\quad$ $14 + 3\lambda = 0$

$\lambda = -14/3$ $\quad$ put in eq. (1)

$3\vec{a} + 7\vec{b} = \frac{-14}{3}\vec{c}$

$9\vec{a} + 21\vec{b} = -14\vec{c}$

$9\vec{a} + 21\vec{b} + 14\vec{c} = 0$

Q.47 [C]

Sol. Given $\overrightarrow{AB} = \sqrt{3}(\vec{a} \times \vec{b})$, $\overrightarrow{BC} = \vec{b} - (\vec{a} \cdot \vec{b})\vec{a}$, $\vec{a}$ is a unit vector

we take

$\overrightarrow{AB} \cdot \overrightarrow{BC} = \sqrt{3}(\vec{a} \times \vec{b})[\vec{b} - (\vec{a} \cdot \vec{b})\vec{a}]$

$= \sqrt{3}(\vec{a} \times \vec{b}) \cdot \vec{b} - (\vec{a} \cdot \vec{b})\{(\vec{a} \times \vec{b}) \cdot \vec{a}\} = 0$

$\Rightarrow AB \perp BC \Rightarrow \angle ABC = \pi/2$

$\therefore AB^2 = 3(\vec{a} \times \vec{b})^2 = 3.b^2 \sin^2\theta$

$= 3b^2 \sin^2\theta$ .....(i)

and $BC^2 = (\vec{b})^2 + (\vec{a} \cdot \vec{b})^2 |\vec{a}|^2 - 2(\vec{b} \cdot \vec{a})(\vec{a} \cdot \vec{b})$

$= (\vec{b})^2 + (\vec{a} \cdot \vec{b})^2 - 2(\vec{a} \cdot \vec{b})^2$

$= (\vec{b})^2 - (\vec{a} \cdot \vec{b})^2$

$= (\vec{b})^2 (1 - \cos^2\theta)$

$BC^2 = b^2 \sin^2\theta$ .....(ii)

From (i) & (ii) $AB^2 = 3BC^2$

$\Rightarrow AB = \sqrt{3}\ BC$

$\therefore \tan A = \frac{BC}{AB} = \frac{1}{\sqrt{3}} \Rightarrow A = \frac{\pi}{6}$

and $C = \frac{\pi}{3}$

Angles are $\frac{\pi}{6}, \frac{\pi}{3}, \frac{\pi}{2}$

Q.48 [C]

Sol. $\therefore (\vec{a} \times \vec{b}) = |\vec{a}|\,|\vec{b}| \sin\frac{\pi}{6}.\hat{n}$

$\Rightarrow (\vec{a} \times \vec{b}).\ \vec{c} = \frac{1}{2}\,|\vec{a}|\,|\vec{b}|.\hat{n}\ \vec{c}$

$\Rightarrow [\vec{a}\ \vec{b}\ \vec{c}] = \frac{1}{2}\,|\vec{a}|\,|\vec{b}|.\ 1\ .\ 1\ \cos 0^\circ$

$\because \hat{n}$ is $\perp$ to both $\vec{a}$ and $\vec{b}$ and $\vec{c}$ is also a unit vector $\perp$ to both $\vec{a}$ and $\vec{b}$

$$\therefore \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}^2 = [\vec{a}\ \vec{b}\ \vec{c}]^2 = \frac{1}{4}|\vec{a}|^2|\vec{b}|^2$$

$= \frac{1}{4}\ (a_1^2+a_2^2+a_3^2)\ (b_1^2+b_2^2+b_3^2)$

Q.49 [A]

Sol. $\because \vec{a} = \hat{i} - \hat{j},\ \vec{b} = \hat{j} - \hat{k},\ \vec{c} = \hat{k} - \hat{i}$

Let $\vec{d} = x\hat{i} + y\hat{j} + z\hat{k}$

$\Rightarrow x^2 + y^2 + z^2 = 1$ .....(i)

$\therefore \vec{a}\ .\ \vec{d} = 0 \Rightarrow x - y = 0$

$\Rightarrow x = y$ .....(ii)

and $[\vec{b}\ \vec{c}\ \vec{d}] = 0$

$$\Rightarrow \begin{vmatrix} 0 & 1 & -1 \\ -1 & 0 & 1 \\ x & y & z \end{vmatrix} = 0$$

$\Rightarrow x + y + z = 0$

$\Rightarrow 2x + z = 0$ from (ii)

$\Rightarrow z = -2x$ .....(iii)

from (i), (ii) and (iii) we get

$x^2 + x^2 + 4x^2 = 1$

$\Rightarrow x = \pm\frac{1}{\sqrt{6}}$

$\vec{d} = \pm\frac{\hat{i}+\hat{j}-2\hat{k}}{\sqrt{6}}$

Q.50 [B]

Sol. $\vec{p}, \vec{q}, \vec{r}$ are three mutually perpendicular vector of same magnitude so

let $\vec{p} = a\hat{i}, \vec{q} = a\hat{j}, \vec{r} = a\hat{k}$

and Let $\vec{x} = x_1\hat{i} + y_1\hat{j} + z_1\hat{k}$

$\therefore \vec{p} \times ((\vec{x} - \vec{q}) \times \vec{p}) = \vec{p} \times (\vec{x} \times \vec{p} - \vec{q} \times \vec{p})$

$= \vec{p} \times (\vec{x} \times \vec{p}) - \vec{p} \times (\vec{q} \times \vec{p})$

$= (\vec{p} \cdot \vec{p})\vec{x} - (\vec{p} \cdot \vec{x})\vec{p} - (\vec{p} \cdot \vec{p})\vec{q} + (\vec{p} \cdot \vec{q})\vec{p}$

$= a^2\vec{x} - a^2x_1\hat{i} - a^3\hat{j} + 0$

Similarly

$\vec{q} \times ((\vec{x} - \vec{r}) \times \vec{q}) = a^2\vec{x} - a^2y_1\hat{j} - a^3.\hat{k}$

and $\vec{r} \times ((\vec{x} - \vec{p}) \times \vec{r}) = a^2\vec{x} - a^2z_1\hat{k} - a^3.\hat{i}$

Put these values in equation we get

$3a^2\vec{x} - a^2(x_1\hat{i} + y_1\hat{j} + z_1\hat{k}) - a^2(a\hat{i} + a\hat{j} + a\hat{k}) = 0$

$\Rightarrow 3\vec{x} - \vec{x} - (\vec{p} + \vec{q} + \vec{r}) = 0$

$\Rightarrow \vec{x} = \frac{1}{2}(\vec{p} + \vec{q} + \vec{r})$

Q.51 [D]

Sol. Given $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = 4\hat{i} + 3\hat{j} + 4\hat{k}$

and $\vec{c} = \hat{i} + \alpha\hat{j} + \beta\hat{k}$ are linearly dependent so $\vec{c} = \lambda\vec{a} + \mu\vec{b}$ For some λ, μ

$\Rightarrow \hat{i} + \alpha\hat{j} + \beta\hat{k} = \lambda(\hat{i} + \hat{j} + \hat{k}) + \mu(4\hat{i} + 3\hat{j} + 4\hat{k})$

$= (\lambda + 4\mu)\hat{i} + (\lambda + 3\mu)\hat{j} + (\lambda + 4\mu)\hat{k}$

Comparing coefficient we get

$\lambda + 4\mu = 1$ .....(i)

$\lambda + 3\mu = \alpha$ .....(ii)

$\lambda + 4\mu = \beta$ .....(iii)

from (i) & (iii) we get

$\beta = 1$

Given $|\vec{c}| = \sqrt{3}$

$1 + \alpha^2 + \beta^2 = 3$

$\Rightarrow \alpha^2 = 1 \qquad \because \beta = 1$

$\Rightarrow \alpha = \pm 1$

Q.52 [A]

Sol. $\vec{c}$ is coplanar with $\vec{a}$ and $\vec{b}$

$\Rightarrow \vec{c} = x\vec{a} + y\vec{b}$ .....(i)

$\because \vec{c}$ is perpendicular to $\vec{a}$

$\Rightarrow \vec{c} \cdot \vec{a} = 0$

$\Rightarrow x\vec{a} \cdot \vec{a} + y\vec{b} \cdot \vec{a} = 0$

$\Rightarrow 6x + 3y = 0$

$\Rightarrow y = -2x$ .....(ii)

$\Rightarrow \vec{c} = x(\vec{a} - 2\vec{b}) = 3x(-\hat{j} + \hat{k})$

$\Rightarrow |\vec{c}|^2 = 9x^2(1 + 1) = 18x^2$

$\because \vec{c}$ is a unit vector $\Rightarrow |\vec{c}| = 1$

$\Rightarrow x = \pm \frac{1}{3\sqrt{2}}$

$\Rightarrow \vec{c} = \pm \frac{1}{\sqrt{2}}(-\hat{j} + \hat{k})$

Q.53 [A]

Sol. $\vec{A}.(\vec{B} + \vec{C}) \times (\vec{A} + \vec{B} + \vec{C})$

$= \vec{A}.(\vec{B} \times \vec{A}) + \vec{A}.(\vec{B} \times \vec{B}) + \vec{A}.(\vec{B} \times \vec{C}) + \vec{A}.(\vec{C} \times \vec{A}) + A.(\vec{C} \times \vec{B}) + \vec{A}.(\vec{C} \times \vec{C})$

$= 0 + 0 + [A\ B\ C] + 0 - [A\ B\ C] + 0 = 0$

Q.54 [A]

Sol. $\vec{a}, \vec{b}, \vec{c}$ are unit coplanar vectors,

$2\vec{a} - \vec{b}, 2\vec{b} - \vec{c}, 2\vec{c} - \vec{a}$ are also coplanar vectors

Thus $[2\vec{a} - \vec{b}, 2\vec{b} - \vec{c}, 2\vec{c} - \vec{a}] = 0$

Q.55 [C]

Sol. $\vec{a} = \hat{i} - \hat{k}$, $b = x\hat{i} + \hat{j} + (1 - x)\hat{k}$ and $\vec{c} = y\hat{i} + x\hat{j} + (1 + x - y)\hat{k}$ then

$$[\vec{a}\ \vec{b}\ \vec{c}] = \begin{vmatrix} 1 & 0 & -1 \\ x & 1 & 1-x \\ y & x & 1+x-y \end{vmatrix}$$

$= 1(1 + x - y - x(1 - x) - 1(x^2 - y))$

$= 1 + x - y - x + x^2 - x^2 + y = 1$

$[\vec{a}\ \vec{b}\ \vec{c}]$ depends neither x nor y

Q.56 [B]

Sol. $\vec{a}, \vec{b}, \vec{c}$ are unit vectors

$\Rightarrow \vec{a}.\vec{a} = \vec{b}.\vec{b} = \vec{c}.\vec{c} = 1$

Let

$x = |\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2$

$= 2(|\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 - (\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a}))$

$= 6 - 2(\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a})$

Now

$|\vec{a} + \vec{b} + \vec{c}|^2 \geq 0$

$\Rightarrow |\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 + 2(\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a}) \geq 0$

$\Rightarrow -2(\vec{a}.\vec{b}+\vec{b}.\vec{c}+\vec{c}.\vec{a}) \le 3$

$\Rightarrow 6-2(\vec{a}.\vec{b}+\vec{b}.\vec{c}+\vec{c}.\vec{a}) \le 9$

$= x \le 9$

$\Rightarrow$ x does not exceed 9

Q.57 [B]

Sol. Given that $\vec{a}$ and $\vec{b}$ are unit vector

$\Rightarrow |\vec{a}| = |\vec{b}| = 1$

Given that $\vec{a} + 2\vec{b}$ and $5\vec{a} - 4\vec{b}$ are $\perp^r$

$\Rightarrow (\vec{a} + 2\vec{b}).(5\vec{a} - 4\vec{b}) = 0$

$\Rightarrow 5|\vec{a}|^2 - 8|\vec{b}|^2 + 6\vec{a}.\vec{b} = 0$

$\Rightarrow 5 - 8 + 6\,\vec{a}.\vec{b} = 0$

$\Rightarrow 6|\vec{a}||\vec{b}|\cos\theta = 3$

$\Rightarrow \cos\theta = 1/2$

$\Rightarrow \theta = 60^\circ$

Q.58 [C]

Sol. $\vec{V} = 2\hat{i} + \hat{j} - \hat{k}$, $\vec{W} = \hat{i} + 3\hat{k}$ and $\vec{U}$ is a unit vector

$\Rightarrow |\vec{U}| = 1$

$[\vec{U}\ \vec{V}\ \vec{W}] = \vec{U}.(\vec{V} \times \vec{W})$

$\Rightarrow \vec{U}.(2\hat{i} + \hat{j} - \hat{k}) \times (\hat{i} + 3\hat{k})$

$\Rightarrow \vec{U}.(3\hat{i} - 7\hat{j} - \hat{k})$

$= 1.\sqrt{9+49+1}\cos\theta$

$= \sqrt{59}\cos\theta$

It is maximum when $\cos\theta = 1$

$[\vec{U}\ \vec{V}\ \vec{W}]_{max} = \sqrt{59}$

Q.59 [C]

Sol. $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and Let $\vec{b} = x\hat{i} + y\hat{j} + z\hat{k}$

Given $\vec{a}.\vec{b} = 1$

$x + y + z = 1$ .....(i)

and $\vec{a} \times \vec{b} = j - k$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 1 \\ x & y & z \end{vmatrix} = j - k$$

$\Rightarrow i(z-y)+j(x-z)+k(y-x)=j-k$

from comparing we get

$z-y=0 \quad \Rightarrow z=y$ .....(ii)

$x-z=1$ .....(iii)

and $x-y=1$ .....(iv)

solving we get

$x=1, y=0, z=0$

$\Rightarrow \vec{b}=\hat{i}$

Q.60 [A]

Sol. Any vector $\vec{r}$ coplanar with $\vec{a}$ and $\vec{b}$ we can written as

$\vec{r}=\vec{a}+\lambda\vec{b}$

$\Rightarrow \vec{r}=(2\hat{i}+\hat{j}+\hat{k})+\lambda(\hat{i}-\hat{j}+\hat{k})$

$\Rightarrow \vec{r}=(2+\lambda)\hat{i}+(1-\lambda)\hat{j}+(1+\lambda)\hat{k}$

$\therefore \vec{r}$ is orthogonal with $3\hat{i}+2\hat{j}+6\hat{k}$

$\Rightarrow 3(2+\lambda)+2(1-\lambda)+6(1+\lambda)=0$

$\Rightarrow 7\lambda+14=0$

$\Rightarrow \lambda=-2$

$\Rightarrow \vec{r}=3\hat{j}-\hat{k}$

since $\vec{r}$ is a unit vector

$\Rightarrow \vec{r}=\frac{3\hat{j}-\hat{k}}{\sqrt{10}}$

Q.61 [B]

Sol. we observe that

$$\vec{a}\cdot\vec{b}_1=\vec{a}\cdot\vec{b}-\left(\frac{\vec{b}\cdot\vec{a}}{|\vec{a}|^2}\right)\vec{a}\cdot\vec{a}$$

$$=\vec{a}\cdot\vec{b}-\vec{a}\cdot\vec{b}=0$$

$$\vec{a}\cdot\vec{c}_2=\vec{a}\cdot\vec{c}-\frac{\vec{a}\cdot\vec{c}}{|\vec{a}|^2}|\vec{a}|^2-\left(\frac{\vec{c}\cdot\vec{b}_1}{|\vec{b}_1|}\right)$$

$$=\vec{a}\cdot\vec{c}-\vec{a}\cdot\vec{c}-0=0$$

$\because [\vec{a}\cdot\vec{b}_1=0]$ and $\vec{b}_1\cdot\vec{c}_2=\vec{b}_1\left(\vec{c}-\frac{\vec{c}\cdot\vec{a}}{|\vec{a}|^2}\vec{a}-\frac{\vec{c}\cdot\vec{b}_1}{|\vec{b}_1|^2}\vec{b}_1\right)$

$$=\vec{b}_1\cdot\vec{c}-\frac{(\vec{c}\cdot\vec{a})(\vec{b}_1\cdot\vec{a})}{|\vec{a}|^2}-\frac{\vec{c}\cdot\vec{b}_1}{|\vec{b}_1|^2}|\vec{b}_1|^2$$

$= \vec{b_1} . \vec{c} - 0 - \vec{b_1} . \vec{c} = 0$

$\Rightarrow$ The set of orthogonal vector is $[\vec{a}\ \vec{b_1}\ \vec{c_2}]$

Q.62 [B]

Sol. Any vector $\vec{r}$ in the plane of $\vec{a}$ & $\vec{b}$ can be written as

$\vec{r} = \vec{a} + \lambda \vec{b}$

$\Rightarrow \vec{r} = (\hat{i}+2\hat{j} + \hat{k}) + \lambda(\hat{i}-\hat{j} + \hat{k})$

$= (1 + \lambda)\hat{i} + (2 - \lambda)\hat{j} + (1 + \lambda)\hat{k}$

Projection of $\vec{r}$ on $\vec{c} = \dfrac{\vec{r} . \vec{c}}{|\vec{c}|}$

$\Rightarrow \dfrac{1}{\sqrt{3}} = \dfrac{|(1+\lambda)+(2-\lambda)-(1+\lambda)|}{\sqrt{3}}$

$\Rightarrow |2 - \lambda| = 1$

$\Rightarrow \lambda = 1$ or 3

$\Rightarrow \vec{r} = 2\hat{i} + \hat{j} + 2\hat{k}$ or $4\hat{i} - \hat{j} + 4\hat{k}$

Q.63 [C]

Sol. Let $\vec{a} = -\lambda 2\hat{i}+\hat{j}+\hat{k}$, $\vec{b} = \hat{i}-\lambda^2\hat{j}+\hat{k}$

and $\vec{c} = \hat{i}+\hat{j}-\lambda^2\hat{k}$

$\vec{a}, \vec{b}, \vec{c}$ are coplanar

$\Rightarrow [\vec{a}\ \vec{b}\ \vec{c}] = 0$

$$= \begin{vmatrix} -\lambda^2 & 1 & 1 \\ 1 & -\lambda^2 & 1 \\ 1 & 1 & -\lambda^2 \end{vmatrix} = 0$$

$= \lambda^6 - 3\lambda^2 - 2 = 0$

Let $\lambda^2 = t$

$\Rightarrow t^3 - 3t - 2 = 0$

$(t - 2)(t + 1)^2 = 0$

$\Rightarrow t = 2, t = -1$

$t \neq -1$

$\Rightarrow t = 2 \Rightarrow \lambda^2 = 2$

$\lambda = \pm \sqrt{2}$

two values

Q.64 [B]

Sol. $\vec{a} + \vec{b} + \vec{c} = 0$

Taking cross product by $\vec{a}, \vec{b}, \vec{c}$

$\vec{a} \times (\vec{a} + \vec{b} + \vec{c}) = \vec{a} \times 0 = 0$

$\Rightarrow \vec{a} \times \vec{b} + \vec{a} \times \vec{c} = 0$

$\Rightarrow \vec{a} \times \vec{b} = \vec{c} \times \vec{a}$ .....(i)

and

$\vec{b} \times (\vec{a} + \vec{b} + \vec{c}) = \vec{b} \times 0 = 0$

$\Rightarrow \vec{b} \times \vec{a} + \vec{b} \times \vec{c} = 0$

$\Rightarrow \vec{a} \times \vec{b} = \vec{b} \times \vec{c}$ .....(ii)

form (i) & (ii)

$\Rightarrow \vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a}$

$\because \vec{a} \times \vec{b} \neq 0, \ \vec{b} \times \vec{c} \neq 0 \ \ \vec{c} \times \vec{a} \neq 0$

$\Rightarrow \vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a} \neq 0$

Q.65 [A]

Sol. $\therefore \vec{a} \cdot \vec{b} = |a|\,|b| \cos\theta = \frac{1}{2} \Rightarrow \theta = 60^\circ$

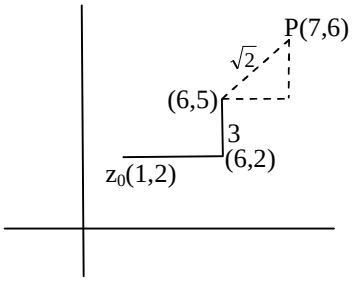
volume $|[\hat{a}\ \hat{b}\ \hat{c}]|$

$= |(\hat{a} \times \hat{b}).\hat{c}| = \sqrt{\begin{vmatrix} \hat{a}.\hat{a} & \hat{a}.\hat{b} & \hat{a}.\hat{c} \\ \hat{b}.\hat{a} & \hat{b}.\hat{b} & \hat{b}.\hat{c} \\ \hat{c}.\hat{a} & \hat{c}.\hat{b} & \hat{c}.\hat{c} \end{vmatrix}}$

$= \frac{1}{\sqrt{2}}$

Q.66 [D]

Sol.



We see that the point P is (7, 6)

$\Rightarrow P = 7 + 6\hat{i}$

Now it is rotated by $\frac{\pi}{2}$ angle in anti clock wise since

$\Rightarrow \hat{i}(7 + 6\hat{i}) = -6 + 7\hat{i}$

Q.67 [C]

Sol. $(\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d}) = \begin{vmatrix} \vec{a}.\vec{c} & \vec{a}.\vec{d} \\ \vec{b}.\vec{c} & \vec{b}.\vec{d} \end{vmatrix} = 1$

$$\Rightarrow \begin{vmatrix} \frac{1}{2} & \vec{a}.\vec{d} \\ \vec{b}.\vec{c} & \vec{b}.\vec{d} \end{vmatrix} = 1$$

$$\Rightarrow \frac{1}{2}(\vec{b}.\vec{d}) - (\vec{a}.\vec{d})(\vec{b}.\vec{c}) = 1$$

$$\left(|\vec{a}||\vec{b}|\sin\theta_1\hat{n}_1\right) . \left(|\vec{c}||\vec{d}|\sin\theta_2\hat{n}_2\right) = 1$$

$$\Rightarrow \sin\theta_1\sin\theta_2\,\hat{n}_1.\hat{n}_2 = 1$$

$$\theta_1 = \theta_2 = \frac{\pi}{2};\alpha = 0$$

$$\vec{a} \perp \vec{b} \perp \vec{c} \;\&\; \vec{d} \;\&\; \vec{n}_1 \parallel \vec{n}_2$$

Q.68 [A]

Sol. $\overrightarrow{PQ} = 6i + j$

$\overrightarrow{SR} = 6i+j$

$\overrightarrow{RQ} = i - 3j$

$\overrightarrow{SP} = i - 3j$

$|\overrightarrow{PQ}| \neq |\overrightarrow{RQ}|$ ($\therefore$ not a rhombus or a rectangle)

PQ || RS

RQ || SP

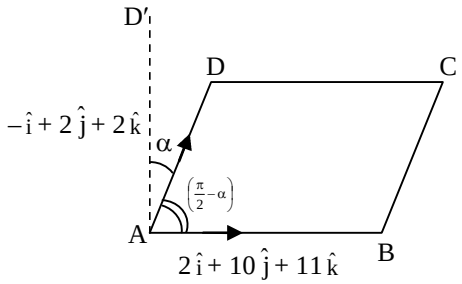
Also $\overrightarrow{PQ} . \overrightarrow{RQ} \neq 0$

$\therefore$ PQRS is not a square

$\Rightarrow$ PQRS is a parallelogram

Q.69 [B]

Sol.



$$\cos\left(\frac{\pi}{2}-\alpha\right) = \frac{\overrightarrow{AB}.\overrightarrow{AD}}{|\overrightarrow{AB}||\overrightarrow{AD}|} = \frac{40}{3(15)} = \frac{8}{9}$$

$$\sin\alpha = \frac{8}{9} \Rightarrow \cos\alpha = \frac{\sqrt{17}}{9}$$

Q.70 [C]

Sol. Let $\vec{v} = x\hat{i} + y\hat{j} + z\hat{k}$

$\because [\vec{a}\ \vec{b}\ \vec{v}] = 0$

$$\begin{vmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ x & y & z \end{vmatrix} = 0$$

On solving $x = z$ ....(1)

$\because$ projection of $\vec{v}$ on $\vec{c}$ is $\frac{1}{\sqrt{3}}$

So, $\frac{1}{\sqrt{3}} = \frac{\vec{v}.\vec{c}}{|\vec{c}|} \Rightarrow \frac{x-y-z}{\sqrt{3}} = \frac{1}{\sqrt{3}}$

$\Rightarrow x - y - z = 1$ ....(2)

So solving (1) & (2)

$y = -1$ & $x = z$

Q.71 [C]

Sol. $|\vec{a}+\vec{b}| = \sqrt{29}$

$\vec{a} \times (2\hat{i}+3\hat{j}+4\hat{k}) = (2\hat{i}+3\hat{j}+4\hat{k}) \times \vec{b}$

$(\vec{a}+\vec{b}) \times (2\hat{i}+3\hat{j}+4\hat{k}) = \vec{0}$

$\vec{a}+\vec{b} = \lambda(2\hat{i}+3\hat{j}+4\hat{k})$

$|\vec{a}+\vec{b}| = \sqrt{4\lambda^2+9\lambda^2+16\lambda^2} = |\lambda|\sqrt{29}$

$\Rightarrow \lambda = 1, -1$

$\vec{a}+\vec{b} = \pm(2\hat{i}+3\hat{j}+4\hat{k})$

$(\vec{a}+\vec{b}) . (-7\hat{i}+2\hat{j}+3\hat{k})$

$= \pm(2\hat{i}+3\hat{j}+4\hat{k}) . (-7\hat{i}+2\hat{j}+3\hat{k}) = \pm 4$

Q.72 [B]

Sol. Let (x, y, z) be the unit vector $\perp$ to

$\vec{a}$ = (1,1,0) and $\vec{b}$ = (0, 1, 1)

$\Rightarrow$ x + y = 0 and y + z = 0 .....(i)

and $x^2 + y^2 + z^2 = 1$ .....(ii)

from (i) we have

x = – y and z = – y

from (ii) we get

$y^2 + y^2 + y^2 = 1$

$\Rightarrow y = \pm \frac{1}{\sqrt{3}}$

Clearly two vectors possible

Q.73 [D]

Sol. Given that $\vec{a}\ \vec{b}\ \vec{c}$ are non coplanar

$\Rightarrow [\vec{a}\ \vec{b}\ \vec{c}] \neq 0$

Now, $(\vec{a}+\vec{b}).\vec{p} + (\vec{b}+\vec{c}).\vec{q} + (\vec{c}+\vec{a}).\vec{r}$

$= (\vec{a}+\vec{b}) . \frac{\vec{b}\times\vec{c}}{[\vec{a}\vec{b}\vec{c}]} + (\vec{b}+\vec{c}) . \frac{\vec{c}\times\vec{a}}{[\vec{a}\vec{b}\vec{c}]} + (\vec{c}+\vec{a}) . \frac{\vec{a}\times\vec{b}}{[\vec{a}\vec{b}\vec{c}]}$

$= \frac{\vec{a}.\vec{b}\times\vec{c}+\vec{b}.\vec{c}\times\vec{a}+\vec{c}.\vec{a}\times\vec{b}}{[\vec{a}\,\vec{b}\,\vec{c}]}$

using $\vec{b}\,.\,\vec{b}\times\vec{c} = \vec{c}\,.\,\vec{c}\times\vec{a} = \vec{a}\,.\,\vec{a}\times\vec{b} = 0$

$= \frac{[\vec{a}\,\vec{b}\,\vec{c}]+[\vec{a}\,\vec{b}\,\vec{c}]+[\vec{a}\,\vec{b}\,\vec{c}]}{[\vec{a}\,\vec{b}\,\vec{c}]} = 3$

Q.74 [B]

Sol. $\because$ Vectors $a\hat{i} + a\hat{j} + c\hat{k},\ \hat{i}+\hat{k},\ c\hat{i} + c\hat{j} + b\hat{k}$

are coplanar so

$$\begin{vmatrix} a & a & c \\ 1 & 0 & 1 \\ c & c & b \end{vmatrix} = 0$$

$\Rightarrow a(-c) - a(b - c) + c(c) = 0$

$\Rightarrow c^2 - ab = 0 \Rightarrow c^2 = ab$

$\Rightarrow$ a,c,b are in G.P. and c is the G.M of a and b

Q.75 [A]

Sol. $\vec{OP} = \vec{p}\ ,\ \vec{OQ} = \vec{q}$

$\vec{R} = \frac{3\vec{p}+2\vec{q}}{5}$ [$\because$ R divide PQ internally in the ratio 2 : 3]

and $\vec{S} = \frac{3\vec{p}-2\vec{q}}{1}$ [$\because$ S divide PQ externally in the ratio 2 :3]

Given $\vec{OR} \perp \vec{OS}$

$\Rightarrow \vec{OR}\,.\,\vec{OS} = 0$

$\Rightarrow \frac{3\vec{p}+2\vec{q}}{5}\,.\,\frac{3\vec{p}-2\vec{q}}{1} = 0$

$\Rightarrow 9|\vec{p}\,|^2 - 4\,|\vec{q}\,|^2 = 0$

$\Rightarrow 9p^2 = 4q^2$

Q.76 [B]

Sol. Let $\vec{a} = \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$

$\vec{b} = \beta\hat{i} + \gamma\hat{j} + \alpha\hat{k}$

$\vec{c} = \gamma\hat{i} + \alpha\hat{j} + \beta\hat{k}$

Then $|\vec{b} - \vec{a}| = |(\beta-\alpha)\hat{i} + (\gamma - \beta)\hat{j} + (\alpha - \gamma)\hat{k}|$

$= \sqrt{2(\alpha^2+\beta^2+\gamma^2-\alpha\beta-\beta\gamma-\gamma\alpha)}$

$|\vec{c} - \vec{b}| = |(\gamma-\beta)\hat{i} + (\alpha - \gamma)\hat{j} + (\beta - \alpha)\hat{k}|$

$= \sqrt{2(\alpha^2+\beta^2+\gamma^2-\alpha\beta-\beta\gamma-\gamma\alpha)}$

and $|\vec{a} - \vec{c}| = |(\alpha-\gamma)\hat{i} + (\beta - \alpha)\hat{j} + (\gamma - \beta)\hat{k}|$

$= \sqrt{2(\alpha^2+\beta^2+\gamma^2-\alpha\beta-\beta\gamma-\gamma\alpha)}$

Clearly it is a equilateral triangle

Q.77 [B]

Sol. $|(\vec{a}\times\vec{b})\times\vec{c}| = |\vec{a}\times\vec{b}||\vec{c}|\sin30^\circ$

$= \frac{1}{2}|\vec{a}\times\vec{b}||\vec{c}|$ .....(i)

Given $\vec{a} = 2\hat{i}+\hat{j}-2\hat{k}$ and $\vec{b} = \hat{i}+\hat{j}$

we have $\vec{a}\times\vec{b} = 2\hat{i}-2\hat{j}+\hat{k}$

$\Rightarrow |\vec{a}\times\vec{b}| = \sqrt{9} = 3$ .....(ii)

Given $|\vec{c}-\vec{a}| = 2\sqrt{2}$

$\Rightarrow |\vec{c}-\vec{a}|^2 = 8$

$(\vec{c}-\vec{a}).(\vec{c}-\vec{a}) = 8$

$\Rightarrow |\vec{c}|^2 - \vec{a}.\vec{c} - \vec{c}.\vec{a} + |\vec{a}|^2 = 8$

$\because |\vec{a}| = 3$ and $\vec{a}.\vec{c} = |c|$

$\Rightarrow |c|^2 - 2|c| + 1 = 0$

$\Rightarrow (|\vec{c}|-1)^2 = 0$

$\Rightarrow |\vec{c}| = 1$ .....(iii)

so from (i), (ii) and (iii) we get

$|(\vec{a}\times\vec{b})\times\vec{c}| = \frac{1}{2}\times 3\times 1 = \frac{3}{2}$

Q.78 [A]

Sol. Given that $(\vec{a}\times\vec{b})\times(\vec{c}\times\vec{d}) = 0$ .....(i)

P_1 is the plane determined by $\vec{a}$ and $\vec{b}$

$\therefore$ Normal vector $\vec{n_1}$ to P_1 is given by

$\vec{n_1} = \vec{a}\times\vec{b}$ .....(ii)

Similarly P_2 is the plane determined by $\vec{c}$ and $\vec{d}$

$\therefore$ Normal vector $\vec{n_2}$ to P_2 is given by

$\vec{n_2} = \vec{c}\times\vec{d}$ .....(iii)

from (i), (ii) & (iii) we get

$\vec{n_1}\times\vec{n_2} = 0$

$\Rightarrow n_1 \parallel n_2$

Hence planes will be parallel to each other

Hence angle between P_1 and P_2 is 0 (zero)

Q.79 [A]

Sol. Four or more than four non zero vectors are always linearly dependent.

Q.80 [C]

Sol. If $\vec{a}$ and $\vec{b}$ are reciprocal, then

$\vec{a} = \lambda\vec{b},\ \lambda \in R^+$ and $|\vec{a}||\vec{b}| = 1$

$\Rightarrow |\vec{a}| = |\lambda||\vec{b}|$

$\Rightarrow |\lambda| = \frac{|\vec{a}|}{|\vec{b}|} = \frac{1}{|\vec{b}|^2}$

$\Rightarrow \vec{a} = \frac{1}{|\vec{b}|^2}\vec{b}$

$\Rightarrow \vec{a}.\vec{b} = \frac{1}{|\vec{b}|^2}|\vec{b}||\vec{b}|\cos 0 = 1$

Q.81 [C]

Sol. $\vec{a} + \vec{b} = \vec{p}$

$\Rightarrow |\vec{a} + \vec{b}|^2 = |\vec{p}|^2$

$\Rightarrow (\vec{a} + \vec{b}).(\vec{a} + \vec{b}) = |\vec{p}|^2$

$= |\vec{a}|^2 + |\vec{b}|^2 + 2.\vec{a}.\vec{b} = |\vec{p}|^2$

Also, $\vec{a} - \vec{b} = \vec{q}$

$\Rightarrow |\vec{a} - \vec{b}|^2 = |\vec{q}|^2$

$\Rightarrow (\vec{a} - \vec{b}).(\vec{a} - \vec{b}) = |\vec{q}|^2$

$= |\vec{a}|^2 + |\vec{b}|^2 - 2.\vec{a}.\vec{b} = |\vec{q}|^2$

Thus $2(|\vec{a}|^2 + |\vec{b}|^2) = |\vec{p}|^2 + |\vec{q}|^2$

Q.82 [B]

Sol. $\vec{a} + \vec{b} = -\vec{c}$

$\Rightarrow |\vec{a} + \vec{b}|^2 = |\vec{c}|^2 = 1$

$\Rightarrow |\vec{a}|^2 + |\vec{b}|^2 + 2\vec{a}.\vec{b} = 1$

$\Rightarrow \vec{a}.\vec{b} = -\frac{1}{2}$

$\Rightarrow |\vec{a}||\vec{b}|\cos\theta = -\frac{1}{2}$

$\Rightarrow \cos\theta = -\frac{1}{2}$

$\Rightarrow \theta = \frac{2\pi}{3}$

Q.83 [B]

Sol. Projection of $\vec{a}$ on $\vec{b}$ is $\frac{\vec{a}.\vec{b}}{|\vec{b}|}$

Thus required projection

$$= \frac{(\hat{i}+2\hat{j}+3\hat{k}).(\hat{i}-2\hat{j}-2\hat{k})}{\sqrt{1+4+4}}$$

$$= \frac{1-4-6}{3} = -3$$

Q.84 [D]

Sol. $(\vec{a}+\vec{b}).(\vec{a}-\vec{b}) = |\vec{a}|^2 - |\vec{b}|^2 = 0$

Thus projection of $\vec{a}+\vec{b}$ on $\vec{a}-\vec{b}$ is zero.

Q.85 [B]

Sol. Area vector of parallelogram

$$= \frac{1}{2}(\overrightarrow{AC} \times \overrightarrow{BD})$$

$$= \frac{1}{2}\begin{vmatrix} i & j & k \\ 1 & -2 & 1 \\ -1 & 2 & -5 \end{vmatrix}$$

$$= \frac{1}{2}(8\hat{i}+4\hat{j})$$

$$= 4\hat{i}+2\hat{j}$$

$\therefore$ Area of the parallelogram

$$= |4\hat{i}+2\hat{j}| = 2\sqrt{5} \text{ sq. units}$$

Q.86 [B]

Sol. $\vec{a}.\vec{b} = (x\hat{i}+(x-1)\hat{j}+\hat{k}).((x+1)\hat{i}+\hat{j}+a\hat{k})$

$= x(x + 1) + x - 1 + a$

$= x^2 + 2x + a - 1$

We must have

$\vec{a}.\vec{b} > 0 \ \forall x \in R$

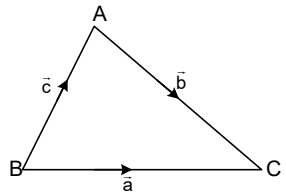
$\Rightarrow x^2 + 2x + a - 1 > 0 \ \forall x \in R$

$\Rightarrow 4 - 4(a - 1) < 0$

$\Rightarrow a > 2$

Q.87 [D]

Sol. Clearly $\vec{a},\vec{b}$ and $\vec{c}$ represents the sides of a triangle.



It's area vector,

$= \frac{1}{2}\vec{a}\times\vec{b}$

$= \frac{1}{2}\vec{b}\times\vec{c} = \frac{1}{2}\vec{c}\ \text{x}\ \vec{a}$

Thus, $\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a} = -\vec{a}\times\vec{b}$

$\Rightarrow \quad 2\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a} = 0$

Q.88 [A]

Sol. $\vec{a}\times\vec{b} = \vec{c},\ \vec{b}\times\vec{c} = \vec{a}$

Taking cross with $\vec{b}$ in first equation, we get

$\vec{b}\times(\vec{a}\times\vec{b}) = \vec{b}\times\vec{c} = \vec{a}$

$\Rightarrow |\vec{b}|^2\,\vec{a} - (\vec{a}.\vec{b})\vec{b} = \vec{a}$

$\Rightarrow |\vec{b}|^2 = 1$ and $\vec{a}.\vec{b} = 0$

Also, $|\vec{a}\times\vec{b}| = |\vec{c}|$

$\Rightarrow |\vec{a}||\vec{b}|\sin\frac{\pi}{2} = |\vec{c}|$

$\Rightarrow |\vec{a}| = |\vec{c}|$

Q.89 [B]

Sol. $\vec{a}+\vec{b}+\vec{c} = \vec{x},$

Taking dot with $\vec{x}$ on both sides, we get

$\vec{x}.\vec{a}+\vec{x}.\vec{b}+\vec{x}.\vec{c} = \vec{x}.\vec{x} = |\vec{x}|^2 = 4$

$\Rightarrow \quad 1+\frac{3}{2}+\vec{x}.\vec{c} = 4$

$\Rightarrow \vec{x}.\vec{c} = \frac{3}{2}$

If 'θ' be the angle between $\vec{c}$ and $\vec{x}$ then

$|\vec{x}||\vec{c}|\cos\theta = \frac{3}{2}$

$\Rightarrow \cos\theta = \frac{3}{4}$

$\Rightarrow \quad \theta = \cos^{-1}\left(\frac{3}{4}\right)$

Q.90 [C]

Sol. $|\vec{a}+\vec{b}+\vec{c}|^2$

$= (\vec{a}+\vec{b}+\vec{c}).(\vec{a}+\vec{b}+\vec{c})$

$= |\vec{a}|^2+|\vec{b}|^2+|\vec{c}|^2+2.\vec{a}.\vec{b}+2\vec{b}.\vec{c}+2\vec{c}.\vec{a}$

$= 1 + 4 + 4 + 0 + 0 + 0 = 9$

$\Rightarrow \left|\vec{a}+\vec{b}+\vec{c}\right| = 3$

Q.91 [D]

Sol. $\vec{a}+5\vec{b}+3\vec{c}=\vec{0}$

Thus $\vec{a},\vec{b},\vec{c}$ are coplanar.

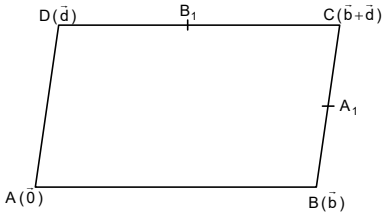
Hence $\vec{a}.(\vec{b}\times\vec{c})=0$

Q.92 [C]

Sol. Let P.V. of A,B,D be $\vec{0},\vec{b}$ and $\vec{d}$ respectively.

Then P.V. of C = $\vec{b}+\vec{d}$

Also, P.V. of $A_1=\vec{b}+\frac{\vec{d}}{2}$



and, P.V. of $B_1=\vec{d}+\frac{\vec{b}}{2}$

$\Rightarrow \overrightarrow{AA_1}+\overrightarrow{AB_1}=\frac{3}{2}(\vec{b}+\vec{d})=\frac{3}{2}\overrightarrow{AC}$

Q.93 [C]

Sol. Total force, $\vec{F}=\vec{F}_1+\vec{F}_2=\hat{i}-3\hat{j}+5\hat{k}$

Displacement, $\vec{d}=6\hat{i}+\hat{j}-3\hat{k}-(4\hat{i}-3\hat{j}-2\hat{k})$

$=2\hat{i}+4\hat{j}-\hat{k}$

Work done = $\vec{F}\,.\,\vec{d}$

= 2 – 12 – 5 = - 15 units.

Q.94 [C]

Sol. Let P.V. of A, B, C and D be $\vec{a},\vec{b},\vec{c}$ and $\vec{0}$

$\Rightarrow \overrightarrow{AB}\times\overrightarrow{CD}=(\vec{b}-\vec{a})\times-\vec{c}$,

$\overrightarrow{BC}\times\overrightarrow{AD}=(\vec{c}-\vec{b})\times-\vec{a}$

and $\overrightarrow{CA}\times\overrightarrow{BD}=(\vec{a}-\vec{c})\times-\vec{b}$

$\Rightarrow \vec{AB}\times\vec{CD}+\vec{BC}\times\vec{AD}+\vec{CA}\times\vec{BD}$

$=\vec{c}\times\vec{b}+\vec{a}\times\vec{c}+\vec{a}\times\vec{c}+\vec{b}\times\vec{a}-\vec{a}\times\vec{b}+\vec{c}\times\vec{b}$

= $2(\vec{c}\times\vec{b}+\vec{b}\times\vec{a}+\vec{a}\times\vec{c})$

= $2(\vec{c}\times(\vec{b}-\vec{a})-\vec{a}\times(\vec{b}-\vec{a}))$

= $2((\vec{c}-\vec{a})\times(\vec{b}-\vec{a}))$

= $2(\overrightarrow{AC}\times\overrightarrow{AB})$

$\Rightarrow |\vec{AB}\times\vec{CD}+\vec{BC}\times\vec{AD}+\vec{CA}\times\vec{BD}|$

$= 4\left|\frac{1}{2}(\overrightarrow{AC}\times\overrightarrow{AB})\right|$

$= 4\Delta_{ABC}$

Q.95 [A]

Sol. $\overrightarrow{AB} = -\hat{i}+5\hat{j}-3\hat{k}$

$\overrightarrow{AC} = -4\hat{i}+3\hat{j}+3\hat{k}$

$\overrightarrow{AD} = \hat{i}+7\hat{j}(\lambda+1)\hat{k}$

If vector $\overrightarrow{AB}, \overrightarrow{AC}$ and $\overrightarrow{AD}$ are coplanar, then

$$\begin{vmatrix} -1 & 5 & -3 \\ -4 & 3 & 3 \\ 1 & 7 & \lambda+1 \end{vmatrix} = 0$$

$\Rightarrow \lambda = -\frac{146}{17}$

Q.96 [B]

Sol. $[\vec{a}+\vec{b},\vec{b}+\vec{c},\vec{c}+\vec{a}]$

$= (\vec{a}+\vec{b}).((\vec{b}+\vec{c})\times(\vec{c}+\vec{a}))$

$= (\vec{a}+\vec{b}).(\vec{b}\times\vec{c}+\vec{b}\times\vec{a}+\vec{c}\times\vec{a})$

$= [\vec{a}\ \vec{b}\ \vec{c}]+[\vec{b}\vec{c}\ \vec{a}]$

$= 2[\vec{a}\ \vec{b}\ \vec{c}]$

Q.97 [A]

Sol. $a = 4i+2j-4k \Rightarrow |a| = \sqrt{16+16+4} = 6$

$b = -3i+2j+12k \Rightarrow |b| = \sqrt{144+4+9} = \sqrt{157}$

$c = -i-4j-8k \Rightarrow |c| = \sqrt{64+16+1} = 9$

Hence perimeter is $15+\sqrt{157}$.

Q.98 [C]

Sol. $\hat{i}\times(\vec{a}\times\hat{i}) = (\hat{i}.\hat{i})\vec{a}-(\vec{a}.\hat{i})\vec{i} = \vec{a}-(\vec{a}.\hat{i})\hat{i}$

Similarly, $\hat{j}\times(\vec{a}\times\hat{j}) = \vec{a}-(\vec{a}.\hat{j})\hat{j}$

and $\hat{k}\times(\vec{a}\times\hat{k}) = \vec{a}-(\vec{a}.\hat{k})\hat{k}$

$\Rightarrow \hat{i}\times(\vec{a}\times\hat{i})+\hat{j}\times(\vec{a}\times\hat{j})+\hat{k}\times(\vec{a}\times\hat{k})$

$= 3\vec{a}-((\vec{a}.\hat{i})\hat{i}+(\vec{a}.\hat{j})\hat{j}+(\vec{a}.\hat{k})\hat{k})$

$= 2\vec{a}$

Q.99 [A]

Sol. $[\vec{a}\times\vec{b},\vec{a}\times\vec{c},\vec{d}]$

$=(\vec{a}\times\vec{b}).((\vec{a}\times\vec{c})\times\vec{d})$

$=(\vec{a}\times\vec{b}).((\vec{a}.\vec{d})\vec{c}-(\vec{c}.\vec{d})\vec{a})$

$=(\vec{a}.\vec{d})[\vec{a}\ \vec{b}\ \vec{c}]$

Q.100 [D]

Sol. $(\vec{b}\times\vec{c}).(\vec{a}\times\vec{d})=(\vec{b}.\vec{a})(\vec{c}.\vec{d})-(\vec{b}.\vec{d})(\vec{c}.\vec{a})$

$(\vec{c}\times\vec{a}).(\vec{b}\times\vec{d})=(\vec{c}.\vec{b})(\vec{a}.\vec{d})-(\vec{c}.\vec{d})(\vec{a}.\vec{b})$

$(\vec{a}\times\vec{b}).(\vec{c}\times\vec{d})=(\vec{a}.\vec{c})(\vec{b}.\vec{d})-(\vec{a}.\vec{d})(\vec{b}.\vec{c})$

$\Rightarrow(\vec{b}\times\vec{c}).(\vec{a}\times\vec{d})+(\vec{c}\times\vec{d}).(\vec{b}\times\vec{d})+(\vec{a}\times\vec{b}).(\vec{c}\times\vec{d})=0$

CRASH COURSE

SAMPLE

BIOLOGY

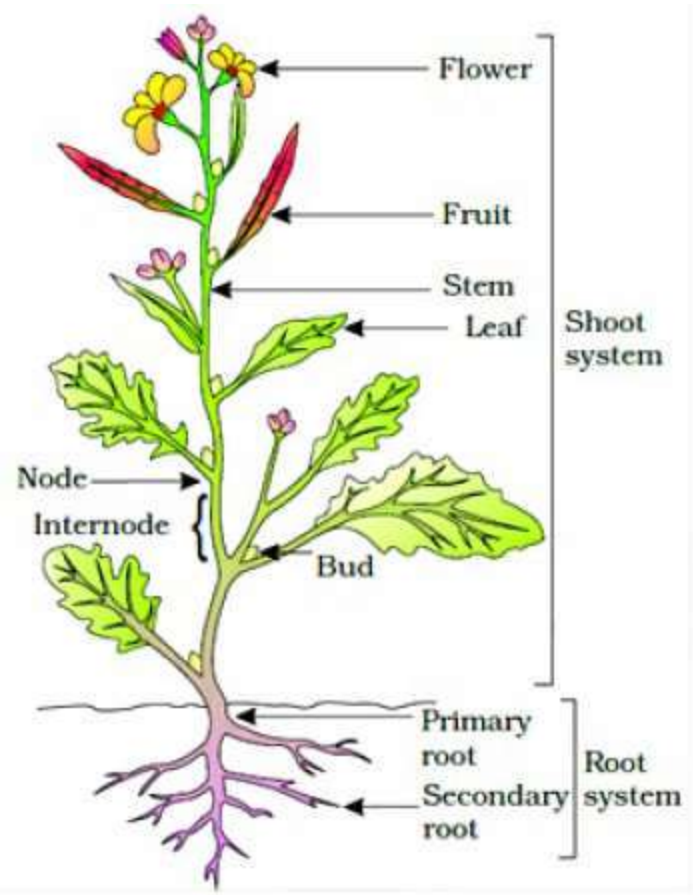
MORPHOLOGY OF FLOWERING PLANTS

Morphology is the branch of biological science that deals with the study of form, size, colour, structure and relative position of various parts of organisms.

IMPORTANCE OF MORPHOLOGY :-

1. Knowledge of morphology is essential for recognition or identification of plants.
2. It gives information about the range of variations found in species.
3. Deficiency and toxicity symptoms are morphological changes that occur in response to shortage or excess of minerals.

Parts of Flowering Plants –

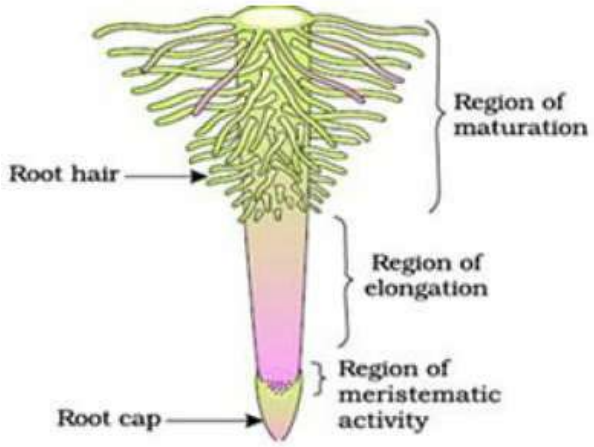


- All the flowering plants have roots, stem, leaves, flower and fruits. The underground parts of flowering plant are the **root system** and the portion above the ground forms the **shoot system**.

The Root

- In Dicotyledons, elongation of radicle forms the primary roots which bears lateral roots of several orders called secondary roots, tertiary roots, etc.
  Primary roots along with lateral roots forms the **Tap root system**. Example: Mustard, Gram, etc.
- In monocotyledons, primary root is replaced by large number of roots at its base of stem to constitute the **Fibrous root system**. Wheat, rice etc.
- The roots that arise from other parts of plant beside radicle are called **adventitious roots**. Example- Grass, Banyan tree, Maize, etc.
- The main function of root system are absorption of water and minerals from soil, providing proper anchorage to the plant parts and storing reserve food materials.

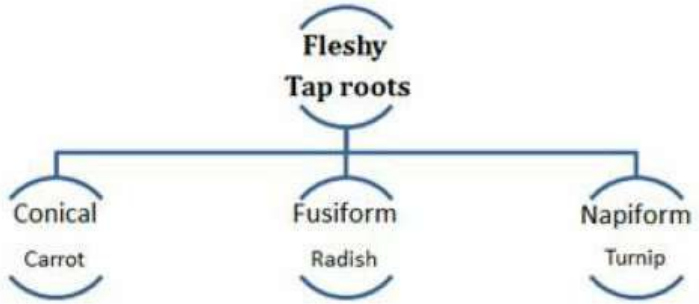
Regions of Roots –



- The apex of root is covered by a thimble-like structure called **root cap**, it protect the tender apex of root while making way through soil.
- Above the root cap is region of meristematic activity having small cells with dense cytoplasm.
- The part above the region of meristematic activity is region of elongation where cells undergo elongation and enlargement to increase the length of root.
- **Region of maturation** contains root hairs that help in absorption of water and minerals.

Modification of roots - Roots are modified for storage, nitrogen fixation, aeration and support.

- Tap root of carrot, turnip and adventitious root of sweet potato get swollen to store food.
- Prop root of Banyan and Stilt root of maize and sugarcane have supporting root coming out from lower node of stems.
- In Rhizophora, Pneumatophores help to get oxygen for respiration as it grows in swampy areas.



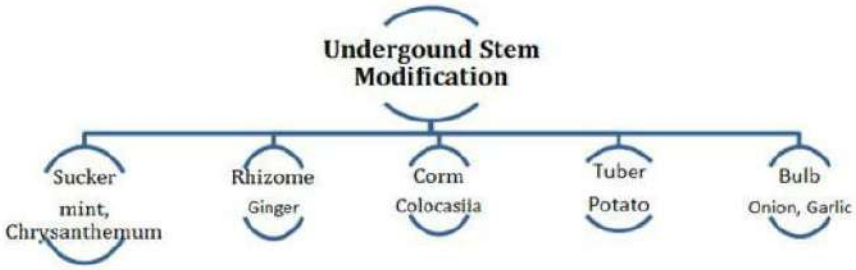
The Stem

- It is the ascending part of axis bearing branches, leaves, flowers and fruits. It develops from Plumule of the embryo.
- Stem bears nodes and internodes. The region of stem where leaves are born are called nodes and portion between two nodes are called internodes.
- The main function of stem is spreading branches, bearing leaves, flowers and fruits. It also conducts water and minerals from root to leaves and product of photosynthesis.
- Some stem perform special functions like storage of food, support, protection and vegetative propagation.

Modification of stems -

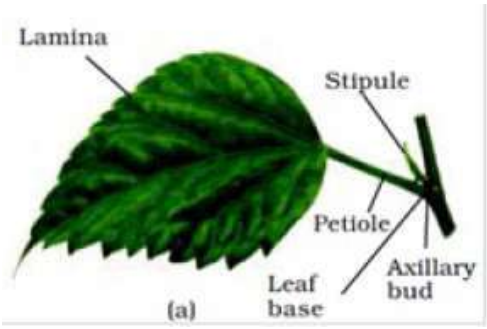
- Underground stem of potato, ginger and turmeric are modified to store food. They also act as organ of perennation in unfavorable conditions.
- Stem tendril help plants to climb as in cucumber, pumpkins, and grapes.

- Axillary buds of stem may modify into woody, straight and pointed thorns as in Citrus and Bougainvillea.
- Plants of arid regions modify their stem to flattened (Opuntia), fleshy cylindrical (Euphorbia) having chlorophyll for photosynthesis.



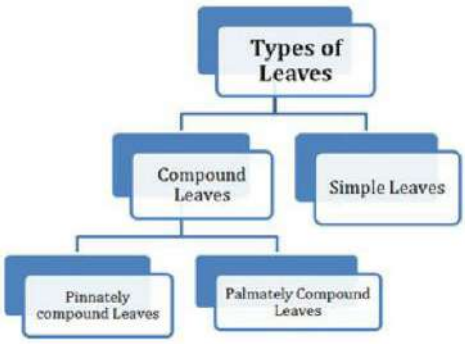
The Leaf

- Leaf is a green, dissimilar exogenous lateral flattened outgrowth which is borne on the node of a stem or its branches is specialized to perform photosynthesis.



- Leaves originate from shoot apical meristem and are arranged in an acropetal order.
- A typical leaf consists of three parts- Leaf base, Petiole, Lamina. Leaf is attached with stem by Leaf Base which may bear two small leaf like structure called stipule.
- Middle prominent vein is called mid vein. Veins provide rigidity to the leaf blade and act as channel for transport of water and minerals.
- The arrangement of vein and veinlets in the lamina is called venation.

Reticulate venation	Parallel venation
1. Veinlets form a network. 2. Veins are irregularly distributed. 3. It is present in all Dicotyledons like Gram, Pea, Beans and Mango etc.	1. A network is absent. 2. Veins are parallel to one another. 3. It is present in Monocotyledons like Grass, Banana, Rice, etc.



- A leaf having a single or undivided lamina is called Simple leaf. The incisions do not touch the mid rib. Example- Mango, Guava etc.
- When the incision of lamina reach up to the midrib and breaking it into a number of leaflets, it is called Compound leaves.

- In a Pinnately compound leaves, a number of leaflets are present on common axis called rachis. Example- Neem.
- In Palmately compound leaves, the leaflets are attached at common point. Example- Silk cotton.
- The pattern of arrangement of leaves on the stem or branch is called Phyllotaxy.
- In alternate type of phyllotaxy single leaf arise at each node as in China rose.
- In opposite types of phyllotaxy a pair of leaves arise from each node opposite to each other as in Guava.
- If more than two leaves arise at a node and form a whorl is called whorled type of phyllotaxy as in Alstonia.
- Leaves are modified to perform other functions like converted to tendril for climbing as in Peas and spines for defence in Cactus.

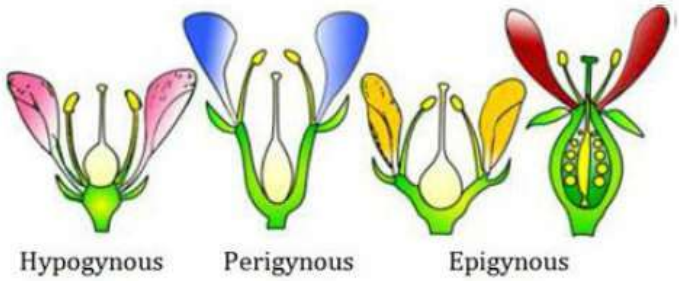
Inflorescence

The arrangement of flowers on the floral axis is termed as inflorescence. Two main types of inflorescence are racemose and cymose.

Racemose	Cymose
1. The main axis continuous to grow. 2. Flowers are borne laterally in an acropetal succession. 3. Example- Radish, Mustard.	1. Main axis terminates in flower having limited growth. 2. Flowers are borne in a basipetal succession. 3. Example- Jasmine, Bougainvillea.

The flower

- Flower is the reproductive part of angiospermic plants for sexual means of reproduction.
- A typical flower has four whorls arranged on a swollen end of stalk or pedicel called thalamus. They are Calyx, Corolla, Androecium and Gynoecium.
- When a flower has both androecium and gynoecium, the flower is called bisexual and flower having either androecium or gynoecium only is called unisexual.
- When flower can be divided into two equal radial halves in any radii passing through center the symmetry of flower is called actinomorphic (radial symmetry) as in Mustard, Datura, and Chili.
- When flower can be divided into two similar parts only in one vertical plane it is zygomorphic as in Pea, Gulmohar, Cassia etc.
- When Floral appendages are in multiple of 3,4 or 5 they are called trimerous, tetramerous and pentamerous respectively. Flower with bracts are called bracteates and without it ebracteate.
- Based on the position of ovary with respect to other floral part on thalamus, flowers are of following types:

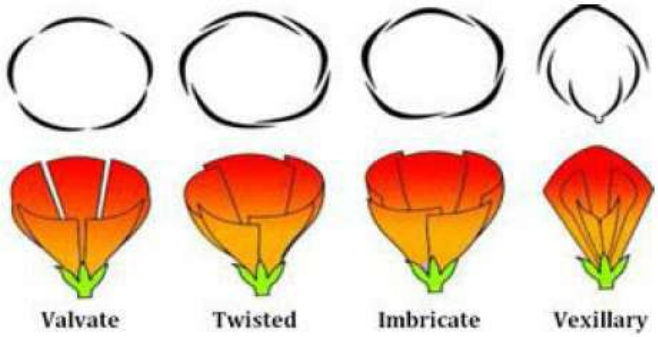


1. **Hypogynous flower**- Ovary occupies the highest position. The ovary in such case is called superior. Eg. Mustard, brinjal and china rose.
2. **Perigynous flowers**-If the gynoecium is situated at the centre and other parts are on the rim at same height. Ovary is called half-inferior.
3. **Epigynous flowers**- The margin of thalamus grows to completely cover the ovary. Ovary is said to be inferior.

Calyx is the outermost whorl of the flower; its members are called sepals. They are generally green and leafy; protect the flower in bud stage. It may be gamosepalous (sepals united) or polysepalous (sepals free).

Corolla consists of petals, brightly coloured to attract the insects for pollination. They may be gamopetalous or polypetalous.

1. The mode of arrangement of sepals or petals in floral bud with respect to the other members of same whorl is called aestivation. In valvate, the whorls of sepals or petals touch each other as in Calotropis. In Twisted aestivation, the whorls overlap each other as in China rose.
2. In Imbricate aestivation, margin overlap each other but not in particular fashion as in Gulmohur.
3. In pea and bean flowers, there are five petals- the largest (standard) overlaps the two lateral petals (wings) which in turn overlap two smallest anterior petals (keel). This type of aestivation is known as **vexillary or papilionaceous.**



The Androecium

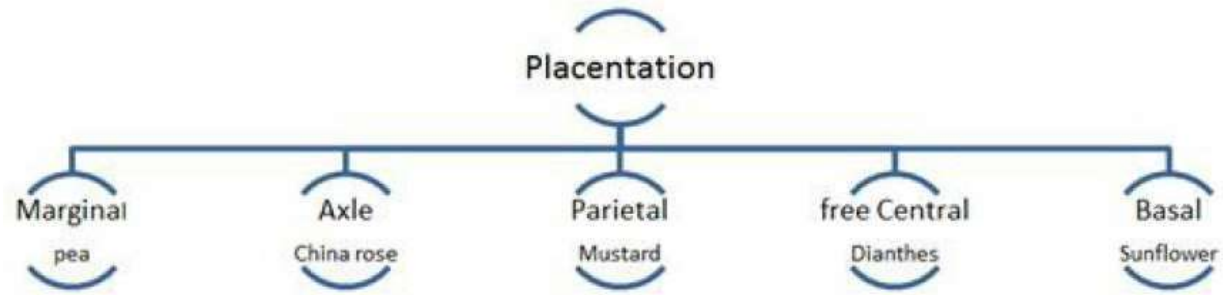
- Androecium represent the male reproductive parts of flower, consists of stamens. Each stamen consists of filament and anther. Pollen grains are produced in pollen sac. Sterile stamen is called **Stemenode**.
- When stamens are attached with petals it is called epipetalous (Brinjal). Stamen may be free (polyandrous) or may be united in one bundle (monoadelphous), two bundles (diadelphous), more than two (polyadelphous).

The Gynoecium

- Female reproductive part of flower consists of one or more carpels. Each carpel is made up of stigma style and ovary.
- When more than one carpel is present, it may be free (apocarpous) as in lotus and rose or fused together (syncarpous) as in mustard and tomato.
- After fertilisation, ovules change into seeds and ovary mature into fruits.

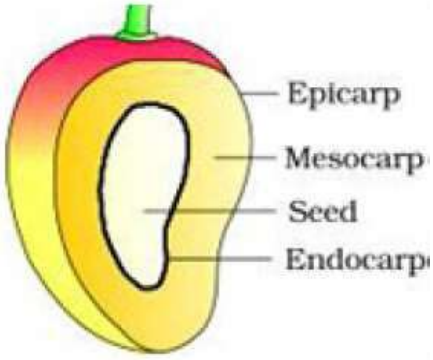
Placentation

- The arrangement of ovules within the ovary is called placentation.

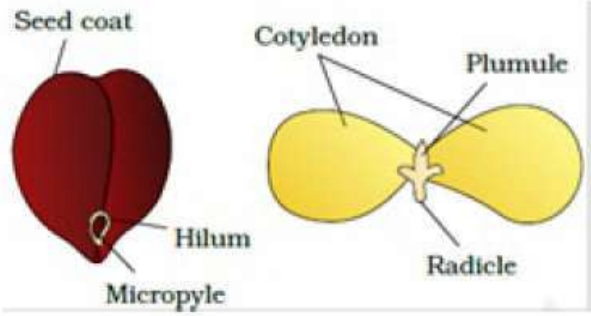


The fruit

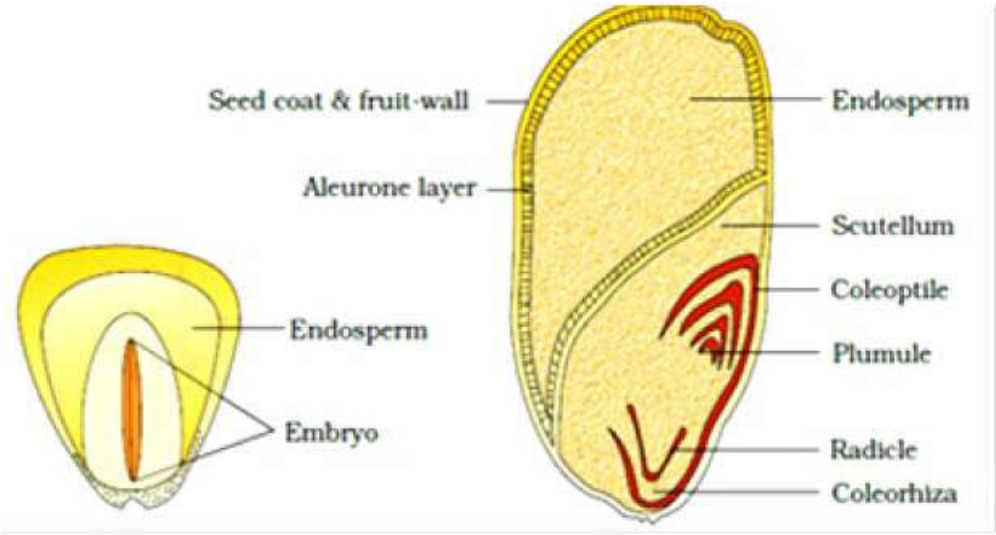
- Mature and ripened ovary developed after fertilisation is fruit. If a fruit is formed without fertilisation of ovary it is called parthenocarpic fruit.
- Fruit consists of seeds and pericarp. Thick and fleshy pericarp is three layered called epicarp, mesocarp and endocarp.



- Dicotyledonous Seed is made up of a seed coat and an embryo. Embryo is made up of embryonal axis, radicle and cotyledons.
- Seed coat has two layers outer testa and inner tegmen. Hilum is scar through which seed is attached to the ovary. Small pore above the hilum is called micropyle.



Monocotyledonous seeds



- In monocotyledonous seed, outer covering of endosperm separate the embryo by a proteinous layer called aleurone layer.
- Single cotyledon is called as scutellum having a short axis bearing Plumule and radicle.
- Plumule and radicle are closed inside sheaths called as coleoptile and coleorhiza respectively.

SEMI -TECHNICAL DESCRIPTION OF A TYPICAL :-

FLOWERING PLANT

- The plant is described beginning with its habit, vegetative characters - roots, stem and leaves and then floral characters inflorescence and flower parts.
- The floral formula is represented by some symbols. In the floral formula, Br stands for bracteate K stands for calyx, C for corolla, P for perianth, A for androecium and G for Gynoecium. Fusion is indicated by enclosing the figure within bracket and adhesion by a line drawn above the symbols of the floral parts.

Family Fabaceae -

- This family was earlier known as Papilionoideae. Herbs, shrubs or tree root with root nodules. Pinnately compound leaves with reticulate venation.

Economic importance

Plants belonging to this family are sources of pulses like Gram, Arhar, Bean. Pea etc. and edible oils like groundnut, soybean, etc.

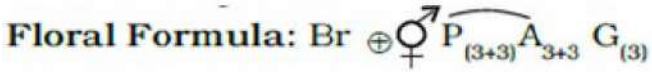
Family Solanaceae -

- Plant body herbs or shrubs, rarely small trees, commonly known as **potato family**. Leaves simple or pinnately compound. Reticulate venation.

Many of them are source of food (potato, tomato, Brinjal etc.), spices (Chilli) etc.

Family Liliaceae

- Commonly known as Lily family. Monocots, perennial herbs. Leaves alternate with parallel venation.
- Underground bulbs, corms or rhizomes.
- Flower bisexual, actinomorphic, sepals and petals are absent, having perianth.



It includes ornamental plants (Tulip), Medicine (aloe) and vegetable (colchicine).

EXERCISE-1

1. Roots developing from plant parts other than radicle are
(A) Tap root (B) Adventitious root (C) Both 1 & 2 (D) None of the above
2. Radish is an example of -
(A) Fusiform root (B) Napiform root (C) Conical root (D) Tuberous root
3. Roots associated with nitrogen fixing bacteria are -
(A) Fusiform root (B) Napiform root (C) Nodulated root (D) Conical root
4. Which is a modification of root does not store food
(A) Napiform root (B) Fusiform root (C) Tuberous root (D) Stilt root
5. Lateral organs of stem are -
(A) Endogenous in origin (B) Exogenous in origin
(C) Both (D) None of the above
6. Which is an offset
(A) Cynodon dactylon (B) Eichhornia (C) Fragaria (D) Mentha
7. Rhizome of ginger is a modification of stem because -
(A) It bears Adventitious roots (B) It bears nodes and internodes
(C) It is underground (D) It stores food material
8. Phylloclade is found in -
(A) Opuntia (B) Cactus (C) Acacia (D) Both (A) & (B)
9. Nodulated roots occurs in
(A) Leguminosae (B) Solanaceae (C) Malvaceae (D) Papilionatae
10. Prop roots are -
(A) Tap root (B) Adventitious root (C) Secondary root (D) All
11. Thorns, spines and prickles are -
(A) Defensive organs (B) Respiratory organs
(C) Both 1 & 2 (D) None of the above
12. A monocot can be distinguished from a dicot by -
(A) Aestivation (B) Venation (C) Both 1 & 2 (D) None of the above
13. Ochreate stipules occur in the family -
(A) Cruciferae (B) Solanaceae (C) Compositae (D) Polygonaceae
14. Leaves are changed into spines in Xerophytic structure called
(A) Phyllode (B) Tuber (C) Phylloclade (D) All the above
15. A dicot plant showing parallel venation is -
(A) Dioscorea (B) Calophyllum (C) Cotton (D) Mango
16. In cythium the ratio between female to male flower is -
(A) one : one (B) one : many (C) many : one (D) many : many
17. Catkin is a type of -
(A) Flower (B) Inflorescence (C) Stem (D) All
18. A biparous cyme ending in uniparous cyme constitutes -
(A) Verticillaster (B) Panicle (C) Hypanthodium (D) Cyathium
19. In Racemose, Flowers are arranged in -
(A) Acropetal succession (B) Centrifugal order
(C) Centripetal order (D) All
20. The most advanced type of Inflorescenceis -
(A) Corymb (B) Capitulum (C) Spadix (D) Catkin
21. Axis of Inflorescence is -
(A) Pedicel (B) Peduncle (C) Petiole (D) All

22. Pedicellate flowers arising from a single point form
(A) umbel (B) cymose head (C) capitulum (D) verticillaster
23. An edible inflorescence is
(A) Brassica rapa (B) Mustard (C) Raphanus Sativus (D) Brassica oleracea
24. Prop roots of Banyan tree are meant for
(A) Respiration (B) Absorption of water from soil
(C) Providing support to big tree (D) All
25. Prickles of rose are -
(A) Modified leaves (B) Modified stipules
(C) Exogenous in origin (D) Endogenous in origin
26. Function of stem is
(A) Bear leaves and branches (B) Conduction of water & minerals
(C) Conduction and storage of food (D) All
27. Which is not a stem modification -
(A) Rhizome of ginger (B) Corm of Colocasia
(C) Pitcher of Nepenthes (D) Tuber of potato
28. Arrangement of leaves on a stem branch is -
(A) Venation (B) Vernation (C) Infloresecence (D) Phyllotaxy
29. The largest leaf belongs to
(A) Nerium (B) Tobacco (C) Victoria (D) Rafflesia
30. Occurance of different types of leaves on the same plant is
(A) Heterophylly (B) Heterotrophy (C) Heteronasty (D) All
31. Inflorescence is collection of
(A) Petals (B) Stamens (C) Flowers (D) Carpels
32. Which one of the following is of related type
(A) Catkin and Hypanthodium (B) Raceme and Cyathium
(C) Corymb and umbel (D) Verticillaster and spike
33. Zig–Zag development of flower on inflorescence axis is
(A) Cyathium (B) Capitulum (C) Helicoid cyme (D) Scorpioid cyme
34. Number of female flower in a cyathium is
(A) 1 (B) 2 (C) 3 (D) 4
35. Arrangement of sepals & petals with respect of other is
(A) Venation (B) Aestivation (C) Cohesion (D) Adhesion
36. Didynamous condition is related to
(A) Androecium (B) Inflorescence (C) Gynoecium (D) All
37. Stamens attached to petals are
(A) Epipetalous (B) Epiphyllous (C) Episepalous (D) All
38. The floral organs arise from
(A) Mother axis (B) Thalamus (C) Root (D) Pedicel
39. If the filaments are fused in a single group the condition is
(A) Monoadelphous (B) Polyadelphous (C) Both 1 & 2 (D) None of the above
40. Syncarpous gynoecium has two or more
(A) free carpels (B) fused carpels (C) free ovaries (D) All
41. A typical flower with superior ovary and other floral parts inferior is
(A) Polygamous (B) Hypogynous (C) Perigynous (D) Epigynous
42. Pappus is madification of -
(A) Bracts (B) Corolla (C) Calyx (D) All
43. Synandrous condition is fusion of
(A) Filaments only (B) Both filaments and anthers
(C) Anthers only (D) Petals

44. A characteristic of angiosperm is
(A) Flowers (B) Roots (C) Seed (D) All
45. Basifixed anther is attached to filament
(A) At top firmly (B) At base firmly (C) Both 1 & 2 (D) All
46. Adhesion in a flower is -
(A) Union of dissimilar parts (B) Union of similar parts
(C) Both 1 & 2 (D) None of the above
47. Cruciform corolla is found in
(A) Pea (B) China rose (C) Radish (D) Sunflower
48. Axis between corolla and androecieum is
(A) Anthophore (B) Gynophore (C) Gynandrophore (D) Androphore
49. The fourth whorl of flower is of
(A) Petals (B) Stamens (C) Carpels (D) Sepals
50. Which of the following are schizocarpic fruits:-
(A) Siliqua & Legume (B) Capsule & Berry
(C) Lomentum & Capsule (D) Carcerulus & Lomentum
51. Fruit of brinjal :-
(A) Berry (B) Hesperidium (C) Drupe (D) Pome
52. Which of the following plants produces edible root :-
(A) Raphanus sativus (B) Brassica campestris
(C) Brassica oleracea (D) Eruca sativa
53. Which of the following is false fruit :-
(A) Pome (B) Pepo (C) Hesperidium (D) Drupe
54. A true fruit develops from :-
(A) Ovary (B) Thalamus (C) Petals (D) Receptacle
55. A berryfruit is :-
(A) Fleshy and single seeded (B) Fleshyand multiseeded
(C) Dry and multiseeded (D) Dehiscent & single seeded
56. Immature 'Fig' or 'Gular' fruit is :-
(A) Berry (B) Syconus (C) Samara (D) Pepo
57. Inflorescence and fruit of sunflower is :-
(A) Capitulum and achene (B) Corymb and cypsella
(C) Capitulum and cypsela (D) Corymb and achene
58. Water melon is :-
(A) Pome (B) Sorosis (C) Pepo (D) Drupe
59. Pneumatophores are found in-
(A) The vegetation which is found in marshyand saline lake
(B) The vegetation which found in saline soil
(C) Xerophytes (D) Epiphytes
60. Tetradyanamous conditions occur in :–
(A) Cruciferae (B) Malvaceae (C) Solanaceae (D) Lilliaceae
61. Which is correct pair for edible part :–
(A) Tomato – Thalamus (B) Maize – Cotyledons
(C) Guava – Mesocarp (D) Date palm – Pericarp
62. Bicarpellary gynoecium and oblique ovary occurs in –
(A) Mustard (B) Banana (C) Pisum (D) Brinjal
63. What is the eye of potato :–
(A) Axillarybud (B) Accessory bud (C) Adventitious bud (D) Apical bud

64. Edible part in mango is :-
(A) Mesocarp (B) Epicarp (C) Endocarp (D) Epidermis

65. Cruciferous plants when crushed emit a pungent smell, It is due to the presence of:-
(A) Oxalic acid (B) Alkaloids (C) Iron compounds (D) Sulphur compounds

66. Myrosin in plant parts is characteristic of :-
(A) Cruciferae (B) Malvaceae (C) Solanaceae (D) Liliaceae

67. Ebracteate flowers mainlyfound in :-
(A) Solanaceae (B) Malvaceae (C) Cruciferae (D) Liliaceae

68. Point out the correct floral formula of cruciferae :-
(A) $K_{2+2}\,C_{4x}\,A_{2+4}\underline{G}_{(B)}$ (B) $K_5\,C_6\,A_3\,\underline{G}_{(B)}$ (C) $K_{2+2}\,C_4\,A_{2+4}\underline{G}_{(B)}$ (D) $K_4\,C_4\,A_2\,\underline{G}_{(B)}$

69. Mustard oil is obtained from :-
(A) Brassica campestris (B) Brassica oleracea
(C) Brassica rapa (D) Capsella bursa pestoris

70. In Cruciferae the two carpels in each flower are placed:-
(A) Transversely (B) Obliquely (C) Anteroposteriorly (D) Separately

71. In Brassica oleracea var. capitata the edible part is :-
(A) Inflorescence (B) Flower bud (C) Vegetative bud (D) Stem

72. Shepherd's purse plant belong to family :-
(A) Cruciferae (B) Malvaceae (C) Solanaceae (D) Leguminosae

73. "Halima"a medicinal plant belongs to family:-
(A) Cruciferae (B) Solanaceae (C) Malvaceae (D) Papilionatae

74. The placentation in a multilocular ovary where the ovules are borne over the entire inner surface is called:-
(A) Pendulous (B) Marginal (C) Superficial (D) Parietal

75. Bicarpellaryovarywith parietal placentation is found in:-
(A) Cruciferae (B) Leguminosae (C) Malvaceae (D) Compositae

76. The winter annual Iberis is commonly called as :-
(A) Pansy (B) Candy-tuft (C) Poppy (D) Snapdragon

77. Claw is found in the petals of :-
(A) Cruciferae (B) Fabaceae (C) Liliaceae (D) Solanaceae

78. "Shepherd's purse" is a comman name of :-
(A) Iberis amara (B) Crinum ajiaticum (C) Capsella bursapestoris (D) Abutilon indica

79. Floral formula of Malvaceae:-
(A) $Br\,\%\,\male\;Epi_{3-7}\,K_{(5)}\,\overset{\frown}{C_{(5)}}\,A_{(\infty)}\,\underline{G}_{(B)}$ (B) $Br\oplus\male\;K_{(5)}\,C_5\,A_{(\infty)}\;\underline{G}_{(5-\infty)}$
(C) $Br\oplus\male Epi_{3-7}\,K_{(5)}\,\overset{\frown}{C_5}\,A_{(\infty)}\,\underline{G}_{(5-\infty)}$ (D) $Br\oplus K_{(5)}\,C_4\,A_{2+2}\;\underline{G}_{(B)}$

80. Inflorescence in Malvaceae is:-
(A) Racemose (B) Solitary (C) Cyathium (D) Hypanthodium

81. Number of stamens present in malvaceae is:-
(A) Infinite (∞) (B) Five (5) (C) Ten (10) (D) Nine + one (9+1)

82. Urena repanda is used for hydrophobia belongs to the family :-
(A) Cruciferae (B) Malvaceae (C) Solanaceae (D) Leguminosae

83. Which of the following is not a seed surface fiber :-
(A) Kapok (B) Silk cotton (C) Cotton (D) Dhaincha

84. Red shoe polish is obtained from:-
(A) China jute (B) China Rose (C) Indian Rose (D) Gul.e. khera

85. Aestivation of petals in family Malvaceae is:-
(A) Valvate (B) Imbricate (C) Twisted (D) Vexillary

86. Anthers with onlytwo microsporangia are found in :-
(A) Cucurbitaceae (B) Leguminosae (C) Cruciferae (D) Malvaceae

87. Ladyfinger belongs to family :-
(A) Malvaceae (B) Cruciferae (C) Compositae (D) None

88. The surface fibres of commercial use are obtained from :-
(A) Gossypium (B) Agave (C) Helianthus (D) Solanum

89. Which one of the following groups of plants produces fibres of economic importance :-
(A) Gossypium, Hibiscus, Crotalaria (B) Gossypium, Cassia, Lycopersicum
(C) Gossypium, Brassica, Glycine (D) Gossypium, Agave, Nicotiana

90. Mark the silk cotton plant :-
(A) Sida (B) Ceiba (C) Malaviscus (D) Kydia

91. Shoe flower belongs to :-
(A) Solanaceae (B) Malvaceae (C) Papilionatae (D) Liliaceae

92. Br or Ebr $\oplus\ \male\ \female\ K_{(5)}\ \overset{\frown}{C_{(5)}\ A_5}\ \underline{G}_{(B)}$ is the floral formula of :-
(A) Cruciferae (B) Leguminosae (C) Solanaceae (D) Papilionatae

93. Solanaceae belongs to :-
(A) Bicarpellatae (B) Parietales (C) Thalamiflorae (D) Calyciflorae

94. Inflorescence in Solanaceae is :-
(A) Racemose (B) Cymose (C) Hypanthodium (D) Verticillaster

95. The carpels of Solanum flower are obliquely placed because :-
(A) Posterior and anterior carpels turn by 1800
(B) Posterior and anterior carpels move to the left
(C) Posterior carpels turn to right and anterior to the left
(D) Posterior carpels turn to left and anterior to the right

96. Solanaceae belongs to order:-
(A) Polymoniales (B) Rosales (C) Parietales (D) Passiflorales

97. Persistant calyx is characteristics of :-
(A) Allium/ Liliaceae (B)Hibiscus / Malvaceae
(C) Dalbergia / Papilionatae (D) Solanum/ solanaceae

98. Atropa belladona, an important medicinal plant is of the family:-
(A) Liliaceae (B) Cucurbitaceae (C) Cruciferae (D) Solanaceae

99. 'Simla mirch' (Capsicumfruitescence) chillies and potato belongs to family :-
(A) Solanaceae (B) Compositae (C) Gramineae (D) Cruciferae

100. Tomato belongs to genus :-
(A) Solanum (B) Lycopodium (C) Physalis (D) Lycopersicon

101. Nicotiana belongs to :-
(A) Malvaceae (B) Liliaceae (C) Solanaceae (D) Cruciferae

102. Drug "Henbane" is obtained from :-
(A) Atropa (B) Hyoscyamus (C) Withania (D) Nicotiana

103. The drug 'Belladona' is obtained from :-
(A) Atropa (B) Rauwolfia (C) Solanum (D) Capsicum

104. What is the major edible part of a brinjal fruit (egg plant) :-
(A) Pericarp (B) Thalamus (C) Placenta (D) Style

105. Plants with inferior ovary are included in :-
(A) Coronariae (B) Thalamiflorae (C) Bicarpellatae (D) Calyciflorae

106. Apocarpous condition occurs in:-
(A) Rosales (B) Polymoniales (C) Parietales (D) Coronariae

107. Standard in Papilionatae is :-
(A) Posterior outer most (B) Posterior inner most
(C) Anterior outer most (D) Anterior inner most

108. Sleeping movements commonlyoccur in plants of family:-
(A) Leguminosae (B) Liliaceae (C) Malvaceae (D) Compositae
109. Major source of protein is :-
(A) Oryza sativa (B) Cicer arietinum (C) Beta vulgaris (D) Rhizobium leguminosarum
110. Pulses yieldingmain familyof plants is :-
(A) Poaceae (Graminae) (B) Cucurbitaceae
(C) Liliaceae (D) Papilionaceae
111. The botanical name of ground nut is :-
(A) Cicer arietinum (B) Glycine max (C) Arachis hypogea (D) Lens esculentus
112. One of the following is a fibre yielding plant, which one is it :-
(A) Crotalaria juncea (B) Cicer arietinum
(C) Triticum vulgare (D) Impatiens balsamina
113. Which of the following plant's seeds are used as Jeweller's weight:-
(A) Cajanus cajan (B) Lens culinaris (C) Glycine max (D) Abrus precatorius
114. Which of the following statements is correct :-
(A) Flower is a modified root (B) Flower is a modified shoot
(C) Flower is a modified leaf (D) Flower is a modified inflorescence
115. The leguminous plants are important in agriculture because :-
(A) They are disease resistant (B) Theyrequire verylittle irrigation
(C) Theyhelp in nitrogen economyof nature (D) Crops of legumes can be produced in a year
116. Many plants of this family are rich source of proteins :-
(A) Cruciferae (B) Leguminosae (C) Liliaceae (D) Compositae
117. Largest botanical garden of India is :-
(A) Indian botanical garden Sibpur (B) National botanical research institute Luckhnow
(C) Lal bagh garden Banglore (D) None of the above
118. Blue dye is obtained from the leaves of :-
(A) Indigofera tinctoria (B) Opium
(C) Aloe (D) Delbergia sissoo
119. In family papilionaceae, 5 petals form a unique association, In which 3 different elements participate, these are vexillum, alae & carina. What is the number of these elements:-
(A) 1, 2, 2 respectively (B) 2, 1, 2 respectively
(C) 1,1,3 respectively (D) 2,2,1 respectively
120. Nodulated roots bearing family is :-
(A) Mimosoideae (B) Cesalpinoideae (C) Papilionatae (D) Solanaceae
121. A bisexual flower which never opens in its life span is called :-
(A) Dichogamous (B) Homogamous (C) Cleistogamous (D) Heterogamous
122. Floral diagram is :-
(A) The figure of a flower (B) The three-dimensional appearance of a flower
(C) L.S. of a flower (D) T.S. of a floral bud
123. The name papilionatae and cruciferae is based on :-
(A) Corolla (B) Androecium (C) Gynoecium (D) Fruit
124. 'Pea nut or Ground nut oil is obtained from :-
(A) Lathyrus odoratus (B) Pisum sativum
(C) Arachis hypogea (D) Glycine max, Brassica juncea
125. Botanical name of our national tree ' Siris' is :-
(A) Saraca indica (B) Ashoka Indiana (C) Abrus indica (D) Albizzia lebbec
126. Staminodes commonlyoccur in :-
(A) Liliaceae (B) Papilionatae (C) Caesalpinoideae (D) All the above

127. The botanical name for 'Kattha' is :-
(A) Acacia concinna (B) Acacia catechu (C) Acacia Senegal (D) Acacia nilotica
128. Haematoxylon campechianum, the heart wood of which yields dye 'haematoxylin' belongs to :-
(A) Papilionaceae (B) Caesalpiniaceae (C) Mimosaceae (D) Cucurbitaceae
129. "Gulal" a coloured powderything used in Holi festival is obtained form :-
(A) Caesalpinoidae family (B) Mimosoideae family
(C) Papilionatae family (D) Liliaceae
130. Staminodes occur in family:-
(A) Papilionatae/Arachis (B) malvaceae/Hibiscus
(C) Cesalpinoideae/Cassia (D) Cruciferae/Iberis
131. Floral formula of Cesalpinoideae is :-
(A) $\% \, ♂♀ \, K_5 \, C_{(5)} \, A_{1+(9)} \, \underline{G}_1$ (B) $\% \, ♂♀ \, K_{(5)} \, C_{(5)} \, A_5 \, \underline{G}_1$
(C) $\% \, ♂♀ \, K_5 \, C_{(5)} \, A_{10} \, \underline{G}_1$ (D) $\% \, ♂♀ \, K_5 \, C_5 \, A_{7+3} \, \underline{G}_1$
132. Fruit lomentum is characteristic feature of the sub family:-
(A) Papilionatae (B) Caesalpinoideae (C) Mimosoideae (D) Leguminosae
133. Floral formula Br $\oplus ♂♀ \, K_{(4-5)} \, C_{4-5} \, A_{\alpha} \, \underline{G}_1$ respresenting which family/sub family :-
(A) Solanaceae (B) Liliaceae (C) Mimosoidae (D) Caesalpinoidae
134. "Stipules modified into thorns"in family:-
(A) Caesalpinaceae (B) Papilionaceae (C) Mimosoideae (D) None of these
135. Parkinsonia is an example of :-
(A) Phylloclade (B) Winged fruit (C) Parachute mechanism (D) Phyllode
136. Nectaries are found in :-
(A) Cruciferae (B) Compositae (C) Papilionatae (D) Ceasalpinoidae
137. The floral formula for Liliaceae family is represented as :-
(A) $Br \oplus ♂♀ \, \overset{\frown}{P_{5+5}} \, A_{5+5} \, \underline{G}_{(5)}$ (B) $Br \oplus ♂♀ \, \overset{\frown}{P_{3+3}} \, A_{3+3} \, \underline{G}_{(C)}$
(C) $Br \oplus ♂♀ \, K_4 \, \overset{\frown}{C_4} \, A_4 \, \underline{G}_{(C)}$ (D) $Br \oplus ♂♀ \, \overset{\frown}{C_{3+3}} \, A_{3+3} \, \underline{G}_{(C)}$
138. The botanical name for onion & garlic can be written as :-
(A) Allium cepa & Asphodelus tenuifolius (B) Allium sativum & Allium cepa
(C) Asphodelus tenuifolius & Allium sativum (D) Allium cepa & Allium sativum
139. The stipules are modified into tendrils in :-
(A) Smilax (B) Asphodelus (C) Gloriosa (D) Asparagus
140. Alliumcepa belongs to the family :-
(A) Solanaceae (B) Liliaceae (C) Cruciferae (D) Compositae
141. RatcideUrginia indica belongs to family :-
(A) Liliaceae (B) Cruciferae (C) Malvaceae (D) Solanaceae
142. In familyliliaceae flowers are :-
(A) Trimerous and hypogynous (B) Pentamerous and epigynous
(C) Trimerous and epigynous (D) Pentamerous and hypogynous
143. Garlic is useful in reducing :-
(A) Urea in blood (B) Blood in reproductive organs
(C) Cholesterol in blood (D) Serum in blood
144. Colchicum autumnale belongs to :-
(A) Leguminosae (B) Cruciferae (C) Liliaceae (D) Malvaceae
145. The botanical name of "Satawar" is :-
(A) Smilax (B) Asparagus (C) Yucca (D) Lilium

146. Which of these yields valuable timber :-
(A) Acacia arabica (B) Dalbergia sissoo (C) Mangifera indica (D) Prosopis

147. Character common between malvaceae, Papilionaceae and cucurbitaceae :-
(A) Cohesion of sepals (B) Cohesion of carpels
(C) Both of these (D) None of these

148. In which of the following families unisexual male and female flowers occur on one plant :-
(A) Malvaceae (B) Leguminosae (C) Cucurbitaceae (D) Cruciferae

149. Bitterness of cucurbits is due to :-
(A) The acid present in them (B) Presence of bitter seed in them
(C) The alkalinityin their pulp (D) The occurrence of triterpenes

150. Capitulum inflorescence is seen in :-
(A) Cruciferae (B) Liliaceae (C) Compositae (D) Solanaceae

151. A family whose name is based upon its inflorescence is :-
(A) Euphorbiaceae (B) Asteraceae (C) Fabaceae (D) Malvaceae

152. Beaked, syngeneseous anthers and epipetalous stamens are found in :-
(A) Liliaceae (B) Solanaceae (C) Compositae (D) Malvaceae

153. Presence of racemose head and bicarpellary syncarpus ovary with basal placentation belongs to
(A) Malvaceae (B) Compositae (C) Liliaceae (D) Solanaceae

154. Which of the following stands for Congress grass :-
(A) Cynodon (Gramineae) (B) Parthenium (Compositae)
(C) Aspidiastra (Liliaceae) (D) Candytuft (Cruciferae)

155. Parachute mechanism of fruit and seed dispersal is common in compositae is due to the structure called :-
(A) Bracts (B) Thorns (C) Corolla (D) Pappus

156. In Gramineae the perianth is represented by small scaly lodicules which are generally :-
(A) Two (B) Three (C) Four (D) Five

157. 'Awn' of wheat and barley is developed from :-
(A) Glume - I (B) Glume - II (C) Lemma (D) Palea

158. The typical floral formula of Gramineae is :-
(A) $Br\ \%\ \male\female\ P_2A_3\ \underline{G}_1$ (B) $Br \oplus \male\female\ P_2A_3\underline{G}_{(B)}$ (C) $Br \oplus \male\female\ P_2A_2\ \underline{G}_{(C)}$ (D) $Br \oplus \male\female\ P_2A_3\underline{G}_3$

159. The familyof most importance is :-
(A) Solanaceae (B) Gramineae (C) Compositae (D) Leguminosae

160. Oryza sativa belongs to :-
(A) Solanaceae (B) Liliaceae (C) Gramineae (D) Asteraceae

ANSWER KEY

EXERCISE-1

1.	B	2	A	3	C	4	D	5	B	6.	B	7	B
8	D	9	D	10	B	11.	A	12	B	13	D	14	C
15	B	16.	B	17	B	18	A	19	A	20	B	21	B
22	A	23	C	24	C	25	C	26	D	27	C	28	D
29	C	30	A	31	C	32	C	33	D	34	A	35	B
36	A	37	A	38	B	39	A	40	B	41	B	42	C
43	B	44	A	45	B	46	A	47	C	48	D	49	C
50	D	51	A	52	A	53	A	54	A	55	B	56	B
57	C	58	C	59	A	60	A	61	D	62	D	63	A
64	A	65	D	66	A	67	C	68	A	69	A	70	A
71	C	72	A	73	A	74	C	75	A	76	B	77	A
78	C	79	B	80	B	81	A	82	B	83	D	84	B
85	C	86	D	87	A	88	A	89	A	90	B	91	B
92	C	93	A	94	B	95	C	96	A	97	D	98	D
99	A	100	D	101	C	102	B	103	A	104	C	105	D
106	A	107	A	108	A	109	B	110	D	111	C	112	A
113	D	114	B	115	C	116	B	117	A	118	A	119	A
120	C	121	C	122	D	123	A	124	C	125	D	126	C
127	B	128	B	129	A	130	C	131	D	132	C	133	C
134	C	135	D	136	A	137	B	138	D	139	A	140	B
141	A	142	A	143	C	144	C	145	B	146	B	147	A
148	C	149	D	150	C	151	B	152	C	153	B	154	B
155	D	156	A	157	C	158	A	159	B	160	C		

SAMPLE

CHAPTER-WISE TEST

PHYSICS | CHEMISTRY | MATHEMATICS | BIOLOGY

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KOTA
FOUNDATION & NEET-JEE

JEE-MAIN : CHAPTER WISE TEST – 05

Chapter Name : Laws of Motion

Class : XI	**Date** :	**Max. Marks** : 100
Subject : Physics	**Section** :	**Duration** : 1 Hour

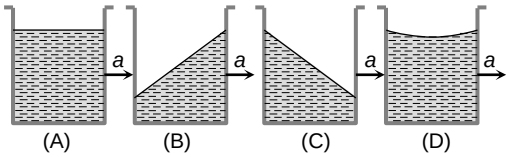
Student Name :

INSTRUCTION :

1. This Test consists of 30 questions. Number of questions to be attempted 25.
2. There are 2 sections (A & B). Section A will be of multiple-choice questions (MCQs) and section B will contain numerical based questions whose answers are to be filled in as a numerical value.
3. In section A all questions are compulsory and in section B candidates have to attempt any 5 questions out of 10.
4. Candidates will be awarded 4 marks for each correct response -1 mark will be given for indicating incorrect response in section A. There is no negative marking in section B.
5. No deduction from the total score will be made if no response is indicated.

Section - A

1. A vessel containing water is given a constant acceleration a towards the right, along a straight horizontal path. Which of the following diagram represents the surface of the liquid



(a) A (b) B
(c) C (d) D

2. A closed compartment containing gas is moving with some acceleration in horizontal direction. Neglect effect of gravity. Then the pressure in the compartment is
(a) Same everywhere
(b) Lower in front side
(c) Lower in rear side
(d) Lower in upper side

3. A ship of mass 3×10^7 kg initially at rest is pulled by a force of 5×10^4 N through a distance of 3 m. Assume that the resistance due to water is negligible, the speed of the ship is
(a) 1.5 m/s (b) 60 m/s
(c) 0.1 m/s (d) 5 m/s

4. The mass of a body measured by a physical balance in a lift at rest is found to be m. If the lift is going up with an acceleration a, its mass will be measured as
(a) $m\left(1-\frac{a}{g}\right)$ (b) $m\left(1+\frac{a}{g}\right)$
(c) m (d) Zero

5. Three weights W, 2W and 3W are connected to identical springs suspended from a rigid horizontal rod. The assembly of the rod and the weights fall freely. The positions of the weights from the rod are such that
(a) 3W will be farthest
(b) W will be farthest
(c) All will be at the same distance
(d) 2W will be farthest

6. When forces F_1,F_2,F_3 are acting on a particle of mass m such that F_2 and F_3 are mutually perpendicular, then the particle remains stationary. If the force F_1 is now removed then the acceleration of the particle is
(a) F_1/m (b) F_2F_3/mF_1
(c) $(F_2-F_3)/m$ (d) F_2/m

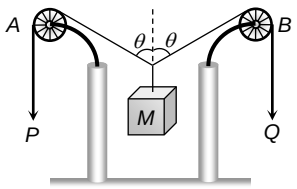
7. A rocket is propelled by a gas which is initially at a temperature of 4000 K. The temperature of the gas falls to 1000 K as it leaves the exhaust nozzle. The gas which will acquire the largest momentum while leaving the nozzle, is
(a) Hydrogen (b) Helium
(c) Nitrogen (d) Argon

8. Consider the following statement: When jumping from some height, you should bend your knees as you come to rest, instead of keeping your legs stiff. Which of the following relations can be useful in explaining the statement
(a) $\Delta\vec{P_1} = -\Delta\vec{P_2}$
(b) $\Delta E = -\Delta(PE + KE) = 0$
(c) $\vec{F}\Delta t = m\Delta\vec{v}$
(d) $\Delta\vec{x} \propto \Delta\vec{F}$
Where symbols have their usual meaning

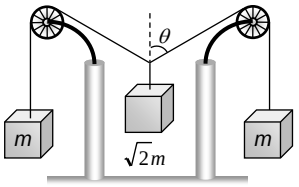
9. A false balance has equal arms. An object weigh X when placed in one pan and Y when placed in other pan, then the weight W of the object is equal to
(a) $\sqrt{XY}$ (b) $\frac{X+Y}{2}$
(c) $\frac{X^2+Y^2}{2}$ (d) $\frac{2}{\sqrt{X^2+Y^2}}$

10. The vector sum of two forces is perpendicular to their vector differences. In that case, the force
(a) Are equal to each other in magnitude
(b) Are not equal to each other in magnitude
(c) Cannot be predicted
(d) Are equal to each other

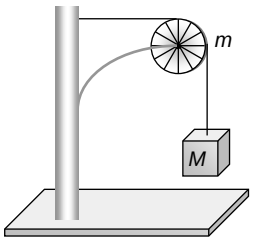
11. In the arrangement shown in figure the ends P and Q of an unstretchable string move downwards with uniform speed U. Pulleys A and B are fixed. Mass M moves upwards with a speed
(a) $2U\cos\theta$
(b) $U\cos\theta$
(c) $\frac{2U}{\cos\theta}$
(d) $\frac{U}{\cos\theta}$



12. The pulleys and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be
(a) 0^o
(b) 30^o
(c) 45^o
(d) 60^o

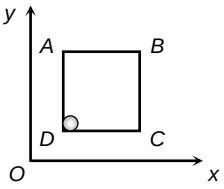


13. A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by
(a) $\sqrt{2}Mg$
(b) $\sqrt{2}mg$
(c) $\sqrt{(M+m)^2+m^2}g$
(d) $\sqrt{(M+m)^2+M^2}g$



14. A pulley fixed to the ceilling carries a string with blocks of mass m and 3 m attached to its ends. The masses of string and pulley are negligible. When the system is released, its centre of mass moves with what acceleration
(a) 0 (b) $g/4$
(c) $g/2$ (d) $-g/2$

15. A solid sphere of mass 2 kg is resting inside a cube as shown in the figure. The cube is moving with a velocity $v = (5t\,\hat{i} + 2t\,\hat{j})$ m/s. Here t is the time in second. All surface are smooth. The sphere is at rest with respect to the cube. What is the total force exerted by the sphere on the cube. (Take g = 10 m/s^2)



(a) $\sqrt{29}$N (b) 29 N
(c) 26N (d) $\sqrt{89}$ N

16. A stick of 1 m is moving with velocity of $2.7\times10^8 ms^{-1}$. What is the apparent length of the stick ($c = 3\times10^8 ms^{-1}$)
(a) 10 m (b) 0.22 m
(c) 0.44 m (d) 2.4 m

17. One day on a spacecraft corresponds to 2 days on the earth. The speed of the spacecraft relative to the earth is

(a) $1.5\times10^{8}ms^{-1}$ (b) $2.1\times10^{8}ms^{-1}$

(c) $2.6\times10^{8}ms^{-1}$ (d) $5.2\times10^{8}ms^{-1}$

18. A flat plate moves normally with a speed v_1 towards a horizontal jet of water of uniform area of cross-section. The jet discharges water at the rate of volume V per second at a speed of v_2. The density of water is ρ. Assume that water splashes along the surface of the plate at right angles to the original motion. The magnitude of the force acting on the plate due to the jet of water is

(a) ρVv_1 (b) $\rho V(v_1+v_2)$

(c) $\frac{\rho V}{v_1+v_2}v_1^2$ (d) $\rho\left[\frac{V}{v_2}\right](v_1+v_2)^2$

19. **Assertion :** If the net external force on the body is zero, then its acceleration is zero.

Reason : Acceleration does not depend on force.

20. **Assertion :** Newton's second law of motion gives the measurement of force.

Reason : According to Newton's second law of motion, force is directly proportional to the rate of change of momentum.

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

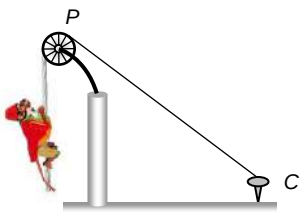
(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

Section - B

1. A force of 5 N acts on a body of weight 9.8 N. What is the acceleration produced in m/sec^2
2. Gravels are dropped on a conveyor belt at the rate of 0.5 kg/sec. The extra force required in newtons to keep the belt moving at 2 m/sec is
3. A machine gun fires a bullet of mass 40 g with a velocity 1200 ms^{-1}. The man holding it can exert a maximum force of 144 N on the gun. How many bullets can he fire per second at the most
4. An automobile travelling with a speed of 60 km/h, can brake to stop within a distance of 20 m. If the car is going twice as fast, i.e. 120 km/h, the stopping distance will be (in m)
5. A man of weight 75 kg is standing in an elevator which is moving with an acceleration of $5m/s^2$ in upward direction the apparent weight of the man will be $(g=10\ m/s^2)$ (in n)
6. There is a simple pendulum hanging from the ceiling of a lift. When the lift is stand still, the time period of the pendulum is T. If the resultant acceleration becomes g/4, then the new time period of the pendulum is (in T)
7. A body of mass 5 kg starts from the origin with an initial velocity $\vec{u}=30\hat{i}+40\hat{j}ms^{-1}$. If a constant force $\vec{F}=-(\hat{i}+5\hat{j})N$ acts on the body, the time in which the y–component of the velocity becomes zero is (in sec.)
8. A solid disc of mass M is just held in air horizontally by throwing 40 stones per sec vertically upwards to strike the disc each with a velocity 6 ms^{-1}. If the mass of each stone is 0.05kg what is the mass of the disc $(g=10ms^{-2})$ (in k.g.)
9. The tension in the spring is (in N)

10. One end of a massless rope, which passes over a massless and frictionless pulley P is tied to a hook C while the other end is free. Maximum tension that the rope can bear is 360 N. with what value of minimum safe acceleration (in ms^{-2}) can a monkey of 60kg move down on the rope



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NEET UG : CHAPTER WISE TEST – 03

Chapter Name : Classification of Elements and Periodicity in Properties

Class : XI	**Date** :	**Max. Marks** : 180
Subject : Chemistry	**Section** :	**Duration** : 1 Hour

Student Name :

INSTRUCTION :

1. This Test consists of 50 questions.
2. Candidates need to attempt any 45 questions.
3. Candidates will be awarded 4 marks for each correct response and -1 mark will be given for incorrect response.
4. No deduction from the total score will be made if no response is indicated.

1. If the difference in electronegativities of two elements is very large, then
   (a) The bond is 50% ionic
   (b) The bond is 100% covalent
   (c) The bond is more covalent than ionic
   (d) The bond is more ionic than covalent
2. Which of the following elements will have the lowest electron affinity
   (a) Nitrogen (b) Flourine
   (c) Chlorine (d) Phosphorus
3. The correct order of second ionization potential of carbon, nitrogen, oxygen and fluorine is
   (a) C > N > O > F (b) O > N > F > C
   (c) O > F > N > C (d) F > O > N > C
4. Which of the following species has the highest ionisation potential
   (a) Li^+ (b) Mg^+
   (c) Al^+ (d) Ne
5. Which of the following elements are analogous to the lanthanides
   (a) Actinides (b) Borides
   (c) Carbides (d) Hydrides
6. Which of the order for ionisation energy is correct
   (a) Be > B > C > N > O (b) B < Be < C < O < N
   (c) B < Be < C < N < O (d) B < Be < N < C < O
7. Modern periodic table is based on the atomic number of the elements. The experiment which proved the significance of the atomic number was
   (a) Millikan's oil drop experiment
   (b) Moseley's work on X -ray spectra
   (c) Bragg's work on X -ray diffraction
   (d) Discovery of X -rays by Rontgen
8. Which one of the elements is most metallic
   (a) P (b) As
   (c) Sb (d) Bi
9. For a p - block element, its 3d, 3s, 3p and 4s orbitals are completely filled and the differentiating electron goes to the 4p orbital. The element should have its atomic number in the range
   (a) 13 - 18 (b) 21 - 26
   (c) 31 - 36 (d) 49 – 54
10. The most common lanthanide is
    (a) Lanthanum (b) Cerium
    (c) Samarium (d) Plutonium
11. In a period, elements are arranged in strict sequence of
    (a) Decreasing charges in the nucleus
    (b) Increasing charges in the nucleus
    (c) Constant charges in the nucleus
    (d) Equal charges in the nucleus

12. Some of the polar crystal when heated produce electric current. This phenomena is termed as
(a) Ferroelectric effect
(b) Phyroelectric effect
(c) Antiferroelectric effect
(d) Piezoelectric effect

13. Which of the following pairs has elements containing same number of electrons in the outermost orbit
(a) $N-O$ (b) $Na-Cl$
(c) $Ca-Cl$ (d) $Cl-Br$

14. Coinage metals are present in
(a) s-block (b) d-block
(c) p-block (d) f-block

15. In which of the following metal carbonate which metal carbonate is decomposed on heating
(a) $MgCO_3$ (b) Na_2CO_3
(c) K_2CO_3 (d) Pb_2CO_3

16. Which one of the following is the correct decreasing order of boiling point
(a) $H_2O > H_2S > H_2Se > H_2Te$
(b) $H_2Te > H_2Se > H_2S > H_2O$
(c) $H_2O > H_2Te > H_2Se > H_2S$
(d) $H_2Te > H_2O > H_2Se > H_2O$

17. The elements having the electronic configuration, $[Kr]\ 4d^{10}f^{14},5s^2p^6d^2,6s^2$ belongs to
(a) s-block (b) p-block
(c) d-block (d) f-block

18. The element with atomic number 36 belongs to …… block in the periodic table
(a) p (b) s
(c) f (d) d

19. An element has the electronic configuration $1s^2,2s^2\,2p^6,\ 3s^2\,3p^6\,3d^5,4s^1$. It is a
(a) s-block element (b) p-block element
(c) d-block element (d) Inert gas

20. Which of the following dinegative anion is quite common
(a) S^{2-} (b) Se^{2-}
(c) Te^{2-} (d) O^{2-}

21. Which of the following property displays progressive increase down a group in the Bohr's periodic table
(a) Electronegativity (b) Electron affinity
(c) Ionization potential (d) Size of the atom

22. Which ion has greatest radius in the following
(a) H^- (b) F^-
(c) Br^- (d) I^-

23. Which has the maximum atomic radius
(a) Al (b) Si
(c) P (d) Mg

24. Which one of the following ions has the highest value of ionic radius
(a) O^{2-} (b) B^{3+}
(c) Li^+ (d) F^-

25. On going down a main sub-group in the periodic table (example Li to Cs in IA or Be to Ra in IIA), the expected trend of changes in atomic radius is a
(a) Continuous increase
(b) Continuous decrease
(c) Periodic one, an increase followed by a decrease
(d) A decrease followed by increase

26. Which of the following alkali metal ions has lowest ionic mobility in aqueous solutions
(a) Rb^+ (b) Cs^+
(c) Li^+ (d) Na^+

27. Ionic radii are
(a) Directly proportional to effective nuclear charge
(b) Directly proportional to square of effective nuclear charge
(c) Inversely proportional to effective nuclear charge
(d) Inversely proportional to square of effective nuclear charge.

28. The correct sequence of increasing covalent character is represented by
(a) $LiCl < NaCl < BeCl_2$
(b) $BeCl_2 < NaCl < LiCl$
(c) $NaCl < LiCl < BeCl$
(d) $BeCl_2 < LiCl < NaCl$

29. Correct energy value order is
(a) $ns\ np\ nd(n-1)f$
(b) $ns\ np(n-1)d\ (n-2)f$
(c) $ns\ np(n-1)d\ (n-1)f$
(d) $ns(n-1)d\ n(n-1)f$

30. The ionic conductance of following cation in a given concentration are in the order
(a) $Li^+ < Na^+ > K^+ < Rb^+$
(b) $Li^+ > Na^+ > K^+ > Rb^+$
(c) $Li^+ < Na^+ > K^+ > Rb^+$
(d) $Li^+ = Na^+ < K^+ < Rb^+$

31. If first orbit energy of He^+ is – 54.4 eV, then the second orbit energy will be
(a) – 54.4 eV (b) – 13.6 Ev
(c) – 27.2 eV (d) + 27.2 eV

32. Which of the following has highest first ionization energy
(a) Sulphur (b) Oxygen
(c) Nitrogen (d) Phosphorus

33. The second ionization potential is
(a) Less than the first ionization potential
(b) Equal to the first ionization potential
(c) Greater than the first ionization potential
(d) None of these

34. **Assertion :** Positive ions will be wider than parent atoms
Reason : Nuclear charge pulls them closer
(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) f assertion is true but reason is false.
(d) If the assertion and reason both are false.

35. **Assertion :** The atomic radii of calcium is smaller than sodium.
Reason : Calcium has a lower nuclear charge than sodium
(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) f assertion is true but reason is false.
(d) If the assertion and reason both are false.

36. Mg and Li are similar in their properties due to
(a) Same e/m ratio
(b) Same electron affinity
(c) Same group
(d) Same ionic potential

37. Which of the following has the highest first ionisation energy
(a) Li (b) Be
(c) B (d) C

38. The correct order of reactivity of halogens is
(a) $F > Cl > Br > I$ (b) $F < Cl > Br < I$
(c) $F < Cl < Br < I$ (d) $F < Cl < Br > I$

39. The first ionisation potential is maximum for
(a) B (b) N
(c) O (d) Be

40. The correct order of ionisation energy for comparing carbon, nitrogen and oxygen atoms is
(a) $C > N > O$ (b) $C > N < O$
(c) $C < N > O$ (d) $C < N < O$

41. The correct order of electron affinity of B, C, N, O is
(a) $O > C > N > B$ (b) $B > N > C > O$
(c) $O > C > B > N$ (d) $O > B > C > N$

42. Which one has maximum electron affinity
(a) N (b) Be
(c) B (d) Cl

43. The electron affinity for the inert gases is
(a) Zero (b) High
(c) Negative (d) Positive

44. Electron affinity is the
(a) Energy absorbed when an electron is added to an isolated atom in the gaseous state
(b) Energy released when an electron is added to an isolated atom in the gaseous state
(c) Energy required to take out an electron from an isolated gaseous atom
(d) Power of an atom to attract an electron to itself

45. Ionic compounds are formed most easily with
(a) Low electron affinity, high ionisation energy
(b) High electron affinity, low ionisation energy
(c) Low electron affinity, low ionisation energy
(d) High electron affinity, high ionisation energy

46. Which of the following sets of atoms is arranged in order of increasing electronegativity
(a) S, Si, P (b) S, P, Si
(c) Si, P, S (d) Si, S, P

47. Which of the following property displays progressive increase with the rise in atomic number across a period in the periodic table
(a) Electronegativity (b) Electron affinity
(c) Ionization potential (d) Size of the atom

48. 3 and 6 electrons are present in the outermost orbit of A and B respectively. The chemical formula of its compound will be
(a) A_3B_2 (b) A_2B_3
(c) A_2B (d) AB

49. The most basic element is
(a) Fluorine (b) Iodine
(c) Chlorine (d) Bromine

50. Which of the following set has the strongest tendency to form anions
(a) Ga, In and Te (b) Na, Mg and Al
(c) N, O and F (d) V, Cr and Mn

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MHT-CET : CHAPTER WISE TEST

Chapter Name: Matrices & Determinants

Class: XII	Date:	Max. Marks: 100
Subject: Mathematics	Section:	Duration: 90 Minutes

Student Name:

INSTRUCTION:

1. This Test consists of 50 questions.
2. Candidates need to attempt all questions.
3. Candidates will be awarded 2 marks for each correct response.
4. There is no negative marking for the wrong answer.

1. The minimum number of zeros in a upper triangular matrix will be-

(a) $\frac{n(n-1)}{2}$ (b) $\frac{n(n+1)}{2}$

(c) $\frac{2n(n-1)}{2}$ (d) None of these

2. If A and B are matrices of order m × n and n × n respectively, then which of the following are defined -

(a) AB, BA (b) AB, A^2

(c) A^2, B^2 (d) AB, B^2

3. If $A = \begin{bmatrix} -2 & 1 \\ 0 & 3 \end{bmatrix}$ and $f(x) = 2x^2 - 3x$, then f(a) equals -

(a) $\begin{bmatrix} 14 & -1 \\ 0 & 9 \end{bmatrix}$ (b) $\begin{bmatrix} -14 & 1 \\ 0 & 9 \end{bmatrix}$

(c) $\begin{bmatrix} 14 & 1 \\ 0 & -9 \end{bmatrix}$ (d) None of these

4. If $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}$, then A^5 equals-

(a) 5A (b) 10A

(c) 16A (d) 32 A

5. If $A = \begin{bmatrix} 1 & k \\ 0 & 1 \end{bmatrix}$ then A^n equal to-

(a) $\begin{bmatrix} 1 & k^n \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & nk \\ 0 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} k^n & 1 \\ 0 & 1 \end{bmatrix}$ (d) None of these

6. If $A = \begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix}$ then (A– 2I) (A – 3I) equals-

(a) $A^2 + 6I$ (b) I

(c) Zero matrix (d) None of these

7. If $A_\alpha = \begin{bmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{bmatrix}$, then which of following statement is true -

(a) $A_\alpha . A_\beta = A_{\alpha\beta}$ & $(A_\alpha)^n = \begin{bmatrix} \cos^n\alpha & \sin^n\alpha \\ -\sin^n\alpha & \cos^n\alpha \end{bmatrix}$

(b) $A_\alpha . A_\beta = A_{\alpha\beta}$ & $(A_\alpha)^n = \begin{bmatrix} \cos n\alpha & \sin n\alpha \\ -\sin n\alpha & \cos n\alpha \end{bmatrix}$

(c) $A_\alpha . A_\beta = A_{\alpha+\beta}$ & $(A_\alpha)^n = \begin{bmatrix} \cos^n\alpha & \sin^n\alpha \\ -\sin^n\alpha & \cos^n\alpha \end{bmatrix}$

(d) $A_\alpha . A_\beta = A_{\alpha+\beta}$ & $(A_\alpha)^n = \begin{bmatrix} \cos n\alpha & \sin n\alpha \\ -\sin n\alpha & \cos n\alpha \end{bmatrix}$

8. If A, B are 3 × 2 order matrices and C is a 2×3 order matrix, then which of the following matrices not defined -

(a) $A^T + B$ (b) $B + C^T$

(c) $A^T + C$ (d) $A^T + B^T$

9. If A is skew symmetric matrix & C is column matrix then C′A C =

(a) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

(c) [1] (d) [0]

10. For any square matrix A, $A + A^T$ will be symmetric matrix then $A - A^T$ will be-
(a) unit matrix
(b) symmetric matrix
(c) skew symmetric matrix
(d) null matrix

11. If A is square matrix then $A + A^T$ will be-
(a) inverse matrix
(b) skew symmetric matrix
(c) symmetric matrix
(d) unit matrix

12. Matrix A and transpose matrix A^T then AA^T will be –
(a) Symmetric (b) Inverse matrix
(c) Skew symmetric (d) None of these

13. If A is symmetric as well as skew symmetric matrix, then-
(a) A is a diagonal matrix
(b) A is a null matrix
(c) A is a unit matrix
(d) A is a triangular matrix

14. If A is a square matrix of order 3, then correct statement is -
(a) det (–A) = – det A (b) det (–A) = 0
(c) det (A+ I) = I + det A (d) det 2A = 2 det A

15. If $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & 4 \\ 0 & 0 & 2 \end{bmatrix}$, then the value of adj (adj A) is-
(a) $|A|^2$ (b) – 2A
(c) 2A (d) A^2

16 If $A = \begin{bmatrix} 3 & 2 \\ 1 & -4 \end{bmatrix}$ then A (adj A) =
(a) –14 I (b) –10A
(c) 8 I (d) –1.14 I

17. If k is a scalar and I is a unit matrix of order 3, then adj (kI) equals-
(a) k^3 I (b) k^2I
(c) – k^3 I (d) – k^2 I

18. Matrix A = $\begin{bmatrix} -5 & -8 & 0 \\ 3 & 5 & 0 \\ 1 & 2 & -1 \end{bmatrix}$ is -
(a) Involutory (b) idempotent
(c) nilpotent (d) orthogonal

19. Matrix A = $\begin{bmatrix} 1 & -3 & -4 \\ -1 & 3 & 4 \\ 1 & -3 & -4 \end{bmatrix}$ is -
(a) Involutory (b) idempotent
(c) nilpotent (d) orthogonal

20 If A is an idempotent matrix and I is identity matrix of the same order, then the value of n, $n \in N$ such that $(A + I)^n = I + 127 A$ is-
(a) n = 7 (b) n = 8
(c) n = 9 (d) n = 3

21. If ΔABC is a scalene triangle, then the value of $\begin{vmatrix} \sin A & \sin B & \sin C \\ \cos A & \cos B & \cos C \\ 1 & 1 & 1 \end{vmatrix}$ is
(a) = 0 (b) $\neq 0$
(c) cannot say (d) None of these

22. Co-factors of element of the second row of the determinant $\begin{vmatrix} 1 & 2 & 3 \\ -4 & 3 & 6 \\ 2 & -7 & 9 \end{vmatrix}$ are-
(a) 39, 3, 11 (b) –39, 3, 11
(c) 39, –3, 11 (d) 39, 3, –11

23. Without expanding value of the determinant $\begin{vmatrix} 0 & p-q & p-r \\ q-p & 0 & q-r \\ r-p & r-q & 0 \end{vmatrix}$ is-
(a) (p – r) (q – r) (b) (q – r) (p – q)
(c) 0 (d) None of these

24. If a, b,c are positive and are the pth, qth and rth terms respectively of a G.P., then the value of $\begin{vmatrix} \log a & p & 1 \\ \log b & q & 1 \\ \log c & r & 1 \end{vmatrix}$ is -
(a) 0 (b) p
(c) q (d) r

25. $\begin{vmatrix} b+c & c & b \\ c & c+a & a \\ b & a & a+b \end{vmatrix}$ =
(a) a + b + c (b) 2a + b + c
(c) ab + bc + ca (d) 4abc.

26. The value of the determinant

$$\begin{vmatrix} 1 & \cos(\beta-\alpha) & \cos(\gamma-\alpha) \\ \cos(\alpha-\beta) & 1 & \cos(\gamma-\beta) \\ \cos(\alpha-\gamma) & \cos(\beta-\gamma) & 1 \end{vmatrix}$$

is equal to
(a) $\cos\alpha + \cos\beta + \cos\gamma$
(b) $\cos\alpha\cos\beta + \cos\beta\cos\gamma + \cos\gamma\cos\alpha$
(c) –1
(d) 0

27. If $a + b + c \neq 0$ and the system of equations
$ax + by + cz = 0$
$bx + cy + az = 0$
$cx + ay + bz = 0$
has a non-trivial solution, then the roots of the equation $at^2 + bt + c = 0$, are
(a) imaginary
(b) real and distinct
(c) real and of opposite sign
(d) real and equal

28. Solution of the system of equations
$a^2x + ay + z = -a^3$, $b^2x + by + z = -b^3$,
$c^2x + cy + z = -c^3$ is-
(a) $x=-(a+b+c)$, $y = ab + bc + ca$, $z = -abc$
(b) $x=(a+b+c)$, $y = ab + bc + ca$, $z = -abc$
(c) $x=-(a-b-c)$, $y = ab + bc + ca$, $z = -abc$
(d) None of these

29. The value of the determinant

$$\begin{vmatrix} {}^{n-1}C_{r-1} & {}^{n-1}C_r & {}^{n-1}C_{r+1} \\ {}^{n-1}C_r & {}^{n-1}C_{r+1} & {}^{n-1}C_{r+2} \\ {}^{n}C_r & {}^{n}C_{r+1} & {}^{n}C_{r+2} \end{vmatrix}$$ is -

(a) 0 (b) 1
(c) –1 (d) None

30. The system of equations
$2x - y + z = 0$
$x - 2y + z = 0$
$\lambda x - y + 2z = 0$
has infinite number of nontrivial solutions for -
(a) $\lambda = 1$ (b) $\lambda = 5$
(c) $\lambda = -5$ (d) no real value of λ

31. If $a \neq b \neq c$ such that

$$\begin{vmatrix} a^3-1 & b^3-1 & c^3-1 \\ a & b & c \\ a^2 & b^2 & c^2 \end{vmatrix} = 0$$ then

(a) $ab + bc + ca = 0$ (b) $a + b + c = 0$
(c) $abc = 1$ (d) $a + b + c = 1$

32. $\begin{vmatrix} 1+a^2-b^2 & 2ab & -2b \\ 2ab & 1-a^2+b^2 & 2a \\ 2b & -2a & 1-a^2-b^2 \end{vmatrix} =$

(a) $(1-a^2-b^2)^3$ (b) $(1+a^2+b^2)^3$
(c) $(1+a^2-b^2)^3$ (d) None of these

33. If α, β, γ are the roots of $x^3 - 3x + 2 = 0$, then the value of the determinant $\begin{vmatrix} \alpha & \beta & \gamma \\ \beta & \gamma & \alpha \\ \gamma & \alpha & \beta \end{vmatrix}$ is equal to
(a) –3 (b) 2
(c) 1 (d) none

34. **Assertion:** The system of equations possess a non-trivial solution for the equations
$x + xy + 3z = 0$, $3x + xy - 2z = 0$
& $2x + 3y - 4z = 0$
then value of k is $\frac{29}{2}$

Reason: for non-trivial solution $\Delta = 0$
(a) If both Assertion -1 and Reason-2 are true and the Reason-2 is correct explanation of the Assertion -1.
(b) If both Assertion -1 and Reason-2 are true but Reason -2 is not correct explanation of the Assertion -1.
(c) If Assertion-1 is true but the Reason-2 is false.
(d) If Assertion -1 is false but Reason-2 is true.

35. **Assertion:**

$$\begin{vmatrix} \cos(\theta+\alpha) & \cos(\theta+\beta) & \cos(\theta+\gamma) \\ \sin(\theta+\alpha) & \sin(\theta+\beta) & \sin(\theta+\gamma) \\ \sin(\beta-\gamma) & \sin(\gamma-\alpha) & \sin(\alpha-\beta) \end{vmatrix}$$ is

independent of θ

Reason: If $f(\theta) = c$, then $f(\theta)$ is independent of θ.
(a) If both Assertion -1 and Reason-2 are true and the Reason-2 is correct explanation of the Assertion -1.
(b) If both Assertion -1 and Reason-2 are true but Reason -2 is not correct explanation of the Assertion -1.
(c) If Assertion-1 is true but the Reason-2 is false.
(d) If Assertion -1 is false but Reason-2 is true.

36. Let $\omega = -\frac{1}{2}+i\frac{\sqrt{3}}{2}$. Then the value of the determinant $\begin{vmatrix}1 & 1 & 1\\ 1 & -1-\omega^2 & \omega^2\\ 1 & \omega^2 & \omega^4\end{vmatrix}$ is-

(a) 3ω (b) $3\omega(\omega-1)$

(c) $3\omega^2$ (d) $3\omega(1-\omega)$

37. If $x + ay = 0$; $y + az = 0$; $z + ax = 0$, then value of 'a' for which system of equations will have infinite number of solutions is

(a) a =1 (b) a = 0

(c) a = –1 (d) no value of a

38. Consider the system of equations

$x - 2y + 3z = -1$

$-x + y - 2z = k$

$x - 3y + 4z = 1$

Assertion: The system of equations has no solution for $k \neq 3$ and

Reason: The determinant

$\begin{vmatrix}1 & 3 & -1\\ -1 & -2 & k\\ 1 & 4 & 1\end{vmatrix} \neq 0$, for $k \neq 3$

(a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

(b) If both Assertion and Reason are true but Reason is not correct explanation of the Assertion.

(c) If Assertion is true but the Reason is false.

(d) If Assertion is false but Reason is true

39. If ω ($\neq 1$) is a cube root of unity, then $\begin{vmatrix}1 & 1+i+\omega^2 & \omega^2\\ 1-i & -1 & \omega^2-1\\ -i & -i+\omega-1 & -1\end{vmatrix}$ equals

(a) 0 (b) 1

(c) i (d) ω

40. Let a, b, c be the real numbers. Then following system of equations in x, y and

$\frac{x^2}{a^2}+\frac{y^2}{b^2}-\frac{z^2}{c^2}=1,\ \frac{x^2}{a^2}-\frac{y^2}{b^2}+\frac{z^2}{c^2}=1,$

$-\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$ has

(a) no solution

(b) unique solution

(c) infinitely many solutions

(d) finitely many solutions

41. If $A = \begin{bmatrix}5 & 2\\ 1 & 0\end{bmatrix}$ and $B = \begin{bmatrix}2 & 3\\ 5 & -1\end{bmatrix}$, then $|2A - 3B|$ equals –

(a) -53 (b) -50

(c) -55 (d) -52

42. The total number of matrices formed with the help of 6 different numbers are T(6!), then the value of T will be

(a) 3 (b) 5

(c) 4 (d) 1

43. How many matrices can be obtained by using one or more numbers from four given numbers-

(a) 147 (b) 145

(c) 150 (d) 148

44. The root of the equation

$[x\ 1\ 2]\begin{bmatrix}0 & 1 & 1\\ 1 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}\begin{bmatrix}x\\ -1\\ 1\end{bmatrix} = 0$ is-

(a) 0.31 (b) 0.33

(c) 0.35 (d) 0.40

45. If $A = \begin{bmatrix}1 & 2\\ 2 & 3\end{bmatrix}$ and $A^2 - KA - I_2 = 0$, then value of K is -

(a) 1 (b) 3

(c) 2 (d) 4

46. If $ax^4 + bx^3 + cx^2 + dx + e =$ $\begin{vmatrix}2x & x-1 & x+1\\ x+1 & x^2-x & x-1\\ x-1 & x+1 & 3x\end{vmatrix}$, then the value of e, is

(a) 0 (b) 1

(c) 2 (d) 4

47. If A, B and C are the angles of a triangle, then $\begin{vmatrix}\sin 2A & \sin C & \sin B\\ \sin C & \sin 2B & \sin A\\ \sin B & \sin A & \sin 2C\end{vmatrix} =$

(a) 3 (b) 0

(c) 2 (d) 4

48. If the following equations

$x + y - 3 = 0$

$(1 + \lambda)x + (2 + \lambda)y - 8 = 0$

$x - (1 + \lambda)y + (2 + \lambda) = 0$

are consistent then the value of λ is

(a) 4 (b) 2

(c) 1 (d) 3

49. If $\begin{vmatrix} 1+x & x & x^2 \\ x & 1+x & x^2 \\ x^2 & x & 1+x \end{vmatrix}$ $= ax^5 + bx^4 + cx^3 + dx^2 + \lambda x + \mu$ be an identity in x, where a, b, c, d, λ, μ are independent of x. Then the value of λ is

(a) 1 (b) 3

(c) 2 (d) 4

50. The value of the determinant $\begin{vmatrix} (2^x - 2^{-x})^2 & (2^x + 2^{-x})^2 & 1 \\ (3^x - 3^{-x})^2 & (3^x + 3^{-x})^2 & 1 \\ (4^x - 4^{-x})^2 & (4^x + 4^{-x})^2 & 1 \end{vmatrix}$ is equal to

(a) 3 (b) 2

(c) 0 (d) 1

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NEET UG : CHAPTER WISE TEST - 04

Chapter Name : Principles of Inheritance And Variation

Class : XII	**Date** :	**Max. Marks** : 360
Subject : Biology	**Section** :	**Duration** : 1 Hour

Student Name :

INSTRUCTION :

1. This Test consists of 90 questions.
2. All questions are compulsory.
3. Candidates will be awarded 4 marks for each correct response and -1 mark will be given for incorrect response.
4. No deduction from the total score will be made if no response is indicated.

Q.1 Select the incorrect statement for Gregor Mendel –
(1) He conducted hybridization experiments on garden pea for seven years.
(2) He applied statistical analysis and mathematical logic for the first time to the problems in biology.
(3) His experiments had a small sampling size.
(4) He conducted artificial cross-polination experiments using several true-breeding pea lines.

Q.2 Mendel observed that all the F_1 progeny plants.
(1) resembled either one of the parents (2) resembled neither of the parents
(3) resembled both of the parents (4) shows 3 : 1 ratio

Q.3 Accoding to Mendel, "factors" or "genes"
(1) are the units of inheritance
(2) contain information that is required to express a particular trait
(3) Both 1 and 2
(4) None of the above

Q.4 The segregration of alleles is a random process and so there is a _____ chance of a gametes containing either allele.
(1) 25% (2) 50% (3) 75% (4) 100%

Q.5 Based on observation on monohybrid crosses Mendel draw some conclusion. Which of the following is not correct–
(1) Characters are controlled by discrete units called factors
(2) Factors occur in pairs
(3) In a similar pair of factors one member of the pair dominates the other
(4) The postulate of dominance also explains the proportion of 3 : 1 obtained at the F_2

Q.6 In the inheritance of flower colour in dog flower plant, the F_1 had a phenotype that
(1) resembles both of the parents (2) did not resembles either of the two parents
(3) resembles with only one parent (4) 1 and 3 both

Q.7 The phenotype of any character will not be affected if the modified allele produces–

(1) Normal enzyme (2) Non-functional enzyme
(3) No-enzyme at all (4) 2 and 3 both

Q.8 The three different alleles of human ABO blood types will produce how many genotypes & phenotypes respectively–

(1) 4 & 6 (2) 6 & 4 (3) 6 & 6 (4) 4 & 4

Q.9 "When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters". This explains–

(1) Law of dominance (2) Law of segregation
(3) Law of independent assortment (4) Postulate of paired factors

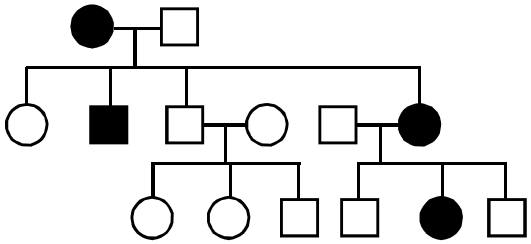
Q.10 Morgan coined the term _____ to describe the physical association of genes on a chromosome & the term _____ to describe the generation of non-parental gene combinations.

(1) Recombination; Linkage (2) Recombination; Non-recombination
(3) Linkage; Non-recombination (4) Linkage; Recombination

Q.11 In which organism female in homogametic & also have one chromosomes more than male.

(1) Birds (2) Drosophila (3) Chicks (4) Grasshopper

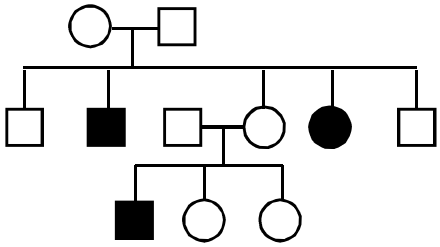
Q.12 Given below is the pedigree of an autosomal dominant disorder-Myotonic dystrophy.



In this pedigree the genotype of all affected children will be –

(1) AA (2) Aa (3) AA or Aa (4) aa

Q.13 Given below is the pedigree of sickle cell anaemia, in a family



In this the RBC of both parents will be –

(1) Normal (2) Sickle shaped
(3) Both normal & sickle shaped (4) Cannot be determined

Q.14 The accessibility of promotor regions of prokaryotic DNA by RNA polymerase is in many cases regulated by the interaction of some protein with sequences termed as –

(1) Promoter (2) Operator (3) Regulator (4) Cistron

Q.15 Which of the following is not associated with HGP–

(1) Bioinformatics (2) Cloning vectors BAC & YAC
(3) Automated DNA sequencers (4) VNTR

Q.16 In density gradient centrifugation, the bulk DNA forms _____ while satellite DNA forms ____.

(1) Major peak; Minor peak (2) Minor peak; Major peak
(3) Major peak; Major peak (4) Minor peak; Minor peak

Q.17 Select the incorrect statement.

(1) DNA from single cell is enough to perform DNAfingerprinting analysis

(2) DNA fingerprinting has much wider applications in determining population & genetic diversities.

(3) The VNTR belongs to a class of satellite DNA referred as microsatellite.

(4) DNA fingerprint differs from individual to individual in a population except in the case of monozygotic twins.

Q.18 Other than pea plants it was found that sometimes the F_1 had a phenotype that did not resemble either of the two parents and was in between the two. It is due to

(1) Complete Dominance (2) Incomplete Dominance

(3) Co-Dominance (4) Complementary gene interaction

Q.19 Which of the following material is good to understand incomplete dominance

(1) Sweet Pea (2) Cattle (3) Snapdrogon (4) Kernel colour in wheat

Q.20 Find out the correct match –

(1) F_1 resembled either of the two parents - Dominance

(2) F_1 resembled in between - incomplete dominance

(3) F_1 resembled both parent - Co-dominance

(4) All are correct

Q.21 Which is incorrect –

(i) ABO blood groups are controlled by the gene I

(ii) Gene I has four alleles

(iii) I^A and I^B produce same type of sugar

(iv) I or I° produce different type of sugar

(v) I^A and I^B are incomplete dominant

(1) i, ii (2) v, ii (3) ii, iii, iv (4) ii, iii, iv, v

Q.22 Which Scientist has no role in rediscovery of Mendel's results

(1) Vries (2) Correns (3) Tschermak (4) Morgan

Q.23 Experimental verification of the chromosomal theory of inheritance done by Thomas Hunt Morgan and his colleagues they worked with –

(1) Pea plant (2) Sweet pea plant (3) Snapdragon (4) Drosophila

Q.24 Which is incorrect for Drosophila melanogaster

(1) They could be grown on simple synthetic medium

(2) Single mating could produce a large number of progeny

(3) They complete their life cycle in about 7 weeks

(4) There was a clear differentiation of the sexes.

Q.25 Regulation of lac operon by repressor is referred to as–

(1) Positive regulation (2) Nagative regulation

(3) Both (1) and (2) (4) None

Q.26 Which is incorrect

(1) i-gene codes for the repressor of lac operon

(2) z-gene codes for the beta-galactosidase

(3) y-gene codes for transacetylase

(4) three gene products are required for metabolism of lactose

Q.27 Which is the primary step for regulation of gene expression?
(1) Transport of m-RNA from nucleus to the cytoplasm
(2) Translational level
(3) Processing level
(4) Transcriptional level

Q.28 Which step is not correct in DNA finger printing–
(1) Isolation of DNA (2) Digestion of DNA by DNA ligase enzyme
(3) Separation of DNA by electophoresis (4) Hybridisation using labelled VNTR probe

Q.29 Find out the correct sequence of structural gene in lac operon
(1) y, a, z (2) a, z, y (3) z, y, a (4) z, a y

Q.30 Which of the following is not observed in a monohybrid cross–
(1) Recessive parental trait is expressed without any blending in the F_2-generation
(2) Recessive parental trait is expressed without any blending in the F_1-generation
(3) Dominance also explains the proportion of 3 : 1 obtained at the F_2
(4) Genotype ratio is 1 : 2 : 1

Q.31 Gene which code for a pair of contrasting traits are known as –
(1) Allele (2) Non allele (3) Pseudoallele (4) Isoallele

Q.32 The modified allele is equivalent to the unmodified allele when it produces–
(1) A non functional enzyme (2) No enzyme
(3) The normal enzyme (4) All the above

Q.33 Grasshopper is an example of –
(1) XO type of sex determination (2) XY type of sex determination
(3) Environmental sex determination (4) Genic balance theory

Q.34 Which of the following is responsible for sex determination in chick :-
(1) Sperm (2) Egg (3) Somatic cell (4) Every cell of body

Q.35 Morgan and his group found that when genes were grouped on the same chromosome, some genes were very tightly linked and showed–
(1) Very low recombination (2) Higher recombination
(3) No recombination (4) 100% parental combination

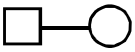
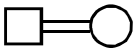
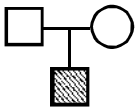
Q.36 Which statement is not true for ***Drosophila melanogaster–***
(1) They complete their life cycle about two weeks
(2) Single mating produce large number of progeny flies
(3) It has few hereditary variation that can be seen with high power microscope
(4) It has clear differentiation of the sex

Q.37 In which of the following sex is determined by female individual –
(1) Human (2) Drosophila (3) Birds (4) Grasshopper

Q.38 The recessive characters are –
(1) Only expressed in heterozygous condition
(2) Only expressed in homozygous condition
(3) Blend in heterozygous condition
(4) Always impure

Q.39 Which statement is true–
(1) Characters segregate during formation of gametes
(2) All characters show true dominance
(3) The characters always blend in heterozygous condition
(4) Mendelian disorder are determined by or absence or excess of one or more chromosome

Q.40 Which of the following symbol is used for mating between relatives (Consangeineous mating)

(1)  (2)  (3)  (4) 

Q.41 Theoretically a normal phenotype is expressed when a particular substrate trasnform in to product but in which of following condition phenotype may be affected–
(1) When the modified allele produce normal enzyme
(2) When the modified allele produce a non functional enzyme
(3) When the unmodified allele produce no enzyme
(4) All the above

Q.42 Which of the following condition is true for codominance–
(1) Phenotype of F_1 resembled either of the two parents
(2) Phenotype of F_1 did not resemble either of two parents
(3) Phenotype of F_1 resembles both parents
(4) None of these

Q.43 Which of the followig is a good example of multiple allele–
(1) ABO blood groups (2) Size of starch grain in pea
(3) Shape of seed (4) Flower colour in pea

Q.44 In sickle cell anaemia–
(1) The mutant haemoglobin molecule undergoes polymerisation under low oxygen tension causing the change in the shape of RBC
(2) Substitution of Glutamic acid by valine at the sixth position of the α-chain of haemoglobin
(3) The mutant haemoglobin undergoes polymerization under high oxygen tension causing the change in shape of RBC
(4) α-globin chain is modified

Q.45 The experimental verification of the chromosomal theory of inheritance by–
(1) Boveri (2) Sutton (3) T.H. Morgan (4) Bateson

Q.46 Male heterogamy found in case of
(1) XO type male in Grasshopper (2) XY type male in human
(3) ZW male in birds (4) 1 and 2 both

Q.47 In a cross between true red flowered (RR) and true breeding white flowered (rr), snapdragon plant, the F_1(Rr) was pink. When the F_1 was self pollinated the F_2 resulted in the following ratio 1(RR) red; 2(Rr) pink; 1(rr) white. Above condition can be explained by–
(1) True dominance (2) Incomplete dominance
(3) Lethal gene (4) Independent assortment

Q.48 In case of inheritance of one gene 3 : 1 phenotypic ratio can be explained on the basis of–
(1) Incomplete dominance (2) Codominance
(3) Dominance (4) Linkage

Q.49 In case of ABO blood group allele I^A and I^B if present together then –
(1) Ony I^A allele expresses (2) Only I^B allele expresses
(3) Both I^A and I^B alleles express (4) None of these

Q.50 In which of the following monosomic male is found
(1) Human (2) Birds (3) Honey bee (4) Grasshopper

Q.51 Breeding is possible between two member of -
(1) Genus (2) Family (3) Order (4) Species

Q.52 In which one of the following combinations (1-4) of the number of chromosomes is the present day hexaploid wheat correctly represented

Combination	(1)	(2)	(3)	(4)
Monosomic	21	7	21	41
Haploid	28	28	7	21
Nullisomic	42	40	42	40
Trisomic	43	42	43	43

Q.53 In a mutational event, when adenine is replaced by guanine, it is case of -
(1) Frameshift mutation (2) Transcription
(3) Transition (4) Transversion

Q.54 A normal-visioned man whose father was colour-blind, marries a woman whose father was also colour-blind. They have their first child as a daughter. What are the chances that this child would be colour-blind ?
(1) zero percent (2) 25% (3) 50% (4) 100%

Q.55 A certain road accident patient with unknown blood group needs immediate blood transfusion. His one doctor friend at once offers his blood. What was the blood group of the donor ?
(1) Blood group AB (2) Blood group O (3) Blood group A (4) Blood group B

Q.56 If two persons with' AB' blood group marry and have sufficiently large number of children, these children could be classified as 'A' blood group: 'AB' blood group: 'B' blood group in 1:2:1 ratio. Modern technique of protein electrophoresis reveals presence of both 'A' and 'B' type proteins in 'AB' blood group individuals. This is an example of :
(1) Incomplete dominance (2) Partial dominance
(3) Complete dominance (4) Codominance

Q.57 Which Mendelian idea is depicted by a cross in which the F_1 generation resembles both the parents?
(1) law of dominance (2) inheritance of one gene
(3) co - dominance (4) incomplete dominance

Q.58 The tendency of population to remain in genetic equilibrium may be disturbed by :
(1) lack of migration (2) lack of mutations
(3) lack of random mating (4) random mating

Q.59 If both parents are carriers for thalessemia, which is an autosomal recessive disorder, what are the chances of pregnancy resulting in an affected child?
(1) 50% (2) 25% (3) 100% (4) no chance

Q.60 Which of the following statements is not true of two cenes that show 50% recombination frequency?
(1) The genes are tightly linked
(2) The genes show independent assortment
(3) If the genes are present on the same chromosome, they undergo more than one crossovers in every meiosis
(4) The genes may be on different chromosomes

Q.61 The incorrect statement with regard to Haemophilia is :
(1) It is a recessive disease
(2) It is a dominant disease
(3) A single protein involved in the clotting of blood is affected
(4) It is a sex - linked disease

Q.62 In a population of 1000 individuals 360 belong to genotype AA, 480 to Aa and the remaining 160 to aa. Based on this data, the frequency of allele A in the population is :
(1) 0.6 (2) 0.7 (3) 0.4 (4) 0.5

Q.63 Fruit colour in squash is an example of :
(1) Complementary genes (2) Inhibitory genes
(3) Recessive epistasis (4) Dominant epistasis

Q.64 A man whose father was colour blind marries a woman who had a colour blind mother and normal father. What percentage of male children of this couple will be colour blind?
(1) 50% (2) 75% (3) 25% (4) 0%

Q.65 A human female with Turner's syndrome :
(1) exhibits male characters
(2) is able to produce children with normal husband.
(3) has 45 chromosomes with XO.
(4) has one additional X chromosome.

Q.66 A man with blood group 'A' marries a woman with blood group 'B'. What are all the possible blood groups of their offsprings?
(1) A, B and AB only (2) A, B, AB and O (3) O only (4) A and B only

Q.67 How many pairs of contrasting characters in pea plants were studied by Mendel in his experiments?
(1) Six (2) Eight (3) Seven (4) Five

Q.68 The movement of a gene from one linkage group to another is called:
(1) Duplication (2) Translocation (3) Crossing over (4) Inversion

Q.69 Alleles are:
(1) true breeding homozygotes (2) different molecular forms of a gene
(3) heterozygotes (4) different phenotype

Q.70 Which of the following most appropriately describes haemophilia ?
(1) Recessive gene disorder (2) X -linked recessive gene disorder
(3) Chromosomal disorder (4) Dominant gene disorder

Q.71 A tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant. When the F_1 plants were selfed the resulting genotypes were in the ratio of :
(1) 1 : 2 : 1 : : Tall homozygous : Tall heterozygous : Dwarf
(2) 1 : 2 : 1 : : Tall heterozygous : Tall homozygous : Dwarf
(3) 3 : 1 : : Tall : Dwarf
(4) 3 : 1 : : Dwarf : Tall

Q.72 Match the terms in **Column I** with their description in **Column II** and choose the correct option:

Column I	**Column II**
(a) Dominance	(i) Many genes govern a single character
(b) Co dominance	(ii) In a heterozygous organism only one allele expresses itself
(c) Pleiotropy	(iii) In a heterozygous organism both alleles express themselves fully
(d) Polygenic	(iv) A single gene influences inheritance many characters

(1) a-(ii), b-(i), c-(iv), d-(iii) (2) a-(ii), b-(iii), c-(iv), d-(i)
(3) a-(iv), b-(i), c-(ii), d-(iii) (4) a-(iv), b-(iii), c-(i), d-(ii)

Q.73 Pick out the correct statements :
(a) Haemophilia is a sex-linked recessive disease.
(b) Down's syndrome is due to aneuploidy.
(c) Phenylketonuria is an autosomal recessive gene disorder.(d) Sickle cell anaemia is an X-linked recessive gene disorder.
(1) (a) and (d) are correct. (2) (b) and (d) are correct.
(3) (a), (c) and (d) are correct. (4) (a), (b) and (c) are correct.

Q.74 A cell at telophase stage is observed by a student in a plant brought from the field. He tells his teacher that this cell is not like other cells at telophase stage. There is no formation of cell plate and thus the cell is containing more number of chromosomes as compared to other dividing cells. This would result in :
(1) Aneuploidy (2) Polyploidy
(3) Somaclonal variation (4) Polyteny

Q.75 The mechanism that causes a gene to move from one linkage group to another is called
(1) Corossing-over (2) inversion (3) duplication (4) translocation

Q.76 A true breeding plant is
(1) Always homozygous recessive in its genetic constitution
(2) One that is able to bred on its own
(3) Produced due to cross pollination among unrelated plants
(4) near homozygous and produces offspiring of its kind

Q.77 A molecule that can act as a genetic material must fulfill the traits given, except
(1) it should provide the scope for slow changes that are required for evolution
(2) it should be able to express itself in the form of 'Mendelian characters'
(3) it should be able to generate its replica
(4) it should be unstable structurally and chemically

Q.78 If the sequence of bases in the coding strand of a double stranded DNA is 5'- GTTCGAGTC-3', the sequence of bases in its transcript will be
(1) 5'-GACUCGAAC-3' (2) 5'-CAAGCUCAG-3'
(3) 5' –GUUCGAGUC-3' (4) 5'-CUGAGCUUG-3'

Q.79 If 'A' represents the dominant gene and 'a' represents its recessive allele, which of the following would be the most likely result in the first generation offspring when Aa is crossed with aa?
(1) All will exhibit dominant phenotype.
(2) All will exhibit recessive phenotype.
(3) Dominant and recessive phenotypes will be 50% each.
(4) Dominant phenotype will be 75%.

Q.80 Which one from those given below is the periods for Mendel's hybridization expermients?
(1) 1856 – 1863 (2) 1840 – 1850 (3) 1857 – 1869 (4) 1870 - 1877

Q.81 Among the following characters, which one was not considered by Mendel in his experiments on pea ?
(1) Stem - Tall of Dwarf (2) Trichomes - Glandular or non-glandular
(3) Seed - Green or Yellow (4) Pod - Inflated or Constricted

Q.82 If there are 999 bases in RNA that codes for a protein with 333 amino acids, and the base at position 901 is deleted such that the length of the RNA becomes 998 bases, how many codons will be altered ?
(1) 1 (2) 11 (3) 33 (4) 333

Q.83 The genotypes of a Husband and Wife are I^AI^B and I^Ai.
Among the blood types of their children how many different genotypes and phenotypes are possible
(1) 3 genotypes ; 3 phenotypes (2) 3 genotypes; 4 phenotypes
(3) 4 genotypes ; 3 Phenotypes (4) 4 genotypes ; 4 phenotypes

Q.84 The final proof for DNA as the genetic material came from the experiments of
(1) Griffith (2) Hershey and Chase
(3) Avery, Mcleod and McCarty (4) Har Gobind Khorana

Q.85 Thalassemia and sickle cell anemia are caused due to a problem in globin molecule synthesis. Select the correct statement.
(1) Both are due to a qualitative defect in globin chain synthesis.
(2) Both are due to a qualitative defect in globin chain synthesis.
(3) Thalassemia is due to less synthesis of globin molecules.
(4) Sickle cell anemia is due to a quantitative problem of globin molecules

Q.86 **Assertion :** In humans, the gamete contributed by the male determines whether the child produced will be male or female.
Reason : Sex in humans is a polygenic trait depending upon a cumulative effect of some genes on X-chromosome and some on Y-chromosome.
(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (1).
(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).
(3) If Assertion is true statement but Reason is false, then mark (3).
(4) If both Assertion and Reason are false statements, then mark (4).

Q.87 According to mendelism which character is showing dominance -

(1) Terminal position of flower (2) Green colour in seed coat

(3) Wrinkled seeds (4) Green pod colour

Q.88 Irregularity is found in Drosophila during the organ differentiation for example-in place of wing, long legs are formed. Which gene is responsible for -

(1) Double dominant gene (2) Homeiotic gene

(3) Complementary gene (4) Plastid

Q.89 Mendel obtained wrinkled seeds in pea due to deposition of sugars instead of starch. It was due to which enzyme -

(1) Amylase (2) Invertase

(3) Diastase (4) Absence of starch branching enzyme

Q.90 A gene said to be dominant if –

(1) It express its effect only in homozygous stage

(2) It expressed only in heterozygous condition

(3) It expressed both in homozygous and heterozygous condition

(4) It never expressed in any condition

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