CBSE MOCK QUESTION PAPER
CLASS : XII
(FOR SESSION 2023-24)

HINTS & SOLUTIONS

PHYSICS

SECTION-A

1. (D)
2. (B)
3. (B)
4. (B)
5. (A)
6. (A)
7. (A)
8. (A)
9. (B)
10. (C)
11. (B)

$Q = 2\,(BE_{He}) - (BE_{Li} + BE_D)$

$= [2(4 \times 7) - (5.5 \times 7 + 2 \times 1)]$ MeV

$= (56 - 38.5 - 2)$ MeV $= 16$ MeV

12. **(B)**

Velocity at highest point = u sinθ

$\therefore\ \lambda_D = \dfrac{h}{mu\sin\theta}$ (Since θ is velocity w.r.t. vertical)

13. **(A)**
14. **(C)**
15. **(B)**

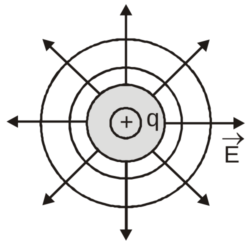
Heating of core happened due to hysterisis loss, not just because core is made of iron.

16. **(A)**

Both (A) & (R) are true and (R) is correct explanation of (A).

SECTION-B

17. For an isolated charge the equipotential surfaces are concentric spherical shells and the separation between consecutive equipotential surfaces increases in the weaker electric field.



18. Electric flux through plates of capacitor,

$\phi_E = \dfrac{q}{\varepsilon_0}$

Displacement current, I_D

$= \varepsilon_0 \dfrac{d\phi_E}{dt} = \varepsilon_0 \dfrac{\left(\dfrac{q}{\varepsilon_0}\right)}{dt} = 0$

Conduction current, $I = C\dfrac{dV}{dt} = 0$ as voltage becomes constant

So, $I = I_D = 0$ for a charged capacitor.

19. The relation between the angle of incidence i, angle of prism, A and the angle of minimum deviation, δ_m for a triangular prism is given by, $i = \dfrac{A + \delta_m}{2}$

20. Permanent magnets are those magnets made of ferromagnetic material with high retentivity and coercivity. For example steel.

21. Since the value of stopping potential for the pair of curves (1 and 2) and (3 and 4) are the same hence curves 1 and 2 correspond to similar materials while curves 3 and 4 represent different materials.
The pairs of curves (1 and 3) and (2 and 4) correspond to different materials but same intensity of incident radiation as the saturation current depend upon intensity and not on material.

OR

Since, the positive terminal of the batteries are connected together, so the equivalent emf of the batteries is given by $\varepsilon = 200V - 10V = 190V$.
Hence, the current in the circuit is given by

$I = \frac{\varepsilon}{R} = \frac{190}{38\Omega} = 5A \qquad I = 5A$

SECTION-C

22. (i) To measure current upto 5 A the shunt S should have a value, such that for 5 A input current through system , 4 A should pass through shunt S and 1 A should pass through given ammeter.
$1 \times R_A = 4S$
$1 \times 0.8 = 4S$
$S = 0.2\ \Omega$
Thus, the shunt resistance is $0.2\ \Omega$.
(ii) Combined resistance of the ammeter and the shunt,

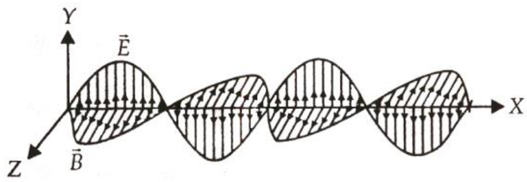
$$R = \frac{0.8S}{0.8+S} = \frac{0.8\times 0.2}{0.8+0.2} = \frac{0.16}{1} = 0.16\Omega$$

23. The given circuit is a common emitter (CE) configuration of an npn transistor. The input circuit is forward biased and collector circuit is reverse biased.
On decreasing the resistance R in emitter base circuit i.e. input circuit the forward biasing increases , which in turn increases the emitter current, base current and collector currents.

$$I_e = I_b + I_c$$

Now due to extra collector current through lamp, the lamp will glow brighter and potential drop across it i.e. V also increases.

24. (a) In figure the velocity of propagation of em wave is along X axis $\vec{\upsilon} = \upsilon\hat{i}$ and electric field $\vec{E}$ along Y-axis and magnetic field $\vec{B}$ along Z-axis. Y



(b) Speed of em wave can be given as the ratio of magnitude of electric field (E_0) to the magnitude of magnetic field (B_o), i.e.,

$c = \frac{E_0}{B_0}$

25. (a) In a nuclear reaction, the sum of the masses of the target nucleus (^2_1H) and the bombarding particle (^2_1H) may be greater than the product (^3_2He) nucleus and the outgoing neutron ^1_0n. So from the law of conservation of mass-energy some energy (3.27 MeV) is evolved due to mass defect in the nuclear reaction. This energy is called Q-value of the nuclear reaction.
(b) Density of the nucleus

$$= \frac{\text{mass of nucleus}}{\text{Volume of nucleus}}$$

Mass of the nucleus
$= A$ amu
$= A \times 1.66 \times 10^{-27}$ kg
Volume of the nucleus

$$= \frac{4}{3}\pi R^3 = \frac{4}{3}\pi(R_0 A^{1/3})^3 = \frac{4}{3}\pi R_0^3 A$$

Thus, density

$$= \frac{A\times 1.66\times 10^{-27}}{\left(\frac{4}{3}\pi R_0^3\right)A} = \frac{1.66\times 10^{-27}}{\left(\frac{4}{3}\pi R_0^3\right)}$$

Which shows that the density is independent of mass number A.

Using, $R_0 = 1.1 \times 10^{-15}$m, we get

density = 2.97×10^{17} kg m^{-3}

26. **Working of photodiode :**

A junction diode made from light sensitive semiconductor is called a photodiode. A photodiode is a

pn junction diode arranged in reverse biasing. The number of charge carriers increases when light of suitable frequency is made to fall on the pn junction, because new electron holes pairs are created by absorbing the photons of suitable frequency. Intensity of light controls the number of charge carriers. Due to this property photodiodes are used to detect optical signals.

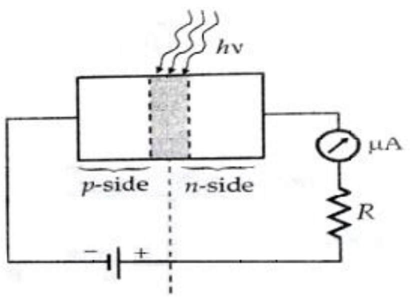


Fig. A reverse biased photodiode illuminated with light

OR

1. There is very little resistance to limit the current in LED. Therefore, a resistor must be used in series with the LED to avoid any damage to it.

2. The reverse breakdown voltages of LEDs are very low, typically around 5 V. So care should be taken while fabricating a pn-junction diode so that the p side should only attached to the positive of battery and vice versa as LED easily get damaged by a small reverse voltages.

The semiconductor used for fabrication of visible LEDs must at least have a band gap of 1.8 eV (spectral range of visible light is from about 0.4 μm to 0.7 μm , i.e., from about 3 eV to 1.8 eV).

27. Given that focal length of convex lens, $f_1 = +25$ cm

and focal length of concave lens, $f_2 = -20$ cm

Equivalent focal length,

$$F = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{25} + \frac{1}{-20} = -\frac{1}{100}$$

$F = -100$ cm

Power of the combination,

$$P = \frac{1}{F(m)} = \frac{1}{-1m} = -1D$$

The focal length of the combination

=1 m =100 cm.

The system will be diverging in nature as the focal length is in negative.

28. **(i)** Let the capacity of given capacitor is C and a voltage V_1

$Q_1 = CV_1$ -----(i)

changed potential, $V_2 = V - 120$

$Q_1 = 120\mu C$

$Q_2 = CV_2$ ------(ii)

Dividing equation (i) by (ii),

we get $\frac{Q_1}{Q_2} = \frac{CV_1}{CV_2}$

$$\Rightarrow \quad \frac{360}{120} = \frac{V}{V-120}$$

$V = 180$

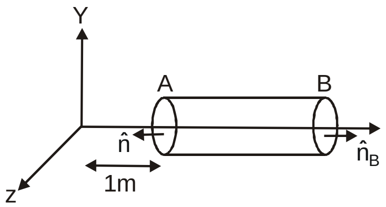
$$C = \Rightarrow \frac{Q_1}{V_1} = \frac{360 \times 10^{-6}}{180} = 2 \;\; 10^{-6} F = 2\mu F$$

(ii) If the Voltage applied had increased by 120V, then $V_3 =$ 180 + 120 = 300 V Hence, Charge stored in the capacitor,

$Q_3 = CV_3 = 2 \times 10^{-6} \times 300 = 600\mu C$

OR

(i)



Given, $\vec{E} = 50x\ \hat{i}$ and A= 25 cm^2 = = 25 x 10^{-4}m^2

As the electric field is only along the x-axis, so, flux will pass only through the cross-section of cylinder.

Magnitude of electric field at cross-section A ,

E_A = 50 x 1 = 50 NC^1

Magnitude of electric field at cross-section B,

E_B = 50 x 2 =100 N C^{-1}

The corresponding electric fluxes are

$$\phi_A = \vec{E}_A.\vec{A} = 50 \text{ x } 25 \text{ x } 10^{-4} \cos 180°$$

$$= -0.125 N\,C^{-1}\,M^2$$

$$\phi_B = \vec{E}_B.\vec{A} = 100 \text{ x } 25 \text{ x } 10^{-4} \cos 0°$$

So the net flux through the cylinder, ϕ

$\phi = \phi_A + \phi_B$

$= -0.125 + 0.25 = 0.125\ NC^{-1}M^2$

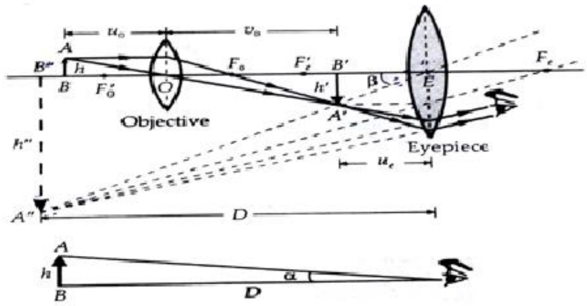
(ii) Using Gauss's Law

$$\oint \vec{E}.d\vec{A} = \frac{q}{\varepsilon_0} \Rightarrow \quad 0.125 = \frac{q}{8.85 \times 10^{-12}}$$

q = 8.85 x 0.125 x 10^{-12}= 1.1 x 10^{-12} C

SECTION-E

31.



Magnifying power.

$$m = \frac{\beta}{\alpha} = \frac{\tan\beta}{\tan\alpha} = \frac{h'}{h}.\frac{D}{u_e} = m_0 m_e$$

Here $m_0 = \dfrac{h'}{h} = \dfrac{v_0}{u_0}$

As the eyepice acts as a simple microscope, so

$$m_e = \frac{D}{u_e} = 1 + \frac{D}{f_e} = \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$$

As the object AB is placed close to the focus F_0 of the objective, therefore,

$u_0 = f_0$

Also the object is formed close to the eyelens whose focal length is short, therefor $v_0 = L$ The length of the microscope tube or the distance between the two lenses

$$\therefore \quad m_0 = \frac{v_0}{u_0} = \frac{L}{-f_0}$$

$$\therefore \quad m = -\frac{L}{f_0}\left(1 + \frac{D}{f_e}\right)$$

[for final image at D]

When the final image is formed at infinity.

When the imge lies at the focus of the eyepiece i.e., = the image is formed at infinity, Magnification due to objective $m_0 = \frac{h'}{h} = \frac{L}{-f_0}$

Angular magnification due to eyepiece, $m_e = \frac{D}{f_e}$

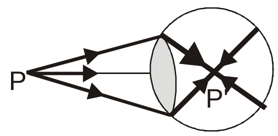
Total magnification when the final imge is formed at infinity,

$$m = m_0 \times m_e = \frac{L}{f_0} \times \frac{D}{f_e}.$$

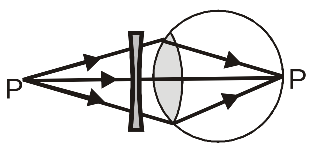
Obviously, magnifying power of the compound microscope is large when both f_0 and f_e are small.

(b) Nearsightedness or Myopia: A person suffering from myopia can see only nearby objects clearly, but cannot see the objects beyond a certain distance clearly.

Myopic eye:

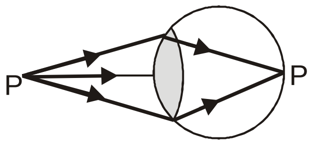


Correction: In order to correct the eye for this defect, a concave lens of suitable focal length is placed close to the eye so that the parallel ray of light from an object at infinity after refraction through the lens appears to come from the far point of the myopic eye.



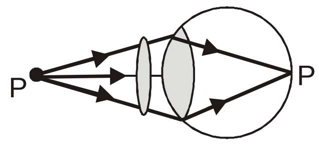
Farsightedness or Hypermetropia : A Person suffering from hypermetropia can see distant objects clearly, but cannot see nearby objects.

Hypermetropic eye:



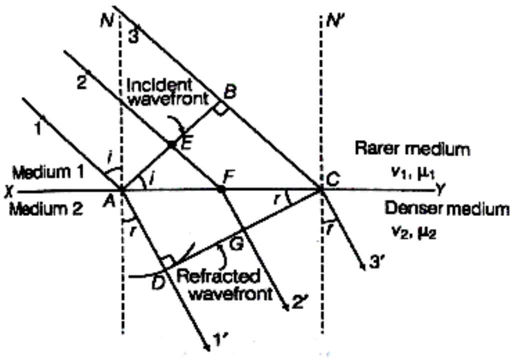
Correction: To correct this defect, a convex lens of suitable focal length is placed close to the eye so

That the rays of light from an object placed at the point p after refraction through the lens appear to come from the near point P of the hypermetropic eye.



OR

Sol. (a) Let 1, 2, 3 be the incident rays and 1', 2',3' be the corresponding refracted rays.



Laws of refraction by Huygens' principle

If v_1,v_2 are the speeds of light in the two media and t is the time taken by light to go from B to C or A to D or E to G

through F, then $t = \frac{EF}{v_1} + \frac{FG}{v_2}$

In ΔAFE, $\sin i = \frac{EF}{AF}$

In ΔFGC, $\sin r = \frac{FG}{FC}$

$$\Rightarrow \quad T = \frac{AF \sin i}{v_1} + \frac{FC \sin r}{v_2} \quad ....(iii)$$

$$\Rightarrow \quad t = \frac{AC \sin r}{v_2} + AF\left(\frac{\sin i}{v_1} - \frac{\sin r}{v_2}\right)$$

For rays of light from different parts on the incident wavefront, the values of AF are different. But light from different points of the incident wavefront should take the same time to reach the corresponding points on the refracted wavefront. So, t should not depend upon AF. This is possible only, if

$$\frac{\sin i}{v_1} - \frac{\sin r}{v_2} = 0$$

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} \qquad \text{.... (iv)}$$

Now, if c represents the speed of light in vacuum, then $\mu_1 = \frac{c}{v_1}$ and $\mu_2 = \frac{c}{v_2}$ are known as the refractive indices of medium 1 and medium 2, repectively.

In terms of refractive indices, Eq. (iv) can be written as

$$\Rightarrow \quad \mu = \frac{\sin i}{\sin r}$$

This is known as Snell's law of refraction.

(b)

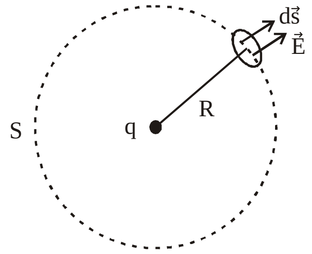
(i) The frequency of reflected and refracted light remains same as the frequency of incident light because frequency only depends on the source of light.

(ii) Since the frequency remains same, hence there is no reduction in energy.

32. Gauss theorem :-

it states that total flux through closed surface is $\frac{1}{\varepsilon_0}$ times the net charge enclosed by the closed surface.

$$\phi = \oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$$



Suppose the surface
s is a sphere of radius R centred on q.
Then surface s is a Gaussian surface.
Electric field at any point on s is

$$E = \frac{1}{4\pi\varepsilon_0}.\frac{q}{R^2}$$

flux through is $d\phi_E = \vec{E}.d\vec{s}$

$= Eds \cos 0°$

$= Eds$

Total flux through surface s is $\phi_E = E \int ds$

$= E \times 4\pi R^2$

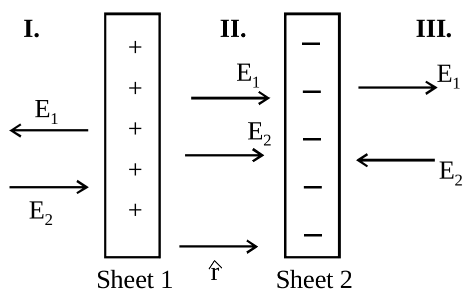
$= \frac{1}{4\pi\varepsilon_0}.\frac{q}{R^2} \times 4\pi R^2$

$= \frac{q}{\varepsilon_0}$

$\phi = \frac{q}{\varepsilon_0}$

so flux does not depends on the size and shape.

(b) $+\sigma$ $\qquad$ -2σ



(i) In between two sheets :- fields due to two sheets are

$E_1 = \frac{\hat{r}}{2\varepsilon_0}\sigma$, $E_2 = \frac{\hat{r}}{\varepsilon_0}\sigma$

$E = \vec{E}_1 + \vec{E}_2$

$= \frac{\hat{r}}{2\varepsilon_0}\sigma + \frac{\hat{r}}{\varepsilon_0}\sigma = \left(\frac{\sigma + 2\sigma}{2\varepsilon}\right)\hat{r} = \frac{3\sigma}{2\varepsilon_0}\hat{r}$

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(ii) Out side near the sheet 1 : fields due to the two sheets are

$$\vec{E}_1 = \frac{\sigma}{2\varepsilon_0}(-\hat{r}),\ \vec{E}_2 = \frac{\sigma}{\varepsilon_0}\hat{r}$$

Total field $\vec{E} = \vec{E}_1 + \vec{E}_2$

$$= \frac{-\hat{r}}{2\varepsilon_0}\sigma + \frac{\hat{r}}{\varepsilon_0}\sigma$$

$$= \frac{(-\sigma + 2\sigma)}{2\varepsilon_0}\hat{r}$$

$$= \frac{\sigma}{2\varepsilon_0}\hat{r}$$

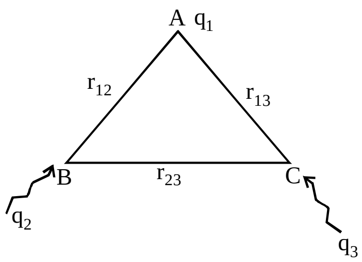
OR

Sol. (a) Electric potential at a point in an electric field is the amount of work done to moving unit positive charge from infinity to that point against the electrostatic forces. Without changing its kinetic energy.

$$\text{Electric potential} = \frac{\text{Work done}}{\text{Charge}}$$

$$\text{Unit} = \frac{\text{Joule}}{\text{coulomb}} = \text{Volt}$$

(b)



work done to bring charge q_1 from infinity to A

$w_1 = 0$

Now work done to bring q_2 charge from infinity to B

$$w_2 = \frac{Kq_1q_2}{r_{12}}$$

Similarly work done to bring q_3 charge from infinity to point C

$$w_3 = \left[\frac{Kq_1}{r_{13}} + \frac{Kq_2}{r_{23}}\right]q_3$$

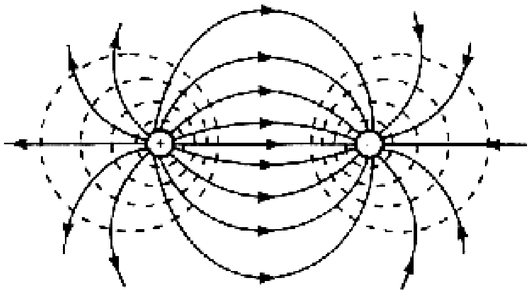
$$= \frac{Kq_1q_3}{r_{13}} + \frac{Kq_2q_3}{r_{23}}$$

So net potential energy of the system

$= w_1 + w_2 + w_3$

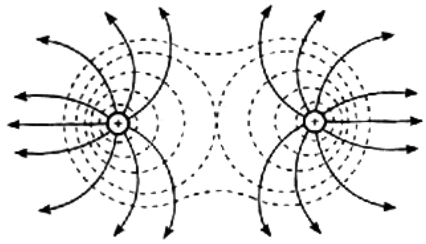
$$= \frac{Kq_1q_2}{r_{12}} + \frac{Kq_1q_3}{r_{13}} + \frac{Kq_2q_3}{r_{23}}$$

(i) **Equipotential surfaces of two equal and opposite point-charges (Electric dipole) :** Fig. shows the equipotential surfaces of two equal and opposite charges, + q and – q, separated by a small distance. They are close together in the region in between the charges.



Equipotential surfaces for two equal and opposite charges.

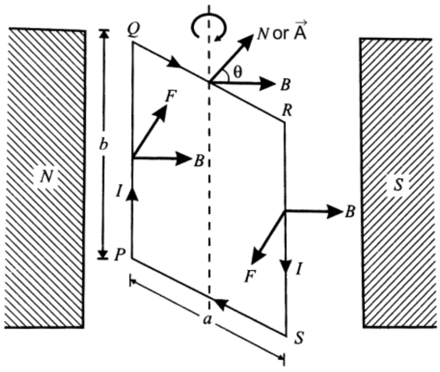
(ii) **Equipotential surfaces of two equal positive charge Fig.** shows the equipotential surfaces of two equal and positive charges, each equal to + q, separated by a small distance. The equipotential surfaces are far apart in the regions in between the two charges, indicating a weak field in such regions.



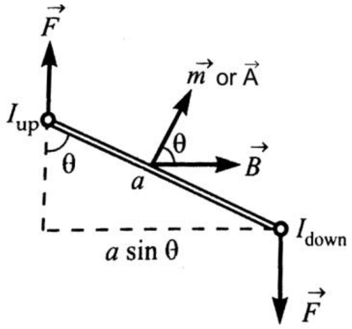
33. (a)

Torque on a current loop in a uniform magnetic field :

Consider a rectangular coil PQRS suspended in a uniform magnetic field , with its axis perpendicular to the field.



(a)



(b)

(a) A rectangular loop PQRS in a uniform magnetic field .

(b) Top view of the loop, magnetic dipole moment is shown.

Let I = current flowing through the coil PQRS

a, b = sides of the coil PQRS

A = ab = area of the coil

θ = angle between the direction of and normal to the plane of the coil.

According to Fleming's left hand rule, the magnetic forces on sides PQ and QR are equal, opposite and collinear (along the axis of the loop), so their resultant is zero.

The side PQ experiences a normal inward force equal to IbB while the side RS experiences an equal normal outward force. These two forces form a couple which exerts a torque given by

τ = Force × perpendicular distance

= IbB × a sinθ = IBA sinθ

If the rectangular loop has N turns, the torque increases N times i.e.,

$\boxed{\tau = NIBA\sin\theta}$

But NIA = m, the magnetic moment of the loop, so

$\boxed{\tau = mB\sin\theta}$

In vector notation, the torque is given by

$\boxed{\vec{\tau} = NI\vec{A}\times\vec{B}}$ or $\boxed{\vec{\tau} = \vec{m}\times\vec{B}}$

The direction of the torque is such that it rotates the loop clockwise about the axis of suspension.

Special Cases

(i) When θ = 0°, τ = 0, i.e., the torque is minimum when the plane of the loop is perpendicular to the magnetic field.

(ii) When θ = 90°, τ = NIBA, i.e., the torque is maximum when the plane of the loop is parallel to the magnetic field. Thus

τ_{max} = NIBA

(b)

Where θ = angle between velocity of particle and magnetic field = 90^0

So, Lorentz force, F = BqV

Thus the particles will move in circular path.

$Bq\upsilon = \frac{mV^2}{r}$ $r = \frac{mV}{Bq}$

Let m_p = mass of proton m_d = mass of deuteron,

V_p = velocity of proton and V_d = velocity of deuteron

The charge of proton and deuteron are equal.

Given that $m_pV_p = m_dV_d$

$r_p = \frac{m_p\upsilon_p}{Bq}$ -----(i)

$r_d = \frac{m_d\upsilon_d}{Bq}$ -----(ii)

As (i) and (ii) are equal so $r_p = r_d = r$

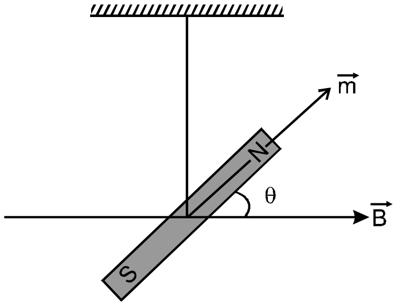
Thus, the trajectory of both the particles will be same.

OR

(a) In the position of equilibrium, the magnetic dipole lies along . When it is slightly rotated from his position and released, it begins to vibrate about the field direction under the restoring torque,

$\tau = -mB \sin \theta$

The negative sign indicates that the direction of torque τ is such so as to decrease θ.



For small angular displacement θ, $\sin \theta \approx \theta$

$\therefore \quad \tau = -mB\theta$

If I is the moment of inertia of the magnet, then the deflecting torque on the magnet is

$$\tau = I\alpha = I\frac{d^2\theta}{dt^2}$$

In the equilbrium condition,

Deflecting torque = Restoring torque

$$\therefore \quad I\frac{d^2\theta}{dt^2} = -mB\theta$$

or $$\frac{d^2\theta}{dt^2} = \frac{mB}{I}\theta = -\omega^2\theta$$

i.e., angular acceleration $\frac{d^2\theta}{dt^2} \propto$ angular displacement θ.

Hence the oscillation of a freely suspended magnetic dipole in a uniform magnetic field are simple harmonic. The time period of oscillation is given by

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{I}{mB}}$$

(b) (i) As, Horizontal component of earth's magnetic field, $B_H = B\cos \delta$

Putting $\delta = 90^0$ $B_H = 0$

(ii) For a compass needle align vertical at a certain

place, angle of dip, $\delta = 90^0$

CHEMISTRY

SECTION A

1.	**(B)**	**2.**	**(C)**	**3.**	**(D)**
4.	**(B)**	**5.**	**(A)**	**6.**	**(A)**
7.	**(C)**	**8.**	**(C)**	**9.**	**(C)**
10.	**(D)**	**11.**	**(A)**	**12.**	**(A)**
13.	**(A)**	**14.**	**(D)**	**15.**	**(A)**
16.	**(D)**				

SECTION B

17. (a) Zero

(b) mol L^{-1} s^{-1}

18. (60)

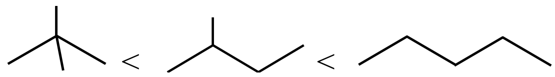
1.2% solution (wt./vol) of glucose is isotonic with 4 g/litre of solution of X at 27ºC, so

$C_1 = C_2$

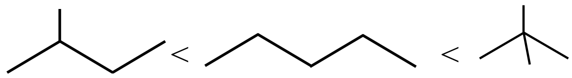
$$\frac{1.2 \times 1000}{180 \times 100} = \frac{4}{M_X}$$

so M_X = 60 g/mole.

19. (a) Boiling point order:



Melting point order:



(b) Aryl halides are extremely less reactive towards nucleophilic substitution reactions due to the following reasons :

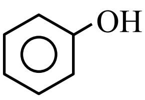
(i) **Resonance effect :** C–Cl bond acquires a partial double bond character.

(ii) **Difference in the hybridisation of carbon atom in C–X bond :** In aryl halides the carbon atom attached to the halogen is sp^2 hybridised & in haloalkanes carbon atom attached to halogen is sp^3 hybridised. The sp^2 hybridised carbon with greater s-character is more electronegative and can hold the electron pair of C–X bond more tightly than sp^3 hybridised carbon in haloalkane.

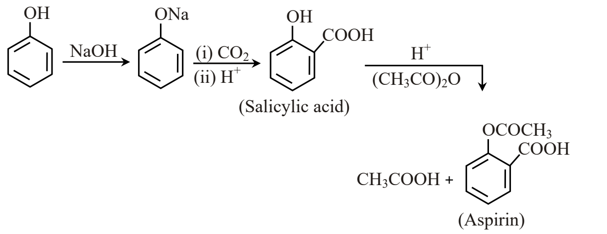
(iii) **Instability of phenyl cation :** In case of haloarenes, the phenyl cation formed as a result of self ionisation will not be stabilised by resonance and therefore S_N1 mechanism is ruled out.

(iv) Because of the possible repulsion it is less likely for the electron rich nucleophile to approach electron rich arenes.

20. (a) The $-NH_2$ group of aniline is acetylated before nitration to control nitration reaction and formation of oxidation product.

(b) Phenol is formed. 

OR

(a) 

(b) $Ph–Br \xrightarrow[\text{ether}]{\text{Mg}} Ph–MgBr \xrightarrow[\text{(2) } NH_4Cl]{\text{(1) HCHO}}$

$Ph–CH_2–OH \xrightarrow{Cu/\Delta} Ph–CHO$

21. (a) In α-helix, a polypeptide chain is stabilised by the formation of hydrogen bonds between

—NH— group of amino acids in one turn with the >C=O group of amino acids belonging to adjacent turn.

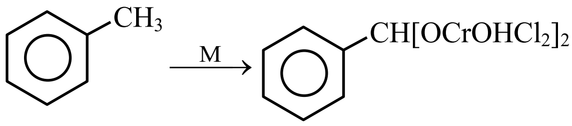
(b) Glucose gives pentaacetate derivative on acetylation with acetic anhydride. This confirms the presence of five —OH groups.

SECTION C

22. (a) $[Co(H_2O)_4Cl_2]Cl$
(tetraaquadichloridocobalt(III) chloride)
(b) Crystal field splitting energy increases in the order $[Cr(Cl)_6]^{3-} < [Cr(NH_3)_6]^{3+} < [Cr(CN)_6]^{3-}$
(c) An optically active complex of the type $[M(AA)_2X_2]^{n+}$ indicates cis-octahedral structure, e.g. cis-$[Pt(en)_2Cl_2]^{2+}$ or cis-$[Cr(en)_2Cl_2]^{+}$

23. (a) Electrolyte 'B' is strong as on dilution the number of ions remains the same, only interionic attraction decreases therefore increase in Λ_m is small.
(b) (105)
(c) 442 Scm^2 $equivalent^{-1}$.

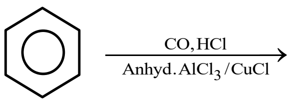
24. (a) Etard reaction



Toluene

$\xrightarrow{H_3O^{\oplus}}$ Ph–CH=O (Benzaldehyde)

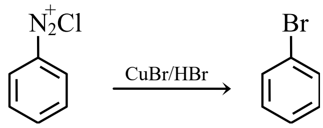
(b) Gattermann Koch reaction



PhCHO

(Benzaldehyde)

(c) Sandmayer's reaction



25. $\underset{(A)}{C_5H_{11}Br} \xrightarrow{\text{alc. KOH}} \underset{(B)}{\text{Alkene } (C_5H_{10})} \xrightarrow{Br_2 \text{ in } CS_2} \underset{(C)}{C_5H_{10}Br_2}$

$\xrightarrow[-2HBr]{\text{Alc. KOH}} \underset{\text{D(Alkyne)}}{C_5H_8} \xrightarrow{\text{Na–liq. } NH_3} \underset{\text{Sodium alkylide}}{C_5H_7–Na} + \frac{1}{2} H_2$

The reactions suggest that (D) is a terminal alkyne. This means triple bond is at the end of the chain. It could be either (I) or (II).

$CH_3–CH_2–CH_2–C\equiv CH$ (I)

$CH_3–\underset{\displaystyle CH_3}{\underset{|}{CH}}–C\equiv CH$ (II)

Since alkyne 'D' on hydrogenation yields straight chain alkane, therefore structure I is the structure of alkyne (D).
Hence, the structures of A, B and C are as follows :
(A) $CH_3—CH_2—CH_2—CH_2—CH_2Br$
(B) $CH_3—CH_2—CH_2—CH=CH_2$
(C) $CH_3—CH_2—CH_2—CH (Br)—CH_2Br$

26. (a) In starch and glycogen, glycosidic α-linkage is present and in cellulose, glycosidic β-linkage is present between glucose units.

(b) On hydrolysis sucrose (dextrorotatory), gives glucose (dextrorotatory, + 52.5°) and fructose (laevorotatory, – 92.4°). Since laevorotation of fructose is more than the dextrorotation of glucose, the mixture becomes laevorotatory.

(c) On prolonged heating with HI, glucose gives *n*-hexane.

$$\text{Glucose} \xrightarrow[\Delta]{HI} \underset{\text{(n–Hexane)}}{CH_3–CH_2–CH_2–CH_2–CH_2–CH_3}$$

27. (i) Compound A : $CH_3–\overset{\displaystyle CH_3}{\overset{|}{\underset{\underset{\displaystyle Br}{|}}{C}}}–CH_3$ Compound B : $CH_3–CH_2–\underset{\underset{\displaystyle Br}{|}}{CH}–CH_3$

(ii) Compound 'B' is chiral and gives S_N2 reaction with aq. KOH.

28. **(13.02)**

$$\ln \frac{K_2}{K_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln 2 = \frac{E_a}{2}\left(\frac{1}{300} - \frac{1}{310}\right)$$

$E_a = 13020$ cal

SECTION D

29. (a) A = $[Co(NH_3)_5SO_4]Cl$ or
B = $[Co(NH_3)_5Cl]SO_4$

(b) Ionisation isomerism

(c) A = Pentaammine sulphato cobalt(III) chloride

B = Pentaamine chloro cobalt(III) sulphate

30. (a) Threshold energy for the reaction
= 300 kJ mol^{-1}

(b) Enthalpy change for the forward reaction
$\Delta rH = 100 – 150 = –50$ kJ mol^{-1}

(c) Activation energy for forward reaction
= 300 – 150 = 150 kJ mol^{-1}

OR

Activation energy for backward reaction
= 300 – 100 = 200 kJ mol^{-1}

SECTION E

31. (a) (i) Vanadium (V) oxide in contact process for oxidation of SO_2 to SO_3.

(ii) Finely divided iron in Haber's process in conversion of N_2 and H_2 to NH_3.

(b) This is due to lanthanoid contraction.

(c) For 4.90 BM magnetic moments total number of unpaired electron in it is 4

$\therefore$ total spin $= \frac{4}{2} = 2$

(d) The 5f electrons are more effectively shielded from nuclear charge. In other words the 5f electrons themselves provide poor shielding from element to element in the series.

(e) The most stable oxidation state of lanthanides is +3. Hence, ions in +2 state tend to change to +3 state by loss of electron and those in +4 state tend to change to +3 state by gain of electron.

(f) It involves two steps : step-1 : Fusion, step-2 : Oxidation

MnO_2 (fused) + KOH(s) + O_2 (excess)

$$\xrightarrow[\text{(1)}]{\text{Strong heating}} \underset{\text{Dark green}}{K_2MnO_4}$$

$$\xrightarrow[\substack{\text{oxidising agent}\\ (2)}]{Cl_2/O_3+H_2O/CO_2} \underset{\text{Purple}}{KMnO_4}$$

(g) Reaction between iodide and persulphate ions is :

$$2I^- + S_2O_8^{2-} \xrightarrow{Fe(III)} I_2 + 2SO_4^{2-}$$

Role of Fe (III) ions :

$$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$$

$$2Fe^{2+} + S_2O_8^{2-} \longrightarrow 2Fe^{3+} + 2SO_4^{2-}$$

32. (a) At a given pressure the solubility of oxygen in water increases with decrease in temperature. Presence of more oxygen at lower temperature makes the aquatic species more comfortable in cold water.

(b) In pure liquid water the entire surface of liquid is occupied by the molecules of water. When a non volatile solute, for example glucose is dissolved in water, the fraction of surface covered by the solvent molecules gets reduced because some positions are occupied by glucose molecules. As a result number of solvent molecules escaping from the surface also gets reduced, consequently the vapour pressure of aqueous solution of glucose is reduced.

(c) $P_X^0 = 55$ cmHg, $P_Y^0 = 80$ cmHg

OR

(a) A substance (solute) dissolves in a solvent if intermolecular interactions are similar in both the components; for example, polar solutes dissolve in polar solvents and non polar solutes in non polar solvents thus we can say "like dissolves like".

(b) m = 135

$\Delta T_b = K_b$ molality

$$0.100 = 2.16 \times \frac{0.1/m}{16/1000}$$

so m = **135 Ans.**

33. $\underset{\substack{\text{2-Methylbut-2-ene} \\ \text{(A)}}}{CH_3{-}CH{=}\underset{\substack{|\\CH_3}}{C}{-}CH_3} \xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} \underset{\text{(B)}}{H_3C{-}CHO} + \underset{\text{(C)}}{O{=}\underset{\substack{|\\CH_3}}{C}{-}CH_3}$

Other isomers of 'A' will not give products corresponding to the given tests.

$\underset{\text{Acetone (C)}}{CH_3{-}\underset{\substack{|\\CH_3}}{C}{=}O} \xrightarrow{I_2 + NaOH} CH_3{-}COONa + CHI_3$

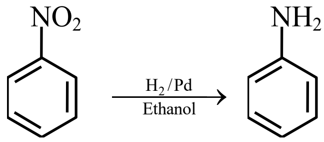
OR

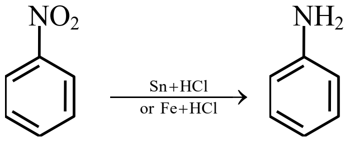
(a) (i) (I) > (II) > (III) > (IV)

General reactivity aldehyde > ketone

(ii) $FCH_2COOH > ClCH_2COOH > C_6H_5CH_2COOH > CH_3COOH > CH_3CH_2OH$

Reason $\Rightarrow$ stability of conjugate base increases by electron withdrawing effect.

(b) (a) 

(b) 

(c) $CH_3{-}\overset{\overset{O}{||}}{C}{-}NH_2 \xrightarrow[\text{(ii)}H_2O]{\text{(i)}LiAlH_4}$

$CH_3{-}CH_2{-}NH_2$

MATHEMATICS

SECTION-A

1. **(B)**

(f.g)(2) = f(2) × g(2) = 6 × 1 = 6

2. **(D)**

$$\left(\frac{d^2y}{dx^2}\right)^4 = y + \left(\frac{dy}{dx}\right)^6$$

$\therefore$ order = 2, degree = 4

3. **(B)**

$$\int e^x\left(\frac{x-2}{x^3}\right)dx = \int e^x\left(\frac{1}{x^2} - \frac{2}{x^3}\right)dx$$

$$\Rightarrow \frac{e^x}{x^2} + C$$

4. **(C)**

$$\lim_{x\to 0}\frac{1-\cos 7x}{1-\cos 3x} \quad \left(\frac{0}{0}\text{form}\right)\left(\frac{0}{0}\text{ रूप}\right)$$

$$= \lim_{x\to 0}\frac{2\sin^2\frac{7x}{2}}{2\sin^2\frac{3x}{2}} = \lim_{x\to 0}\frac{\left(\frac{7}{2}\right)^2\left(\frac{\sin\frac{7x}{2}}{\frac{7x}{2}}\right)^2}{\left(\frac{3}{2}\right)^2\left(\frac{\sin\frac{3x}{2}}{\frac{3x}{2}}\right)^2} = \frac{49}{9}$$

5. **(B)**

6. **(D)**

Total ways = 14 – 1! = 13!

favorable ways = 7! . 6!

7. **(A)**

$$I = \int \frac{x^4}{x^5(x^5+1)}\,dx$$

Let $x^5 = t \quad 5x^4\,dx = dt$

$$I = \frac{1}{5}\int \frac{dt}{t(t+1)} \quad = \frac{1}{5}\int \frac{dt}{t(t+1)}$$

$$= \frac{1}{5}\,[\ell n|t| - \ell n\,|(t+1)|] + C$$

$$= \frac{1}{5}\,\ln\left(\frac{x^5}{1+x^5}\right) + C = -\frac{1}{5}\,\ell n\left|1+\frac{1}{x^5}\right| + C$$

8. **(C)**

Trace of A = $a_{11} + a_{22} + a_{33}$

For skew symmetric matrix $a_{11} = a_{22} = a_{33} = 0$

Trace of A = 0

9. **(C)**

$a_{ij} = 2i + j$

$a_{11} = 2 + 1 = 1$, $a_{21} = 4 + 1 = 5$,

$a_{31} = 2 \times 3 + 1 = 7$

$a_{12} = 2 + 2 = 4$, $a_{22} = 2.2 + 2 = 6$,

$a_{32} = 2 \times 3 + 2 = 8$.

$$\therefore A = \begin{bmatrix} 3 & 4 \\ 5 & 6 \\ 7 & 8 \end{bmatrix}$$

10. **(D)**

$$\frac{dy}{y^2} = \frac{xdx}{\sqrt{1+4x^2}} \Rightarrow \frac{dy}{y^3} = \frac{1}{8}\frac{8xdx}{\sqrt{1+4x^2}}$$

$$\Rightarrow \frac{y^{-2}}{-2} = \frac{1}{8}\frac{\sqrt{1+4x^2}}{\frac{1}{2}} + k$$

11. **(A)**

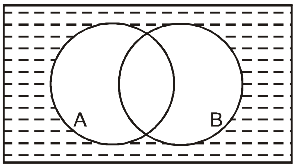
$$\lim_{x\to 5} \frac{x^2 - bx + 25}{(x-5)(x-2)} = f(5)$$

Now, $5^2 - b(5) + 25 = 0 \Rightarrow b = 10$

$\Rightarrow f(5)$

$$= \lim_{x\to 5} \frac{(x-5)^2}{(x-5)(x-2)} = \lim_{x\to 5} \frac{x-5}{x-2} = \frac{0}{3} = 0$$

12. **(C)**



$A^c - B$

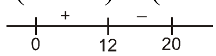
13. **(D)**

$x + y = 20$

$x^3 y^2 = x^3(20 - x)^2 = f(x)$

$f'(x) = 3x^2(20 - x)^2 - 2x^3(20 - x)$

$= (20 - x)x^2\,(60 - 5x)$



$\Rightarrow$ maximum at x = 12

14. **(B)**

$$I = \int_0^{\ell n 2} t\cdot e^{-t}dt \qquad \ell nx = t \Rightarrow x = e^t$$

$$= \left(t\left(-e^{-t}\right)\right)_0^{\ell n 2} - \int_0^{\ell n 2}\left(\left(-e^{-t}\right)dt\right)$$

$$= -2^{\ell n 2} + -e^{-\ell n 2} + e^{\circ}$$

$$= \frac{-1}{2}\ell n 2 - \frac{1}{2} + 1 = \frac{1-\ell n 2}{2}$$

15. **(B)**

$$\frac{dy}{dx} = 2x + 2$$

If x & y coordinates of the particle are changing at the same rate then

$$\frac{dy}{dx} = 1 \Rightarrow x = \frac{-1}{2}\;, y = \frac{-3}{4}$$

16. **(A)**

odd —— 1, 3, 5.

$$p\,(\text{prime/ odd}) = \frac{2}{3}$$

17. **(D)**

18. **(B)**

$$A = \begin{bmatrix} 2 & -1 \\ -7 & 4 \end{bmatrix},\; B = \begin{bmatrix} 4 & 1 \\ 7 & 2 \end{bmatrix}$$

$$A^T = \begin{bmatrix} 2 & -7 \\ -1 & 4 \end{bmatrix},\; B^T = \begin{bmatrix} 4 & 7 \\ 1 & 2 \end{bmatrix}$$

$B^TA^T =$ is an identity matrix.

19. **(A)**

20. **(B)**

SECTION-B

21. (1)

22. $\frac{2}{3}\left((x+3)^{3/2}+(x+2)^{3/2}\right)+C$

23. (14)

24. is equal to $\frac{1}{2}+\ell n\,3$

25. (7)

$s=\lambda,\ \mu=\sqrt{3} \Rightarrow \lambda^2+m^2=4+3=7$

SECTION-C

26. $2x+x=41 \Rightarrow x=\frac{41}{3}\notin N$

$\therefore$ R is not reflexive

$2x+y=41 \not\Rightarrow 2y+x=41$

$\therefore$ R is not symmetric

$2x+y=41$ and $2y+z=41 \Rightarrow 4x-z=41$

$\Rightarrow (x, z)\notin R$

$\therefore$ R is not transitive

27. $\ln x\,(1-y)^2 = c-\frac{1}{2}y^2-2y+\frac{1}{2}x^2$

Or

$-\frac{1}{2y^2}=\frac{1}{4}\sqrt{1+4x^2}+k$

28. $\frac{1}{\sqrt{6}}\tan^{-1}\left(\frac{\sqrt{2}\tan x}{\sqrt{3}}\right)+C$

29. $1\le x<4$

30. $\frac{11}{15}$

Let A = event that we get a white ball,

B = event that we get a black ball

So, the events are mutually exclusive

$P(A)=\frac{{}^{6}C_1}{{}^{15}C_1},\ P(B)=\frac{{}^{5}C_1}{{}^{15}C_1}$

So, $P(A+B)=P(A)+P(B)=\frac{6}{15}+\frac{5}{15}=\frac{11}{15}$

31. $\frac{1}{20}\ \ell n\,3$

Or

$\frac{\pi}{2}$

SECTION-D

32. $\pm\frac{1}{\sqrt{2}}$

$\tan^{-1}\left(\frac{x-1}{x-2}\right)+\tan^{-1}\left(\frac{x+1}{x+2}\right)$

$=\tan^{-1}\left[\frac{\frac{x-1}{x-2}+\frac{x+1}{x+2}}{1-\frac{x^2-1}{x^2-4}}\right]$

$=\tan^{-1}\left(\frac{4-2x^2}{3}\right)=\frac{\pi}{4}$

case- I : $\frac{4-2x^2}{3}=1 \Rightarrow x=\pm\frac{1}{\sqrt{2}}$ ... (1)

If $\frac{(x-1)(x+1)}{(x-2)(x+2)}<1 \Rightarrow x\in(-2, 2)$ ...(2)

from (1) & (2) $x=\pm\frac{1}{\sqrt{2}}$

case-II : If $\frac{(x-1)(x+1)}{(x-2)(x+2)}>1$

$\Rightarrow x\in(-\infty,-2)\cup(2,\infty)$ .....(3)

$\tan^{-1}\left(\frac{4-2x^2}{3}\right)+\pi=\frac{\pi}{4}$

$\frac{4-2x^2}{3}=1\ \ x=\pm\frac{1}{\sqrt{2}}$ .....(4)

from (3) & (4) $\Rightarrow x\in\phi$

case-III : $\therefore \frac{(x-1)(x+1)}{(x-2)(x+2)}=1$

no solution

$\Rightarrow x=\pm\frac{1}{\sqrt{2}}$ are the solutions

33. $\frac{1}{2}\tan^{-1}x - \frac{1}{\sqrt{2}}\tan^{-1}\frac{x}{\sqrt{2}} + \frac{1}{2\sqrt{3}}\tan^{-1}\frac{x}{\sqrt{3}} + C$

34. (i) P = 1000 + 1500e^{-kt} where $k = \frac{1}{10}\ln\left(\frac{5}{3}\right)$;

(ii) T = 10 $\log_{5/3}(3)$; (iii) P = 1000 as $t \to \infty$

$$\frac{dp}{dt} \propto -(p-1000)$$

$$\frac{dp}{dt} = -k(p-1000)$$

$$\Rightarrow \ell n(p-1000) = -kt + c$$

$$\Rightarrow p = 1000 + ae^{-kt}$$

$$p(0) = 2500 \Rightarrow 2500 = 1000 + ae^{0}$$

$$\Rightarrow a = 1500$$

$$\Rightarrow p = 1000 + 1500e^{-kt}$$

$$p(10) = 1900 \Rightarrow 1900 = 1000 + 1500\,e^{-k(10)}$$

$$\Rightarrow e^{-10k} = \frac{9}{15} \Rightarrow e^{-k} = \left(\frac{3}{5}\right)^{1/10}$$

$$\Rightarrow 1500\,e^{-kt} + 1000 = 1500 \text{ Þ } e^{-kt} = 1/3$$

$$\Rightarrow \left(\frac{3}{5}\right)^{t/10} = \frac{1}{3} \Rightarrow \frac{t}{10} = \log_{\frac{3}{5}}\left(\frac{1}{3}\right)$$

$$\Rightarrow t = 10\log_{\left(\frac{3}{5}\right)}\left(\frac{1}{3}\right)$$

35. $x = 0$ or $x = \pm\sqrt{\frac{3}{2}\left(a^2+b^2+c^2\right)}$

$$\begin{vmatrix} a-x & c & b \\ c & b-x & a \\ b & a & c-x \end{vmatrix} = 0.$$

Applying $C_1 = C_1 + C_2 + C_3$

$$\begin{vmatrix} a+b+c-x & c & b \\ c+b+a-x & b-x & a \\ b+a+c-x & a & c-x \end{vmatrix} = 0$$

$$\Rightarrow \begin{vmatrix} -x & c & b \\ -x & b-x & a \\ -x & a & c-x \end{vmatrix} = 0$$

$$\Rightarrow -x\begin{vmatrix} 1 & c & b \\ 1 & b-x & a \\ 1 & a & c-x \end{vmatrix} = 0$$

$$\Rightarrow -x\,[(x^2-(b+c)x+bc-a^2)-(c^2-cx-ab) + (ac-b^2+bx)] = 0$$

$$\Rightarrow -x[x^2-a^2-b^2-c^2+bc+ab+ac] = 0$$

$$\Rightarrow x = 0,\ x = \pm\sqrt{a^2+b^2+c^2-ab-bc-ca}$$

$$\because\ a+b+c = 0$$

$$\Rightarrow ab+bc+ca = -\frac{1}{2}(a^2+b^2+c^2)$$

$$\Rightarrow x = 0,\ x = \pm\sqrt{\frac{3}{2}(a^2+b^2+c^2)}$$

Or

Ans. (4)

$$\begin{vmatrix} 15-2x & 11 & 10 \\ 11-3x & 17 & 16 \\ 7-x & 14 & 13 \end{vmatrix}$$

Applying $C_2 \to C_2 - C_3$

$$\begin{vmatrix} 15-2x & 1 & 10 \\ 11-3x & 1 & 16 \\ 7-x & 1 & 13 \end{vmatrix} = 0$$

Applying $R_1 \to R_1 - R_3$ & $R_2 \to R_2 - R_3$

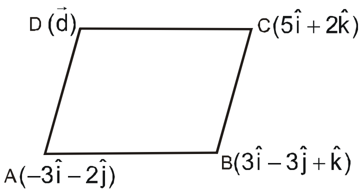
$$\begin{vmatrix} 8-x & 0 & -3 \\ 4-2x & 0 & 3 \\ 7-x & 1 & 13 \end{vmatrix} = 0$$

$$\Rightarrow -1[(8-x)3 + 3(4-2x)] = 0 \Rightarrow 9x = 36$$

$$\Rightarrow x = 4$$

SECTION-E

36. (i) $-\hat{i}+\hat{j}+\hat{k}$ (ii) $\dfrac{6}{\sqrt{19}}(6\hat{i}-\hat{j}+\hat{k})$ (iii) $\dfrac{2\pi}{3}$



(i) $(3\hat{i}-3\hat{j}+\hat{k}+\vec{d}) \equiv 2\hat{i}-2\hat{j}+2\hat{k}$

$\Rightarrow \vec{d}=-\hat{i}+\hat{j}+\hat{k}$

(ii) $\overrightarrow{AB}=6\hat{i}-\hat{j}+\hat{k}$

$\overrightarrow{AC}=8\hat{i}+2\hat{j}+2\hat{k}$

$\Rightarrow |\overrightarrow{AC}|=\sqrt{64+4+4} = \sqrt{72}$

Required vector is $\dfrac{\sqrt{72}}{\sqrt{38}}(6\hat{i}-\hat{j}+\hat{k})$

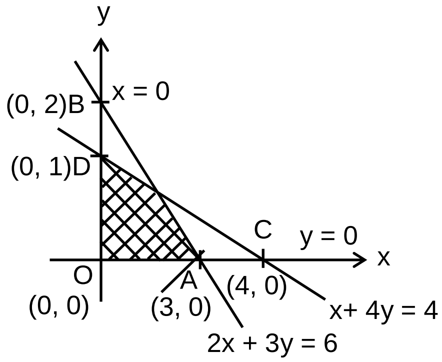
$= \dfrac{6}{\sqrt{19}}(6\hat{i}-\hat{j}+\hat{k})$

(iii) $\overrightarrow{BD}=-4\hat{i}+4\hat{j} \Rightarrow \cos\theta=\dfrac{\overrightarrow{AC}.\overrightarrow{BD}}{|\overrightarrow{AC}||\overrightarrow{BD}|}$

$= \dfrac{-32+8}{\sqrt{72}\sqrt{32}} = \dfrac{-24}{6\sqrt{2}\cdot 4\sqrt{2}} = -\dfrac{1}{2}$

$\Rightarrow \theta=\dfrac{2\pi}{3}$

37. (i)



(ii) (0, 0), (0, 1), (3, 0), $\left(\dfrac{12}{5},\dfrac{2}{5}\right)$

(iii) $\dfrac{16}{5}$

38. (i) (a) Reflexive and Transitive

(b) Symmetric and Transitive

(ii) (a) Symmetric

(b) Symmetric and Transitive