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CODE-A **SUBJECT : PHYSICS & CHEMISTRY**

WEST BENGAL JOINT ENTRANCE EXAMINATION (WBJEE) 2018

Date: 22 April, 2018 | Duration: 2 Hours | Max. Marks: 100

:: IMPORTANT INSTRUCTIONS ::

1. This question paper contains all objective questions divided into three categories. Each question has four answer options given.
2. **Category-I :** Carry 1 marks each and only one option is correct. In case of incorrect answer or any combination of more than one answer, ¼ marks will be deducted.
3. **Category-II :** Carry 2 marks each and only one option is correct. In case of incorrect answer or any combination of more than one answer, ½ marks will be deducted.
4. **Category-III :** Carry 2 marks each and one or more option(s) is/are correct. If all correct answers are not marked and also no incorrect answer is marked then score = 2 × number of correct answers marked ÷ actual number of correct answers. If any wrong option is marked or if any combination including a wrong option is marked, the answer will considered wrong but there is no negative marking for the same and zero marks will be awarded.
5. Questions must be answered on, OMR sheet by darkening the appropriate bubble marked (A), (B), (C) or (D).
6. Use only Black/Blue ball point pen to mark the answer by complete filing up of the respective bubbles.
7. Mark the answers only in the space provided. Do not make any stray mark on the OMR.
8. Write question booklet number and your roll number carefully in the specified locations of the OMR. Also fill appropriate bubbles.
9. Write your name (in block letter), name of the examination centre and put you full signature in appropriate boxes in the OMR.
10. The OMRs will be processed by electronic means. Hence it is liable to become invalid if there is any mistake in the question booklet number or roll number entered or if there is any mistake in filling corresponding bubbles. Also it may become invalid if there is any discrepancy in the name of the candidate, name of the examination center or signature of the candidate vis-à-vis what is given in the candidate's admit card. The OMR may also become invalid due to folding or putting stray marks on it or any damage to it. The consequence of such invalidation due to incorrect marking or careless handling by the candidate will be sole responsibility of candidate.
11. Candidates are not allowed to carry any written or printed material, calculator, pen, docu-pen, log table, wristwatch, any communication device like mobile phones etc. inside the examination hall. Any candidate found with such items will reported against & his/her candidature will be summarily cancelled.
12. Rough work must be done on the question paper itself. Additional blank pages are given in the question paper for rough work.
13. Hand over the OMR to the invigilator before leaving the Examination Hall.
14. This paper contains questions in both English and Bengali. Necessary care and precaution were taken while framing the Bengali version. However if any discrepancy(ies) is/are found between the two versions, the information provided in the English version will stand and will be treated as final.

PHYSICS

Category – I (Q.1 to Q.30)

Carry 1 mark each and only one option is correct. In case of incorrect answer or any combination of more than one answer ¼ marks will be deducted.

1. The velocity (v) of a particle (under a force F) depends on its distance (x) from the origin (with x > 0) $v \propto \frac{1}{\sqrt{x}}$. Find how the magnitude of the force (F) on the particle depends on x.

(A) $F \propto \frac{1}{x^{\frac{3}{2}}}$ (B) $F \propto \frac{1}{x}$ (C) $F \propto \frac{1}{x^2}$ (D) $F \propto x$

Ans. **(C)**

Sol. $V \propto \frac{1}{\sqrt{x}}$

$$\frac{dv}{dt} = \frac{1}{2x^{3/2}} \cdot \frac{dx}{dt} -$$

$$\frac{dv}{dt} \propto \frac{1}{x^{3/2}} \times \frac{1}{x^{1/2}}$$

$$\frac{dv}{dt} \propto \frac{1}{x^2} \Rightarrow F \propto \frac{1}{x^2}$$

2. The ratio of accelerations due to gravity $g_1 : g_2$ on the surfaces of two planets is 5 : 2 and the ratio of their respective average densities $\rho_1 : \rho_2$ is 2 : 1. What is the ratio of respective escape velocities $v_1 : v_2$ from the surface of the plants ?

(A) 5 : 2 (B) $\sqrt{5} : \sqrt{2}$ (C) $5 : 2\sqrt{2}$ (D) 25 : 4

Ans. **(C)**

Sol. $-\frac{Gmm}{R} + \frac{1}{2}mv^2 = 0$

$$V = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2GM}{R^2}R} = \sqrt{2gR}$$

$$\frac{\frac{G\rho_1 x \frac{4}{3}\pi R_1^3}{R_1^2}}{G.\frac{\rho_2 x \frac{4}{3}\pi R_2^3}{R_2^2}} = \frac{5}{2} \quad \Rightarrow \frac{R_1}{R_2} = \frac{5}{2} \times \frac{\rho_2}{\rho_1} = \frac{5}{2} \times \frac{1}{2} = \frac{5}{4}$$

$$\therefore \frac{V_1}{V_2} = \sqrt{\frac{g_1R_1}{g_2R_2}} = \sqrt{\frac{5}{2} X \frac{5}{4}} = \frac{5}{2\sqrt{2}}$$

3. A spherical liquid drop is placed on a horizontal plane. A small disturbance causes the volume of the drop to oscillate. The time period of oscillation (T) of the liquid drop depends on radius (r) of the drop, density (ρ) and surface tension (s) of the liquid. Which among the following will be a possible expression for T (where k is a dimensionless constant) ?

(A) $k\sqrt{\frac{\rho r}{s}}$ (B) $k\sqrt{\frac{\rho^2 r}{s}}$ (C) $k\sqrt{\frac{\rho r^3}{s}}$ (D) $k\sqrt{\frac{\rho r^3}{s^2}}$

Ans. **(C)**

Sol. $T = kr^x \rho^y s^z$

$T \rightarrow T, r \rightarrow L, \rho \rightarrow ML^{-3}, S \rightarrow MT^{-2}$

$S = \frac{F}{\ell} = \frac{ma}{\ell} = \frac{m}{s^2}$

$T^1 = KL^x (ML^{-3})^y (MT^{-2})^z \qquad \Rightarrow T^1 = KL^{x-3y} M^{y+z} T^{-2z}.$

$-2z = 1 \qquad \Rightarrow z = -\frac{1}{2}, \ y + z = 0 \qquad y = -z = +\frac{1}{2}$

$x - 3y = 0 \qquad \Rightarrow x = 3y = \frac{3}{2}$

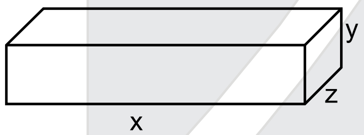
$T = Kr^{3/2} \rho^{1/2} s^{-1/2} = K\sqrt{\frac{\rho r^3}{s}}$

4. The stress along the length of a rod (with rectangular cross section) is 1% of the Young's modulus of its material. What is the approximate percentage of change of its volume ? (Poisson's ratio of the material of the rod is 0.3)

(A) 3% (B) 1% (C) 0.7% (D) 0.4%

Ans. **(D)**

Sol.



$\Rightarrow \qquad v = xyz$

$\frac{dv}{v} = \frac{dx}{x} + \frac{dy}{y} + \frac{dz}{z} = \frac{d\ell}{\ell} - \mu\frac{d\ell}{\ell} - \mu\frac{d\ell}{\ell} = (1-2\mu)\frac{d\ell}{\ell}$

Stress = Y × strain

$0.01\,Y = Y\frac{d\ell}{\ell} \Rightarrow \frac{d\ell}{\ell} = 0.01.$

$\frac{dv}{v} = 0.01 \times (1 - 0.6) = 0.01 \times 0.4.$

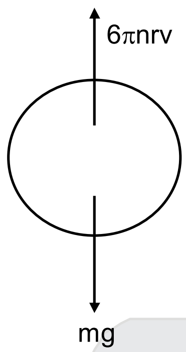
% Volume change = 0.4%

5. What will be the approximate terminal velocity of a rain drop of diameter 1.8×10^{-3} m, when density of rain water $\approx 10^3$ kgm^{-3} and the co-efficient of viscosity of air $\approx 1.8 \times 10^{-5}$ Nsm^{-2} ? (Neglect buoyancy of air).

(A) 49 ms^{-1} (B) 98 ms^{-1} (C) 392 ms^{-1} (D) 980 ms^{-1}

Ans. **(B)**

Sol.



$$6\pi\eta rv = \frac{4}{3}\pi r^3 pg$$

$$v = \frac{2}{9\eta} r^2 pg$$

$$v = \frac{2 \times 0.9 \times 0.9 \times 10^{-6} \times 10^3 \times 9.8}{9 \times 1.8 \times 10^{-5}}$$

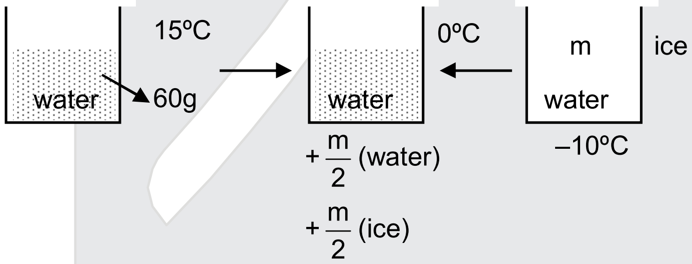
$$= 9.8 \times 10^{-6} \times 10^{7} = 98\ ms^{-1}$$

6. The water equivalent of a calorimeter is 10 g and it contains 50 g of water at 15°C. Some amount of ice, initially at –10°C is dropped in it and half of the ice melts till equilibrium is reached. What was the initial amount of ice that was dropped (when specific heat of ice = 0.5 cal $gm^{-1}°C^{-1}$, specific heat of water = 1.0 cal $gm^{-1}°C^{-1}$ and latent heat of melting of ice = 80 cal gm^{-1}) ?

(A) 10g (B) 18g (C) 20g (D) 30g

Ans. **(C)**

Sol.



$$\Rightarrow m \times \frac{1}{2} \times 10 + \frac{m}{2} \times 80 = 60 \times 1 \times 15$$

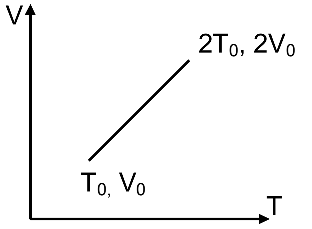
$$\Rightarrow m = \frac{60x15}{45} = 20\ gm$$

7. One mole of a mono-atomic ideal gas undergoes a quasi-static process, which is depicted by a straight line joining points (V_0, T_0) and $(2V_0, 3T_0)$ in a V-T diagram. What is the value of the heat capacity of the gas at the point (V_0, T_0) ?

(A) R (B) $\frac{3}{2}R$ (C) 2R (D) 0

Ans. **(C)**

Sol.



$pdv + nc_vdT = ncdT$

$\Rightarrow C = C_v + \frac{p}{n}\frac{dv}{dT}$

at V_0, T_0

$\frac{dv}{dT} = \frac{V_0}{2T_0}$, $P_0V_0 = nRT_0$

$C = C_v + \frac{p_0}{n}\frac{dv}{dT}$ $\qquad \frac{p_0}{n} = \frac{RT_0}{v_0}$

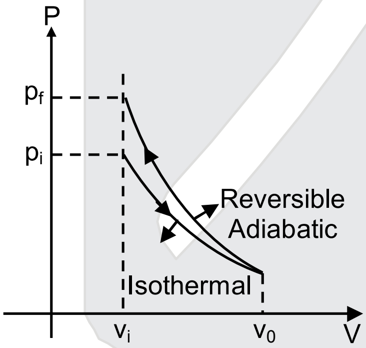
$C = \frac{3}{2}R + \frac{RT_0}{v_0} \times \frac{v_0}{2T_0} = \frac{3}{2}R + \frac{R}{2} = 2R$

8. For an ideal gas with initial pressure and volume P_i and V_i, respectively, a reversible isothermal expansion happens, when its volume becomes V_0. Then it is compressed to its original volume V_i by a reversible adiabatic process. If the final pressure is P_f then which of the following statements is true ?

(A) $P_f = P_i$ (B) $P_f > P_i$ (C) $P_f < P_i$ (D) $\frac{P_f}{V_0} = \frac{P_i}{V_i}$

Ans. **(B)**

Sol.



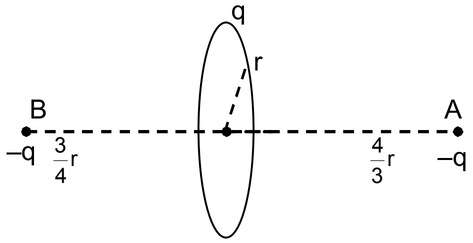
$p_f > p_i$

9. A point charge – q is carried from a point A to another point B on the axis of a charged ring of radius 'r' carrying a charge +q. If the point A is at a distance $\frac{4}{3}r$ from the centre of the ring and the point B is $\frac{3}{4}r$ from the centre but on the opposite side, what is the net work that need to be done for this ?

(A) $-\frac{7}{5}\frac{q^2}{4\pi\varepsilon_0 r}$ (B) $-\frac{1}{5}\frac{q^2}{4\pi\varepsilon_0 r}$ (C) $\frac{7}{5}\frac{q^2}{4\pi\varepsilon_0 r}$ (D) $\frac{1}{5}\frac{q^2}{4\pi\varepsilon_0 r}$

Ans. **(B)**

Sol.



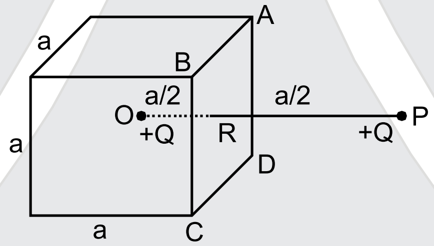
$W = U_B - V_A$

$$W = -\frac{Kqq}{\sqrt{r^2 + \frac{9}{16}r^2}} + \frac{Kq^2}{\sqrt{r^2 + \frac{16}{9}r^2}}$$

$$= -\frac{4kq^2}{5r} + \frac{3kq^2}{5r} = -\frac{kq^2}{5r}$$

$$= -\frac{1}{5}\frac{q^2}{4\pi\varepsilon_0 r}$$

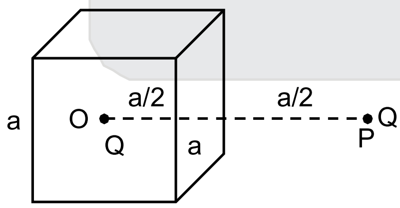
10. Consider a region in free space bounded by the surfaces of an imaginary cube having sides of length 'a' as shown in the diagram. A charge +Q is placed at the centre 'O' of the cube. P is such a point outside the cube that the line OP perpendicularly intersects the surface ABCD at R and also OR = RP = a/2. A charge +Q is placed at point P also. What is the total electric flux through the five faces of the cube other than ABCD ?



(A) $\frac{Q}{\varepsilon_0}$ (B) $\frac{5Q}{6\varepsilon_0}$ (C) $\frac{10Q}{6\varepsilon_0}$ (D) Zero

Ans. **(A)**

Sol.



Flux due to charge at O

$\Rightarrow \phi_1 = 5 \times \frac{Q}{6 \in_0}$

Flux due to charge at P

$\phi_2 = \frac{Q}{6 \in_0}$

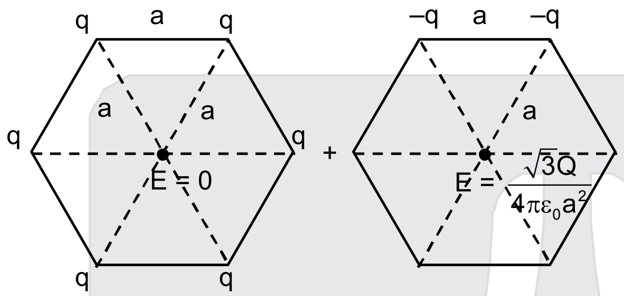
$\phi = \phi_1 + \phi_2 = \frac{Q}{\in_0}$

11. Four equal charges of value +Q are placed at any four vertices of a regular hexagon of side 'a'. By suitable choosing the vertices, what can be the maximum possible magnitude of electric field at the centre of the hexagon ?

(A) $\frac{Q}{4\pi\varepsilon_0 a^2}$ (B) $\frac{\sqrt{2}Q}{4\pi\varepsilon_0 a^2}$ (C) $\frac{\sqrt{3}Q}{4\pi\varepsilon_0 a^2}$ (D) $\frac{2Q}{4\pi\varepsilon_0 a^2}$

Ans. **(C)**

Sol.



to maximize the electric field at the centre both –q should be present at adjacent vertices

$E = \sqrt{E_1^2 + E_1^2 + E_1^2} = \sqrt{3}E_1$

$E_1 = \frac{kQ}{a^2} = \frac{Q}{4\pi\varepsilon_0 a^2}$

$E = \frac{\sqrt{3}Q}{4\pi\varepsilon_0 a^2}$

12. A proton of mass 'm' moving with a speed v (<< c, velocity of light in vacuum) completes a circular orbit in time 'T' in a uniform magnetic field. If the speed of the proton is increased to $\sqrt{2}$ v, what will be time needed to complete the circular orbit ?

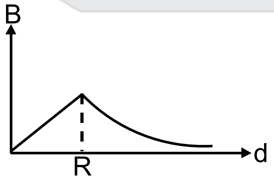
(A) $\sqrt{2}$ T (B) T (C) $\frac{T}{\sqrt{2}}$ (D) $\frac{T}{2}$

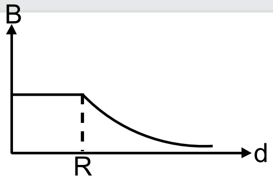
Ans. **(B)**

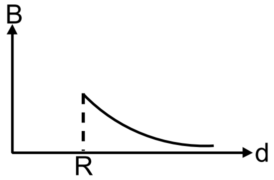
Sol. $T = \frac{2\pi m}{qB}$

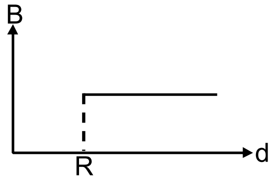
T is independent of v.

13. A uniform current is flowing along the length of an infinite, straight, thin, hollow cylinder of radius 'R'. The magnetic field 'B' produced at a perpendicular distance 'd' from the axis of the cylinder is plotted in a graph. Which of the following figures looks like the plot ?

(A)


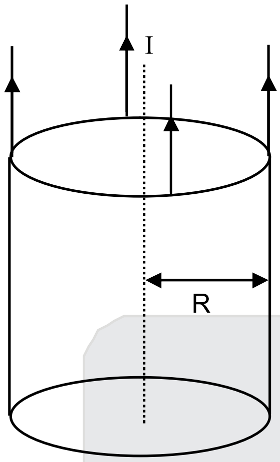
(B)


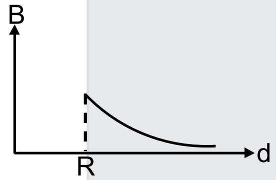
(C)


(D)


Ans. **(C)**

Sol.





For d < R $\quad B \times 2\pi d = \mu_0 I_{in} = 0$

$B = 0$

For d > R $\quad B \times 2\pi d = \mu_0 I = 0$

$B = \dfrac{\mu_0 I}{2\pi d}$

14. A circular loop of radius 'r' of conducting wire connected with a voltage source of zero internal resistance produces a magnetic filed 'B' at its centre. If instead, a circular loop of radius '2r' made of same material, having the same cross section is connected to the same voltage source, what will be the magnetic field at its centre ?

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

Ans. **(B)**

Sol. When radius is doubled the resistance in the circuit is also doubled. Therefore the current in the circuit becomes halved.

$\frac{\mu_0 I}{2r} = B$

$\frac{\mu_0 I'}{2r'} = B'$ where $I' = \frac{I}{2}$, $r' = 2r$

$\therefore\ B' = \frac{\mu_0 I}{8r} = \frac{B}{4}$

15. An alternating current is flowing through a series LCR circuit. It is found that the current reaches a value of 1 mA at both 200 Hz and 800 Hz frequency. What is the Resonance frequency of the circuit?

(A) 600 Hz (B) 300 Hz (C) 500 Hz (D) 400 Hz

Ans. **(D)**

Sol. $\omega L = \frac{1}{\omega C} \qquad \omega = \frac{1}{\sqrt{LC}}$

$\Rightarrow$ X_L and X_C will get interchanged.

$\Rightarrow$ $200L = \frac{1}{800C} \Rightarrow \frac{1}{\sqrt{LC}} = \sqrt{200 \times 800} = 400\text{Hz}$

16. An electric bulb, a capacitor, battery and a switch are all in series in a circuit. How does the intensity of light very when the switch is turned on?

(A) Continues to increase gradually.

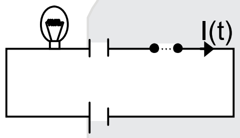
(B) Gradually increases for some time and then becomes steady.

(C) Sharply rises initially and then gradually decreases.

(D) Gradually increases for some then time and then gradually decreases.

Ans. **(C)**

Sol. $I(t) = \frac{\varepsilon}{R} e^{-t/RC}$



Intensity α $I^2 R = \varepsilon^2 Re^{-2t/RC}$

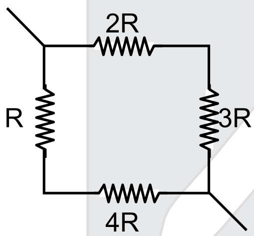
17. Four resistors, 100Ω, 200Ω, 300Ω, and 400Ω, are connected to form four sides of a square. The resistors can be connected in any order. What is the maximum possible equivalent resistance across the diagonal of the square ?

(A) 210 Ω (B) 240 Ω (C) 300 Ω (D) 250 Ω

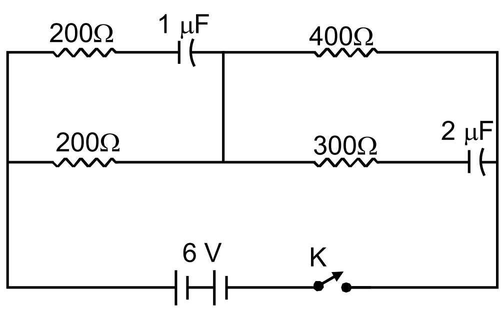
Ans. **(D)**

Sol. $R_{eff}^{max} = \frac{5R \times 5R}{5R + 5R}$ where R = 100

=2.5R = 250



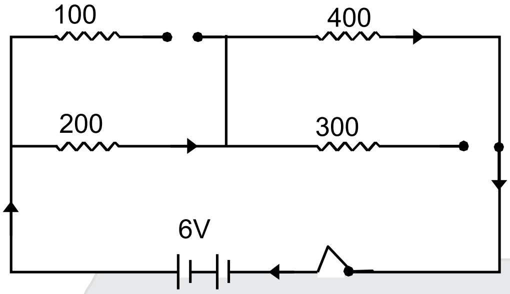
18. What will be current through the 210 Ω resistor in the given circuit a long time after the switch 'K' is made on ?



(A) Zero (B) 100 mA (C) 10 mA (D) 1 mA

Ans. **(C)**

Sol. $I_{steady} = \frac{6}{600} = 10$ mA



Hint : Capacitors behave as infinite resistance in steady state

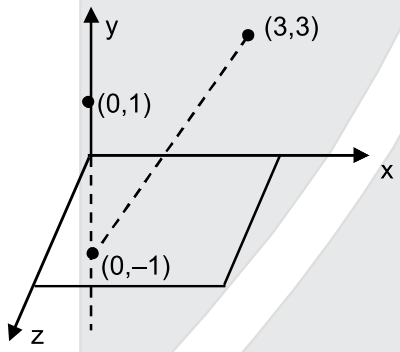
Ans: - (D)

19. A point source is placed at co-ordinates (0, 1) in X-Y plane. A ray of light from the source is reflected on a plane along the X-axis and perpendicular to the X-Y plane. The reflected ray passes through the point (3, 3). What is the path length of the ray from (0, 1) to (3, 3) ?

(A) 5 (B) $\sqrt{13}$ (C) $2\sqrt{13}$ (D) $1 + 2\sqrt{3}$

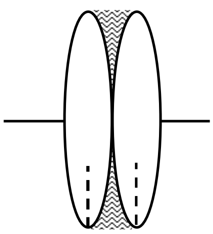
Ans. **(A)**

Sol.



$a = \sqrt{3^2 + 4^2} = 5$

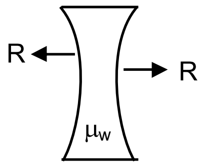
20. Two identical equi-convex lenses, each of focal length 'f' are placed side by side in contact with each other with a layer of water in between them as shown in the figure. If refractive index of the material of the lenses is greater then that of water, how the combined focal length 'F' is related to 'f' ?



(A) F > f (B) $\frac{f}{2} < F < f$ (C) $F < \frac{f}{2}$ (D) F = f

Ans. **(B)**

Sol.



$$\frac{1}{f_w} = (\mu_w - 1)\left(-\frac{2}{R}\right) = -\frac{\mu_w - 1}{\mu_\ell - 1}\left(\frac{1}{f_\ell}\right)$$

$$\frac{1}{f_\ell} = (\mu_\ell - 1)\frac{2}{R}$$

$\mu_\ell > \mu_w$

$$\frac{1}{f_{eq}} = \frac{2}{f_\ell} - \frac{1}{f_\ell}\left(\frac{\mu_w - 1}{\mu_\ell - 1}\right)$$

$$= \frac{1}{f_\ell}\left(2 - \frac{\mu_w - 1}{\mu_\ell - 1}\right)$$

$\mu_\ell - 1 > \mu_w - 1$

$\Rightarrow \quad \frac{\mu_w - 1}{\mu_\ell - 1} < 1 \qquad \frac{1}{f} < \frac{1}{f_{eq}} < \frac{2}{f}$

$$\frac{f}{2} < f_{eq} < f$$

21. There is a small air bubble at the centre of a solid glass sphere of radius 'r' and refractive index 'μ'. What will be the apparent distance of the bubble from the centre of the sphere, when viewed from outside ?

(A) r (B) $\frac{r}{\mu}$ (C) $r\left(1 - \frac{1}{\mu}\right)$ (D) Zero

Ans. **(D)**

Sol. All incident rays are normal to surface, therefore there will be no deviation in the refracting ray.

22. If Young's double slit experiment is done with white light, which of the following statements will be true?

(A) All the bright fringes will be coloured.
(B) All the bright fringes will be white.
(C) The central fringe will be white.
(D) No stable interference pattern will be white.

Ans. **(C)**

Sol. $\Delta x = 0$ at centre for all wavelengths.

23. How the linear velocity 'v' of an electron in the Bohr orbit is related to its quantum number 'n' ?

(A) $v \propto \frac{1}{n}$ (B) $v \propto \frac{1}{n^2}$ (C) $v \propto \frac{1}{\sqrt{n}}$ (D) $v \propto n$

Ans. **(A)**

Sol. $v = \frac{Ze^2}{2 \epsilon_0 nh}$

24. If the half life of a radioactive nucleus is 3 days, nearly what fraction of the initial number of nuclei will decay on the 3rd day ? (Given that $\sqrt[3]{0.25} \approx 0.63$)

(A) 0.63 (B) 0.5 (C) 0.37 (D) 0.13

Ans. **(D)**

Sol. Fractional Decay on third day

$$= \frac{\left[N_0e^{-2/\tau} - N_0e^{-3/\tau}\right]}{N_0} \quad ; \text{ where } \tau = t_{1/2} / \ln 2 = 3/\ln 2$$

$$= e^{-\frac{2\ln 2}{3}} - e^{-\ln 2}$$

$$= 2^{-\frac{2}{3}} - 2^{-1}$$

$= 0.63 - 0.5 = 0.13$

25. An electron accelerated through a potential of 10,000 V from rest has a de-Broglie wave length 'λ'. What should be the accelerating potential so that the wave length is doubled ?

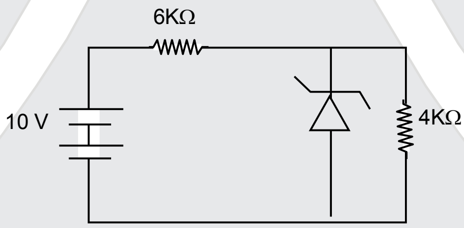
(A) 20,000 V (B) 40,000 V (C) 5,000 V (D) 2,500 V

Ans. **(C)**

Sol. $(10000)e = \frac{hc}{\lambda}$

$$\therefore \frac{hc}{2\lambda} = (5000)e$$

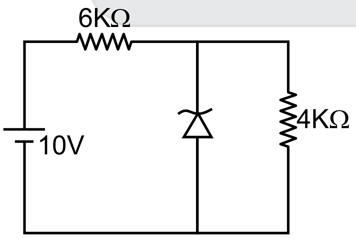
27. What will be the current flowing through the 6KΩ resistor in the circuit shown, where the breakdown voltage of the zener is 6 V ?



(A) $\frac{2}{3}$ mA (B) 1 mA (C) 10 mA (D) $\frac{3}{2}$ mA

Ans. **(A)**

Sol.



$\because$ Zener break done = 6V

So potential across 4KΩ = 6V

and potential across 6KΩ = (10 – 6) = 4V

Current through the 6KΩ = $\frac{4}{6000}$A $\Rightarrow$ $\frac{2}{3000}$A = $\frac{2}{3}$mA

28. In case of a simple harmonic motion, if the velocity is plotted along the X-axis and the displacement (from the equilibrium position)(is plotted along the Y-axis, the resultant curve happens to be an ellipse with the ratio :

$$\frac{\text{major axis(along X)}}{\text{minor axis(along Y)}} = 20\pi$$

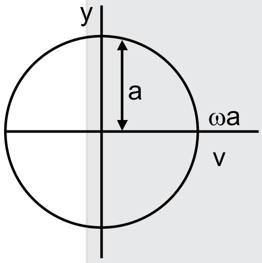
What is the frequency of the simple harmonic motion ?

(A) 100 Hz (B) 20 Hz (C) 10 Hz (D) $\frac{1}{10}$ Hz

Ans. **(C)**

Sol. Relation between velocity & x in SHM is H.

$\frac{v^2}{\omega^2 A^2} + \frac{x^2}{A^2} = 1$ $\rightarrow$ Ellipse



Major axis = $2\omega A$
minor axis = 2a.

Given : $\frac{2\omega a}{2a}$

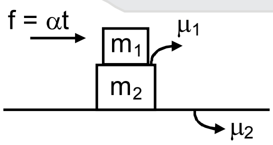
$\omega = 20\pi$
$2\pi f = 20\pi$
f = 10Hz

29. A block of mass m_2 is placed on a horizontal table and another block of mass m_1 is placed on top of it. An increasing horizontal force $F = \alpha t$ is exerted on the upper block but the lower block never moves as a result. If the co-efficient of friction between the blocks is μ_1 and that between the lower block and the table is μ_2, then what is the maximum possible value of μ_1/μ_2 ?

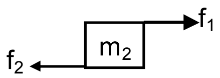
(A) $\frac{m_2}{m_1}$ (B) $1+\frac{m_2}{m_1}$ (C) $\frac{m_1}{m_2}$ (D) $1+\frac{m_1}{m_2}$

Ans. **(B)**

Sol.



FBD of lower block (m_2)



f_2 = acting friction between lower block & the table.
f_1 = acting friction between lower block & upper block.
$\because$ m_2 never moves.
So $f_1 \le f_2$

So friction acting in between the block is always less than or equal to friction acting between lower block & table.

So $\mu_1 m_1 g \le \mu_2(m_1 + m_2)g$

$$\frac{\mu_1}{\mu_2} \le \frac{m_1 + m_2}{m_1}$$

$$\frac{\mu_1}{\mu_2} \le 1 + \frac{m_2}{m_1}$$

So maximum value of $\frac{\mu_1}{\mu_2} = 1 + \frac{m_2}{m_1}$

30. In a triangle ABC, the sides AB and AC are represented by the vectors $3\hat{i}+\hat{j}+\hat{k}$ and $\hat{i}+2\hat{j}+\hat{k}$ respectively. Calculate the angle $\angle$ ABC.

(A) $\cos^{-1}\sqrt{\frac{5}{11}}$ (B) $\cos^{-1}\sqrt{\frac{6}{11}}$ (C) $\left(90^\circ - \cos^{-1}\sqrt{\frac{5}{11}}\right)$ (D) $\left(180^\circ - \cos^{-1}\sqrt{\frac{5}{11}}\right)$

Ans. **(A)**

Sol. $\overrightarrow{AB} = 3\hat{i}+\hat{j}+\hat{k}$

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

$\overrightarrow{CB} = \overrightarrow{AB} - \overrightarrow{AC}$

$2\hat{i}-\hat{j}$

$\angle$ABC is angle between $\overrightarrow{AB}$ and $\overrightarrow{CB}$

$\overrightarrow{AB}.\overrightarrow{CB} = \left|\overrightarrow{AB}\right|\left|\overrightarrow{CB}\right|\cos\theta$

$\Rightarrow \quad 5 = \left|\sqrt{11}\right|\left|\sqrt{5}\right|\cos\theta$

$$\cos\theta = \frac{\sqrt{5}}{\sqrt{11}}$$

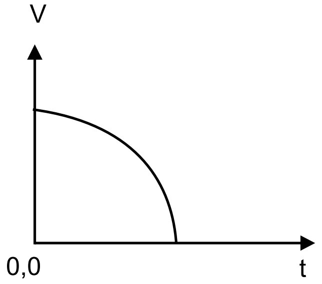
$$\theta = \cos^{-1}\left(\frac{\sqrt{5}}{\sqrt{11}}\right)$$

Category – II (Q.31 to Q.35)

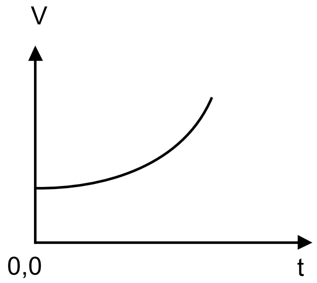
Carry 2 marks each and only one option is correct. In case of incorrect answer or any combination of more than one answer ½ marks will be deducted.

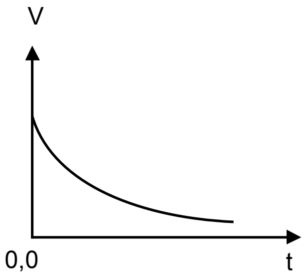
31. The insulated plates of a charged parallel plate capacitor (with small separation between the plates) are approaching each other due to electrostatic attraction. Assuming no other force to be operative and no radiation taking place, which of the following graphs approximately shows the variation with time (t) of the potential difference (V) between the plates ?

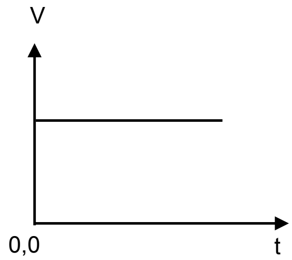
(A)



(B)

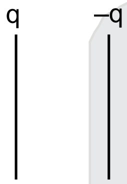


(C) 

(D) 

Ans. **(A)**

Sol.

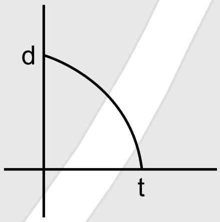


As separation between the plates are decreasing as they approach each other.
and V = E.d
Electric field remains constant between the plates, so $v \propto d$

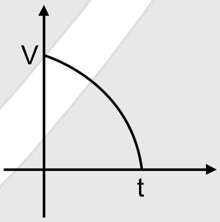
force on each plate = $\frac{q^2}{2A\varepsilon_0}$

acceleration = $\frac{q^2}{2A\varepsilon_0(m)}$

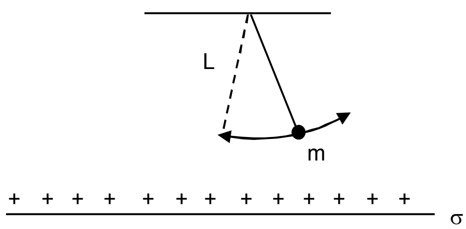
a = constant so



So V - t curve



32. The bob of a pendulum of mass 'm', suspended by an inextensible string of length 'L' as shown in the figure carries a small charge 'a'. An infinite horizontal plane conductor with uniform surface charge density 'σ'. is placed below it. What will be the time period of the pendulum for small amplitude oscillations



(A) $2\pi\sqrt{\frac{L}{\left(g-\frac{mq}{\varepsilon_0\sigma}\right)}}$ (B) $\sqrt{\frac{L}{\left(g-\frac{mq\sigma}{\varepsilon_0}\right)}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{L}{\left(g-\frac{q\sigma}{\varepsilon_0 m}\right)}}$ (D) $2\pi\sqrt{\frac{L}{\left(g-\frac{q\sigma}{\varepsilon_0 m}\right)}}$

Ans. **(D)**

Sol. $TP = 2\pi\sqrt{\dfrac{L}{g-\dfrac{qE}{m}}}$

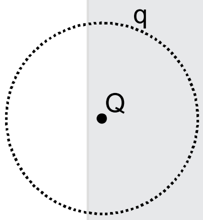
$= 2\pi\sqrt{\dfrac{L}{g-\dfrac{q\sigma}{\varepsilon_0(m)}}}$

33. A light charged particle is revolving in a circle of radius 'r' in electrostatic attraction of a static heavy particle with opposite charge. How does the magnetic field 'B' at the centre of the circle due to the moving charge depend on 'r' ?

(A) $B \propto \dfrac{1}{r}$ (B) $B \propto \dfrac{1}{r^2}$ (C) $B \propto \dfrac{1}{r^{\frac{3}{2}}}$ (D) $B \propto \dfrac{1}{r^{\frac{5}{2}}}$

Ans. **(D)**

Sol.



Electrostatic force of attraction

$f = \dfrac{KqQ}{r^2}$

$\dfrac{mv^2}{r} = \dfrac{KqQ}{r^2}$

$v \propto \dfrac{1}{\sqrt{r}}$

$T.P. = \dfrac{2\pi r}{v}$ $\quad T.P. \propto \dfrac{r}{v}$

$T.P. \propto r^{3/2}$

$I \propto \dfrac{Q}{T.P.}$ $\quad \therefore \quad I \propto r^{-3/2}$

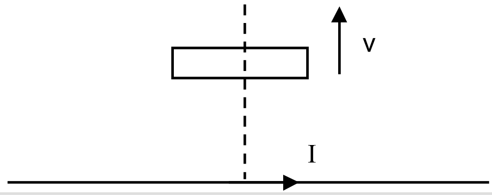
$B = \dfrac{\mu_0 I}{2r}$

$B \propto I \quad B \propto \dfrac{I}{r}$

$B \propto \dfrac{I}{r} \quad B \propto \dfrac{r^{-3/2}}{r}$

$B \propto r^{-5/2}$

34. As shown in the figure, a rectangular loop of a conducting wire is moving away with a constant velocity 'v' in a perpendicular direction from a very long straight conductor carrying a steady current 'I'. When the breadth of the rectangular loop is very small compared to its distance from the straight conductor, how does the e.m.f. 'E' induced in the loop vary with time 't' ?



(A) $E \propto \frac{1}{t^2}$ (B) $E \propto \frac{1}{t}$ (C) $E \propto \ell n(t)$ (D) $E \propto \frac{1}{t^3}$

Ans. **(A)**

Sol. $\varepsilon = -\frac{d\varphi}{dt}$

$\varepsilon = -\frac{d(B.A)}{dt}$

$\varepsilon = -A\frac{dB}{dt}$

$= -A\frac{d}{dt}\frac{\mu_0 i}{2\pi(vt)}$

$\Rightarrow \ -Ai\frac{\mu_0}{2\pi v}\frac{d}{dt}(t^{-1})$

$\Rightarrow Ai\frac{\mu_0}{2\pi v}t^{-2}$

$\varepsilon \propto \frac{1}{T^2}$

35. A solid spherical ball and a hollow spherical ball of two different materials of densities ρ_1 and ρ_2 respectively have same outer radii and same mass. What will be the ratio the moment of inertia (about an axis passing through the centre) of the hollow sphere to that of the solid sphere ?

(A) $\frac{\rho_2}{\rho_1}\left(1-\frac{\rho_2}{\rho_1}\right)^{\frac{5}{3}}$ (B) $\frac{\rho_2}{\rho_1}\left[1-\left(1-\frac{\rho_2}{\rho_1}\right)^{\frac{5}{3}}\right]$ (C) $\frac{\rho_2}{\rho_1}\left(1-\frac{\rho_1}{\rho_2}\right)^{\frac{5}{3}}$ (D) $\frac{\rho_2}{\rho_1}\left[1-\left(1-\frac{\rho_1}{\rho_2}\right)^{\frac{5}{3}}\right]$

Ans. **(D)**

Sol. $\rho_1 \rightarrow$ solid

$\rho_2 \rightarrow$ Hollow

$\mu = \frac{4}{3}\pi\rho_1 R^3 = \frac{4}{3}\pi\rho_2[R^3 - R^3_{inner}]$

$\Rightarrow R^3 - R^3_{inner} = \frac{\rho_1}{\rho_2}R^3$

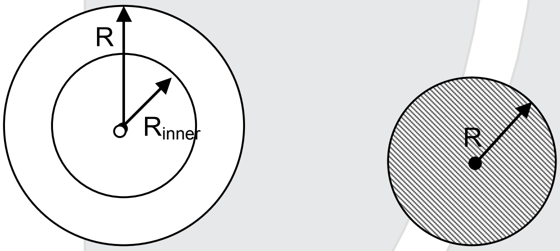
$$\Rightarrow \quad R_{inner}^3 = R^3\left[1-\frac{\rho_1}{\rho_2}\right]$$

$$\Rightarrow \quad R_{inner} = R\left[1-\frac{\rho_1}{\rho_2}\right]^{1/3}$$

$$\frac{I_{Hollow}}{I_{solid}} = \frac{\frac{4}{3}\pi R^3\rho_2 \times \frac{2}{5}R^2 - \frac{4}{3}\pi R_{inner}^3\rho_2 \times \frac{2}{5}R_{inner}^2}{\frac{2}{5}\times\frac{4}{3}\pi R^3\rho_1}$$

$$= \frac{\rho_2}{\rho_1}\left[\frac{R^5 - R_{inner}^5}{R^5}\right] = \frac{\rho_2}{\rho_1}\left[1-\left(\frac{R_{inner}}{R}\right)^5\right]$$

$$= \frac{\rho_2}{\rho_1}\left[1-\left[1-\frac{\rho_1}{\rho_2}\right]^{5/3}\right]$$



Category – III (Q.36 to Q.40)

Carry 2 marks each and one or more option(s) is/are correct. If all correct answers are not marked and also no incorrect answer is marked then score = 2 × number of correct answers marked ÷ actual number of correct answers. If any wrong option is marked or if any combination including a wrong option is marked, the answer will considered wrong but there is no negative marking for the same and zero marks will be awarded.

36. Which of the following statement(s) is/are true ?
"Internal energy of an ideal gas ...."

(A) decreases in an isobaric process.
(B) remains constant in an isothermal process.
(C) increases in an isobaric process.
(D) decreases in an isobaric expansion.

Ans. **(B)**

Sol. In isothermal process $\Delta U = 0$
In isobaric expansion $V \propto T$ so ΔU increases.

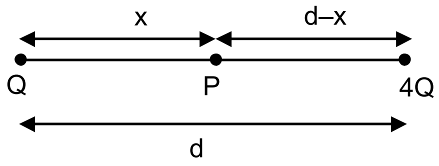
37. Two positive charges Q and 4Q are placed at points A and B respectively, where B is at a distance 'd' units to the right of A. The total electric potential due to these charges is minimum at P on the line through A and B, What is (are) the distance(s) of P from A ?

(A) $\frac{d}{3}$ units to the right of A
(B) $\frac{d}{3}$ units to the left of A
(C) $\frac{d}{5}$ units to the right of A
(D) d units to the left of A

Ans. **(A)**

Sol. Electric potential is minimum where $\vec{E} = 0$

here



$$\frac{kQ}{x^2} = \frac{k4Q}{(d-x)^2}$$

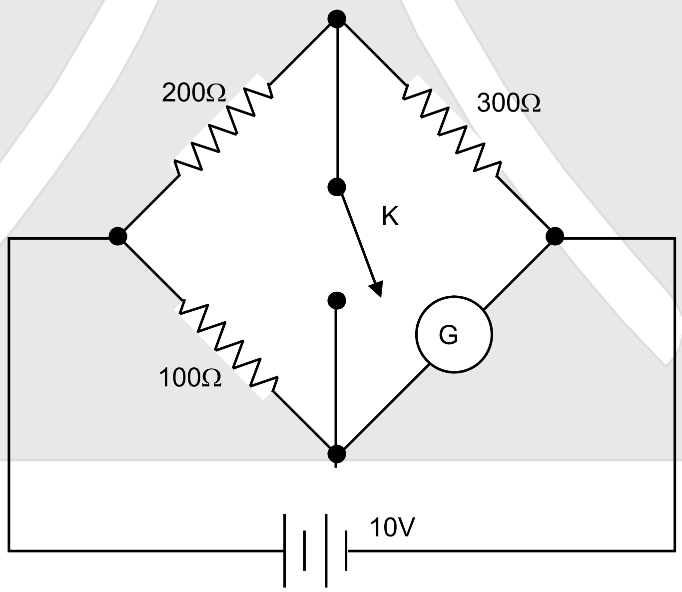
$$\frac{1}{x} = \frac{2}{d-x}$$

$d - x = 2x$

$$x = \frac{d}{3}$$

$\frac{d}{3}$ units right of A.

38. A non–zero current passes through the galvanometer G shown in the circuit when the key 'K' is closed and its value does not change when the key is opened. Then which of the following statement(s) is/are true ?



(A) The galvanometer resistance is infinite.

(B) The current through the galvanometer is 40 mA.

(C) After the key is closed, the current through the 200Ω resistor is same as the current through the 300Ω resistor.

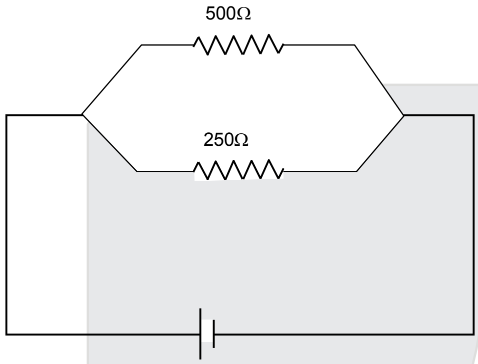
(D) The galvanometer resistance is 150Ω.

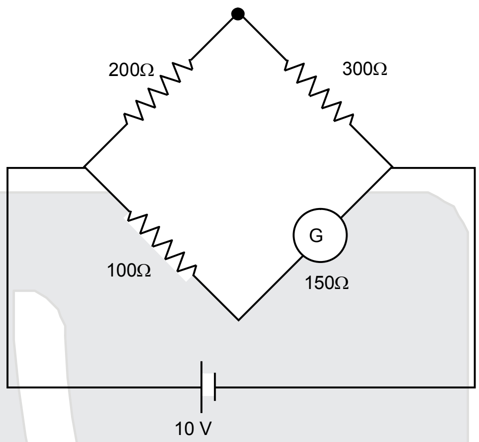
Ans. **(B), (C), (D)**

Sol. It is a case of balanced wheatstone bridge

$$\frac{200}{300} = \frac{100}{a}$$

G = 150Ω





$$R_{eq} = \frac{500 \times 250}{750} = \frac{500}{3}\Omega$$

Now, current through galvanometer

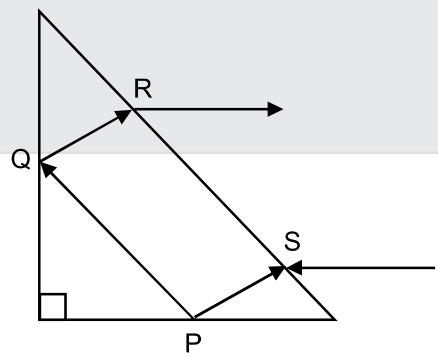
$$\frac{10}{250} = \frac{1}{25} = 0.04A$$

$\Rightarrow$ 40mA

200Ω and 300Ω are in series

100Ω and 150Ω (G) are in series

39. A ray of light is incident on a right angled isosceles prism parallel to its base as shown in the figure. Refractive index of the material of the prism is $\sqrt{2}$. Then which of the following statement(s) is/are true?



(A) The reflection at P is total internal.

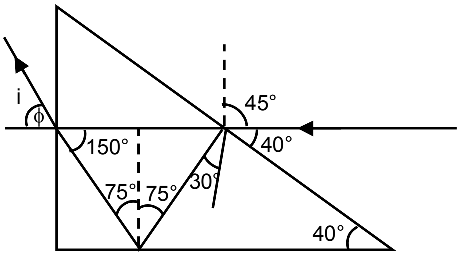
(B) The reflection at Q is total internal.

(C) The ray emerging at R is parallel to the ray incident at S.

(D) Total deviation of the ray is 150°.

Ans. **(A), (C)**

Sol.



$1.\sin i = \sqrt{2}.\sin 15°$

$1.\ \sin i = \sqrt{2}\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)$

$\sin i = = \frac{\sqrt{3}-1}{2}$

Ans. Ray will undergo TIR at P only Ans. (A)

If Ray emerge from R (Partially) it is possible, then it will become parallel to the incident Ray so ans (C)

40. The intensity of a sound appears to an observer to be periodic. Which of the following can be the cause of it ?

(A) The intensity of the source is periodic.

(B) The source is moving towards the observer.

(C) The observer is moving away from the source.

(D) The source is producing a sound composed of two nearby frequencies.

Ans. (A, D)

CHEMISTRY

Category – I (Q.41 to Q.70)

Carry 1 marks each and only one option is correct. In case of incorrect answer or any combination of more than one answer, ¼ marks will be deducted.

41. Ferric ion forms a Prussian blue precipitate due to the formation of

(A) $K_4[Fe(CN)_6]$ (B) $K_3[Fe(CN)_6]$ (C) $Fe(CNS)_3$ (D) $Fe_4[Fe(CN)_6]_3$

Ans. (D)

Sol. Ferric ion forms a prussian blue precipitate due to formation of $Fe_4[Fe(CN)_6]_3$.

$Fe^{+3} + [Fe(CN)_6]^{-4} \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3}$

42. The nucleus ${}^{64}_{29}Cu$ accepts an orbital electron to yield.

(A) ${}^{65}_{28}Ni$ (B) ${}^{64}_{30}Zn$ (C) ${}^{64}_{28}Ni$ (D) ${}^{65}_{30}Zn$

Ans. (C)

Sol. $\underset{\left(\text{K electron Capture}\right)}{{}_{29}Cu^{64} + {}_{-1}e^0} \longrightarrow {}_{28}Ni^{64}$

43. How many moles of electrons will weigh one kilogram ?

(A) 6.023×10^{23} (B) $\frac{1}{9.108}\times10^{31}$ (C) $\frac{6.023}{9.108}\times10^{54}$ (D) $\frac{1}{9.108\times6.023}\times10^{8}$

Ans. (D)

Sol. Mass of one mole of electron = $9.108 \times 10^{-31} \times 6.023 \times 10^{23}$ Kg

Then no of mole of e^- in 1 kg $= \frac{1}{9.108\times6.023\times10^{-8}}$

$= \frac{1}{9.108\times6.023}\times10^{8}$ mole of e^-

44. Equal weights of ethane and hydrogen are mixed in an empty container at 25 ºC. The fraction of total pressure exerted by hydrogen is

(A) 1: 2 (B) 1 : 1 (C) 1 : 16 (D) 15 : 16

Ans. (D)

Sol.

	C_2H_6	H_2
Initial gram weight =	Wg	Wg
Mole =	$\frac{W}{30}$	$\frac{W}{2}$

$$\frac{P_{H_2}}{P_{Total}} = X_{H_2} = \frac{n_{H_2}}{n_{H_2}+n_{C_2H_6}} = \frac{\frac{W}{2}}{\frac{W}{2}+\frac{W}{30}} = \frac{\frac{W}{2}}{\frac{15W+W}{30}} = \frac{W}{2}\times\frac{30}{16W} = \frac{15}{16}.$$

45. The heat of neutralization of a strong base and a strong acid is 13.7 kcal. The heat released when 0.6 mole HCl solution is added to 0.25 mole of NaOH is

(A) 3.425 kcal (B) 8.22 kcal (C) 11.645 kcal (D) 13.7 kcal

Ans. (A)

Sol. $\underset{1\,\text{mole}}{HCl} + \underset{1\,\text{mole}}{NaOH} \longrightarrow NaCl + H_2O \qquad \Delta H = -13.7$ Kcal

$\underset{0.25\text{ mole}}{HCl} + \underset{0.6\text{ mole}}{NaOH} \longrightarrow NaCl + H_2O$

then HCl is limiting reagent

0 0.6–0.25 0.25 mole

Then release energy = 13.7 × 0.25 = 3.425 Kcal

46. A compound formed by elements X and Y crystallizes in the cubic structure, where X atoms are at the corners of a cube and Y atoms are at the centres of the body. The formula of the compound is :

(A) XY (B) XY_2 (C) X_2Y_3 (D) XY_3

Ans. (A)

Sol. $X = 8 \times \frac{1}{8} = 1$ (at corner)

Y = 1 × 1 = 1 (at body center)

So formula of compound = XY

47. What amount of electricity can deposit 1 mole of Al metal at cathode when passed through molten $AlCl_3$?

(A) 0.3 F (B) 1 F (C) 3F (D) 1/3F

Ans. (C)

Sol. $A\ell C\ell_3 \longrightarrow A\ell^{+3} + 3C\ell^-$

At cathode : $A\ell^{+3} + 3e^- \longrightarrow A\ell$

3 mole 1 mole

or 3 F

so required charge = 3F

48. Given the standard half-cell potentials (E°) of the following as

$Zn = Zn^{2+} + 2e^-$ E° = +0.76 V

$Fe = Fe^{2+} + 2e^-$ E° = 0.41 V

Then the standard e.m.f. of the cell with the reaction $Fe^{2+} + Zn \rightarrow Zn^{2+} + Fe$ is

(A) –0.35V (B) + 0.35 V (C) +1.17 V (D) –1.17 V

Ans. (B)

Sol. $Zn^{+2} + 2e^- \longrightarrow Zn$ E° = – 0.76 V (SRP) (Anode)

$Fe^{+2} + 2e^- \longrightarrow Fe$ E° = – 0.41 V (SRP) (Cathode)

$E^o_{cell} = E^\circ_{Fe^{+2}/fe} - E^\circ_{Zn^{+2}/Zn}$

= – 0.41 + 0.76 = 0.35 V

49. The following equilibrium constants are given :

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \ ; K_1$$

$$N_2 + O_2 \rightleftharpoons 2NO \ ; K_2$$

$$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O \ ; K_3$$

The equilibrium constant for the oxidation of 2 mol of NH_3 to give NO is

(A) $K_1 \cdot \frac{K_2}{K_3}$ (B) $K_2 \cdot \frac{K_3^3}{K_1}$ (C) $K_2 \cdot \frac{K_3^2}{K_1}$ (D) $K_2^2 \cdot \frac{K_3}{K_1}$

Ans. (B)

Sol. $2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O$

$$K = \frac{[NO]^2[H_2O]^3}{[NH_3]^2[O_2]^{5/2}}$$

According to question for given reaction

$$K_1 = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K_2 = \frac{[NO]^2}{[N_2][O_2]}$$

$$K_3 = \frac{[H_2O]}{[H_2][O_2]^{1/2}}$$

$$K = K_2 \cdot \frac{K_3^3}{K_1} = \frac{[NO]^2}{[N_2][O_2]} \times \frac{[H_2O]^3}{[H_2]^3[O_2]^{3/2}} \times \frac{[N_2][H_2]^3}{[NH_3]^2}$$

$$= \frac{[NO]^2[H_2O]^3}{[NH_3]^2[O_2]^{5/2}}$$

50. Which one of the following is a condensation polymer ?

(A) PVC (B) Teflon (C) Dacron (D) Polystyrene

Ans. (C)

Sol. Dacron is a condensation of polymer of terephthalic acid and ethylene glycol.

51. Which of the following is present in maximum amount in 'acid rain' ?

(A) HNO_3 (B) H_2SO_4 (C) HCl (D) H_2CO_3

Ans. (B)

Sol. $2SO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow H_2SO_4 \text{ (aq.)}$

52. Which of the set of oxides are arranged in the proper order of basic, amphoteric, acidic?

(A) SO_2, P_2O_5, CO (B) BaO, Al_2O_3, SO_2

(C) CaO, SiO_2, Al_2O_3 (D) CO_2, Al_2O_3, CO

Ans. (B)

Sol.

Basic	Amphoteric	acidic
BaO	Al_2O_3	SO_2

53. Out of the following outer electronic configurations of atoms, the highest oxidation state is achieved by which one ?

(A) $(n-1)\,d^8\,ns^2$ (B) $(n-1)\,d^5\,ns^2$ (C) $(n-1)\,d^3\,ns^2$ (D) $(n-1)\,d^5\,ns^1$

Ans. (B)

Sol. $(n-1)\,d^5\,ns^2 \longrightarrow [Mn]$

Mn show highest Oxidation state = +7

54. At room temperature, the reaction between water and fluorine produces

(A) HF and H_2O_2 (B) HF, O_2 and F_2O_2 (C) F^-, O_2 and H^+ (D) HOF and HF

Ans. (C)

Sol. $F_2 + H_2O \xrightarrow{\text{room temperature}} HF + O_2$

$\downarrow$

$H^+ + F^-$

55. Which of the following is least thermally stable?

(A) $MgCO_3$ (B) $CaCO_3$ (C) $SrCO_3$ (D) $BeCO_3$

Ans. (D)

Sol. $BeCO_3$ $MgCO_3$ $CaCO_3$ $SrCO_3$ $\longrightarrow$

Ionic character $\uparrow$ thermal stability $\uparrow$

Least thermal stable is $BeCO_3$

56. Cl_2O_7 is the anhydride of

(A) HOCl (B) $HClO_2$ (C) $HClO_3$ (D) $HClO_4$

Ans. (D)

Sol. $2HClO_4 \xrightarrow{-H_2O} Cl_2O_7$

57. The main reason that $SiCl_4$ is easily hydrolysed as compared to CCl_4 is that

(A) Si-Cl bond is weaker than C-Cl bond.

(B) $SiCl_4$ can form hydrogen bonds.

(C) $SiCl_4$ is covalent.

(D) Si can extend its coordination number beyond four.

Ans. (D)

Sol. In $SiCl_4$ vacant d–orbitals are present. So hydrolysed by co–ordination bond formation and Si expand its valency.

58. Silver chloride dissolves in excess of ammonium hydroxide solution. The cation present in the resulting solution is

(A) $[Ag(NH_3)_6]^+$ (B) $[Ag(NH_3)_4]^+$ (C) Ag^+ (D) $[Ag(NH_3)_2]^+$

Ans. (D)

Sol. $\underset{\text{excess}}{Ag^+ + NH_3} \longrightarrow \left[Ag(NH_3)_2\right]^+$

59. The ease of hydrolysis in the compounds CH_3COCl(I), $CH_3–CO–O–COCH_3$(II), $CH_3COOC_2H_5$(III) and CH_3CONH_2(IV) is of the order

(A) I > II > III > IV (B) IV > III > II > I (C) I > II > IV > III (D) II > I > IV > III

Ans. (A)

Sol. Reactivity towards hydrolysis of acid derivatives is

Acid halide > Anhydride > Ester > Amide

60. $CH_3–C\equiv C$ MgBr can be prepared by the reaction of

(A) $CH_3–C\equiv C–Br$ with $MgBr_2$ (B) $CH_3–C\equiv CH$ with $MgBr_2$

(C) $CH_3–C\equiv CH$ with KBr and Mg metal (D) $CH_3–C\equiv CH$ with CH_3MgBr

Ans. (D)

Sol. $CH_3–C\equiv C–H + CH_3MgBr \longrightarrow CH_3–C\equiv CMgBr + CH_4$

61. The number of alkene(s) which can produce-2-butanol by the successive treatment of (i) B_2H_6 in tetrahydrofuran solvent and (ii) alkaline H_2O_2 solution is

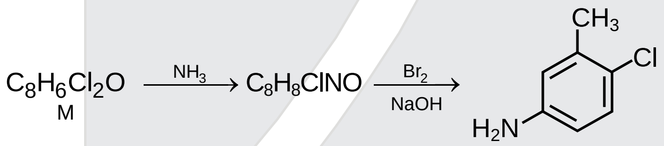
(A) 1 (B) 2 (C) 3 (D) 4

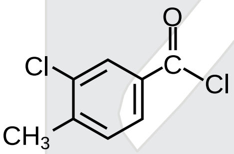
Ans. (A)

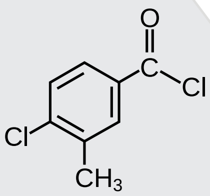
Sol. $CH_3-CH=CH-CH_3 \xrightarrow[(2)\ H_2O_2\ /\ OH^-]{(1)\ B_2H_6} CH_3–\underset{\underset{OH}{|}}{CH}–CH_2–CH_3$

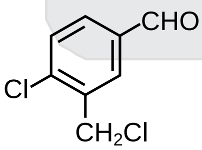
Butan-2-ol

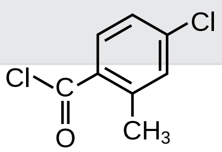
62. Identify **'M'** in the following sequence of reactions :



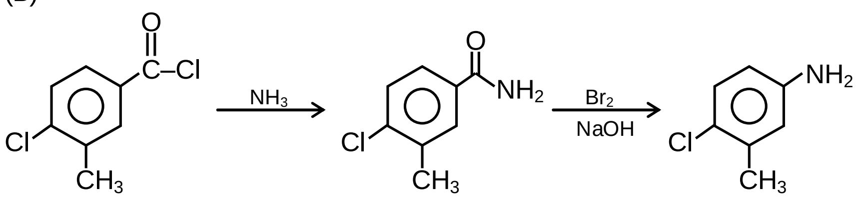
(A) 

(B) 

(C) 

(D) 

Ans. (B)

Sol. 

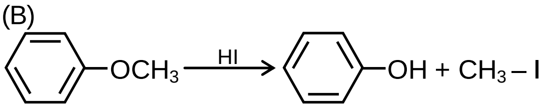
63. Methoxybenzene on treatment with HI produces :

(A) Iodobenzene and methanol (B) Phenol and methyl iodide

(C) Iodobenzene and methyl iodide (D) Phenol and methanol

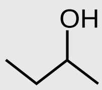
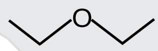
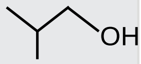
Ans. (B)

Sol.



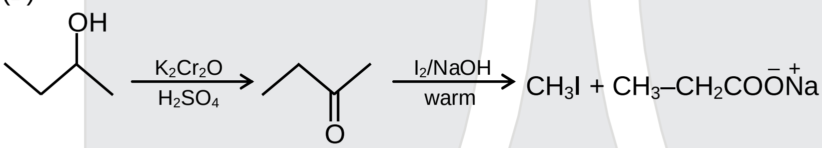
64. $\underset{N}{C_4H_{10}O} \xrightarrow[H_2SO_4]{K_2Cr_2O_7} C_4H_8O \xrightarrow[\text{warm}]{I_2/NaOH} CHI_3$

Here, **N** is

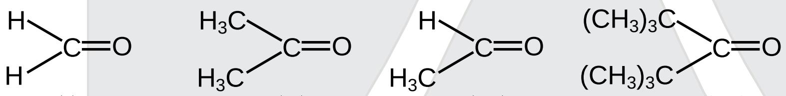
(A)  (B)  (C)  (D) 

Ans. (B)

Sol.



65. The correct order of reactivity for the addition reaction of the following carbonyl compounds with ethylmagnesium iodide is



(I) (II) (III) (IV)

(A) I > III > II > IV (B) IV > III > II > I (C) I > II > IV > III (D) III > II > I > IV

Ans. (A)

Sol. Reactivity order for nucleophilic addition reaction is

$H–CHO > CH_3–CHO > (CH_3)_2CO > [C(CH_3)_3]_2CO$

Reactivity $\propto \dfrac{1}{\text{Steric crowding}}$

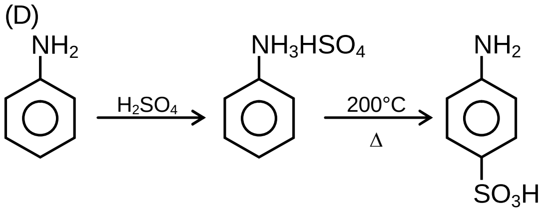
66. If aniline is treated with conc. H_2SO_4 and heated at 200 ºC, the product is

(A) Anilinium sulphate (B) Benzenesulphonic acid

(C) m-Aminobenzenesulphonic acid (D) Sulphanilic acid

Ans. (D)

Sol.



Sulphanilic acid

67. Which of the following electronic configuration is not possible ?

(A) $n = 3, l = 0, m = 0$ (B) $n = 3, l = 1, m = -1$

(C) $n = 2, l = 0, m = -1$ (D) $n = 2, l = 1, m = 0$

Ans. (C)

Sol.

(A) $n = 3$	$\ell = 0$	$m = 0$	3 s
(B) $n = 3$	$\ell = 1$	$m = 1$	3 p
(C) $n = 2$	$\ell = 0$	$\underline{m = -1}$	Not possible
(D) $n = 2$	$\ell = 1$	$m = 0$	3 p

68. The number of unpaired electrons in Ni (atomic number = 28) are

(A) 0 (B) 2 (C) 4 (D) 8

Ans. (B)

Sol. $_{28}Ni \longrightarrow [Ar]\ 3d^8 4s^2$

3d: $\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}$ 4s: $\boxed{\uparrow\downarrow}$

No of unpaired e^- = 2

69. Which of the following has the strongest H-bond ?

(A) O – H … S (B) S – H … O (C) F – H … F (D) F – H … O

Ans. (C)

Sol. Fluorine always formed strong hydrogen bond.

70. The half life of C^{14} is 5760 years. For a "200" mg sample of C^{14}, the time taken to change to 25 mg is

(A) 11520 years (B) 23040 years (C) 5760 years (D) 17280 years

Ans. (D)

Sol.

$$200\text{ mg} \xrightarrow{t_{1/2} = 5760\text{ years}} 100\text{ mg} \xrightarrow{t_{1/2} = 5760\text{ years}} 50\text{ mg} \xrightarrow{t_{1/2} = 5760\text{ years}} 25\text{ mg}$$

17280 years

Or $C_t = C_0/2^n$, $t = n \times t_{1/2}$

Category – II (Q.71 to Q.75)

Carry 2 marks each and only one option is correct. In case of incorrect answer or any combination of more than one answer, ½ marks will be deducted.

71. During a reversible adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio $\frac{C_p}{C_v}$ for the gas is

(A) $\frac{3}{2}$ (B) $\frac{7}{2}$ (C) $\frac{5}{3}$ (D) $\frac{9}{7}$

Ans. (A)

Sol. $PT^{\frac{\gamma}{1-\gamma}} = \text{Constant}$ for reversible adiabatic process

PT^{-3} = Constant

$\frac{\gamma}{1-\gamma} = -3$

$\gamma = -3 + 3\gamma$; $3 = 2\gamma$ so $\gamma = 3/2$

72. [X] + dil. $H_2SO_4 \longrightarrow$ [Y] : Colourless, suffocating gas

[Y] + $K_2Cr_2O_7 + H_2SO_4 \longrightarrow$ Green colouration of solution

Then, [X] and [Y] are

(A) SO_3^{2-}, SO_2 (B) Cl^-, HCl (C) S^{2-}, H_2S (D) CO_3^{2-}, CO_2

Ans. (A)

Sol. $\underset{[x]}{SO_3^{-2}}$ + dil $H_2SO_4 \longrightarrow \underset{[y]}{SO_2(g)}$ colourless, suffocating gas

$SO_2(g) + K_2Cr_2O_7 + H_2SO_4 \longrightarrow$ Green colour of solution due $Cr_2(SO_4)_3$

73. $[P] \xrightarrow{Br_2} C_2H_4Br_2 \xrightarrow[NH_3]{NaNH_2} Q$

$[Q] \xrightarrow[Hg^{2+},\Delta]{20\%H_2SO_4} [R] \xrightarrow{Zn-Hg/HCl} [S]$

The species P, Q, R and S respectively are

(A) ethene, ethyne, ethanal, ethane
(B) ethane, ethyne, ethanal, ethene
(C) ethene, ethyne, ethanal, ethanol
(D) ethyne, ethane, ethene, ethanal

Ans. (A)

Sol. $CH_2{=}CH_2 \xrightarrow{Br_2} Br{-}CH_2{-}CH_2{-}Br \xrightarrow[NH_3]{NaNH_2} HC{\equiv}CH \xrightarrow[Hg^{+2}]{HgSO_4} CH_3{-}CHO \xrightarrow[HCl]{Zn-Hg} CH_3{-}CH_3$

74. The number of possible organobromine compounds which can be obtained in the allylic bromination of 1–butene with N–bromosuccinimide is

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

Ans. (D)

Sol. $CH_2{=}CH{-}CH_2{-}CH_3 \xrightarrow{NBS} CH_2{=}CH{-}\dot{C}H{-}CH_3 \longleftrightarrow \dot{C}H_2{-}CH{=}CH{-}CH_3$

$\downarrow$ $\downarrow$

$CH_2{=}CH{-}\overset{*}{C}H(Br){-}CH_3$ (±) $\qquad$ $CH_2(Br){-}CH\overset{*}{=}CH{-}CH_3$ (cis + trans)

75. A metal M (specific heat 0.16) forms a metal chloride with $\approx$65% chlorine present in it. The formula of the metal chloride will be

(A) MCl (B) MCl_2 (C) MCl_3 (D) MCl_4

Ans. (B)

Sol. Let metal chloride is MCl_x then,

$$\frac{6.4}{\text{Specific Heat}} = \text{Atomic weight}$$

$$\frac{6.4}{0.16} = \text{Atomic weight}$$

Atomic weight = 40 = (Ca) so $CaCl_2$

according to question

$$\frac{x \times 35.5}{40 + x \times 35.5} = 0.65$$

$\Rightarrow$ x = 2 approx

So $MCl_x = MCl_2$

Category – III (Q.76 to Q.80)

Carry 2 marks each and one or more option(s) is/are correct. If all correct answers are not marked and also no incorrect answer is marked then score = 2 × number of correct answers marked ÷ actual number of correct answers. If any wrong option is marked or if any combination including a wrong option is marked, the answer will considered wrong but there is no negative marking for the same and zero marks will be awarded.

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76. Among the following, the extensive variables are

(A) H (Enthalpy) (B) P (Pressure)

(C) E (Internal energy) (D) V (Volume)

Ans. (A,C,D)

Sol. Extensive variable $\longrightarrow$ enthalpy, E (Internal energy) , Volume (V)

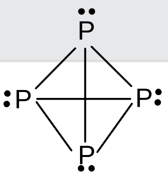
77. White phosphorus P_4 has the following characteristics :

(A) 6 P – P single bonds (B) 4 P – P single bonds

(C) 4 lone pair of electrons (D) P – P – P angle of 60º

Ans. (A,C, D)

Sol. White phosphorus (P_4) =

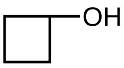


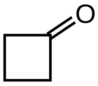
(A) 6 P–P Single Bond

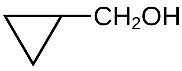
(C) 4 line pair of electrons

(D) Bond angle $\angle$ P – P – P = 60°

78. The possible product (s) to be obtained from the reaction of cyclobutyl amine with HNO_2 is/are

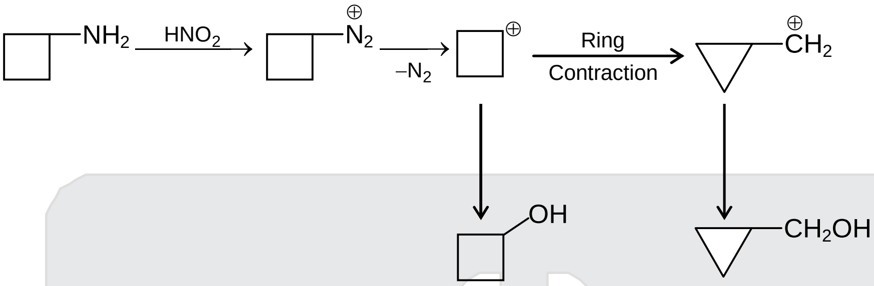
(A) 

(B) 

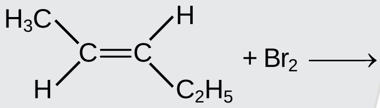
(C) 

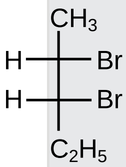
(D) $H_2C = CH_2$

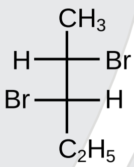
Ans. (A & C)

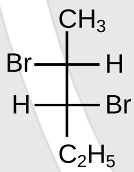
Sol. (A) 

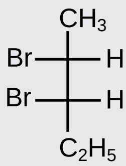
79. The major product(s) obtained in the following reaction is/are



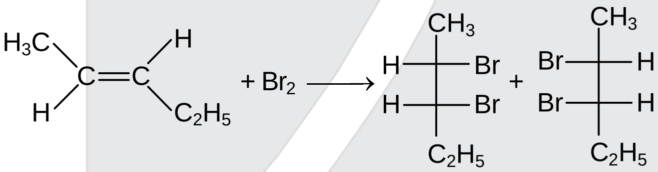
(A) 

(B) 

(C) 

(D) 

Ans. (A & D)

Sol. 

(pair of enatiomers)

80. Which statements are correct for the peroxide ion ?

(A) It has five completely filled anti-bonding molecular orbitals.

(B) It is diamagnetic.

(C) It has bond order one.

(D) It is isoelectronic with neon.

Ans. (B,D)

Sol. O_2^{2-} (peroxide ion)

$$\sigma 1s^2, \overset{*}{\sigma} 1s^2, \sigma 2s^2, \overset{*}{\sigma} 2s^2, \sigma 2p_z^2, \left[\pi 2p_x^2 = \pi 2p_y^2\right], \left[\overset{*}{\pi} 2p_x^2 = \overset{*}{\pi} 2p_y^2\right], \overset{*}{\sigma} 2p_z^0$$

B.O = $\dfrac{10-8}{2} = 1$, no. of unpaired electron = 0 (diamagnetic)