JEE(Main)-2024 | 05 April 2024 (Shift-2 Evening) | Question Paper with Solutions | Memory Based

MATHEMATICS

1. Find the coefficient of x^0 in expansion of $\left(\frac{3^{1/5}}{x}+\frac{x}{5^{1/3}}\right)^{12}$

Ans. $12c_6\frac{3^{6/5}}{5^2}$

Sol. $T_{r+1}={}^{12}C_r\left(\frac{3^{1/5}}{x}\right)^{12-r}\left(\frac{x}{5^{1/3}}\right)^r$

$=x^{-12+r}x^r=x^0$

$2r-12=0$

$r=6$

$\boxed{\text{coeff of } x^0 \Rightarrow 12c_6\frac{3^{6/5}}{5^2}}$

2. $x|x|+2|x-5|+2x+3=0.$

Ans. $x=-\sqrt{13}$

Sol. (I) $5\geq x\geq 0.$

$x^2+2(-x+5)+2x+3=0$

$x^2-2x+10+2x+3=0$

$x^2+13=0$

No solution.

(II) $x\geq 5$

$x^2+2x-10+2x+3=0.$

$x^2+4x-7=0.$

$x=\frac{-4\pm\sqrt{16+28}}{2}$

$x=\frac{-4\pm\sqrt{44}}{2}$

$x\neq\frac{\sqrt{44}-4}{2}.$

$x\neq\frac{-\sqrt{44}-4}{2},$

(III) $x\leq 0.$

$-x^2-2x+10+2x+3=0.$

$-x^2+13=0.$

$x^2=13$

$x=\pm\sqrt{13}$

$x\neq\sqrt{13}$

Only one solution $x=-\sqrt{13}$

3. Minimum value of k so that $4^{x+1} + 4^{1-x}, \frac{k}{2}, 16^x + 16^{-x}$ are in A.P.

Ans. 10

Sol. $k = 4^x \cdot 4 + \frac{4}{4^x} + 16^x + \frac{1}{16^x}$

$k_{min} = 4 + 4 + 2 = 10$

4. Find word formed by all letters of the word "HBBOJ" whose Rank is 50^{th} when letters are arranged in dictionary.

Ans. O B H O J

Sol. B B H J O

$\left.\begin{matrix} \underline{B} \quad ---- \rightarrow 24 \\ \underline{H} \quad ---- \rightarrow 12 \\ J \quad ---- \rightarrow 12 \end{matrix}\right\} 48$

O B H J O $\rightarrow 49^{th}$

O B H O J $\rightarrow 50^{th}$

Ans. O B H O J

5. Let (α, β, γ) be the image of $(3,5,8)$ in the line $\frac{x-1}{2} = \frac{y-3}{3} = \frac{z-2}{4}$ then value of $3\alpha + 4\beta + 5\gamma$ is.

Ans. (_)

Sol. Let $m(2\lambda + 1, 3\lambda + 3, 4\lambda + 2)$

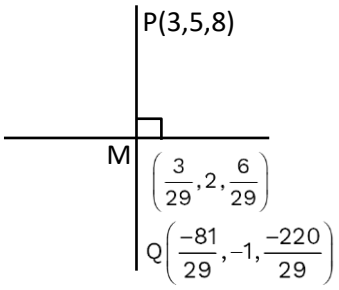
$\overrightarrow{PM} = (2\lambda - 2)\hat{i} + (3\lambda - 2)\hat{j} + (4\lambda - 6)\hat{k}$

Now. $\overrightarrow{PM} \cdot (2\hat{i} + 3\hat{i} + 4\hat{k}) = 0$

$2(2\lambda - 2) + 3(3\lambda + 3) + 4(4\lambda + 2) = 0$

$29\lambda + 13 = 0 \Rightarrow \left(\lambda = \frac{-13}{29}\right)$

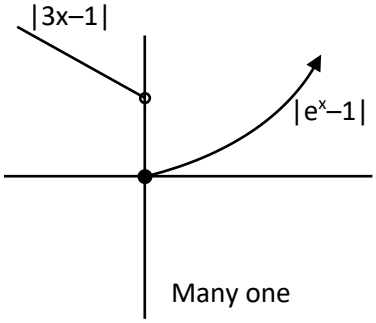
$m\left(\frac{3}{29}, 2, \frac{6}{29}\right)$



6. Let $f(x) = |x - 1|$ and $g(x) = \begin{cases} e^x, & x \geq 0 \\ 3x, & x < 0 \end{cases}$ then f(g(x)) is one one or Many one

Ans. Many One

Sol. $f(g(x)) = |g(x) - 1| = \begin{cases} |e^x - 1|, & x \geq 0 \\ |3x - 1|, & x < 0 \end{cases}$



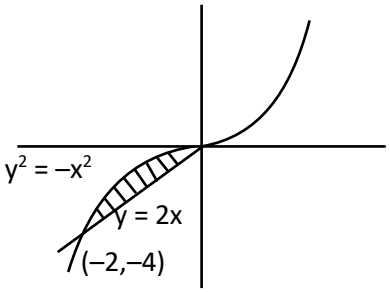
7. Find area enclosed by $y = x|x|$ and $y = x - |x|$.

Ans. 4/3

Sol. $x < 0$ $\quad\quad$ $x > 0$

$y_1 = -x^2$ $\quad\quad$ $y = x^2$

$y_2 = 2x$



$$\text{Auc} = \left|\int_{-2}^{0}\left(-x^2 - 2x\right)dx\right|$$

$$\text{Auc} = \left|\left(-\frac{x^3}{3} - x^2\right)\Big|_{-2}^{0}\right|$$

Auc = 4 / 3 Ans

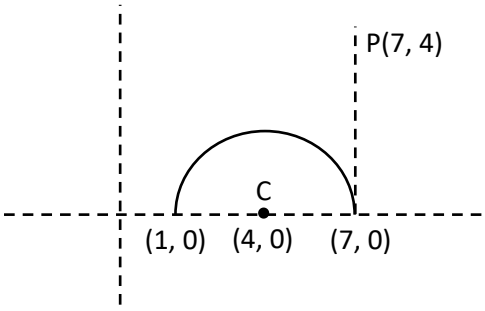
8. Find minimum value of expression $(x-7)^2 + \left(\sqrt{-x^2+8x-7} - 4\right)^2$ where $x \in [1,7]$

Ans. 4

Sol. $(x-7)^2 + \left(\sqrt{9-(x-4)^2} - 4\right)^2$

Square of distance between

$\left(x, \sqrt{9-(x-4)^2}\right)$ & $(7,4)$



Minimum distance $= PC - r = 5 - 3 = 2$

Ans 4

9. Find number of points of discontinuity of $f(x) = 2x^2 + [x^2] - [x]$ where $x \in [-1, 2]$

Ans. 4

Sol. Points to be check on $x = -1, 0, 1, \sqrt{2}, \sqrt{3}, 2$

Discontinues at $x = 0, -1, \sqrt{2}, \sqrt{3}$

Continuous at x = 1 & 2

10. $C_1 : (x - 1)^2 + (y - 1)^2 = 1$

C_2 : centre (–1, 0), R = 2

Common chord passes through y-axis at P. Square of distance P from centre of C_1.

Ans. 2

Sol. common chord is $C_1 - C_2 = 0$

$\Rightarrow \quad 4x + 2y - 1 = 3$

$4x + 2y = 4$

intersect y-axis at P(0,2)

$PC_1 = \sqrt{2}$

Ans = 2

11. Let $S = \left\{2, 2^2, 2^3, 2^4, \ldots\ldots 2^9\right\}$. A, B, C are subsets of S having equal elements. Given that $A \cap B = B \cap C = C \cap A = \phi$. Find total number of ways A, B, C can chosen if $A \cup B \cup C = S$.

Ans. $\frac{9!}{(3!)^3}$

Sol. $\left(\frac{9!}{(3!)^3} \times \frac{1}{(3!)}\right) \times 3!$

$= \frac{9!}{(3!)^3}$

12. Let set $A = \{1, 2, 3, 4, 5, 6\}$ and $ax^2 + bx + c = 0$ be a quadratic equation where $(a, b, c \in A)$ has real roots, then if the probability that one root is greater than other is P then find the value of $43P$.

Ans. 38

Sol. For real roots.

$b^2 \geq 4ac$

(i) $b = 6$ $\quad ac \le 9$

$\left.\begin{array}{l} a=1\ \ c=1\ldots6 \\ a=2\ \ c=1,2,3,4 \\ a=3\ \ c=1,2,3 \\ a=4\ \ c=1,2 \\ a=5\ \ c=1 \\ a=6\ \ c=1 \end{array}\right\}$ 17 cases

(II) $b = 5$ $\quad ac \le \frac{25}{4}$

$\left.\begin{array}{l} a=1\ \ c=1\ldots6 \\ a=2\ \ c=1,2,3 \\ a=3\ \ c=1,2 \\ a=4\ \ c=1 \\ a=5\ \ c=1 \\ a=6\ \ c=1 \end{array}\right\}$ 14 cases

(III) $b = 4$ $\quad ac \le 4$

$\left.\begin{array}{l} a=1\ \ c=1,2,3,4 \\ a=2\ \ c=1,2 \\ a=3\ \ c=1 \\ a=4\ \ c=1 \end{array}\right\}$ 8 cases

(IV) $b = 3$ $\quad ac \le \frac{9}{4}$

$\left.\begin{array}{l} a=1\ c=1,2 \\ a=2\ \ c=1 \end{array}\right\}$ 3 cases

(V) $b = 2$ $\quad ac \le 1$

$\left.\begin{array}{l} ac=1 \end{array}\right\}$ 1 case

Total cases

$\Rightarrow 17 + 8 + 14 + 3 + 1$

$= 43$

If equal roots $b^2 = 4ac$

$\left.\begin{array}{lll} b=2 & ac=1 & 1 \text{ case} \\ b=4 & ac=4 & 3 \text{ cases} \\ b=6 & ac=9 & 1 \text{ case} \end{array}\right\}$ 5 cases

Probability $= 1 - \frac{5}{43}$

$\Rightarrow \frac{38}{43}$

Ans. 38

13. Find the number of solutions of the equation:

$5|x + 3| + 7|x - 7| = 5.$

Ans. 0

Sol. $f(x) = 5|x + 3| + 7|x - 7|$

For: $-3 < x < 7$

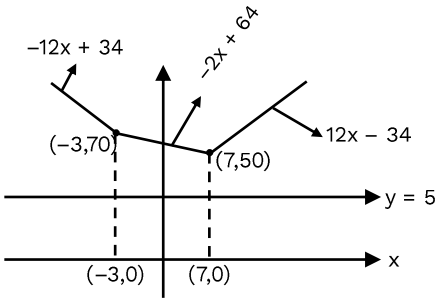
$f(x) = -2x + 64$

For ; $x \geq 7$

$f(x) = 12x - 34$

For ; $x \leq -3$

$f(x) = -12x + 34$.



No solution.

14. Find D.E. of circle whose centre lies on y = x and pass through origin.

Ans. $y'\left(x^2 + y^2 - 2xy - 2y^2\right) = 2x^2 + 2xy - x^2 - y^2$

Sol. $x^2 + y^2 + \alpha x + \alpha y = 0$

$2x + 2yy' + \alpha + \alpha y' = 0$

$$\alpha = -\frac{2\left(x + yy'\right)}{\left(1 + y'\right)}$$

$$x^2 + y^2 - \frac{2\left(x + yy'\right)x}{1 + y'} - 2\frac{\left(x + yy'\right)}{1 + y'}y = 0$$

$$\left(1 + y'\right)\left(x^2 + y^2\right) - 2x^2 - 2xyy' - 2xy - 2y^2y' = 0$$

$$y'\left(x^2 + y^2 - 2xy - 2y^2\right) = 2x^2 + 2xy - x^2 - y^2$$

15. A square ABCD of side "4" is given and a square AEFG of side "2" is given where F is mid-point of AB. Find radius of circle which touches BC, CD and passer through F.

Ans. radius $= (4 - 2\sqrt{2})$

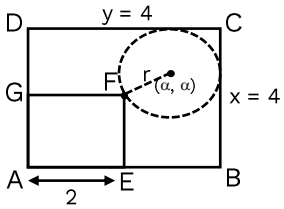
Sol. $(\alpha - 2)^2 + (\alpha - 2)^2$

$= (4 - \alpha)^2$

$2\left[\alpha^2 + 4 - 4\alpha\right] = \alpha^2 + 16 - 8\alpha$

$\alpha^2 = 8$

radius $= (4 - 2\sqrt{2})$



16. Area of region enclosed by

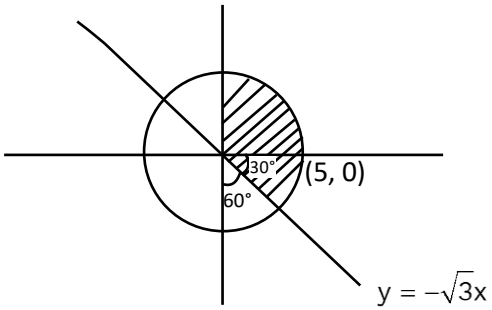
$$S_1 : |z| \le 5, S_2 : \text{Re}(z) \ge 0 \ \& \ \text{Im}\left(\frac{z+1-\sqrt{3}i}{1-\sqrt{3}i}\right) \ge 0$$

Ans. $\frac{25\pi}{3}$

Sol. $\frac{z+1-\sqrt{3}i}{1-\sqrt{3}i} = \frac{((x+1)+i(4-\sqrt{3}))(1+\sqrt{3}i)}{4}$

$\Rightarrow \sqrt{3}(x+1)+4-\sqrt{3} \ge 0$

$\sqrt{3}x + y \ge 0$



$\text{Area} = \frac{\pi(5)^2}{2} - \frac{1}{2} \cdot 25 \cdot \frac{\pi}{3}$

$= \frac{25\pi}{2}\left(1-\frac{1}{3}\right) = \frac{25\pi}{3}$

17. Let $\frac{dy}{dx} + \frac{2xy}{\left(1+x^2\right)^2} = x \cdot e^{-1/1+x^2}, y(0) = \frac{1}{e}$ and $y(x) = g(x) \cdot e^{-1/1+x^2}$, then area bounded by $y = g(x)$ and $y - x = 4$ is

Ans. $\frac{14\sqrt{7}}{3}$

Sol. $\text{I.F.} = e^{-\int \frac{2x}{(1+x^2)^2} dx} = e^{1/1+x^2}$

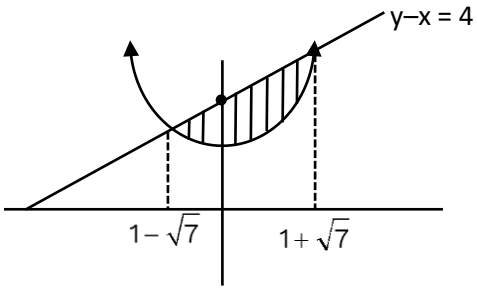
$\therefore \quad y \cdot e^{\frac{1}{1+x^2}} = \int x dx + c$

$y \cdot e^{\frac{1}{1+x^2}} = \frac{x^2}{2} + c$

$y = \left(\frac{x^2}{2} + c\right) e^{-1/1+x^2}$

put $x = 0, \frac{1}{e} = ce^{-1} \Rightarrow c = 1$

$\therefore \quad g(x) = \frac{x^2}{2} + 1$



$$A = \int_{1-\sqrt{7}}^{1+\sqrt{7}} \left(4 + x - \frac{x^2}{2} - 1\right) dx$$

$$= \frac{14\sqrt{7}}{3}$$

18. The number of real solutions of equation:

$x|x + 5| + 2|x + 7| - 2 = 0$

Ans. 3

Sol. (I) $x \geq -5$

$x^2 + 5x + 2x + 14 - 2 = 0$

$\Rightarrow x^2 + 7x + 12 = 0$

$\Rightarrow x = -3, -4$ (Accepted solutions)

(II) $-7 < x < -5$

$x(-x - 5) + 2(x + 7) - 2 = 0$

$\Rightarrow -x^2 - 5x + 2x + 14 - 2 = 0$

$\Rightarrow x^2 - 3x + 12 = 0$

$\Rightarrow x^2 + 3x - 12 = 0 \quad \Rightarrow x = \frac{-3 \pm \sqrt{9 + 48}}{2}$

$x = \frac{-3 \pm \sqrt{57}}{2}$

(Accepted solutions) $\Rightarrow x = \frac{-3 - \sqrt{57}}{2}$

(III) $x \leq -7$

$-x^2 - 5x - 2x - 14 - 2 = 0$

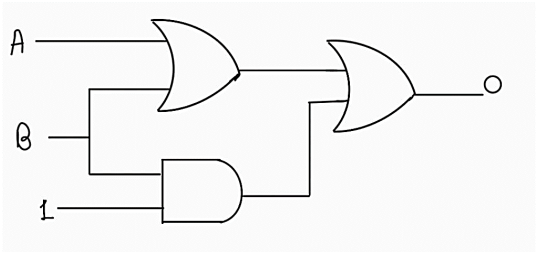
$\Rightarrow x^2 + 7x + 16 = 0$

D < 0, hence no real solution

So number of solution = 3

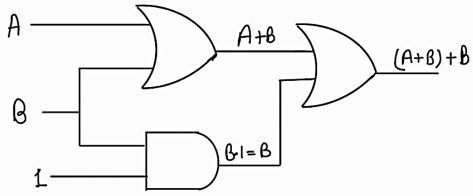
PHYSICS

1. In the given fig, find out A and B so that output will be 0.



Ans. 0,0

Sol.



B	1	B·1
0	1	0
1	1	1

A	B	A+B	(A+B)+B
1	0	1	1
1	1	1	1
0	0	0	0
0	1	1	1

So the values A and B will be 0.

2. In real gas equation $\left[P+\frac{an^2}{V^2}\right]\left[V-nb\right]=nRT$, find dimensional formula of ab^{-1}.

Ans. $[ML^2T^{-2}]$

Sol. $\frac{a}{v^2}=P$

$a = P.V^2$

$[a] = [ML^5T^{-2}]$

Dimensions of V = dimensions of b

$[b] = [L^3]$

$[ab^{-1}] = [ML^5T^{-2}L^{-3}] = [ML^2T^{-2}]$

3. A man revolving in a circle has completed 120 rev in 3 minutes. Find the centripetal acceleration of the monkey sitting on the shoulder of the man if the radius of circle is 9m. (Constant angular velocity)

Ans. 160 m/s^2

Sol. Total distance = $2\pi \times 120 = 240\pi$

$$\omega = \frac{240\pi}{3\times 60} = \frac{4\pi}{3}$$

$$a_c = \omega^2 R = \left(\frac{4\pi}{3}\right)^2 \times 9 = 160 \text{ m/s}^2$$

4. A constant power P is delivered to a particle of mass m. If motion starts from rest at t = 0, the find distance travelled by particle as a function of time t.

Ans. $x = \left(\frac{2}{3}\sqrt{\frac{2p}{m}}\right)t^{3/2}$

Sol. $Pt = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2pt}{m}}$

$\frac{dx}{dt} = \sqrt{\frac{2pt}{m}}$

$\int_0^x dx = \int_0^t \sqrt{\frac{2pt}{m}} \cdot dt$

$x = \sqrt{\frac{2P}{m}} \cdot \frac{t^{3/2}}{3/2}$

$= \left(\frac{2}{3}\sqrt{\frac{2p}{m}}\right)t^{3/2}$

5. A particle is projected from horizontal at an angle such that maximum possible range is 64 m. Keeping angle of projection same, if velocity of projection becomes half then calculate new value of maximum possible range.

Ans. 16 m

Sol. For $\theta = 45^\circ$

$R_{max} = \frac{u^2}{g}$

$u \rightarrow \frac{u}{2}$

$R'_{max} = \frac{R_{max}}{4} = \frac{64}{4} = 16m$

6. A uniform wire having resistance 20Ω is divided into 10 equal parts. Now each part is connected in parallel. Find equivalent resistance of the new combination.

Ans. (_)

Sol. $R = \frac{20}{10} = 2\Omega$

$\frac{1}{R_{eq}} = \frac{1}{2} + \frac{1}{2} + \ldots\ldots\ldots 10 \text{ times}$

$\frac{1}{R_{eq}} = \frac{10}{2} = 5$

$R_{eq} = 0.2\Omega$

7. If there is a charge q travelling in an electric field (E) and magnetic field (B) with speed v. Find out force due to electric field and magnetic field on the charge.

Ans. $\vec{F}_1 = q\vec{E}$, $\vec{F}_2 = q(\vec{v} \times \vec{B})$

Sol. $\vec{F}_1 = q\vec{E}$

$\vec{F}_2 = q(\vec{v} \times \vec{B})$

8. If λ_{min} of lyman series is 915 Å, find the λ_{max} of balmer series.

Ans. 6588Å

Sol. $l_{min} \rightarrow$ max energy $\quad [n = \infty \rightarrow n = 1]$

$L_{max} \rightarrow$ min energy $\quad [n = 3 \rightarrow n = 2]$

$$\frac{hc}{\lambda_{min}} = Rz^2\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right] = Rz^2$$

$$\frac{hc}{\lambda_{max}} = Rz^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = Rz^2 \times \frac{5}{36}$$

$$\frac{\lambda_{min}}{\lambda_{max}} = \frac{1\times 36}{5} \Rightarrow \lambda_{max} = \lambda_{min} \times \frac{36}{5} = \frac{915\times 36}{5} = 6588Å$$

9. If 20 division of vernier scale coincide with 19th division of main scale then find out main scale division (given 0.1 mm is the least count of vernier callipers).

Ans. 2mm

Sol. 20 VSD = 19 MSD

1 VSD = $\frac{19}{20}$ MSD

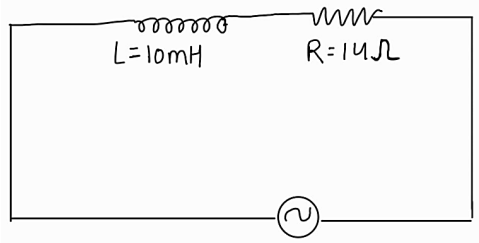
LC = 1 MSD- 1VSD

= 1 MSD – $\frac{19}{20}$ MSD

0.1 mm = $\frac{1}{20}$ MSD

1 MSD = 2mm

10. In a series of RL circuit having 14Ω an inductance 10mH, applied source voltage is 220 V having frequency 50Hz. Find RMS value of current in the circuit.



Ans. = 15.33

Sol. $X_L = 2\pi fL = 2\pi \times 50 \times 10 \times 10^{-3}$

$\Rightarrow X_L = \pi\ \Omega$

$$Z = \sqrt{R^2 + X_L^{\ 2}} = \sqrt{14^2 + \pi^2}$$

$$\Rightarrow I_{rms} = \frac{V_{rms}}{Z} = \frac{220}{\sqrt{14^2 + \pi^2}} = 15.33$$

11. Which of the following is incorrect –

(1) Stopping potential depends on frequency of incident light

(2) Stopping potential increases by increasing intensity

(3) Stopping potential depends on nature of material

(4) Stopping potential is equal to K.E/e

Ans. (2)

Sol. $K.E_{max} = h\nu - \phi$

$\Rightarrow ev_s = h\nu - \phi$

$\Rightarrow v_s = \left(\frac{h}{e}\right)\nu - \frac{\phi}{e}$

So, stopping potential depends on frequency of light and nature of material of metal. Stopping potential does not depends on intensity on incident light.

12. Current flowing in a coil depends on time 't' given by i = 3t + 2, where t is in sec. If induced emf in the coil is 12mV, then find self inductance (in mH) of coil.

Ans. 4

Sol. $E = L\frac{dr}{dt}$

$12 = L \times 3$

$L = 4$ mH

13. A geostationary satellite with time period of 6 hrs, orbiting around a planet of mass $\frac{m_e}{4}$ (m_e = mass of earth). If R_e is radius of earth then find radius of orbit.

Ans. $\left[\frac{Gm_e}{4}\left(\frac{T}{2\pi}\right)^2\right]^{1/3}$

Sol. $\left[\frac{Gm_e}{4}\left(\frac{T}{2\pi}\right)^2\right]^{1/3}$

14. It is given that $P \propto T^3$ then find the value of $\frac{C_p}{C_v}$ (process is adiabatic).

Ans. 3/2

Sol. $P \propto T^3 \Rightarrow PT^{-3} = \text{const}$

$\Rightarrow P(PV)^{-3} = \text{const} \quad (\because PV = nRT)$

$P^{-2}V^{-3} = \text{const}$

$\Rightarrow PV^{3/2} = \text{const}$

$\Rightarrow \gamma = \frac{3}{2} = \frac{C_p}{C_v}$

15. A hollow sphere is performing pure rolling on ground, find the ratio of rotational kinetic energy and total kinetic energy.

Ans. 2/5

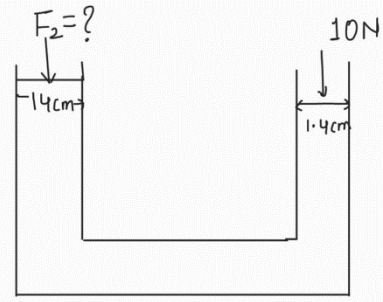
Sol. Rotational K.E.= $\frac{1}{2}I\omega^2 = \frac{1}{2}I\frac{v^2}{R^2}$

$T.E = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{R^2}$

$I = \frac{2}{3}mR^2$

$\frac{R.K.E}{T.E} = \frac{\frac{1}{2}\times\frac{2}{3}mR^2\times\frac{v^2}{R^2}}{\frac{1}{2}mv^2 + \frac{1}{2}\times\frac{2}{3}\times\frac{v^2}{R^2}\times mR^2} = \frac{\frac{1}{3}}{\frac{1}{2}+\frac{1}{3}} = \frac{2}{5}$

16. If the small diameter of piston is $d_1 = 1.4$ cm and the larger diameter of piston is $d_2 = 14$ cm. If force of 10N is applied on small piston then find out F_2 required to maintain same level.



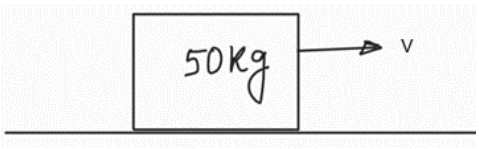
Ans. 1000 N

Sol. $\frac{F_2}{A_2} = \frac{F_1}{A_1}$

$F_2 = \frac{F_1}{A_1} A_2 = \frac{10 \times \pi \times 7^2}{\pi \times 0.7^2}$

F = 1000 N

17. A block having mass 50 kg moving with velocity v, if coefficient of kinetic friction is 0.3 then force due to kinetic friction (take g = 9.8m/s^2)

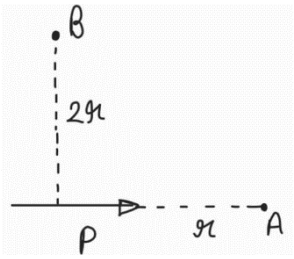


Ans. 147 N

Sol. f = μmg

f = 0.3 × 50 × 9.8 = 147 N

18. Find ratio of electric field at points A and B, produced by electric dipole.



Ans. 16

Sol. $E_A = \frac{2kp}{r^3}$

$E_B = \frac{k.p}{(2r)^3}$

$\frac{E_A}{E_B} = 16$

19. Match the column of order of wavelength of infrared, γ-rays, X-rays and UV rays.

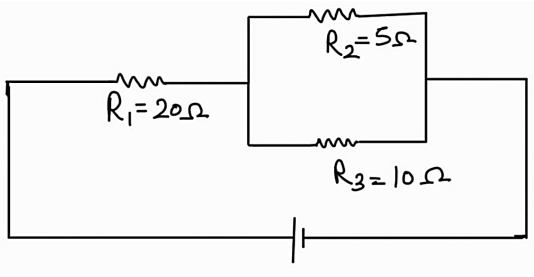
List-I		List-II	
(a)	Infrared	(i)	Less then 10^{-3} nm.
(b)	γ-rays	(ii)	10^{-3} to 1 nm.
(c)	X-rays	(iii)	1 to 300 nm.
(d)	UV-rays	(iv)	300 to 600 nm.

Ans. a → iv, b → i, c → ii, d → iii

Sol. $\lambda_{\gamma} < \lambda_{x\text{-rays}} < \lambda_{uv\text{-rays}} < \lambda_{IR}$

a → iv, b → i, c → ii, d → iii

20. The ratio of heat dissipated per second through 5Ω and 10Ω will be –



Ans. 2/1

Sol. since voltage drop is same, so heat dissipated is inverse ratio of resistance,

$H_{R1} : H_{R2} = \frac{1}{R_1} : \frac{1}{R_2}$

$\frac{H_1}{H_2} = \frac{10}{5} = \frac{2}{1}$

21. Why metal chain hangs at the rear part of tankers containing inflammable liquid.

(1) To make it look fancy

(2) To inform other vehicles about tanker

(3) So that extra electron can be transferred to earth.

(4) To protect the Tyre from damage.

Ans. (3)

Sol. Due to air drag charges induced on tanker, to neutralise the charge metal chains hangs at the rear part of the tankers touching with earth.

22. A Force acts on a body such that momentum $\vec{p} = \cos(kt)\,\hat{i} - \sin(kt)\,\hat{j}$. Find the angle between $\vec{p}$ and $\vec{F}$.

Ans. 90°

Sol. $\vec{F} = \frac{d\vec{p}}{dt} = -K\sin(Kt)\hat{i} - K\cos(Kt)\hat{j}$

$\vec{P}.\vec{F} = 0$

$\Rightarrow \theta = 90°$

23. A sonometer wire of length 90cm, whose fundamental frequency is 400Hz. Wire has same tension and now, fundamental frequency changed to 600Hz. Find the new length of wire.

Ans. 60cm

Sol. $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}}$

$n\ell$ = const

$n_1\ell_1 = n_2\ell_2$

$n_1 = 400$, $n_2 = 600$

$\ell_1 = 90cm$, $\ell_2 = ?$

$400 \times 90 = 600 \times \ell_2$

$\ell_2 = 60cm$

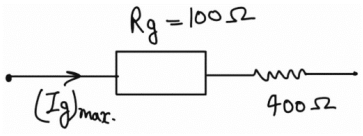
24. A galvanometer having resistance 100Ω is connected in series with 400Ω resistance and measures maximum of 10V and now galvanometer is converted into ammeter. What should be the value of shunt resistance so that it can measure maximum of 10A of current.

Ans. 0.2Ω

Sol. $V = (I_g)_{max} \times 500$

$10 = (I_g)_{max} \times 500$

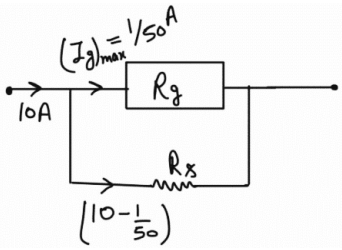
$(I_g)_{max} = \frac{1}{50}A$



$\left(10 - \frac{1}{50}\right)Rs = \frac{1}{50} \times Rg$

$Rs = \frac{\frac{1}{50} \times 100}{\left(10 - \frac{1}{50}\right)} = \frac{2}{10 - 0.02}$

$Rs = 0.2\Omega$



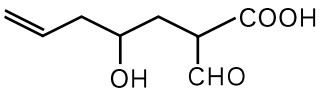
25. Find the expression for mean free path of a gas molecule of number density n and diameter of molecule is d.

Ans. $\lambda = \frac{1}{\sqrt{2}\pi nd^2}$

Sol. $\lambda = \frac{1}{\sqrt{2}\pi nd^2}$

CHEMISTRY

1. IUPAC naming of given compound



(1) 2-formyl-4-hydroxy hept-6-enoic acid

(2) 6-formyl-4-hydroxy hept-1-enoic acid

(3) 4-hydroxy-6-formyl-hept-1-enoic acid

(4) 4-hydroxy-2-formyl-hept-6-enoic acid

Ans. (1)

Sol. 2-formyl-4-hydroxy hept-6-enoic acid .

2. Coagulation of egg is due to

(1) Denaturation of protein (2) 2° structure does not change

(3) 1° structure does not change (4) 3° structure does not change

Ans. (1)

Sol. Coagulation of egg is due to denaturation of protein.

3. Square planar complex Mabcd will have how many isomers

(1) 2 (2) 3 (3) 4 (4) 5

Ans. (2)

Sol. Square planar complex Mabcd will have 3 isomers.

4. For n = 4, |m| = 1, $m_s = \frac{1}{2}$ then maximum number of electron with this combination will be

Ans. (6)

Sol. n = 4, l = 0, 1, 2, 3

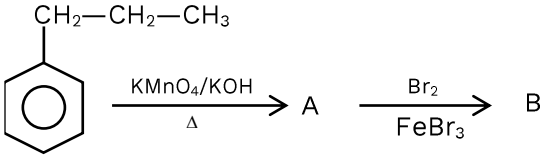
l = 0, m = 0

l = 1, m = –1, 0, +1 $\Rightarrow$ 2

l = 2, m = –2, –1, 0, +1, +2 $\Rightarrow$ 2

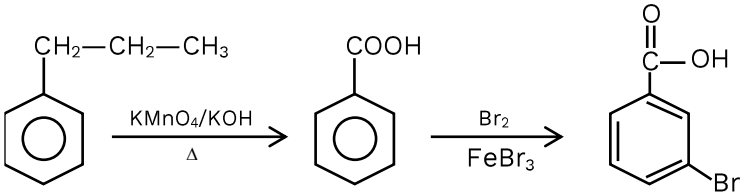
l = 3, m = –3, –2, –1, 0, +1, +2, +3 $\Rightarrow$ 2

5. Calculate number of π bond present in product B



Ans. (4)

Sol.



total number of π bond in B = 4

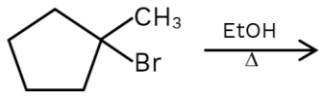
6. Which of the following doesn't have electron in t_2 orbital

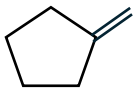
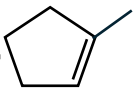
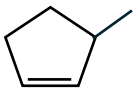
(1) $[TiCl_4]$ (2) $[MnO_4]^{2-}$ (3) $[FeCl_4]^{2-}$ (4) $[Co(CN)_4]^{2-}$

Ans. (1)

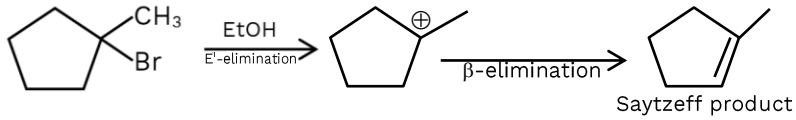
Sol. Ti^{+4} have d^0 electronic configuration.

7. Major product in the given reaction



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

Ans. (2)

Sol. 

8. **Statement-A :** NF_3 have less dipole moment than NH_3.

Statement-R : F is more electronegative and bond moment of N–H bond is in same direction of lone pair.

(1) Both A and R are correct and R is the correct explanation of A.

(2) Both A and R are correct, but R is not the correct explanation of A.

(3) A is correct but, R is incorrect.

(4) R is correct but, A is incorrect.

Ans. (1)

Sol. NF_3 have less dipole moment than NH_3.

F is more electronegative and bond moment of N–H bond is in same direction of lone pair.

Both A and R are correct and R is the correct explanation of A.

9. Compound having dipole moment = 0

H_2, BF_3, CH_4, NH_3, H_2O, CO_2, NF_3, BeF_2, SiF_4, H_2S

Ans. (6)

Sol. H_2, BF_3, CH_4, CO_2, BeF_2, SiF_4 will have dipole moment = 0.

10. Find the major product in given sequence

$$CH_3—CH_2—OH \xrightarrow[(iii)NaOH/CaO/\Delta]{(i)Jones\,reagent\ (ii)KMnO_4}$$

(1) Acetic acid (2) Acetaldehyde (3) ethane (4) methane

Ans. (4)

Sol. $$CH_3—CH_2—OH \xrightarrow[(ii)KMnO_4]{(i)Jones\,reagent} CH_3-COOH \xrightarrow[decarboxylation]{(iii)NaOH/CaO/\Delta} CH_4+CO_2$$

11.

List-I	**List-II**
(P) IF	(1) Linear
(Q) IF_7	(2) Pentagonal bipyramidal
(R) ICl_3	(3) T-shape
(S) BF_3	(4) Trigonal Planar

(1) P→1; Q→2; R→3; S→4 (2) P→2; Q→3; R→4; S→1
(3) P→3; Q→4; R→2; S→1 (4) P→4; Q→1; R→2; S→3

Ans. (1)

Sol. P→1; Q→2; R→3; S→4 is the correct match.

12. $FeO.Cr_2O_3 + Na_2CO_3 \xrightarrow{air} A + B + C\ (CO_2)$

Sum of magnetic moment (nearest integer) of central metals in A and B will be

Ans. (6)

Sol. A = $Fe_2O_3 \rightarrow Fe^{+3} \rightarrow d^5$ configuration, μ = 5.87 BM

B = $Na_2CrO_4 \rightarrow Cr^{+6} \rightarrow d^0$ configuration, μ = 0 BM

13. $E^o_{M^{2+}/M} = 0.34V$ and $E^o_{X_2/X^-} = -0.46V$

Select the correct statement

(1) $E_{cell} = 0.80V$

(2) $E_{cell} = -0.80V$

(3) Cell reaction $M + X_2 \rightarrow M^{2+} + 2X^-$ is spontaneous

(4) Cell reaction $M^{2+} + 2X^- \rightarrow M + X_2$ is spontaneous

Ans. (4)

Sol. $E^0_{cell} = E^0_{M^{2+}/M} + E^0_{X^-/X_2}$

$= -0.34 + 0.46 = 0.12V$

Cell reaction $M^{2+} + 2X^- \rightarrow M + X_2$ is spontaneous

14. Ti^{2+}, Cr^{2+}, V^{2+}

How many of them liberate H_2 gas with dil. mineral acid

(1) 0 (2) 2 (3) 1 (4) 3

Ans. (4)

Sol. All of them liberate H_2 gas.

15. Correct order of increasing atomic size of 13th group element will be

(1) Tl > In > Al > Ga > B (2)Tl < In > Al > Ga > B

(3) Tl > In > Al < Ga > B (4) In > Tl > Ga > Al > B

Ans. (1)

Sol. Tl > In > Al > Ga > B is correct order of atomic size.

16. On passing 1C charge through an aq. $AgNO_3$ solution:

(1) 1g atom of Ag is deposited

(2) 1 electrochemical equivalent of Ag is deposited

(3) 1 chemical equivalent of Ag is deposited

(4) 1 gm of Ag is deposited

Ans. (2)

Sol. $W = Z \times q$

Given : $q = 1$

$W = Z$

Thus, 1 electrochemical equivalent of Ag is deposited

17.

List-I	**List-II**
(P) Metamer	(1) Isopentane & neopentane
(Q) Chain isomer	(2) propanal & propanone
(R) Functional isomer	(3) methoxy propane & ethoxyethane
(S) Position isomer	(4) n-propanol & isopropanol

(1) P→3; Q→1; R→2; S→4 (2) P→3; Q→1; R→4; S→2

(3) P→3; Q→2; R→1; S→4 (4) P→1; Q→3; R→2; S→4

Ans. (1)

Sol. P→3; Q→1; R→2; S→4 is correct match

18. Acetic acid dimerizes in liquid benzene. 60 g of acetic acid is dissolved in 500g of benzene.

Find the value of ΔT_f (Given : $K_f = 5\ \frac{K \times kg}{mole}$)

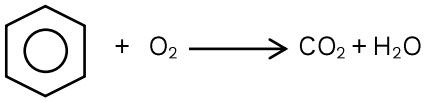
Assume complete association

Ans. (5)

Sol. $i = 1 - \frac{1}{2} = \frac{1}{2}$

$$\Delta T_f = \frac{1}{2} \times 5 \left(\frac{\frac{60}{60}}{0.5} \right) = 5$$

19. Given combustion of benzene $\Delta_C H = -3267$ KJ/mol



Calculate standard enthalpy of formation for 2 mole of benzene from the following data

$\Delta_f H_{CO_2} = -393.5\ kJ/mol$

$\Delta_f H_{H_2O} = -285.83\ kJ/mol$

Ans. (97.02)

Sol. $C_6H_6 + \frac{15}{2} O_2 \rightarrow 6CO_2 + 3H_2O$

$\Delta H = \Delta_f H_{product} - \Delta_f H_{reactant}$

$-3267 = 6\Delta_f H_{CO_2} + 3\Delta_f H_{H_2O} - \Delta_f H_{C_6H_6}$

$-3267 = (6 \times -393.5) + (3 \times -285.8) - \Delta_f H_{C_6H_6}$

$\Delta_f H_{C_6H_6} = -48.51$ kJ/mol

For 2 mol = $2 \times -48.51 = -97.02$ kJ/mol

20. Given elementary reaction

$$2A + B \rightleftharpoons C$$

Initial pressure 1.5 0.7

After time t pressure of C = 0.5. Find $\frac{R_1}{R_2}$

Ans. (31.5)

Sol. $t = 0 \rightarrow [A] = 1.5, \quad [B] = 0.7$

Given at time t [C] = 0.5

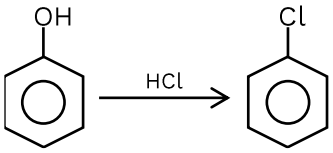
$t = t \rightarrow [A] = 0.5, \quad [B] = 0.2$

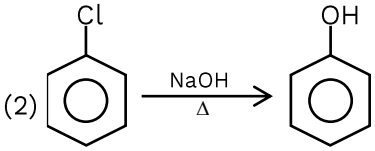
$$\frac{R_1}{R_2} = \frac{k[A]^2[B]}{k[A_t]^2[B_t]}$$

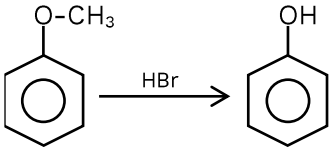
$$\frac{R_1}{R_2} = \frac{k[1.5]^2[0.7]}{k[0.5]^2[0.2]}$$

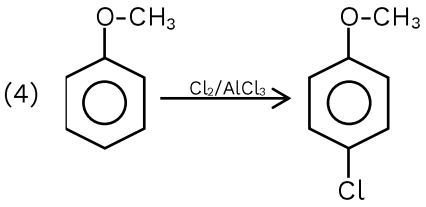
$$\frac{63}{2} = 31.5$$

21. Which of the following is incorrect match for product

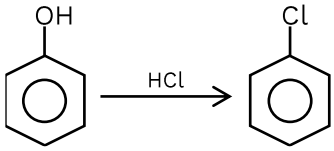
(1) 

(2) 

(3) 

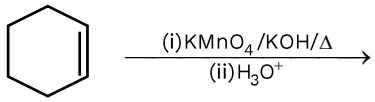
(4) 

Ans. (1)

Sol. 

The substitution of -OH group in phenol is not possible due to delocalization of its lone pair within benzene ring

22. Consider the following reaction :



(1) Adipic acid (2) Oxalic acid (3) Succinic acid (4) Benzoic Acid

Ans. (1)

Sol.