JEE(Main) 2025 | DATE: 24-01-2025 (SHIFT-2) | PAPER-1 | MEMORY BASED

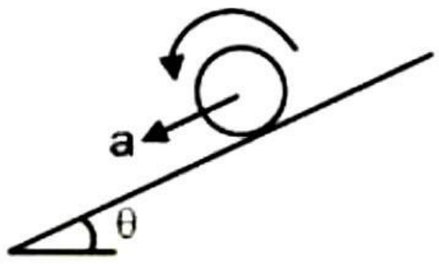
PART : PHYSICS

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. $V = R\omega$

$$\frac{Kt}{Krot} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}\times I\omega^2} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}\times\frac{2}{5}mv^2} = \frac{5}{2}$$

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

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

$g' = 9\,g$

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

(3) $E = M_0C^2 + PC^2$ (4) $E^2 = M_0C + PC$

Ans. **(2)**

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

$$P^2 = \frac{m0^2v^2}{\left(1-\frac{v^2}{c^2}\right)} = \frac{m_0^2\frac{v^2}{c^2}c^2}{\left(1-\frac{v^2}{c^2}\right)}$$

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

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

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

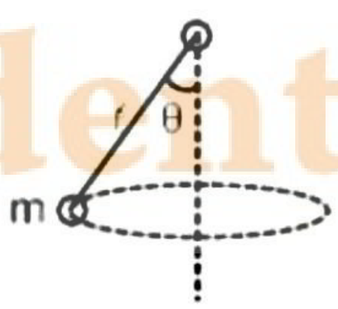
$p^2c^2 = -(m^0c^2)^2 + (mc^2)^2$

$(mc^2)^2 = p^2c^2 + (m_0c^2)^2$

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

$E = \sqrt{(pc)^2 + (m_0c^2)^2}$

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 $\omega = \frac{3}{\pi}\frac{rev}{sec}$ and tension in the string is $x(m\ell)$ then value of x is _____



Ans. **36.00**

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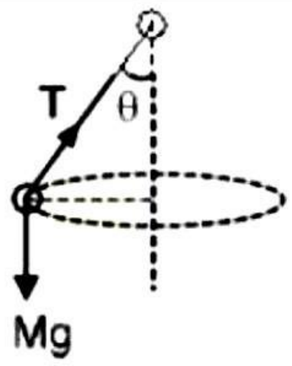
Sol.



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

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

$\omega = 6$

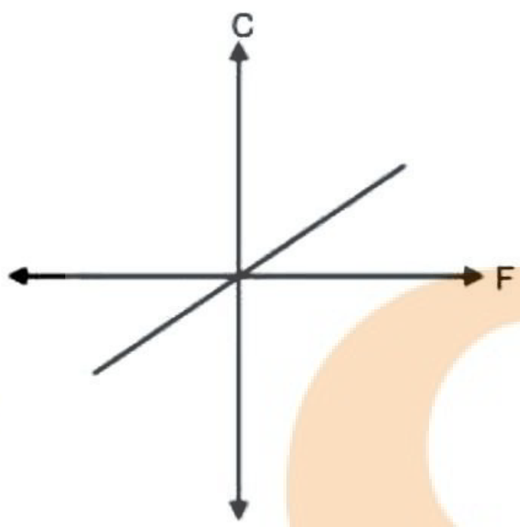
$T\sin\theta = m(\ell\sin\theta)\omega^2$

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

$x = 36$

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

(1)



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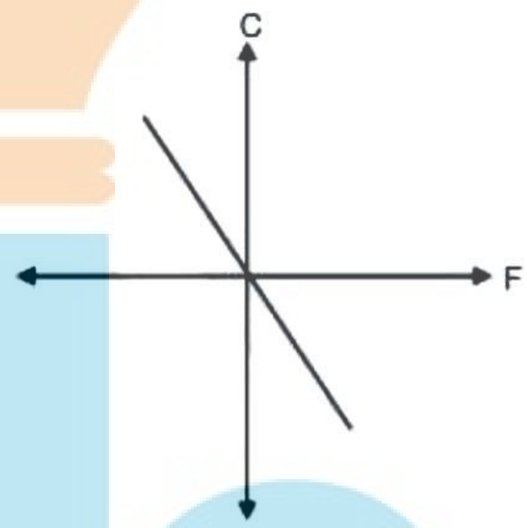

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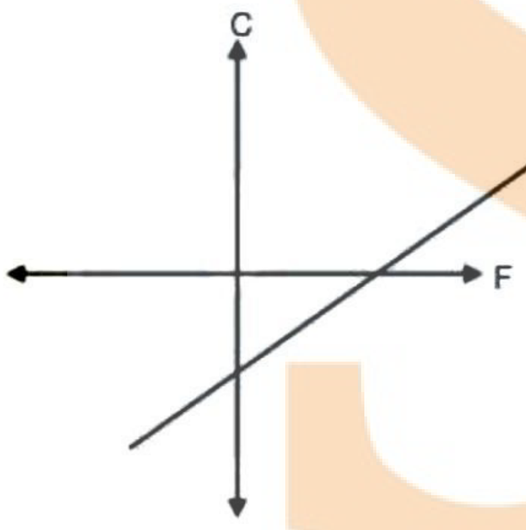

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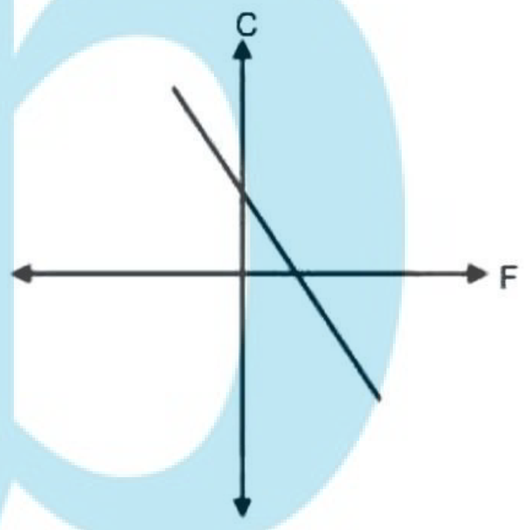

Ans. **(3)**

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

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

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

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

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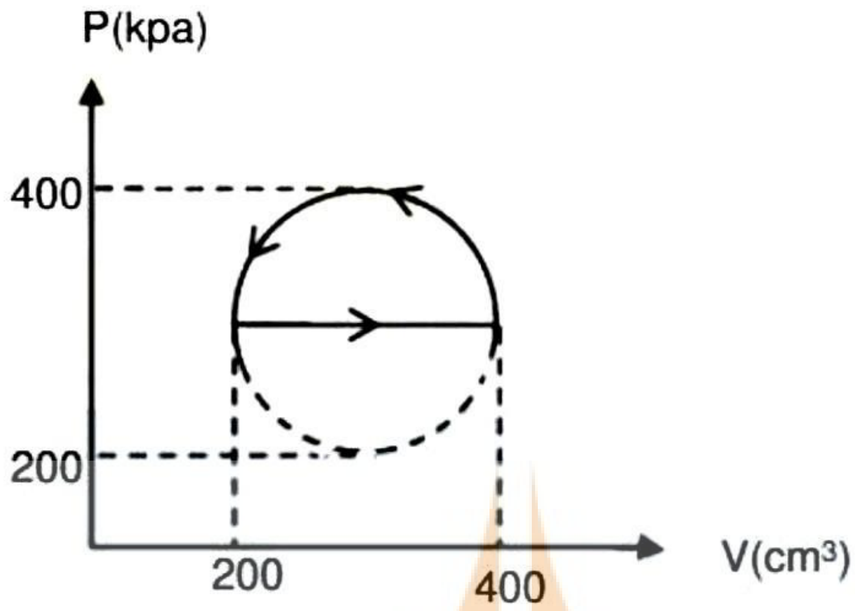
7. An ideal gas is undergone through a cyclic process as shown in the graph. The net heat ejected by the gas during one cycle will be : -



(1) 5 πJ (2) 10 πJ (3) 15 πJ (4) 2.5 πJ

Ans. **(1)**

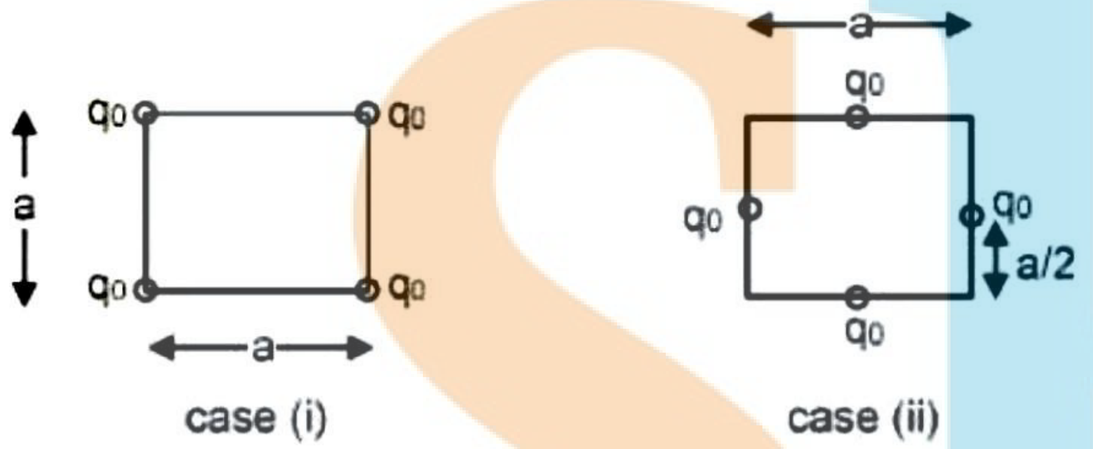
Sol. W_{cycle} = Area enclosed by P - V cycle = $\frac{\pi ab}{2}$

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

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

Heat rejected by the gas = 5πJ

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

Ans. **(1)**

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

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

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

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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. $T.V^{\gamma-1}$ = 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 $\lambda_{air} = 690$ nm , D = 0.72 meter d = 1.5mm
(1) 0.23 mm (2) 1.23 mm (3) 2.28 mm (4) 0.40 mm

Ans. **(1)**

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

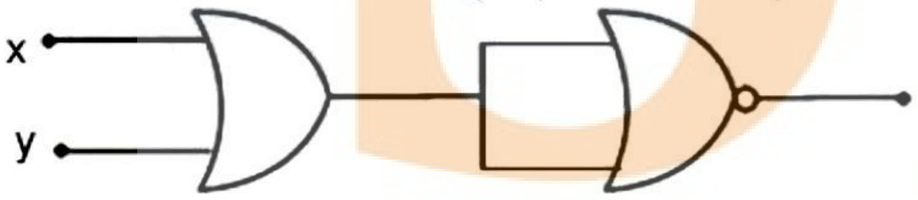
$= \frac{690\times10^{-9}\times72\times10^{-2}}{144\times10}$

$= \frac{690}{2\times3\times10^{-3}}$

$= 230 \times 1^{-6}$

0.23 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)**

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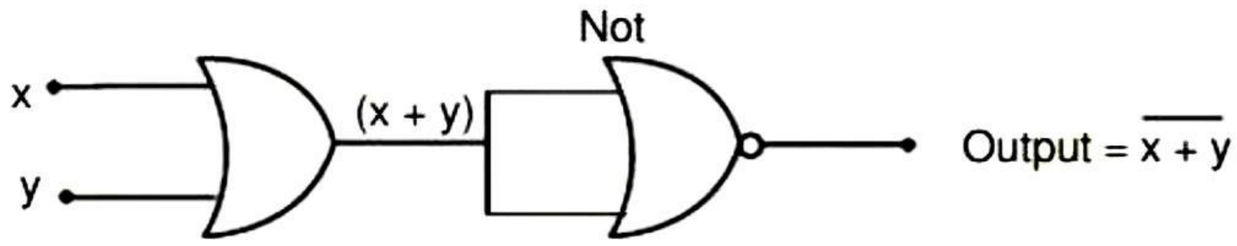
Sol.



(A) x = 0, y = 0 ⇒ output = 0 + 0 = 1

(B) x = 0 , y = 1 ⇒ output 0 + 1 = 0

(C) x = 1, y = 0 ⇒ output 1 + 0 = 0

(D) x = 1, y = 1 ⇒ 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. $P_1 = P = \frac{N_1 hc}{\lambda_1}$ $P = \frac{Nhc}{\lambda}$ N → No. of photon/sec

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

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

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

$n_2 = 5 \times 10^{14}$ 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 400km^2, on a camera film of size 2cm × 2 cm. find the focal length of the lens used in camera in mm.

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

Ans. **(3)**

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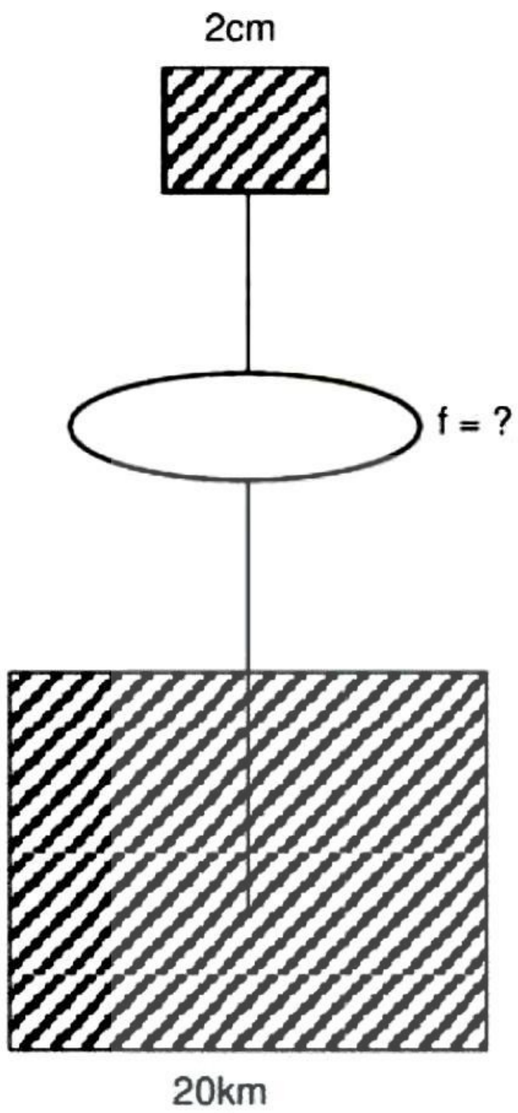
Sol.



$$|m| = \frac{h_i}{h_0} = \frac{2cm}{20km} = \frac{2\times10^{-2}}{20\times10^{3}} = 10^{-6}$$

Since the image is real, so it will be inverted

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

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

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

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

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

$$f = \frac{18km}{10^{6}} = \frac{18\times10^{3}\times10^{3}mm}{10^{6}}$$

$$f = 18\ mm$$

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

(1) 7 (2) 4 (3) 9 (4) 2

Ans. **(4)**

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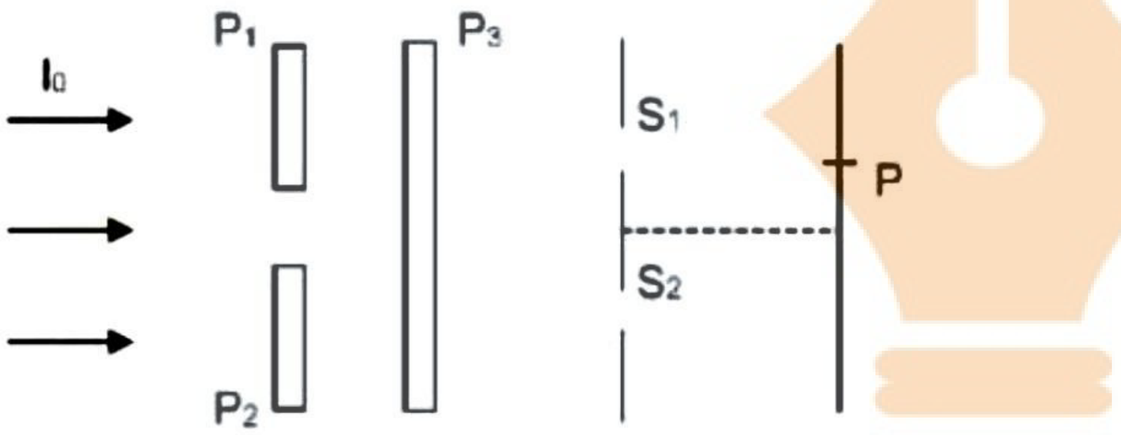
Sol.

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

$$\frac{9\times10^{9}\times2\times10^{-8}\times2\times10^{-8}}{9\times10^{-3}} = R^2$$

R = 2 cm

17.



In the following diagram polarizer P_1 & P_2 are orthogonal and P_3 is aligned at 45º 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 Þ $\frac{I_0}{2}\cos^2 45 = \frac{I_0}{2}\left(\frac{1}{2}\right) = \frac{I_0}{4}$

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 16ºC. During first 4 minutes, its temperature falls from 40ºC to 24ºC, then find its temperature after 4 minutes.

(1) 12ºC (2) 22ºC (3) 10ºC (4) 18.7ºC

Ans. **(4)**

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

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

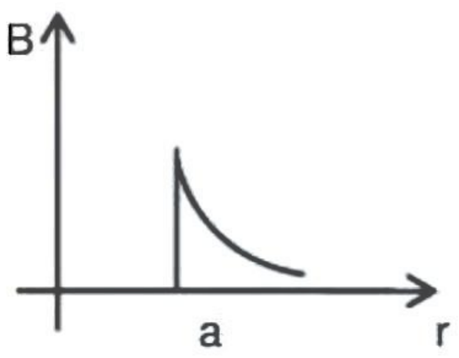
$$\left(\frac{24-T}{4\min}\right) = k\left(\frac{T+24}{2} - 16\right) \quad \ldots(ii)$$

Solving the equations we get

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

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

(1)



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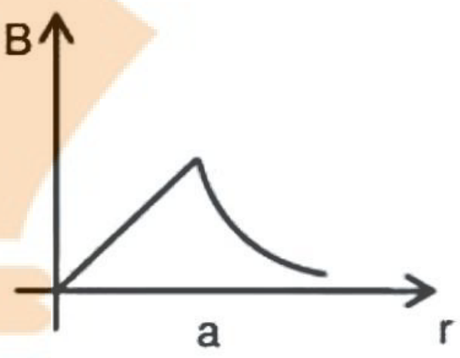

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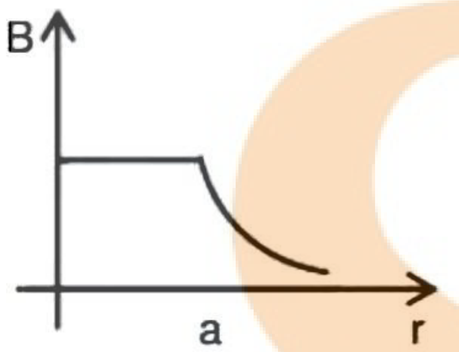

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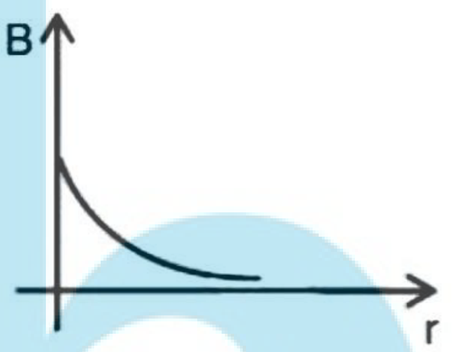

Ans. **(2)**

20. The position vector of a particle varies with time as $\vec{r} = \left(5t^2\hat{i} - 5t\hat{j}\right)$ 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)**

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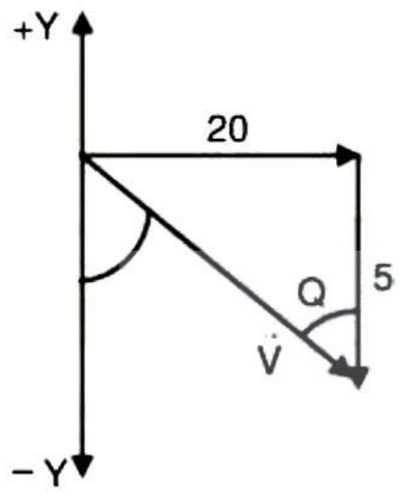
Sol. $\vec{v} = \frac{d\vec{r}}{dt} = 10t\hat{i} - 5\hat{j}$

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

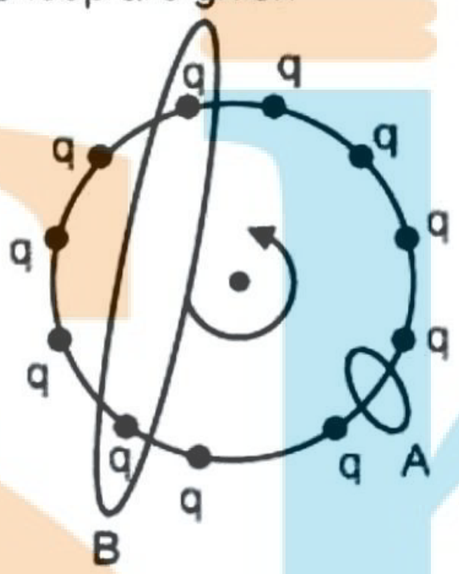
$= 5\sqrt{17}$ m/sec



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

$\theta = \tan^{-1}(4)$ with – y 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) $\frac{nqw}{2\pi}$ (2) $\frac{nqw}{\pi}$ (3) $\frac{2\pi w}{nq}$ (4) $\frac{2\pi}{nqw}$

Ans. **(1)**

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

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

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

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

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

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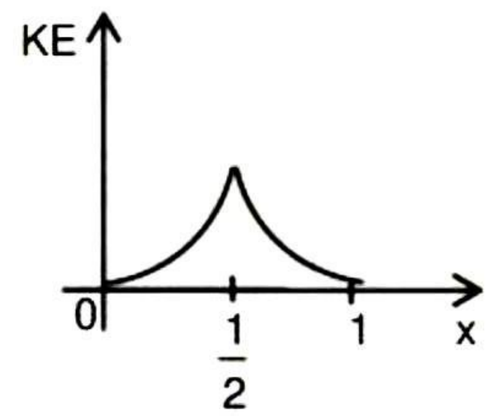
22. $x(t) = x_0 \sin^2\left(\frac{t}{2}\right)$ (where $x_0 = 1$) find graph of Kinetic energy v/s x

(1)



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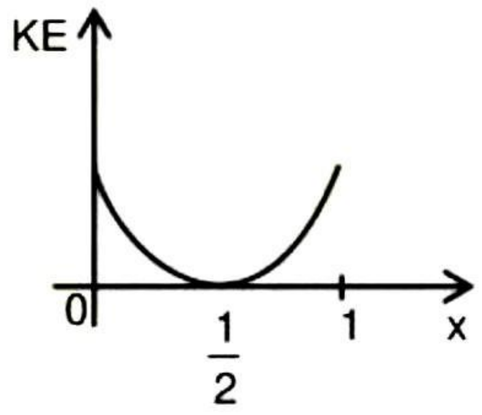

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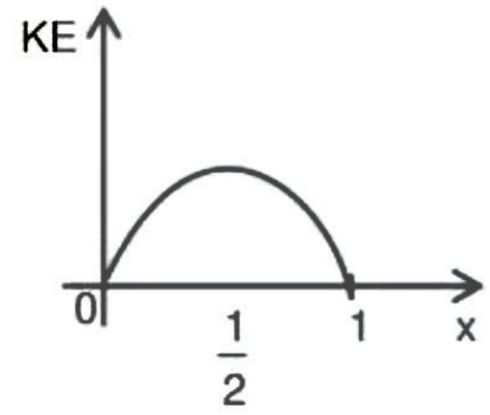

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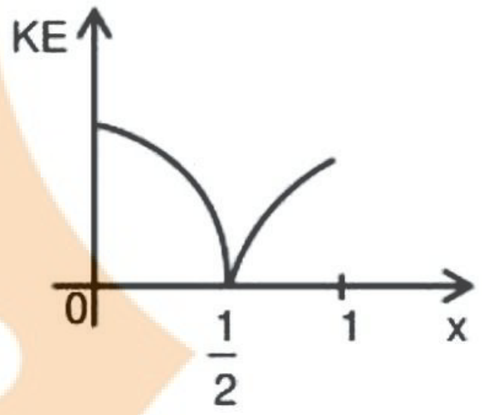


Ans. **(3)**

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

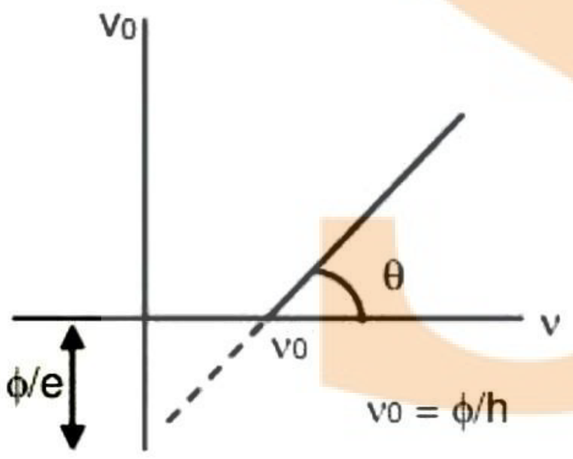
(3) h is related to slope (4) to find D, we don't require h.

Ans. **(1)**

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

$$v_0 = \frac{h\nu}{e} - \frac{h\nu_0}{e}$$

$$v_0 = \frac{h\nu}{e} - \frac{d}{e}$$



$$\tan\theta = \frac{h}{e} = \text{slope}$$

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 1amp. 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)**

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Sol. We know that

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

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

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

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

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

(1) 5×10^{8} N/m^2 (2) 5×10^{9} N/m^2 (3) 5×10^{10} N/m^2 (4) 5×10^{11} N/m^2

Ans. **(2)**

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

$$K = \frac{\text{ExcessPressure}(P)}{\text{VolumetricStrain}(\Delta V/V)}$$

Given data :

Bulk modulus, $K = 25 \times 10^{11}$ 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 :

5×10^{9} N/m^2

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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 <Intra 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 → Blue → Green → Violet (2) Violet → Blue → Pale blue → Green

(3) Pale blue → Blue → Violet → Green (4) Green → Pale blue → Blue → viole

Ans. **(4)**

Sol.

$[Ni(H_2O)_6]^{2+}$ (Green) $\xrightarrow{en(aq)}$ $[Ni(H_2O)_4\ en]^{2+}$ (Pale blue)

$\downarrow$ en(aq)

$[Ni(H_2O)_2\ (en)_2]^{2+}$ (Blue)

$\downarrow$ en(aq)

$[Ni(en)_3]^{2+}$ (Violet)

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 S1 >Ge & Pb, Sn exceptional

5. Compound $\xrightarrow{\text{aquaregia}}$ B $\xrightarrow[CH_3COOH]{KNO_2}$ Yellow ppt

(1) NiS (2) ZnS (3) CoS (4) MnS

Ans. **(3)**

Sol. $CoS \xrightarrow{\text{aquaregia}} CoCl_2 \xrightarrow[CH_3COOH]{KNO_2} K_3[Co(NO_2)_6]\downarrow$ Yellow

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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)**

Sol. $C : H : O = \frac{54.2}{12} : \frac{9.2}{1} : \frac{36.6}{16}$

$=4.6 : 9.2 : 2.3$

$=2 : 4 : 1$

$Ef = C_2H_4O_1 \quad (E.F.)_{mass} = 44$

$n = \frac{132}{44} = 3 \therefore Mf = (C_2H_4O)_3 = C_6H_{12}O_3$

7. Consider the following reactions

$S_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow SO_{3(g)} + 2x$ kJ

$SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)} + y$ kJ

Calculate heat of reaction (kJ) for the given reaction

$S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$

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

Ans. **(4)**

Sol. $\Delta H_1 = -2x$

$\Delta H_2 = -y$

$S_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow SO_{3(g)}, \Delta H_1 = -2x$

$SO_{3(g)} \rightarrow SO_{2(g)} + \frac{1}{2}O_{2(g)}, \Delta H_2 = y$

$S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$

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

$= -2x + y$

$= y - 2x$ 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

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

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

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

Ans. **(1)**

9. Calculate the overall activation energy

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

$E_{a_2} = 40$kJ

$E_{a_3} = 20$kJ

Ans. **(20)**

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Sol. $e^{-Ea/RT} = \sqrt{\frac{e^{-Ea_1/RT} \cdot e^{-Ea_3/RT}}{e^{-Ea_2/RT}}}$

$$e^{-Ea/RT} = \sqrt{e^{\frac{(Ea_2 - Ea_1 - Ea_3)}{RT}}}$$

$$-E_a = (Ea_2 - Ea_1 - Ea_3) \times \frac{1}{2}$$

$$E_a = (Ea_1 + Ea_3 - Ea_2) \times \frac{1}{2}$$

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

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 is 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
$X \rightarrow$	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.

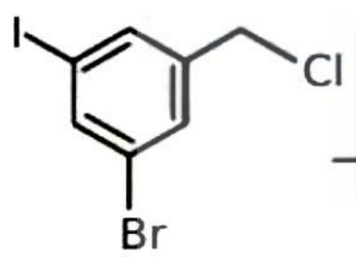
$$MX_2 \longrightarrow M^{+2} + 2X^-$$

Ans. **(78)**

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

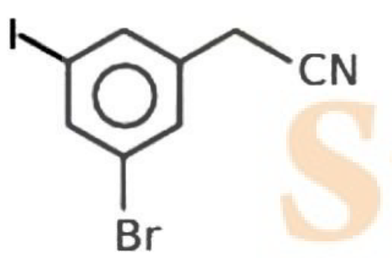
$$2.5 = 1 + 2\alpha$$
$$1.5 = 2\alpha$$
$$\alpha = 0.75$$
$$\%\alpha = 75$$

13.

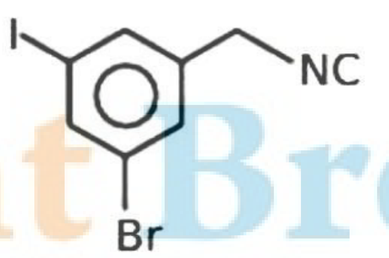


AgCN → P Major Product?

(1)



(2)



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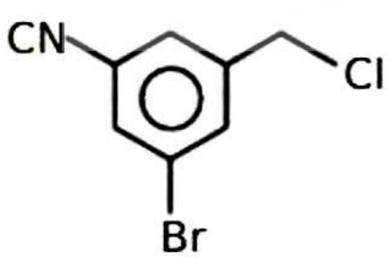

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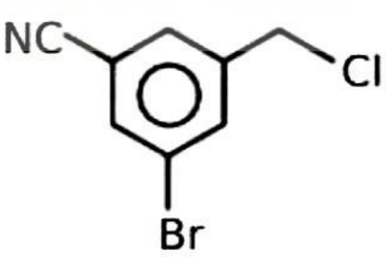

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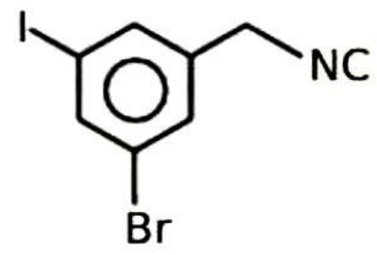
Ans. **(2)**

Sol.



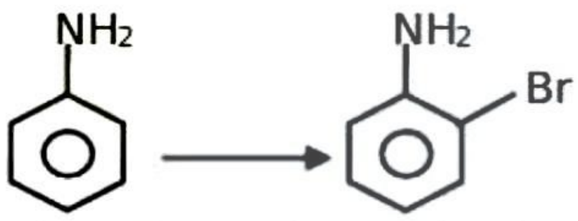
14. Match the following reactions given in Column-I with respective reagents given in Column-II.

	Column-I		**Column-II**
(a)	Etard Reaction	(p)	$SnCl_2$ +HCl
(b)	Gattermann Reaction	(q)	CrO_2Cl_2
(c)	Gattermann Koch Reaction	(r)	Cu +HCl
(d)	Staphen Reaction	(s)	CO +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)**

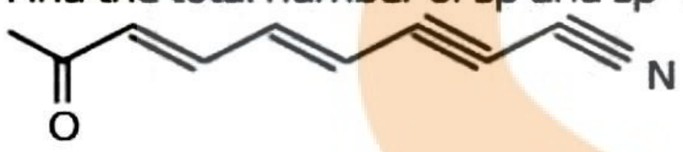
15.



Above conversion can be done by using which reagents among the following.
(1) Fe/Br_2, $H_2O(\Delta)$, H_2SO_4 (2) Ac_2O, H_2SO_4, Br_2,NaOH
(3) Ac_2O, $Br_2/AcOH$, H_2O/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.



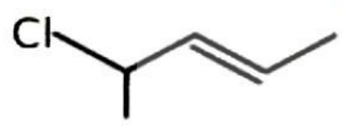
Ans. **(8)**

Sol. sp^2 =5
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)**

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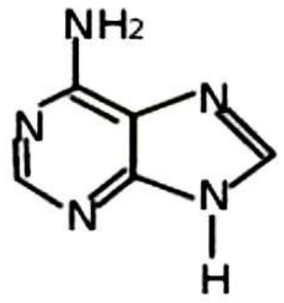
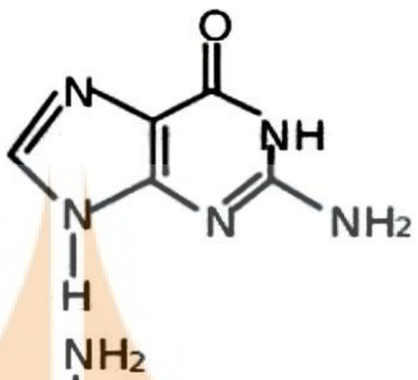
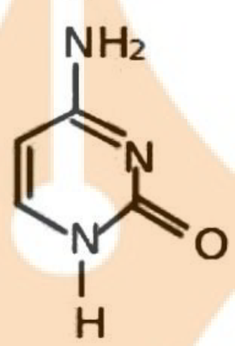
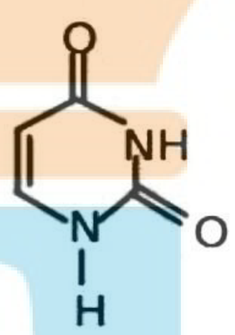
19. Match the following Nitrogenous Bates with their respective structures.

	Column-I		Column-II
(a)	Cytosine	(p)	
(b)	Uracil	(q)	
(c)	Guanine	(r)	
(d)	Adenine	(s)	

(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)**

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PART : MATHEMATICS

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

Ans. **(6)**

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

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

$\frac{7}{7} = \frac{5}{7} + \frac{1}{7^2}(5 + a) + \ldots\ldots\ldots\ldots \infty$ ..... (ii)

subtract from equation (i) .....equation (ii)

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

$6 = 5 + \frac{1}{7}a\left[1 + \frac{1}{7} + \ldots\ldots\ldots\ldots \infty\right]$

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

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

$a = 6$

2. If A and B are binomial coefficients of 30^{th} and 12^{th} 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. $T_{30} = {}^{2n-1}C_{29}.x^{29}$, $A = {}^{2n-1}C_{29}$

$T_{12} = {}^{2n-1}C_{11}.x^{11}$, $B = {}^{2n-1}C_{11}$

$2A = 5B$

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

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

$n = 21.$

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

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

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

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

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

Equation (2) – (1)

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

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

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

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

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 $A = 2^4 = 16$

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 $\Rightarrow$ $ad = bc = 1$

$1 \times 1 = 1$

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

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

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

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

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

from (i) $\mu=263$

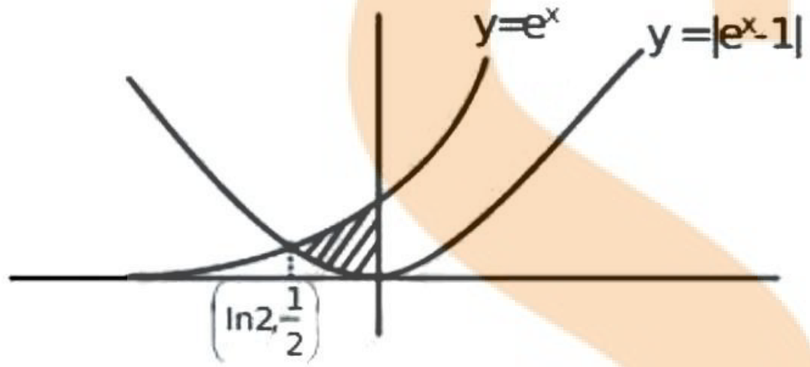
$\lambda+\mu=\frac{19}{5}+263=\frac{1334}{5}$

7. The area bounded by $y=e^x$, $y=|e^x-1|$ and y-axis is ____

(1) ln2 (2) $1+\ln2$ (3) $1-\ln2$ (4) $2\ln2$

Ans. **(3)**

Sol.



$e^x=1-e^x$

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

$x=-\ln2$

required area $=\int_{-\ln2}^{0}(e^x-(1-e^x))dx=\left[2e^x-x\right]_{-\ln2}^{0}$

$=2-(2e^{-\ln2}+\ln2)=2-1-\ln2=1-\ln2$

8. $f(x)=[x]+|x-2| \quad ; \quad -2<x<3$

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)**

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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 4girls 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.

${}^5C_4\times{}^3C_1\times{}^5C_0\times{}^6C_3=5\times3\times1\times20=300$

${}^5C_3\times{}^3C_2\times{}^5C_1\times{}^6C_2=10\times3\times5\times15=2250$

${}^5C_2\times{}^3C_3\times{}^5C_2\times{}^6C_1=10\times1\times10\times6=600$

$300+2250+600=3150$

10. $2\cos x\frac{dy}{dx}=\sin2x-2y\sin x$, $y(x)=y$ 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. $(2\cos x)\,y'(x)=\sin2x-2y(x)\sin x$

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

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

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

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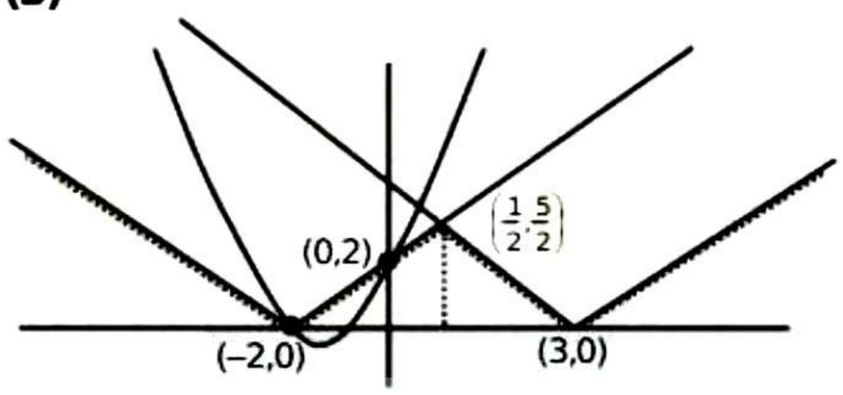
11. Number of real solutions of the equation $x^2+3x+2=\min\{|x-3|, |x+2|\}$ is ____

(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 $2(y(2))$ is

Ans. **(39)**

Sol. Divide by x^2

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

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

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

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

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

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

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

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

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

$$2y(2)=39$$

13. If

$$\lim_{x\to0}\begin{vmatrix} a+\frac{\sin x}{x} & 1 & b \\ a & 1+\frac{\sin x}{x} & b \\ a & 1 & b+\frac{\sin x}{x}\end{vmatrix}=\lambda a+\mu b+C$$

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)**

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Sol.

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

$R_1 \to R_1 - R_2$

$R_2 \to R_2 - R_3$

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

$C_2 \to C_1 + C_2$

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

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

So $\lambda = 1, \mu = 1, C = 2$

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

14. If $f : (-\infty, \infty) \to (-\infty, 1)$, and $f(x) = \dfrac{2^x - 2^{-x}}{2^x + 2^{-x}}$, 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. $f(x) = \dfrac{2^{2x} - 1}{2^{2x} + 1} = \dfrac{2^{2x} + 1 - 2}{2^{2x} + 1} = 1 - \dfrac{2}{2^{2x} + 1}$

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

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

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

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

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

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

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

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

15. Given $\dfrac{x^2}{a^2} \dfrac{-y^2}{b^2} = 1$ is a hyperbola with latus rectum $12\sqrt{5}$ and eccentricity $\sqrt{\dfrac{5}{2}}$ and another hyperbola $\dfrac{x^2}{A^2} \dfrac{-y^2}{B^2} = -1$ 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) $\sqrt{\dfrac{13}{5}}$
(4) $\sqrt{\dfrac{11}{5}}$

Ans. **(4)**

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

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

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

from (i) and (ii)

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

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

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

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

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

from (iii) & (iv)

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

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

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