PART : MATHEMATICS

1. Let $\int_0^x \sqrt{1-(y'(t))^2}\,dt = \int_0^x y(t)dt$, $0 \le x \le 3$, $y \ge 0$, $y(0) = 0$. Then at $x = 2$, $y^n + y + 1$ is equal to

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

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

Sol. $\sqrt{1-y'(x)^2} = y(x)$

$\Rightarrow 1 - (y')^2 = y^2 \Rightarrow -2y'y'' = 2yy' \Rightarrow y'' + y = 0$

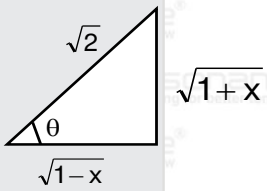
$\Rightarrow y'' + y + 1 = 1$

2. The integral $\int_{1/4}^{3/4} \cos\left(2\cot^{-1}\sqrt{\frac{1-x}{1+x}}\right)dx$ is equal to

(1) $-\frac{1}{2}$ (2) $-\frac{1}{4}$ (3) $\frac{1}{4}$ (4) $\frac{1}{2}$

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

Sol. $\cot^{-1}\sqrt{\frac{1-x}{1+x}} = \theta \Rightarrow \cot\theta = \sqrt{\frac{1-x}{1+x}}$



$\cos\left(2\cot^{-1}\sqrt{\frac{1-x}{1+x}}\right) = \cos 2\theta = 2\cos^2\theta - 1 = 2 \times \frac{1-x}{2} - 1 = 1 - x - 1$

$= -x$

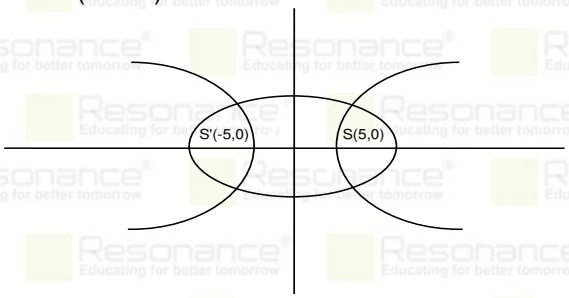
$\int_{1/4}^{3/4}(-x)dx = -\frac{x^2}{2}\Big|_{1/4}^{3/4} = -\frac{1}{2}\left(\frac{9}{16} - \frac{1}{16}\right) = -\frac{1}{2} \times \frac{8}{16} = -\frac{1}{4}$

3. Let the foci of a hyperbola H coincide with the foci of the ellipse $E : \frac{(x-1)^2}{100} + \frac{(y-1)^2}{75} = 1$ and the eccentricity of the hyperbola H be the reciprocal of the eccentricity of the ellipse E. If the length of the transverse axis of H is α and the length of its conjugate is β, then $3\alpha^2 + 2\beta^2$ is equal to

(1) 242 (2) 205 (3) 237 (4) 225

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

Sol. $b^2 = a^2(1 - e^2)$



$a^2e^2 = a^2 - b^2 = 100 - 75$

$ae = 5$

$10e = 5$

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

α, β will be same if we take

$E : \frac{x^2}{100} + \frac{y^2}{75} = 1$

Let $H : \frac{x^2}{a_1^2} - \frac{y^2}{b_1^2} = 1$

$e_1 = 2$

$b_1^2 = a_1^2(e_1^2 - 1)$

$b_1^2 = 3a_1^2$

$a_1e_1 = 5 \Rightarrow a_1 = \frac{5}{2}$

$\Rightarrow 2a_1 = 5 = \alpha$ & $b_1 = \sqrt{3}a_1 = \frac{5\sqrt{3}}{2}$

$\Rightarrow 2b_1 = 5\sqrt{3} = \beta$

$3\alpha^2 + 2\beta^2 = 3 \times 25 + 2 \times 75 = 225$

4. $\lim\limits_{x \to \frac{\pi}{2}} \left(\frac{\int_{x^3}^{(\pi/2)^3} \left(\sin\left(2t^{1/3}\right) + \cos\left(t^{1/3}\right)\right) dt}{\left(x - \frac{\pi}{2}\right)^2} \right)$ is equal to

(1) $\frac{5\pi^2}{9}$ (2) $\frac{11\pi^2}{10}$ (3) $\frac{3\pi^2}{2}$ (4) $\frac{9\pi^2}{8}$

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

Sol. L. hoptal's rule

$\Rightarrow \lim\limits_{x \to \frac{\pi}{2}} \frac{-3x^2.(\sin 2x + \cos x)}{2\left(x - \frac{\pi}{2}\right)} = \lim\limits_{x \to \frac{\pi}{2}} \frac{-3x^2 \cos x(2\sin x + 1)}{2\left(x - \frac{\pi}{2}\right)}$

$= \lim\limits_{x \to \frac{\pi}{2}} \frac{-9 \times \frac{\pi^2}{4}}{2} \times \frac{\cos x}{x - \frac{\pi}{2}} = \lim\limits_{x \to \frac{\pi}{2}} \frac{-9\pi^2}{8} \times \frac{-\sin x}{1}$

$= \frac{9\pi^2}{8}$

5. If $\log_e y = 3 \sin^{-1} x$, then $(1 - x^2)\, y'' - xy'$ at $x = \frac{1}{2}$ is equal to

(1) $3e^{\pi/2}$ (2) $3e^{\pi/6}$ (3) $9e^{\pi/2}$ (4) $9e^{\pi/6}$

Ans. **NTA (3)**

Sol. $\frac{y'}{y} = \frac{3}{\sqrt{1-x^2}} \Rightarrow \sqrt{1-x^2}\, y' = 3y \Rightarrow (1 - x^2)y'^2 = 9y^2$

$\Rightarrow (1-x^2)\cdot 2y'\cdot y'' - 2x\cdot y'^2 = 18y\cdot y'$

$\Rightarrow (1-x^2)y'' - xy' = 9y$

at $x = \frac{1}{2}$

$(1-x^2)y'' - xy' = 9e^{\pi/2}$

at $x = \frac{1}{2}$

$\ln y = 3\ \sin^{-1}\frac{1}{2} = 3\times\frac{\pi}{6}$

$y = e^{\frac{\pi}{2}}$

6. $\lim\limits_{x\to 0}\dfrac{e-(1+2x)^{\frac{1}{2x}}}{x}$ is equal to

(1) $e - e^2$ (2) 0 (3) $-\frac{2}{e}$ (4) e

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

Sol. $\lim\limits_{x\to 0}\dfrac{e-e^{\frac{\ln(1+2x)}{2x}}}{x} = \lim\limits_{x\to 0}\dfrac{(-e)\left\{e^{\frac{\ln(1+2x)}{2x}-1}-1\right\}}{x}$

$= \lim\limits_{x\to 0}(-e)\cdot\dfrac{\left\{\frac{\ln(1+2x)}{2x}-1\right\}}{x} = -e\cdot\lim\limits_{x\to 0}\dfrac{\ln(1+2x)-2x}{2x^2}$

$= -e\cdot\lim\limits_{x\to 0}\dfrac{2x-\frac{4x^2}{2}+\frac{8x^3}{3}-.....-2x}{2x^2}$

$= (-e)\cdot\left(\dfrac{-\frac{4}{2}}{2}\right) = e$

7. Let z be a complex number such that the real part of $\frac{z-2i}{z+2i}$ is zero. Then, the maximum value of $|z-(6+8i)|$ is equal to

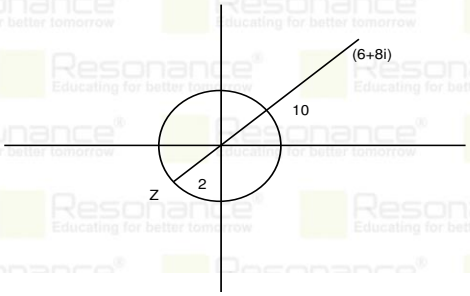
(1) 10 (2) 12 (3) 8 (4) ∞

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

Sol. $\dfrac{z-2i}{z+2i}+\dfrac{\bar{z}-2i}{\bar{z}+2i} = 0 \Rightarrow (z-2i)(\bar{z}-2i)+(z+2i)(\bar{z}+2i) = 0$

$\Rightarrow z\bar{z} - 2i\bar{z} - 2iz - 4 + z\bar{z} + 2iz + 2i\bar{z} - 4 = 0$

$\Rightarrow z\bar{z} = 4 \Rightarrow |z| = 2$



max. $|z-(6+8i)| = 10 + 2 = 12$

8. Let α,β ; $\alpha > \beta$, be the roots of the equation $x^2 - \sqrt{2}x - \sqrt{3} = 0$. Let $P_n = \alpha^n - \beta^n$, $n \in N$. Then $\left(11\sqrt{3} - 10\sqrt{2}\right)P_{10} + \left(11\sqrt{2} + 10\right)P_{11} - 11P_{12}$ is equal to

(1) $10\sqrt{2}P_9$ (2) $11\sqrt{3}P_9$ (3) $10\sqrt{3}P_9$ (4) $11\sqrt{2}P_9$

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

Sol. $P_{n+2} - \sqrt{2}\,P_{n+1} - \sqrt{3}\,P_n = 0$ .....(i)

$n = 9$

$P_{11} - \sqrt{2}P_{10} - \sqrt{3}P_9 = 0$

$\left(11\sqrt{3} - 10\sqrt{2}\right)P_{10} + \left(11\sqrt{2} + 10\right)P_{11} - 11P_{12}$

$= 11\sqrt{3}\,P_{10} - 10\sqrt{2}\,P_{10} + 11\sqrt{2}\,P_{11} + 10P_{11} - 11P_{12}$

$= -11\left(P_{12} - \sqrt{2}P_{11} - \sqrt{3}P_{10}\right) - 10\sqrt{2}\,P_{10} + 10P_{11}$

$= -11 \times 0 - 10\left(\sqrt{2}P_{10} - P_{11}\right)$

$= 10\left(P_{11} - \sqrt{2}P_{10}\right)$

$= 10\sqrt{3}\,P_9$

9. The value of the integral $\int_{-1}^{2} \log_e\left(x + \sqrt{x^2+1}\right)dx$ is

(1) $\sqrt{2} - \sqrt{5} + \log_e\left(\frac{7+4\sqrt{5}}{1+\sqrt{2}}\right)$ (2) $\sqrt{2} - \sqrt{5} + \log_e\left(\frac{9+4\sqrt{5}}{1+\sqrt{2}}\right)$

(3) $\sqrt{5} - \sqrt{2} + \log_e\left(\frac{7+4\sqrt{5}}{1+\sqrt{2}}\right)$ (4) $\sqrt{5} - \sqrt{2} + \log_e\left(\frac{9+4\sqrt{5}}{1+\sqrt{2}}\right)$

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

Sol. $x \cdot \ln\left(x + \sqrt{x^2+1}\right)\Big|_{-1}^{2} - \int_{-1}^{2} x \cdot \frac{1}{x + \sqrt{x^2+1}} \times \left(1 + \frac{1}{2\sqrt{x^2+1}} \times 2x\right)dx$

$= 2\ln\left(2+\sqrt{5}\right) + \ln\left(\sqrt{2}-1\right) - \int_{-1}^{2} \frac{x}{\sqrt{x^2+1}}dx$

$= \ln\left(9+4\sqrt{5}\right)\left(\sqrt{2}-1\right) - \int_{\sqrt{2}}^{\sqrt{5}} \frac{t\,dt}{t}$ $\qquad x^2 + 1 = t^2 \Rightarrow xdx = tdt$

$= \sqrt{2} - \sqrt{5} + \ln\left(\frac{9+4\sqrt{5}}{1+\sqrt{2}}\right)$

10. Two vertices of a triangle ABC are A(3,–1) and B (–2, 3), and its orthcenter is P(,1,1). If the coordinates of the point C are (α,β) and the centre of the of the circle circumscribing the triangle PAB is (h,k), then the value of $(\alpha + \beta) + 2(h + k)$ equals.

(1) 5 (2) 81 (3) 51 (4) 15

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

Sol. $m_{AP} = \frac{-2}{2} = -1 \Rightarrow \perp^r$ bisector of AP is $y - 0 = +1 \cdot (x - 2)$ .....(i)

$m_{BP} = \frac{2}{-3} \Rightarrow \perp^r$ bisector of BP is $y - 2 = +\frac{3}{2}\left(x + \frac{1}{2}\right)$ .....(ii)

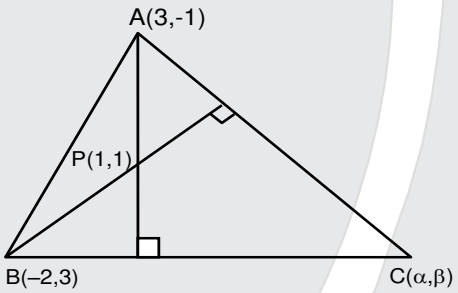
from equation (i) & (ii)

$\Rightarrow x - 2 - 2 = \frac{3}{2}\left(x + \frac{1}{2}\right) \Rightarrow 2x - 8 = 3x + \frac{3}{2} \Rightarrow x = -8 - \frac{3}{2}$

$x = -\frac{19}{2}$, $y = -\frac{19}{2} - 2 = -\frac{23}{2}$

$2(h+k) = -19 - 23 = -42$

Now, $m_{BC} = \frac{\beta - 3}{\alpha + 2} = 1 \Rightarrow \beta = \alpha + 5$ .....(iii)



& $m_{AC} = \frac{\beta + 1}{\alpha - 3} = \frac{3}{2} \Rightarrow 2(\alpha + 5) + 2 = 3\alpha - 9$

$\alpha = 21$, $\beta = 26$

$(\alpha + \beta) + 2(h, k) = 47 - 42 = 5$

11. Let a, ar, ar^2, …….. be an infinite G.P. $\sum_{n=0}^{\infty} ar^n = 57$ and $\sum_{n=0}^{\infty} a^3 r^{3n} = 9747$, then a + 18r is equal to

(1) 46 (2) 31 (3) 38 (4) 27

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

Sol. $\frac{a}{1-r} = 57$ .....(ii) & $\frac{a^3}{1-r^3} = 9747$ .....(ii)

(ii) $\Rightarrow \frac{a \cdot a^2}{(1-r)(1+r^2+r)} = 9747 \Rightarrow 57 \cdot \frac{a^2}{1+r^2+r} = 9747$

$\Rightarrow \frac{a^2}{1+r^2+r} = 171 \Rightarrow 57 \times 57 \times (1-r)^2 = 171(1 + r^2 + r)$

$\Rightarrow 19 + 19r^2 - 38r = 1 + r^2 + r \Rightarrow 18r^2 - 39r + 18 = 0 \Rightarrow 6r^2 - 13r + 6 = 0$

$\Rightarrow 6r^2 - 9r - 4r + 6 = 0 \Rightarrow 36(2r - 3) - 2(2r - 3) = 0 \Rightarrow r = \frac{3}{2} \times \frac{2}{3}$

$a = 57(1 - r) = 57\left(1 - \frac{2}{3}\right) = 19$

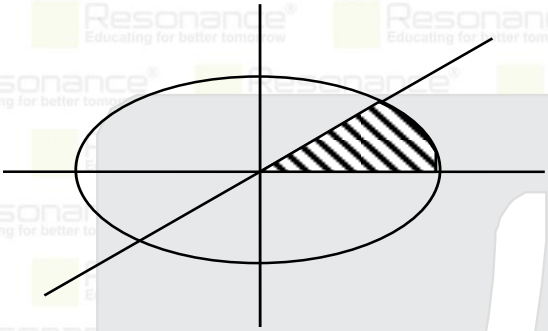
$a + 18r = 19 + 18 \times \frac{2}{3} = 19 + 12 = 31$

12. The area (in square units) of the region enclosed by the ellipse $x^2 + 3y^2 = 18$ in the first quadrant below the line $y = x$ is

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

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

Sol.



$\frac{x^2}{18} + \frac{y^2}{6} = 1$ & $y = x$

$\frac{x^2}{18} + \frac{x^2}{6} = 1 \Rightarrow 4x^2 = 18$

$x = \pm\frac{3}{\sqrt{2}} = y$

$$\text{Area} = \int_0^{\frac{3}{\sqrt{2}}} \sqrt{18\left(1-\frac{y^2}{6}\right)}dy - \int_0^{3/\sqrt{2}} y\,dy = \int_0^{\frac{3}{\sqrt{2}}} \sqrt{18-3y^2}\,dy - \frac{1}{2}\times\frac{9}{2}$$

$= \sqrt{3}\,\pi$

13. Let $B = \begin{bmatrix} 1 & 3 \\ 1 & 5 \end{bmatrix}$ and A be a 2×2 matrix such that $AB^{-1} = A^{-1}$. If $BCB^{-1} = A$ and $C^4 + \alpha C^2 + \beta I = 0$, then $2\beta - \alpha$ is equal to

(1) 8 (2) 16 (3) 2 (4) 10

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

Sol. $AB^{-1} = A^{-1} \Rightarrow A^2B^{-1} = I \Rightarrow A^2 = B$

& $BCB^{-1} = A \Rightarrow BC = AB \Rightarrow ABC = A^2B$

$\Rightarrow BC \cdot C = B^2 \Rightarrow BC^2 = B^2 \Rightarrow B^{-1}BC^2 = B^{-1}B^2$

$\Rightarrow C^2 = B$

$C^4 + \alpha C^2 + \beta I = 0 \Rightarrow B^2 + \alpha B + \beta \cdot I = 0$ .....(i)

Ch. Equation: $|B - xI| = 0 \Rightarrow \begin{vmatrix} 1-x & 3 \\ 1 & 5-x \end{vmatrix} = 0 \Rightarrow x^2 - 6x + 5 - 3 = 0$

$\Rightarrow B^2 - 6B + 2I = 0$ .....(ii)

from (i) & (ii) $\alpha = -6$, $\beta = 2$

so $2\beta - \alpha = 4 + 6 = 10$

14. Let the range of the function $f(x) = \frac{1}{2+\sin 3x+\cos 3x}$, $x \in R$ be [a,b]. If α and β are respectively the A.M. and the G.M. of a and b, then $\frac{\alpha}{\beta}$ is equal to

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

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

Sol. $\sqrt{2} \le \sin 3x+\cos 3x \le \sqrt{2}$

So, range of f(x) is $\left[\frac{1}{2+\sqrt{2}}, \frac{1}{2-\sqrt{2}}\right]$

So, $a = \frac{1}{2+\sqrt{2}}$, $b = \frac{1}{2-\sqrt{2}} \Rightarrow \frac{a}{b} = \frac{2-\sqrt{2}}{2+\sqrt{2}} = \frac{\sqrt{2}-1}{\sqrt{2}+1} = \left(\sqrt{2}-1\right)^2 = \frac{1}{\left(\sqrt{2}+1\right)^2}$

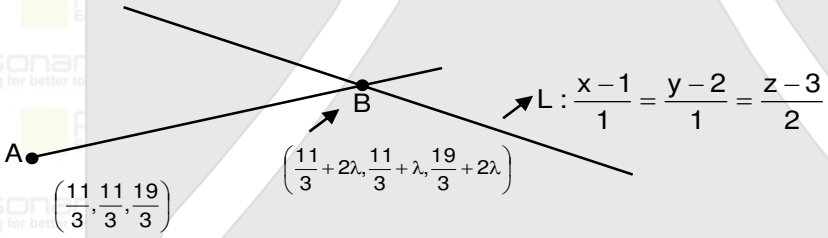
$\frac{\alpha}{\beta} = \frac{(a+b)/2}{\sqrt{ab}} = \frac{1}{2}\left\{\sqrt{\frac{a}{b}}+\sqrt{\frac{b}{a}}\right\} = \frac{1}{2}\left\{\sqrt{2}-1+\sqrt{2}+1\right\} = \sqrt{2}$

15. Consider the line L passing through the point (1,2,3) and (2,3,5) . The distances of the point $\left(\frac{11}{3}, \frac{11}{3}, \frac{19}{3}\right)$ from the line L along the line $\frac{3x-11}{2} = \frac{3y-11}{1} = \frac{3z-19}{2}$ is equal to

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

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

Sol. $A\left(\frac{11}{3}, \frac{11}{3}, \frac{19}{3}\right)$ lies on line $\frac{x-\frac{11}{3}}{2} = \frac{y-\frac{11}{3}}{1} = \frac{z-\frac{19}{3}}{2} = \lambda$



B lies on L so $\frac{11}{3}+2\lambda-1 = \frac{11}{3}+\lambda-2 = \frac{\frac{19}{3}+2\lambda-3}{2}$

$\Rightarrow \lambda = -1$

So, B $\left(\frac{11}{3}-2, \frac{11}{3}-1, \frac{19}{3}-2\right)$ So, AB = $\sqrt{4+1+4} = 3$

16. If an unbiased dice is rolled thrice, then the probability of getting a greater number in the i^{th} roll than the number obtained in the $(i-1)^{th}$ roll, i = 2, 3 is equal to

(1) $\frac{5}{54}$ (2) $\frac{1}{54}$ (3) $\frac{3}{54}$ (4) $\frac{2}{54}$

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

Sol. I II III
x < y < z

Req. Prob = $\frac{{}^{6}C_3}{6\times6\times6} = \frac{\frac{6\times5\times4}{3\times2}}{6\times6\times6}$

$= \frac{5}{6\times3\times3} = \frac{5}{54}$

17. Let $\vec{a}+2\hat{i}+\alpha\hat{j}+\hat{k}$, $\vec{b}=-\hat{i}+\hat{k}$, $\vec{c}=\beta\hat{j}-\hat{k}$, where α and β are integers and $\alpha\beta = -6$. Let the values of the ordered of pair (α,β). For which the area of the parallelogram of diagonals $\vec{a}+\vec{b}$ and $\vec{b}+\vec{c}$ is $\frac{\sqrt{21}}{2}$, be (α_1,β_1) and (α_2,β_2) . Then $\alpha_1^2+\beta_1^2-\alpha_2\beta_2$ is equal to

(1) 24 (2) 19 (3) 17 (4) 21

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

Sol. Area of //gm $= \frac{1}{2}\left|(\vec{a}+\vec{b})\times(\vec{b}+\vec{c})\right| = \frac{\sqrt{21}}{2}$

$$\left|\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 1 & \alpha & 2\\ -1 & \beta & 0\end{vmatrix}\right| = \sqrt{21} \quad \left|\hat{i}(-2\beta)-\hat{j}(2)+\hat{k}(\beta+\alpha)\right| = \sqrt{21}$$

$\Rightarrow 4\beta^2 + 4 + (\beta+\alpha)^2 = 21$
$\Rightarrow 5\beta^2 + \alpha^2 + 2x(-6) = 17$
$\Rightarrow 5\beta^2 + \frac{36}{\beta^2} = 29$
$\Rightarrow 5\beta^4 - 29\beta^2 + 36 = 0$
$\Rightarrow 5\beta^4 - 20\beta^2 - 9\beta^2 + 36 = 0$
$\Rightarrow 5\beta^2(\beta^2-4) - 9(\beta^2-4) = 0 \quad \Rightarrow \beta^2 = 4, \frac{9}{5}$ (rejected)

$\beta = -2, 2$
So, (3, –2) or (–3,2)
So, $\alpha_1^2+\beta_1^2-\alpha_2\beta_2 = 9+4+6$
$= 19$

18. Between the following two statement :

Statement I : Let $\vec{a}=\hat{i}+2\hat{j}-3\hat{k}$ and $\vec{b}=2\hat{i}+\hat{j}-\hat{k}$. Then the vector $\vec{r}$ satisfying $\vec{a}\times\vec{r}=\vec{a}\times\vec{b}$ and $\vec{a}.\vec{r}=0$ is of magnitude $\sqrt{10}$

Statement II : In a triangle ABC, cos2A + cos2B + cos2C $\geq -\frac{3}{2}$

(1) Both Statement I and Statement II are incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Statement I is correct but Statement II is incorrect

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

Sol. I : $\vec{a}\times(\vec{r}-\vec{b})=0 \Rightarrow \vec{r}=\vec{b}+\lambda\vec{a}=\vec{a}\cdot\vec{r}=\vec{a}\cdot\vec{b}+\lambda|\vec{a}|^2 \Rightarrow 0=2+2+3+\lambda(1+4+9) \Rightarrow \lambda=-\frac{1}{2}$

So, $\vec{r}=\vec{b}-\frac{1}{2}\vec{a}=2\hat{i}+\hat{j}+\hat{k}-\frac{\hat{i}}{2}-\hat{j}+\frac{3}{2}\hat{k}$

$\vec{r}=\frac{3}{2}\hat{i}+\frac{1}{2}\hat{k} \Rightarrow |\vec{r}|=\sqrt{\frac{9}{4}+\frac{1}{4}}=\frac{\sqrt{10}}{2}$

So, ST – I is incorrect

II: $\cos2A+\cos2B+\cos2C = 2\cos(A+B).\cos(A-B)+\cos2C = -2\cos C\cos(A-B)+2\cos^2C-1$

$= -2\cos C\{\cos(A-B)-\cos C\}-1 = 2t^2-2\cos(A-B)\,t-1 = 2\{t^2-\cos(A-B)\,t)\}-1$

$= 2\{(t-\frac{1}{2}\cos(A-B))^2-\frac{1}{4}\cos^2(A-B)\}-1 \geq -\frac{1}{2}\cos^2(A-B)-1 \geq -\frac{1}{2}-1$

i.e., $\cos2A+\cos2B+\cos2C \geq -\frac{3}{2}$ correct

19. If the variance of the frequency distribution

x	c	2c	3c	4c	5c	6c
f	2	1	1	1	1	1

is 160 , then the value of $c \in N$ is

(1) 5 (2) 8 (3) 7 (4) 6

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

Sol. $\sigma^2 = \frac{\Sigma f_i x_i^2}{\Sigma f_i}-\left(\frac{\Sigma f_i x_i}{\Sigma f_i}\right)^2 = 160$

$\Rightarrow \frac{c^2(2+4+9+16+25+36)}{7}-\left(\frac{c\cdot(2+2+3+4+5+6)}{7}\right)^2 = 160$

$c^2\times\frac{92}{7}-c^2\times\left(\frac{22}{7}\right)^2 = 160$

$\frac{c^2}{49}\times\{92\times7-4\times121\} = 160 \Rightarrow \frac{c^2}{49}\times160 = 160 \Rightarrow c = 7$ Ans.

20. The sum of the coefficient of $x^{2/3}$ in the binomial expansion of $\left(x^{2/3}+\frac{1}{2}x^{-2/5}\right)^9$ is

(1) $\frac{69}{16}$ (2) $\frac{63}{16}$ (3) $\frac{21}{14}$ (4) $\frac{19}{4}$

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

Sol. $T_{r+1} = {}^9C_r\left(x^{2/3}\right)^{9-r}\cdot\left(\frac{1}{2}x^{-2/5}\right)^r = {}^9C_r\left(\frac{1}{2}\right)^r\cdot x^{6-\frac{2r}{3}-\frac{2r}{5}}$

$= {}^9C_r\cdot\frac{1}{2^r}\cdot x^{6-\frac{16r}{15}}$

(I) $6-\frac{16r}{15}=\frac{2}{3}\Rightarrow r=5$ & **(II)** $6-\frac{16r}{15}=\frac{-2}{3}\Rightarrow 6+\frac{2}{5}=\frac{16r}{15}=\frac{32}{5}$ $r=6$

$\text{Sum}={}^9C_5\cdot\frac{1}{2^5}+{}^9C_6\cdot\frac{1}{2^6}=\frac{1}{2^6}\left\{2\cdot{}^9C_4+{}^9C_3\right\}=\frac{1}{2^6}\left({}^9C_4+{}^{10}C_4\right)$

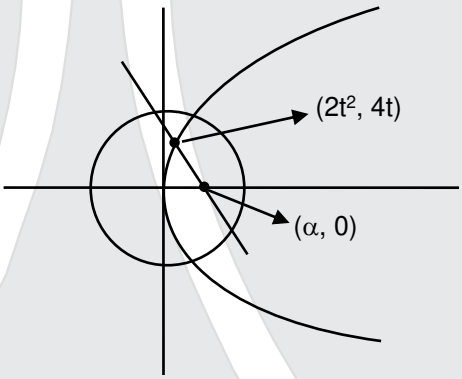
$=\frac{21}{4}$

21. Consider the circle C : $x^2 + y^2 = 4$ and the parabola P : $y^2 = 8x$. If the set of all values of α , for which three chords of the circle C on three distinct lines passing through the point $(\alpha, 0)$ are bisected by the parabola P is the interval (p,q), then $(2q - p)^2$ is equal to

Ans. **NTA (80)**
RESO (80)

Sol.

$4t^4 + 16t^2 - 4 = 0$
$t^4 + 3t^2 - 1 < 0$
$(t^2 + 2)^2 - 4 - 1 < 0$
$|t^2 + 2| < \sqrt{5}$
$t^2 < \sqrt{5} - 2$
$2t^2 < 2\sqrt{5} - 4$
$T = S_1$
$x.2t^2 + y.4t - 4 = 4t^4 + 16t^2 - 4$
$(\alpha, 0) \rightarrow 2t^2\alpha + 0 = 4t^4 + 16t^2$
$4t^4 + (16 - 2\alpha)t^2 = 0$
$2t^2 (2t^2 + (8 - \alpha)) = 0$
$\Rightarrow$ $t = 0$ & $2t^2 + 8 - \alpha = 0$
$2t^2 = \alpha - 8 > 0$
$\alpha > 8$ & $\alpha - 8 < 2\sqrt{5} - 4$
$8 < \alpha < 2\sqrt{5} + 4 \Rightarrow p = 8 , q = 2\sqrt{5} + 4$
$(2q - p)^2 = (4\sqrt{5} + 8 - 8)^2 = 16 \times 5 = 80$



22. let the set of the values of p, for which $f(x) = \left(p^2 - 6p + 8\right)\left(\sin^2 2x - \cos^2 2x\right) + 2(2 - p)x + 7$ does not have any critical point, be the interval (a,b). Then 16ab is equal to ___

Ans. **NTA (252)**
RESO (252)

Sol. $f(x) = -(p^2 - 6p + 8)(\cos 4x) + 2(2 - p)x + 7$
$f'(x) = +(p^2 - 6p + 8)\, 4\sin 4x + 2(2 - p)$
$= 4(p - 4)(p - 2)\sin 4x + 2(2 - p)$
$= 2(p - 2)\{2(p - 4)\sin 4x - 1\}$
$p \neq 2$ & $2(p - 4)\sin 4x - 1 \neq 0$

$\sin 4x \neq \frac{1}{2(p-4)} \Rightarrow \left|\frac{1}{2(p-4)}\right| > 1$

$|2(p - 4)| < 1 \Rightarrow -\frac{1}{2} < p - 4 < \frac{1}{2} \Rightarrow \frac{7}{2} < p < \frac{9}{2}$

$a = \frac{7}{2}$, $b = \frac{9}{2} \Rightarrow 16ab = 16 \times \frac{7}{2} \times \frac{9}{2} = 63 \times 4 = 252.$

23. If $\left(\frac{1}{\alpha+1}+\frac{1}{\alpha+2}+.....+\frac{1}{\alpha+1012}\right)-\left(\frac{1}{2.1}+\frac{1}{4.3}+\frac{1}{6.5}+....+\frac{1}{2024.2023}\right)=\frac{1}{2024}$, then α is equal to ____

Ans. **NTA (1011)**
RESO (1011)

Sol. $\frac{1}{2.1}+\frac{1}{4.3}+\frac{1}{6.5}+.....+\frac{1}{2024.2023}=1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+.....+\frac{1}{2023}-\frac{1}{2024}$

So, $\frac{1}{\alpha+1}+\frac{1}{\alpha+2}+.....+\frac{1}{\alpha+1012}=1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+.....+\frac{1}{2023}-\frac{1}{2024}+\frac{1}{2024}$

$= 1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{2023}-2\left(\frac{1}{2}+\frac{1}{4}+\frac{1}{6}+.....+\frac{1}{2022}\right)$

$= 1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{2023}-\left(1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{1011}\right)$

$= \frac{1}{1012}+\frac{1}{1013}+.....+\frac{1}{2023}$

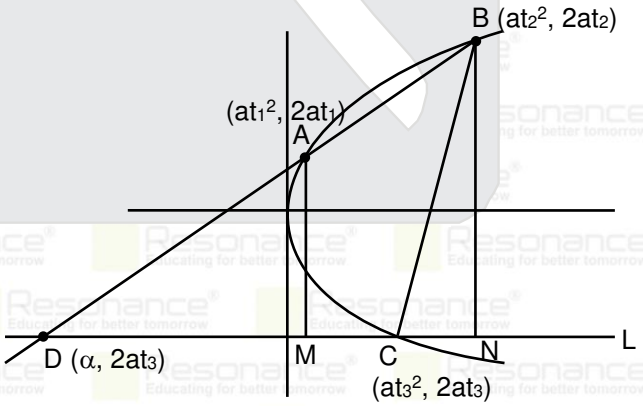
$\Rightarrow \frac{1}{\alpha+1}+\frac{1}{\alpha+2}+.....+\frac{1}{\alpha+1012}=\frac{1}{(1011+1)}+\frac{1}{(1011+2)}+.....+\frac{1}{(1011+1012)}$

$\Rightarrow \alpha = 1011.$

24. Let A, B and C be three points on the parabola $y^2 = 6x$ and let the line segment AB meet the line L through C parallel to the x-axis at the point D. Let M and N respectively be the feet of the perpendiculars from A and B on L. Then $\left(\frac{AM\cdot BN}{CD}\right)^2$ is equal to _____

Ans. **NTA (36)**
RESO (36)

Sol.



$AM = 2a(t_3 - t_1)$

$BN = 2a(t_3 - t_2)$

$AB \rightarrow y = \frac{2}{t_1+t_2}x + a.\frac{2t_1t_2}{t_1+t_2}$

$D \rightarrow 2at_3 = \frac{2}{t_1+t_2}\alpha + a\frac{2t_1t_2}{t_1+t_2}$

$\alpha = a(t_3t_1 + t_3t_2 - t_1t_2)$

So, $CD = at_3^2 - a(t_3t_1 + t_3t_2 - t_1t_2)$

$= a\{t_3(t_3 - t_1) - t_2(t_3 - t_1)\}$

$= a(t_3 - t_1)(t_3 - t_2)$

So, $\left(\frac{AM.BN}{CD}\right)^2 = (4a)^2 = (6)^2 = 36.$

25. The number of integers, between 100 and 1000 having the sum of their digits equals to 14, is _____

Ans. **NTA (70)**
RESO (70)

Sol. | x | y | z |

$x + y + z = 14$

$1 \le x \le 9$, $0 \le y \le 9$, $0 \le z \le 9$

Coefficient of t^{14} in $(t + t^2 + ...+t^9)\ (1+ t + t^2 + ……+ t^9)^2$

$= t^{13}\ |1 + t + ……+ t^8|\ (1 + t^2 + …….+t^9)^2$

$= t^{13}\left|\frac{1.(1-t^9)}{(1-t)} \times \frac{1.(1-t^{10})^2}{(1-t)^2}\right| = t^{13}\ |(1 - t^9)\ (1 - 2t^{10})\ (1 - t)^{-3}$

$= t^{13}\ |\ (1 - t^9 - 2t^{10})\ (1 - t)^{-3} = {}^{13+3-1}C_{13} - {}^{4+3-1}C_4 - 2 \times {}^{3+3-1}C_3$

$= {}^{15}C_2 - {}^6C_2 - 2 \times {}^5C_2 = \frac{15 \times 14}{2} - \frac{6 \times 5}{2} - 2 \times 10 = 15 \times 7 - 15 - 20 = 90 - 20 = 70.$

26. Let the inverse trigonometric functions take principal values. The number of real solutions of the equation $2\sin^{-1}x + 3\cos^{-1}x = \frac{2\pi}{5}$, is _____

Ans. **NTA (0)**
RESO (0)

Sol. $2\sin^{-1}x + 3\left(\frac{\pi}{2} - \sin^{-1}x\right) = \frac{2\pi}{5}$

$\sin^{-1}x = \frac{3\pi}{2} - \frac{2\pi}{5} = \frac{11\pi}{10} > \frac{\pi}{2}$

So, Number of solutions = 0.

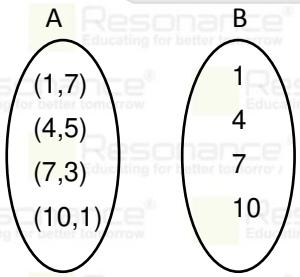
27. Let $A = \{(x,y) : 2x + 3y = 23, x, y \in N\}$ and $B = \{x : (x, y) \in A\}$. Then the number of one-one functions from A to B is equal to _____

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

Sol. $3y = 23 - 2x$

$y = \frac{21}{3} + \frac{2-2x}{3}$

$y = 7 - \frac{2(x-1)}{3}$



No. of one-one function from A to B
$= 4! = 24.$

28. For a differentiable function $f : R \to R$, suppose $f'(x) = 3f(x) + \alpha$, where $\alpha \in R$, $f(0) = 1$ and $\lim\limits_{x\to-\infty} f(x) = 7$. Then $9f(-\log_e 3)$ is equal to _____.

Ans. **NTA (61)**
RESO (61)

Sol. $\dfrac{dy}{dx} = 3y + \alpha$

$\dfrac{1}{3y+\alpha}dy = dx$

$\dfrac{1}{3}\sin|3y+\alpha| = x + c$

$|3y + \alpha| = e^{3c} \cdot e^{3x}$

$3y + \alpha = \lambda e^{3x}$

$f(0) = 1 \quad \Rightarrow \quad 3 + \alpha = \lambda$

$3y + \alpha = (\alpha + 3)e^{3x}$

$f(x) = \dfrac{1}{3}\left\{(\alpha+3)e^{3x} - \alpha\right\}$

$\lim\limits_{x\to-\infty} f(x) = -\dfrac{\alpha}{3} = 7 \qquad \alpha = -21$

$f(x) = \dfrac{1}{3}(-18e^{3x} + 21) = -6(e^x)^3 + 7$

$f(-\ell n3) = -6(e^{-\ell n3})^3 = +7$

$= -6 \times \dfrac{1}{27} + 7$

$= -\dfrac{2}{9} + 7 = \dfrac{61}{9}$

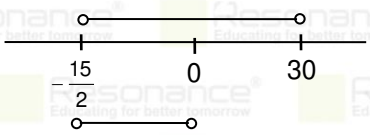
$\Rightarrow \quad 9\,f(-\ell n3) = 61$

29. Consider the matrices : $A = \begin{bmatrix} 2 & -5 \\ 3 & m \end{bmatrix}$, $B = \begin{bmatrix} 20 \\ m \end{bmatrix}$ and $X = \begin{bmatrix} x \\ y \end{bmatrix}$. Let the set of all m, for which the system of equations AX = B has a negative solution (i.e., $x < 0$ and $y < 0$), be the interval (a,b). Then $8\int_a^b |A|\,dm$ is equal to _____

Ans. **NTA (450)**
RESO (450)

Sol. $X = A^{-1}B = \dfrac{1}{2m+15}\begin{bmatrix} m & -5 \\ -3 & 2 \end{bmatrix}\begin{bmatrix} 20 \\ m \end{bmatrix} = \dfrac{1}{2m+15}\begin{bmatrix} 20m-5m \\ -60+2m \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix}$

$\dfrac{15m}{2m+15} < 0 \quad \& \quad \dfrac{2m-60}{2m+15} < 0$



$\Rightarrow \quad m \in \left(-\dfrac{15}{2}, 0\right)$

$$a = -\frac{15}{2}\ ,\ b = 0$$

Now $8\int_a^b |A|\,dm = 8\int_{-\frac{15}{2}}^{0}(2m+15)dm$

$= 8\left[m^2+15m\right]_{-\frac{15}{2}}^{0} = 8\left[m(m+15)\right]_{-\frac{15}{2}}^{0}$

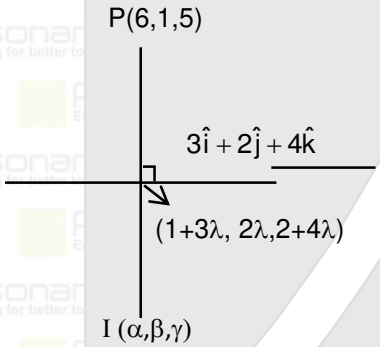
$= 8\left\{0+\frac{15}{2}\left(-\frac{15}{2}+15\right)\right\} = 4\times15\times\frac{15}{2}$

$= 2 \times 225 = 450.$

30. The square of the distance of the image of the point (6,1,5) in the line $\frac{x-1}{3}=\frac{y}{2}=\frac{z-2}{4}$, from the origin is _____

Ans. **NTA (62)**
RESO (62)

Sol.



$$\frac{\alpha+6}{2} = 1+3\lambda$$

$$\frac{\beta+1}{2} = 2\lambda$$

$$\frac{\gamma+5}{2} = 2+4\lambda$$

$$\{(\alpha-6)\hat{i}+(\beta-1)\hat{j}+(\gamma-5)\hat{k}\}.(3\hat{i}+2\hat{j}+4\hat{k}) = 0$$

$3\alpha - 18 + 2\beta - 2 + 4\gamma - 20 = 0$

$3\alpha + 2\beta + 4\gamma = 40$ ……(i)

$3(2 + 6\lambda - 6) + 2(4\lambda - 1) + 4(4 + 8\lambda - 5) = 40$

$(18 + 8 + 32)\lambda - 12 - 2 - 4 = 40$

$58\lambda = 58 \quad \Rightarrow \quad \lambda = 1$

$I(\alpha,\beta,\gamma) = (2,3,7)$

$0(0,0,0)$

$OI^2 = (\sqrt{4+9+49})^2 = 62.$

PART : PHYSICS

31. A spherical ball of radius 1×10^{-4} m and density 10^5 kg/m^3 falls freely under gravity through a distance h before entering a tank of water, If after entering in water the velocity of the ball does not change, then the value of h is approximately: (The coefficient of viscosity of water is 9.8×10^{-6} N s/m^2)

1×10^{-4} m त्रिज्या तथा 10^5 kg/m^3 घनत्व की एक गोलीय गेंद पानी के एक टैंक में प्रवेश करने से पूर्व h ऊँचाई से गुरुत्व के अधीन मुक्त रुप से गिरती है। यदि पानी में प्रवेश करने के उपरान्त वेग अपरिवर्तित रहता हो तो h का लगमग मान है : (पानी का श्यानता गुणांक 9.8×10^{-6} N s/m^2)

(1) 2296 m (2) 2396 m (3) 2518 m (4) 2249 m

Ans. **(3)**

Sol. $V_T = \frac{2}{9}\frac{R^2 g}{\eta}(\rho_b - \rho_w)$

$= \frac{2}{9} \times \frac{10^{-8} \times 10}{9.8 \times 10^{-6}} \times (10^5 - 10^3)$ $\quad V_T = \sqrt{2gh}$

$= \frac{2}{9} \times \frac{10^{-2} \times 10}{9.8} \times (99000)$ $\quad h = \frac{V_T^2}{2g} = \frac{224.5 \times 224.5}{2 \times 10}$

$= \frac{2 \times 9900}{9 \times 9.8} = 224.5$ m/s $\quad = 2520$ m

32. The excess pressure inside a soap bubble is thrice the excess pressure inside a second soap bubble. The ratio between the volume of the first and the second bubble is :

एक साबुन के बुलबुले में अधिक्य दाब दूसरे साबुन बुलबुले के अन्दर अधिक्य दाब से तीन गुना है। प्रथम तथा द्वितीय बुलबुले के आयतनों का अनुपता है :

(1) 1 : 27 (2) 1 : 3 (3) 1 : 9 (4) 1 : 81

Ans. **(1)**

Sol. $P_1 = P_{excess_1} = \frac{4T}{R_1}$

$P_2 = P_{excess_2} = \frac{4T}{R_2}$

$P_1 = 3P_2$ (given)

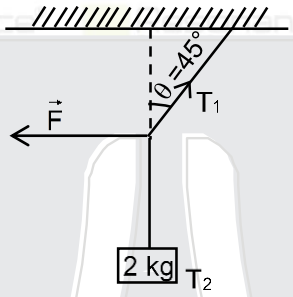
$\frac{4T}{R_1} = \frac{3(4T)}{R_2}$

$R_2 = 3R_1$

$\frac{V_1}{V_2} = \frac{\frac{4}{3}\pi R_1^3}{\frac{4}{3}\pi R_2^3} = \frac{R_1^3}{R_2^3} = \frac{R_1^3}{R_2^3} = \frac{R_1^3}{3^3 R_1^3} = \frac{1}{27}$

33. A 1 kg mass is suspended from the ceiling by a rope of length 4m. A horizontal force F is applied at the mid point of the rope so that the rope makes an angle of 45° with respect to the vertical axis as shown in figure. The magnitude of F is : (Assume that the system is in equilibrium and g = 10 m/s^2)]

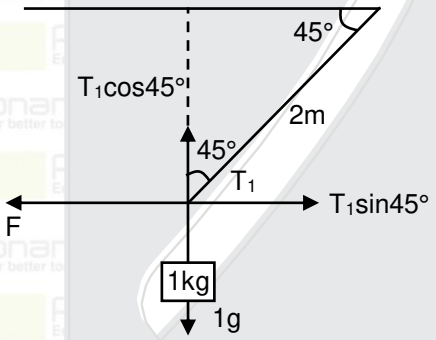
एक किग्रा द्रव्यमान को 4 मी लम्बाई की एक रस्सी द्वारा सीलिंग से लटकाया गया है। रस्सी के मध्य बिन्दु पर क्षैतिज बल F के अनुप्रयोग से चित्र अनुसार उर्ध्वाधर अक्ष से 45° का एक कोण बनता है। F का परिमाण है : (द्रव्यमान को साम्यवस्था में मानकर तथा g = 10 मी/से^{2})]



(1) $\frac{10}{\sqrt{2}}$ N (2) $\frac{1}{10\times\sqrt{2}}$ N (3) 10 N (4) 1 N

Ans. **(3)**

Sol.



at equilibrium

$$\frac{T_1}{\sqrt{2}} = 1g \quad ...(1)$$

$$T_1 = \sqrt{2}\,g$$

$$F = \frac{T_1}{\sqrt{2}} = \frac{\sqrt{2}\,g}{\sqrt{2}} = g = 10N$$

34. A satellite of 10^3 kg mass is revolving in circular orbit of radius 2R. If $\frac{10^4 R}{6}$ J energy is supplied to the satellite, it would revolve in a new circular orbit of radius : (use g = 10 m/s^2 , R = radius of earth)

10^3 किग्रा द्रव्यमान का एक उपग्रह 2R त्रिज्या की एक कक्षा में परिक्रमण कर रहा है। यदि उपग्रह को $\frac{10^4 R}{6}$ जूल ऊर्जा प्रदान की जाये तो यह किस त्रिज्या की नई कक्षा में परिक्रमण करेगा :

(दिया गया है g = 10 मी/से^{2} , R = पृथ्वी की त्रिज्या)

(1) 2.5 R (2) 6 R (3) 3 R (4) 4 R

Ans. **(2)**

Sol. $TE_i + \text{Energy supplied} = TE_f$

$$-\frac{GMm}{2r_1} + E_{supplied} = -\frac{GMm}{2r_2}$$

$$-\frac{GMm}{4R} + \frac{10^4 R}{6} = -\frac{GMm}{2r_2}$$

$$-\frac{mgR^2}{4R} + \frac{10^4}{6}R = -\frac{mgR^2}{2r_2}$$

$$-\frac{mgR}{4} + \frac{10^4}{6}R = -\frac{mgR^2}{2r_2}$$

$$-\frac{10^3 \times 10 \times R}{4} + \frac{10^4 R}{6} = -\frac{10^4 R^2}{2r_2}$$

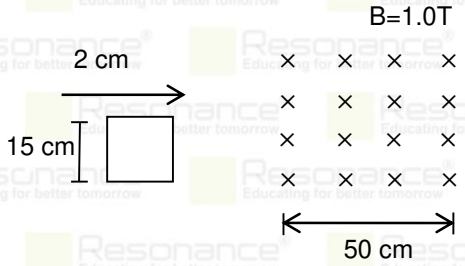
$$10^4 R\left[\frac{1}{6} - \frac{1}{4}\right] = -\frac{10^4 R^2}{2r_2}$$

$$-\frac{1}{12} = -\frac{R}{2r_2}$$

$r_2 = 6\ R$

35. A square loop of side 15 cm being moved towards right at a constant speed of 2 cm/s as shown in figure. The front edge enters the 50 cm wide magnetic field at t =0. the value of induced emf in the loop at t = 10 s wil be

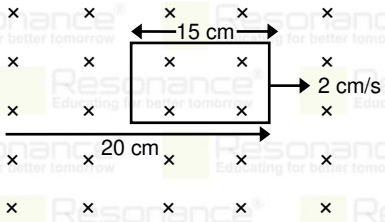
प्रदर्शित चित्र के अनुसार 15 सेमी भुजा का एक वर्गाकार लूप 2 सेमी/से की नियत चाल से दाहिनी ओर गति करता है। t =0 पर सम्मुख 50 सेमी चौडाई के चुम्बकीय क्षेत्र में प्रवेश करती है। t = 10 s पर लूप में उत्पन्न वि.बा.बल का मान होगा :



(1) 0.3 mV (2) 3 mV (3) zero (4) 4.5 mV

Ans. **(3)**

Sol. At t = 10 sec s = vt = 2 × 10 = 20 cm



loop is completely inside uniform B

ϕ = constant

$\frac{d\phi}{dt} = 0$

$e_{ind} = 0$

36. The magnetic field in a plane electromagnetic wave is . $B_y = (3.5\times10^{-7})\sin(1.5\times10^3 x + 0.5\times10^{11}t)T$. The corresponding electric field will be :

एक समतल विद्धुतचुंबकीय तरंग में चुम्बकीय क्षेत्र $B_y = (3.5\times10^{-7})\sin(1.5\times10^3 x + 0.5\times10^{11}t)T$ है। . वैद्युत क्षेत्र होगा :

(1) $E_y = 10.5\sin(1.5\times10^3 x + 0.5\times10^{11}t)Vm^{-1}$

(2) $E_z = 1.17\sin(1.5\times10^3 x + 0.5\times10^{11}t)Vm^{-1}$

(3) $E_y = 1.17\sin(1.5\times10^3 x + 0.5\times10^{11}t)Vm^{-1}$

(4) $E_z = 105\sin(1.5\times10^3 x + 0.5\times10^{11}t)Vm^{-1}$

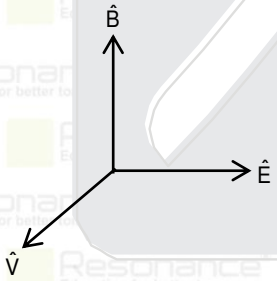
NTA Ans. (4)

Note : Answer is not there in any option. It should be a bonus.

Sol. $B_y = (3.5 \times 10^{-7}T)\sin(1.5 \times 10^3 x + 0.5 \times 10^{11}t)$

$V = \frac{\omega}{K} = \frac{0.5\times10^{11}}{1.5\times10^3} = \frac{1}{3}\times10^8$ m/s

along negative x-axis as per wave equation



$\hat{B}\times\hat{V} = \hat{E}$

$\hat{J}\times(-\hat{i}) = \hat{K} = \hat{E}$

$\therefore$ $\vec{E}$ is along z-axis

$E_0 = VB_0 = \frac{1}{3}\times10^8\times3.5\times10^{-7} = \frac{35}{3} = 11.67$ V/m

$\therefore E_z = 11.67\sin(1.5 \times 10^3 x + 0.5 \times 10^{11}t)$ V/m

Note : Answer is not there in any option. It should be a bonus.

37. A proton and deuteron (q = +e, m = 2.0u) having same kinetic energies enter a region of uniform magnetic field $\vec{B}$, moving perpendicular of $\vec{B}$. The ratio of the radius r_d of deuteron path to the radius r_p of the proton path is

समान गतिज ऊर्जा का एक प्रोटान तथा एक ड्यूट्रॉन (q = +e, m = 2.0u) एक समान चुम्बकीय क्षेत्र $\vec{B}$ के परिसर में प्रवेश करता है तथा $\vec{B}$ के लम्बवत गति करता है। ड्यूट्रॉन पथ की त्रिज्या r_d तथा प्रोटॉन पथ की त्रिज्या r_p का अनुपात है :

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

Ans. **(4)**

Sol. $r = \frac{mv}{qB} = \frac{\sqrt{2mE_k}}{qB}$

$r \propto \frac{\sqrt{m}}{q}$

$\frac{r_d}{r_p} = \sqrt{\frac{m_d}{m_p}} \times \frac{q_p}{q_d}$

$\frac{r_d}{r_p} = \sqrt{\frac{2}{1}} \times \frac{1}{1} = \frac{\sqrt{2}}{1}$

38. A nucleus at rest disintegrates into two smaller nuclei with their masses in the ratio of 2 :1. After disintegration they will move :

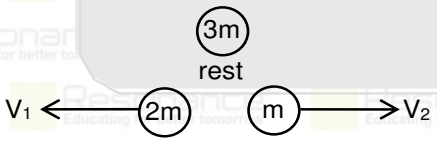
(1) in opposite directions with speed in the ratio of 1 : 2 respectively.
(2) in opposite directions with the same speed
(3) in the same directions with same speed
(4) in opposite directions with speed in the ratio of 2 : 1 respectively.

विरामवस्था में एक नाभिक 2 :1 के द्रव्यमान अनुपात में दो छोटे नाभिकों में विखण्डित होता है। विखण्डन के उपरान्त वे गति करेंगे :

(1) विपरीत दिशा में क्रमशः 1 : 2 अनुपातों की चालों से।
(2) विपरीत दिशा में क्रमशः 2 : 1 अनुपातों की चालों से।
(3) समान दिशा में समान चाल से।
(4) विपरीत दिशा में समान चाल से।

Ans. **(1)**

Sol.



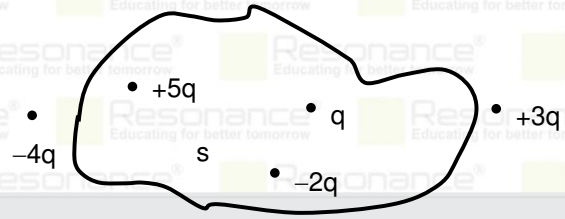
$P_i = P_f = 0$

$-2mv_1 + mv_2 = 0$

$2v_1 = v_2$

$\frac{v_1}{v_2} = \frac{1}{2}$

39. Five charges +q, +5q, -2q, +3q and -4q are situated as shown in the figure. The electric flux due to this configuration through the surface S is :
प्रदर्शित चित्र के अनुसार, पॉच आवेश +q, +5q, -2q, +3q तथा –4q स्थापित हैं। इस अभिविन्यास के कारण s सतह से गुजरने वाला फ्लस्क है :



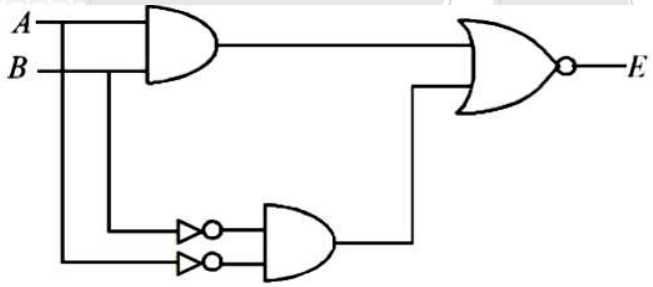
(1) $\frac{q}{\epsilon_0}$ (2) $\frac{4q}{\epsilon_0}$ (3) $\frac{5q}{\epsilon_0}$ (4) $\frac{3q}{\epsilon_0}$

Ans. **(2)**

Sol. $\phi_{\text{closed surface}} = \frac{q_{in}}{\epsilon_0}$

$= \frac{5q+q-2q}{\epsilon_0} = \frac{4q}{\epsilon_0}$

40.



A	B	E
0	0	0
0	1	X
1	0	Y
1	1	0

In the truth table of the above circuit the value of X and Y are:
उपरोक्त परिपथ की सत्यता सारणी में क्रमशः X तथा Y के मान है:

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

Ans. **(3)**

Sol. output of logic gate circuit is

$E = \overline{(A.B)+(\bar{A}.\bar{B})}$

A	B	$\bar{A}$	$\bar{B}$	A.B	$\bar{A}.\bar{B}$	$(A.B)+\bar{A}.\bar{B}$	E	
0	0	1	1	0	1	1	0	
0	1	1	0	0	0	0	1	x
1	0	0	1	0	0	0	1	y
1	1	0	0	1	0	1	0	

X = 1
y = 1

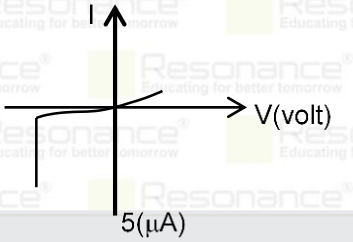
41. UV light of 4.13 eV is incident on a photosensitive metal surface having work function 3.13 eV. The maximum kinetic energy of ejected photoelectrons will be :
4.13 eV का एक पराबैंगनी प्रकाश 3.13 eV कार्यफलन की धातु की सतह पर आपतित होता है। प्रकाश इलैक्ट्रॉनों की अधिकतम गतिज ऊर्जा होगी :

(1) 3.13 eV (2) 1 eV (3) 4.13 eV (4) 7.26 eV

Ans. **(2)**

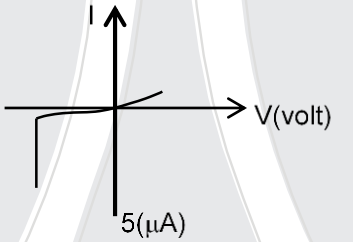
Sol. $K_{max} = E - \phi$
$= 4.13\ eV - 3.13\ eV = 1\ eV$

42. The I-V characteristics of an electronic device shown in the figure. The device is:



(1) a solar cell
(2) a zener diode which can be used as a voltage regulator
(3) a diode which can be used as a rectifier
(4) transistor which can be used as an amplifier

एक इलैक्ट्रॉनिक युक्ति का I-V अभिलाक्षणिक चित्र में दर्शाया गया है। युक्ति है :

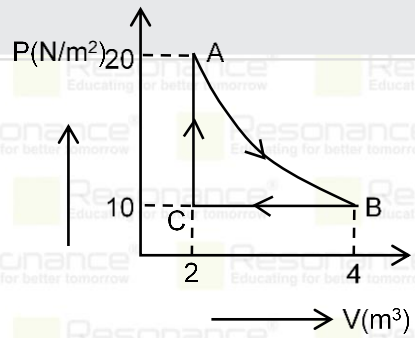


(1) एक सोलर सेल a solar cell
(2) वोल्टेज रेगुलेटर के रुप में प्रयुक्त एक जीनर डायोड
(3) दिष्टकारी के रुप में प्रयुक्त डायोड
(4) प्रवर्धक के रुप में प्रयुक्त एक ट्रांजिस्टर

Ans. **(2)**
Sol. Theory Based, (zener diode as voltage regulator.)

43. A real gas within a closed chamber at 27°C undergoes the cyclic process as shown in figure. The gas obeys $PV^3 = RT$ equation for the path A to B. The net work done in the complete cycle is (assuming R = 8 J/mol K) :

एक बन्द चेम्बर में 27°C पर एक वास्तविक गैस प्रदर्शित चित्र के अनुसार एक चक्रीय प्रक्रम से गुजरती है। A से B पथ के लिए गैस $PV^3 = RT$ समीकरण का अनुसरण करती है। चक्र पूर्ण करने के लिए कुल कार्य है .
(यदि R = 8 J/mol K) :



(1) 225 J (2) 205 J (3) –20 J (4) 20

Ans. **(2)**

Sol. $T_{AB} = 27°C + 273 = 300\ K$ constant

$$W_{AB} = \int_{V_A}^{V_B} PdV = \int_{V_A}^{V_B} \frac{RT}{V^3} dV$$

$$= RT\left[-\frac{1}{2V^2}\right]_{V_A}^{V_B}$$

$$= \frac{300R}{2}\left[\frac{1}{V_A^2} - \frac{1}{V_B^2}\right]$$

$$= \frac{300R}{2}\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$= \frac{300R}{2}\left[\frac{3}{16}\right] \quad R = 8J\ moll\ k\ given$$

$$= \frac{300}{2} \times \frac{3}{16} \times 8 = 225\ J$$

W_{BC} = Area under BC from graph

$= -10 \times 2 = -20\ J$

$W_{CA} = 0$

$\therefore W_{cycle} = W_{AB} + W_{BC} + W_{CA}$

$= 225 - 20 + 0 = 205\ J$

44. The energy released in the fusion of 2 kg of hydrogen deep in the sun E_H and the energy released in the fission of 2 kg of ^{235}U is E_U. The ratio $\frac{E_H}{E_U}$ is approximately :

(consider the fusion reaction as $4{}_1^1H + 2e^- \rightarrow {}_2^4He + 2\upsilon + 6\gamma + 26.7\ MeV$, energy released in the fission reaction of ^{235}U is 200 MeV per fission nucleus and $N_A = 6.023 \times 10^{23}$)

सूर्य में 2 kg हाइड्रोजन के संलयन में उत्पन्न ऊर्जा E_H तथा 2 kg के ^{235}U विखण्डन में उत्पन्न ऊर्जा E_U है। अनुपात $\frac{E_H}{E_U}$ लगभग बराबर है :

($4{}_1^1H + 2e^- \rightarrow {}_2^4He + 2\upsilon + 6\gamma + 26.7\ MeV$ को संलयन अभिक्रिया मानकर तथा ^{235}U की विखण्डन अभिक्रिया में प्रति नाभिक विखण्डन उत्पन्न ऊर्जा 200 MeV है, $N_A = 6.023 \times 10^{23}$)

(1) 9.13 (2) 15.04 (3) 7.62 (4) 25.6

Ans. **(3)**

Sol. 2 kg H-atom = 2000 gm H-atom

= 2000 mole H-atom

= $2000 \times N_A$ atoms

$$E_H = \frac{2000 \times N_A}{4} \times 26.7 MeV$$

$$2\ kg\ U^{235} = \frac{2000}{235} \times N_A\ atom$$

$$\therefore E_U = \frac{2000}{235} \times N_A \times 200\ MeV$$

$$\frac{E_H}{E_u} = \frac{\frac{2000}{4} N_A \times 26.7}{\frac{2000}{235} \times N_A \times 200} = \frac{235}{4} \times \frac{26.7}{200} = 7.84$$

45. Two cars are travelling towards each other at speed of 20 ms^{-1} each. When the cars are 300 m apart, both the drivers apply brakes and the cars retard at the rate of 2 ms^{-2}. The distance between them when they come to rest is :

दो कारें 20 मी/से की चाल से एक दूसरे की ओर गति कर रही हैं। जब वे एक दूसरे से 300 मी की दूरी पर है, दोनों ड्राइवर 2 मी से$^{-2}$ की दर से मंदन आरोपित करते हुए ब्रेक लगाते हैं। उनके विराम में आने पर उनके बीच की दूरी है :

(1) 100 m (2) 25 m (3) 50 m (4) 200 m

Ans. **(1)**

Sol.



$v = u + at = 20 - 2t$

$t = 10$

$v_{app} = 40, a_{app} = -4$

$S_{app} = 40(10) - \frac{1}{2}4(10)^2$

$= 400 - 200 = 200$ m

$d = 300 - 200 = 100$ m

46. The temperature of a gas is –78°C and the average translational kinetic energy of its molecules is K. The temperature at which the average translational kinetic energy of the molecules of the same gas becomes 2 K is

एक गैस का तापमान –78°C है एवं इसके अणुओं की औसत स्थानान्तरीय गतिज ऊर्जा K है। वह ताप जिस पर गैस के अणुओं की औसत स्थानान्तरीय गतिज ऊर्जा 2K हो जाये, है :

(1) 117°C (2) –39°C (3) –78°C (4) 127°C

Ans. **(1)**

Sol. $E = \frac{3}{2}kT$

$\frac{E_1}{E_2} = \frac{T_1}{T_2}$

$\frac{k}{2k} = \frac{T_1}{T_2}$

$T_2 = 2T_1$

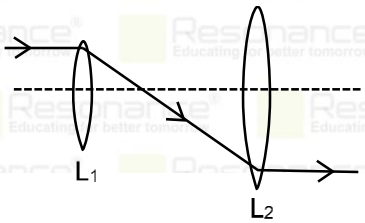
$T_1 = -78 + 273 = 195$ k

$T_2 = 2 \times 195\text{k} = 390$ k

$t_2°C = 390 - 273 = 117°C$

47. The following figure represents two biconvex lenses L_1 and L_2 having focal length 10 cm and 15 cm respectively. The distance between L_1 & L_2 is:

निम्नलिखित चित्र क्रमशः 10 cm व 15 cm फोकस दूरी के L_1 व L_2 दो द्वि–उत्तल लैसों को दर्शाता है। L_1 व L_2 के बीच की दूरी है :



(1) 15 cm (2) 10 cm (3) 35 cm (4) 25 cm

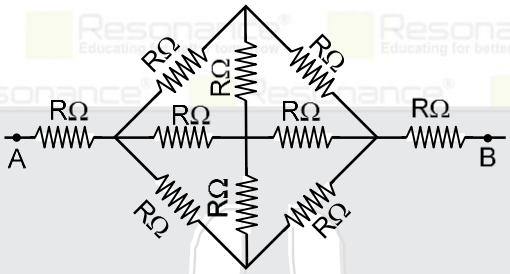
Ans. **(4)**

Sol. $d = f_1 + f_2$

$= 10 + 15$

$d = 25$ cm

48. The effective resistance between A and B. if resistance of each resistor is R, will be
यदि प्रत्येक प्रतिरोध R हो तो A व B के बीच तुल्य प्रतिरोध क्या होगा :



(1) $\frac{2}{3}R$ (2) $\frac{8}{3}R$ (3) $\frac{5R}{3}$ (4) $\frac{4R}{3}$

Ans. **(2)**

Sol. $R_{eq} = R + \frac{2R}{3} + R$

$\frac{8R}{3}$

49. The de-Broglie wavelength associated with a particle of mass m and energy E is $h/\sqrt{2mE}$. The dimensional formula for Planck's constant is :
m द्रव्यमान तथा E ऊर्जा के एक कण से संबद्ध डी–ब्राग्ली तरंग दैर्घ्य $h/\sqrt{2mE}$ है। प्लांक नियतांक का विमीय सूत्र है :

(1) $\left[ML^2T^{-1}\right]$ (2) $\left[ML^{-1}T^{-2}\right]$ (3) $\left[MLT^{-2}\right]$ (4) $\left[M^2L^2T^{-2}\right]$

Ans. **(1)**

Sol. $\lambda = \frac{h}{p}$

$h = p\lambda$

$= MVL$

$= M\frac{L}{T}L$

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

50. A hydrogen atom in ground state is given an energy of 10.2 eV. How many spectral lines will be emitted due to transition of electrons ?
हाइड्रोजन परमाणु को मूल अवस्था में 10.2 eV ऊर्जा दी गई है। इलैक्ट्रॉन के संक्रमण के कारण कितनी स्पैक्ट्रमी रेखाएँ उत्सर्जित होगी ?

(1) 10 (2) 6 (3) 1 (4) 3

Ans. **(3)**

Sol. $E_2 - E_1 = 10.2\,eV$

only one spectral line will be emitted

51. Monochromatic light of wavelength 500 nm is used in Young's double slit experiment. An interference pattern is obtained on a screen. When one of the slits is covered with a very thin glass plate (refractive index = 1.5) the central maximum is shifted to a position previously occupied the 4th bright fringe. The thickness of the glass-plate is _____μm

यंग द्विझिर्री प्रयोग में प्रयुक्त एकवर्णी प्रकाश की तरंग दैर्ध्य 500 nm है। एक व्यतिकरण प्रारूप एक पर्दे पर प्राप्त होता है एक झिर्री को एक बहुत पतली कॉच प्लेट (अपवर्तनांक = 1.5) से ढक दिया गया है। अब केन्द्रीय उच्चिष्ठ पूर्व में उपस्थित चौथी फ्रिंज की स्थिति तक विस्थापित हो जाता है। कॉच की प्लेट की मोटाई _____μm है।

Ans. **04.00**

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

$y = (\mu - 1)t\frac{D}{d} = \frac{4\lambda D}{d}$

$(\mu - 1)t = 4\lambda$

$t = \frac{4\lambda}{\mu - 1} = \frac{4 \times 5 \times 10^{-7}}{.5}$

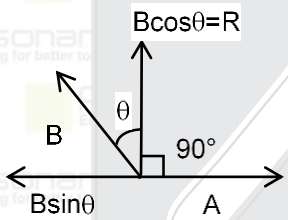
$t = 4\ \mu m$

52. The resultant of two vectors $\vec{A}$ and $\vec{B}$ is perpendicular to $\vec{A}$ and its magnitude is half that of $\vec{B}$. The angle between vectors $\vec{A}$ and $\vec{B}$ is

दो सदिशों $\vec{A}$ व $\vec{B}$ का परिणामी $\vec{A}$ के लम्बवत है तथा इसका परिमाण $\vec{B}$ के परिमाण का आधा है। $\vec{A}$ तथा $\vec{B}$ के बीच का कोण _____°है

Ans. **150°**

Sol.



If $A - B\sin\theta = 0$

$\therefore R = B\cos\theta$

$R = \frac{B}{2} = B\cos\theta$

$\cos\theta = \frac{1}{2}$

$\theta = 60°$

$\therefore$ Angle between $\vec{A}\ \&\ \vec{B} = 90° + 60° = 150°$

53. A force $(3x^2 + 2x - 5)$N displaces a body from x =2 m to x = 4m. Work done by this force is _____J.

$(3x^2 + 2x - 5)$N का एक बल किसी वस्तु को x =2 m से x = 4m तक विस्थापित करता है। इस बल द्वारा क्रत कार्य _____J. है।

Ans. **58.00**

Sol. $W = \int F dx$

$= \int_2^4 (3x^2 + 2x - 5)dx$

$= \left[3\frac{x^3}{3} + \frac{2x^2}{2} - 5x\right]_2^4$

$= \left(x^3 + x^2 - 5x\right)_2^4$

$= (64 - 8) + (16 - 4) - 5\,(4 - 2)$

$= 56 + 12 - 10 = 58$ J

54. A straight magnetic strip has a magnetic moment of 44 Am^2. If the strip is bent in a semicircular shape, Its magnetic moment will be _____ Am^2. (given $\pi = \frac{22}{7}$)

एक सीधी चुम्बकीय पट्टी का चुम्बकीय आघूर्ण 44 Am^2 है। यदि इसे अद्धवृत्ताकार आकृति में मोड़ दिया जाये तो पट्टी का चुम्बकीय आघूर्ण ____ Am^2 होगा (दिया गया है $\pi = \frac{22}{7}$)

Ans. **28.00**

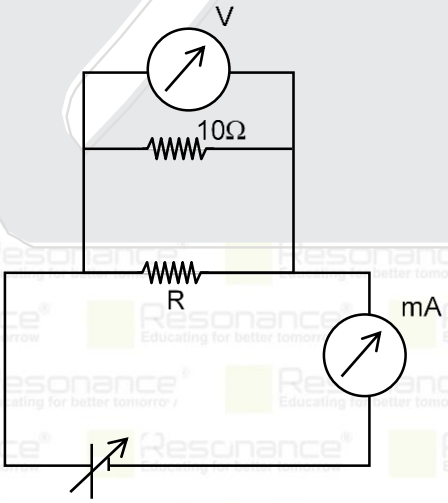
Sol. $M = m\ell = 44 \qquad \ell = \pi r$

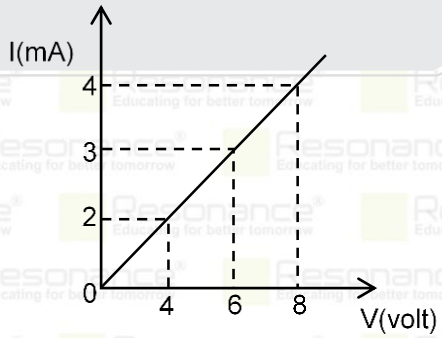
$M' = m\,(2r) = m\left(\frac{2\ell}{\pi}\right)$

$= \frac{2}{\pi}(m\ell) = \frac{2}{\pi} \times 44 = \frac{2 \times 7}{22} \times 44 = 28$

55. To determine the resistance (R) of a wire, a circuit is designed below. The V-I characteristic curve for this circuit is plotted for the voltmeter and the ammeter readings as shown in figure. The value of R is _____Ω.

प्रतिरोध (R) को ज्ञात करने हेतु निम्न परिपथ तैयार किया गया हैं इस परिपथ का (V-I) अभिलाक्षणिक वक्र वोल्टमीटर तथा अमीटर के पाठयांक के लिए खींचा गया है जैसा कि चित्र में प्रदर्शित है। R का मान _____Ω. है।





Ans. **2500**

Sol. Let R is in KΩ

$$\frac{10R}{10+R} = \frac{V}{I} = 2$$

$10 R = 20 + 2 R$

$8 R = 20$

$R = \frac{20}{8} K\Omega$

$= \frac{20}{8} \times 1000\ \Omega = \frac{5000}{2}$

$= 2500\ \Omega$

56. A capacitor of reactance $4\sqrt{3}\ \Omega$ and a resistor of resistance $4\ \Omega$ are connected in series with an ac source of peak value $8\sqrt{2}$ V. The power dissipation in the circuit is _____W.

$4\sqrt{3}\ \Omega$ प्रतिघात का एक संधारित्र तथा $4\ \Omega$ का एक प्रतिरोध $8\sqrt{2}$ V शिखर मान के एक प्रत्यावर्ती स्त्रोत से श्रेणी क्रम में जुड़ा है। परिपथ में शक्ति क्षय _____W है।

Ans. **04.00**

Sol. $Z = \sqrt{R^2 + X_c^2}$

$= \sqrt{4^2 + (4\sqrt{3})^2} = \sqrt{16+48} = 8\Omega$

$V_{max} = 8\sqrt{2}$

$I_{max} = \frac{V_{max}}{z} = \frac{8\sqrt{2}}{8} = \sqrt{2}\ A$

$I_{rms} = \frac{I_{max}}{\sqrt{2}} = 1\ A$

$P_{av} = I^2_{rms} R = 1^2 \times (4) = 4\ W$

57. A circular disc reaches from top to bottom of an inclined plane of length l. When it slips down the plane, if takes t s. When it rolls down the plane then it takes $\left(\frac{\alpha}{2}\right)^{1/2}$ t s, where α is

एक वृत्ताकार चकती l लम्बाई के एक आनत तल पर शिखर से निचले बिन्दु तक पहुँचती है। जब यह नीचे फिसलती है तो t सेकंड समय लेती है। जब नीचे लुढ़कती है तो यह $\left(\frac{\alpha}{2}\right)^{1/2}$ t सेकंड समय लेती है, जहाँ α = _____है।

Ans. **03.00**

Sol. $t = \sqrt{\frac{2\ell}{g\sin\theta}}$ when slips

$t_R = \sqrt{\frac{2\ell}{\left(\frac{g\sin\theta}{1+\frac{I}{mR^2}}\right)}}$ when rolls

$= \sqrt{\frac{2\ell\left(1+\frac{1}{2}\right)}{g\sin\theta}} = \sqrt{\frac{3}{2}\frac{2\ell}{g\sin\theta}}$

$= \frac{t}{t_R} = \sqrt{\frac{2}{3}}$

$t_R = \sqrt{\frac{3}{2}}t$

$= \left(\frac{3}{2}\right)^{\frac{1}{2}}t$

$\therefore \alpha = 3$

58. At room temperature (27°C), the resistance of a heating element is 50 Ω. The temperature coefficient of the material is $2.4 \times 10^{-4}\ {}^0C^{-1}$. The temperature of the element, when its resistance is 62 Ω is _____°C.

सामान्य तापमान (27°C) पर एक ऊष्मा तन्तु का प्रतिरोध 50 Ω है। पदार्थ का ताप गुणांक $2.4 \times 10^{-4}\ {}^0C^{-1}$ है। 62 Ω प्रतिरोध होने पर तन्तु का तापमान _____°C है।

Ans. **1027**

Sol. $R_2 = R_1(1 + \alpha\Delta t)$

$62 = 50(1 + 2.4 \times 10^{-4}\Delta t)$

$12 = 50 \times 2.4 \times 10^{-4}\Delta T$

$12 = 120 \times 10^{-4}\Delta t$

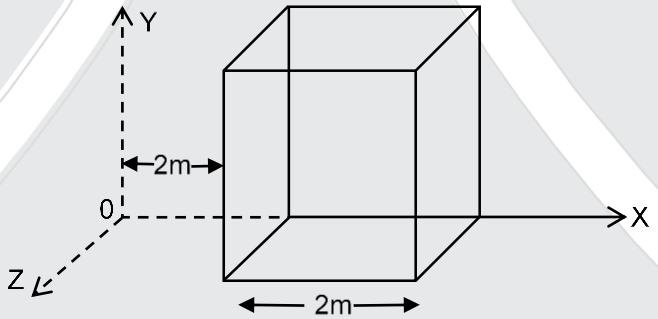
$\Delta t = \frac{12}{120 \times 10^{-4}} = \frac{1}{10^{-3}} = 1000$

$t - 27 = 1000$

$t = 1027°C$

59. An electric field $\vec{E} = (2x\hat{i})NC^{-1}$ exists in space. A cube of side 2m is placed in the space as per figure given below. The electric flux through the cube is_____ Nm^2/C.

आकाश में उपस्थित वैद्युत क्षेत्र $\vec{E} = (2x\hat{i})NC^{-1}$ है। चित्र के अनुसार आकाश में 2 मी भुजा का एक घन रख दिया गया है। इस घन से गुजरने वाला वैद्युत फ्लस्क _____ Nm^2 है



Ans. **16.00**

Sol. a = 2m side of cube

$\phi_{net} = 2x_2a^2 - 2x_1.a^2$

$= 2a^2(x_2 - x_1)$

$= 2 \times 4\ (4 - 2)$

$= 8 \times 2 = 16\ \frac{Nm^2}{C}$

60. A particle of mass 0.50 kg executes simple harmonic motion under force $F = -50\left(Nm^{-1}\right)x$. The time period of oscillation is $\frac{x}{35}$ s. The value of x is _____. (given $\pi = \frac{22}{7}$)

0.50 किग्रा द्रव्यमान का एक कण किसी बल $F = -50\left(Nm^{-1}\right)x$. के अन्तर्गत सरल आवर्त गति करता है। दोलन का आवर्तकाल $\frac{x}{35}$ s से है। x का मान _____ है। (दिया गया है $\pi = \frac{22}{7}$)

Ans. **22.00**

Sol. $K = 50$

$m = 0.5$

$T = 2\pi\sqrt{\frac{m}{k}}$

$= 2\pi\sqrt{\frac{0.5}{50}}$

$= \frac{2\pi}{10} = \frac{\pi}{5} = \frac{22}{35}$ sec

$\therefore \quad x = 22$

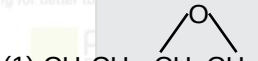
PART : CHEMISTRY

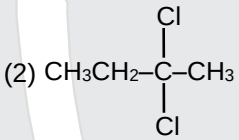
61. The **correct** statement regarding ethyne is
(1) The C–C bonds in ethyne is shorter than that in ethane
(2) The carbon-carbon bonds in ethyne is weaker than that in ethene
(3) Both carbon are sp hybridised
(4) Ethyne is linear

Ans. **NTA (2)**

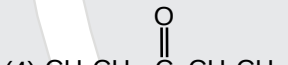
Sol. $C \equiv C > C = C$ (Bond Energy)

62. Which of the following compound can give positive iodoform test when treated with aqueous KOH solution followed by potassium hypoiodite.

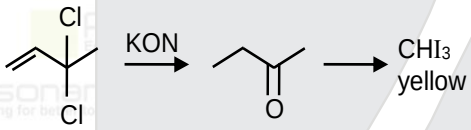
(1) 

(2) 

(3) $CH_3CH_2CH_2CHO$

(4) 

Ans. **NTA (2)**

Sol. 

63. The coordination environment of Ca^{2+} ion in its complex with $EDTA^{4-}$ is:
(1) tetrahedral (2) trigonal prismatic (3) square planar (4) octahedral

Ans. **NTA (4)**

Sol. Co-ordination number of Ca^{2+} with EDTA is 6
Hybridisation = sp^3d^2
Shape = octahedral

64. The correct increasing order for bond angles among BF_3, PF_3 and ClF_3 is:
(1) $BF_3 < PF_3 < ClF_3$ (2) $BF_3 = PF_3 < ClF_3$ (3) $ClF_3 < PF_3 < BF_3$ (4) $PF_3 < BF_3 < ClF_3$

Ans. **NTA (3)**

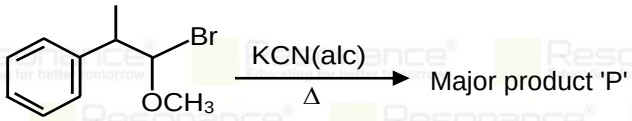
Sol. $BF_3 \Rightarrow sp^2 \Rightarrow$ Bond angle = 120°
$PF_3 \Rightarrow sp^3 \Rightarrow$ Bond angle = 109°.28'
$ClF_3 \Rightarrow sp^3d \Rightarrow$ Bond angle = 90°

65. The **incorrect** statement about Glucose is :
(1) Glucose remains in multiple isomeric form in its aqueous solution
(2) Glucose is an aldohexose
(3) Glucose is one of the monomer unit in sucrose
(4) Glucose is soluble in water because of having aldehyde functional group

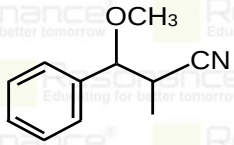
Ans. **NTA (4)**

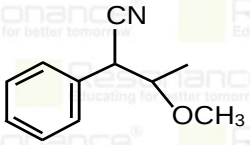
Sol. Solubility is due to –on group

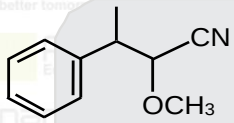
66.

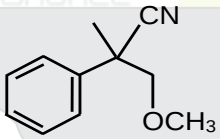


In the above reaction product 'P' is

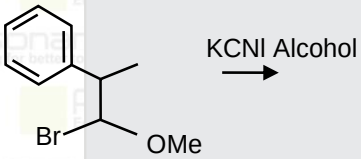
(1) 

(2) 

(3) 

(4) 

Ans. **NTA (3)**

Sol. 

SN^2

(–Br is replaced due to its leaving nature)

67. Match List I with List II

	List I (Test)		**List II (Observation)**
A.	Br_2 water test	I.	Yellow orange or orange red precipitate formed
B.	Ceric ammonium nitrate test	II.	Reddish orange colour disappers
C.	Ferric chloride test	III.	Red colour appears
D	2, 4-DNP test	IV.	Blue, Green, Violet or Red colour appear

Choose the correct answer from the options given below:

(1) A-I, B-II, C-III, D-IV (2) A-III, B-IV, C-I, D-II (3) A-II, B-III, C-IV, D-I (4) A-IV, B-I, C-II, D-III

Ans. **NTA (3)**

Sol. Fact based

68. Match List I with List II

	List I (Test)		**List II (Observation)**
A.	Br_2 water test	I.	Tl > In > Ga > Al > B
B.	Ceric ammonium nitrate test	II.	B > Tl > Al ≈ Ga > In
C.	Ferric chloride test	III.	Tl > In > Al > Ga > B
D	2, 4-DNP test	IV.	B > Al > Tl > In > Ga

Choose the correct answer from the options given below:

(1) A-II, B-III, C-IV, D-I (2) A-III, B-IV, C-I, D-II (3) A-IV, B-I, C-II, D-III (4) A-I, B-II, C-III, D-IV

Ans. **NTA (3)**

69. Given below are two statements:

Statement - I : The higher oxidation states are more stable down the group among transition elements unlike p-block elements.

Statement - II : Copper can not liberate hydrogen from weak acids.

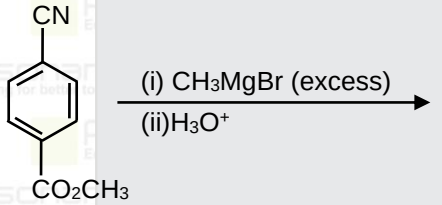
In the light of the above statements, choose the correct answer from the options given below:

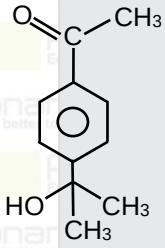
(1) Statement I is false but Statement II is true (2) Statement I is true but Statement II is false

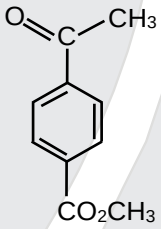
(3) Both Statement I and Statement II are true (4) Both Statement I and Statement II are false

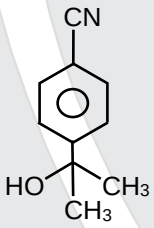
Ans. **NTA (3)**

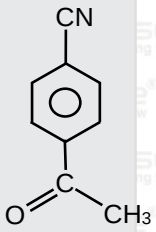
70. Major product of the following reaction is



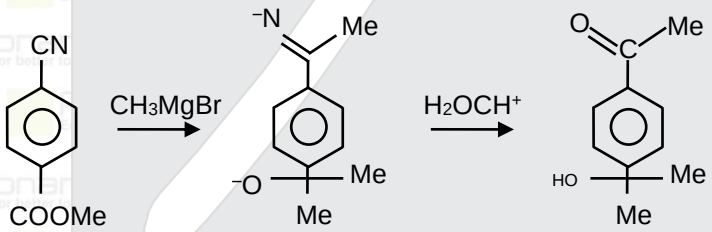
(1) 

(2) 

(3) 

(4) 

Ans. **NTA (1)**

Sol. 

71. For a sparingly soluble salt AB_2, the equilibrium concentrations of A^{2+} ions and B^- ions are 1.2×10^{-4}M and 0.24×10^{-3}M, respectively. The solubility product of AB_2 is:

(1) 0.276×10^{-12} (2) 0.069×10^{-12} (3) 27.65×10^{-12} (4) 6.91×10^{-12}

Ans. **NTA (4)**

Sol. $AB_2 \longrightarrow A^{2+} + 2B^-$

1.2×10^{-4} 0.24×10^{-3}

$K_{sp} = [A^{+2}] [B^-]^2$

$= (1.2 \times 10^{-4}) \times (0.24 \times 10^{-3})^2$

$= 0.06912 \times 10^{-4} \times 10^{-6}$

$= 0.06912 \times 10^{-10}$

72. Match List I with List II

	List I		List II
A.	$K_2[Ni(CN_4)]$	I.	sp^3
B.	$[Ni(CO)_4]$	II.	sp^3d^2
C.	$[Co(NH_3)_6Cl_3$	III.	dsp^2
D	$Na_3[CoF_6]$	IV.	d^2sp^3

Choose the correct answer from the options given below:

(1) A-III, B-II, C-IV, D-I (2) A-III, B-I, C-II, D-IV (3) A-I, B-III, C-II, D-IV (4) A-III, B-I, C-IV, D-II

Ans. **NTA (4)**

Sol. A. $K_2[Ni(CN)_4]$

Ni^{2+} - $[Ar]3d^6$

dsp^2 hybridisation as CN^- is strong field ligand.

B. $[Ni(CO)_4]$

Ni - $[Ar]3d^84s^2$

sp^2 hybridisation as CO is strong field ligand.

C. $[Co(NH_3)_6Cl_3$

Co^{3+} - $[Ar]3d^6$

d^2sp^3 hybridisation as NH_3 is strong field ligand.

D. $Na_3[CoF_6]$

Co^{3+} - $[Ar]3d^6$

sp^3d^2 hybridisation as F^- is weak field ligand.

73. Match List I with List II

	LIST I (Element)		LIST II (Electronic Configuration)
A.	N	I.	$[Ar]3d^{10}4s^24p^5$
B.	S	II.	$[Ne]3s^23p^4$
C.	Br	III.	$[He]2s^22p^3$
D	Kr	IV.	$[Ar]3d^{10}4s^24p^6$

Choose the correct answer from the options given below:

(1) A-I, B-IV, C-III, D-II (2) A-III, B-II, C-I, D-IV (3) A-II, B-I, C-IV, D-III (4) A-IV, B-III, C-II, D-I

Ans. **NTA (2)**

Sol. N – [He] $2s^2$, $2p^3$

S – [Ne] $3s^2$, $3p^4$

Br – [Ar] $3d^{10}$, $4s^2$, $4p^5$

Kr – [Rn] d^{10}, $4s^2$, $4p^6$

74. Which out of the following is a correct equation to show change in molar conductivity with respecdt to concentration for a weak electrolyte, if the symbols carry their usual meaning:

(1) $\wedge_m - \wedge_m^0 - AC^{\frac{1}{2}} = 0$ (2) $\wedge_m - \wedge_m^0 + AC^{\frac{1}{2}} = 0$

(3) $\wedge_m^2 C + K_a \wedge_m^{0^2} = K_a \wedge_m \wedge_m^0 = 0$ (4) $\wedge_m^2 C = K_a \wedge_m^{0^2} + K_a \wedge_m \wedge_m^0 = 0$

Ans. **NTA (4)**

75. The electronic configuration of Einsteinium is: (Given atomic number of Einsteinium = 99)

(1) $[Rn]5f^{13}6d^{0}7s^{2}$ (2) $[Rn]5f^{11}6d^{0}7s^{2}$ (3) $[Rn]5f^{12}6d^{0}7s^{2}$ (4) $[Rn]5f^{10}6d^{0}7s^{2}$

Ans. **NTA (2)**

Sol. $[Rn]5f^{11}6d^{0}7s^{2}$

76. The candela is the luminous intensity, in a given direction of a source that emits monochromatic radiation of frequency 'A' × 10^{12} hertz and that has a radiant intensity in that direction of $\frac{1}{'B'}$ watt per steradian.

'A' and 'B' are respectively

(1) 450 and $\frac{1}{683}$ (2) 540 and $\frac{1}{683}$ (3) 450 and 683 (4) 540 and 683

Ans. **NTA (4)**

77. Which of the following compounds will give silver mirror with ammoniacal silver nitrate?

A. Formic acid

B. Formaldehyde

C. Benzaldehyde

D. Acetone

Choose the **correct** answer from the options given below:

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

Ans. **NTA (2)**

Sol. Fact based

78. Match List I with List II

	List I (Cell)		**List II (Use / Property / Reaction)**
A.	Leclanche cell	I.	Converts energy of combustion into electrical energy
B.	Ni-Cd cell	II.	Does not involve any ion in solution and is used in hearing aids
C.	Fuel cell	III.	Rechargeable
D	Mercury cell	IV.	Reaction at anode $Zn \rightarrow Zn^{2+} + 2e^{-}$

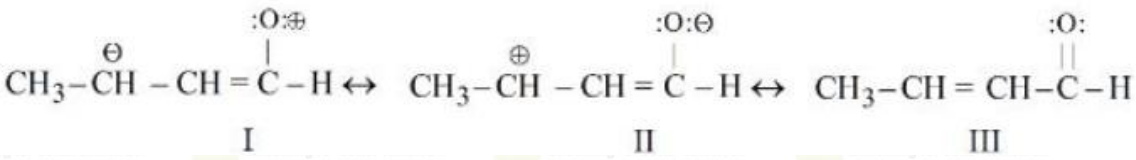
Choose the **correct** answer from the options given below:

(1) A-I, B-II, C-III, D-IV (2) A-III, B-I, C-IV, D-II (3) A-IV, B-III, C-I, D-II (4) A-II, B-III, C-IV, D-I

Ans. **NTA (3)**

Sol. Ni-Cd cell is secondary cell and are rechargeable meroury cell is used in hearing aid.

79. The correct stability order of the following resonance structures of $CH_3–CH=CH–CHO$ is



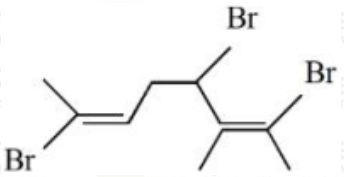
I II III

(1) III > II > I (2) I > II > III (3) II > III > I (4) II > I > III

Ans. **NTA (1)**

Sol. III structure is most stable due to maximum no. of II bonds.

80. Total number of stereo isomers possible for the given structure :



(1) 2 (2) 4 (3) 3 (4) 8

Ans. **NTA (4)**

Sol. $2^3 = 8$

one (1) chiral carbon and (2) two C = C

81. Based on Heisenberg's uncertainty principle, the uncertainty in the velocity of the electron to be found within an atomic nucleus of diameter 10^{-15} m is _____ $\times 10^9$ ms^{-1} (nearest integer).

[Given : mass of electron = 9.1×10^{-31} kg, Plank's constant (h) = 6.626×10^{-34} Js]

(Value of n = 3.14)

Ans. **NTA (58)**

Sol. Heisenberg's uncertainty formula

$$\Delta x.m\Delta V = \frac{h}{4\pi}$$

$$\Delta V = \frac{h}{4\pi \times x.m} = \frac{6.626\times10^{-34}}{4\pi\times10^{-15}\times9.1\times10^{-31}}$$

$$\Delta V = 58 \times 10^{+9} \text{ m/s}$$

82. The vapour pressure of pure benzene and methyl benzene at 27·C is given as 80 Torr and 24 Torr, respectively. The mole fraction of methyl benzene in vapour phase, in equilibrium with an equimolar mixture of those two liquids (ideal solution) at the same temperature is _____ $\times 10^{-2}$ (inearest integer).

Ans. **NTA (23)**

Sol. Total vapour presurre,

$p_{total} = p_{benzene} + p_{methy}$

$= 80 + 24 = 104$ torr

Mole fraction of methyl benzene in vapour phase,

$$x = \frac{p_{methyl}}{p_{total}} = \frac{24}{104} = 0.2307$$

$= 23 \times 10^{-2}$

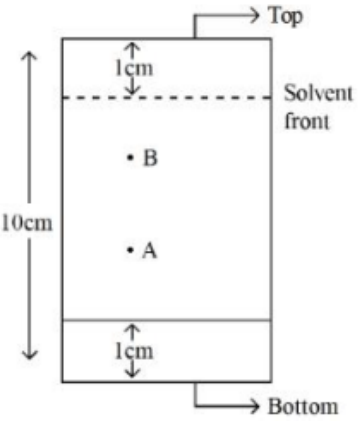
83. Number of oxygen atoms present in chemical formula of fuming sulphuric acid is :

Ans. **NTA (7)**

Sol. Fuming sulphuric acid is oleum ($H_2S_2O_7$)

$\therefore$ 7 o-atom are present in fuming sulphuric acid.

84.



In the given TLC, the distance of spot A and B are 5 cm and 7 cm from the bottom of TLC plate, respectively.

R_f values of B is $x \times 10^{-1}$ times more than A. The value is x is _____ .

Ans. **NTA (15)**

85. When ΔH_{vap} = 30 kJ/mol and ΔS_{vap} = 75 J $mol^{-1}K^{-1}$, then the temperature of vapour, at one atmosphere is _____ K.

Ans. **NTA (400)**

Sol. $\Delta H_{vap.}$ = 30 kJ / mol

$\Delta S_{vap.}$ = 75 mol^{-1} K^{-1}

$\Delta H = T\Delta S$

$$T = \frac{\Delta H_{vap}}{\Delta S_{vap}} = \frac{30\times10^3}{75}$$

T = 400 K

86. Consider the following first order gas phase reaction at constant temperature

$$A(g) \rightarrow 2B(g) + C(g)$$

If the total pressure of the gases is found to be 200 torr after 23 sec. and 300 torr upon the complete decomposition of A after a very long time, then the rate constant of the given reaction is _____ $\times 10^{-2} s^{-1}$ (nearest integer)

[Given : log10(2) = 0.301]

Ans. **NTA (3)**

Sol.

	A	→	2B	+	C
t = 0	p		0		0
t = 23 sec	p–x		2x		x

Total pressure after 23 second is

$300 = p - x + 2x + x$

$300 = p + 2x$

$300 = 200 + 2x$

$2x = 100$

$x = 50$

$$K = \frac{2.303}{t}\log\frac{p}{p-x} = \frac{2.303}{23}$$

87. Number of compounds from the following which **cannot** undergo Friedel-Crafts reaction is : _____
toluene, nitrobenzene, xylene, cumene, aniline, chlorobenzene, m-nitroaniline, m-dinitrobenzene

Ans. **NTA (4)**

Sol. –M groups on benzene restricts FC also online doe not gives FC

88. Total number of electrons present in (π^*) molecular orbitals of O_2, O_2^+ and O_2^- is _____.

Ans. **NTA (6)**

Sol. ($16e^-$)

$\sigma^1_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^1_{2p^2}, \pi^1_{2px} = \pi^1_{2py}$

$\pi^*_{2px^1} = \pi^*_{2py^1}$

Total number of e in p* orbital of O_2, O_2^+, O_2^-

$= 2 + 1 + 3 = 6$

89. Consider the following test for a group-IV cation.

$M^{2-} + H_2S \rightarrow$ A (Black precipitate) + byproduct

A + aqua regia $\rightarrow$ B + NOCl + S + H_2O

B + KNO_2 + $CH_3COOH \rightarrow$ C + byproduct

The spin-only magnetic moment value of the metal complex C is _____ BM
(Nearest integer)

Ans. **NTA (0)**

90. A transition metal 'M' among Sc, Ti, V, Cr, Mn and Fe has the highest second ionisation enthalpy. The spin-only magnetic moment value of M^+ ion is _____
BM (Near integer)
(Given atomic number Sc : 21, Ti : 22, V : 23, Cr : 24, Mn : 25, Fe : 26)

Ans. **NTA (6)**

Sol. Sc^{+2}, Ti^{+2}, V^{+2}, Cr^{+2}, Mn^{+2}

In the above Mn2+ have highest IE due to stable half-filled configuration

Mn = [Ar] $4s^2\ 3d^5$

$\Rightarrow$ 5 unpaired electron

Now, $\mu_{spin} = \sqrt{5(5+2)}$ BM = $\sqrt{35} \approx 6$ BM