PART : MATHEMATICS

1. If the system of equation

$$11x+y+\lambda z=-5$$

$$2x+3y+5z=3$$

$$8x-19y-39z=\mu$$

Has infinitely many solutions, then $\lambda^4-\mu$ is equal to :

(1) 45 (2) 47 (3) 49 (4) 51

Ans. **NTA (2)**
RESO (2)

Sol. Multiply by 2 $22x + 2y + 2\lambda z = -10$
Multiply by 7 $14x + 21y + 35z = 21$
subtract $8x - 19y + (2\lambda - 35)z = -31$
It is identical to other equation as far as coefficient of x, y are
$\Rightarrow$ $2\lambda - 35 = -39$, $-31 = \mu$
$\lambda = -2$, $\mu = -31$
$\lambda^4-\mu = 47$

2. Consider the following statements:
Statement I : For any two non-zero complex numbers z_1, z_2,

$$\left(|z_1|+|z_2|\right)\left|\frac{z_1}{|z_1|}+\frac{z_2}{|z_2|}\right| \le 2\left(|z_1|+|z_2|\right) \text{ and}$$

Statement II : If x, y, z are three distinct complex numbers and a, b. c are three positive real Numbers such that $\frac{a}{|y-z|}=\frac{b}{|z-x|}=\frac{c}{|x-y|}$, then

$$\frac{a^2}{y-z}+\frac{b^2}{z-x}+\frac{c^2}{x-y}=1$$

Between the above two Statements,
(1) both Statement I and Statement II are incorrect.
(2) Statement I is correct but Statement II is incorrect.
(3) Statement I is incorrect but Statement II are correct.
(4) both Statement I and Statement II are correct.

Ans. **NTA (2)**
RESO(2)

Sol. Statement-1 : $\left(|z_1|+|z_2|\right)\left|\frac{z_1}{|z_1|}+\frac{z_2}{|z_2|}\right| \le 2(|z_1|+|z_2|)$

$\therefore$ $\left|\frac{z_1}{|z_1|}+\frac{z_2}{|z_2|}\right| \le \left|\frac{z_1}{|z_1|}\right|+\left|\frac{z_2}{|z_2|}\right|$

$\Rightarrow$ $\left|\frac{z_1}{|z_1|}+\frac{z_2}{|z_2|}\right| \le 2$

$\Rightarrow$ Statement-1 is correct.

Statement-2:

Let $\frac{a}{|y-z|}=\frac{b}{|z-x|}=\frac{c}{|x-y|}=k$

$\Rightarrow$ $a^2 = K^2 |y - z|^2$

$\Rightarrow$ $a^2 = K^2(y-z)(\bar{y}-\bar{z})$

$\Rightarrow \quad \frac{a^2}{y-z} = K^2(\bar{y}-\bar{z})$

Similarly $\frac{b^2}{z-x} = K^2(\bar{z}-\bar{x})$

and $\frac{c^2}{x-y} = K^2(\bar{x}-\bar{y})$

Now, $\frac{a^2}{y-z} + \frac{b^2}{z-x} + \frac{c^2}{x-y} = 0$

Statement-2 is incorrect.

3. If $\frac{1}{\sqrt{1}+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \ldots\ldots + \frac{1}{\sqrt{99}+\sqrt{100}} = m$ and $\frac{1}{1.2} + \frac{1}{2.3} + \ldots\ldots + \frac{1}{99.100} = n$, then the point (m, n) lies on the line

(1) $11(x-1)-100(y-2)=0$

(2) $11x-100y=0$

(3) $11(x-1)-100y=0$

(4) $11(x-2)-100(y-1)=0$

Ans. **NTA (2)**
RESO(2)

Sol. $m = (\sqrt{2}-1)+(\sqrt{3}-\sqrt{2})+(\sqrt{4}-\sqrt{3})+\ldots\ldots+(\sqrt{100}-\sqrt{99})$

$m = 10-1 = 9$

$n = \frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \ldots\ldots + \frac{1}{99.100}$

$= \left(1-\frac{1}{2}\right)+\left(\frac{1}{2}-\frac{1}{3}\right)+\left(\frac{1}{3}-\frac{1}{4}\right)+\ldots\ldots+\left(\frac{1}{99}-\frac{1}{100}\right)$

$= 1-\frac{1}{100} = \frac{99}{100}$

4. If the function $f(x) = \frac{\sin 3x + \alpha \sin x - \beta \cos 3x}{x^3}$, $x \in R$, is continuous at x = 0, then $f(0)$ is equal to :

(1) 2 (2) –2 (3) –4 (4) 4

Ans. **NTA (3)**
RESO(3)

Sol. $\frac{3x - \frac{(3x)^3}{3!} + \alpha\left(x - \frac{x^3}{3!}\right) - \beta\left(1 - \frac{9x^2}{2!}\right)}{x^3}$

$\beta = 0, \quad \alpha = -3$

$= \lim_{x\to 0} \frac{-3^3\frac{x^3}{6} + 3.\frac{x^3}{6}}{x^3} = \frac{3-3^3}{2\times 3}$

$= \frac{1-9}{2} = -4$

5. Let A and B be two square matrices of order 3 such that |A| = 3 and |B| = 2. Then $\left|A^TA(adj(2A))^{-1}(adj(4B))(adj(AB))^{-1}AA^T\right|$ is equal to :

(1) 81 (2) 64 (3) 32 (4) 108

Ans. **NTA (2)**
RESO(2)

Sol. $\left|A^TA(adj(2A))^{-1}(adj(4B))(adj(AB))^{-1}AA^T\right|$

$=|A||A^T||(2A)^{-1}|^2|\left(|AB|^2\right)^{-1}|^2|4B|^2|A||A^T|$

$=|A|^2|A|^2\ \frac{1}{2^6}\ \frac{1}{|A|^2}\ \frac{1}{|A|^2}\ \frac{1}{|B|^2}\ 4^6\ |B|^2 = 2^6 = 64$

6. If y = y(x) is the solution of the differential equation $\frac{dy}{dx}+2y=\sin(2x), y(0)=\frac{3}{4}$, then $y\left(\frac{\pi}{8}\right)$ is equal to :

(1) $e^{\frac{\pi}{8}}$ (2) $e^{\frac{\pi}{4}}$ (3) $e^{\frac{-\pi}{8}}$ (4) $e^{\frac{-\pi}{4}}$

Ans. **NTA (4)**
RESO(4)

Sol. I.F. = e^{2x}

G.S. $y.e^{2x}=\int e^{2x}.\sin 2x dx + C$

$y.e^{2x}=\frac{e^{2x}}{\left(2^2+2^2\right)}(2.\sin 2x - 2.\cos 2x)+C$

$x = 0,\ y=\frac{3}{4} \quad \Rightarrow \quad \frac{3}{4}=\left(-\frac{1}{4}\right)+C \quad \Rightarrow\ C = 1$

$y.e^{2x}=\frac{1}{4}e^{2x}(\sin 2x-\cos 2x)+1$

$x=\frac{\pi}{8} \Rightarrow y=e^{-\frac{\pi}{4}}$

7. If the line $\frac{2-x}{3}=\frac{3y-2}{4\lambda+1}=4-z$ makes a right angle with line $\frac{x+3}{3\mu}=\frac{1-2y}{6}=\frac{5-z}{7}$, then $4\lambda + 9\mu$ is equal to :

(1) 6 (2) 5 (3) 13 (4) 4

Ans. **NTA (1)**
RESO(1)

Sol. Lines are : $\frac{x-2}{-3}=\frac{y-2/3}{\frac{4\lambda+1}{3}}=\frac{z-4}{-1}$

and : $\frac{x-3}{3\mu}=\frac{y-1/2}{-3}=\frac{x-5}{-7}$

Lines are perpendicular

$-3(3\mu)+\left(\frac{4\lambda+1}{3}\right)(-3)+(-1)(-7)=0$

$-9\mu - 4\lambda - 1 + 7 = 0$

$4\lambda + 9\mu = 6$

8. The coefficient a, b, c in the quadratic equation $ax^2 + bx + c = 0$ are chosen from the set {1, 2, 3, 4, 5, 6, 7, 8}. The probability of this equation having repeated roots is :

(1) $\frac{1}{64}$ (2) $\frac{3}{256}$ (3) $\frac{1}{128}$ (4) $\frac{3}{128}$

Ans. **NTA (1)**
RESO(1)

Sol. For equal roots $b^2 = 4ac$

$b^2 = 1^2 \Rightarrow 1 = 4ac$ not possible
$b^2 = 2^2 \Rightarrow 1 = ac \Rightarrow a = 1, c = 1$ 1way
$b^2 = 3^2 \Rightarrow 9 = 4ac$ not possible
$b^2 = 4^2 \Rightarrow 4 = ac \Rightarrow a = 1, c = 4$ or $a = 2, c = 2$ or $a = 4, c = 1$ 3way
$b^2 = 5^2 \Rightarrow 25 = 4ac$ not possible
$b^2 = 6^2 \Rightarrow 9 = ac \Rightarrow a = 3, c = 3$ 1way
$b^2 = 7^2 \Rightarrow 49 = 4ac$ not possible
$b^2 = 8^2 \Rightarrow 16 = ac \Rightarrow a = 2, c = 8$ or $a = 4, c = 4$ or $a = 8, c = 2$ 3way
Favourable = 1 + 3 + 1 + 3 = 8, Total = 8^3

9. For the function $f(x) = \sin x + 3x - \frac{2}{\pi}(x^2 + x)$, where $x \in [0, \frac{\pi}{2}]$ consider two following two statements :

(I) f is increasing in $\left(0, \frac{\pi}{2}\right)$.

(II) f' is decreasing in $\left(0, \frac{\pi}{2}\right)$.

Between the above two statements,
(1) only (II) is true.
(2) both (I) and (II) are true.
(3) neither (I) nor (II) is true.
(4) only (I) is true.

Ans. **NTA (2)**
RESO(2)

Sol. $F(x) = \sin x - \frac{2}{\pi}(x^2 + x) + 3x$

$F'(x) = \cos x - \frac{2}{\pi}(2x + 1) + 3$

$F'(x) = \cos x - \frac{4\pi}{\pi} - \frac{2}{\pi} + 3$

$\Rightarrow$ $F'(x) > 0 \ \forall \ x \in (0, \pi/2) \ \therefore \ \frac{4x}{\pi} \in (0, 2)$

$\Rightarrow$ F(x) is an increasing function

Now $F''(x) = -\sin x - \frac{2}{\pi} < 0, \quad \forall \ x \in (0, \pi/2)$

$\Rightarrow$ F'(x) is decreasing function

$\Rightarrow$ Both statement are true

10. Let A = {1, 3, 7, 9, 11} and B = {2, 4, 5, 7, 8, 10, 12}. Then the total number of one –one maps f : A→B, such that $f(1) + f(3) = 14$, is :

(1) 120 (2) 480 (3) 240 (4) 180

Ans. **NTA (3)**
RESO(3)

Sol. A = {1,3,7,9,11}
B = {2,4,5,7,8,10,12}
f(1) + f(3) = 14
f(1) = 4 f(3) = 10
f(1) = 10, f(3) = 4
f(1) = 12, f(3) = 2
f(1) = 2 , f(3) = 12
Total one-one maps = 4 × 5 × 4 × 3 = 240

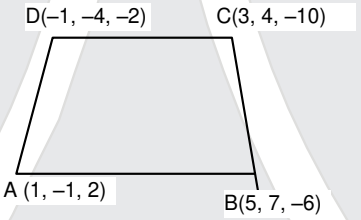
11. If A(1, –1, 2), B(5, 7, –6), C(3, 4, – 10) and D (–1, – 4, –2) are the vertices of a quadrilateral ABCD, then its area is :

(1) $24\sqrt{7}$ (2) $24\sqrt{29}$ (3) $48\sqrt{7}$ (4) $12\sqrt{29}$

Ans. **NTA (4)**
RESO(4)

Sol. Diagonal $\overrightarrow{AC} = 2\hat{i} + 5\hat{j} - 12\hat{k}$

and $\overrightarrow{BD} = -6\hat{i} - 11\hat{j} + 4\hat{k}$



$$\overrightarrow{AC} \times \overrightarrow{BD} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 5 & -12 \\ -6 & -11 & 4 \end{vmatrix}$$

$= 8\left(-14\hat{i} + 8\hat{j} + \hat{k}\right)$

Area $= \frac{1}{2}\left|\overrightarrow{AC} \times \overrightarrow{BD}\right| = 4\sqrt{196 + 64 + 1}$

$= 12\sqrt{29}$

12. The value of $\int_{-\pi}^{\pi} \frac{2y(1+\sin y)}{1+\cos^2 y}dy$ is :

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

Ans. **NTA (3)**
RESO(3)

Sol. $I = \int_{-\pi}^{\pi} \frac{2y}{1+\cos^2 y}dy + \int_{-\pi}^{\pi} \frac{2y\sin y}{1+\cos^2 y}dy$

$I = 0 + \int_{0}^{\pi} \frac{4y\sin y}{1+\cos^2 y}dy$ _____(1)

$I = 4\int_{0}^{\pi} \frac{(\pi - y)\sin(\pi - y)}{1+\cos^2(\pi - y)}dy$

$$I = 4\int_0^{\pi} \frac{(\pi - y)\sin y}{1+\cos^2 y}\,dy \quad \text{_____(2)}$$

From (1) and (2)

$$2I = 4\int_0^{\pi} \frac{\pi \sin y}{1+\cos^2 y}\,dy$$

Let $\cos y = t$

$-\sin dy = dt$

$$2I = 4\pi\int_1^{-1} \frac{-dt}{1+t^2}$$

$$I = 4\pi\int_0^{1} \frac{dt}{1+t^2}\,dt$$

$$I = 4\pi\left(\tan^{-1} t\right)_0^1$$

$$I = 4\pi\left(\frac{\pi}{4} - 0\right) = \pi^2$$

13. Let two straight lines drawn from the origin O interest the line 34x+ 4y = 12 at the point P and Q such that ΔOPQ is an isosceles triangle and $\angle POQ = 90°$. If $I = OP^2 + PQ^2 + QO^2$, then the greatest integer less than of equal; to I is :

(1) 42 (2) 44 (3) 46 (4) 48

Ans. **NTA (3)**

RESO(3)

Sol P $(r\cos\theta, r\sin\theta)$

Q $(-r\sin\theta, r\cos\theta)$

$OP^2 = OQ^2 = r^2$

$PQ^2 = 2r^2 \Rightarrow \ell = 4r^2$

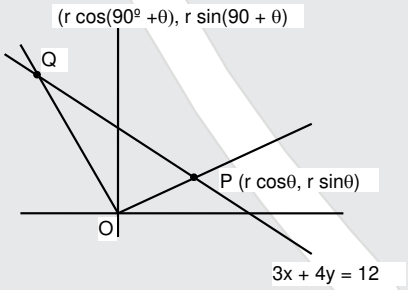
$\therefore$ P and Q lies on $3x + 4y = 12$

$3(r\cos\theta) + 4(r\sin\theta) = 12$

$$\Rightarrow 3\cos\theta + 4\sin\theta = \frac{12}{r} \quad \text{_____(1)}$$

and $3(-r\sin\theta) + 4(r\cos\theta) = 12$

$$-3\sin\theta + 4\cos\theta = \frac{12}{r} \quad \text{_____(2)}$$



from $(1)^2 + (2)^2$

$$25 = \frac{288}{r^2} \Rightarrow r^2 = \frac{288}{25}$$

$$\ell = 4r^2 = 4 \times \frac{288}{25} = 46.08$$

$$[\ell] = 46$$

14. Let a rectangle ABCD of sides 2 and 4 be inscribed in another rectangle PQRS such that the vertices of the rectangle ABCD lie on the sides of the rectangle PQRS. Let a and b be the sides of the rectangle PQRS when its area is maximum. Then $(a + b)^2$ is equal to :

(1) 80 (2) 60 (3) 72 (4) 64

Ans. **NTA (3)**

RESO(3)

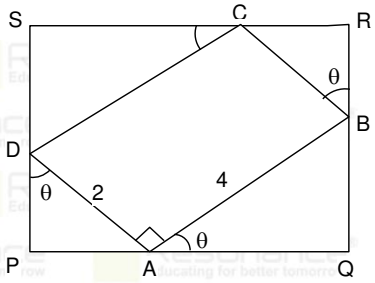
Sol. PA = 2sinθ , AQ = 4cosθ

$\Rightarrow$ PQ = 2sinθ + 4cosθ

QB = 4sinθ, BR = 2cosθ $\Rightarrow$ QR = 4sinθ + 2cosθ

Area = (PQ) (QR) = 8 $\sin^2\theta$ +4sinθcosθ + 16 cosθsinθ +8$\cos^2\theta$

= 8 + 10 sin2θ



area will be maximum when $\theta = \frac{\pi}{4}$

a = PQ = $\frac{6}{\sqrt{2}}$, b = QR = $\frac{6}{\sqrt{2}}$, $(a+b)^2 = 72$

15. The integral $\int_0^{\frac{\pi}{4}} \frac{136\sin x}{3\sin x + 5\cos x}dx$ is equal to :

(1) $3\pi - 25\log_e 2 + 10\log_e 5$

(2) $3\pi - 10\log_e\left(2\sqrt{2}\right) + 10\log_e 5$

(3) $3\pi - 30\log_e 2 + 20\log_e 5$

(4) $3\pi - 50\log_e 2 + 20\log_e 5$

Ans. **NTA (4)**

RESO(4)

Sol. 136 sinx = A (3 sinx + 5 cosx) + B (3cosx – 5sinx)

136 = 3A – 5B ____(1)

0 = 5A + 3B _____(2)

from (1) & (2)

A = 12, B = –20

$$I = \int_0^{\frac{\pi}{4}} \left(12 - \frac{20(3\cos x - 5\sin x)}{3\sin x + 5\cos x}\right)dx = \left(12x - 20\ell n|3\sin x + 5\cos x|\right)_0^{\frac{\pi}{4}}$$

$$= 3\pi - 20\ell 4\sqrt{2} + 20\ell n5 \quad = 3\pi - 50\ell 2 + 20\ell n5$$

16. Suppose $\theta \in [0, \frac{\pi}{4}]$ is a solution of 4cosθ – 3sinθ = 1. Then cosθ is equal to:

(1) $\frac{4}{\left(3\sqrt{6}-2\right)}$ (2) $\frac{4}{\left(3\sqrt{6}+2\right)}$ (3) $\frac{6+\sqrt{6}}{\left(3\sqrt{6}+2\right)}$ (4) $\frac{6-\sqrt{6}}{\left(3\sqrt{6}-2\right)}$

Ans. **NTA (1)**

RESO(1)

Sol. $(4\cos\theta - 1)^2 = 9\sin^2\theta$

$25\cos^2\theta - 8\cos\theta - 8 = 0 \Rightarrow \cos\theta = \frac{4 \pm 6\sqrt{6}}{25}$

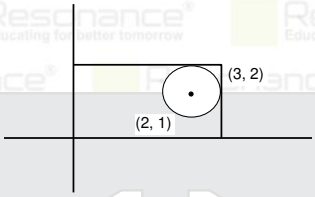
As $\theta \in \left[0, \frac{\pi}{4}\right] \Rightarrow \cos\theta = \frac{4+6\sqrt{6}}{25}$

17. Let a circle C of radius 1 and closer to the origin be such that the lines passing through the point (3, 2) and parallel to the coordinate axes touch it. Then the shortest distance of the circle C from the point (5, 5) is :

(1) 4 (2) 5 (3) $2\sqrt{2}$ (4) $4\sqrt{2}$

Ans. **NTA (1)**
RESO(1)

Sol. Centre of circle is (2, 1)



minimum distance of circle

from (5, 5)

$= \sqrt{(5-2)^2+(5-1)^2} - 1$

$= 5 - 1 = 4$

18. Let the line $2x + 3y - k = 0$, $k > 0$, intersect the x-axis and y-axis at the point A and B, respectively. If the equation of the circle having the line segment AB as a diameter is $x^2 + y^2 - 3x - 2y = 0$ and the length of the latus rectum of the ellipse $x^2 + 9y^2 = k^2$ is m/n, where and m and n are co-prime, then 2m + n is equal; to :

(1) 10 (2) 12 (3) 11 (4) 13

Ans. **NTA (3)**
RESO(3)

Sol. $A\left(\frac{K}{2}, 0\right)$, $B\left(0, \frac{K}{3}\right)$

Equation of circle having AB as diameter

$\left(x - \frac{K}{2}\right)(x-0) + (y-0)\left(y - \frac{K}{3}\right) = 0$

$x^2 + y^2 - \frac{K}{2}x - \frac{K}{3}y = 0 \Rightarrow \frac{k}{2} = 3 \Rightarrow k = 6$

Ellipse : $x^2 + \frac{y^2}{1/9} = K^2$

$\frac{x^2}{K^2} + \frac{y^2}{K^2/9} = 1$

Length of L.R. = $\frac{2x(K^2/9)}{K} = \frac{2K}{9} = \frac{4}{3}$

$\Rightarrow$ m = 4 , n = 3

2m + n = 11

19. Let d be the distance of the point intersection of the lines $\frac{x+6}{3} = \frac{y}{2} = \frac{z+1}{1}$ and $\frac{x-7}{4} = \frac{y-9}{3} = \frac{z-4}{2}$ from the point (7, 8, 9). Then $d^2 + 6$ is equal to :

(1) 72 (2) 69 (3) 75 (4) 78

Ans. **NTA (3)**

RESO(3)

Sol. Any point on 1st line : $3\lambda - 6 ; 2\lambda, \lambda - 1$
and any point on 2nd line : $4\mu + 7 , 3\mu + 9 \;\; 2\mu + 4$
Now, $3\lambda - 6 = 4\mu + 7$ ……..(1)
$2\lambda = 3\mu + 9$ ……..(2)
$\lambda - 1 = 2\mu + 4$ ……..(3)
$\Rightarrow$ $\lambda = 3 = \mu = -1$
Intersection point (3, 6, 2)
Now, $d = \sqrt{(7-3)^2 + (8-6)^2 + (9-2)^2} = \sqrt{69}$

20. Let $f(x) = x^5 + 2x^3 + 3x + 1$, $x \in R$, and g(x) be a function such that $g(f(x)) = x$ for all $x \in R$. Then $\frac{g(7)}{g'(7)}$ is equal to :
(1) 7 (2) 42 (3) 1 (4) 14

Ans. **NTA (4)**
RESO(4)

Sol. Put $x = 1 \Rightarrow f(1) = 7 \Rightarrow g(7) = 1$

$g(f(x)) = x \quad \Rightarrow g'(f(x)) = \frac{1}{5x^4 + 6x^2 + 3}$

Put $x = 1 \quad \Rightarrow g'(7) = \frac{1}{14}$

$\frac{g(7)}{g'(7)} = 14$

21. The number of distinct real roots of the equation $|x|\,|x + 2| - 5\,|x + 1| - 1 = 0$ Is _____

Ans. **NTA (3)**
RESO(3)

Sol. $|x|\,|x + 2| - 5\,|x + 1| = 1$

Case I : $x \le -2$
$x^2 + 2x + 5x + 5 = 1$
$x^2 + 7x + 4 = 0$
$x = \frac{-7 \pm \sqrt{49 - 4}}{2} = \frac{-7 \pm \sqrt{45}}{2}$
$\Rightarrow x = \frac{-7 - \sqrt{45}}{2}$ only

Case II : $-2 < x \le -1$
$-x^2 - 2x + 5x + 5 = 1$
$x^2 - 3x - 4 = 0 \qquad (x - 4)(x + 1) = 0$
$x = 4, -1 \qquad \Rightarrow x = -1$ only $\quad x \ne 4$

Case III : $-1 < x \le 0$
$-x^2 - 2x - 5x - 5 = 1$
$x^2 + 7x + 6 = 0 \qquad (x + 1)(x + 6) = 0$
$x = -1, -6 \Rightarrow$ No solution

Case IV : $x \ge 0$
$x^2 + 2x - 5x - 5 = 1$
$x^2 - 3x - 6 = 0$
$x = \frac{3 \pm \sqrt{33}}{2}$
$x = \frac{3 + \sqrt{33}}{2}$ only

No. of real roots = 3

22. Let $a_1, a_2, a_3, \ldots$ be in arithmetic progression of positive terms.

Let $A_k = a_1^2 - a_2^2 + a_3^2 - a_4^2 + \ldots + a_{2k-1}^2 - a_{2k}^2$

If $A_3 = -153$, $A_5 = -435$ and $a_1^2 + a_2^2 + a_3^2 = 66$, then $a_{17} - A_7$ is equal to_____.

Ans. **NTA (910)**
RESO(910)

Sol. $A_k = -d[a_1 + a_2 + a_3 + ,\ldots\ldots\ldots + a_{2k}]$

$A_3 = -153$

$\Rightarrow \quad 2a_1 + 5d = \frac{51}{d} \qquad \ldots\ldots\ldots\ldots(1)$

$A_5 = -435$

$\Rightarrow \quad 2a_1 + 9d = \frac{87}{d} \qquad \ldots\ldots\ldots\ldots(2)$

From (1) & (2)

$d = 3$

Now, $a_1^2 + (a_1 + d)^2 + (a_1 + 2d)^2 = 66$

$a_1^2 + (a_1 + 3)^2 + (a_1 + 6)^2 = 66$

$a_1^2 + 6a_1 - 7 = 0$

$(a_1 + 7)(a_1 - 1) = 0$

$\Rightarrow \quad a_1 = 1$

$a_{17} = a_1 + 16d = 1 + 16 \times 3 = 49$

$A_7 = -3[7(2 \times 1 + 13 \times 3)] = -861$

$a_{17} - A_7 = 49 + 861 = 910$

23. Let $\vec{a} = \hat{i} - 3\hat{j} + 7\hat{k}$, $\vec{b} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{c}$ be a vector such that $(\vec{a} + 2\vec{b}) \times \vec{c} = 3(\vec{c} \times \vec{a})$

If $\vec{a} \cdot \vec{c} = 130$, then $\vec{b} \cdot \vec{c}$ is equal to _____.

Ans. **NTA (30)**
RESO(30)

Sol. $(\vec{a} + 2\vec{b}) \times \vec{c} = 3(\vec{c} \times \vec{a})$

$2(\vec{b} \times \vec{c}) = 4(\vec{c} \times \vec{a})$

$(\vec{b} + 2\vec{a}) \times \vec{c} = 0 \Rightarrow \vec{c}$ is parallel to $(\vec{b} + 2\vec{a})$

$\vec{c} = \lambda(\vec{b} + 2\vec{a})$

$\vec{c} = \lambda(4\hat{i} - 7\hat{j} + 15\hat{k})$

$\therefore \ \vec{a} \cdot \vec{c} = 130 \Rightarrow 4\lambda + 21\lambda + 105\lambda = 130$

$130\lambda = 130 \Rightarrow \lambda = 1$

$\Rightarrow \vec{c} = 4\hat{i} - 7\hat{j} + 15\hat{k}$, Now $\vec{b} \cdot \vec{c} = 30$

24. If the constant term in the expansion of $(1 + 2x - 3x^3)\left(\frac{3}{2}x^2 - \frac{1}{3x}\right)^9$ is P then 108P is equal to _____.

Ans. **NTA (54)**
RESO(54)

Sol. $(1 + 2x - 3x^3)\left(\frac{3}{2}x^2 - \frac{1}{3x}\right)^9$

General term of $\left(\frac{3}{2}x^2 - \frac{1}{3x}\right)^9$ is

$(-1)^r\ {}^9C_r 3^{.9-2r}.\left(\frac{1}{2}\right)^{9-r} x^{18-3r}$

Constant term $P = {}^9C_6 3^{-3}.2^{-3} + 3.{}^9C_7 3^{-5}2^{-2}$

$P = \frac{1}{2}$

Now, $108\ P = 54$

25. The number of ways of getting a sum 16 on throwing a dice four times is _____

Ans. **NTA (125)**
RESO(125)

Sol. $x_1 + x_2 + x_3 + x_4 = 16 \qquad x_i \in \{1, 2, 3, 4, 5, 6\}$
For I = 1, 2, 3, 4

Coefficient of x^{16} in : $\left(x^1 + x^2 + x^3 + ... + x^6\right)^4$

$: x^4\left(x^6 + x^1 + x^2 + x^3 + ...x^5\right)^4$

Coefficient x^{12} in : $\left(\frac{1-x^6}{1-x}\right)^4$

$: \left(1-x^6\right)^4(1-x)^{-4}$

$: \left(1 - {}^4C_1x^6 + {}^4C_2x^{12}.....\right)(1-x)^{-4}$

x^{12} $: (1-x)^{-4} - 4x^6\,(1-x)^{-4} + 6x^{12}\,(1-x)^{-4}$

$: {}^{12+4-1}C_{4-1} - 4 \times {}^{6+4-1}C_{4-1} + 6\ {}^{4-1}C_{4-1}$

$: {}^{15}C_3 - 4\ {}^9C_3 + 6 \times {}^3C_3$

$: 455 - 336 + 6 = 125$

26. Let f be differentiable function in the interval $(0, \infty)$, such that f(1) = 1 and $\lim_{t\to x}\frac{t^2f(x) - x^2f(t)}{t-x} = 1$ for each x > 0. Then 2f(2) + 3 f(3) is equal to.

Ans. **NTA (24)**
RESO(24)

Sol. $\lim_{t\to x}\frac{2tf(x) - x^2f'(t)}{1} = 1$

$2xf(x) - x^2 f'(x) = 1$

Let y = f(x)

$\frac{dy}{dx} - \frac{2}{x}y = \frac{-1}{x^2}, \qquad \text{I.F.} = e^{-2\ell nx} = \frac{1}{x^2}$

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

$C = \frac{2}{3} \qquad f(x) = \frac{1}{3x} + \frac{2x^2}{3}$

$f(2) = \frac{1}{6} + \frac{8}{3} \qquad 2f(2) = \frac{1}{3} + \frac{16}{3} = \frac{17}{3}$

$3f(3) = \frac{1}{3} + 2(9) = \frac{1+54}{3} = \frac{55}{3}$

$2f(2) + 3f(3) = \frac{72}{3} = 24$

27. If $S = \{a \in R : |2a - 1| = 3[a] + 2[a]\}$, where [t] denotes the greatest integer less than or equal to t and {t} represents the fractional part of t, then $72\sum_{a\in S} a$ is equal to

Ans. **NTA (18)**
RESO(18)

Sol. $|2a - 1| = 3[a] + 2\{a\}$

Case-I : $a \geq \frac{1}{2}$

$2a - 1 = [a] + 2a \quad (\because a = [a] + \{a\})$

$\Rightarrow [a] = -1$

$a \in [-1, 0)$ but $a \geq \frac{1}{2}$, $\Rightarrow$ No value of a

Case-II: $a < \frac{1}{2}$

$1 - 2a = [a] + 2a$

$1 = [a] + 4a$

$1 = 5[a] + 4\{a\}$

$4\{a\} = 1 - 5[a]$

$0 \leq 4\{a\} < 4$

$0 \leq 1 - 5[a] < 4$

$\frac{1}{3} \geq [a] \geq -\frac{3}{5} \Rightarrow [a] = 0 \Rightarrow \{a\} = \frac{1}{4}$

$\Rightarrow a = \frac{1}{4}$

Now, $72\,\Sigma a = 72 \times \frac{1}{4} = 18$

28. From a lot of 10 items, which include 3 defective items, a sample of 5 items is drawn at random. Let the random variable X denotes the number of defective items in the sample. If the variance of X is σ^2, then $96\sigma^2$ is equal to _____

Ans. **NTA (56)**
RESO(56)

Sol. X =denotes number of defective

X	0	1	2	3
P(x)	$\frac{{}^7C_5}{{}^{10}C_5} = \frac{1}{12}$	$\frac{{}^7C_4 \times {}^3C_1}{{}^{10}C_5} = \frac{5}{12}$	$\frac{{}^7C_3 \times {}^3C_2}{{}^{10}C_5} = \frac{5}{12}$	$\frac{{}^7C_2 \times {}^3C_3}{{}^{10}C_5} = \frac{1}{12}$
$P_ix_i^2$	0	$\frac{5}{12}$	$\frac{20}{12}$	$\frac{9}{12}$
P_ix_i	0	$\frac{5}{12}$	$\frac{10}{12}$	$\frac{3}{12}$

$\sum P_ix_i = \frac{18}{12}$

$\sum P_ix_i^2 = \frac{34}{12} \qquad \sigma^2 = \sum P_ix_i^2 - \left(\sum P_ix_i\right)^2$

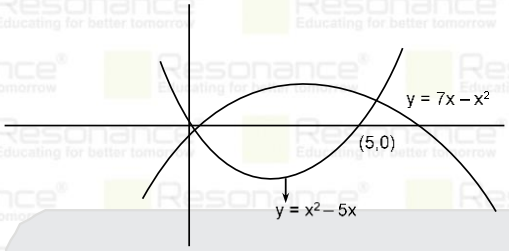
$= \frac{34}{12} - \left(\frac{18}{12}\right)^2 \qquad = \frac{7}{12}$

Now $96\sigma^2 = 96 \times \frac{7}{12} = 56$

29. The area of the region enclosed by the parabolas $y = x^2 - 5x$ and $y = 7x - x^2$ is _____ .

Ans. **NTA (198)**
RESO (72)

Sol. Intersection point of curves:



$x^2 - 5x = 7x - x^2$

$2x^2 = 12\,x$

$\Rightarrow$ $x = 0,6$

Point are (0,0) and (6,6)

Required area $= \int_0^6 \left(12x - 2x^2\right) dx$

$$= 12\left(\frac{x^2}{2}\right)_0^6 - 2\left(\frac{x^3}{3}\right)_0^6$$

$= 6^3 - 6^3 \times 2/3 = 72$

30. Suppose AB is a focal chord of the parabola $y^2 = 12x$ of length ℓ and slope $m < \sqrt{3}$. If the distance of the chord AB from the origin is d, then ℓd^2 is equal to _____

Ans. **NTA (108)**
RESO (108)

Sol. $\ell = 3\left(t + \frac{1}{t}\right)^2$, chord is $2x - \left(t - \frac{1}{t}\right)y - 6 = 0$

$$d = \frac{6}{\sqrt{4 + \left(t - \frac{1}{t}\right)^2}} = \frac{6}{\left|\left(t + \frac{1}{t}\right)\right|}$$

$$\ell d^2 = 3\left(t + \frac{1}{t}\right)^2 \times \frac{36}{\left(t + \frac{1}{t}\right)^2} = 108$$

PART : PHYSICS

31. A simple pendulum doing small oscillations at a place R height above earth surface has time period of $T_1 = 4$ s. T_2 would be it's time period if its is brought to a point which is at a height 2R from earth surface. Choose the correct relation [R = radius of earth] :

पृथ्वी तल से R ऊँचाई पर एक स्थान पर एक सरल लोलक छोटे दोलन कर रहा है जिसका आवर्तकाल $T_1 = 4$ s है। यदि इसे पृथ्वी सतह से 2R ऊँचाई पर किसी बिन्दु पर ले जाया जाता है तो इसका आवर्तकाल T_2 है। [R = पृथ्वी की त्रिज्या]। सही सम्बन्ध चुनिए :

(1) $2T_1 = T_2$ (2) $T_1 = T_2$ (3) $2T_1 = 3T_2$ (4) $3T_1 = 2T_2$

Ans. **(4)**

Sol. $T_1 = 2\pi\sqrt{\frac{\ell}{g_1}}$

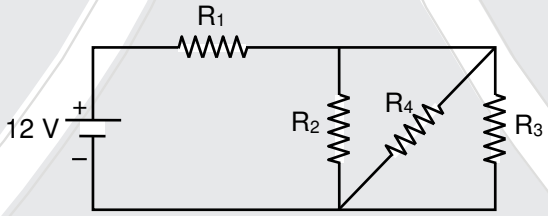
$T_2 = 2\pi\sqrt{\frac{\ell}{g_2}}$

$\frac{T_1}{T_2} = \sqrt{\frac{g_2}{g_1}} = \frac{R_1^2}{R_2^2} = \sqrt{\frac{(R+h_1)^2}{(R+h_2)^2}} = \sqrt{\frac{(2R)^2}{(3R)^2}}$

$\frac{T_1}{T_2} = \sqrt{\frac{4}{9}} = \frac{2}{3}$

32. In the given figure $R_1 = 10\Omega$, $R_2 = 8\Omega$, $R_3 = 4\Omega$ and $R_4 = 8\Omega$. Battery is ideal with emf 12V. Equivalent resistance of the circuit and current supplied by battery are respectively :

दिये गये चित्र में, $R_1 = 10\Omega$, $R_2 = 8\Omega$, $R_3 = 4\Omega$ तथा $R_4 = 8\Omega$ है। 12V विद्युत वाहक बल की एक आदर्श बैटरी है। परिपथ का तुल्य प्रतिरोध तथा बैटरी द्वारा प्रवाहित धारा क्रमशः हैं :



(1) 12 Ω and तथा 1 A (2) 12 Ω and तथा 11.4 A

(3) 10.5 Ω and तथा 1.14 A (4) 10.5 Ω and तथा 1 A

Ans. **(1)**

Sol. Req. = 10 + 2 = 12Ω

and $i = \frac{V}{R_{eq}} = \frac{12}{12} = 1A$

33. Light emerges out of a convex lens when a source of light kept at its focus. The shape of wavefront of the light is :

(1) Plane (2) Cylindrical

(3) Spherical (4) Both spherical and cylindrical

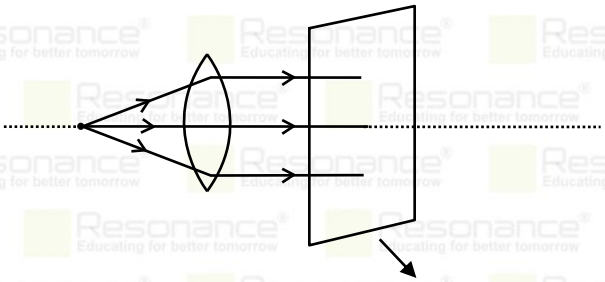
जब प्रकाश स्त्रोत को उत्तल लैंस के फोकस पर रखा जाये तो प्रकाश इससे पारगमित होता है। इस प्रकाश के तरंगाग्र की आकृति है :

(1) समतल (2) बेलनाकार

(3) गोलीय (4) दोनों गोलीय व बेलनाकार

Ans. **(1)**

Sol.



34. A wooden block of mass 5 kg rests on a soft horizontal floor. When an iron cylinder of mass 25 kg is placed on the top of the block, the floor yields and the block and the cylinder together go down with an acceleration of 0.1 ms^{-2}. The action force of the system on the floor is equal to :
5 kg द्रव्यमान का एक लकड़ी का गुटका एक कोमल क्षैतिज फर्श पर रखा है। जब 25 kg द्रव्यमान का एक लोहे का बेलन गुटके के शिखर पर रखा जाता है फर्श दबता है तथा गुटका व बेलन एकसाथ 0.1 ms^{-2} त्वरण से नीचे जाने लगते हैं। निकाय का फर्श पर क्रियाबल है :

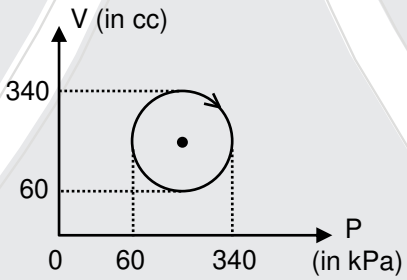
(1) 196 N (2) 297 N (3) 291 N (4) 294 N

Ans. **(3)**

Sol. $30g - N = 30 \times 0.1$

$\Rightarrow N = 294 - 3 = 291$ N

35. The heat absorbed by a system in going through the given cyclic process is :
दिये गये चक्रीय प्रक्रम से गुजरने वाले किसी निकाय द्वारा अवशोषित ऊष्मा है :



(1) 616 J (2) 431.2 J (3) 19.6 J (4) 61.6 J

Ans. **(4)**

Sol. This is cyclic process so $\Delta U = 0$

From 1st law of T.D $\Delta Q = \Delta U + \Delta W$

$\Delta Q = \Delta W$

ΔW = Area enclosed by the cycle

$$R = \frac{(340 - 60)}{2}$$

$$R = \frac{280}{2} = 140$$

ΔW = Area

$\Delta W = 3.14 \times (140)^2 \times 10^3 \times 10^{-6}$

$\Delta W = 3.14 \times 140 \times 140 \times 10^{-3} = 61.544$

$\Delta Q = 61.544$

36. Match List-I with List-II :

List-I	List-II
(A) Kinetic energy of planet	(I) –GMm/a
(B) Gravitation Potential energy of sun-planet system	(II) GMm/2a
(C) Total mechanical energy of planet	(III) $\frac{Gm}{r}$
(D) Escape energy at the surface of planet for unit mass object	(IV) –GMm/2a

(Where a = radius of planet orbit, r = radius of planet, M = mass of Sun, m = mass of planet)
Choose the correct answer from the options given below :
(1) (A)-(III), (B)-(IV), (C)-(I), (D)-(II) (2) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(3) (A)-(I), (B)-(IV), (C)-(II), (D)-(III) (4) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

सूची-I का सूची-II से मिलान कीजिए :

सूची-I	सूची-II
(A) ग्रह की गतिज ऊर्जा	(I) –GMm/a
(B) सूर्य-ग्रह निकाय की गुरूत्वीय स्थितिज ऊर्जा	(II) GMm/2a
(C) ग्रह की कुल यांत्रिक ऊर्जा	(III) $\frac{Gm}{r}$
(D) एकांक द्रव्यमान की वस्तु के लिए ग्रह की सतह पर पलायन ऊर्जा	(IV) –GMm/2a

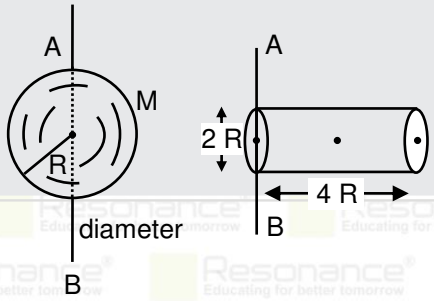
(जहॉ a = ग्रह कक्षा की त्रिज्या, r = ग्रह की त्रिज्या, M = सूर्य का द्रव्यमान, m = ग्रह का द्रव्यमान)
नीचे दिये गये विकल्पों से सही उत्तर चुनिए :
(1) (A)-(III), (B)-(IV), (C)-(I), (D)-(II) (2) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(3) (A)-(I), (B)-(IV), (C)-(II), (D)-(III) (4) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

Ans. **(4)**

Sol. (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

37. Ratio of radius of gyration of a hollow sphere to that of a solid cylinder of equal mass, for moment of inertia about their diameter axis AB as shown in figure is $\sqrt{\frac{8}{x}}$. The value of x is :

प्रदर्शित चित्र के अनुसार समान द्रव्यमान के एक खोखले गोले तथा ठोस बेलन की क्रमशः AB अक्षों के परितः जड़त्व आघुर्ण के लिए इनकी घूर्णन त्रिज्याओं का अनुपात $\sqrt{\frac{8}{x}}$ है। x का मान है :



(1) 67 (2) 51 (3) 17 (4) 34

Ans. **(1)**

Sol. $mk_1^2 = \frac{2}{3}mR^2$

$mk_2^2 = \frac{4mR^2}{3} + \frac{mR^2}{4} + 4mR^2 = \frac{67}{12}mR^2$

$\frac{k_1}{k_2} = \sqrt{\frac{8}{67}} = \sqrt{\frac{8}{x}}$

$\therefore$ x = 67

38. If G be the gravitational constant and u be the energy density then which of the following quantity have the dimensions as that of the $\sqrt{uG}$:

(1) pressure gradient per unit mass (2) Gravitational potential

(3) Force per unit mass (4) Energy per unit mass

यदि G सार्वत्रिक गुरूत्वाकर्षण नियतांक तथा u ऊर्जा घनत्व हो तो निम्न में से कौनसी राशि की विमा $\sqrt{uG}$ की विमा के समान है :

(1) प्रति एकांक द्रव्यमान की दाब प्रवणता (2) गुरूत्वीय स्थितिज ऊर्जा

(3) प्रति एकांक द्रव्यमान का बल (4) प्रति एकांक द्रव्यमान की ऊर्जा

Ans. **(3)**

Sol. $u = \frac{\text{Energy}}{\text{Volume}} = \frac{M^1L^2T^{-2}}{L^3} = M^1L^{-1}T^{-2}$

$G = \frac{M^1LT^{-2} \times L^2}{M^2} = M^{-1}L^3T^{-2}$

$\sqrt{ug} = (M^1L^{-1}T^{-2} \times M^{-1}L^3T^{-2})^{1/2}$

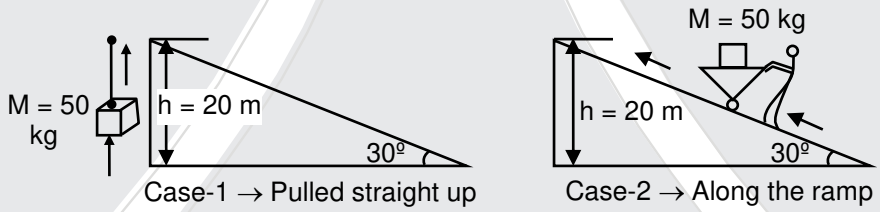
$= [L^2\,T^{-4}]^{1/2}$

$= L^1T^{-2}$

Force per unit mass $= \frac{F}{m} = \frac{ma}{m} = a$

39. A body of mass 50 kg is lifted to a height of 20 m from the ground in the two different ways as shown in the figure. The ratio of work done against the gravity in both the respective cases, will be :

दिये गये चित्रों के अनुसार 50 kg द्रव्यमान के एक पिण्ड की पृथ्वी तल से 20 m की ऊँचाई तक दो तरीकों से ऊपर ले जाया जाता है। दोनों स्थितियों में गुरूत्व के विरूद्ध किये गये क्रमशः कार्यो का अनुपात होगा :



Case-1 → Pulled straight up Case-2 → Along the ramp

(1) 2 : 1 (2) 1 : 2 (3) $\sqrt{3}$: 2 (4) 1 : 1

Ans. **(4)**

Sol. In both the cases

$W = -mgh$

So $\frac{W_1}{W_2} = 1$

40. A alternative voltage of amplitude 40 V and frequency 4 kHz is applied directly across the capacitor of 12 μF. The maximum displacement current between the plates of the capacitor is nearly :

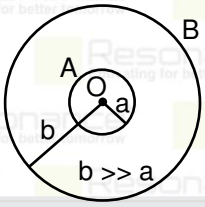
40 V आयाम तथा 4 kHz आवृत्ति के एक प्रत्यावर्ती वोल्टेज को 12 μF के संधारित्र से जोड़ा गया है। संधारित्र की प्लेटों के बीच अधिकतम विस्थापन धारा लगभग है :

(1) 10 A (2) 13 A (3) 8 A (4) 12 A

Ans. **(4)**

Sol. $I_{disp}=I_{peak}= \frac{V_o}{X_c} = \frac{40}{1/\omega c} = 40\times8\pi\times10^3\times12\times10^{-6}=12.05$

41. Two conducting circular loops A and B are placed in the same plane with their centres coinciding as shown in figure. The mutual inductance between them is :
दो वृत्ताकार चालक लूप A तथा B को एक समान सतह पर चित्र के अनुसार इस प्रकार रखा गया है कि इनके केन्द्र संपाती हैं। इनके बीच अन्योन्य प्रेरकत्व है :



(1) $\frac{\mu_0 \pi a^2}{2b}$ (2) $\frac{\mu_0 \pi b^2}{2a}$ (3) $\frac{\mu_0}{2\pi} \cdot \frac{a^2}{b}$ (4) $\frac{\mu_0}{2\pi} \cdot \frac{b^2}{a}$

Ans. **(1)**

Sol. $\phi = = MI$

$$\left(\frac{\mu_0 I}{2.b}\right) \pi a^2 = MI$$

$$M = \frac{\mu_0 \pi a^2}{2b}$$

42. The angle between vector $\vec{Q}$ and the resultant of $\left(2\vec{Q}+2\vec{P}\right)$ and $\left(2\vec{Q}-2\vec{P}\right)$ is :
$\left(2\vec{Q}+2\vec{P}\right)$ एवं $\left(2\vec{Q}-2\vec{P}\right)$ के परिणामी तथा $\vec{Q}$ के बीच का कोण है :

(1) 0º (2) $\tan^{-1}\frac{\left(2\vec{Q}-2\vec{P}\right)}{2\vec{Q}+2\vec{P}}$ (3) $\tan^{-1}\left(\frac{P}{Q}\right)$ (4) $\tan^{-1}\left(\frac{2Q}{P}\right)$

Ans. **(1)**

Sol. Let the resultant = $\left(2\vec{Q}+2\vec{P}\right)+\left(2\vec{Q}-2\vec{P}\right)$

$$\vec{R} = 4\vec{Q}$$

Angle between $\vec{Q}$ and $\vec{R}$

$\vec{Q}$ and $4\vec{Q}$

We can say that, $\vec{R}$ is the same direction along $\vec{Q}$ with four times its magnitude.

43. If the collision frequency of hydrogen molecules in a closed chamber at 27º C is Z, then the collision frequency of the same system at 127º C is :
यदि 27º C पर एक बन्द चेम्बर में हाइड्रोजन अणुओं की संघट्ट आवृत्ति Z हो तब 127º C पर समान निकाय की संघट्ट आवृत्ति है :

(1) $\frac{\sqrt{3}}{2}Z$ (2) $\frac{2}{\sqrt{3}}Z$ (3) $\frac{3}{4}Z$ (4) $\frac{4}{3}Z$

Ans. **(2)**

Sol. $f \propto v_{rms}$

$f \propto \sqrt{T}$

$$\frac{f_{27}}{f_{127}} = \frac{\sqrt{300}}{\sqrt{400}} = \frac{\sqrt{3}}{2}$$

$$\frac{z}{f_{127}} = \frac{\sqrt{3}}{2} \Rightarrow f_{127} = \frac{2}{\sqrt{3}}z$$

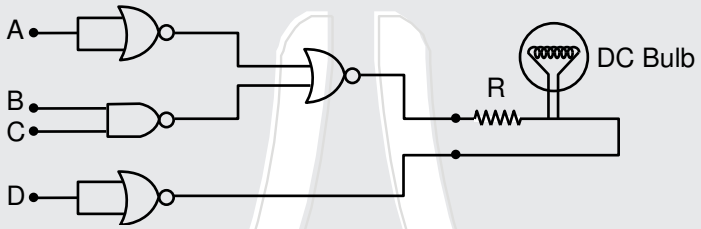
44. In hydrogen like system the ratio of coulombian force and gravitational force between an electron and a proton is in the order of :
हाइड्रोजन समतुल्य निकाय में एक इलेक्ट्रॉन तथा एक प्रोटॉन के बीच लगने वाले कूलॉम्ब बल तथा गुरूत्वीय बल के अनुपात की कोटि है :
(1) 10^{39} (2) 10^{29} (3) 10^{36} (4) 10^{19}

Ans. **(1)**

Sol. $\frac{|F_e|}{|F_g|} = \frac{1}{4\pi\epsilon_o}\frac{e^2}{r^2} \times \frac{r^2}{Gm_em_p}$

$=2.4\times10^{39}$

45. Following gates section is connected in a complete suitable circuit.
निम्नलिखित गेट खण्ड को एक उपयुक्त परिपथ पूरा करने में जोड़ा जाता है :



For which of the following combination, bulb will glow (ON) :
निम्नलिखित किस संयोजन के लिए बल्ब जलेगा :
(1) A = 1, B = 0, C = 0, D = 0 (2) A = 0, B = 0, C = 0, D = 1
(3) A = 0, B = 1, C = 1, D = 1 (4) A = 1, B = 1, C = 1, D = 0

Ans. **(1)**

Sol. $y_1 = \overline{\overline{A} + \overline{B \bullet C}}$

$y_2 = \overline{D}$

Bulb will glow when $y_1 = 1$ & $y_2 = 0$
or $y_1 = 0$ & $y_2 = 1$

46. Time period of oscillation of the same simple pendulum measured using four different measuring clocks were recorded as 4.62 s, 4.632 s, 4.6 s and 4.64 s. The arithmetic mean of these readings in correct significant figure is :
एक ही सल आवर्तन दोलक का आवर्तकाल चार विभिन्न मापक घड़ियों द्वारा नापा गया, पाया गया 4.62 s, 4.632 s, 4.6 s और 4.64 s इन सबका अंकगणितीय औसत है :
(1) 4.62 s (2) 5 s (3) 4.6 s (4) 4.623 s

Ans. **(3)**

Sol. $\frac{4.62 + 4.632 + 4.6 + 4.64}{4} = 4.623$

So correct significant figure is =4.6

47. Given below are two statements :
Statement-I : When a capillary tube is dipped into a liquid, the liquid neither rises nor falls in the capillary. The contact angle may be 0º.
Statement-II : The contact angle between a solid and a liquid is a property of the material of the solid and liquid as well.
In the light of the above statement, choose the correct answer from the options given below :
(1) Both Statement I and Statement II are true.
(2) Statement I is false but Statement II is true.
(3) Statement I is true and Statement II is false.
(4) Both Statement I and Statement II are false.

नीचे दो कथन दिये गये हैं :

कथन-I : केशनली को द्रव में डुबाने पर द्रव केशनली में न तो ऊपर चढ़ता हैं और न ही नीचे उतरता है। स्पर्श कोण 0º हो सकता है।

कथन-II : किसी ठोस तथा द्रव के बीच बना स्पर्श कोण ठोस के पदार्थ एवं द्रव का एक गुण है। उपरोक्त कथनों के आधार पर, नीचे दिये गये विकल्पों में से सबसे उचित उत्तर चुनिए :

(1) दोनों कथन I व कथन II सही हैं।

(2) कथन I गलत है परन्तु कथन II सही हैं।

(3) कथन I सही है परन्तु कथन II गलत हैं।

(4) दोनों कथन I व कथन II गलत हैं।

Ans. (2)

48. In a co-axial straight cable, the central conductor and the outer conductor carry equal currents in opposite directions. The magnetic field is zero :

(1) inside the outer conductor (2) inside the inner conductor

(3) outside the cable (4) in between the two conductors

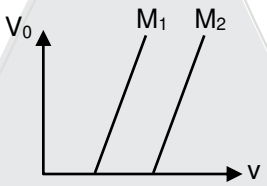
एक सह–अक्षीय सीधी केबिल में केन्द्रीय चालक तथा बाहरी चालक में बराबर तथा विपरीत दिशाओं में धाराएँ प्रवाहित होती हैं।

(1) बाहरी चालक के अन्दर (2) आन्तरिक चालक के अन्दर

(3) केबिल के बाहर (4) दोनों चालकों के मध्य में

Ans. (3)

49. Given below are two statements :



Statement-I : Figure shows the variation of stopping potential with frequency (v) for the two photosensitive materials M_1 and M_2. The slope gives value of $\frac{h}{e}$, where h is Planck's constant, e is the charge of electron.

Statement-II : M_2 will emit photoelectrons of greater kinetic energy for the incident radiation having same frequency.

In the light of the above statements, choose the most appropriate answer from the options given below.

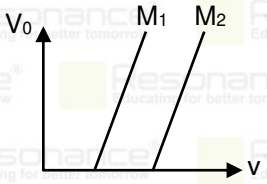
(1) Statement I is incorrect but Statement II is correct.

(2) Both Statement I and Statement II are incorrect.

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

(4) Both Statement I and Statement II are correct.

नीचे दो कथन दिये गये हैं :



कथन-I : दो प्रकाश सुग्राही पदार्थों M_1 व M2 के लिए आवृत्ति (v) के साथ विभव पतन को चित्र प्रदर्शित करता है। प्रवणता का मान $\frac{h}{e}$ है जहाँ h प्लांक नियतांक तथा e इलेक्ट्रॉन का आवेश है।

कथन-II : समान आवृत्ति के आपतित विकिरण के लिए M_2 अधिक गतिज ऊर्जा के प्रकाश इलेक्ट्रॉन उत्सर्जित करेगा। उपरोक्त कथनों के आधार पर, नीचे दिये गये विकल्पों में से सबसे उचित उत्तर चुनिए :

(1) कथन I गलत है परन्तु कथन II सही हैं।

(2) दोनों कथन I व कथन II गलत हैं।

(3) कथन I सही है परन्तु कथन II गलत हैं।

(4) दोनों कथन I व कथन II सही हैं।

Ans. **(3)**

Sol. $KE_{max} = K = h\upsilon - \phi$

$\phi_1 < \phi_2$

for same υ

K_1 same υ

$K_1 = h\upsilon - \phi_1$

$K_2 = h\upsilon - \phi_2$

$K_1 > K_2$ statement-2 is correct

$ev_s = kE_{max} = h\upsilon - \phi$

$V_s = \frac{h}{e}\upsilon - \frac{\phi}{e}$

slope of $V_s - \upsilon$ graph $= \frac{h}{e}$ = constant (independent of metal) statement-1 is also true

50. An electron rotates in a circle around a nucleus having positive charge Ze. Correct relation between total energy (E) of electron to its potential energy (U) is :

एक इलेक्ट्रॉन Ze धनावेश के नाभिक के परितः एक वृत्त में घूमता है। इलेक्ट्रॉन की कुल ऊर्जा (E) तथा इसकी स्थितिज ऊर्जा (U) में सही सम्बन्ध है :

(1) E = U (2) 2E = U (3) E = 2U (4) 2E = 3U

Ans. **(2)**

Sol. We know that

$E = -k = \frac{U}{2}$

$E = \frac{U}{2} \Rightarrow$

$U = 2E$

51. If three helium nuclei combine to form a carbon nucleus then the energy released in this reaction is _____ $\times 10^{-2}$ MeV. (Given 1 u = 931 MeV/c^2, atomic mass of helium = 4.002603u)

यदि तील हीलियम नाभिक मिलकर एक कार्बन नाभिक बनायें तो इस क्रिया में निकली ऊर्जा है _____ $\times 10^{-2}$ MeV है। (दिया है 1 u = 931 MeV/c^2, हीलिश्म का परमाणु द्रव्यमान = 4.002603u)

Ans. **727**

Sol. $3\ {}_2He^4 \rightarrow {}_6C^{12} + Q$

(Atomic weight of ${}_2He^4$ = 4.00264)

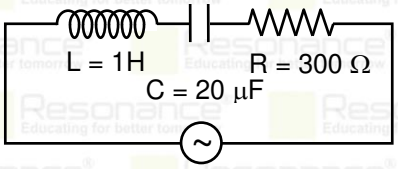
(Atomic weight of ${}_6C^{12}$ = 124)

$\Delta m = 3(4.0026) - 12 = 0.00784$

$Q = \Delta mc^2 = (00078) \times 931$ Mev

Q = 7.2618 Mev Ans

52. An ac source is connected in given series LCR circuit. The rms potential difference across the capacitor of 20 μF is _____ V.
एक प्रत्यावर्ती धारा स्त्रोत को श्रेणीबद्ध LCR परिपथ के साथ जोड़ा जाता है। संधारित्र 20 μF पर वर्ग माध्य मूल विभवान्तर _____ V होगा।



$V = 50\sqrt{2}\sin 100t$ volt

Ans. **50**

Sol. $X_C = \frac{1}{100\times 20\times 10^{-6}} = 500\ \Omega$

$[X_L = \omega L = (100)(1) = 100\ \Omega]$

$Z = \sqrt{R^2 + (X_C - X_L)^2} = \sqrt{(300)^2 + (500-100)^2}$

$Z = 500\ \Omega$

$[i_{rms} = \frac{v_{rms}}{2} = \frac{50}{500}$ Amp$]$

$v_{rms} = i_{rms}X_C = \frac{50}{500}\times 500 = 50$ volt Ans.

(Across capacitor)

53. A body moves on a frictionless plane starting from rest. If S_n is distance moved between t = n – 1 and t = n and S_{n-1} is distance moved between t = n – 2 and t = n – 1, then the ratio $\frac{S_{n-1}}{S_n}$ is $\left(1-\frac{2}{x}\right)$ for n = 10. The value of x is _____.
एक वस्तु स्थिर अवस्था से एक घर्षण रहित तल पर गति करती है। यदि S_n समय t = n – 1 तथा t = n के बीच चली गयी दूरी है और S_{n-1} समय t = n – 2 तथा t = n – 1 के बीच चली गयी दूरी है तब n = 10 के लिए $\frac{S_{n-1}}{S_n}$ है। x का मान है _____।

Ans. **19**

Sol. we know that

$S_n = 0 + \frac{a}{2}(2n-1) = \frac{a}{2}(2n-1)$ .....(i) (u = 0)

$S_{n-1} = 0 + \frac{a}{2}[2(n-1)-1]$

$= \frac{a}{2}(2n-2-1) = \frac{a}{2}(2n-3)$ .....(ii)

So $\frac{S_{n-1}}{S_n} = \frac{2n-3}{2n-1} = \frac{17}{19}$

$1-\frac{2}{x} = \frac{17}{19}$

x=19

54. Three capacitors of capacitances 25 μF, 30 μF and 45 μF are connected in parallel to a supply of 100 V. Energy stored in the above combination is E. When these capacitors are connected in series to the same supply, the stored energy is $\frac{9}{x}E$. The value of x is _____.

तीन संधारित्र, धारिता 25 μF, 30 μF और 45 μF को एक 100 V विभव के स्त्रोत से समान्तर में जोड़े गये हैं। इस रूप में एकत्रित ऊर्जा E है। यदि इन तीनों संधारित्रों के स्त्रोत से क्षेणी क्रम में लगा दें तब एकत्र ऊर्जा है $\frac{9}{x}E$, तब x का मान _____ है।

Ans. **86**

Sol. $E = \frac{1}{2} C_{eq} V^2 = \frac{1}{2} 100V^2$

& $U = \frac{1}{2} C_{eq} V^2 = \frac{1}{2} \frac{900}{86} V^2$

$\frac{U}{E} = \frac{900}{86 \times 100}$

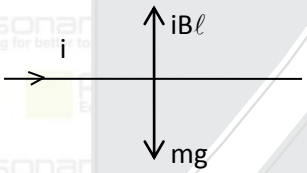
$\Rightarrow \frac{U}{E} = \frac{9}{86} \Rightarrow U = \frac{9}{86} E$

55. A 2A current carrying straight metal wire of resistance 1 Ω, resistivity 2×10^{-6} Ωm, area of cross-section 10 mm^2 and mass 500 g is suspended horizontally in mid air by applying a uniform magnetic field $\vec{B}$. The magnitude of B is _____ $\times 10^{-1}$ T (given, g = 10 m/s^2).

एक 2A विद्युत धारा बहते हुए सीधे धातु के तार को एम समान चुम्बकीय क्षेत्र $\vec{B}$ में हवा में क्षैतिज रूप में लटकाया जाता है, तार का प्रतिरोध 1 Ω, प्रतिरोधकता 2×10^{-6} Ωm, परिच्छेद–क्षेत्रफल 10 mm^2 तथा द्रव्यमान 500 g है। चुम्बकीय $\vec{B}$ का मान _____ $\times 10^{-1}$ T (दिया है, g = 10 m/s^2).

Ans. **5**

Sol.



$B = \frac{mg}{i\ell} = \frac{mg\rho}{iRA}$

$= \frac{0.5 \times 10 \times 2 \times 10^{-6}}{2 \times 1 \times 10 \times 10^{-6}}$

$= 5 \times 10^{-1} T \Rightarrow R = \frac{\rho\ell}{A} \Rightarrow \ell = \frac{RA}{\rho}$

56. The electric field between the two parallel plates of a capacitor of 1.5 μF capacitance drops to one third of its initial value in 6.6 μs when the plates are connected by a thin wire.
The resistance of this wire is _____ Ω. (Given, log3 = 1.1)

एक संधारित्र, धारिता 1.5 μF की दो प्लेटों के मध्य विद्युत क्षेत्र 6.6 μs में अपने प्रारम्भिक मान का एक तिहाई रह जाता है जब दोनों प्लेटों को एक पतले तार से जोड़ा जाता है। तार का प्रतिरोध _____ Ω है (दिया है, log3 = 1.1)

Ans. **4**

Sol. $\frac{E_i}{E_f}=\frac{\sigma_i/\epsilon_o}{\sigma_f/\epsilon_o}$

$\Rightarrow \frac{\sigma_i}{\sigma_f}=\frac{E}{E/3}=3$

$\frac{Q_i}{Q_f}=3$

$Q_f=Q_i e^{\frac{-t}{Rc}}$

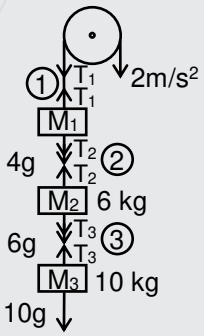
$\frac{Q_i}{3}=Q_i e^{\frac{-6.6}{1.5R}}$

$\frac{1}{3}=e^{\frac{-4.4}{R}} \Rightarrow 3=e^{\frac{4.4}{R}}$

$\Rightarrow R=\frac{4.4}{\ln 3}=4\Omega$

57. Three blocks M_1, M_2, M_3 having masses 4 kg, 6 kg and 10 kg respectively are hanging from a smooth pully using rope 1, 2 and 3 as shown in figure. The tension in the rope 1, T_1 when they are moving upward with acceleration of 2 ms^{-2} is _____ N (if g = 10 m/s^2).

एक घिरनी से चित्र के अनुसार क्रमशः 4kg, 6 kg, 10 kg द्रव्यमान के तीन गुटके M_1, M_2, M_3 तीन रस्सियों 1, 2 द्वारा 3 द्वारा लटकाए गये हैं, घिरनी चिकनी है। जब ये ऊपर त्वरण 2 ms^{-2} से गति कर रहे हैं तो रस्सी 1 में तनाव T_1 _____ N (g = 10 m/s^2) है।



Ans. **240**

Sol. $T_1 - 20g = 20a$

$\Rightarrow$ $T_1 = 200 + 20 \times 2$

$\Rightarrow$ $T_1 = 200 + 40 = 240$ N

58. In Young's double slit experiment, carried out with light of wavelength 5000 Å, the distance between the slits is 0.3 mm and the screen is at 200 cm from the slits. The central maximum is at x = 0 cm. The value of x for third maxima is _____ mm.

एक यंग के द्वि–झिर्री प्रयोग को तरंगदैर्ध्य 5000 Å के प्रकाश के साथ किया जाता है, दो झिर्रियों के मध्य दूरी 0.3 mm तथा पर्दे से झिर्री तल की दूरी 200 cm है। मुख्य केन्द्रीय उच्चिष्ठ x = 0 cm पर है, तीसरे उच्चिष्ठ के लिए x का मान _____ mm है।

Ans. **10**

Sol. $d << D$, and $\lambda << d$

$$\Rightarrow \beta = \frac{\lambda D}{d} = \frac{5\times10^{-7}\times2}{3\times10^{-4}}$$

$$\beta = \frac{10}{3}\times10^{-3} = \frac{10}{3} \text{ mm}$$

$$Y_{3\text{rd maxima}} = 3\beta = 10 \text{ mm}$$

59. The density and breaking stress of a wire are 6×10^4 kg/m^3 and 1.2×10^8 N/m^2 respectively. The wire is suspended from a rigid support on a planet where acceleration due to gravity is $\frac{1^{rd}}{3}$ of the value on the surface of earth. The maximum length of the wire with breaking is _____ m (take, g = 10 m/s^2).
एक तान का घनत्व तथा परिभंजक तनाव क्रमशः 6×10^4 kg/m^3 तथा 1.2×10^8 N/m^2 है। तार को एक ग्रह पर किसी मजबूत आधार से लटकाया गया है जहाँ गुरूत्वीय त्वरण, पृथ्वी पर गुरूत्वीय त्वरण का $\frac{1^{rd}}{3}$ है। तार की टूटने की अधिकतम लम्बाई होगी _____ m (दिया है, g = 10 m/s^2).

Ans. **600**

Sol.



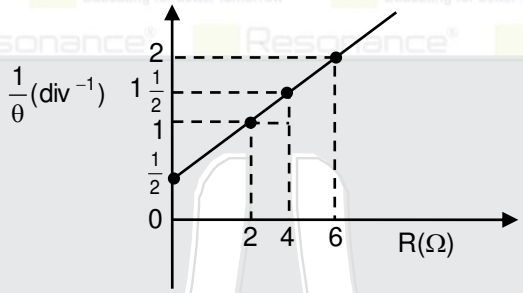
$$T = mg$$

$$\sigma = \frac{T}{A} = \frac{mg}{A} = \frac{(\sigma A\ell)g}{A}$$

$$\Rightarrow \ell = \frac{\sigma}{\rho g} = \frac{1.2\times10^8\times3}{6\times10^4\times10} = 600 \text{ m}$$

60. In the experiment to determine the galvanometer resistance by half-deflection method, the plot of $\frac{1}{\theta}$ vs the resistance (R) of the resistance box is shown in the figure. The figure of merit of the galvanometer is _____ × 10^{-1} A/division. [The source has emf 2V]

अर्द्ध–विक्षेप विधि द्वारा गैल्वेनोमीटर का प्रतिरोध ज्ञात करने के लिए $\frac{1}{\theta}$ तथा प्रतिरोध बॉक्स के प्रतिरोध (R) का ग्राफ चित्र में दिखाया गया है। इसमें गैल्वेनोमीटर का दक्षतांक K _____ × 10^{-1} A/division है। [स्त्रोत का विद्युत वाहक बल 2V]



Ans. **5**

Sol. Slope = $\frac{\left(\frac{1}{\theta}\right)}{R} = \frac{1}{4}$

Ampere per division = $\frac{V\left(\frac{1}{\theta}\right)}{R} = \frac{V}{4} = 2 \times \frac{1}{4} = \frac{1}{2} = 0.5 = 5 \times 10^{-1}$ A/div.

PART : CHEMISTRY

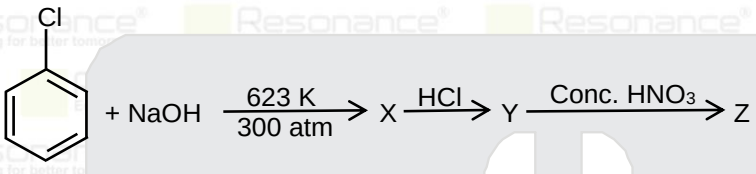
61. The metal that shows highest and maximum number of oxidation state is:

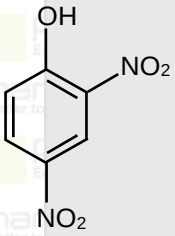
(1) Mn (2) Co (3) Fe (4) Ti

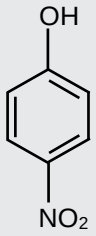
Ans. **NTA (1)**

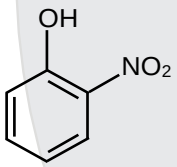
Sol. Mn shows highest oxidation state (Mn^{+7}) in 3d series metals.

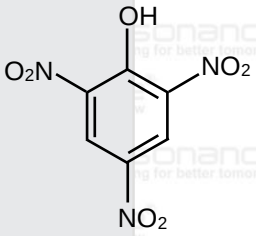
62. Identify compound (Z) in the following reaction sequence.



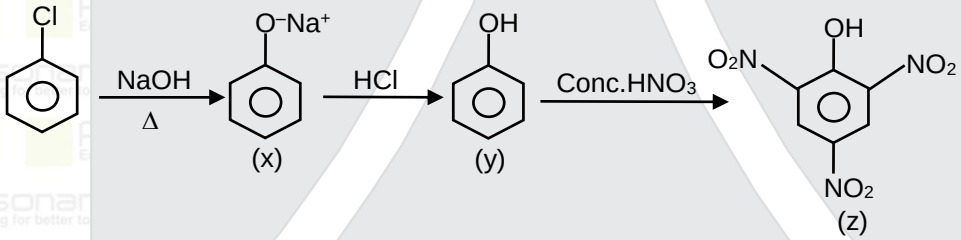
(1) 

(2) 

(3) 

(4) 

Ans. **NTA (4)**

Sol. 

63. Which one of the following complexes will exhibit the least paramagnetic behaviour?

[Atomic number, Cr = 24, Mn = 25, Fe = 26, Co = 27]

(1) $[Fe(H_2O)_6]^{2+}$ (2) $[Cr(H_2O)_6]^{2+}$ (3) $[Mn(H_2O)_6]^{2+}$ (4) $[Co(H_2O)_6]^{2+}$

Ans. **NTA (4)**

Sol.

	No. of unpaired e^-	**Li = $\sqrt{n(n+2)}$ B.M.**
$[Co(H_2O)_6]^{2+}$	3	3.87
$[Fe(H_2O)_6]^{2+}$	4	4.89
$[Mn(H_2O)_6]^{2+}$	5	5.92
$[Cr(H_2O)_6]^{2+}$	4	4.89

Least paramagnetic behaviour = $[Co(H_2O)_6]^{2+}$

64. Which of the following gives a positive test with ninhydrin?

(1) Cellulose (2) Starch (3) Polyvinyl chloride (4) Egg albumin

Ans. **NTA (4)**

Sol. Ninhydrine test is used for amino acids formed in proteins egg albumin is a protein gives amino acid on hydrolysis.

65. Molar ionic conductivities of divalent cation and anion are 57 5 cm^3 mol^1 and 73 5 cm^3 mol^{-1} respectively. The molar conductivity of solution of an electrolyte with the above cation and anion will be:

(1) 187 S cm^2 mol^{-1} (2) 260 S cm^2 mol^{-1} (3) 65 S cm^2 mol^{-1} (4) 130 S cm^2 mol^{-1}

Ans. **NTA (4)**

Sol. $\wedge_C^{+2} = 57$ S $cm^2 mol^{-1}$

$\wedge_A^{+2} = 73$ S $cm^2 mol^{-1}$

$\Lambda_{solution} = \lambda_C^{+2} + \wedge_A^{-2}$

$= 57 + 73$

$= 130$ S cm^2 mol^{-1}

66. The number of neutrons present in the more abundant isotope of boron is 'x'. Amorphous boron upon heating with air forms a product, in which the oxidation state of boron is 'y'. The value of x + y is _____.

(1) 4 (2) 6 (3) 3 (4) 9

Ans. **NTA (4)**

Sol. More abundant isotope = B^{11}

[Number of neutrons = 6]

x = 6

$B + O_2 \rightarrow B_2O_3$

Oxidation state of B in B_2O_3 = +3

So, y = 3

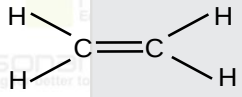
Hence, x + y = 9

67. Number of σ and π bonds present in ethylene molecule is respectively:

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

Ans. **NTA (1)**

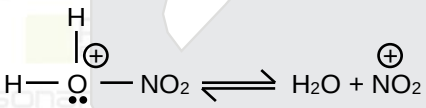
Sol.



Ethylene

68. **Given below are two statements:**

Statement I: Nitration of benzene involves the following step



Statement II: Use of Lewis base promotes the electrophilic substitution of benzene. In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Statement I is correct but Statement II is incorrect

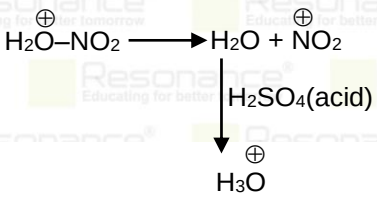
(2) Both Statement I and Statement II are incorrect

(3) Both Statement I and Statement II are correct

(4) Statement I is incorrect but Statement II is correct

Ans. **NTA (1)**

Sol.



69. Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**

Assertion (A): Enthalpy of neutralisation of strong monobasic acid with strong monoacidic base is always –57 kJ mol^{-1}

Reason (R): Enthalpy of neutralisation is the amount of heat liberated when one mole of H^+ ions furnished by acid combine with one mole of OH ions furnished by base to form one mole of water.

In the light of the above statements, choose the correct answer from the options given below.

(1) **(A)** is true but **(R)** is false

(2) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**

(3) **(A)** is false but **(R)** is true

(4) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**

Ans. **NTA (4)**

Sol. Enthalpy of neutralization of SA and SB is always –57 kJ/mol because strong monoacid gives one mole of H^+ and strong mono base give one mole of OH^- which form one mole of water.

70. The incorrect postulates of the Dalton's atomic theory are:

(A) Atoms of different elements differ in mass.

(B) Matter consists of divisible atoms.

(C) Compounds are formed when atoms of different element combine in a fixed ratio.

(D) All the atoms of given element have different properties including mass.

(E) Chemical reactions involve reorganisation of atoms.

Choose the correct answer from the options given below:

(1) (C), (D), (E) only (2) (B), (D) only (3) (A), (B), (D) only (4) (B), (D), (E) only

Ans. **NTA (2)**

Sol. (B), (D)

71. The following reaction occurs in the Blast furnance where iron ore is reduced to iron metal

$Fe_2O_{3(s)} + 3CO_{(g)} \rightleftharpoons Fe_{(l)} + 3CO_{2(g)}$

Using the Le-chatelier's principle, predict which one of the following will not disturb the equilibrium.

(1) Removal of CO_2 (2) Removal of CO (3) Addition of Fe_2CO_3 (4) Addition of CO_2

Ans. **NTA (3)**

Sol. When solid added no effect on equilibrium.

72. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): Cis form of alkene is found to be more polar than the trans form.

Reason (R): Dipole moment of trans isomer of 2-butene is zero.

In the light of the above statements, choose the correct answer from the options given below:

(1) **(A)** is false but **(R)** is true

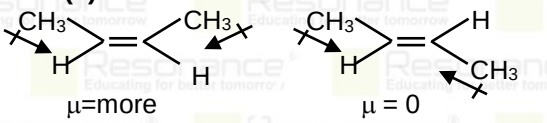
(2) **(A)** is true but **(R)** is false

(3) Both **(A)** and **(R)** are true but **(R)** is **NOT** the correct explanation of **(A)**

(4) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**

Ans. **NTA (4)**

Sol.



73. The correct order of ligands arranged in increasing field strength.

(1) $H_2O < {}^-OH < CN^- < NH_3$ (2) $F^- < Br^- < I^- < NH_3$

(3) $Cl^- < {}^-OH < Br^- < CN^-$ (4) $Br^- < F^- < H_2O < NH_3$

Ans. **NTA (4)**

Sol. Experimental order $Br^- < F^- < H_2O < NH_3$

74. The reaction at cathode in the cells commonly used in clocks involves.

(1) oxidation of Mn from +2 to +7 (2) oxidation of Mn from +3 to +4

(3) reduction of Mn from +4 to +3 (4) reduction of Mn from +7 to +2

Ans. **NTA (3)**

Sol. In the cathode reaction manganese (Mn) is reduced from the +4 oxidation state to the +3 state.

75. For the Compounds:

(A) $H_3C - CH_2 - O - CH_2 - CH_2 - CH_3$ (B) $H_3C - CH_2 - CH_2 - CH_2 - CH_3$

(C) $H_3C - \underset{\underset{O}{\|}}{CH} - CH_2 - CH_2 - CH_3$ (D) $H_3C - \underset{\underset{OH}{|}}{CH} - CH_2 - CH_2 - CH_3$

The increasing order of boiling point is:

Choose the correct answer from the options given below:

(1) (A) < (B) < (C) < (D) (2) (B) < (A) < (C) < (D)

(3) (D) < (C) < (A) < (B) (4) (B) < (A) < (D) < (C)

Ans. **NTA (2)**

Sol. D has higher B.P. due to inter H-bond C has dp-dp interaction 4 has polarising & molar mass than B.

76. **Given below are two statement:**

Statements 1: Bromination of phenol in solvent with low polarity such as CHCI, or CS, requires Lewis acid catalyst.

Statements II: The Lewis acid catalyst polarises the bromine to generate Br^+.

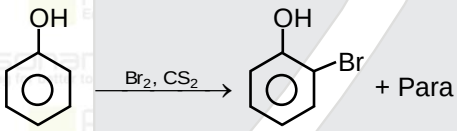
In the light of the above statements, choose the correct answer from the options given below:

(1) **Statement I** is true but **Statement II** is false (2) Both **Statement I** and **Statement II** are false

(3) Both **Statement I** and **Statement II** are true (4) **Statement I** is false but **Statement II** is true

Ans. **NTA (4)**

Sol.



+ Para

Lewis acid must not be taken

$Br{-}Br + AlBr_3 \rightarrow Br{-}\overset{+}{B}r{-}\overset{-}{A}lBr_3{-}Br + \overset{-}{A}lBr_4$

77. **Given below are two statements:**

Statement I: In group 13, the stability of +1 oxidation state increases down the group.

Statement II: The atomic size of gallium is greater than that of aluminium.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) **Statement I** is incorrect but **Statement II** is correct

(2) **Statement I** is correct but **Statement II** is incorrect

(3) Both **Statement I** and **Statement II** are incorrect

(4) Both **Statement I** and **Statement II** are correct

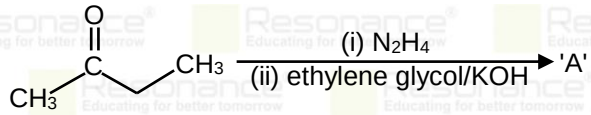
Ans. **NTA (2)**

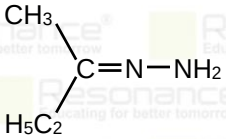
Sol. **Statement I :** Number of d and f electrons, increases down the group and due to poor shelding of d and f electrons.

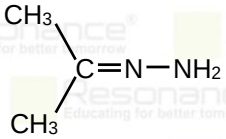
Stability of lower oxidation states increases down the groups.

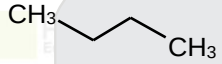
Statement II : The atomic size of aluminium is greater than that of gallium.

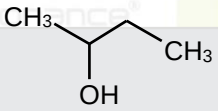
78. Identify 'A' in the following reaction:



(1) 

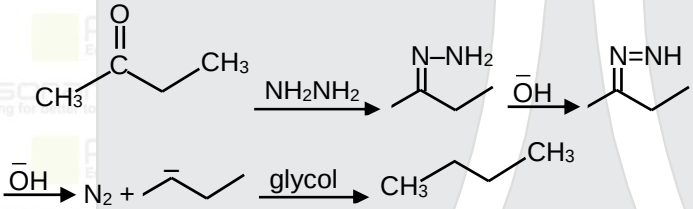
(2) 

(3) 

(4) 

Ans. **NTA (3)**

Sol. Identify 'A' in the following reaction:



79. An organic compound has 42.1% carbon, 6.4% hydrogen and remainder is oxygen. If its molecular weight is 342, then its molecular formula is:

(1) $C_{11}H_{18}O_{12}$ (2) $C_{12}H_{20}O_{12}$ (3) $C_{14}H_{20}O_{10}$ (4) $C_{12}H_{22}O_{11}$

Ans. **NTA (4)**

Sol. $C_{12}H_{22}O_{11} = 342$

80. The statement(s) that are correct about the species O^{2-}, F^-, Na^+ and Mg^{2+}.

(A) All are isoelectronic

(B) All have the same nuclear charge

(C) O^{2-} has the largest ionic radii

(D) Mg^{2+} has the smallest ionic radii

Choose the most appropriate answer from the options given below:

(1) (A), (B), (C) and (D) (2) (C) and (D) only

(3) (B), (C) and (D) only (4) (A), (C) and (D) only

Ans. **NTA (4)**

Sol.

	O^{-2}		F^-		Na^+		Mg^{+2}
No. of e^-	10		10		10		10
(Ionic radiums)	O^{-2}	>	F^-	>	Na^+	>	Mg^{+2}
(Z_{eff})	O^{-2}	<	F^-	<	Na^+	<	Mg^{+2}

81. 9.3 g of pure aniline is treated with bromine water at room temperature to give a white precipitate of the product 'P'. The mass of product 'P' obtaind is 26.4 g. The percentage yield is _____%.

Ans. **NTA (80)**

82. The value of Rydberg constant (R_H) is 2.18×10^{-18} J. The velocity of electron having mass 9.1×10^{-31} kg in Bohr's first orbit of hydrogen atom = _____ $\times 10^5$ ms^{-1} (nearest integer).

Ans. **NTA (22)**

Sol. $V = 2.18 \times 10^6 \times \frac{Z}{n}$

$= 2.18 \times 10^5 \times \frac{1}{1} \approx 22 \times 10^5$ (nearest)

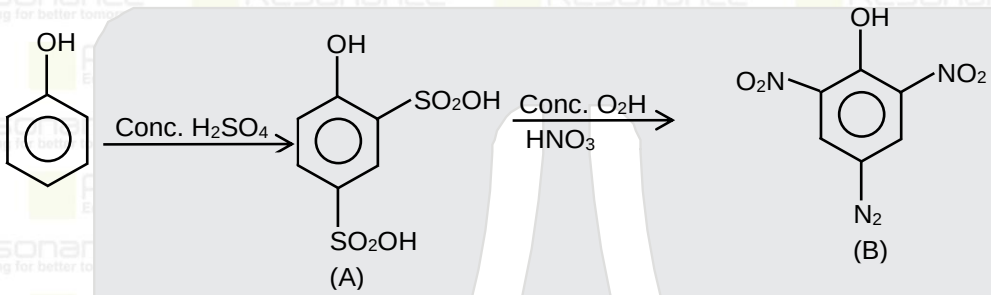
83. Consider the given chemical reaction sequence:



Total sum of oxygen atoms in Product A and Product B are _____.

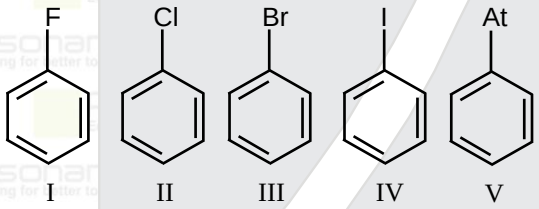
Ans. **NTA (14)**

Sol.



Total sum of oxygen atoms in Product A and Product B are _____.

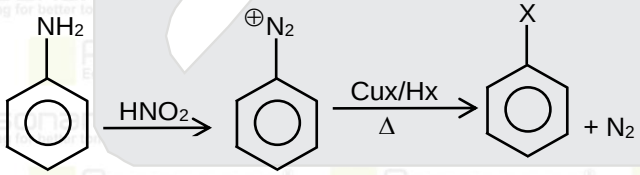
84. The number of halobenzenes from the following that can be prepared by Sandmeyer's reaction is _____.



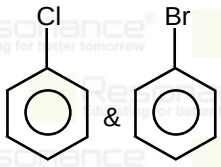
Ans. **NTA (2)**

Sol. A + B = 14

(7) (7)



X = Cl & Br only



Can be prepared by sanmeyer reaction.

85. The heat of combustion of solid benzoic acid at constant volume is –321.30 kJ at 27°C. The heat of combustion at constant pressure is (–321.30 – xR) kJ, the vaue of x is _____.

Ans. **NTA (150)**

Sol. $C_6H_5COOH(s) + \frac{15}{2}O_2(g) \rightarrow 7CO_2(g) + 3H_2O(\ell)$

$\Delta H = \Delta U + \Delta n_g RT$

$= -321.30 - \frac{1}{2}\frac{R}{100} \times 300$

$= (-321.30 - 150\ R)$ kJ

86.



In a borax bead test under hot condition, a metal salt (one from the given) is heated at point B of the flame, resulted in green colour salt bead. The spin-only magnetic moment value of the salt is _____ BM (Nearest integer)

[Given atomic number of Cu = 29, Ni = 28, Mn = 25, Fe = 26]

Ans. **NTA (6)**

Sol. For Fe^{+3} $3d^5$ (n = 5) $\sqrt{n(n+2)}$BM

$\sqrt{35}$ BM

= 6 BM

87. The spin-only magnetic moment value of the ion among Ti^{2+}, V^{2+}, Co^{3+} and Cr^{2+}, that acts as strong oxidising agent in aqueous solution is _____ BM (Near integer).

(Given atomic numbers: ti : 22, V : 23, Cr : 24, Co : 27)

Ans. **NTA (5)**

Sol. Strong oxidising agent = Co^{+3}

No. of unpaired electron in Co^{+3} $[3d^6]$ = 4

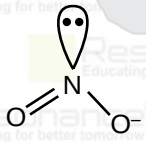
Hence $\mu = \sqrt{n(n+2)} = \sqrt{24}$ BM

Nearest integer = 5

88. In the lewis dot structure for NO_2^-, total number of valence electrons around nitrogen is _____.

Ans. **NTA (8)**

Sol.



Number of valence e^- around N-atom = 8

89. An artificial cell is made by encapsulating 0.2 M glucose solution within a semipermeable membrane. The osmotic pressure developed when the artificial cell is placed within a 0.05 M solution of NaCl at 300 K is _____ $\times 10^{-1}$ bar. (nearest integer).

[Given: R = 0.083 L bar mol^{-1} K^{-1}]

Assume complete dissociation of NaCl

Ans. **NTA (25)**

Sol. 0.2 M Glucose 0.05 NaCl sol.

$NaCl \longrightarrow Na^+ + Cl^-$

0.05 M 0.05 M 0.05 M

Total $C_1 = 0.05 + 0.05 = 0.1$ M (NaCl)

$C_2 = 0.2$ M (Glucose)

$\pi = (C_2 - C_1)RT$

$= (0.2 - 0.1) \times 0.083 \times 300$

$= 2.49$ bar

$= 24.9 \times 10^{-1}$ bar

90. During Kinetic study of reaction $2A + B \rightarrow C + D$, the following results were obtained:

	A [M]	B [M]	initial rate of formation of D
I	0.1	0.1	6.0×10^{-3}
II	0.3	0.2	7.2×10^{-2}
III	0.3	0.4	2.88×10^{-1}
IV	0.4	0.1	2.40×10^{-2}

Based on above data, overall order of the reaction is _____.

Ans. **NTA (3)**

Sol. $r = k[A]^x[B]^y$

(I) $6 \times 10^{-3} = k[0.1]^x[0.1]^y$

(IV) $2.4 \times 10^{-2} = k[0.4]^x[0.1]^y$

(IV) / (I)

$4 = (4)^x$

$x = 1$

$r = k[A]^x[B]^y$

(III) $2.88 \times 10^{-1} = k[0.3]^x[0.4]^y$

(II) $7.2 \times 10^{-2} = k[0.3]^x[0.2]^y$

(III/(II)

$4 = 2^4$

$y = 2$

overall order = $x + y = 1 + 2 = 3$