

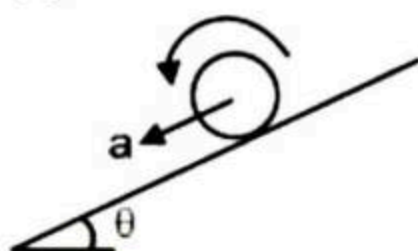
PART : PHYSICS

1. A solid sphere and a hollow sphere are roll down purely equal distances on same inclined plane (starting from rest) in time t_1 and t_2 then

(1) $t_1 > t_2$ (2) $t_1 < t_2$ (3) $t_1 = 2t_2$ (4) $t_1 = t_2$

Ans. (2)

Sol.



$$a = \frac{g \sin \theta}{1 + \frac{I_{cm}}{mr^2}}$$

$$(I_{cm})_{solid} < (I_{cm})_{hollow}$$

$$a_{solid} > a_{hollow}$$

$$t_1 < t_2$$

2. A solid sphere rolls without slipping on a horizontal plane. What is ratio of translation kinetic energy to the rotation kinetic energy of the sphere?

(1) $4/3$ (2) $3/4$ (3) $2/5$ (4) $5/2$

Ans. (4)

Sol. $V = R\omega$

$$\frac{K_t}{K_{rot}} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}I\omega^2} = \frac{\frac{1}{2}mv^2}{\frac{1}{2} \times \frac{2}{5}mv^2} = \frac{5}{2}$$

3. Acceleration due to gravity on the surface of earth is g and acceleration due to gravity on a planet whose diameter is $\frac{1}{3}$ of that of earth and same mass as that of earth is g' . If $g' = ng$ then n is.

(1) 9 (2) 2 (3) $\frac{1}{2}$ (4) 6

Ans. (1)

Sol. $g = \frac{GM}{R^2}$

$$g' = \frac{GM}{\left(\frac{R}{3}\right)^2} = \frac{9GM}{R^2}$$

$$g' = 9g$$

4. If an object of rest mass M_0 has momentum p and total energy E then which the of the following will be correct ? (where C is the velocity of light) -

(1) $E^2 = M_0^2 C^2 + P^2 C^2$

(2) $E^2 = M_0^2 C^4 + P^2 C^2$

(3) $E = M_0 C^2 + PC^2$

(4) $E^2 = M_0 C + PC$

Ans. (2)

Sol. In relativistic case $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

$$P^2 = \frac{m_0^2 v^2}{\left(1 - \frac{v^2}{c^2}\right)} = \frac{m_0^2 \frac{v^2}{c^2} c^2}{\left(1 - \frac{v^2}{c^2}\right)}$$

$$P^2 = \frac{m_0^2 c^2 \left(\frac{v^2}{c^2} - 1 + 1\right)}{\left(1 - \frac{v^2}{c^2}\right)}$$

$$P^2 = m_0^2 c^2 + \frac{m_0^2 c^2}{\left(1 - \frac{v^2}{c^2}\right)}$$

$$p^2 c^2 = m_0^2 c^2 + \left(\frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}\right)^2 c^4$$

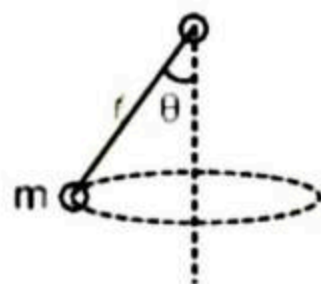
$$p^2 c^2 = -(m_0 c^2)^2 + (mc^2)^2$$

$$(mc^2)^2 = p^2 c^2 + (m_0 c^2)^2$$

$$E^2 = p^2 c^2 + m_0^2 c^4$$

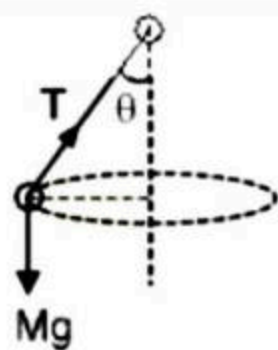
$$E = \sqrt{(pc)^2 + (m_0 c^2)^2}$$

5. A bob of mass m is attached to a string of length ' l '. If it is rotating in a horizontal circle of radius r with angular velocity $\omega = \frac{3 \text{ rev}}{\pi \text{ sec}}$ and tension in the string is $x(m\ell)$ then value of x is _____



Ans. 36.00

Sol.



$$\omega = \frac{3 \text{ rev}}{\pi \text{ sec}}$$

$$\omega = \frac{3}{\pi} \times 2\pi \frac{\text{rev}}{\text{sec}}$$

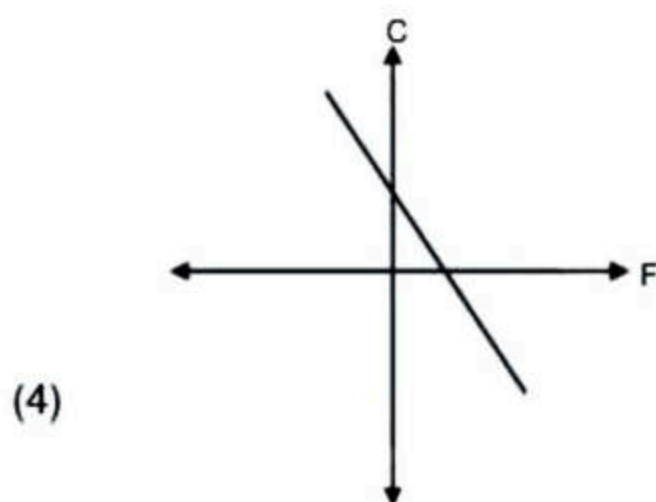
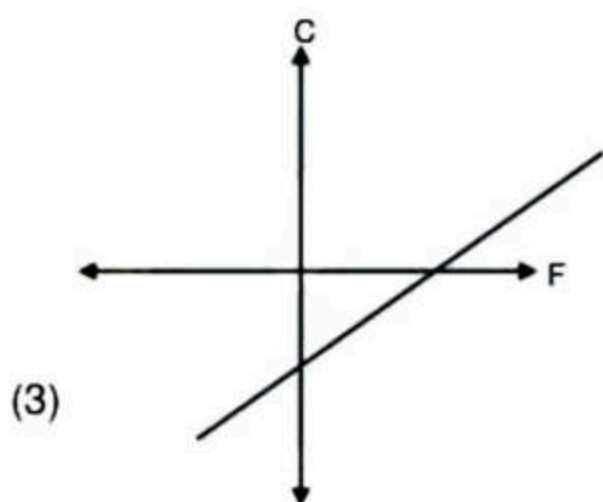
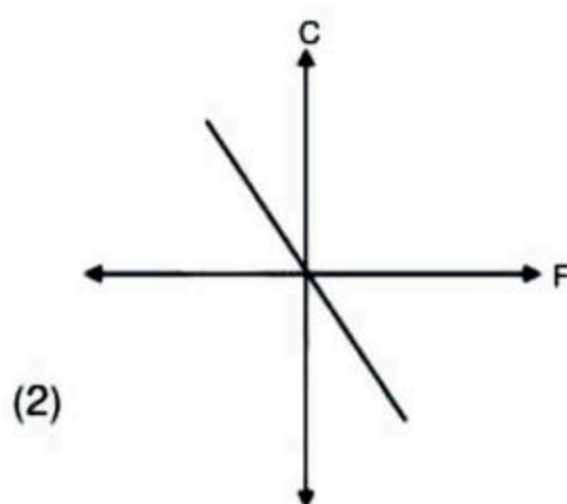
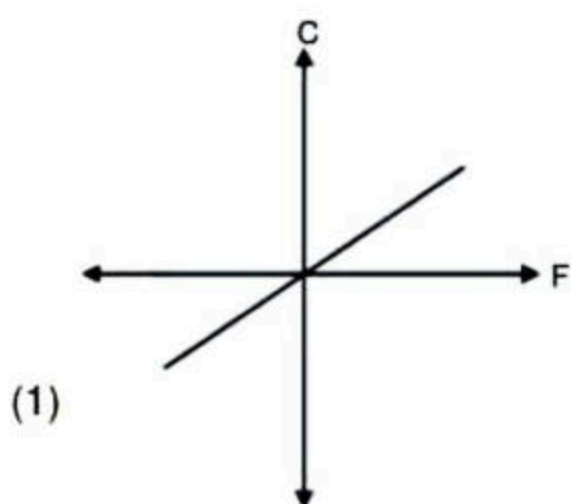
$$\omega = 6$$

$$T \sin \theta = m(\ell \sin \theta) \omega^2$$

$$T = m \omega^2 \ell = m(36) \ell = x(m \ell)$$

$$x = 36$$

6. Which of the following graph is correct. Hence F = Fahrenheit. & C = Celsius



Ans. (3)

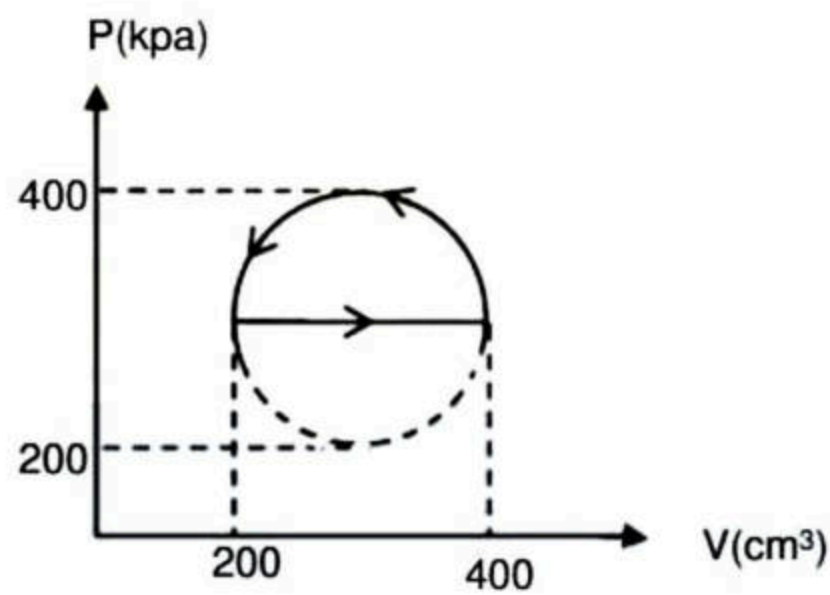
Sol. $\frac{C - 0}{100} = \frac{F - 32}{180} \Rightarrow C = \frac{5}{9}(F - 32)$

$$C = \frac{5F}{9} - \frac{160}{9}$$

$$\text{Slope} = \frac{5}{9} = +\text{Ve}$$

$$\text{Intercept} = \frac{-160}{9}$$

7. An ideal gas is undergone through a cyclic process as shown in the graph. The net heat ejected by the gas during one cycle will be :-



- (1) $5\pi\text{J}$ (2) $10\pi\text{J}$ (3) $15\pi\text{J}$ (4) $2.5\pi\text{J}$

Ans. (1)

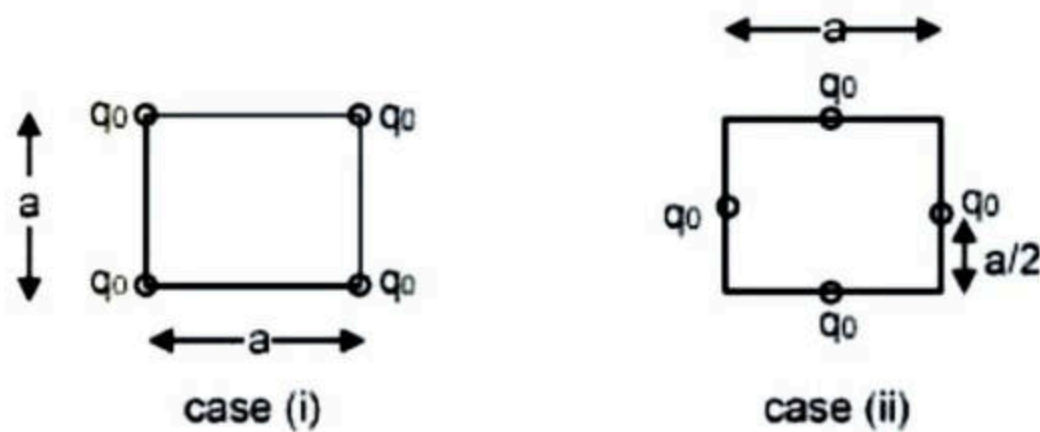
Sol. $W_{\text{cycle}} = \text{Area enclosed by P - V cycle} = \frac{\pi ab}{2}$

$$W_{\text{cycle}} = -\frac{1}{2} \pi (100 \times (10^{-2})^3) (100 \times 10^3)$$

$$Q_{\text{cycle}} = W_{\text{cycle}} = -5\pi$$

Heat rejected by the gas = $5\pi\text{J}$

8.



Four charges each of value q_0 are placed as shown. If potential energy of system is k_1 in case (i) and PE of system is k_2 in case (ii) then what is value of $k_2 - k_1$

- (1) $\frac{kq_0^2}{a} [3\sqrt{2} - 2]$ (2) $\frac{kq_0^2}{a} [5\sqrt{2} - 2]$ (3) $\frac{kq_0^2}{a} [3\sqrt{2} + 2]$ (4) Zero

Ans. (1)

Sol. $k_1 = 2 \left[\frac{kq_0^2}{a} + \frac{kq_0^2}{a} + \frac{kq_0^2}{\sqrt{2}a} \right] = \frac{2kq_0^2}{a} \left[2 + \frac{1}{\sqrt{2}} \right]$

$$k_2 = 2 \left[\frac{kq_0^2}{a/\sqrt{2}} \times 2 + \frac{kq_0^2}{a} \right] = \frac{2kq_0^2}{a} [2\sqrt{2} + 1]$$

$$k_2 - k_1 = \frac{kq_0^2}{a} (3\sqrt{2} - 2)$$

9. **Statement-1:** If in adiabatic process volume is decrease from V to $V/2$ then temperature also decreases
Statement-2: Free expansion is irreversible as well as adiabatic
 (1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
 (2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
 (3) Statement-1 is True, Statement-2 is False
 (4) Statement-1 is False, Statement-2 is True

Ans. (4)

Sol. $T.V^{\gamma-1} = \text{constant}$
 when volume decreases then temperature increases

10. Which of the following option is correct for increasing order of wave length

(i) Infrared ray

(ii) x-ray

(iii) UV-ray

(iv) Microwave-ray

(1) (i), (ii), (iii), (iv) (2) (iv), (i), (iii), (ii) (3) (ii), (iii), (i), (iv) (4) (ii), (iii), (i), (iv)

Ans. (3)

Sol. $\lambda_x < \lambda_{UV} < \lambda_{Ir} < \lambda_{Micro}$

11. Find the fringe width, if complete YDSE is immersed in a medium of refractive index $\mu = 1.44$.

Given $\lambda_{air} = 690 \text{ nm}$, $D = 0.72 \text{ meter}$ $d = 1.5 \text{ mm}$

(1) 0.23 mm (2) 1.23 mm (3) 2.28 mm (4) 0.40 mm

Ans. (1)

Sol.
$$\beta_{red} = \frac{\lambda_{air}}{\mu} \frac{D}{d}$$

$$= \frac{690 \times 10^{-9} \times 72 \times 10^{-2}}{144 \times 10}$$

$$= \frac{690}{2 \times 3 \times 10^{-3}}$$

$$= 230 \times 10^{-6}$$

$$0.23 \text{ mm}$$

12. For which of the following inputs, the output will be zero (0) :-



(A) $x = 0, y = 0$

(B) $x = 0, y = 1$

(C) $x = 1, y = 0$

(D) $x = 1, y = 1$

(1) A,B,C

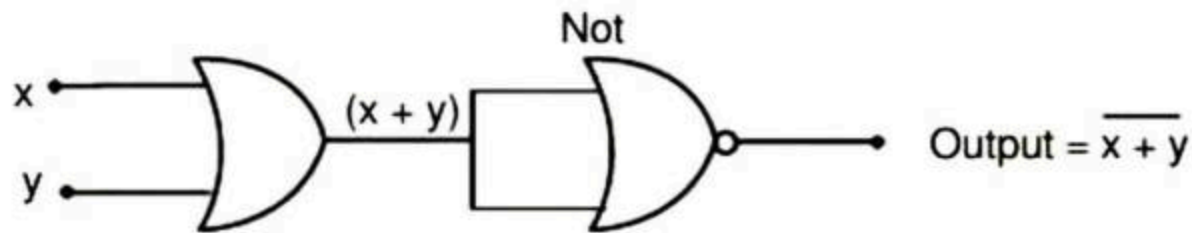
(2) B, C, D

(3) Only A

(4) Only D

Ans. (2)

Sol.



- (A) $x = 0, y = 0 \Rightarrow \text{output} = 0 + 0 = 1$
 (B) $x = 0, y = 1 \Rightarrow \text{output} = 0 + 1 = 0$
 (C) $x = 1, y = 0 \Rightarrow \text{output} = 1 + 0 = 0$
 (D) $x = 1, y = 1 \Rightarrow \text{output} = 1 + 1 = 0$

13. Power of two sources S_1 and S_2 are in ratio 2 : 1 and 2×10^{15} photons per sec of wavelength 600 nm from S_1 are emitted then find the number of photons per second emitted from source S_2 of wavelength 300 nm ?

- (1) 5×10^{15} (2) 2×10^{15} (3) 5×10^{14} (4) 2×10^{14}

Ans. (3)

Sol. $P_1 = P = \frac{N_1 hc}{\lambda_1}$ $P = \frac{N_2 hc}{\lambda_2}$ $N \rightarrow \text{No. of photon/sec}$

$$P_2 = \frac{P}{2} = \frac{N_2 hc}{\lambda_2}$$

$$\frac{P_1}{P_2} = \frac{N_1}{N_2} \cdot \frac{\lambda_2}{\lambda_1}$$

$$N_2 = \frac{N_1 \lambda_2}{\lambda_1 \cdot 2} = \frac{2 \times 10^{15} \times 300}{600 \times 2}$$

$$n_2 = 5 \times 10^{14} \text{ per second}$$

14. **Statement (1)** : An electron in a uniform magnetic field, can move without changing its velocity vector.

Statement (2) : In the above case, the magnetic field should be along the direction of its velocity.

- (1) Both statement 1 and statement 2 is correct, and statement 2 is the correct explanation of statement 1
 (2) Both statement 1 and Statement 2 is correct but statement 2 is not the correct explanation of statement 1
 (3) Statement 1 is correct, but statement 2 is incorrect
 (4) Statement 1 is incorrect, but statement 2 is correct.

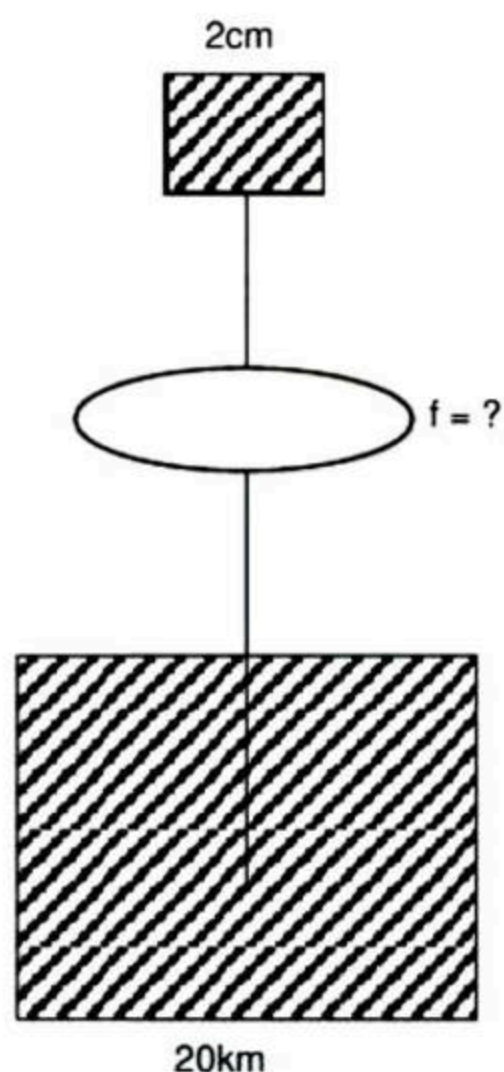
Ans. (1)

15. A drone camera situated at a height of 18 km, capture an image of area 400 km^2 , on a camera film of size $2 \text{ cm} \times 2 \text{ cm}$. find the focal length of the lens used in camera in mm.

- (1) 6 (2) 14 (3) 18 (4) 27

Ans. (3)

Sol.



$$|m| = \frac{h_i}{h_o} = \frac{2\text{cm}}{20\text{km}} = \frac{2 \times 10^{-2}}{20 \times 10^3} = 10^{-6}$$

Since the image is real, so it will be inverted

$$m = -10^{-6} = \frac{-1}{10^6}$$

$$m = \frac{f}{f + u}$$

$$-\frac{10}{10^6} = \frac{f}{f + (-18\text{km})}$$

$$10^6 f = -f + 18 \text{ km}$$

$$10^6 f = 18 \text{ km}$$

$$f = \frac{18\text{km}}{10^6} = \frac{18 \times 10^3 \times 10^3 \text{mm}}{10^6}$$

$$f = 18 \text{ mm}$$

16. A spherical conductor carries a charge of $4 \times 10^{-8}\text{C}$ brought in contact with an uncharged spherical conductor and they are separated by a distance r . Now force between them is $9 \times 10^{-3} \text{ N}$. Determine the separation between the charges.

(1) 7

(2) 4

(3) 9

(4) 2

Ans. (4)

Sol.

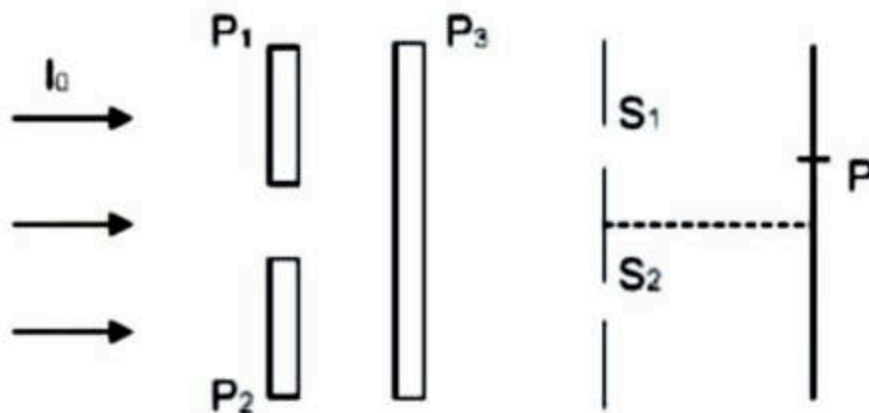


$$\frac{Kq^2}{R^2} = 9 \times 10^{-3}$$

$$\frac{9 \times 10^9 \times 2 \times 10^{-8} \times 2 \times 10^{-8}}{9 \times 10^{-3}} = R^2$$

$$R = 2 \text{ cm}$$

17.



In the following diagram polarizer P_1 & P_2 are orthogonal and P_3 is aligned at 45° w.r.t. P_1 and P_2 . If unpolarised light of intensity I_0 is incident on P_1 and P_2 and light after passing through P_3 is used in YDSE.

at some point P where path difference is $\frac{\lambda}{3}$, What is resultant intensity?

- (1) $\frac{I_0}{2}$ (2) $\frac{I_0}{3}$ (3) $\frac{I_0}{4}$ (4) I_0

Ans. (3)

Sol. Intensity after P_1 & P_2 is $\frac{I_0}{2}$ and after P_3 $\frac{I_0}{2} \cos^2 45 = \frac{I_0}{2} \left(\frac{1}{2} \right) = \frac{I_0}{4}$

$$\text{Now, } I_P = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \Delta\theta$$

$$= \frac{I_0}{4} + \frac{I_0}{4} + 2\frac{I_0}{4} \cos \left[\frac{2\pi}{\lambda} \left(\frac{\lambda}{3} \right) \right]$$

$$= \frac{I_0}{2} + \frac{I_0}{2} \left[-\frac{1}{2} \right]$$

$$I_P = \frac{I_0}{4}$$

18. A hot body is placed in the surrounding of temperature 16°C . During first 4 minutes, its temperature falls from 40°C to 24°C , then find its temperature after 4 minutes.

- (1) 12°C (2) 22°C (3) 10°C (4) 18.7°C

Ans. (4)

Sol. $\left(\frac{dT}{dt}\right) = k(T - T_0)$

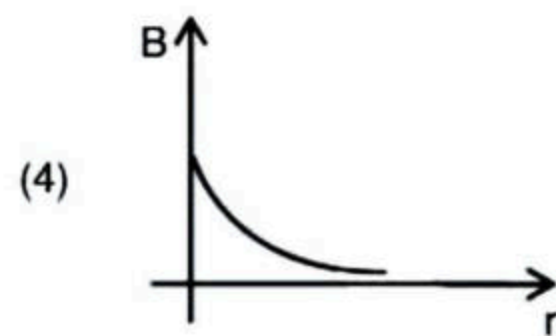
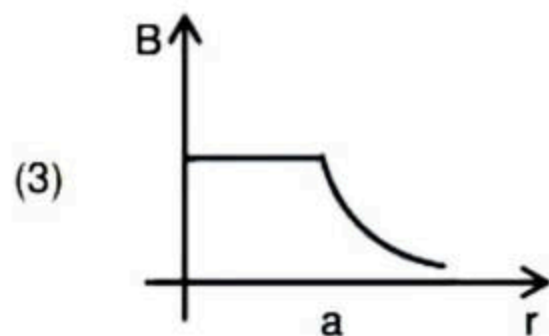
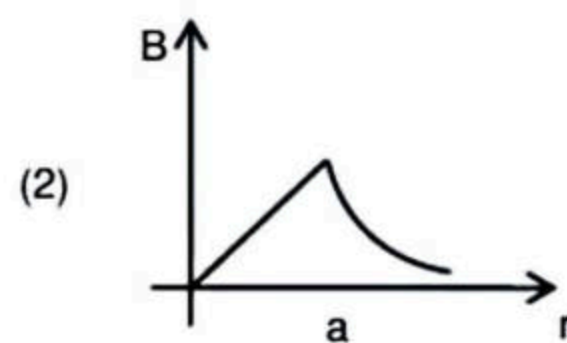
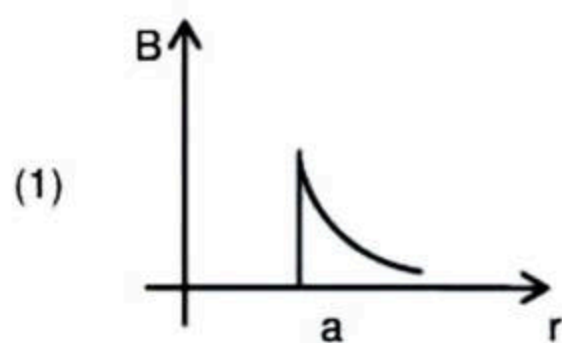
$$\left(\frac{40 - 24}{4 \text{ min}}\right) = k\left(\frac{24 + 40}{2} - 16\right) \quad \dots(i)$$

$$\left(\frac{24 - T}{4 \text{ min}}\right) = k\left(\frac{T + 24}{2} - 16\right) \quad \dots(ii)$$

Solving the equations we get

$$T = \frac{56}{3} = 18.7^\circ\text{C}$$

- 19.** An infinitely long wire has current 'i' and its radius is 'a'. Choose the correct graph for 'B' v/s 'r' where 'r' is distance from centre of wire



Ans. (2)

- 20.** The position vector of a particle varies with time as $\vec{r} = (5t^2\hat{i} - 5t\hat{j})$ m. The magnitude and direction of velocity at $t = 2$ will be ;

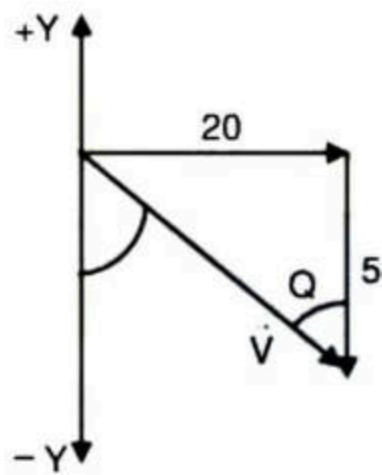
- (1) $5\sqrt{15}$
 (2) $5\sqrt{17}$ m/sec. at an angle of $\tan^{-1}(4)$ with $-y$ axis
 (3) $5\sqrt{17}$ m/sec. at an angle of $\tan^{-1}(4)$ with x axis
 (4) $5\sqrt{17}$ m/sec. at an angle of $\tan^{-1}(4)$ with $-x$ axis

Ans. (2)

Sol. $\vec{v} = \frac{d\vec{r}}{dt} = 10t\hat{i} - 5\hat{j}$

$$\vec{v}_{t=2} = 20\hat{i} - 5\hat{j} \Rightarrow |\vec{v}| = \sqrt{(20)^2 + (5)^2} = \sqrt{425}$$

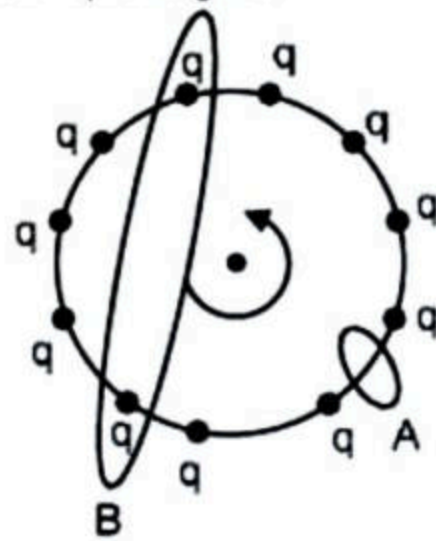
$$= 5\sqrt{17} \text{ m/sec}$$



$$\tan\theta = \frac{20}{5} = 4$$

$$\theta = \tan^{-1}(4) \text{ with } -y \text{ axis}$$

- 21.** Find the difference of the current ($I_A - I_B$). If n charge particles move in a circular path with ω angular velocity and there are two ampere's loop are given



where I_A is net current passing through the amperian loop A and I_B is the net current passing through loop B.

(1) $\frac{nq\omega}{2\pi}$

(2) $\frac{nq\omega}{\pi}$

(3) $\frac{2\pi\omega}{nq}$

(4) $\frac{2\pi}{nq\omega}$

Ans. (1)

Sol. In loop B incoming and outgoing current is equal & opposite so $I_B = 0$

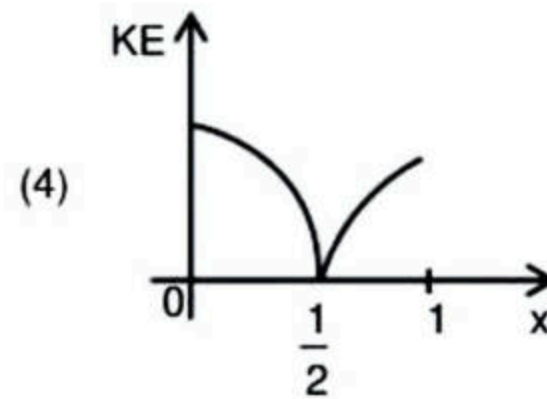
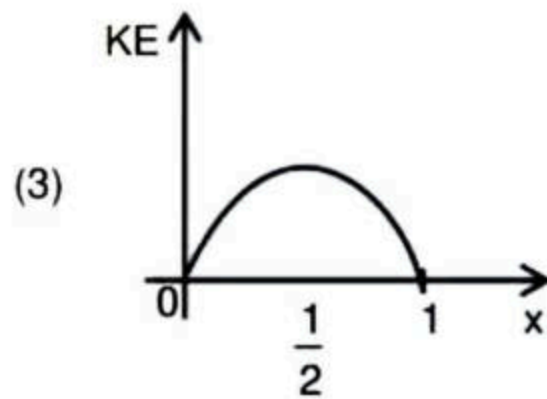
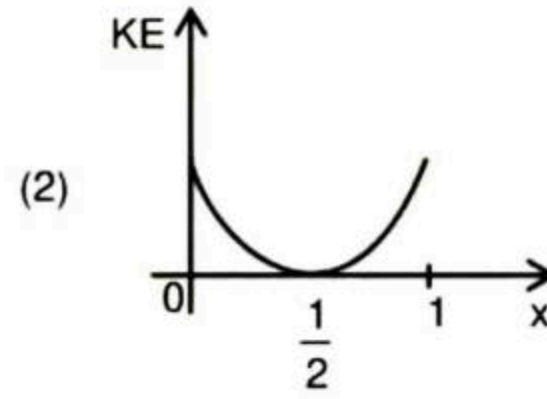
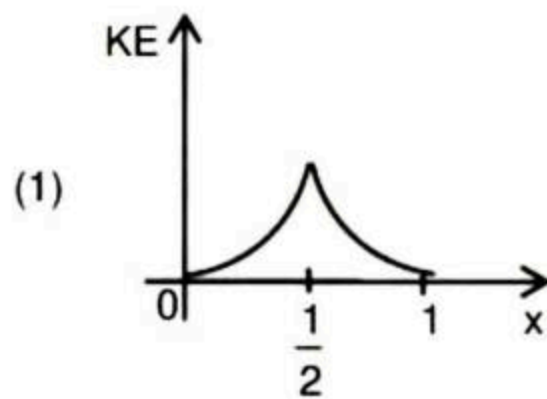
$$T = \frac{2\pi}{\omega}$$

$$I_A = \frac{nq}{T}$$

$$I_A = \frac{nq\omega}{2\pi}$$

$$I_A - I_B = \frac{nq\omega}{2\pi}$$

22. $x(t) = x_0 \sin^2\left(\frac{t}{2}\right)$ (where $x_0 = 1$) find graph of Kinetic energy v/s x



Ans. (3)

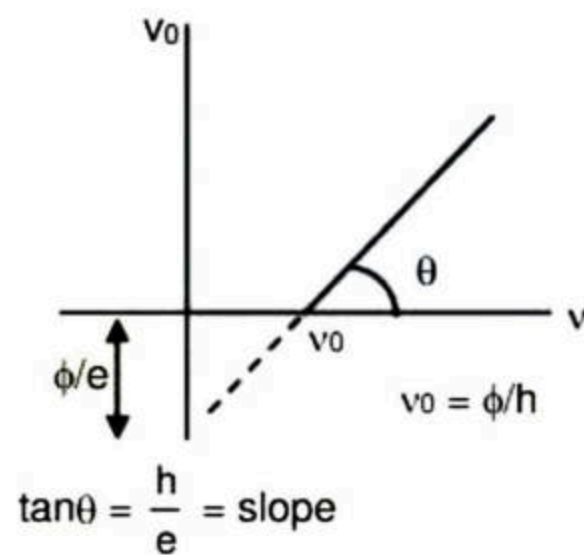
23. For the graph of stopping potential V_0 v/s frequency which statement is correct .
 (1) graph is linear (2) slope is d/h
 (3) h is related to slope (4) to find D , we don't require h .

Ans. (1)

Sol. $eV_0 = h\nu - h\nu_0$

$$V_0 = \frac{h\nu}{e} - \frac{h\nu_0}{e}$$

$$V_0 = \frac{h\nu}{e} - \frac{d}{e}$$



24. A electron is moving in a circular path inside a solenoid with a time period of 75 ns. The current through the solenoid is 1 amp. Determine the number of turns per unit length of solenoid.



(1) 3.8×10^3

(2) 38×10^3

(3) 4.3×10^3

(4) 43×10^3

Ans. (1)

Sol. We know that

$$B = \frac{2\pi m}{qT} = \frac{2 \times 3.14 \times 9.1 \times 10^{-31}}{1.6 \times 10^{-16} \times 75 \times 10^{-9}}$$

$$B = 4.78 \times 10^{-3} \text{ T}$$

$$\text{So, } n = \frac{B}{\mu_0 I} = \frac{B}{\mu_0 I} \frac{4.78 \times 10^{-3}}{4\pi \times 10^{-2} \times 1}$$

$$n = 3.8 \times 10^3$$

25. A material has a bulk modulus of $25 \times 10^{11} \text{ N/m}^2$. If it undergoes a volumetric strain of 0.2%, what is the excess pressure applied ?

- (1) $5 \times 10^8 \text{ N/m}^2$ (2) $5 \times 10^9 \text{ N/m}^2$ (3) $5 \times 10^{10} \text{ N/m}^2$ (4) $5 \times 10^{11} \text{ N/m}^2$

Ans. (2)

Sol. The bulk modulus K of a material is defined by the formula :

$$K = \frac{\text{Excess Pressure}(P)}{\text{Volumetric Strain}(\Delta V/V)}$$

Given data :

Bulk modulus, $K = 25 \times 10^{11} \text{ N/m}^2$

Volumetric strain, $\frac{\Delta V}{V} = 0.002$

Rearranging the formula to solve for excess pressure :

$$P = K \times \left(\frac{\Delta V}{V} \right)$$

Thus, the excess pressure is :

$$5 \times 10^9 \text{ N/m}^2$$

PART : CHEMISTRY

1. Arrange the following in ascending order wavelength

λ_1 = Infrared

λ_2 = Micro

λ_3 = X-ray

λ_4 = U.V.

(1) $\lambda_3 < \lambda_4 < \lambda_1 < \lambda_2$ (2) $\lambda_3 < \lambda_1 < \lambda_4 < \lambda_2$ (3) $\lambda_2 < \lambda_1 < \lambda_4 < \lambda_3$ (4) $\lambda_1 < \lambda_4 < \lambda_2 < \lambda_3$

Ans. (1)

Sol. Order of wavelength in EM spectrum:

Cosmic < Gamma < X-rays < UV < Visible < Infra Red < Micro < Radio

2. $t_{2g}^3 e_g^1$ configuration is possible in:

(1) WFL; high spin

(2) WFL; low spin

(3) SFL; high spin

(4) SFL; low spin

Ans. (1)

Sol. WFL will not cause pairing & above is high spin arrangement (greater no. unpaired e^-).

3. When ethane -1, 2-diammine is progressive added to aqueous of Nickel (II) chloride the sequence of colour changed observed will be

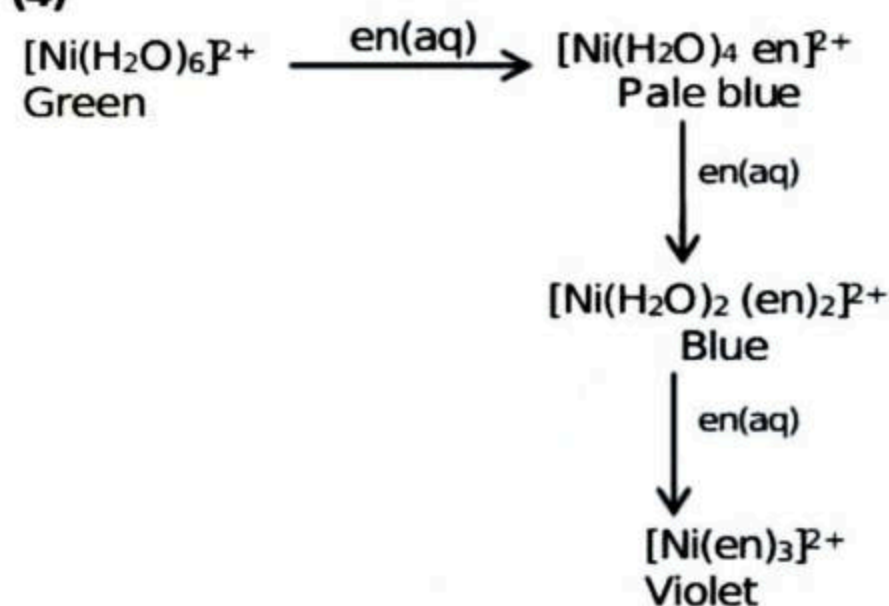
(1) Pale blue $\rightarrow$ Blue $\rightarrow$ Green $\rightarrow$ Violet

(2) Violet $\rightarrow$ Blue $\rightarrow$ Pale blue $\rightarrow$ Green

(3) Pale blue $\rightarrow$ Blue $\rightarrow$ Violet $\rightarrow$ Green

(4) Green $\rightarrow$ Pale blue $\rightarrow$ Blue $\rightarrow$ violet

Ans. (4)



Sol.

4. Statement-I : IE_1 of Sn > Pb

Statement-II : IE_1 of Si > Ge

(1) Both Statement I and statement II are true

(2) Both statement I and statement II are false

(3) Statement I is true but statement II is false

(4) Statement I is false but statement II is true

Ans. (4)

Sol. IE decreases down the gap. So Si > Ge & Pb, Sn exceptional

5. Compound $\xrightarrow{\text{aquaregia}}$ B $\xrightarrow[\text{CH}_3\text{COOH}]{\text{KNO}_2}$ Yellow ppt

(1) NiS

(2) ZnS

(3) CoS

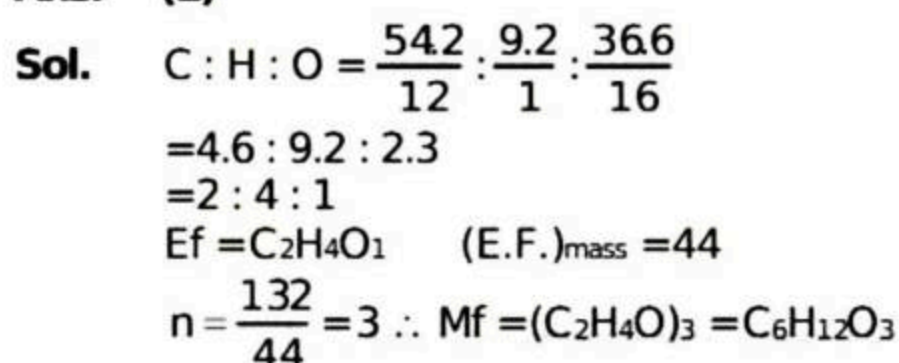
(4) MnS

Ans. (3)

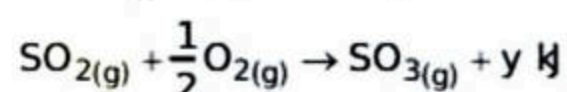
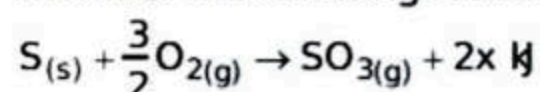
Sol. $\text{CoS} \xrightarrow{\text{aquaregia}} \text{CoCl}_2 \xrightarrow[\text{CH}_3\text{COOH}]{\text{KNO}_2} \text{K}_3[\text{Co}(\text{NO}_2)_6] \downarrow \text{Yellow}$

6. 54.2% C, 9.2% H & 36.6% O are present in a compound. If its molar mass is 132 g, its molecular formula is
 (1) $C_6H_{12}O_3$ (2) $C_4H_8O_2$ (3) $C_6H_{12}O_6$ (4) None of these

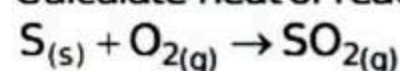
Ans. (1)



7. Consider the following reactions

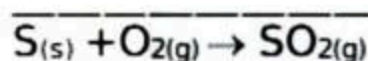
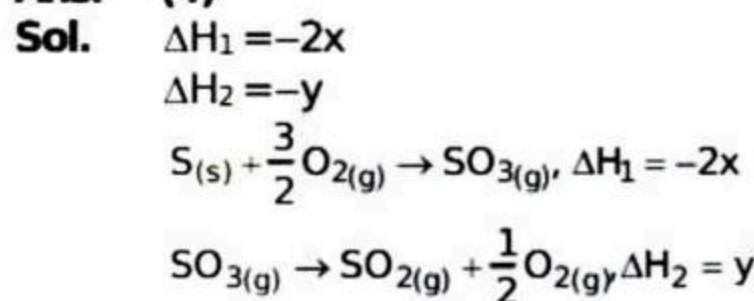


Calculate heat of reaction (kJ) for the given reaction



- (1) $-(x + y)$ (2) $-(2x + y)$ (3) x/y (4) $y - 2x$

Ans. (4)



$$\Delta H_r = \Delta H_1 + \Delta H_2$$

$$= -2x + y$$

$$= y - 2x \text{ kJ}$$

8. Match the following cations with respective spin magnetic moment

Ions	H(B.M)
(i) Ti^{3+}	(p) 2.83
(ii) Sc^{+3}	(q) 0.00
(iii) V^{+2}	(r) 1.73
(iv) Ni^{+2}	(s) 3.87

(1) i-r; ii-q; iii-s; iv-p

(3) i-s; ii-p; iii-q; iv-r

(2) i-p; ii-q; iii-r; iv-s

(4) i-s; ii-p; iii-r; iv-q

Ans. (1)

9. Calculate the overall activation energy

$$K = \frac{k_1 k_3}{k_2} \quad E_{a_1} = 60 \text{ kJ}$$

$$E_{a_2} = 40 \text{ kJ}$$

$$E_{a_3} = 20 \text{ kJ}$$

Ans. (20)

Sol.
$$e^{-E_a/RT} = \sqrt{\frac{e^{-E_{a1}/RT} \cdot e^{-E_{a3}/RT}}{e^{-E_{a2}/RT}}}$$

$$e^{-E_a/RT} = \sqrt{e^{\frac{(E_{a2} - E_{a1} - E_{a3})}{RT}}}$$

$$-E_a = (E_{a2} - E_{a1} - E_{a3}) \times \frac{1}{2}$$

$$E_a = (E_{a1} + E_{a3} - E_{a2}) \times \frac{1}{2}$$

$$E_a = \frac{1}{2}(60 + 20 - 40) = 20 \text{ kJ}$$

10. Statement-I : Oxygen-oxygen bond length in O_3 is greater than O_2 .

Statement-II : O-O bond order in O_3 is 1.5 and O-O bond order in O_2 is 2.

- (1) Both Statement I and statement II are true (2) Both statement I and statement II are false
 (3) Statement I is true but statement II is false (4) Statement I is false but statement II is true

Ans. (1)

11. The successive ionisation energy (I.E.) of an element 'X' is given

	IE ₁	IE ₂	IE ₃	IE ₄	IE ₅
X →	500	600	2000	2200	2600

Data given in kJ/mol.

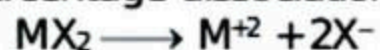
Find out the group number of element X.

- (1) Group-13 (2) Group-14 (3) Group-2 (4) Group-13

Ans. (3)

12. MX_2 observed molar mass: 65.6 Normal molar mass: 164

Find percentage dissociation.



Ans. (78)

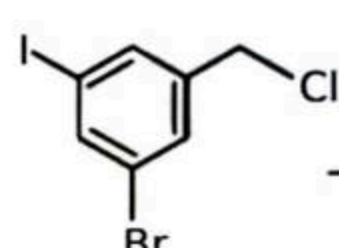
Sol.
$$i = \frac{\text{normal molar mass}}{\text{abnormal molar mass}} = \frac{164}{65.6} = 2.5$$

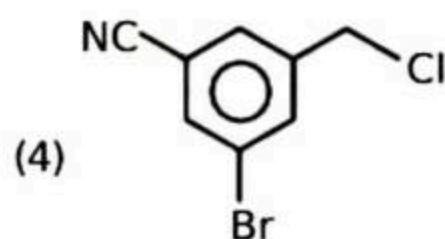
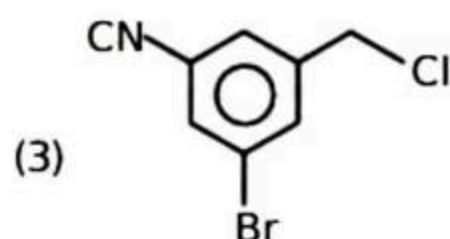
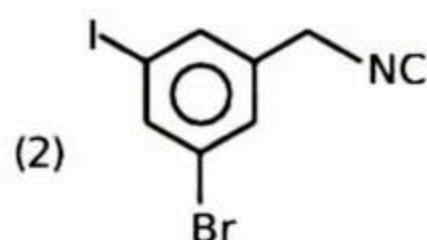
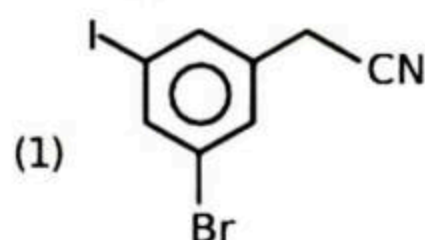
$$2.5 = 1 + 2\alpha$$

$$1.5 = 2\alpha$$

$$\alpha = 0.75$$

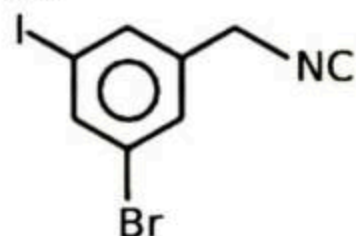
$$\% \alpha = 75$$

13.  $\xrightarrow{AgCN}$ P Major Product?



Ans. (2)

Sol.



14. Match the following reactions given in Column-I with respective reagents given in Column-II.

Column-I

- (a) Etard Reaction
- (b) Gattermann Reaction
- (c) Gattermann Koch Reaction
- (d) Staphen Reaction

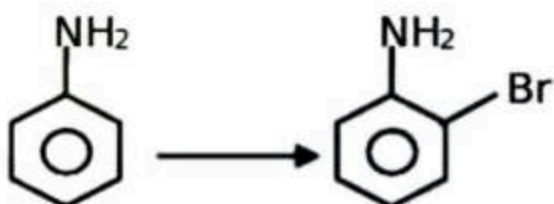
Column-II

- (p) $\text{SnCl}_2 + \text{HCl}$
- (q) CrO_2Cl_2
- (r) $\text{Cu} + \text{HCl}$
- (s) $\text{CO} + \text{HCl}$, Anhydrous AlCl_3

- (1) a-(q); (b)-(r); (c)-(s); (d)-(p)
- (2) a-(p); (b)-(q); (c)-(r); (d)-(s)
- (3) a-(q); (b)-(s); (c)-(p); (d)-(r)
- (4) a-(p); (b)-(r); (c)-(q); (d)-(s)

Ans. (1)

15.

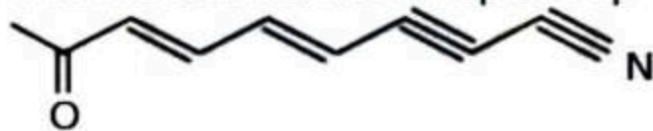


Above conversion can be done by using which reagents among the following.

- (1) Fe/Br_2 , $\text{H}_2\text{O}(\Delta)$, H_2SO_4
- (2) Ac_2O , H_2SO_4 , Br_2 , NaOH
- (3) Ac_2O , Br_2/AcOH , $\text{H}_2\text{O}/\text{H}^+$
- (4) Ac_2O , Br_2/Fe , NaOH

Ans. (2)

16. Find the total number of sp and sp^2 hybridised carbon atoms in the given compound.



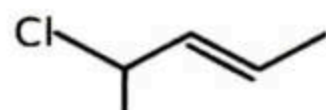
Ans. (8)

Sol. $\text{sp}^2 = 5$
 $\text{sp} = 3$
Total = 8

17. In the carius method, 0.25 gm organic compound is heated with fuming HNO_3 then AgNO_3 is added it gives 0.15 gm AgBr if molecular mass of AgBr is 188 then find mass percentage of Br in that organic compound

Ans. (25.53%)

18.



Find total number of stereoisomers of the given compound.

Ans. (4)

19. Match the following Nitrogenous Bases with their respective structures.

Column-I

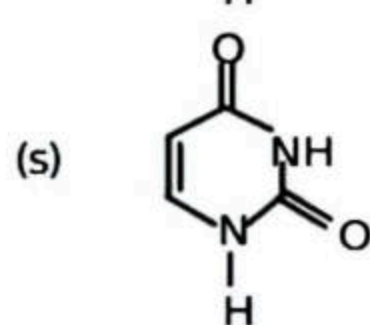
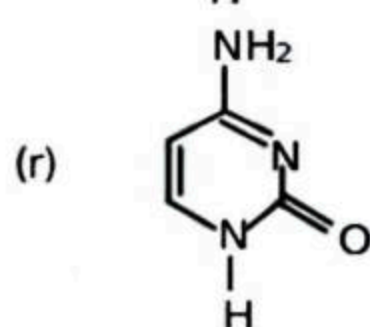
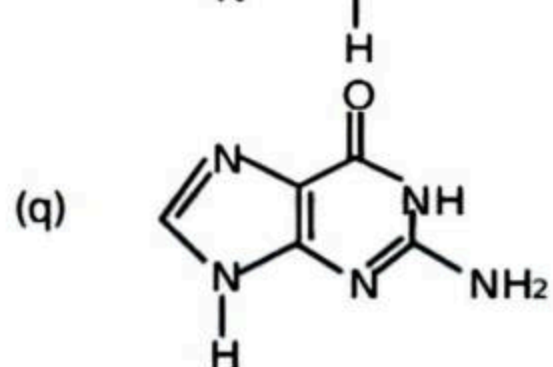
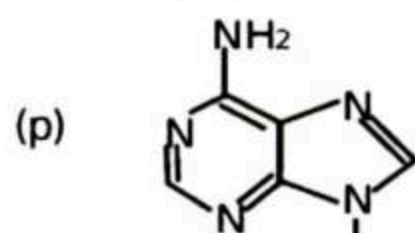
(a) Cytosine

(b) Uracil

(c) Guanine

(d) Adenine

Column-II



(1) a-(q); (b)-(r); (c)-(s); (d)-(p)

(2) a-(r); (b)-(s); (c)-(q); (d)-(p)

(3) a-(q); (b)-(s); (c)-(p); (d)-(r)

(4) a-(p); (b)-(r); (c)-(q); (d)-(s)

Ans. (2)

20. A hydrocarbon X that has molar mass 80 gm contains 90% carbon. Find degree of unsaturation in X.

Ans. (3)

PART : MATHEMATICS

1. If $7 = 5 + \frac{1}{7}(5+a) + \frac{1}{7^2}(5+2a) + \dots \infty$ term then the value of a is:

Ans. (6)

Sol. $7 = 5 + \frac{1}{7}(5+a) + \frac{1}{7^2}(5+2a) + \dots \infty$ (i)

multiply with $\frac{1}{7}$ ever term.

$$\frac{7}{7} = \frac{5}{7} + \frac{1}{7^2}(5+a) + \dots \infty \quad \dots \dots \dots \text{(ii)}$$

subtract from equation (i)equation (ii)

$$7 - \frac{7}{7} = 5 + \frac{1}{7}(a) + \frac{1}{7^2}(a) + \dots \infty$$

$$6 = 5 + \frac{1}{7}a[1 + \frac{1}{7} + \dots \infty]$$

$$1 = \frac{1}{7}a \left[\frac{1}{1 - \frac{1}{7}} \right]$$

$$1 = \frac{1}{7}a \times \frac{7}{6}$$

$$a = 6$$

2. If A and B are binomial coefficients of 30th and 12th term of binomial expansion $(1+x)^{2n-1}$. If $2A = 5B$, then the value of n is:

- (1) 19 (2) 20 (3) 21 (4) 40

Ans. (3)

Sol. $T_{30} = {}^{2n-1}C_{29} \cdot x^{29}, \quad A = {}^{2n-1}C_{29}$
 $T_{12} = {}^{2n-1}C_{11} \cdot x^{11}, \quad B = {}^{2n-1}C_{11}$

$$2A = 5B$$

$$\Rightarrow 2 \times {}^{2n-1}C_{29} = 5 \cdot {}^{2n-1}C_{11}$$

$$\Rightarrow \frac{2}{(2n-30)! \cdot 29!} = \frac{5}{(2n-12)! \cdot 11!}$$

$$n = 21.$$

3. In a arithmetic progression S_n represent the sum of n terms and $S_{12} = 57$, $S_{40} = 1030$ then the value of $S_{30} - S_{10}$ is:

Ans. (515)

Sol. $S_n = \frac{n}{2}[2a + (n-1)d]$

$$S_{12} = \frac{12}{2}[2a + 11d] = 57$$

$$2a + 11d = \frac{19}{2} \quad \dots(1)$$

$$S_{40} = \frac{40}{2} [2a + 39d] = 1030$$

$$2a + 39d = \frac{103}{2} \quad \dots(2)$$

Equation (2) – (1)

$$39d - 11d = \frac{103}{2} - \frac{19}{2}$$

$$d = \frac{3}{2}, a = \frac{-7}{2} \text{ now}$$

$$S_{30} - S_{10} = 15 [2a + 29d] - 5 [2a + 9d] = 20a + 390d$$

$$= 20 \times \left(\frac{-7}{2} \right) + 390 \times \left(\frac{3}{2} \right) = 515$$

4. Equation of the chord having mid point (3, 1) to the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ is :

$$(1) 25x + 5y - 125 = 0$$

$$(2) 48x + 25y - 169 = 0$$

$$(3) 65x + 2y - 12 = 0$$

$$(4) 45x + 4y - 135 = 0$$

Ans. (2)

Sol. $S_1 = T$

$$= \frac{3^2}{25} + \frac{1^2}{16} - 1 = \frac{3x}{25} + \frac{y}{16} - 1$$

$$= \frac{9}{25} + \frac{1}{16} = \frac{3x}{25} + \frac{y}{16}$$

$$= 48x + 25y - 169 = 0$$

5. Let $A = [a_{ij}]_{2 \times 2}$ such that $a_{ij} \in \{0, 1\}$. Probability that randomly chosen such matrix A is non-invertible is

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

$$(2) \frac{5}{8}$$

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

$$(4) \frac{7}{8}$$

Ans. (2)

Sol. Total number of matrices $A = 2^4 = 16$

$$\text{Let } A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

For non-invertible matrix $|A| = 0$

$$\Rightarrow ad - bc = 0$$

$$ad = bc$$

Case 1

$$\Rightarrow$$

$$ad = bc = 0$$

$$({}^2C_1 + {}^2C_2) ({}^2C_1 + {}^2C_2) = 9$$

Case 2

$$\Rightarrow$$

$$ad = bc = 1$$

$$1 \times 1 = 1$$

$$\text{Required probability} = \frac{9+1}{16} = \frac{5}{8}$$

6. If system of equations
 $x + 2y - 3z = 2$
 $2x + \lambda y + 5z = 5$
 $4x + 3y + \mu z = 33$
 has infinite many solutions then $\lambda + \mu$ is

- (1) $\frac{244}{5}$ (2) $\frac{1334}{5}$ (3) $\frac{1296}{5}$ (4) $\frac{4997}{5}$

Ans. (2)

Sol. $\Delta = 0 \quad \Delta = \begin{vmatrix} 1 & 2 & -3 \\ 2 & \lambda & 5 \\ 4 & 3 & \mu \end{vmatrix} = 0$

$12\lambda + \lambda\mu - 4\mu + 7 = \dots\dots\dots(i)$

$\Delta z = \begin{vmatrix} 1 & 2 & 2 \\ 2 & \lambda & 5 \\ 4 & 3 & 33 \end{vmatrix} = 0$

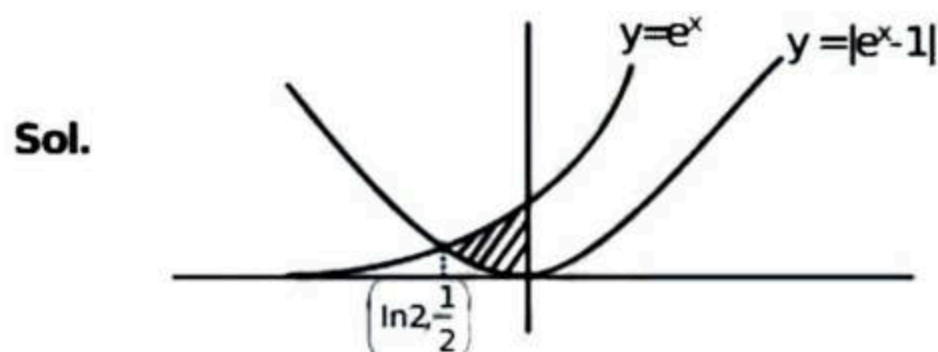
$\lambda = \frac{19}{5}$

from (i) $\mu = 263$

$\lambda + \mu = \frac{19}{5} + 263 = \frac{1334}{5}$

7. The area bounded by $y = e^x$, $y = |e^x - 1|$ and y-axis is ____
 (1) $\ln 2$ (2) $1 + \ln 2$ (3) $1 - \ln 2$ (4) $2\ln 2$

Ans. (3)



$e^x = 1 - e^x$

$e^x = \frac{1}{2}$

$x = -\ln 2$

required area = $\int_{-\ln 2}^0 (e^x - (1 - e^x)) dx = [2e^x - x]_{-\ln 2}^0$

$= 2 - (2e^{-\ln 2} + \ln 2) = 2 - 1 - \ln 2 = 1 - \ln 2$

8. $f(x) = [x] + |x - 2|$; $-2 < x < 3$
 and m = number of points of discontinuity, and
 n = number of points of non differentiability.

Then the value of $m + n$ is:

- (1) 8 (2) 7 (3) 9 (4) - 10

Ans. (1)

Sol. $f(x) = \begin{cases} -x & ; x \in (-2, -1) \\ 1-x & ; x \in [-1, 0) \\ 2-x & ; x \in [0, 1) \\ 3-x & ; x \in [1, 2) \\ x & ; x \in [2, 3) \end{cases}$

As we can see that function is discontinuous at $-1, 0, 1$ and 2 .

Therefore, function is non-differentiable at $-1, 0, 1$ and 2 .

Therefore, $m = 4$ and $n = 4$.

Then, $m + n = 8$.

- 9.** There is a group A of 5 boys and 3 girls and another group B of 5 boys and 6 girls. How many ways can we invite 4 boys and 4 girls for party with 5 from group A and 3 from group B.

(1) 2850

(2) 2550

(3) 3150

(4) 3450

Ans. (3)

Sol. Group A $\Rightarrow$ 5B, 3G

Group B $\Rightarrow$ 5B, 6G

4 Boys and 4 girls invite

5 from group A and 3 from group B

Case (i)

In group A	4B 1G	In B	0B 3G
In group A	3B 2G	In B	1B 2G
In group A	2B 3G	In B	2B 1G
In group A	1B 4G	In B	3B 0G (not possible)

We have three cases than.

$${}^5C_4 \times {}^3C_1 \times {}^5C_0 \times {}^6C_3 = 5 \times 3 \times 1 \times 20 = 300$$

$${}^5C_3 \times {}^3C_2 \times {}^5C_1 \times {}^6C_2 = 10 \times 3 \times 5 \times 15 = 2250$$

$${}^5C_2 \times {}^3C_3 \times {}^5C_2 \times {}^6C_1 = 10 \times 1 \times 10 \times 6 = 600$$

$$300 + 2250 + 600 = 3150$$

- 10.** $2 \cos x \frac{dy}{dx} = \sin 2x - 2y \sin x$, $y(x) = y$ and $y(0) = 0$, then find the value of $y\left(\frac{\pi}{4}\right) + y\left(\frac{\pi}{4}\right)$ is:

(1) $\frac{1}{2}$

(2) $\frac{1}{\sqrt{2}}$

(3) $-\frac{1}{2}$

(4) $-\frac{1}{\sqrt{2}}$

Ans. (2)

Sol. $(2 \cos x) y' (x) = \sin 2x - 2y(x) \sin x$

Put $x = \frac{\pi}{4}$

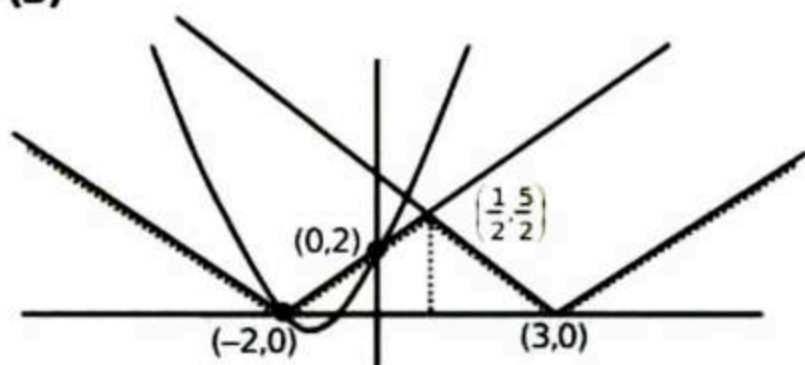
$$2 \times \frac{1}{\sqrt{2}} y\left(\frac{\pi}{4}\right) = 1 - 2y\left(\frac{\pi}{4}\right) \times \frac{1}{\sqrt{2}}$$

$$y\left(\frac{\pi}{4}\right) + y\left(\frac{\pi}{4}\right) = \frac{1}{\sqrt{2}}$$

11. Number of real solutions of the equation $x^2 + 3x + 2 = \min\{|x - 3|, |x + 2|\}$ is _____
 (1) 0 (2) 1 (3) 2 (4) 3

Ans. (3)

Sol.



Total number of solutions = 2

12. Consider the differential equation $x^2 \frac{dy}{dx} = 2xy + 3$ such that $y(1) = 4$ then the value of $2y(2)$ is

Ans. (39)

Sol. Divide by x^2

$$\frac{dy}{dx} - \frac{2}{x}y = \frac{3}{x^2}$$

$$\text{I.F.} = e^{\int -\frac{2}{x} dx} = e^{-2 \ln x} = e^{\ln x^{-2}} = \frac{1}{x^2}$$

$$y \cdot \text{I.F.} = \int \frac{3}{x^2} \cdot \text{I.F.} dx$$

$$\frac{y}{x^2} = 3 \int \frac{dx}{x^4}$$

$$\frac{y}{x^2} = \frac{-1}{x^3} + C$$

$$y(1) = 4 \Rightarrow 4 = -1 + C \Rightarrow C = 5$$

$$\frac{y}{x^2} = \frac{-1}{x^3} + 5$$

$$y = -\frac{1}{x} + 5x^2$$

$$y(2) = -\frac{1}{2} + 20 = \frac{39}{2}$$

$$2y(2) = 39$$

13. If

$$\lim_{x \rightarrow 0} \begin{vmatrix} a + \frac{\sin x}{x} & 1 & b \\ a & 1 + \frac{\sin x}{x} & b \\ a & 1 & b + \frac{\sin x}{x} \end{vmatrix} = \lambda a + \mu b + C$$

where λ and μ are the coefficient of a , b and c is constant then find the value of $(\lambda + \mu + c)^2$

Ans. (16)

Sol.

$$\Rightarrow \begin{vmatrix} a+1 & 1 & b \\ a & 1+1 & b \\ a & 1 & b+1 \end{vmatrix} = \lambda a + \mu b + C$$

$$R_1 \rightarrow R_1 - R_2$$

$$R_2 \rightarrow R_2 - R_3$$

$$\begin{vmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ a & 1 & b+1 \end{vmatrix} = \lambda a + \mu b + C$$

$$C_2 \rightarrow C_1 + C_2$$

$$\begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & -1 \\ a & a+1 & b+1 \end{vmatrix} = \lambda a + \mu b + C$$

$$a + b + 2 = \lambda a + \mu b + C$$

$$\text{So } \lambda = 1, \mu = 1, C = 2$$

$$\text{Now, } (\lambda + \mu + C)^2 = 16$$

14. If $f: (-\infty, \infty) \rightarrow (-\infty, 1)$, and $f(x) = \frac{2^x - 2^{-x}}{2^x + 2^{-x}}$, then $f(x)$ is

(1) one-one and onto

(2) one-one and into

(3) many-one and onto

(4) many-one and into

Ans. (2)

Sol. $f(x) = \frac{2^{2x} - 1}{2^{2x} + 1} = \frac{2^{2x} + 1 - 2}{2^{2x} + 1} = 1 - \frac{2}{2^{2x} + 1}$

2^{2x} is one-one so $f(x)$ is one-one

For $x \in (-\infty, \infty)$

$$2^x \in (0, \infty)$$

$$2^{2x} + 1 \in (1, \infty)$$

$$\frac{1}{2^{2x} + 1} \in (0, 1)$$

$$\frac{-2}{2^{2x} + 1} \in (-2, 0)$$

$$1 - \frac{2}{2^{2x} + 1} \in (-1, 1)$$

Range of $f(x)$ is $(-1, 1)$ but codomain of $f(x)$ is $(-\infty, 1)$ so $f(x)$ is into.

15. Given $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is a hyperbola with latus rectum $12\sqrt{5}$ and eccentricity $\sqrt{\frac{5}{2}}$ and another hyperbola

$\frac{x^2}{A^2} - \frac{y^2}{B^2} = -1$ with latus rectum $15\sqrt{2}$. If the product of transverse axis of both the hyperbola is $100\sqrt{10}$, eccentricity of the later hyperbola is:

(1) 0

(2) 2

(3) $\sqrt{\frac{13}{5}}$

(4) $\sqrt{\frac{11}{5}}$

Ans. (4)

Sol. $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

$$\frac{2b^2}{a} = 12\sqrt{5} \quad \dots\dots\dots (i)$$

$$\sqrt{1 + \frac{b^2}{a^2}} = \sqrt{\frac{5}{2}} \quad \dots\dots\dots (ii)$$

from (i) and (ii)

$$a = 4\sqrt{5} \text{ and } b^2 = 120$$

$$\frac{x^2}{A^2} - \frac{y^2}{B^2} = -1$$

$$\frac{2A^2}{B} = 15\sqrt{2} \quad \dots\dots\dots (iii)$$

(since product of transverse axis = $100\sqrt{10}$)

$$(2a).(2B) = 100\sqrt{10} \quad \dots\dots\dots (iv)$$

from (iii) & (iv)

$$A^2 = \frac{375}{4} \text{ and } B^2 = \frac{625}{8}$$

$$e_2 = \sqrt{1 + \frac{A^2}{B^2}} = \sqrt{\frac{11}{5}} \text{ (substituting the value of } A^2 \text{ and } B^2 \text{ from the above equation).}$$