**JEE(Main)-2024 | 04 April 2024 (Shift-2 Evening) | Question Paper with Solutions | Memory Based**

## MATHEMATICS

**1.** a, b and c are in A.P. a + 1, b, c + 3 are G.P a > 10 and A.M. of a, b, c is 8, then $(G.M.)^3$ of a, b and c.

**Ans.** 120

**Sol.** $(a+1)(c+3)=b^2$

$(a+1)(c+3)=64, a+c=16$

$ac+3a+c+3=64$

$ac+2a+19=64$

$a(16-a)+2a=45$

$a^2-18a+45=0$

$a=15$

$c=1$

$(GM)^3=(abc)=8\times15\times1=120$

**2.** Find area bounded by the curves

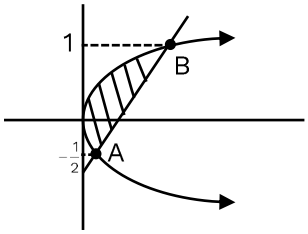
$y^2 \le 2x$ and $y \ge 4x-1$

**Ans.** 9/32

**Sol.** $A=\int_{-1/2}^{1}\left(\left(\frac{y+1}{4}\right)-\frac{y^2}{2}\right)dy$

$A=\left[\frac{y^2}{8}+\frac{1}{4}y-\frac{y^3}{6}\right]_{-\frac{1}{2}}^{1}$

A = 9/32




**3.** Let $f(x)=\int_0^x t+\sin(1-e^t)dt, f(0)=0$, then $\lim_{x\to0}\frac{f(x)}{x^3}$

**Ans.** $-\frac{1}{6.}$

**Sol.** Let $f(x)=\int_0^x t+\sin\left(1-e^t\right)dt$

$f'(x)=x+\sin\left(1-e^x\right)$

Now $\lim_{x\to0}\frac{f(x)}{x^3}$

$\lim_{x\to0}\frac{f'(x)}{3x^2}=\lim_{x\to0}\frac{x+\sin\left(1-e^x\right)}{3x^2}=\lim_{x\to0}\frac{1+\cos\left(1-e^x\right)\left(-e^x\right)}{6x}=$

$\lim_{x\to0}-\frac{\sin\left(1-e^x\right)\left(-e^x\right)\left(-e^x\right)+\left(-e^x\right)\cos\left(1-e^x\right)}{6}=-\frac{1}{6.}$

**4.** If $f(x) = 3\sqrt{x-2} + \sqrt{4-x}$ maximum value is $\alpha$ and minimum value is $\beta$, then $\alpha^2 + \beta^2$

**Ans.** 38

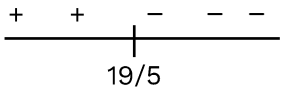
**Sol.** $x \in [2,4]$

$$f'(x) = \frac{3}{2\sqrt{x-2}} - \frac{1}{2\sqrt{4-x}} = 0$$

$$9(4-x) = (x-2)$$

$$10x = 38$$

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




$$\text{Max}, \alpha = 3\sqrt{\frac{9}{5}} + \sqrt{\frac{1}{5}}$$

$$= \frac{10}{\sqrt{5}}$$

$$\beta = 3\sqrt{2}$$

$$\alpha^2 + \beta^2 = \frac{100}{5} + 18$$

$$= 38$$

**5.** $\sin^{-1}x + \cos^{-1}y = \alpha,\ \alpha \in \left(\frac{-\pi}{2}, \pi\right]$ find value of $x^2 + y^2 - 2xy\sin\alpha$

**Ans.** $\cos^2\alpha$

**Sol.** $$xy + \left(\sqrt{1-x^2}\right)\left(\sqrt{1-y^2}\right) = \sin\alpha$$

$$1 - x^2 - y^2 + x^2y^2 = \sin^2\alpha + x^2y^2 - 2xy\sin\alpha$$

$$\cos^2\alpha = x^2 + y^2 - 2xy\sin\alpha$$

**6.** $F(x) = \begin{cases} \dfrac{72^x - 9^x - 8^x + 1}{\sqrt{2} - \sqrt{1+\cos 2x}}, & x \neq 0 \\ a\ln 2 \cdot \ln 3 & , x = 0 \end{cases}$, if $f(x)$ is continuous at $x = 0$, then value of a is

**Ans.** $a = 6\sqrt{2}$

**Sol.** $$\lim_{x\to 0} \frac{(8^x - 1)(9^x - 1)}{x^2} \frac{\left(\sqrt{2} + \sqrt{1+\cos 2x}\right)}{(1-\cos 2x)} \frac{4x^2}{4}$$

$$\frac{\ln 8 \cdot \ln 9 \cdot 2 \cdot 2\sqrt{2}}{4}$$

$$\ln 8 \cdot \ln 9 \cdot \sqrt{2}$$

$$6\sqrt{2}\ln 2 \ln 3$$

$$a = 6\sqrt{2}$$

**7.** Let $f(x) = 4\sqrt{x-2} + \sqrt{4-x}$, find maximum and minimum value of $f(x)$.

**Ans.** $[\sqrt{2}, \sqrt{34}]$

**Sol.** Let $x = 2 + 2\cos^2\theta$

$f(x) = 4\sqrt{2\cos^2\theta} + \sqrt{2\sin^2\theta}$

$= 4\sqrt{2}\,|\cos\theta| + \sqrt{2}\,|\sin\theta|$

$[\sqrt{2}, \sqrt{34}]$

**8.** $\dfrac{1\cdot 2^2 + 2\cdot 3^2 + \ldots + 100\cdot(101)^2}{1^2\cdot 2 + 2^2\cdot 3 + \ldots + (100)^2\times 101} = \dfrac{p}{q}$, find $p - q$?

**Ans.** 4

**Sol.** $$\frac{\sum_{\gamma=1}^{100}\gamma(\gamma+1)^2}{\sum_{\gamma=1}^{100}\gamma^2(\gamma+1)} = \frac{\sum\gamma(\gamma+1)\cdot(\gamma+2) - \sum\gamma(\gamma+1)}{\sum\gamma(\gamma+1)(\gamma+2) - 2\sum\gamma(\gamma+1)}$$

$\sqrt{10}$

$$= \frac{\frac{309-4}{12}}{\frac{309-8}{12}} = \frac{305}{301}$$

$p - q = 4.$

**9.** A relation is $(x_1, y_1)R(x_2,y_2)$ is defined as $\{(x, y)\in N, x_1 \le x_2, y_1 \le y_2\}$ then relations is

(1) Reflexive and symmetric (2) symmetric and transitive

(3) transitive and reflexive (4) None

**Ans.** (3)

**Sol.** for Reflexive $(a,b)R(a,b) \Rightarrow a \le a, b \le b \Rightarrow$ Reflexive

for symmetric If $(a,b)R(c,d)$ then $(c,d)R(a,b)$

$\therefore a \le c \;\&\; b \le d \not\Rightarrow c \le a \;\&\; d \le b$

Not symmetric

for transitive

If $(a,b)R(c,d)$ and $(c,d)R(g,h)$ then $(a,b)R(g,h)$

$a \le c \;\&\; b \le d$ and

$c \le g \;\&\; d \le h \Rightarrow a \le g \,\&\, b \le h$

$\therefore$ transitive

**10.** If $\int \text{cosec}^5\theta d\theta = \alpha(f(x))^4 + \beta(f(x))^2 + \gamma \ln|f(x)| + C$, where C is constant of integration, find $|2\alpha + \beta + \gamma|$

**Ans.** 2

**Sol.** Let $\text{cosec}\theta + \cot\theta = t$

$$\Rightarrow \text{cosec}\theta - \cot\theta = \frac{1}{t}$$

$\Rightarrow \left(-\text{cosec}\theta\cot\theta - \text{cosec}^2\theta\right)d\theta = dt$

$-\left(\frac{1}{2}\left(t+\frac{1}{t}\right)\right)t\,d\theta = dt$

$-\frac{1}{2}\left(t^2+1\right)d\theta = dt$

$d\theta = -\frac{2dt}{t^2+1}$

$\therefore \int t^5 \frac{(-2)}{t^2+1}dt$

$-2\int\left(\left(t^3-t\right)+\frac{t}{t^2+1}\right)dt$

$-2\left[\frac{t^4}{4}-\frac{t^2}{2}+\frac{1}{2}\ln\left(t^2+1\right)\right]+c$

$-2\left[\frac{(\text{cosec}\theta+\cot\theta)^4}{4}-\frac{(\text{cosec}\theta+\cot\theta)^2}{2}+\frac{1}{2}\ln\left((\text{cosec}\theta+\cot\theta)^2+1\right)\right]+c$

So, $\alpha = -\frac{1}{2}$, $\beta = 1$, $\gamma = -2$

$|2\alpha+\beta+\gamma| = 2$

**11.** Coefficient of $x^4, x^5, x^6$ are in AP in $(1+x)^n$. Find n?

**Ans.** 7, 14

**Sol.** ${}^nC_4 + {}^nC_6 = 2\times{}^nC_5$

$1+\frac{(n-4)(n-5)}{30} = \frac{2\times(n-4)}{5}$

$30+n^2-9n+20 = 12n-48$

$n^2-21n+98 = 0$

$n = 7, 14$

**12.** In a group A there are 4 men and 5 women and in group B there are 5 men and 4 women, If 4 people are selected from each group find number of ways to select 4 men and 4 women.

**Ans.** 5626

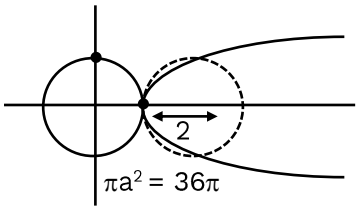
**Sol.**

| (5) | (4) | (4) | (5) | |
|---|---|---|---|---|
| A | | B | | |
| M | w | m | w | |
| 4 | 0 | 0 | 4 | $= {}^5C_4 \times {}^5C_4 = 25$ |
| 3 | 1 | 1 | 3 | $= {}^5C_3 \times {}^4C_1 \times {}^4C_1 \times {}^5C_3 = 1600$ |
| 2 | 2 | 2 | 2 | $= {}^5C_2 \times {}^4C_2 \times {}^4C_2 \times {}^5C_2 = 3600$ |
| 1 | 3 | 3 | 1 | $= {}^5C_1 \times {}^4C_3 \times {}^4C_3 \times {}^5C_1 = 400$ |
| 0 | 4 | 4 | 0 | $= 1$ |
| | | | | Total = 5626 |

**13.** A circle $(C_1)$ centred at (0, 0) touches hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ at vertex. Another circle $(C_2)$ centred at focus of hyperbola touches circle $C_1$. Area of $C_1$ and $C_2$ are $36\pi$ and $4\pi$ respectively then find latus rectum of hyperbola.

**Ans.** $\frac{28}{3}$

**Sol.**




$a = 6$

$ae = 8$

$e = \frac{4}{3}$

$b^2 = 36\left[\frac{16}{9}-1\right] = 28$

$L \cdot R = \frac{2\times 28}{6} = \frac{28}{3}$

**14.** if $\frac{dy}{dx}=\frac{1}{(x+y+2)^2}$ and $f(0)=0$. Then $f(x)=\tan^{-1}\left(\frac{x+y}{x+y+\lambda}\right)$ then find $\lambda$.

**Ans.** $\lambda = 5$

**Sol.**

$x + y + 2 = t$

$1+\frac{dy}{dx}=\frac{dt}{dx}$

$\frac{dt}{dx}-1=\frac{1}{t^2}$

$\Rightarrow \frac{dt}{dx}=\frac{1}{t^2}+1=\frac{t^2+1}{t^2}$

$\Rightarrow \int \frac{t^2+1-1}{1+t^2}dt=\int dx$

$\Rightarrow \int 1dt-\int \frac{1}{1+t^2}dt=\int dx$

$\Rightarrow t-\tan^{-1}t = x+c$

$\Rightarrow (x+y+2)-\tan^{-1}(x+y+2)=x+c$

$= f(0) = 0$

$\Rightarrow 2-\tan^{-1}(2) = C$

$\Rightarrow \quad (x+y+2)-\tan^{-1}(x+y+2)=x+2-\tan^{-1}(2)$

$y=\tan^{-1}(x+y+2)-\tan^{-1}2$

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

**15.** Let $A=\begin{bmatrix}1 & 2\\ 0 & 1\end{bmatrix}$ and $B=I+(\text{adj}\,A)+\left(\text{adj}\,A^2\right)+\cdots n$ terms then B is

**Ans.** -

**Sol.** $\text{adj}(A)=\begin{bmatrix}1 & -2\\ 0 & 1\end{bmatrix}$

$A^2=\begin{bmatrix}1 & 2\\ 0 & 1\end{bmatrix}\begin{bmatrix}1 & 2\\ 0 & 1\end{bmatrix}=\begin{bmatrix}1 & 4\\ 0 & 1\end{bmatrix}$

$\text{adj}(A^2)=\begin{bmatrix}1 & -4\\ 0 & 1\end{bmatrix}$

$B=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}+\begin{bmatrix}1 & -2\\ 0 & 1\end{bmatrix}+\begin{bmatrix}1 & -4\\ 0 & 1\end{bmatrix}+\cdots+\begin{bmatrix}1 & -2n\\ 0 & 1\end{bmatrix}$

$=\begin{bmatrix}n+1 & (-2-4-6\cdots-2n)\\ 0 & n+1\end{bmatrix}$

$=\begin{bmatrix}n+1 & -n(n+1)\\ 0 & (n+1)\end{bmatrix}$

$=(n+1)\begin{bmatrix}1 & -n\\ 0 & 1\end{bmatrix}$

**16.** A team plays 10 games. In every game the team wins with probability $\frac{1}{3}$ and losses with probability $\frac{2}{3}$. Let X be the number of wins of this team in these 10 games while Y be the number of losses of this team in these 10 games. The probability that $|x-y|\le 2$ is

**Ans.** -

**Sol.** $|x-(10-x)|\le 2$

$|2x-10|\le 2$

$-2\le 2x-10\le 2$

$4\le x\le 6$

$4\text{win}+6\text{loss}, 5\text{win}+5\text{loss}, 6\text{win}+4\text{loss}$

$${}^{10}C_4\cdot\left(\frac{1}{3}\right)^4\cdot\left(\frac{2}{3}\right)^6+{}^{10}C_5\cdot\left(\frac{1}{3}\right)^5\cdot\left(\frac{2}{3}\right)^5+{}^{10}C_6\left(\frac{1}{3}\right)^6\left(\frac{2}{3}\right)^4$$

$$\frac{{}^{10}C_4(80)+{}^{10}C_5(32)}{3^{10}}$$

**17.** Let $\vec{a}=\hat{i}+\hat{j}+\hat{k},\vec{b}=2\hat{i}+4\hat{j}-5\hat{k}$ and $\vec{c}=x\hat{i}+2\hat{j}+3\hat{k}, x\in\mathbb{R}$. If $\vec{d}$ is an unit vector in the direction of $\vec{b}+\vec{c}$ such that $\vec{a}\cdot\vec{d}=1$, then $(\vec{a}\times\vec{b})\cdot\vec{c}$ is

**Ans.** 11

**Sol.** $\vec{d}=\lambda((2+x)\hat{i}+(4+2)\hat{j}+(-5+3)\hat{k})$

$\vec{d}=\lambda((2+x)\hat{i}+6\hat{j}-2\hat{k})$

$\vec{a}\cdot\vec{d}=\lambda(\hat{i}+\hat{j}+\hat{k})\cdot((2+x)\hat{i}+6\hat{j}-2\hat{k})=1$

$\Rightarrow\lambda(2+x+6-2)=1$

$\lambda(6+x)=1$ and $|\vec{d}|=1$

$\lambda\sqrt{(2+x)^2+36+4}=1$

$\lambda^2\left((2+x)^2+40\right)=1$

$\therefore x=1$

$\lambda=\frac{1}{7}$

$$\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]=\begin{vmatrix}1 & 1 & 1\\ 2 & 4 & -5\\ 1 & 2 & 3\end{vmatrix}=11$$

**18.** $y^2 = 12x$ has a chord PQ with midpoint (4, 1) then equation of PQ passes through

(1) (–4, 0) (2) (–4, 1) (3) (4, 8) (4) None of these

**Ans.** (1)

**Sol.** $y\times 1=6(x+4)$

$y=6x+24$

**19.** $(x^2 + 4)^2dy + (2x^3y + 8xy - 2)dx = 0$ if $y = y(x)$; If $y(0) = 0$ then $y(2)$ is equal to-

**Ans.** $\frac{1}{16}$

**Sol.** $\left(x^2+4\right)^2 dy+y\cdot 2x\left(x^2+4\right)dx=2dx$

$y\cdot\left(x^2+4\right)^2=2x+c$

$c=0$

$y\cdot(4+4)^2=2\times 2$

$y=\frac{4}{64}=\frac{1}{16}$

**20.** $L_1\cdot\frac{x}{1}=\frac{y}{2}=\frac{z}{3}=\lambda$

$L_2:\frac{x-3}{1}=\frac{y+2}{-2}=\frac{z-9}{2}=\mu$

Two lines $L_1$ and $L_2$ are given and they intersect at point P. A and B are two points, A(8, 7, –1), B(5, 1, 17). Find minimum distance of point P from the line joining A and B

**Ans.** 7

**Sol.** Point of intersection is $P\equiv(1,2,3)$

Equation of $AB:\frac{x-8}{3}=\frac{y-7}{6}=\frac{z+1}{-18}$

Perpendicular distance of $P(1,2,3)$ form AB is 7 and foot of $\perp^r$ is $(7,5,5)$

**21.** Centre of a circle is (0, 0) and radius is $\sqrt{10}$. x + y = 2 is a chord of this circle. Another chord of slope –1 has length 2. Find least possible distance between x + y = 2 and this chord.

**Ans.** -

**Sol.** $x + y = c$

$$\left|\frac{c}{\sqrt{2}}\right| = 2$$

$c = \pm 2\sqrt{2}$

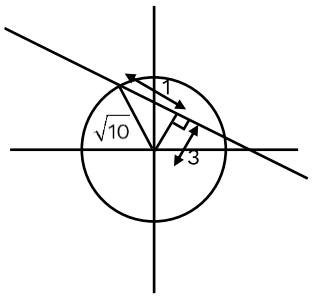
$x + y - 2\sqrt{2} = 0$ ...(1)

$x + y + 2\sqrt{2} = 0$ ...(2)

$x + y - 2 = 0$ ...(3)

For least distance take equation (1) & (3)

$$\text{least distance} = \left|\frac{2\sqrt{2} - 2}{\sqrt{2}}\right|$$



## PHYSICS

**1.** Position of a particle performing SHM is given by $x = 100\sin(\omega t + \pi/3)$. Find its initial velocity if time period is 3.14 sec.

**Ans.** 100

**Sol.** $x = 100 \sin(\omega t + \pi/3)$

$$v = \frac{dx}{dt} = [100 \cos(\omega t + \pi/3) \times \omega$$

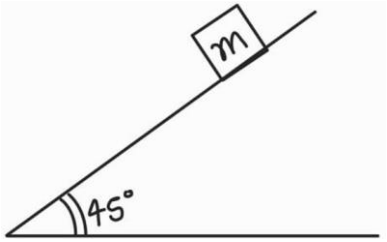
$(v)_{t=0} = 100\omega \cos(\pi/3)$

$= 100 \times \omega/2$

$= 50\omega$

$$= 50 \times \frac{2\pi}{T} = \frac{100\pi}{3.14}$$

**2.** Find the value of friction coefficient between block and the inclined for body to just start sliding.

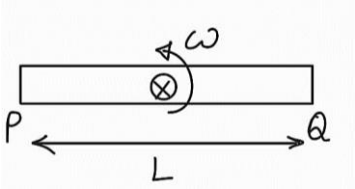



**Ans.** $\mu = 1$

**Sol.** $\mu = \tan 45°$

$\mu = 1$

**3.** Find potential difference between points P and Q in the given figure. Magnetic field is perpendicular to the plane of rotation.




**Ans.** $V_P - V_Q = 0$

**Sol.** P and Q will be at same potential

So $V_P - V_Q = 0$

**4.** In a YDSE setup, slit width are d and 4d, find the ratio of maximum intensity to minimum intensity.

**Ans.** 9 : 1

**Sol.** $$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{4}+\sqrt{1}}{\sqrt{4}-\sqrt{1}}\right)^2 = \left(\frac{3}{1}\right)^2 = \frac{9}{1}$$

**5.** A bus moving with 72 km/hr stops in 4 seconds due to uniform retardation. Find the value of stopping distance.

**Ans.** 40 m

**Sol.** $$S = \left(\frac{u+v}{2}\right)t$$

$$u = 72 \times \frac{5}{18} m/s \qquad \& v = 0$$

Therefore, $$s = \left(\frac{20+0}{2}\right) \times 4$$

$= 40m$

**6.** Find the total flux through the cube if charge Q is present at the centre of its one face.

**Ans.** $\frac{q_{in}}{2\varepsilon_0}$

**Sol.** Let's imagine a cube adjacent to our given cube, then

Charge enclosed in our cube = $\frac{q}{2}$

By Gauss law,

Total flux = $\frac{q_{in}}{2\varepsilon_0}$

**7.** Two wires A and B of same length are made of same material. Radius of B is double of radius of A. Find resistance of B if resistance of A is 2 Ω.

**Ans.** $8\Omega$

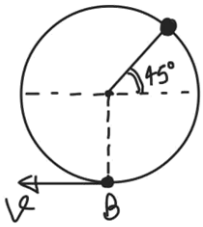
**Sol.** $R = \frac{\rho l}{A}$

$R \propto \frac{1}{r^2}$

$\frac{R_B}{R_A} = \left(\frac{r_B}{r_A}\right)^2$

$R_B = 2 \times 4 = 8\Omega$

**8.** A particle of mass 2 kg attached to a massless string is released from the given position. Find its velocity when it reaches point B. Length of the string is 14 m.




**Ans.** $4\sqrt{30}$ m / s

**Sol.** $mg\,(R + R\cos 45) = \frac{1}{2}mv^2$

$2gR\left(1+\frac{1}{\sqrt{2}}\right) = v^2$

$v^2 = 2 \times 10 \times 14 \times \left(1+\frac{1}{\sqrt{2}}\right)$

$= 280 + \frac{280}{1.4}$

$= 280 + 200$

$v^2 = 480$

$v = 4\sqrt{30}$m / s

**9.** If power consumed by an electrical instrument is 500 watts at 200 volts, then find power consumed at 100 volts.

**Ans.** 125

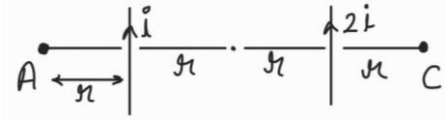
**Sol.** $P = \frac{v^2}{R} \Rightarrow P \propto v^2$

$$\frac{P_2}{P_1} = \left(\frac{V_2}{V_1}\right)^2$$

$$\frac{P_2}{P_1} = \left(\frac{100}{200}\right)^2$$

$$P_2 = \frac{P_1}{4} \Rightarrow P_2 = \frac{500}{4} = 125$$

**10.** Find the ratio of magnitude of magnetic field at point A and B if the wires are infinitely long.



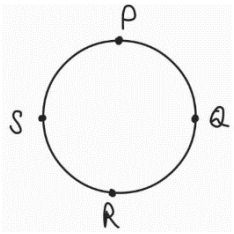

**Ans.** 5 : 7

**Sol.** $\overrightarrow{B_A} = \frac{\mu_0 i}{2\pi r} + \frac{\mu_0 (2i)}{2\pi(3r)} = \frac{\mu_0}{2\pi r}\left[1 + \frac{2}{3}\right] = \frac{5}{3}\frac{\mu_0}{(2\pi r)}$

$$\overrightarrow{B_C} = \frac{\mu_0 (2i)}{2\pi r} + \frac{\mu_0 i}{2\pi(3r)} = \frac{\mu_0}{2\pi r}\left[2 + \frac{1}{3}\right] = \frac{7}{3}\frac{\mu_0}{(2\pi r)}$$

$$\frac{\overrightarrow{B_A}}{\overrightarrow{B_C}} = \frac{5 \times 3}{3 \times 7} = \frac{5}{7}$$

**11.** A particle travels on a circle of radius 2m from P to S. Find the displacement of the particle




**Ans.** 2.82m

**Sol.** $|PS| = \sqrt{r^2 + r^2} = \sqrt{2r} = \sqrt{2} \times 2m = 2.82m$

**12.** Determine the weight of a man standing at a height of 2R (where R = radius of earth) from the earth surface. Given that mass of the man = 90kg.

**Ans.** 10 kg-wt

**Sol.** $g = \frac{g_s}{\left(1 + \frac{h}{R}\right)^2}$

$$g = \frac{g_s}{\left(1 + \frac{2R}{R}\right)^2} = \frac{g_s}{9}$$

Then weight of man at height 2R

$$W = \frac{W_s}{9}$$

= 10 kg-wt

**13.** 3 Kg mass is displaced by 2cm towards 2kg mass. How much should 2kg mass be displaced towards 3kg such that centre of mass remains at the same point.

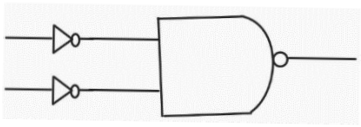
**Ans.** 3cm

**Sol.** As COM remain stationary

$$\overrightarrow{d_{com}} = 0 = \frac{3\times(2)+2(-x)}{5}$$

x = 3cm

**14.** Identify the logic gate.



**Ans.** OR gate

**Sol.** $\overline{\overline{A}.\overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$

OR gate.

**15.** In an thermodynamic process, the value of $\gamma$ is $\frac{3}{2}$. If 1 mol of gas is taken from volume 20 litre 60 litre, then Find the value of work done in the process. Initial pressure is 5 atm.

**Ans.** $600\left(1-\sqrt{3}\right)$ atm litre

**Sol.** For adiabatic process

$Pv^{\gamma}$ = cons.

$\Rightarrow \quad 5(60)^{3/2} = P_f\,(20)^{3/2}$

$\Rightarrow \quad P_f = \left(\frac{60}{20}\right)^{3/2}$

$= 5(3)^{3/2}$

$\Rightarrow \quad \boxed{P_f = 15\sqrt{3}}$ atm

$$\text{Wad.} = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$$

$$= \frac{5\times 60 - 15\sqrt{3}(20)}{\frac{3}{2}-1}$$

$$= \frac{20\times 5\left[3-3\sqrt{3}\right]}{1/2} \text{ litre atm}$$

$$= 200\times 3\left(1-\sqrt{3}\right) \text{atm litre}$$

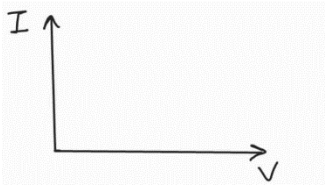
$$= 600\left(1-\sqrt{3}\right) \text{atm litre.}$$

**16.** Find order of wavelength of X-rays, gamma rays, microwaves, and ultraviolet rays.

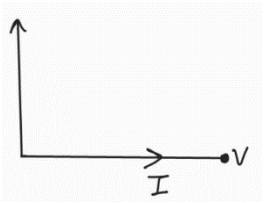
**Ans.** $\lambda_{\gamma} < \lambda_{X\ ray} < \lambda_{U.V\ ray} < \lambda_{microwave}$

**Sol.** Factual

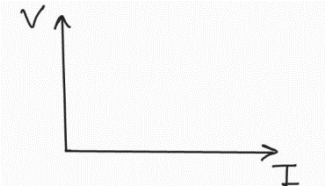
**17.** Match the following

(A) 

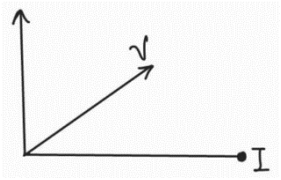
(i) Capacitive

(B) 

(ii) Inductive

(C) 

(iii) Resistive

(D) 


**Ans.** A → (i), B → (ii), C → (iii), D → (ii)

**Sol.** (A) Current leads the voltage ⇒ capacitive

(B) Current leads the voltage ⇒ inductive

(C) Current & voltage are in same phase ⇒ Resistive

(D) Current lags the voltage ⇒ Inductive

**18.** Find out rotational and transnational degree of freedom of $CH_4$ gas molecule.

**Ans.** 3 + 3 = 6

**Sol.** Transnational degree of freedom = 3

Rotational degree of freedom = 3

**19.** A spring mass system has a total energy E and if mass is doubled then what is total energy?

**Ans.** E

**Sol.** $E = \frac{1}{2}m\omega^2A^2$

$E = \frac{1}{2}KA^2$

Total energy = E

**20.** Find relation between T(time period of satellite), R(radius of satellite), G(gravitational const), M(mass of satellite).

**Ans.** $T^2 \propto \frac{R^3}{MG}$

**Sol.** $T \propto R^x G^y M^z$

$[T] = [L]^x [m^{-1}L^3T^{-2}]^y [M]^z$

$0 = x + 3y$

$0 = -y + z$

$1 = -2y$

$y = -\frac{1}{2}$

$z = -\frac{1}{2}$

$x = \frac{3}{2}$

$T \propto \frac{R^{\frac{3}{2}}}{G^{\frac{1}{2}}M^{\frac{1}{2}}}$

$T^2 \propto \frac{R^3}{MG}$

**21.** In a bohr's atom an electron revolves in a orbit whose orbital number (n = 4). Find out the value of angular momentum ?

**Ans.** $2h/\pi$

**Sol.** $L = mvr = = \frac{nh}{2\pi} = \frac{2h}{\pi}$

**22.** **Assertion :** The number of photons increases with increase in frequency of light.
**Reason :** The max. kinetic energy increases with increase in frequency of incident light.

**Ans.** FT

**Sol.** Assertion is false but reason is true

**23.** Magnetic moment is 0.5 $A/m^2$, strength of magnetic field $B = 0.8 \times 10^{-16}$ T, then find the work done for brining the magnet from most stable to least stable position.

**Ans.** $8 \times 10^{-17}$ J

**Sol.** $W_{ext} = -\Delta U$

$\Rightarrow -(M.B)_I - (-M.B)_F$

$\Rightarrow MB[\cos\theta_2 - \cos\theta_1]$

$\Rightarrow 40 \times 10^{-18} \times [2]$

$\Rightarrow 8 \times 10^{-17}$ J

**24.** **Statement 1 :** Contact angle in tube depends on both liquid and tube material.
**Statement 2 :** Height of the capillary is independent of its radius of curvature.

**Ans.** TF

**Sol.** Contact angle depends on the values of cohesive as well as adhesive forces, so it depends on both liquid and tube material.

$h = \frac{2T\cos\theta}{\rho rg}$

## CHEMISTRY

**1.** Arrange the following compounds in increasing order of their stability :-

(a)  (b)  (c)  (d) 

(1) (a) > (c) > (b) > (d)
(2) (d) > (b) > (c) > (a)
(3) (a) > (c) > (b) > (d)
(4) (a) > (b) > (d) > (c)

**Ans.** (1)

**Sol.** As we know compound (a) is aromatic and the compound (d) is antiaromatic
Hence, compound (a) is more stable and compound (d) is least.
In compound (b) and (c) more the $sp^3$ carbon, more is the +I effect.

$$C^- \text{ stability} \propto \frac{1}{+I \text{ effect}} \propto -I \text{ effect}$$

Hence, (c) is more stable then (b)
Therefore, order will be - (a) > (c) > (b) > (d)

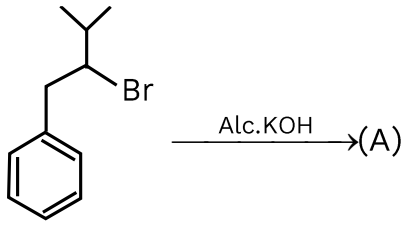
**2.** IUPAC name of catechol is :

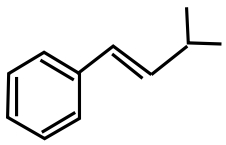
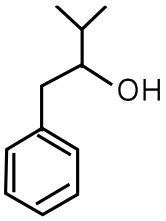
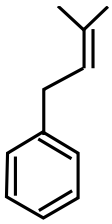
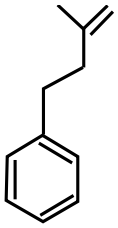
(1) Benzene, 1,2-diol
(2) Benzene, 1,3-diol
(3) Benzene, 1,4-diol
(4) 3-Hydroxyphenol

**Ans.** (1)

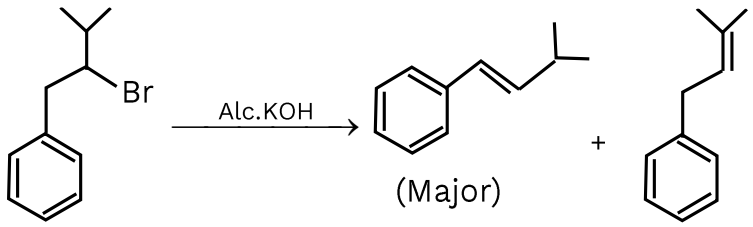
**Sol.** Theory based

**3.** Major product 'A' is




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

**Ans.** (1)

**Sol.** 


Strong base with high temperature tends to $E_2$ reaction.

**4.** Find the atomic number of element having 3 unpaired $e^-$ and belongs to transition series with +2 oxidation state

(1) 22 (2) 23 (3) 24 (4) 25

**Ans.** (2)

**Sol.** $_{23}V = [Ar]3d^3 4s^2$

**5.** Correct order of ionisation enthalpy for

Li, Na, Cl, F

(1) Cl > F > Li > Na (2) F > Cl > Li > Na

(3) Li > Na > F > Cl (4) Li > Na > Cl > F

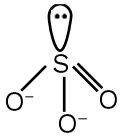
**Ans.** (2)

**Sol.** $\text{I.E.} \propto \text{Zeff} \propto \frac{1}{\text{no. of shell}}$

**6.** Which of the following molecule having pyramidal shape

(1) $SO_4^{2-}$ (2) $SO_3^{2-}$ (3) $S_2O_3^{2-}$ (4) $S_2O_7^{2-}$

**Ans.** (2)

**Sol.** $SO_3^{2-} \rightarrow$ 

**7.** Consider the following statements:

Statement I: The number of emitted photoelectrons Increases with increase in frequency of incident light.

Statement II: Kinetic energy of emitted photoelectrons increases with increase in frequency of incident light

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

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

(3) Both Statement I and statement II are true

(4) Both Statement I and statement II are false

**Ans.** (2)

**Sol.** Theory based, Photoelectric effect

**8.** Which of the following salt form yellowish green gas when treated with conc. $H_2SO_4$ and $MnO_2$

(1) NaCl (2) $Na_2S$ (3) $Na_2SO_4$ (4) None of these

**Ans.** (1)

**Sol.** $Cl^-$ oxidises to give $Cl_2$ (g) of yellowish green colour.

**9.** Find the value of x + y in given complex

$[Fe(NH_3)_x(CN)_y]^{-1}$

**Ans.** (6)

**Sol.** Co-ordination number of $Fe^{+3}$ is 6.

**10.** 1 mole of ideal monoatomic gas compressed adiabatically from volume 2V to 1V.
If initially temperature of gas was T. Then the magnitude of work done in this process is

**Ans.** $w = \frac{3}{2}RT(2^{\frac{2}{3}} - 1)$

**Sol.** $w = \left(\frac{nR\Delta T}{\gamma - 1}\right)$

We known,

$T V^{\gamma-1} = cons.$

$T_1V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$\Rightarrow \quad T(2V)^{\gamma-1} = T_2 (V)^{\gamma-1}$

$\Rightarrow \quad T_2 = 2^{\gamma-1} T$

$\gamma = \frac{5}{3}$

$w = \left(\frac{nR\Delta T}{\gamma - 1}\right)$

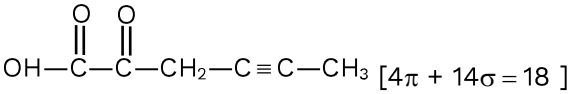
$w = \left(\frac{r(T_2 - T_1)}{\gamma - 1}\right)$

$w = \frac{(2^{\gamma-1}_{T} - T)}{\gamma - 1}R$

$w = \frac{3}{2}RT(2^{\frac{2}{3}} - 1)$

**11.** Find the sum of σ and π bonds present in 2-oxo-hex-4-yne-oicacid

**Ans.** (18)

**Sol.**  $[4\pi + 14\sigma = 18]$

**12.** What is angular momentum of 4th orbit ?

(1) $\frac{2h}{\pi}$ (2) $\frac{h}{\pi}$ (3) $\frac{h}{2\pi}$ (4) $\frac{3h}{2\pi}$

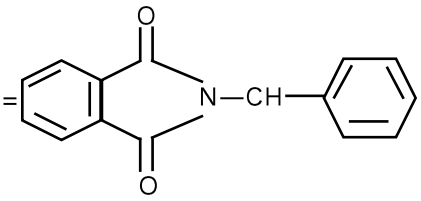
**Ans.** (1)

**Sol.** $mvr = \frac{nh}{2\pi} = \frac{4h}{2\pi} = \frac{2h}{\pi}$

**13.** Phthalimide $\xrightarrow[(2)\text{Benzyl chloride}]{(1)KOH}$ P

Number of π bonds in product 'P'

**Ans.** (8)

**Sol.** P = 

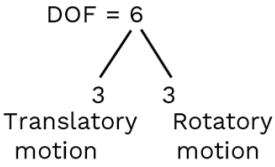
No. of Z bond = 8

**14.** Calculate the degree of freedom for translatory and rotatory motion of $CH_4$ molecule

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

**Ans.** (3)

**Sol.** $CH_4$ Non-Linear Polyatomic molecule




**15.** Commonly used Adsorbents in adsorption chromatography.

**Sol.** Silica gel, Alumina

**16.** Arrange the following in ascending order of wavelength.

(a) Gamma rays (b) X-ray (c) Infrared ray (d) U.V ray

(1) c > d > b > a (2) d > c > b > a (3) c > d > a > b (4) c > b > d > a

**Ans.** (1)

**Sol.** Infra-red ray > U.V ray > X-ray > Gamma rays

**17.** How many orbitals have following set of quantum number n = 4, $m_l = 0$

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

**Ans.** (4)

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

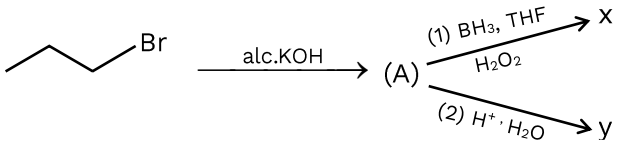
l = 0 $m_\ell = 0$

l = 1 $m_\ell = 1, 0, 1$

l = 2 $m_\ell = -2, -1, 0, 1, 2$

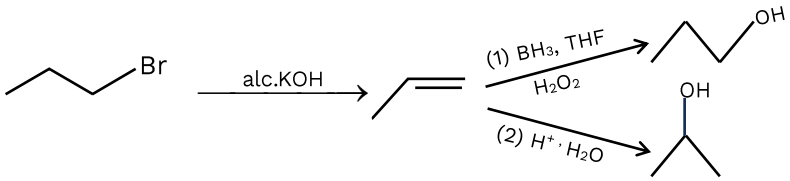
l = 3 $m_\ell = -3, -1, 0, 1, 2, 3$

**18.**




X & y are :-

**Sol.**




Answer is :- Propanol and propan-2-ol

**19.** Calculate heat for Isothermal process if expansion takes place from 20 L to 60 L against 5 atm external pressure

(1) 200 L-atm (2) 400 L-atm (3) 300 L-atm (4) 500 L-atm

**Ans.** (1)

**Sol.** We know according to FLOT,

$\Delta U = q + w$

Isothermal $\Delta T = 0$

$\Delta U = 0$

$q = - w$

$w = - P_{ext} [V_2 - V_1]$

$= - 5 [60-20]$

$w = - 200$ L- atm

$q = - w = - [-200] = 200$ L – atm

**20.** Find the total number of molecules which have non-zero dipole moment among the following

$NH_3$, $BCl_3$, $BeH_2$, $CCl_4$, $XeF_4$

**Ans.** (1)

**Sol.** $NH_3$ is polar among these.

**21.**

| **List-I** | **List-II** |
|---|---|
| (P) α-Glucose and α-Fructose | (1) Functional group isomer |
| (Q) α-Glucose and α-Mannose | (2) Homologous |
| (R) α-Glucose and β-Glucose | (3) Epimers |
| (S) α-Glucose and Ribose | (4) Anomers |

(1) P→B; Q→C; R→D; S→A (2) P→A; Q→C; R→D; S→B

(3) P→A; Q→C; R→B; S→D (4) P→C; Q→A; R→D; S→B

**Ans.** (2)

**Sol.** Based on biomolecules theory.

**22.** For the given chemical reaction :-

$$SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3 \quad K_1 = 4.9 \times 10^{-4}$$

Find $K_2$ = ? for chemical reaction given below

$$2SO_3 \rightleftharpoons 2SO_2 + O_2$$

(1) $4 \times 10^6$ (2) $5 \times 10^7$ (3) $5 \times 10^8$ (4) $5 \times 10^5$

**Ans.** (1)

**Sol.** $K_2 = \left(\frac{1}{K_1}\right)^2$

$= \left(\frac{1}{4.9 \times 10^{-4}}\right)^2$

$= (2000)^2$

$K_2 = 4 \times 10^6$

**23.** Total number of unpaired $e^-$ at central metal ion in $[Co(H_2O)_6]^{3+}$

**Ans.** (0)

**Sol.** For $Co^{+3}$ ion $H_2O$ act as SFL, then unpaired $e^-$ will be zero

**24.** Arrange the following in increasing order of their first ionisation enthalpy:

Al, Ga, In, Tl, B

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

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

**Ans.** (2)

**Sol.** Theory based, Periodic table

**25.** Which of the following represent correct unit of slope of graph between molar conductivity $(\Delta m)$ and $(concen)^x$

(1) $Scm^{1/2}mol^{-1/2}$ (2) $S\,cm^{3/2}mol^{-2}$ (3) $Scm^{7/2}mol^{-1/2}$ (4) $Scm^{5/2}mol^{-3/2}$

**Ans.** (3)

**Sol.** $\wedge_m = \overset{0}{\wedge}_m - A\sqrt{C}$

Slope = $\frac{\wedge_m}{\sqrt{C}}$

**26.** Which of the following statement is incorrect?

(1) In homogeneous mixture composition is uniform

(2) Compounds are formed when atoms of different element combine together in any ratio

(3) Atoms of same element have identical atomic mass a properties

(4) In heterogeneous mixture composition is not uniform

**Ans.** (2)

**Sol.** Fundamentals of mole concept.