21/01/2026
EVENING

Memory Based Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2026 (Online) Phase-1

(Mathematics and Physics, Chemistry)

IMPORTANT INSTRUCTIONS:

(1) The test is of **3 hours** duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains **Three Parts**. **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is **Mathematics**. Each part has only two sections: **Section-A** and **Section-B**.

(4) **Section - A :** Attempt all questions.

(5) **Section - B :** Attempt all questions.

(6) **Section - A (01 – 20)** contains 20 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

(7) **Section - B (21 – 25) contains** 5 **Numerical value** based questions. The answer to each question should be rounded off to the **nearest integer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

1. The largest $n \in N$ for which 7^n divides 101! is :

(1) 15 (2) 16

(3) 17 (4) 18

Ans. (2)

Sol. $101! = 2^{\alpha}3^{\beta}5^{\gamma}7^{\delta}$

$$\text{Exp}(7) = \left[\frac{101}{7}\right] + \left[\frac{101}{7^2}\right] = 16$$

2. Let $f(x) = x^3 + x^2f'(1) + 2xf''(2) + f'''(3)$, then the value of $f'(5) =$

(1) $\frac{117}{5}$ (2) 1

(3) –27 (4) $\frac{-117}{5}$

Ans. (1)

Sol. $f'(x) = 3x^2 + 2xf'(1) + 2f''(2)$

$f''(x) = 6x + 2f'(1)$

$f''(2) = 12 + 2f'(1)$

$\therefore f'(x) = 3x^2 + 2xf'(1) + 2(12 + 2f'(1))$

$f'(x) = 3x^2 + 2(x+2)f'(1) + 24$

Putting, x = 1

$f'(1) = 3 + 6f'(1) + 24$

$-5f'(1) = 27 \Rightarrow f'(1) = \frac{-27}{5}$

$$\therefore f''(2) = 12 + 2\left(\frac{-27}{5}\right) = 12 - \frac{54}{5} = \frac{6}{5}$$

$$\therefore f'(x) = 3x^2 - \frac{54}{5}x + \frac{12}{5}$$

$$\therefore f'(5) = 75 - 54 + \frac{12}{5} = \frac{117}{5}$$

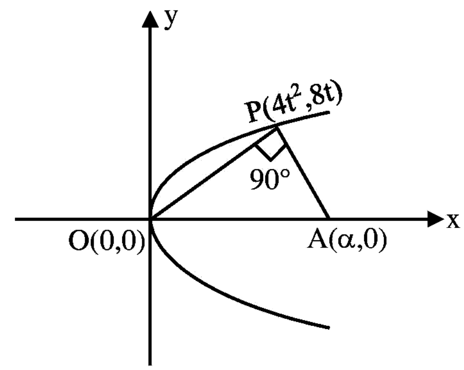
3. Let O be the vertex of the parabola $y^2 = 16x$. The locus of centroid of ΔOPA. When P lies on parabola and A lies on x-axis and $\angle OPA = 90°$, is

(1) $y^2 = 8(3x - 16)$ (2) $9y^2 = 8(3x - 16)$

(3) $y^2 = 8(3x + 16)$ (4) $9y^2 = 8(3x + 16)$

Ans. (2)

Sol.



Let centroid G(h, k)

$3h = \alpha + 4t^2$ …(1)

$3k = 8t$ …(2)

$m_{OP} \times m_{PA} = -1$

$$\Rightarrow \frac{8t}{4t^2} \times \frac{8t}{4t^2 - \alpha} = -1$$

$\Rightarrow 16 = \alpha - 4t^2$ …(3)

(1) + (3)

$\Rightarrow 3h + 16 = 2\alpha$

$\Rightarrow \alpha = \frac{3h+16}{2}$ …(4)

Putting α from (4) & t from (2) in (3)

$$\Rightarrow 16 = \frac{3h+16}{2} - 4 \times \frac{9k^2}{64}$$

$$\Rightarrow 16 = \frac{3h+16}{2} - \frac{9k^2}{16}$$

$256 = 24h + 128 - 9k^2$

$\Rightarrow 9k^2 = 24h - 128$

$9y^2 = 24x - 128$

$9y^2 = 8(3x - 16)$

4. $a_1, \frac{a_2}{2}, \frac{a_3}{2^2}, \ldots, \frac{a_{10}}{2^9}$ are in G.P. with common ratio $\frac{1}{\sqrt{2}}$ and $a_1 + a_2 + \ldots + a_{10} = 62$, then $a_1 =$

(1) $2\left(\sqrt{2}-1\right)$ (2) $2\left(\sqrt{2}+1\right)$

(3) $\sqrt{2}+1$ (4) $\sqrt{2}-1$

Ans. **(1)**

Sol. $\frac{a_2}{2a_1} = \frac{a_3}{2a_2} = \frac{a_4}{2a_3} = \ldots = \frac{a_{10}}{2a_9} = \frac{1}{\sqrt{2}}$

$\therefore a_1, a_2, a_3, \ldots, a_{10}$ are in G.P. with common ratio $\sqrt{2}$

$\therefore \sum_{i=1}^{10} a_i = \frac{a_1((\sqrt{2})^{10}-1)}{\sqrt{2}-1} = 62$

$\Rightarrow a_1 = 2(\sqrt{2}-1)$

5. If $4\int_0^1 \cot^{-1}(1-2x+4x^2)\,dx = a\tan^{-1}2 + b\ell n5,$ then (a + b) is equal to

(1) 6 (2) 8

(3) 3 (4) 5

Ans. **(3)**

Sol. Let $I = \int_0^1 \cot^{-1}(1-2x+4x^2)\,dx$

$$I = \int_0^1 \left(\cot^{-1}(2x-1) - \cot^{-1}(2x)\right)dx \quad \ldots(1)$$

Applying king

$$I = \int_0^1 \left(-\cot^{-1}(2x-1) + \cot^{-1}(2x-2)\right)dx \quad \ldots(2)$$

From (1) & (2)

$$2I = \int_0^1 \left(\cot^{-1}(2x-2) - \cot^{-1}(2x)\right)dx$$

$$= \int_0^1 \cot^{-1}(2x-2)\,dx - \int_0^1 \cot^{-1}(2x)\,dx$$

Applying King

$$= \int_0^1 \cot^{-1}(-2x)\,dx - \int_0^1 \cot^{-1}(2x)\,dx$$

$$= \int_0^1 (\pi - \cot^{-1}(2x))\,dx - \int_0^1 \cot^{-1}(2x)\,dx$$

$$= \int_0^1 (\pi - 2\cot^{-1}(2x))\,dx$$

$$= \pi - 2\int_0^1 (\cot^{-1}2x).1\,dx$$

By parts

$$= \pi - 2\left[\left(x\cot^{-1}2x\right)_0^1 + \int_0^1 \frac{2x}{1+4x^2}dx\right]$$

Let $1 + 4x^2 = t$

$8x\,dx = dt$

$$= \pi - 2\left[\cot^{-1}2 + \frac{1}{4}\int_1^5 \frac{dt}{t}\right]$$

$$= \pi - 2\cot^{-1}2 - \frac{1}{2}\ell n5$$

$$2I = 2\tan^{-1}2 - \frac{1}{2}\ell n5$$

$\Rightarrow 4I = 4\tan^{-1}2 - \ell n5$

$= a\tan^{-1}2 + b\ell n5$

$\Rightarrow a + b = 4 - 1 = 3$

6. Let α and β be the roots of an equation

$x^2 + 2ax + (3a + 10) = 0$ such that $\alpha < 1 < \beta$.

Then the set of all possible values of α is

(1) $\left(-\infty, \frac{-11}{5}\right) \cup (5,\infty)$ (2) $(-\infty, -3)$

(3) $(-\infty, -8) \cup (5, \infty)$ (4) $\left(-\infty, \frac{-11}{5}\right)$

Ans. (4)

Sol. $\because \alpha < 1 < \beta$

$f(1) < 0$

$\Rightarrow 1 + 2a + (3a + 10) < 0$

$\Rightarrow 5a + 11 < 0$

$a < \frac{-11}{5}$

$\therefore\ a \in \left(-\infty, \frac{-11}{5}\right)$

7. Given $A = \begin{bmatrix} 3 & -4 \\ 1 & -1 \end{bmatrix}$ & $B = \begin{bmatrix} -29 & 49 \\ -13 & 18 \end{bmatrix}$

such that $(A^{15} + B)\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$, then value of (x, y) satisfying above equation

(1) x = 11, y = 1 (2) x = –1, y = 2

(3) x = 1, y = 5 (4) x = 11, y = 2

Ans. (4)

Sol. Here $A^n = \begin{bmatrix} 2n+1 & -4n \\ n & -2n+1 \end{bmatrix}$

$\Rightarrow A^{15} = \begin{bmatrix} 31 & -60 \\ 15 & -29 \end{bmatrix}$

$\Rightarrow A^{15} + B = \begin{bmatrix} 2 & -11 \\ 2 & -11 \end{bmatrix}$

Now $\left(A^{15} + B\right)\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

$\Rightarrow \begin{bmatrix} 2 & -11 \\ 2 & -11 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

$\Rightarrow 2x - 11y = 0$

⇒ option **(D)** satisfies the equation

8. The number of solutions of equation tan3x = cotx in $x \in (0, 2\pi)$ is

(1) 4 (2) 6

(3) 2 (4) 8

Ans. (4)

Sol. tan3x = cotx

$\tan 3x = \tan\left(\frac{\pi}{2} - x\right)$

$3x = n\pi + \frac{\pi}{2} - x$

$4x = (2n+1)\frac{\pi}{2}$

$x = (2n+1)\frac{\pi}{8} \quad n \in I$

In $x \in (0, 2\pi)$

$x = \frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}$

∴ Number of solutions are 8

⇒ option(4) is correct

9. Let the line L pass through the point (–3,5,2) and make equal angle with the positive coordinate axes. If distance of L from the point (–2,r,1) is $\sqrt{\frac{14}{3}}$, then sum of all possible values of r is

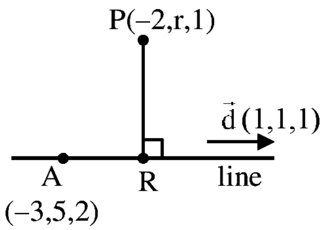
(1) 4 (2) 10

(3) 21 (4) 2

Ans. (2)

Sol. Equation line is : $\frac{x+3}{1}=\frac{y-5}{1}=\frac{z-2}{1}=\lambda$

$\therefore$ General point R on line is R(λ–3, λ+5, λ+2)



$\overrightarrow{PR} \equiv (\lambda-1, \lambda+5-r, \lambda+1)$

Now $\overrightarrow{PR}\cdot\vec{d}=0$

$\Rightarrow (\lambda-1)1+(\lambda+5-r)1+(\lambda+1)1=0$

$\Rightarrow 3\lambda - r + 5 = 0$

$\Rightarrow \lambda = \frac{r-5}{3}$

$\therefore\ R \equiv \left(\frac{r-5}{3}-3, \frac{r-5}{3}+5, \frac{r-5}{3}+2\right)$

$R \equiv \left(\frac{r-14}{3}, \frac{r+10}{3}, \frac{r+1}{3}\right)$

Now

$PR=\sqrt{\frac{14}{3}} \Rightarrow (PR)^2=\frac{14}{3}$

$\Rightarrow \left(\frac{r-14}{3}+2\right)^2+\left(\frac{r+10}{3}-r\right)^2+\left(\frac{r+1}{3}-1\right)^2=\frac{14}{3}$

$\Rightarrow \frac{(r-8)^2}{9}+\frac{(10-2r)^2}{9}+\frac{(r-2)^2}{9}=\frac{14}{3}$

$\Rightarrow (r^2-16r+64)+(100+4r^2-40r)+(r^2-4r+4)=42$

$\Rightarrow 6r^2-60r+126=0$

$\Rightarrow r^2-10r+21=0$

$\Rightarrow r = 3, 7$

sum of possible value of r is = 10

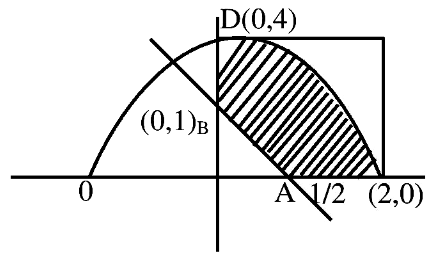
10. If area bounded by curve $1-2x \le y \le 4-x^2$ & $x, y \ge 0$ is equal to $\frac{\alpha}{\beta}$ where G.C.D (α, β) = 1. Find α + β.

(1) 73 (2) 69

(3) 70 (4) 54

Ans. (1)

Sol.



Required area $=\frac{2}{3}\times 8-\frac{1}{2}\times\frac{1}{2}\times 1$

$=\frac{16}{3}-\frac{1}{4}=\frac{61}{12}=\frac{\alpha}{\beta}$

$\Rightarrow \alpha+\beta = 73$

11. Lines L_1 & L_2 are

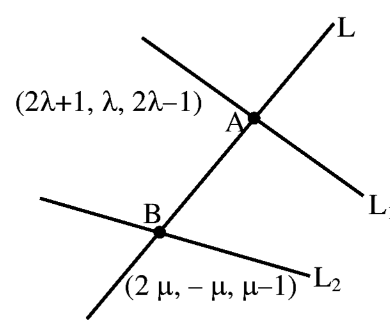
$\frac{x-1}{2}=\frac{y}{1}=\frac{z+1}{2}$ & $\frac{x}{2}=\frac{y}{-1}=\frac{z+1}{1}$ respectively, if a line L with direction ratios (1, 1, 1) intersects L_1 & L_2 at A & B respectively, then Find $(AB)^2$:

(1) 27 (2) 26

(3) 18 (4) 9

Ans. (1)

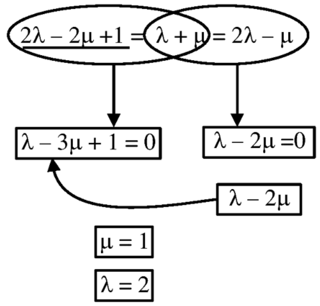
Sol.



D.R. of AB is (2λ –2μ +1, λ + μ, 2λ –μ)

D.R of L is given as (1, 1, 1)

$\therefore$



$\therefore$ A(5, 2, 3)

B (2, –1, 0)

$\therefore AB^2 = 9 + 9 + 9 = 27$

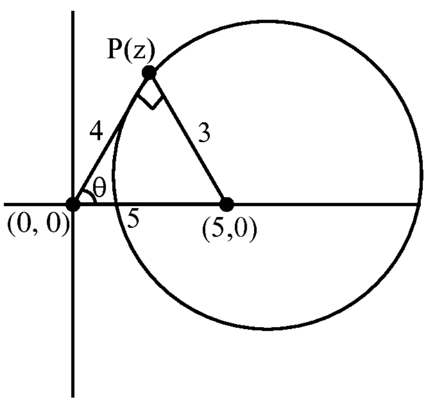
12. Let z_0 be the complex number satisfying $|z - 5| \le 3$ and having maximum positive argument, then $34\left|\dfrac{5z_0 - 12}{5iz_0 + 16}\right|^2$ is equal to

(1) 16 (2) 26

(3)12 (4) 20

Ans. **(4)**

Sol.



$|z - 5| \le 3$

For arg(z) to be maximum, z lies at P.

$z \equiv (4\cos\theta, 4\sin\theta)$

$$\equiv \left(4\cdot\left(\frac{4}{5}\right), 4\left(\frac{3}{5}\right)\right) = \left(\frac{16}{5}, \frac{12}{5}\right) = \frac{16}{5} + \frac{12i}{5}$$

$$\text{Now, } 34\left|\frac{5z_0 - 12}{5iz_0 + 16}\right|^2 = 34\left|\frac{(16+12i) - 12}{(16i - 12) + 16}\right|^2$$

$$= 34\left|\frac{4 + 12i}{16i + 4}\right|^2$$

$$= 34\left(\frac{16 + 144}{256 + 16}\right) = 34\left(\frac{160}{272}\right) = 20$$

13. Let $f(x) = \lim\limits_{n\to\infty}\left(\dfrac{1}{n^3}\sum\limits_{k=1}^{n}\left[\dfrac{k^2}{3^x}\right]\right)$ (where [·] represents greatest integer function) then $12\sum\limits_{j=1}^{\infty} f(j)$ is equal to.

(1) 1 (2) 2

(3) 3 (4) 4

Ans. (2)

Sol. $\sum\limits_{k=1}^{n}\left(\dfrac{k^2}{3^x} - 1\right) < \sum\limits_{k=1}^{n}\left[\dfrac{k^2}{3^x}\right] \le \sum\limits_{k=1}^{n}\dfrac{k^2}{3^x}$

$$\frac{n(n+1)(2n+1)}{6.3^x} < \sum_{k=1}^{n}\left[\frac{k^2}{3^x}\right] \le \frac{n(n+1)(2n+1)}{6.3^x}$$

$$\lim_{n\to\infty}\frac{n(n+1)(2n+1)}{6n^3.3^x} < \lim_{n\to\infty}\frac{1}{n^3}\sum_{k=1}^{n}\left[\frac{k^2}{3^x}\right] \le \lim_{n\to\infty}\frac{n(n+1)(2n+1)}{6.3^x.n^3}$$

$$\frac{1}{3^{x+1}} < \lim_{n\to\infty}\frac{1}{n^3}\sum_{k=1}^{n}\left[\frac{k^2}{3^x}\right] \le \frac{1}{3^{x+1}}$$

$$\Rightarrow f(x) = \frac{1}{3^{x+1}}$$

$$\Rightarrow 12\sum_{j=1}^{\infty} f(j) = 12\sum_{j=1}^{\infty}\frac{1}{3^{j+1}} = 12\left[\frac{1}{9} + \frac{1}{27} + ---\infty\right]$$

$$= 12.\frac{\frac{1}{9}}{1 - \frac{1}{3}} = 12\cdot\frac{\frac{1}{9}}{\frac{2}{3}} = 2$$

14. If probability distribution is given by

x	0	1	2	3
P(x)	$\frac{8a-1}{30}$	$\frac{4a-1}{30}$	$\frac{2a+1}{30}$	b

If $\sigma^2 + \mu^2 = 2$ where σ is standard deviation and μ is means of distribution then $\frac{a}{b}$ is

(1) $\frac{1000}{71}$ (2) $\frac{1110}{71}$

(3) $\frac{990}{71}$ (4) $\frac{994}{71}$

Ans. **(2)**

Sol. $\sigma^2 = \sum xi^2 P(x_i) - \mu^2$

$\sigma^2 + \mu^2 = \sum xi^2 P(x_i)$

$\Rightarrow 1\left(\frac{4a-1}{30}\right) + 4\left(\frac{2a+1}{30}\right) + ab = 2$

$4a + 8a + 3 + 30 + ab = 60$

$12a + 30 \times a \times b = 57$

$4a + 90\ b = 19$

$\sum P(i) = \frac{8a-1}{3} + \frac{4a-1}{30} + \frac{2a+1}{30} + b = 1$

$14a + 30b = 31$

$a = \frac{37}{19}, \quad b = \frac{213}{19 \times 90}$

$\Rightarrow \frac{a}{b} = \frac{1110}{71}$

15. If the line $\alpha x + 4y - \sqrt{7} = 0$, $\alpha \in R$ touches the ellipse $3x^2 + 4y^2 = 1$ at the point P in the first quadrant then one of the focal distance of P is

(1) $\frac{1}{\sqrt{3}} - \frac{1}{2\sqrt{11}}$ (2) $\frac{1}{\sqrt{3}} + \frac{1}{2\sqrt{5}}$

(3) $\frac{1}{\sqrt{3}} - \frac{1}{2\sqrt{5}}$ (4) $\frac{1}{\sqrt{3}} + \frac{1}{2\sqrt{7}}$

Ans. (4)

Sol. $\alpha x + 4y - \sqrt{7} = 0$ touches $3x^2 + 4y^2 = 1$

$\therefore c^2 = a^2m^2 + b^2$

$\frac{7}{16} = \frac{1}{3} \times \frac{\alpha^2}{16} + \frac{1}{4} \Rightarrow \alpha = 3, -3$

Tangent is $3x + 4y - \sqrt{7} = 0$

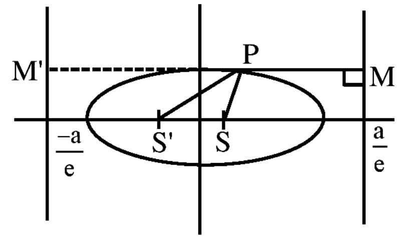
Let the point of contact is $P(x_1 y_1)$

$\therefore$ Tangent is $3xx_1 + 4yy_1 = 1$

$\therefore \frac{3x_1}{3} = \frac{4y_1}{4} = \frac{1}{\sqrt{7}}$

$\therefore P\left(\frac{1}{\sqrt{7}}, \frac{1}{\sqrt{7}}\right)$

ecc. $= \sqrt{1 - \frac{3}{4}} = \frac{1}{2}$



$PS = e\ (PM)$

$= e\left(\frac{a}{e} - \frac{1}{\sqrt{7}}\right)$

$= \frac{1}{2}\left(\frac{2}{\sqrt{3}} - \frac{1}{\sqrt{7}}\right) = \frac{1}{\sqrt{3}} - \frac{1}{2\sqrt{7}}$

$PS' = e\ (PM') = \frac{1}{2}\left(\frac{a}{e} + \frac{1}{\sqrt{7}}\right) = \frac{1}{2}\left(\frac{1}{\sqrt{7}} + \frac{2}{\sqrt{3}}\right)$

$= \frac{1}{\sqrt{3}} + \frac{1}{2\sqrt{7}}$

$\Rightarrow$ (D) option correct

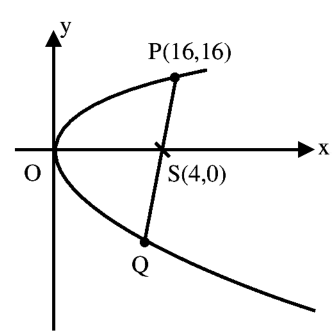
16. Let $y^2 = 16x$, from point (16,16) a focal chord is passing. Point (α,β) divides the focal chord internally in ratio 2 : 3 then minimum value of $(\alpha + \beta)$ is

(1) 22 (2) 11

(3) 9 (4) 10

Ans. (2)

Sol.



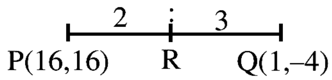
$y^2 = 16x$

for P(16,16), $t_1 = 2$

$\therefore$ Other end Q is $t_2 = \frac{-1}{2}$

i.e. Q (1, – 4)

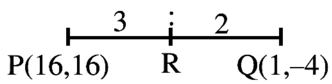
Case-I :



$R\left(\frac{2+48}{5}, \frac{-8+48}{5}\right)$ i.e. $R(10,8)$

$\therefore \alpha + \beta = 18$

Case = II :

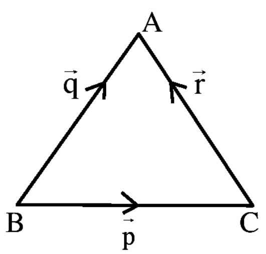


$R\left(\frac{32+3}{5}, \frac{-12+32}{5}\right)$ i.e. R (7,4)

$\therefore \alpha + \beta = 11$

Minimum value of $\alpha + \beta = 11$

17. If three vectors are given as shown



If angle between $\vec{p}$ and $\vec{q}$ is θ and $\cos\theta = \frac{1}{\sqrt{3}}$

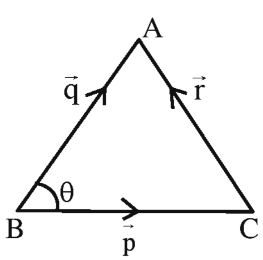
$|\vec{p}| = 2\sqrt{3}$, $|\vec{q}| = 2$ then find $|\vec{p} \times (\vec{q} - 3\vec{r})|^2 - 3|r|^2$

(1) 100 (2) 102

(3) 104 (4) 108

Ans. **(3)**

Sol.



$\vec{p} + \vec{r} = \vec{q}$

$\vec{r} = \vec{q} - \vec{p}$

$\cos\theta = \frac{|p|^2 + |q|^2 - |r|^2}{2|p||q|}$

$\frac{1}{\sqrt{3}} = \frac{12+4-|r|^2}{2 \times 2\sqrt{3} \times 2}$

$\Rightarrow |r|^2 = 8$

$|\vec{p} \times (\vec{q} - 3\vec{r})|^2 - 3|r|^2$

$= |\vec{p} \times (\vec{q} - 3(\vec{q} - \vec{p})|^2 - 3|r|^2$

$= 4|\vec{p} \times \vec{q}|^2 - 3|r|^2$

$= 4 \times 4 \times 3 \times 4 \times \frac{2}{3} - 24 = 104$

18. Let set

$A = \{2,3,4,5,9\}$ and $R = \{(x,y) : 2x \le 3y, x, y \in A\}$

If ℓ is number of elements in R and m is the number of elements required to make R symmetric then find $\ell + m$

Ans. **(25)**

Sol. $y \ge \frac{2x}{3}$

$$\left.\begin{array}{ll} x=2 & y=2,3,4,5,9 \\ x=3 & y=2,3,4,5,9 \\ x=4 & y=3,4,5,9 \\ x=5 & y=4,5,9 \\ x=9 & y=9 \end{array}\right\} \ell = 18$$

	2	3	4	5	9
2	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓
4	×	✓	✓	✓	✓
5	×	×	✓	✓	✓
9	×	×	×	×	✓

m = 7

$\ell + m = 25$

19. If $\left(\frac{1}{^{15}C_0} + \frac{1}{^{15}C_1}\right)\left(\frac{1}{^{15}C_1} + \frac{1}{^{15}C_2}\right)$

$\ldots\ldots \left(\frac{1}{^{15}C_{12}} + \frac{1}{^{15}C_{13}}\right) = \frac{\alpha^{13}}{^{14}C_0 \cdot {}^{14}C_1 \ldots\ldots\ldots {}^{14}C_{12}}$,

Then 30α is equal to

(1) 16 (2) 32

(3) 15 (4) 28

Ans. **(2)**

Sol. $\prod_{r=0}^{12}\left(\frac{1}{^{15}C_r} + \frac{1}{^{15}C_{r+1}}\right) = \prod_{r=0}^{12}\frac{\frac{16}{r+1} \cdot {}^{15}C_r}{^{15}C_r \cdot {}^{15}C_{r+1}}$

$$= \prod_{r=0}^{12} \frac{16}{(r+1)\cdot\frac{15}{r+1}\cdot{}^{14}C_r} = \prod_{r=0}^{12} \frac{\left(\frac{16}{15}\right)}{{}^{14}C_r}$$

$$= \frac{\left(\frac{16}{15}\right)^{13}}{{}^{14}C_0 \cdot {}^{14}C_1 \_\_\_\_ {}^{14}C_{12}} \Rightarrow \alpha = \frac{16}{15}$$

$\Rightarrow 30\alpha = 32$

20. If $x \in \left[\frac{-\sqrt{3}}{2}, \frac{1}{\sqrt{2}}\right]$, then maximum value of the expression $\left(\sin^{-1}x\right)^2 + \left(\cos^{-1}x\right)^2$ is $\frac{n\pi^2}{n+7}$ (where $n \in N$) then n is equal to

Sol. $\left(\sin^{-1}x\right)^2 + \left(\cos^{-1}x\right)^2$

$= \left(\sin^{-1}x + \cos^{-1}x\right)^2 - 2\sin^{-1}x\cos^{-1}x$

$= \frac{\pi^2}{4} - 2\left(\sin^{-1}x\right)\left(\frac{\pi}{2} - \sin^{-1}x\right)$

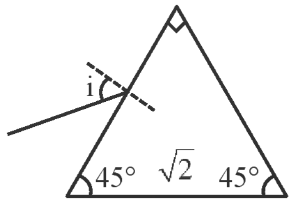
$= 2\left(\sin^{-1}x - \frac{\pi}{4}\right)^2 + \frac{\pi^2}{8}$ where $\sin^{-1}x \in \left[\frac{-\pi}{3}, \frac{\pi}{4}\right]$

Then max value occurs at $\sin^{-1}x = \frac{-\pi}{3}$

Which is $2\left(\frac{\pi}{3} + \frac{\pi}{4}\right)^2 + \frac{\pi^2}{8} = \frac{29\pi^2}{36} = \frac{n\pi^2}{n+7}$

$\Rightarrow n = 29$

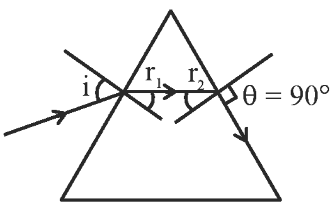
1. Refractive index of prism is $\sqrt{2}$. What should be angle of incidence for a light ray such that the emerging ray grazes out the surface :



(1) 60° (2) 30°
(3) 90° (4) 45°

Ans. **(3)**

Sol.



$\sqrt{2}\sin r_2 = 1\sin 90°$

$r_2 = 45°$

$r_1 + r_2 = A$

$r_1 = 45°$

$1\sin i = \sqrt{2}\sin 45°$

$i = 90°$

2. For YDSE experiment, for angular fringe width :

Statement-1 :- If distance between slits and screen increases then width increases.

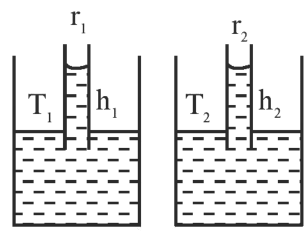
Statement-2 :- Angular fringe width depends on frequency of source.

(1) **Statement 1** is true & **Statement 2** is false
(2) **Statement 1** is false & **Statement 2** is true
(3) Both are true
(4) Both are false

Ans. **(2)**

Sol. Angular fring width is given by λ/d.

3. Two capilaries are dipped in two different liquids having meniscus radius R_1, R_2 ($R_1 > R_2$) and surface Tension T_1 & T_2. If density of liquids are same :



(1) $h_1 = h_2$ then $T_1 = T_2$
(2) $h_1 > h_2$ then $T_1 = T_2$
(3) $h_1 > h_2$ then $T_1 < T_2$
(4) $h_1 < h_2$ then $T_1 = T_2$

Ans. **(4)**

Sol. $h = \frac{2T}{R\rho g}$

$h \propto \frac{1}{R}$

Given $R_1 > R_2$

then $h_1 < h_2$

4. A particle is performing S.H.M. with frequency f_0. If frequency of oscillations of its kinetic energy is 176 Hz, find out f_0

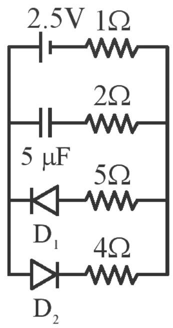
Ans. **(88 Hz)**

Sol. as we know $f_{KE} = 2f_0$

$$f_0 = \frac{f_{KE}}{2} = \frac{176}{2}$$

$$= 88 \text{ Hz}$$

5. In steady-state find charge on capacitor. Assume diodes are ideal :

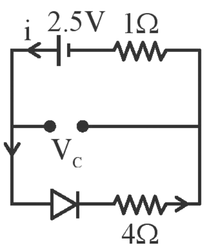


(1) 8 μC (2) 10 μC

(3) 12 μC (4) 20 μC

Ans. (2)

Sol.



in steady state

$i = 2.5/5 = 0.5$ A

$V_C = 4 \times 0.5$

$V_C = 2V$

charge

$Q = CV_C$

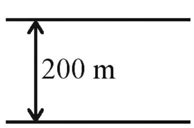
$= 5 \times 2$

$= 10\ \mu C$

6. A boat can row at speed 36 km/hr in still water. The river is flowing at 18 km/hr speed. If boat crosses the river in minimum time then find drift of boat :

Ans. (100 m)

Sol.



$V_r = 18$ km/hr

$V_{b/r} = 36$ km/hr

$V_r = 5$ m/s

$V_{b/r} = 10$ m/s

$$t_{min} = \frac{200}{10} = 20s$$

$D = V_r \times t = 5 \times 20 = 100$ m

7. A charged particle (m, q) is accelerated through a potential difference of 1.21 volt. If de-broglie wavelength of this particle is found to be $\alpha \times 10^{-12}$m. Find out α [$h = 6.6 \times 10^{-23}$ J-sec $mq = 18 \times 10^{-46}$] :

Ans. (10)

Sol. $$\lambda = \frac{h}{\sqrt{2mqV}}$$

$$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 18 \times 10^{-46} \times 1.21}}$$

$\lambda = 10^{-11}$ m $= 10 \times 10^{-12}$ m

$\alpha = 10$

8. Two persons are travelling in same direction in car along two parallel tracks separated by 10 m with speeds 36 km/hr and 72 km/hr. If mass of man and car is 1000 kg each. Find angular momentum of one car with person with respect to another :

(1) 10^4 kg m^2/s

(2) 3.6×10^4 kg m^2/s

(3) 7.2×10^4 kg m^2/s

(4) 10^5 kg m^2/s

Ans. (4)

Sol. $L = m.V_{rel}\, r_\perp$

$$= 1000 \times \left(36 \times \frac{5}{18}\right) \times 10$$

$= 10^5$ kg m^2/s

9. Keeping the significant figurs in view the sum of the 5.01 m, 153.2m and 0.123m is :

(1) 158.33 m

(2) 158.3 m

(3) 158.333 m

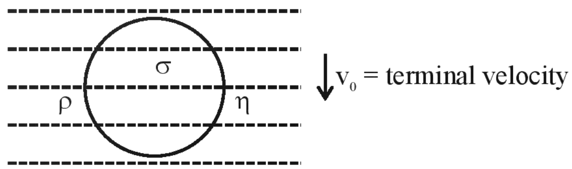
(4) 158.4 m

Ans. (2)

Sol. $L = 5.01 + 153.2 + 0.123$ m $= 158.333$ m

$L = 158.3$ m

10. Figure shows a ball falling in a viscous medium with coefficient of viscosity η. If error in measurement of radius is Δr & that is measurement of terminal velocity is Δv_0. Density of ball & liquid is exactly known, then fractional error in measurement of η (coefficient of viscosity)



(1) $\frac{\Delta\eta}{\eta}=\frac{2\Delta r}{r}+\frac{\Delta v_0}{v_0}$ (2) $\frac{\Delta\eta}{\eta}=\frac{2\Delta r}{r}-\frac{\Delta v_0}{v_0}$

(3) $\frac{\Delta\eta}{\eta}=2\left(\frac{\Delta r}{r}+\frac{\Delta v_0}{v_0}\right)$ (4) $\frac{\Delta\eta}{\eta}=2\left(\frac{\Delta r}{r}-\frac{\Delta v_0}{v_0}\right)$

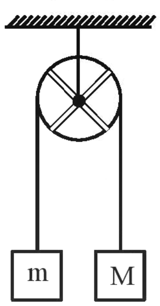
Ans. **(1)**

Sol. $v_0=\frac{2}{9}(\rho_s-\rho_\ell)\frac{r^2 g}{\eta}$ (Here v_0 is terminal velocity)

$$\Rightarrow \eta=\frac{2}{9}(\rho_s-\rho_\ell)\frac{r^2 g}{v_0}$$

$$\therefore \frac{\Delta\eta}{\eta}=\frac{2\Delta r}{r}+\frac{\Delta v_0}{v_0}$$

11. A ring and two rods each of mass M are able to rotate freely about its centre as shown. Find acceleration of each block? There is no slipping between string and pulley.



(1) $\frac{(M-m)g}{5M+m}$

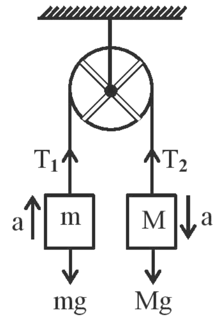
(2) $\frac{2(M-m)g}{8M+m}$

(3) $\frac{3(M-m)g}{8M+3m}$

(4) $\frac{2(M-m)g}{5M+2m}$

Ans. **(3)**

Sol.



$Mg - T_2 = Ma$ ...(1)

$T_1 - mg = ma$ ...(2)

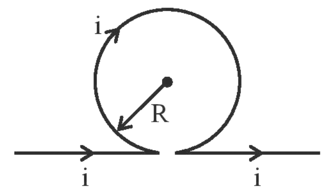
$(T_2 - T_1)r = I\frac{a}{r}$ ...(3)

(1) + (2) + (3)

$$(M-m)g=\left(M+m+\frac{I}{r^2}\right)a$$

$$\text{Here } I = Mr^2+\frac{M\times(2r)^2}{12}\times 2$$

12. Current i is flowing in the long wire as shown in figure. Find magnetic field at centre of circle.



(1) $B=\frac{\mu_0 i}{R}+\frac{\mu_0 i}{2\pi R}$ (2) $B=\frac{\mu_0 i}{2R}+\frac{\mu_0 i}{\pi R}$

(3) $B=\frac{\mu_0 i}{2R}+\frac{\mu_0 i}{2\pi R}$ (4) $B=\frac{\mu_0 i}{R}+\frac{\mu_0 i}{\pi R}$

Ans. **(3)**

Sol. $B=\frac{\mu_0 i}{2R}+\frac{\mu_0 i}{2\pi R}$

13. If position of a particle is given $x = t^2 + t + 1$. Mass of particle is 2 kg. Find work done by force from t = 2 sec to t = 3 sec.

(1) 24 Joule (2) 21 Joule

(3) 28 Joule (4) 20 Joule

Ans. **(1)**

Sol. $v = \frac{dx}{dt} = 2t + 1$

$a = 2$; $F = ma$

$F = 2 \times 2 = 4N$

$x_{(t=2sec)} = 2^2 + 2 + 1 = 7$

$x_{(t=3sec)} = 3^2 + 3 + 1 = 13$

Displacement = $\Delta x = 13 - 7 = 6$

Work done by force = $F \times x$

$= 4 \times 6 = 24$ J

14. Terminal velocity of a spherical ball of radius 6mm in a liquid is given as 20 cm/sec. Find terminal velocity (in cm/s) of a ball of 3mm radius in same liquid.

(1) 5 (2) 10

(3) 7 (4) 9

Ans. **(1)**

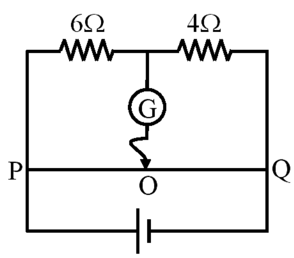
Sol. We know :

Terminal velocity $\propto$ (radius)^2

$$\frac{(v_T)_1}{(v_T)_2} = \left(\frac{6}{3}\right)^2$$

$$(v_T)_2 = \frac{(v_T)_1}{4} = 5 \text{ cm/sec}$$

15. The total length of potential wire PQ is 50 cm in the arrangement shown in the figure. Find out balance length PO (in cm).



(1) 25 (2) 20

(3) 30 (4) 35

Ans. **(3)**

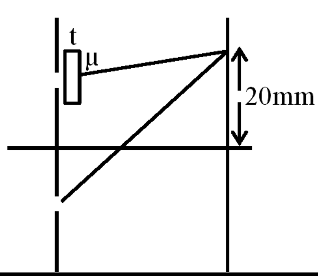
Sol. $\frac{6}{4} = \frac{x}{50 - x}$

$\frac{3}{2} = \frac{x}{50 - x}$

$150 - 3x = 2x$

$x = \frac{150}{5} = 30$ cm

16. In YDSE experiment, central maxima shift by 20 mm if a slab of thickness 20 μm and refractive index μ is placed in front of one of the slit. If distance between slits is 4×10^{-4} m and screen is placed 1m away from slits. Then refractive index is α/10. Find α.



Ans. **14**

Sol. $\frac{Y}{D}.t = t(\mu - 1)$

$$\mu = \left(\frac{Yd}{Dt} + 1\right)$$

$$= \left(\frac{20 \times 10^{-3} \times 4 \times 10^{-4}}{1 \times 20 \times 10^{-6}}\right) + 1$$

$$= \frac{4}{10} + 1$$

$$\Rightarrow \mu = \frac{14}{10}$$

17. A medium having conductivity 10 siemen/meter. Electromagnetic waves of frequency 100 MHz are passed through this medium. Find ratio of maximum displacement current & conduction current. (Given : $\varepsilon_r = 2$)

(1) 400 (2) 600

(3) 900 (4) 1000

Ans. **(3)**

Sol. $i_c = A.\sigma E = A\sigma E_0 \sin(\omega t - kx)$

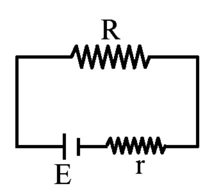
$$i_d = A\varepsilon_r\varepsilon_0 \frac{\partial E}{\partial t}$$

$$= A\varepsilon_r\varepsilon_0 E_0 \omega \cos(\omega t - kx)$$

$$\frac{i_{c\,max}}{i_{d\,max}} = \frac{\sigma}{\varepsilon_r \varepsilon_0 \omega}$$

$$= \frac{10}{2 \times 8.85 \times 10^{-12} \times 100 \times 10^6} = 900$$

18. In a circuit, there is a battery with internal resistance r and emf E, which is connected to external load resistance R as shown. Find value of R so that maximum power dissipates across R :



(1) R = r (2) $R = \frac{r}{2}$

(3) $R = \sqrt{2}\, r$ (4) R = 2r

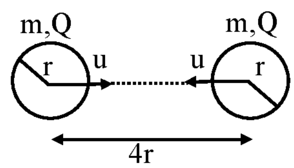
Ans. **(1)**

Sol. For maximum power drawn across load Resistance

$R_{Load} = R_{internal}$

$\boxed{R = r}$

19. Two spheres of same mass m radius r and charge at separation 4r are moving with same speed u towards each other as shown in figure:



Find the u_{min} so that they collide

(1) $\sqrt{\frac{KQ^2 - Gm^2}{4mr}}$ (2) $\sqrt{\frac{KQ^2 - Gm^2}{2mr}}$

(3) $\sqrt{\frac{KQ^2 - Gm^2}{8mr}}$ (4) $\sqrt{\frac{2KQ^2 - Gm^2}{8mr}}$

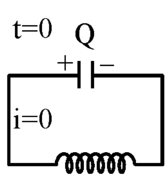
Ans. **(1)**

Sol. Using energy conservation

$$(2)\left(\frac{1}{2}mu^2\right) - \frac{Gm^2}{4r} + \frac{KQ^2}{4r} = -\frac{Gm^2}{2r} + \frac{KQ^2}{2r}$$

$$u = \sqrt{\frac{1}{4mr}\left(KQ^2 - Gm^2\right)}$$

20. In an L-C circuit at t = 0 capacitor is fully charged and zero current in circuit. At $t = t_0$, 25% energy of capacitor goes into inductor then value of t_0 is :



(1) $\frac{\pi}{3}\sqrt{LC}$ (2) $\frac{\pi}{6}\sqrt{LC}$

(3) $\frac{3}{2}\pi\sqrt{LC}$ (4) $\frac{\pi}{2}\sqrt{LC}$

Ans. **(2)**

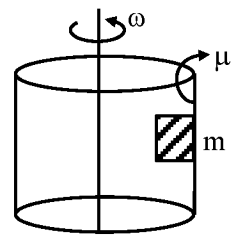
Sol. $U_{c_f} = 75\% U_{c_i}$

$$Q_F^2 = \frac{3}{4}Q_I^2$$

$$Q_i \cos \omega t = \frac{\sqrt{3}}{2}Q_i \Rightarrow t = \frac{T}{12}$$

$$t = \frac{\pi}{6}\sqrt{LC}$$

21. Find ω such that block does not slip on the surface of cylinder :

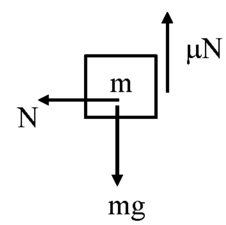


(1) $\sqrt{\frac{g}{\mu r}}$ (2) $\frac{g}{\mu r}$

(3) $\sqrt{\frac{gr}{\mu}}$ (4) $r\sqrt{\frac{g}{\mu}}$

Ans. **(1)**

Sol.



$N = m\omega^2 r$ and $mg = \mu N$

$\mu \times m\omega^2 r = mg$

$$\boxed{\omega = \sqrt{\frac{g}{\mu r}}}$$

22. For a diatomic gas undergoing an isobaric process, work done is 100 Joules then calculate heat supplied during the process :

(1) 350 (2) 400

(3) 450 (4) 700

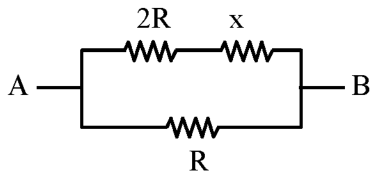
Ans. **(1)**

Sol. $w = 100\text{ J} = nR\Delta T$ for isobaric process.

$$Q = nC_p\Delta T = \left(\frac{f}{2} + 1\right)nR\Delta T$$

$$= \frac{7}{2}.(100) = 350 \text{ Joule.}$$

23. For the given network, the net resistance across AB = x. Then find the value of x :



(1) $x = R\left(\sqrt{2}-1\right)$ (2) $x = R\left(\sqrt{3}+1\right)$

(3) $x = R\left(\sqrt{2}+1\right)$ (4) $x = R\left(\sqrt{3}-1\right)$

Ans. (4)

Sol. $\frac{(2R+x)R}{3R+x} = x$

$2R^2 + xR = 3Rx + x^2$

$x^2 + 2Rx - 2R^2 = 0$

$x = \frac{-2R \pm \sqrt{4R^2+8R^2}}{2}$

$= \frac{-2R \pm 2\sqrt{3}R}{2}$

$= R\left(\sqrt{3}-1\right)$

24. V_{rms} of O_2 gas at 47°C is equal to V_{rms} of H_2 at what temp in celsius:

(1) –253°C (2) –20°C

(3) +20°C (4) +253°C

Ans. (1)

Sol. $V_{rms} = \sqrt{\frac{3RT}{M}}$

$V_{rmsO_2} = V_{rmsH_2}$

$T_{O_2} = 273+47 = 320\,K$

$\sqrt{\frac{3RT_{O_2}}{M_{O_2}}} = \sqrt{\frac{3R\,T_{H_2}}{M_{H_2}}}$

$\frac{T_2}{M_{O_2}} = \frac{T_{H_2}}{M_{H_2}}$

$\frac{320}{32} = \frac{T_{H_2}}{2}$

$T_{H_2} = 20\,K$

$T_{H_2} = -253°C$

25. Energy of an electron in Bohr's model is $-0.04E_0$ eV, where E_0 is ground state energy. If L is angular momentum of electron & h is Planck's constant then $\frac{2\pi L}{h}$ is:

Ans. (5)

Sol. angular momentum $L = \frac{nh}{2\pi}$

$n = \frac{2\pi L}{h}$

Energy $E = -\frac{13.6}{n^2}.z^2 = -\,0.04 \times \left(\frac{+13.6}{1}.z^2\right)$

$n^2 = 25$

$\boxed{n=5}$

SECTION-A

1. When 8.74 g MnO_2 is treated with HCl then what will be the weight of $Cl_2(g)$, obtained :
[Molar mass of MnO_2 = 87.4 g/mol]

(1) 7.1 g (2) 17.1 g
(3) 14.2 g (4) 3.55 g

Ans. (1)

Sol. $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

$\frac{8.74}{87.4}$ Excess

= 0.1 mole 0.1 mole

Wt. of Cl_2 obtained = 0.1 × 71 = 7.1 g

2. Calculate Bond Energy of C – H bond in CH_4.
Given : ΔH_f of $CH_4(g)$ = – x kJ/mol
ΔH_{sub} of carbon = y kJ/mol
B.E. of H – H = z kJ/mol.

(1) $\frac{x-y+z}{4}$ (2) $\frac{y+2z+x}{4}$
(3) $\frac{y-2z-x}{4}$ (4) $\frac{2y-z+x}{4}$

Ans. (2)

Sol. $C(s) + 2H_2(g) \rightarrow CH_4(g)$

$-x = (\Delta H_{sub}$ of carbon) + 2 × (B.E. of H – H)
–4 × (B.E. of C – H)

$-x = y + 2z - 4$ (B.E. of C – H)

B.E. of C – H = $\frac{y+2z+x}{4}$.

3. Following transition are made by an electron in a hydrogen like species. Find energy order of emitted photon :

(A) 1st line of Lyman Series
(B) 2nd line of Balmer Series
(C) 3rd line of Paschen Series
(D) 4th line of Brackett Series

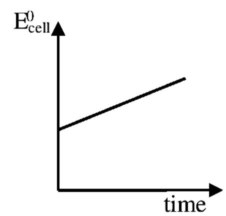
(1) D > A > B > C (2) A > B > C > D
(C) B > C > D > A (4) A > C > B > D

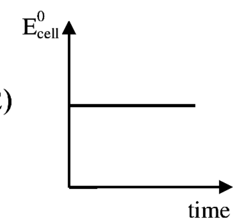
Ans. (2)

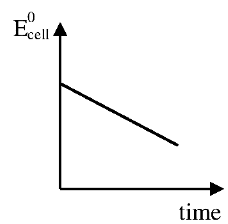
Sol. $\Delta E = 13.6Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

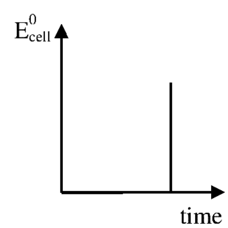
Series	n_1	n_2
1st line (Lyman)	1	2
2nd line (Balmer)	2	4
3rd line (Paschen)	3	6
4th line (Brackett)	4	8

4. For a Daniel cell, select correct variation of E^0_{cell} with time

(1)


(2)


(3)


(4)


Ans. (2)

Sol. E^0_{cell} remain constant with time.

5. $A_g \rightarrow B_g + C_g$

Initial pressure of A is 1 bar after 100 min. total pressure becomes 1.5 bar. Find value of rate constant of the reaction assuming first order reaction.

(1) $6.9 \times 10^{-4}\ min^{-1}$ (2) $6.9 \times 10^{-3}\ min^{-1}$

(3) $6.9 \times 10^{-5}\ min^{-1}$ (4) $6.9 \times 10^{-2}\ min^{-1}$

Ans. (2)

Sol. $A_g \rightarrow B_g + C_g$

1 – –

1–P P P

$P_{total} = 1 + P$

$1.5 = 1 + P$

$P = 0.5$

$K = \frac{1}{100} \ln \frac{1}{0.5}$

$= \frac{0.693}{100}$

$= 6.9 \times 10^{-3}\ min^{-1}$

6. Statement-I : The correct order for radius is Al > Mg > Mg^{2+} > Al^{3+}

Statement-II : Atomic size always depends on electronegativity.

(1) Both statements I and II are correct.

(2) Both statements I and II are false.

(3) Statement I is correct and II is false.

(4) Statement I is false and II is correct.

Ans. (2)

Sol. Correct order of size is Mg > Al > Mg^{2+} > Al^{3+}

Atomic size depends mainly upon $Z_{effective}$ and shell number.

7. **Statement-I :** Bond dissociation energy order is : $Cl_2 > Br_2 > F_2 > I_2$

Statement-II : Bond dissociation energy is independent of bond order

(1) Both statements I and II are correct.

(2) Both statements I and II are false.

(3) Statement I is correct and II is false.

(4) Statement I is false and II is correct.

Ans. (3)

Sol. Bond energy order is $Cl_2 > Br_2 > F_2 > I_2$

Bond energy increases with increase in bond order.

8. NaCl(solid) + H_2SO_4(conc.) + $K_2Cr_2O_7$(s) $\rightarrow$ Product

(1) Product is CrO_2Cl_2 and oxidation state of Cr = +6

(2) Product is $Cr_2O_2Cl_2$ and oxidation state of Cr = +6

(3) Product is $Cr_2O_2Cl_2$ and oxidation state of Cr = +3

(4) Product is CrO_2Cl_2 and oxidation state of Cr = +3

Ans. (1)

Sol. Chromyl chloride test : Product is deep red vapours of CrO_2Cl_2 in which oxidation state of Cr is +6.

9. Which of following is correct order of bond length?

(1) C–H < C≡N < C=O < C–O

(2) C≡N < C–H < C–O < C=O

(3) C–H < C≡N < C–O < C=O

(4) C–O < C≡N < C=O < C–H

Ans. (1)

Sol.

C–H	107 pm
C≡N	116 pm
C–O	143 pm
C=O	121 pm

Data based (From NCERT)

10. Statement-I : The correct order of electron affinity is Cl > Br > S > O

Statement-II : Correct order of ionic character is $PbCl_2 < PbCl_4$, $UF_6 < UF_4$, $SnCl_4 > SnCl_2$

(1) Statement I is correct and statement II is incorrect.

(2) Both statement I and II are correct.

(3) Statement I is incorrect and statement II is correct.

(4) Both statement I and II are incorrect.

Ans. (1)

Sol. Generally on moving down the group electron affinity decreases and on moving across the period electron affinity increase.

In the periodic table Cl has maximum electron affinity.

8. NaCl(solid) + H_2SO_4(conc.) + $K_2Cr_2O_7$(s) $\rightarrow$ Product

(1) Product is CrO_2Cl_2 and oxidation state of Cr = +6

(2) Product is $Cr_2O_2Cl_2$ and oxidation state of Cr = +6

(3) Product is $Cr_2O_2Cl_2$ and oxidation state of Cr = +3

(4) Product is CrO_2Cl_2 and oxidation state of Cr = +3

Ans. **(1)**

Sol. Chromyl chloride test : Product is deep red vapours of CrO_2Cl_2 in which oxidation state of Cr is +6.

9. Which of following is correct order of bond length?

(1) C–H < C≡N < C=O < C–O

(2) C≡N < C–H < C–O < C=O

(3) C–H < C≡N < C–O < C=O

(4) C–O < C≡N < C=O < C–H

Ans. **(1)**

Sol. C–H 107 pm

C≡N 116 pm

C–O 143 pm

C=O 121 pm

Data based (From NCERT)

10. Statement-I : The correct order of electron affinity is Cl > Br > S > O

Statement-II : Correct order of ionic character is $PbCl_2 < PbCl_4$, $UF_6 < UF_4$, $SnCl_4 > SnCl_2$

(1) Statement I is correct and statement II is incorrect.

(2) Both statement I and II are correct.

(3) Statement I is incorrect and statement II is correct.

(4) Both statement I and II are incorrect.

Ans. **(1)**

Sol. Generally on moving down the group electron affinity decreases and on moving across the period electron affinity increase.

In the periodic table Cl has maximum electron affinity.

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

Ans. **(3)**

Sol. 0

14. Match the **list-I** with **list-II**

list-I		list-II	
(P)	Cis-2-Butene, trans-2-butene	(1)	Functional isomers
(Q)	Diethyl ether, Butanol	(2)	Stereoisomers
(R)	1-Butene, 2-Butene	(3)	Position isomers
(S)	n-Pentane, Isopentane	(4)	Chain isomers

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

Ans. **(2)**

Sol. 0

15. Which of the following statement is/are correct?

(a) Nucleotide containing 1,4-linkage.

(b) Quaternary structure of protein is compact folded structure.

(c) During denaturation of protein secondary and tertiary structure destroyed and primary structure retained.

(d) Enthalpy of enzymatic hydrolysis of sucrose is greater than acid catalysed hydrolysis of sucrose.

(1) a, b, c (2) b, c

(3) a, d (4) b, c, d

Ans. **(2)**

Sol. 0

16. Find correct order of rate of reaction of CH_3Br with given nucleophiles $(\overset{\ominus}{Nu})$

(1) $\overset{\ominus}{O}H > Ph\overset{\ominus}{O} > HCO\overset{\ominus}{O} > ClO_4^{\ominus}$

(2) $Ph\overset{\ominus}{O} > \overset{\ominus}{O}H > HCO\overset{\ominus}{O} > ClO_4^{\ominus}$

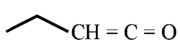
(3) $\overset{\ominus}{O}H > Ph\overset{\ominus}{O} > ClO_4^{\ominus} > HCO\overset{\ominus}{O}$

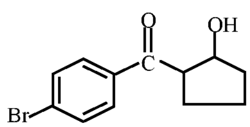
(4) $Ph\overset{\ominus}{O} > \overset{\ominus}{O}H > ClO_4^{\ominus} > HCO\overset{\ominus}{O}$

Ans. **(1)**

Sol. Based on strength of nucleophile (More stable anion is less nucleophilic).

17. **Statement-1 :** There is $2sp^3$, 1 sp^2 and 1 sp hybridised carbon present in -



Statement-2 : 

have two chiral centre.

(1) Statement-1 is incorrect but Statement-2 is correct

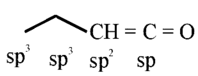
(2) Statement-1 is correct but Statement-2 is incorrect

(3) Both statements are correct.

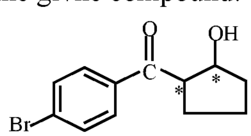
(4) Both statements are incorrect.

Ans. **(3)**

Sol. Both statements are correct.



So there are $2sp^3$, $1sp^2$ and 1sp hybridised carbon in the givne compound.



18. 1 gm of unknown organic compound produce 1.49 of $Mg_2P_2O_7$ determine % of P in unknown organic compound :

(1) 11.61 (2) 21.61

(3) 31.61 (4) 41.61

Ans. **(4)**

Sol. $\% \text{ of P} = \dfrac{n_{Mg_2P_2O_7} \times 2 \times 31}{w_{(\text{unknown compound})}} \times 100$

$= 41.61\%$

19. Calculate $E^o_{Cl^-/AgCl/Ag}$ (in millivolt)

Given : $\left(E^o_{Ag^+/Ag} = 0.79\,V\right)$, $\left(K_{SP(AgCl)} = 10^{-10}\right)$

$\dfrac{2.303\,RT}{F} = 0.059.$

(1) 100 (2) 200

(3) 300 (4) 400

Ans. **(2)**

Sol. $E^o_{Cl^-/AgCl/Ag} = E^o_{Ag^+/Ag} - \dfrac{0.059}{1}\log\dfrac{1}{K_{sp}}$

$= 0.79 - 0.059 \times \log 10^{10}$

$= 0.79 - 0.59$

$= 0.2$ volt

$= 200$ millivolt.

20. In following 4 molecules one is optically active and find the % of carbon in chiral compound

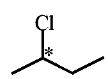
1-Chlorobutane, 2-Chloropropane

2-Chlorobutane, 1-Chloro-2, 2-Dimethyl propane

(1) 11.61 (2) 21.61

(3) 51.89 (4) 41.61

Ans. **(3)**

Sol. 

2-Chlorobutane is optically active and chiral molecule

Molecular formula $\Rightarrow C_4H_9Cl$

Moler mass = 48 + 9 + 35.5 = 92.5

$\%OC = \dfrac{48}{92.5} \times 100 = 51.89\%$

21. For a living cell, osmotic pressure is 12 atm at 300 K, which is isotonic with NaCl(aq.) solution then strength of NaCl solution is _____ $\times 10^{-2}$ g/L.

[R = 0.08 L-atm/mol-K] :

Ans. **(1462)**

Sol. $\pi = iCRT$

$12 = 2 \times C \times 0.08 \times 300$

$C = \dfrac{1}{4}$ mole/L

$\text{Conc.} = \dfrac{1}{4} \times 58.5$ g/L

$= 14.625$ g/L

$= 1462.5 \times 10^{-2}$ g/L

22. Find concentration of X^{2-} at equilibrium in 0.1 M H_2X ? (in order of 10^{-15})

Given : $K_{a_1} = 2.5 \times 10^{-8}$, $K_{a_2} = 1 \times 10^{-13}$.

Ans. **(100)**

Sol. $H_2X \rightleftharpoons H^+ + HX^-$,

$0.1-x \qquad x+y \qquad x-y$

$$2.5 \times 10^{-8} = \frac{(x+y)(x-y)}{0.1-x}$$

$HX^- \rightleftharpoons H^+ + X^{2-}$,

$x-y \qquad x+y \qquad y$

$$1 \times 10^{-13} = \frac{(x+y)(y)}{x-y}$$

Approximate : $K_{a_1} >> K_{a_2} \Rightarrow$ So $x >> y$.

$x + y \approx x, x - y \approx x$

$$10^{-13} = \frac{x.y}{x}$$

$y = 10^{-13}$

$[X^{2-}] = 10^{-13}$

$[X^{2-}] = 100 \times 10^{-15}$

23. Elevation of Boiling point of a solution containing 15 gm solute in 150 gm solvent is 0.5ºC, and relative lowering in vapour pressure is $x \times 10^{-2}$ then find x (Assume dilute solution) Given molar mass of solvent = 300 gm/mole,

$K_b = 5$ K-kg/mole

Ans. **(3)**

Sol. $\Delta T_b = ik_bm$

$0.5 = 5 \times im$

$$\frac{P_0 - P_s}{P_0} = \frac{im \times M_{solvent}}{1000} = 0.1 \times \frac{300}{1000} = 0.03$$

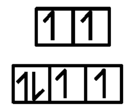
$= 3 \times 10^{-2}$

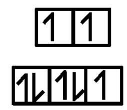
24. Among the following V^{3+}, Ti^{2+}, Ni^{2+}, Fe^{2+}, Co^{2+} for which spin only magnetic moment > 3, and which can form high spin octahedral complex. Find the sum of unpaired electrons in those complexes.

Ans. **(7)**

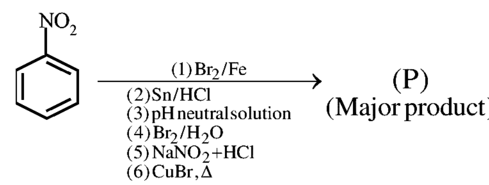
Sol. V^{3+} $3d^3$, Ti^{2+} $3d^2$, Ni^{2+} $3d^8$, Fe^{2+} $3d^6$, Co^{2+} $3d^7$

Only Fe^{2+} and Co^{2+} can form high spin octahedral complex.

Fe^{2+} $3d^6$  $n = 4, \mu > 3$

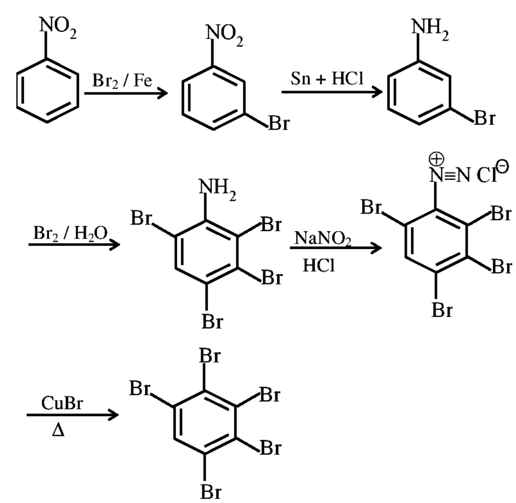
Co^{2+} $3d^7$  $n = 3, \mu > 3$

$\therefore$ Number of unpaired electrons = 4 + 3 = 7

25. 

Number of bromine atom in major product?

Ans. (5)

Sol. 

Number of Br atom in major product (P) = 5