PART : MATHEMATIC

1. If the value of $\frac{3\cos 36^\circ + 5\sin 18^\circ}{5\cos 36^\circ - 3\sin 18^\circ}$ is $\frac{a\sqrt{5}-b}{c}$, where a, b, c are natural numbers and gcd(a, c) = 1, then a + b + c is equal to:

(1) 54 (2) 40 (3) 50 (4) 52

Ans. **NTA (4)**

Reso (4)

Sol. $\frac{3\cos 36^\circ + 5\sin 18^\circ}{5\cos 36^\circ - 3\sin 18^\circ}$

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

$$\frac{8\sqrt{5}-2}{2\sqrt{5}+8}$$

$$\frac{4\sqrt{5}-1}{\sqrt{5}+4}\times\frac{4-\sqrt{5}}{4-\sqrt{5}}$$

$$\frac{-24+17\sqrt{5}}{11} = \frac{a\sqrt{5}-b}{C}$$

a = 17, b = 24, c = 11

a + b + c = 52

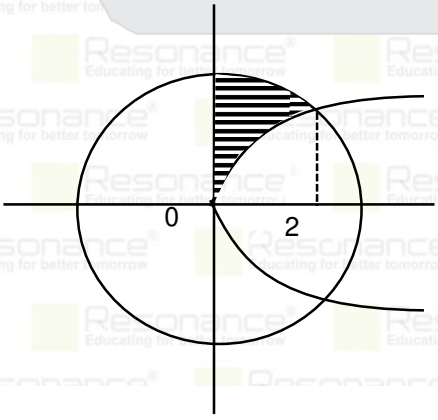
2. The area of the region in the first quadrant inside the circle $x^2 + y^2 = 8$ and outside the parabola $y^2 = 2x$ is equal to:

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

Ans. **NTA (3)**

Reso (3)

Sol.



$x^2 + y^2 = 8$ & $y^2 = 2x$

$x^2 + 2x - 8 = 0$

$(x + 4)(x - 2) = 0, \quad x = \begin{matrix}-4\\+2\end{matrix}$

$$\text{Area} = \int_0^2 \left(\sqrt{8-x^2} - \sqrt{2x}\right)dx$$

$$= \left[\frac{1}{2}x\sqrt{8-x^2} + \frac{8}{2}\sin^{-1}\left(\frac{x}{2\sqrt{2}}\right) - \sqrt{2}.x^{\frac{3}{2}}.\frac{2}{3}\right]_0^2$$

$$= 2 + 4 \times \frac{\pi}{4} - \frac{8}{3} = \pi - \frac{2}{3}$$

3. Let A = {2, 3, 6, 8, 9, 11) and B={1, 4, 5, 10, 15). Let R be a relation on A × B defined by (a, b)R(c, d) if and only if 3ad – 7bc is an even integer. Then the relation R is

(1) transitive but not symmetric. (2) reflexive and symmetric but not transitive.

(3) reflexive but not symmetric. (4) an equivalence relation.

Ans. **NTA (2)**

Reso (2)

Sol. (a, b) R (c, d) = 3ad – 7bc is an even integer for reflexive

(a, b) R (a, b) = 3ab – 7ba

= – 4ab which is an even integer.

For symmetric

(a, b) R (c, d) = 3ad – 7bc = even int.

(c, d) R (a, b) = 3cd – 7ad $\Rightarrow$ also even int.

For transitive

(a, b) R (c, d) = 3ad – 7bc = event int

(c, d) R (e, f) = 3cf – 7de = even int.

then (a, b) R (e, f) = 3af – 7be

Let a = 3, b = 2, c = 4, d = 10, e = 4, f = 1

= 3 × 3 × 1 – 7 × 2 × 4 not even

4. If the system of equations $x + 4y - z = \lambda$, $7x + 9y + \mu z = -3$, $5x + y + 2z = -1$ has infinitely many solutions, then $(2\mu + 3\lambda)$ is equal to:

(1) 2 (2) –3 (3) 3 (4) – 2

Ans. **NTA (2)**

Reso (2)

Sol. $D = \begin{vmatrix}1 & 4 & -1\\7 & 9 & \mu\\5 & 1 & 2\end{vmatrix} = 0$

$18 - 7 + 20\mu + 45 - \mu - 56 = 0$

$19\mu = 0, \ \mu = 0$

$D_3 = \begin{vmatrix}1 & 4 & \lambda\\7 & 9 & -3\\5 & 1 & -1\end{vmatrix} = 0$

$-6 - 4(8) + \lambda(-38) = 0$

$-38 - 38\lambda = 0$

$\lambda = -1$

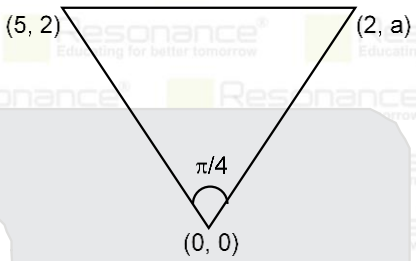
$2\mu + 3\lambda = 0 - 3 = -3$

5. If the line segment joining the points (5, 2) and (2, a) subtends an angle $\frac{\pi}{4}$ at the origin, then the absolute value of the product of all possible values of a is:

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

Ans. **NTA (1)**
Reso (1)

Sol. $\tan\frac{\pi}{4} = \left|\frac{\frac{2}{5}-\frac{a}{2}}{1+\frac{2}{5}\times\frac{a}{2}}\right|$



$4-5a = \pm(10+2a)$

$\oplus$ $4-5a = 10+2a$

$7a = -6$

Θ $4-5a = -10-2a$

$3a = 14$

$a = 14/3$

product $= \left|\frac{-6}{7}\times\frac{14}{3}\right| = 4$

6. Let $f(x) = \begin{cases} -a & \text{if } -a \le x \le 0 \\ x+a & \text{if } 0 < x \le a \end{cases}$, where $a > 0$ and $g(x) = (f(|x|) - |f(x)|)/2$.

Then the function $g : [-a, a] \to [-a, a]$ is

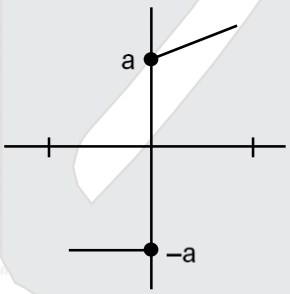
(1) onto (2) neither one–one nor onto.

(3) both one–one and onto. (4) one–one.

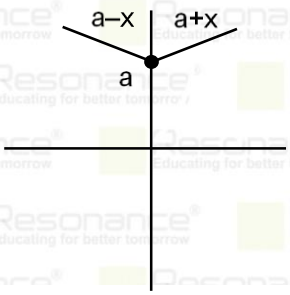
Ans. **NTA (2)**
Reso (2)

Sol. $f(x) = \begin{cases} -a\ ; -a \le x \le 0 \\ x+a\ ; \quad 0 < x \le a \end{cases}$ $g(x) = (f(|x|) - |f(x)|)/2.$

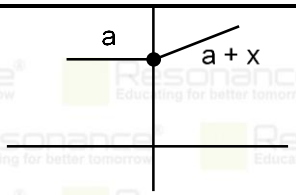
$f(x) =$



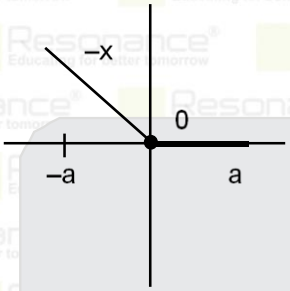
$f(|x|) =$



and $|f(x)|$ =



$g(x)$ =



function $g(x)$ is many one into

7. If the term independent of x in the expansion of $\left(\sqrt{a}x^2+\frac{1}{2x^3}\right)^{10}$ is 105, then a^2 is equal to :

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

Ans. **NTA (2)**
Reso (2)

Sol. $T_{r+1}={}^{10}C_r\left(\sqrt{a}x^2\right)^{10-r}\left(\frac{1}{2x^3}\right)^r$

$2(10-r)-3r=0$
$r=4$

$T_5={}^{10}C_4\left(\sqrt{a}\right)^6\left(\frac{1}{2}\right)^4=105$

$=\frac{10\times9.8.7}{4.3.2.1}\times\frac{9^3}{2.2.2.2}=5\times7\times3$

$a^3=8,\ a=2\ \Rightarrow a^2=4$

8. In an increasing geometric progression of positive terms, the sum of the second and sixth terms is $\frac{70}{3}$ and the product of the third and fifth terms is 49. Then the sum of the 4th, 6 th and 8 th terms is equal to:

(1) 78 (2) 96 (3) 91 (4) 84

Ans. **NTA (3)**
Reso (3)

Sol. $T_2+T_6=70/3$

$ar+ar^5=70/3\ \Rightarrow\ ar(1+r^4)=70/3$ _____(1)

$T_3\times T_5=49$

$ar^2.ar^4=49\ \Rightarrow\ (ar)^2r^4=49$ _____(2)

from (1) and (2) $\frac{\left(1+r^4\right)^2}{r^4}=\frac{70\times70}{3\times3\times49}$

$\left(r^2+\frac{1}{r^2}\right)=\frac{10}{3}=3+\frac{1}{3}$ $r^r=3,\ r=+\sqrt{3}$, $a=\frac{7}{3\sqrt{3}}$

$T_4+T_6+T_8=a(r^3+r^5+r^7)=\frac{7}{3\sqrt{3}}\left(3\sqrt{3}+9\sqrt{3}+27\sqrt{3}\right)=91$

9. If the image of the point (–4, 5) in the line $x + 2y = 2$ lies on the circle $(x + 4)^2 + (y - 3)^2 = r^2$, then r is equal to :

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

Ans. **NTA (4)**

Reso (4)

Sol. $\frac{x+4}{1} = \frac{y-5}{2} = \frac{-2(-4+10-2)}{1+4} = -\frac{8}{5}$

$x + 4 = -\frac{8}{5}$

$y - 5 = -\frac{16}{5}$

$(x + 4)^2 + (y - 3)^2 = r^2$

$\frac{64}{25} + \frac{36}{25} = r^2$

$r = 2$

10. Let $\int_{\alpha}^{\log_e 4} \frac{dx}{\sqrt{e^x - 1}} = \frac{\pi}{6}$. Then e^{α} and $e^{-\alpha}$ are the roots of the equation:

(1) $x^2 - 2x - 8 = 0$ (2) $2x^2 - 5x - 2 = 0$ (3) $x^2 + 2x - 8 = 0$ (4) $2x^2 - 5x + 2 = 0$

Ans. **NTA (4)**

Reso (4)

Sol. $\int_{\alpha}^{\log_e 4} \frac{dx}{\sqrt{e^x - 1}} = \frac{\pi}{6}$

$e^x - 1 = t^2$

$e^x\, dx = 2t\, dt$

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

$2 \tan^{-1} t$

$2 \tan^{-1} \left(\sqrt{e^x - 1}\right)_{\alpha}^{\ell n 4} = \frac{\pi}{6}$

$\frac{\pi}{3} - \tan^{-1}\left(\sqrt{e^{\alpha} - 1}\right) = \frac{\pi}{12}$

$\tan^{-1}\left(\sqrt{e^{\alpha} - 1}\right) = \frac{\pi}{4}$

$\left(\sqrt{e^{\alpha} - 1}\right) = 1$

$e^{\alpha} = 2$ and $e^{-\alpha} = \frac{1}{2}$

$q.e = x^2 - \left(2 + \frac{1}{2}\right) x + 2 \times \frac{1}{2} = 0$

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

11. If $\alpha \neq a, \beta \neq b, \gamma \neq c$ and $\begin{vmatrix} \alpha & b & c \\ a & \beta & c \\ a & b & \gamma \end{vmatrix} = 0$, then $\frac{a}{\alpha - a} + \frac{b}{\beta - b} + \frac{\gamma}{\gamma - c}$ is equal to:

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

Ans. **NTA (4)**

Reso (4)

Sol. $\begin{vmatrix} \alpha & b & c \\ a & \beta & c \\ a & b & \gamma \end{vmatrix} = 0$

$R_1 \to R_1 - R_2$ & $R_2 \to R_2 - R_3$

$$\begin{vmatrix} \alpha - a & b - \beta & 0 \\ 0 & \beta - b & c - x \\ a & b & \gamma \end{vmatrix} = 0$$

$(\alpha - a)[\gamma(\beta - b) - b(c - \gamma)] + (\beta - b)a(c - \gamma)] = 0$

$(\alpha - a)[\gamma(\beta - b) + b(\gamma - c)] + (\beta - b)a(\gamma - c)] = 0$

$$\frac{\gamma}{\gamma - c} + \frac{b}{\beta - b} + \frac{a}{\alpha - a} = 0$$

12. If the shortest distance between the lines $\frac{x - \lambda}{2} = \frac{y - 4}{3} = \frac{z - 3}{4}$ and $\frac{x - 2}{4} = \frac{y - 4}{6} = \frac{z - 7}{8}$ is $\frac{13}{\sqrt{29}}$, then a value of λ is:

(1) $\frac{13}{25}$ (2) -1 (3) 1 (4) $-\frac{13}{25}$

Ans. **NTA (3)**

Reso (3)

Sol. Given lines are parabola

$$d = \frac{\left|(\vec{b} - \vec{a}) \times \vec{p}\right|}{|\vec{p}|}$$

$\vec{b} - \vec{a} = (2 - \gamma)\hat{i} + \hat{j} + 4\hat{k}$

$\vec{P} = 2\hat{i} + 3\hat{j} + 4\hat{k}$

$(\vec{b} - \vec{a}) \times \vec{P} = -12\hat{i} - (8 - 4\lambda - 8)\hat{j} + (6 - 3\lambda - 0)\hat{k} = -12\hat{i} + 4\lambda\hat{j} + 3(2 - \lambda)\hat{k}$

$$d = \frac{\sqrt{144 + 16\lambda^2 + 9(\lambda - 2)^2}}{\sqrt{4 + 9 + 16}} = \frac{13}{\sqrt{29}}$$

$144 + 16\lambda^2 + 9\lambda^2 - 36\lambda + 36 = 169$

$25\lambda^2 - 36\lambda + 11 = 0$

$(25\lambda - 11)(\lambda - 1) = 0$

$\lambda = \frac{11}{25}$ or $\lambda = 1$

13. For a, b > 0, let $f(x) = \begin{cases} \frac{\tan((a+1)x)+b\tan x}{x}, & x<0 \\ 3, & x=0 \\ \frac{\sqrt{ax+b^2x^2}-\sqrt{ax}}{b\sqrt{a}\,x\sqrt{x}}, & x>0 \end{cases}$

be a continuous function at x = 0. Then $\frac{b}{a}$ is equal to :

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

Ans. **NTA (2)**

Reso (2)

Sol. For continuous $f(0^-) = f(0) = f(0^+)$

$f(0^-) = a + 1 + b$

$f(0) = 3$

$f(0^+) = \lim\limits_{x\to 0^+} \frac{\sqrt{a+b^2x}-\sqrt{a}}{b\sqrt{a}x}$

$= \lim\limits_{x\to 0^+} \frac{b^2x}{b\sqrt{a}x\left(\sqrt{a+b^2x}+\sqrt{a}\right)} = \frac{b}{2a}$

$a + 1 + b = 3 = \frac{b}{2a}$

$a + b = 2$ and $b = 6a \quad \Rightarrow \quad \frac{b}{a} = 6$

14. The sum of all possible values of $\theta \in [-\pi, 2\pi]$, for which $\frac{1+i\cos\theta}{1-2i\cos\theta}$ is purely imaginary, is equal to:

(1) 4π (2) 5π (3) 2π (4) 3π

Ans. **NTA (4)**

Reso (4)

Sol. $\theta \in [-\pi, 2\pi]$

$\frac{1+i\cos\theta}{1-2i\cos\theta}$ is purely imaginary

$\frac{1+i\cos\theta}{1-2i\cos\theta} + \frac{1-i\cos\theta}{1+2i\cos\theta} = 0 \qquad (z + \bar{z} = 0)$

$2 = 4\cos^2\theta$

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

$\theta = n\pi \pm \pi/4$

$-\frac{3\pi}{4} + \left(-\pi/4\right) + \left(\pi/4\right) + \left(3\pi/4\right) + \left(\frac{5\pi}{4}\right) + \left(\frac{7\pi}{4}\right) = \frac{3}{\pi}$

15. Let y = y(x) be the solution curve of the differential equation $\sec y \frac{dy}{dx} + 2x \sin y = x^3 \cos y$, y(1) = 0. Then $y\left(\sqrt{3}\right)$ is equal to:

(1) $\frac{\pi}{4}$ (2) $\frac{\pi}{3}$ (3) $\frac{\pi}{6}$ (4) $\frac{\pi}{12}$

Ans. **NTA (1)**
Reso (1)

Sol. $\sec y \frac{dy}{dx} + 2x \sin y = x^3 \cos y$

$\sec^2 y \frac{dy}{dx} + 2x \tan y = x^3$

$\tan y = t$

$\sec^2 y \frac{dy}{dx} = \frac{dt}{dx}$

$\frac{dt}{dx} + 2xt = x^3$

I.F. $= e^{2\int x dx} = e^{x^2}$

solu. $t \cdot e^{x^2} = \int e^{x^2} \cdot x^3 dx$

$\tan y \cdot e^{x^2} = \frac{1}{2}\left[x^2 . e^{x^2} - \int 2x . e^{x^2} dx\right]$

$\tan y\, e^{x^2} = \frac{1}{2}\left[x^2 . e^{x^2} - . e^{x^2}\right] + \frac{c}{2}$

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

$x = 1, y = 0 \Rightarrow 0 = 1 - 1 + C \Rightarrow C = 0$

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

$\tan y = \frac{x^2 - 1}{2}$ put $x = \sqrt{3} \Rightarrow \tan y = \frac{3-1}{2} = 1$

$y = \pi/4$

16. Let $\vec{a} = 4\hat{i} - \hat{j} + \hat{k}$, $\vec{b} = 11\hat{i} - \hat{j} + \hat{k}$ and $\vec{c}$ be a vector such that $\left(\vec{a} + \vec{b}\right) \times \vec{c} = \vec{c} \times \left(-2\vec{a} + 3\vec{b}\right)$. If $\left(2\vec{a} + 3\vec{b}\right).\vec{c}$ =1670, then $|\vec{c}|^2$ is equal to:

(1) 1600 (2) 1609 (3) 1627 (4) 1618

Ans. **NTA (4)**
Reso (4)

Sol. $\vec{c} \times \left(-\vec{a} - \vec{b}\right) + \vec{c} \times \left(2\vec{a} - 3\vec{b}\right) = 0$

$\vec{c} \times \left(\vec{a} - 4\vec{b}\right) = 0$

$\vec{c} = \lambda\left(\vec{a} - 4\vec{b}\right)$

& $\left(2\vec{a} + 3\vec{b}\right)\vec{c} = 1670$

$\left(2\vec{a} + 3\vec{b}\right).(\lambda)(\vec{a} - 4\vec{b}) = 1670$

$\lambda\left(2|\vec{a}|^2 - 5\vec{a} \cdot \vec{b} - 12|\vec{b}|^2\right) = 1670$

$\lambda(2 \times 18 - 5(46) - 12(123)) = 1670$

$\lambda(36 - 230 - 1476) = 1670$

$\lambda = -1$

$\vec{c} = 4\vec{b} - \vec{a} = 40\hat{i} - 3\hat{j} + 3\hat{k}$

$|\vec{c}|^2 = 1600 + 9 + 9 = 1618$

17. Let $\vec{a}=\hat{i}+2\hat{j}+3\hat{k}$, $\vec{b}=2\hat{i}+3\hat{j}-5\hat{k}$ and $\vec{c}=3\hat{i}-\hat{j}+\lambda\hat{k}$ be three vectors. Let $\vec{r}$ be a unit vector along $\vec{b}+\vec{c}$. If $\vec{r}\cdot\vec{a}=3$, then 3λ is equal to :

(1) 30 (2) 21 (3) 27 (4) 25

Ans. **NTA (4)**
Reso (4)

Sol. $r=\dfrac{\vec{b}+\vec{c}}{|\vec{b}+\vec{c}|}$ & $\vec{r}.\vec{a}=3$

$(\vec{b}+\vec{c})\cdot\vec{a}=3|\vec{b}+\vec{c}|$

$\vec{a}.\vec{b}+\vec{a}.\vec{c}=3|\vec{b}+\vec{c}|$

$2+6-15+3-2+3\lambda=3\sqrt{25+4+(\lambda-5)^2}$

$3(\lambda-2)=3\sqrt{29+(\lambda-5)^2}$

$\lambda^2-4\lambda+4=29+\lambda^2-10\lambda+25$

$6\lambda=50$

$\lambda=25/3$

$3\lambda=25$

18. If the function $f(x)=2x^3-9ax^2+12a^2x+1$, $a>0$ has a local maximum at $x=\alpha$ and a local minimum at $x=\alpha^2$, then α and α^2 are the roots of the equation:

(1) $8x^2+6x-1=0$ (2) $x^2-6x+8=0$ (3) $8x^2-6x+1=0$ (4) $x^2+6x+8=0$

Ans. **NTA (2)**
Reso (2)

Sol. $f(x)=2x^3-9ax^2+12a^2x+1$ …….. $a>0$

$f'(x)=6x^2-18ax+12a^2$

$=6[x^2-3ax+2a^2]$

$=6(x-a)(x-2a)$



Maxima at $x=a=\alpha$

minima at $x=2a=\alpha^2$

$2a=a^2$

$a=2$

$\alpha=2$, $\alpha^2=4$

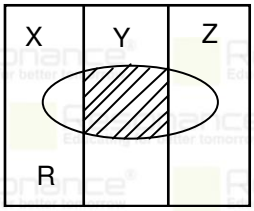
$x^2-6x+8=0$

19. There are three bags X, Y and Z. Bag X contains 5 one-rupee coins and 4 five-rupee coins; Bag Y contains 4 one-rupee coins and 5 five-rupee coins and Bag Z contains 3 one-rupee coins and 6 five-rupee coins. A bag is selected at random and a coin drawn from it at random is found to be a one-rupee coin. Then the probability, that it came from bag Y, is:

(1) $\dfrac{1}{3}$ (2) $\dfrac{5}{12}$ (3) $\dfrac{1}{2}$ (4) $\dfrac{1}{4}$

Ans. **NTA (1)**
Reso (1)

Sol.



R :1 rupee coin P(Y/R) = ??

$$P(Y/R) = \frac{P(Y \cap R)}{P(R)} = \frac{P(Y)P(R/Y)}{P(R)}$$

$$P(Y/R) = \frac{\frac{1}{3}\times\frac{4}{9}}{\frac{1}{3}\times\frac{5}{9}+\frac{1}{3}\times\frac{4}{9}+\frac{1}{3}\times\frac{3}{9}} = \frac{4}{5+4+3} = \frac{1}{3}$$

20. The number of ways five alphabets can be chosen from the alphabets of the word MATHEMATICS, where the chosen alphabets are not necessarily distinct, is equal to:

(1) 175 (2) 181 (3) 179 (4) 177

Ans. **NTA (3)**

Reso (3)

Sol. MM AA TT H E I C S

(1) All distinct = $^8C_5 = 56$

(2) 2 identical – 3 distinct = $^3C_1 \cdot {}^7C_3 = 105$

(3) 2identical – 2other identical , 1 distinct = $^3C_2 \cdot {}^6C_1 = 18$

Ans. 179

21. An arithmetic progression is written in the following way

2

5 8

11 14 17

20 23 26 29

- - - -

$T_{10} = 2 + \frac{9}{2}[6+8\times3]$

$= 2 + 135 = 137$

common difference = 3, and no. of terms are 10

sum = $\frac{10}{2}[2\times137+(10-1)3]$

$= 5[274 + 27] = 5 \times 301 = 1505$

22. Let a, b, c $\in$ N and a < b < c. Let the mean, the mean deviation about the mean and the variance of the 5 observations 9, 25, a, b, c be 18, 4 and $\frac{136}{5}$, respectively. Then 2a + b – c is equal to_____ .

Ans. **NTA (33)**
Reso (33)

Sol. Mean $\mu = \frac{9+25+a+b+c}{5} = 18$

$a + b + c = 56$ .....(1)

$\frac{|18-9|+|18-25|+|18-a|+|18-b|+|18-c|}{5} = 4$

$|18–a| + |18 – b| + |18 – c| = 4$ .....(2)

$\frac{\Sigma x_i^2}{n} - (\mu)^2 = \sigma^2 = \frac{136}{5}$

$\frac{81+625+a^2+b^2+c^2}{5} - (18)^2 = \frac{136}{5}$

$a^2 + b^2 + c^2 = 1050$ ..... (3)

$18 – a + |18 –b| + c – 18 = 4$

$c – a + |18 –b| = 4$ ..... (4)

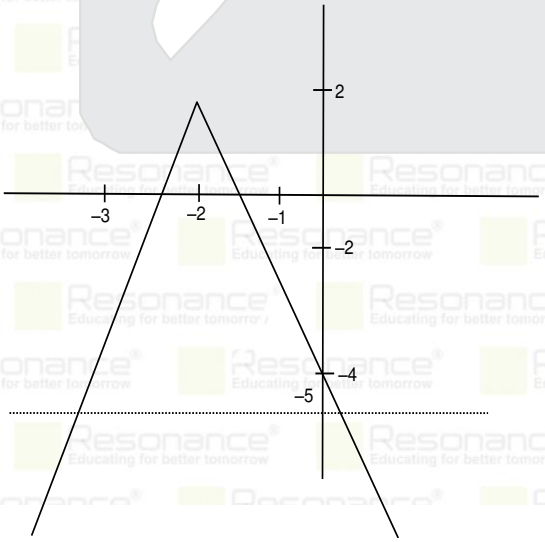
$a = 17, b = 19, c = 20$

$2a + b – c = 34 + 19 – 20 = 33$

23. The number of distinct real roots of the equation $|x + 1|\,|x + 3| – 4|x + 2| + 5 = 0$, is_____ .

Ans. **NTA (2)**
Reso (2)

Sol. $|x+ 1| + |x + 3| – 4|x + 2| = –5$



number of solutions = 2

24. Let P(α, β, γ) be the image of the point Q(1, 6, 4) in the line $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$. Then $2\alpha+\beta+\gamma$ is equal to _____ .

Ans. **NTA (11)**
Reso (11)

Sol. $\overrightarrow{QF}=(\lambda-1)\hat{i}+(2\lambda-5)\hat{j}+(3\lambda-2)\hat{k}$

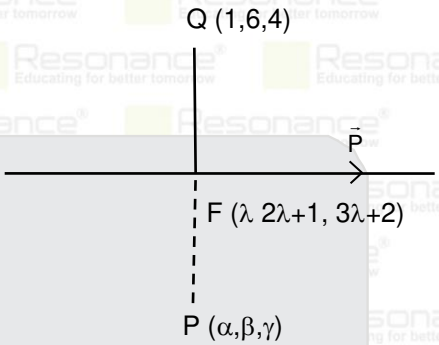
$\overrightarrow{QF}.\vec{P}=0$

$1(\lambda-1)+2(2\lambda-5)+3(3\lambda-2)=0$

$14\lambda-17=0$

$\lambda=17/14$

$F\equiv\left(\frac{17}{14},\frac{48}{14},\frac{79}{14}\right)$



$\alpha=2\times\frac{17}{14}-1$

$\beta=2\times\frac{48}{14}-6$

$\gamma=2\times\frac{79}{14}-4$

$2\alpha+\beta+\gamma=\frac{1}{7}(34+48+79)-12=\frac{161}{7}-12=23-12=11$

25. If $\alpha=\lim\limits_{x\to0^+}\left(\frac{e^{\sqrt{\tan x}}-e^{\sqrt{x}}}{\sqrt{\tan x}-\sqrt{x}}\right)$ and $\beta=\lim\limits_{x\to0}(1+\sin x)^{\frac{1}{2}\cot x}$ are the roots of the quadratic equation $ax^2+bx-\sqrt{e}=0$, then $12\log_e(a+b)$ is equal to _____ .

Ans. **NTA (6)**
Reso (6)

Sol. $\alpha=\lim\limits_{x\to0^+}\cdot\frac{e^{\sqrt{\tan x}}-e^{\sqrt{x}}}{\sqrt{\tan x}-\sqrt{x}}$

$=\lim\limits_{x\to0^+}\cdot e^{\sqrt{x}}\left(\frac{e^{\sqrt{\tan x}}-1}{\sqrt{\tan x}-\sqrt{x}}\right)$

$=e^0\times1=1$

$\beta=\lim\limits_{x\to0^+}(1+\sin x)^{\frac{1}{2}\cot x}$

$e^{\lim\limits_{x\to0}\sin x\cdot\frac{1}{2\tan x}}=e^{1/2}$

Q.E. $x^2-\left(1+\sqrt{e}\right)x+\sqrt{e}=0$

$ax^2+bx-\sqrt{e}=0$

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

$a=-1,\ b=1+\sqrt{e}$

$a+b=\sqrt{e}$

$12\log_e(a+b)=12\log_e\sqrt{e}=12\times\frac{1}{2}=6$

26. If $\int \frac{1}{\sqrt[5]{(x-1)^4(x+3)^6}}dx = A\left(\frac{\alpha x-1}{\beta x+3}\right)^B + C$, where C is the constant of integration, then the value of $\alpha + \beta + 20AB$ is _____ .

Ans. **NTA (7)**
Reso (7)

Sol. $\int \frac{1}{(x-1)^{4/5}(x+3)^{6/5}}dx$

$\frac{x-1}{x+3} = t$

$1 - \frac{4}{x+3} = t$

$+ \frac{4}{(x+3)^2}dx = dt$

$\frac{1}{4}\int \frac{(x+3)^2 dt}{t^{4/5}(x+3)^{4/5}(x+3)^{6/5}}$

$\frac{1}{4}\int t^{-4/5}dt$

$\frac{1}{4}\frac{t^{1/5}}{1/5} + C$

$\frac{5}{4}\left(\frac{x-1}{x+3}\right)^{\frac{1}{5}} + C = A\left(\frac{\alpha x-1}{\beta x+3}\right)^B + C$

$A = 5/4, \alpha = 1, \beta = 1, B = 1/5$

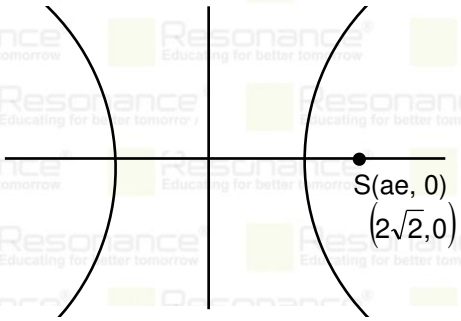
$\alpha + \beta + 20AB$

$1 + 1 + 20 \times \frac{5}{4} \times \frac{1}{5} = 7$

27. Let S be the focus of the hyperbola $\frac{x^2}{3} - \frac{y^2}{5} = 1$, on the positive x-axis. Let C be the circle with its centre at $A\left(\sqrt{6}, \sqrt{5}\right)$ and passing through the point S. If O is the origin and SAB is a diameter of C, then the square of the area of the triangle OSB is equal to _____ .

Ans. **NTA (40)**
Reso (40)

Sol.

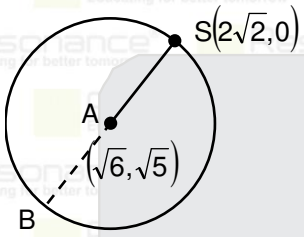


$\frac{x^2}{3}-\frac{y^2}{5}=1$

$e=\sqrt{1+\frac{5}{3}}=\sqrt{\frac{8}{3}}$

$a=\sqrt{3}$, $b=\sqrt{5}$

$ae=2\sqrt{2}$



0(0, 0), $S\equiv\underset{(x_1,\ y_1)}{(2\sqrt{2},0)}$, $B\equiv\underset{(x_2,\ y_2)}{(2\sqrt{6},-2\sqrt{2},2\sqrt{5})}$

Area $=\frac{1}{2}\begin{vmatrix}0 & x_1 & x_2 & 0\\ 0 & y_1 & y_2 & 0\end{vmatrix}=\frac{1}{2}|(x_1y_2-y_1x_2)|$

$=\frac{1}{2}(2\sqrt{2}\times2\sqrt{5})=2\sqrt{10}$

$A^2=40$

28. Let a ray of light passing through the point (3, 10) reflects on the line $2x + y = 6$ and the reflected ray passes through the point (7, 2). If the equation of the incident ray is $ax + by + 1 = 0$, then $a^2 + b^2 + 3ab$ is equal to _____ .

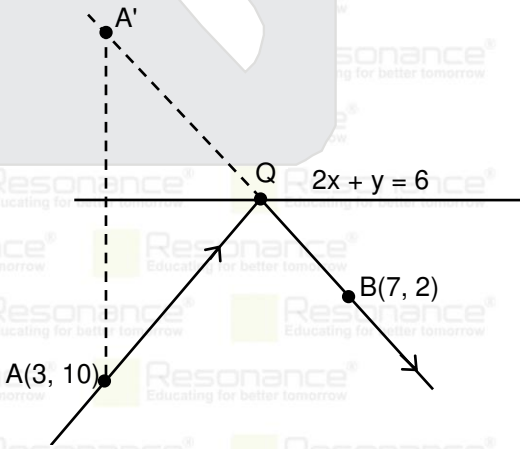
Ans. **NTA (28)**

Reso (28)

Sol. $\frac{x-3}{2}=\frac{y-10}{1}=\frac{-2(6+10-6)}{4+1}=-4$

$x=-5,\ y=6$

$A'(-5, 6), B(7, 2)$



eqⁿ A′B $y-6=\frac{2-6}{7+5}(x+5)$

$3y-18=-x-5$

$x+3y=13$

$2x+6y=26$

$2x+y=6$ (given line)

$5y=20,\quad y=4,\ x=1$

$Q=(1,4)$

Req. line $y-10=\frac{4-10}{1-3}(x-3)$

$y-10=3x-9$

$3x - y + 1 = 0$

$ax + by + 1 = 0$

$a = 3, b = -1$

$a^2 + b^2 + 3ab = 9 + 1 - 9 = 1$

29. Let $\alpha|x| = |y|e^{xy-\beta}$, $\alpha, \beta \in N$ be the solution of the differential equation $xdy - ydx + xy(xdy + ydx) = 0$, $y(1) = 2$. Then $\alpha + \beta$ is equal to _____ .

Ans. **NTA (4)**
Reso (4)

Sol. $a|x| = |y|e^{xy-\beta}$

$$\frac{xdy - ydx}{x^2} + \frac{xy(xdy + ydx)}{x^2} = 0$$

$$d(y/x) + \frac{y}{x}\,d(xy) = 0$$

$$\frac{d\left(\frac{y}{x}\right)}{\frac{y}{x}} + d(xy) = 0$$

$$\ln\left|\frac{y}{x}\right| + xy = c$$

$$\left|\frac{y}{x}\right| = e^{c-xy}$$

$|x| = |y|\, e^{xy-c}$

$x = 1, y = 2$

$1 = 2e^{2-c}$

$e^c = 2e^2$

$|x|e^c = |y|e^{xy}$

$2|x| = |y|e^{xy-2}$

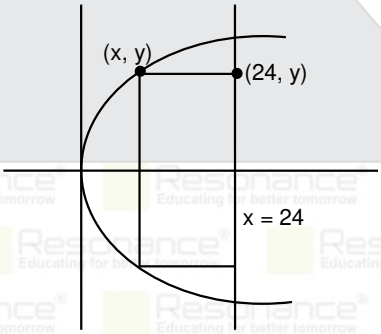
$\alpha = 2, \beta = 2$

$\alpha + \beta = 4$

30. Let A be the region enclosed by the parabola $y^2 = 2x$ and the line $x = 24$. Then the maximum area of the rectangle inscribed in the region A is _____ .

Ans. **NTA (128)**
Reso (128)

Sol.



$y^2 = 2x$

$x = 24$

Area $= (24 - x)2y$

$$\left(24 - \frac{y^2}{2}\right)2y$$

$A = 48y - y^3$

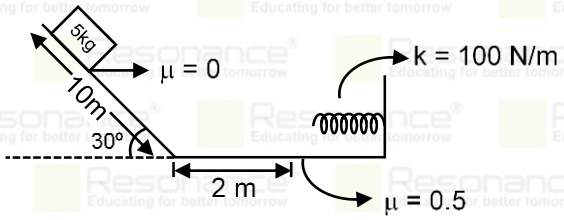
$\frac{dA}{dy} = 48 - 3y^2$, $y = 4$, $x = 8$

Area $= (24 - 8)(2 \times 4)$

$= 128$

PART : PHYSICS

31.



A block is simply released from the top of an inclined plane as shown in the figure above. The maximum compression in the spring when the block hits the spring is :

एक गुटके को प्रदर्शित चित्र के अनुसार एक नततल तल के शीर्ष से छोड़ा जाता है। जब गुटका स्प्रिंग से टकराता है तब स्प्रिंग में उत्पन्न अधिकतम संपीड़न है :

(1) $\sqrt{6}$ m (2) 2 m (3) $\sqrt{5}$ m (4) 1 m

Ans. **(2)**

Sol. $W_{gravity} + W_{friction} + W_{spring} = \Delta KE$

$$mgh - (\mu N \times 2) - \frac{1}{2}kx^2 = 0$$

$$(5 \times 10 \times 5) - (0.5 \times 50 \times 2) = \frac{1}{2} \times 100 \times x^2$$

$x = 2$ m

32. In a hypothetical fission reaction

$_{92}X^{236} \rightarrow {}_{56}Y^{141} + {}_{36}Z^{92} + 3R$

The identity of emitted particles (R) is :

(1) Neutron (2) Proton (3) Electron (4) γ-radiation

एक काल्पनिक विखण्डन अभिक्रिया

$_{92}X^{236} \rightarrow {}_{56}Y^{141} + {}_{36}Z^{92} + 3R$

में उत्सर्जित कण (R) होंगे :

(1) न्यूट्रान (2) प्रोट्रान (3) इलैक्ट्रान (4) γ-विकिरण

Ans. **(1)**

Sol. $_{92}X^{236} \rightarrow {}_{56}Y^{141} + {}_{36}Z^{92} + 3\ {}_{0}n^{1}$

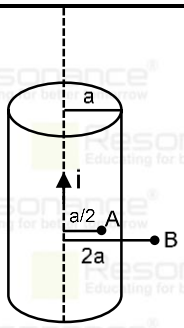
33. A long straight wire of radius a carries a steady current I. The current is uniformly distributed across its cross section. The ratio of the magnetic field at $\frac{a}{2}$ and 2a from axis of the wire is :

a त्रिज्या के एक सीधे लम्बे तार में प्रवाहित स्थाई धारा I है। धारा इसके अनुप्रस्थ काट में समान रूप से वितरित है। तार की अक्ष से $\frac{a}{2}$ तथा 2a दूरी पर चुम्बकीय क्षेत्रों का अनुपात है :

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

Ans. **(4)**

Sol.



$$B_A = \frac{\mu_0 J \times r}{2}$$

$$B_A = \frac{\mu_0 J \times r}{2} = \frac{\mu_0 i \times r}{2(\text{area})} = \frac{\mu_0 i}{2 \times \pi a^2} \times \frac{a}{2} = \frac{\mu_0 i}{4\pi a}$$

$$B_B = \frac{\mu_0 i}{2\pi \times 2a} = \frac{\mu_0 i}{4\pi a}, \quad \frac{B_A}{B_B} = 1$$

34. Least count of a vernier calliper is $\frac{1}{20N}$cm . The value of one division on the main scale is 1 mm. Then the number of divisions of main scale that coincide with N divisions of vernier scale is :

वर्नियर कैलीपर्स की अल्पतमांक $\frac{1}{20N}$cm है। मुख्य पैमाने पर एक खाने का मान 1 मिमी है। वर्नियर पैमाने के N खानों से पूर्णतया मिलने वाले मुख्य पैमाने पर खानों की संख्या है :

(1) $\left(\frac{2N-1}{2}\right)$ (2) $\left(\frac{2N-1}{20N}\right)$ (3) (2N – 1) (4) $\left(\frac{2N-1}{2N}\right)$

Ans. **(1)**

Sol. x MSD = N VSD

$$1\text{VSD} = \frac{x}{N}\text{MSD}$$

LC = 1 MSD – 1 VSD

$$\frac{1}{20N} = \left(1 - \frac{x}{N}\right)\text{MSD}$$

$$\frac{1}{20N} \times 10^{-2} = \left(1 - \frac{x}{N}\right) \times 10^{-3}$$

$$\frac{1}{2N} = 1 - \frac{x}{N}$$

$$x = \left(\frac{2N-1}{2}\right)$$

35. Two satellite A and B go round a planet in circular orbits having radii 4R and R respectively. If the speed of A is 3 v, the speed of B will be :

दो उपग्रह A व B एक ग्रह के परितः क्रमशः 4R व R त्रिज्या की वृत्तीय कक्षाओं में घूम रहे हैं। यदि A की चाल 3 v है, तब B की चाल होगी :

(1) 3v (2) $\frac{4}{3}$v (3) 6v (4) 12v

Ans. **(3)**

Sol. $V = \sqrt{\frac{GM}{R}}$

$V_A = 3v = \sqrt{\frac{GM}{4R}}$

& $V_B = \sqrt{\frac{GM}{R}}$

$\frac{V_B}{3v} = 2$

$\Rightarrow V_B = 6v$

36. If $\in_0$ is the permittivity of free space and E is the electric field, then $\in_0 E^2$ has the dimensions :
यदि मुक्त निर्वात की विद्युतशीलता $\in_0$ तथा विद्युत क्षेत्र E हो तो $\in_0 E^2$ की विमाएँ हैं :

(1) $[ML^2T^{-2}]$ (2) $[M^{-1}L^{-3}T^4A^2]$ (3) $[M^0L^{-2}TA]$ (4) $[ML^{-1}T^{-2}]$

Ans. **(4)**

Sol. Dimensions of $\in_0 E^2$ is same as that of energy density.

so $\left[\in_0 E^2\right] = \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$

37. Water boils in an electric kettle in 20 minutes after being switched on. Using the same main supply, the length of the heating element be _____ to _____ times of its initial length if the water is to be boiled in 15 minutes.

(1) decreased, 4/3 (2) increased, 4/3 (3) increased, 3/4 (4) decreased, 3/4

एक विद्युत केतली का स्विच खोलने के बाद इसमें पानी 20 मिनट में उबलता है। समान स्त्रोत का प्रयोग करके गर्म तन्तु की लम्बाई _____ प्रारम्भिक लम्बाई की _____ गुनी हो जाती है, जब पानी 15 मिनट में उबलता है।

(1) घटकर, 4/3 (2) बढ़कर, 4/3 (3) बढ़कर, 3/4 (4) घटकर, 3/4

Ans. **(4)**

Sol. $Q = \frac{V^2}{R}t = \text{const}$

$\frac{V^2}{R_1}t_1 = \frac{V^2}{R_2}t_2$

$\Rightarrow \quad R_2 = \frac{R_1 t_2}{t_1}$

$= R_1 \frac{15}{20} = \frac{3R_1}{4} \qquad \left\{R = \frac{\rho\ell}{A}\right\}$

so, $\ell_2 = \frac{3}{4}\ell_1$

length decreased

38. There are 100 divisions on the circular scale of a screw gauge of pitch 1mm. With no measuring quantity in between the jaws, the zero of the circular scale lies 5 division below the reference line. The diameter of a wire is then measured using this screw gauge. It is found that 4 linear scale divisions are clearly visible while 60 divisions on circular scale coincide with the reference line. The diameter of the wire is :

1 मिमी पिच के एक पेंचमापी के वृत्तीय पैमाने पर खानों की संख्या 100 है। जबड़ों की बीच बिना वस्तु मापन के लिए वृत्तीय पैमाने का शून्यांक निर्देश रेखा के नीचे 5 खानें पर है। तब इस पेंचमापी का उपयोग करके एक तार का व्यास मापा जाता है। मुख्य पैमाने के 4 खानें पूर्णतया दिखाई देते हैं तथा निर्देश रेखा से वृत्तीय पैमाने के 60 खाने की रेखा मिलती है। तार का व्यास है :

(1) 4.60 mm (2) 4.65 mm (3) 3.35 mm (4) 4.55 mm

Ans. **(4)**

Sol. Least count of screw gauge $= \frac{1}{100} = 0.01$ mm

zero error = 5 × 0.01 = 0.05 mm

diameter of wire

= 4 + 60 × 0.01

= 4.6 mm

so correct diameter of wire

= 4.6 – (0.05)

= 4.55 mm

39. If M_o is the mass of isotope $^{12}_{5}B$, M_p and M_n are the masses of proton and neutron, then nuclear binding energy of isotope is :

यदि $^{12}_{5}B$ समस्थानिक का द्रव्यमान M_o है, प्रोट्रान व न्यूट्रान का द्रव्यमान क्रमशः M_p व M_n है तब समस्थानिक की नाभिकीय बंधन ऊर्जा है :

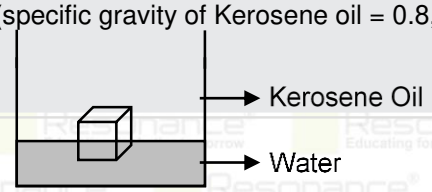
(1) $(M_o - 5M_p - 7M_n)C^2$ (2) $(M_o - 5M_p)C^2$ (3) $(5M_p + 7M_n - M_o)C^2$ (4) $(M_o - 12M_n)C^2$

Ans. **(3)**

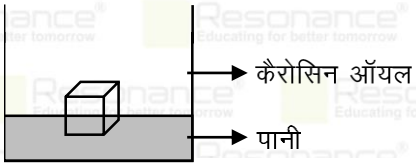
Sol. B.E. = ΔmC^2

= $(5\ M_p + 7\ M_n - M_o)C^2$

40. A cube of ice floats partly in water and partly in kerosene oil. The ratio of volume of ice immersed in water to that in kerosene oil (specific gravity of Kerosene oil = 0.8, specific gravity of ice = 0.9) :



बर्फ का एक घन आंशिक रूप से पानी तथा आंशिक कैरोसिन ऑयल में तैरता है। पानी में डूबे बर्फ के आयतन तथा कैरोसिन ऑयल में डूबे बर्फ के आयतन का अनुपात है : (कैरोसिन ऑयल का विशिष्ट गुरुत्व = 0.8, बर्फ के विशिष्ट गुरुत्व = 0.9) :



(1) 9 : 10 (2) 8 : 9 (3) 5 : 4 (4) 1 : 1

Ans. **(4)**

Sol. $mg = \rho_1 v_1 g + \rho_2 v_2 g$

$\Rightarrow \quad \rho_2 vg = \rho_1 v_1 g + \rho_2 v_2 g$

$\Rightarrow \quad 0.9\ v = 0.8\ v_1 + 1 \times v_2$

$\Rightarrow \quad 0.9\ (v_1 + v_2) = 0.8\ v_1 + v_2$

$\Rightarrow \quad 0.1\ v_1 = 0.1\ v_2$

$\Rightarrow \quad \frac{v_1}{v_2} = 1$

41. A given object takes n times the time to slide down 45º rough inclined plane as it takes the time to slide down an identical perfectly smooth 45º inclined plane. The coefficient of kinetic friction between the object and the surface of inclined plane is :

एक दी गई वस्तु 45º के कोण पर झुके खुरदरे नत तल पर नीचे फिसलने में लगा समय 45º के कोण पर झुकने समान प्रकार के चिकने तल पर नीचे फिसलने में लगे समय का n गुना है। वस्तु व नत तल के बीच गतिक घर्षण गुणांक है :

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

Ans. **(4)**

Sol. $t_2 = nt_1$

$\Rightarrow \quad \sqrt{\frac{2S}{g\sin\theta - \mu g\cos\theta}} = n\sqrt{\frac{2S}{g\sin\theta}}$

$\Rightarrow \quad g\sin\theta = n^2(g\sin\theta - \mu g\cos\theta)$

$\Rightarrow \quad \frac{1}{\sqrt{2}} = n^2\left(\frac{1}{\sqrt{2}} - \frac{\mu}{\sqrt{2}}\right)$

$\Rightarrow \quad 1-\mu = \frac{1}{n^2} \quad \Rightarrow \quad \mu = 1-\frac{1}{n^2}$

42. A coil of negligible resistance is connected in series with 90Ω resistor across 120 V, 60 Hz supply. A voltmeter reads 36 V across resistance. Inductance of the coil is :

एक नगण्य प्रतिरोध की कुंडली को 90Ω के प्रतिरोध के साथ श्रेणीक्रम में जोड़कर 120 V, 60 Hz के स्त्रोत से जोड़ा गया है। प्रतिरोध के सिरों के बीच वोल्टमीटर का पाठयांक 36 V है। कुंडली का प्रेरकत्व है :

(1) 2.86 H (2) 0.91 H (3) 0.286 H (4) 0.76 H

Ans. **(4)**

Sol. $(V_{rms})_R = 36 = i_{rms} \times 90$

$\Rightarrow \quad i_{rms} = \frac{36}{90}A$

Now $Z = \frac{v_{rms}}{i_{rms}} = \frac{120}{36} \times 90 = 300\Omega$

$Z = \sqrt{R^2 + x_L^2}$

$\Rightarrow \quad 300 = \sqrt{90^2 + x_L^2}$

$X_L = 286.181\ \Omega$

Now, $X_L = \omega L$

$286.181 = 2\pi \times 60 \times L$

$L = 0.759$ H

43. A capacitor has air as dielectric medium and two conducting plates of area 12 cm^2 and they are 0.6 cm apart. When a slab of dielectric having are 12 cm^2 and 0.6 cm thickness is inserted between the plates, one of the conducting plates has to be moved by 0.2 cm to keep the capacitance same as in previous case. The dielectric constant of the slab is : (Given $\in_0 = 8.834 \times 10^{-12}$ F/m)

एक संधारित्र में परावैद्युत माध्यम वायु है तथा 0.6 सेमी की दूरी पर स्थित दो 12 सेमी^{2} क्षेत्रफल वाली चालक प्लेटें ली गई हैं। जब 12 सेमी^{2} क्षेत्रफल व 0.6 सेमी मोटाई की एक परावैद्युत पट्टी इसकी प्लेटों के बीच रख दी जाती है, तथा संधारित्र की धारिता समान बनाये रखने के लिए एक चालक प्लेट को 0.2 सेमी विस्थापित कर दिया जाता है। पट्टी का परावैद्युतांक हैं : (दिया है $\in_0 = 8.834 \times 10^{-12}$ F/m)

(1) 1 (2) 0.66 (3) 1.50 (4) 1.33

Ans. **(3)**

Sol. $C = \frac{\in_0 A}{d}$ & $C' = \frac{\in_0 A}{d - t\left(1 - \frac{1}{k}\right)}$

Here, $t\left(1 - \frac{1}{k}\right) = 0.2$

$\Rightarrow$ $0.6\left(1 - \frac{1}{k}\right) = 0.2$

$\Rightarrow$ $\frac{1}{k} = \frac{2}{3}$

$\Rightarrow$ $k = 1.5$

44. A thin circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with angular velocity ω. If another disc of same dimensions but of mass M/2 is placed gently on the first disc co-axially, then the new angular velocity of the system is :

M द्रव्यमान व R त्रिज्या की एक पतली वृत्ताकार चकती क्षैतिज तल में इसके केन्द्र से गुजरने वाली इसके तल के लम्बवत् अक्ष के परितः ω कोणीय वेग से घूम रही हैं। समान आकृति की M/2 द्रव्यमान की दूसरी चकती समअक्षीय रूप से इसके ऊपर धीरे से रख दी जाती है तब निकाय का नया कोणीय वेग है :

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

Ans. **(2)**

Sol. Using angular momentum conservation

$$\frac{MR^2}{2}\omega = \left(\frac{MR^2}{2} + \frac{M}{2}\frac{R^2}{2}\right)\omega'$$

$\Rightarrow$ $\frac{MR^2}{2}\omega = \frac{3}{4}MR^2\omega'$ $\Rightarrow$ $\omega' = \frac{2\omega}{3}$

45. Given below are two statements :

Statement (I) : The mean free path of gas molecules is inversely proportional to square of molecular diameter.

Statement (II) : Average kinetic energy of gas molecular is directly proportional to absolute temperature of gas.

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

(2) Both Statement I and Statement II are false

(3) Statement I is true but Statement II is false

(4) Both Statement I and Statement II are true

नीचे दो कथन दिये गये हैं :

कथन (I) : गैस के अणुओं का औसत मुक्त पथ आण्विक व्यास के वर्ग के व्युत्क्रमानुपाती होता है।

कथन (II) : गैस की औसत गतिज ऊर्जा गैस के परम तापमान के समानुपाती होती है।

(1) कथन I असत्य है, लेकिन कथन II सत्य हैं।

(2) कथन I तथा कथन II दोनों असत्य हैं।

(3) कथन I सत्य है, लेकिन कथन II असत्य हैं।

(4) कथन I तथा कथन II दोनों सत्य हैं।

Ans. **(4)**

Sol. Average kinetic energy of gas of one molecule (KE) = $\frac{f}{2}KT$

$KE \propto T$

Mean free path of gas molecule (λ) = $\frac{1}{\sqrt{2}\pi d^2 n}$

$\lambda \propto \frac{1}{d^2}$

Both statements are true.

46. A diatomic gas ($\gamma = 1.4$) does 100 J of work in an isobaric expansion. The heat given to the gas is :

समदाबी प्रसार में एक द्विपरमाणुक गैस ($\gamma = 1.4$) 100 J कार्य करती है। गैस को दी गई ऊष्मा है :

(1) 250 J (2) 490 J (3) 150 J (4) 350 J

Ans. **(4)**

Sol. $Q = nC_P\Delta T$

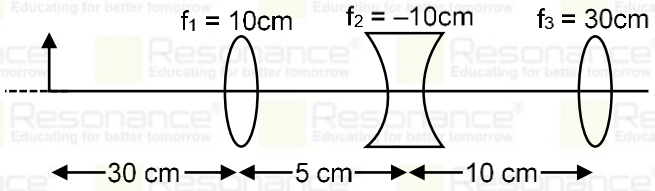
$Q = n\frac{7}{2}R\Delta T$

$= \frac{7}{2}(nR\Delta T)$

$= \frac{7}{2}\Delta w$

$= \frac{7}{2} \times 100 = 350\,J$

47. The position of the image formed by the combination of lenses is :
लैंसो के संयोजन द्वारा बने प्रतिबिम्ब की स्थिति है :



(1) 15 cm (right of second lens) (2) 15 cm (left of second lens)
(3) 30 cm (left of third lens) (4) 30 cm (right of third lens)
(1) 15 cm (दूसरे लैंस से दाँये) (2) 15 cm (दूसरे लैंस से बाँये)
(3) 30 cm (तीसरे लैंस से बाँये) (4) 30 cm (तीसरे लैंस से दाँये)

Ans. **(4)**

Sol. For 1st lens

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\Rightarrow \frac{1}{v}-\frac{1}{-30}=\frac{1}{10}$$

$\Rightarrow V = +15$ cm

for 2nd lens

2nd lens will form image at infinity.

for 3rd lens

3rd lens will form final image on its focus (f = 30 cm, on right side)

48. A plane progressive wave is given by $y = 2\cos 2\pi(330t - x)$m. The frequency of the wave is :
एक समतल प्रगामी तरंग $y = 2\cos 2\pi(330t - x)$m द्वारा प्रदर्शित की गई है। तरंग की आवृत्ति है :

(1) 330 Hz (2) 340 Hz (3) 660 Hz (4) 165 Hz

Ans. **(1)**

Sol. Comparing given equation with standard equation

$$y = a\cos 2\pi(ft - \frac{x}{\lambda})$$

f = 330 Hz.

49. A proton and an electron have the same de Broglie wavelength. If K_p and K_e be the kinetic energies of proton and electron respectively, then choose the correct relation :
एक प्रोट्रान व एक इलैक्ट्रान की डी–ब्रॉग्ली तरंगदैर्ध्य समान हैं। यदि प्रोट्रान व इलैक्ट्रान की गतिज ऊर्जाएँ क्रमशः K_p तथा K_e हों तब सही संबन्ध चुनिए।

(1) $K_p > K_e$ (2) $K_p < K_e$ (3) $K_p = K_e^2$ (4) $K_p = K_e$

Ans. **(2)**

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

λ same so p will also be same.

Now, $K = \frac{p^2}{2m} \Rightarrow K \propto \frac{1}{m}$

$m_p > m_e$

so $K_p < K_e$

50. The angle of projection for a projectile to have same horizontal range and maximum height is :
समान क्षैतिज परास तथा अधिकतम ऊँचाई के एक प्रक्षेप्य के लिए प्रक्षेपण कोण है :

(1) $\tan^{-1}(2)$ (2) $\tan^{-1}(4)$ (3) $\tan^{-1}\left(\frac{1}{4}\right)$ (4) $\tan^{-1}\left(\frac{1}{2}\right)$

Ans. **(2)**

Sol. $\frac{H}{R} = \frac{\tan\theta}{4}$

$H = R$

so $\tan\theta = 4$

$\Rightarrow \theta = \tan^{-1} 4$

51. A body of mass M thrown horizontally with velocity v from the top of the tower of height H touches the ground at a distance of 100 m from the foot of the tower. A body of mass 2 M thrown at a velocity $\frac{v}{2}$ from the top of the tower of height 4H will touch the ground at a distance of _____m.
M द्रव्यमान की एक वस्तु को H ऊँचाई के टॉवर के शिखर से v वेग से क्षैतिज दिशा में फेंका जाता है। जो टॉवर के पाद से 100 मी की दूरी पर जमीन को छूती है। 2 M द्रव्यमान की एक वस्तु को $\frac{v}{2}$ वेग से 4 H ऊँचाई के टॉवर के शिखर से फेंका जाये तो वह _____ मी की दूरी पर पृथ्वी तल (जमीन) को छूएगी।

Ans. **100**

Sol. $100 = v\sqrt{\frac{2H}{g}}$ .....(i)

$x = \frac{v}{2}\sqrt{\frac{2\times 4H}{g}}$ .....(ii)

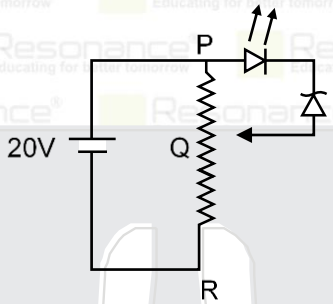
dividing equation (i) by (ii)

$\frac{100}{x} = 1$

$x = 100$ m

52. A potential divider circuit is connected with a dc source of 20V, a light emitting diode of glow in voltage 1.8 V and a zener diode of breakdown voltage of 3.2 V. The length (PR) of the resistive wire is 20 cm. The minimum length of PQ to just glow the LED is _____ cm.

एक विभव विभाजक परिपथ को 20V के एक दिष्ट धारा स्त्रोत, 1.8 V वोल्टेज में चमकने वाले एक प्रकाश उत्सर्जक डायोड तथा 3.2 V के भंजन वोल्टेज के जीनर डायोड से जोड़ा गया हैं। प्रतिरोधक तार की PR लम्बाई 20 सेमी हैं। LED को केवल चमकने हेतु PQ की न्यूनतम लम्बाई _____ सेमी है।



Ans. 5

Sol. Voltage across PQ should be
1.8 + 3.2 = 5V
so V_{QR} = 15 V

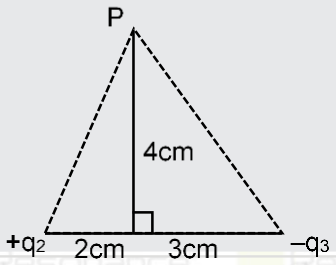
$$\frac{V_{PQ}}{V_{QR}} = \frac{1}{3}$$

So, $\frac{\ell_{PQ}}{\ell_{QR}} = \frac{1}{3}$

so, PQ = 5cm & QR = 15 cm

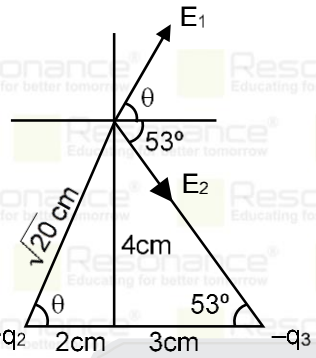
53. If the net electric field at point P along Y axis is zero, then the ratio of $\left|\frac{q_2}{q_3}\right|$ is $\frac{8}{5\sqrt{x}}$, where x = _____.

Y-अक्ष के अनुदिश बिन्दु P पर परिमापी वैद्युत क्षेत्र शून्य हैं, तब $\left|\frac{q_2}{q_3}\right|$ अनुपात $\frac{8}{5\sqrt{x}}$ है, जहाँ x = _____।



Ans. 5

Sol.



Net electric field along y axis = 0

$E_1 \sin\theta = E_2 \sin 53^\circ$

$$\Rightarrow \frac{kq_2}{\left(\sqrt{20}\right)^2} \times \frac{4}{\sqrt{20}} = \frac{kq_3}{5^2} \times \frac{4}{5}$$

$$\Rightarrow \frac{q_2}{q_3} = \frac{8}{5\sqrt{5}} \qquad \text{so,} \qquad x = 5$$

54. The coercively of a magnet is 5×10^3 A/m. The amount of current required to be passed in a solenoid of length 30 cm and the number of turns 150, so that the magnet gets demagnetised when inside the solenoid is _____ A.

एक चुम्बक की निग्राहिता 5×10^3 A/m है। 150 फेरों की 30 सेमी लम्बाई की परिनालिका से गुजरने वाली धारा की मात्रा _____ A है ताकि परिनालिका के अन्दर चुम्बक अचुम्बकित हो जाए।

Ans. **10**

Sol. $B = \mu_0 ni = \mu_0 H$

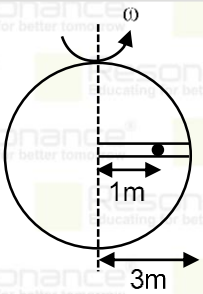
$ni = H$

$$\frac{150}{0.3} \times i = 5 \times 10^3$$

$i = 10$ A

55. A circular table is rotating with an angular velocity of ω rad/s about its axis (see figure). There is a smooth groove along a radial direction on the table. A steel ball is gently placed at a distance of 1 m on the groove. All the surfaces are smooth. If the radius of the table is 3m, the radial velocity of the ball w.r.t. the table at the time ball leaves the table is $x\sqrt{2\omega}\,m/s$, where the value of x is _____.

एक वृत्ताकार मेज अपनी अक्ष के परितः ω रेडियन/से के कोणीय वेग से घूम रही है (चित्र देखिए)। मेज की त्रिज्य दिशा के अनुदिश एक चिकनी पट्टी रूपी खाँचा है। सब सतह चिकनी है। यदि मेज की त्रिज्या 3 मी हो मेज के सापेक्ष गेंद की त्रिज्य वेग $x\sqrt{2\omega}$ मी/से है जिस समय गेंद मेज को छोड़ती है। जहाँ x का मान _____ है।



Ans. **2**

Sol. $a = \omega^2 r$

$$\Rightarrow \quad v\frac{dv}{dr} = \omega^2 r \quad \Rightarrow \quad \int_0^v v dv = \omega^2 \int_{r_0}^{r} r dr \Rightarrow \frac{v^2}{2} = \frac{\omega^2}{2}\left(r^2 - r_0^2\right)$$

$$\Rightarrow \quad v = \omega\sqrt{r^2 - r_0^2}$$

$$= \omega\sqrt{9-1}$$

$$= 2\sqrt{2}\,\omega$$

so, $x = 2$

56. An object of mass 0.2 kg executes simple harmonic motion along x axis with frequency of $\left(\frac{25}{\pi}\right)$ Hz. At the position x = 0.04 m the object has kinetic energy 0.5 J and potential energy 0.4 J. The amplitude of oscillation is _____ cm.

0.2 किग्रा द्रव्यमान की एक वस्तु $\left(\frac{25}{\pi}\right)$ Hz से आवृत्ति से x-अक्ष के अनुदिश सरल आवर्त गति करती है। x = 0.04 स्थिति में वस्तु की गतिज ऊर्जा 0.5 J तथा स्थितिज ऊर्जा 0.4 J है। दोलक का आयाम _____ सेमी है।

Ans. **6**

Sol. $K = \frac{1}{2}m\omega^2\left(A^2 - x^2\right)$

$$U = \frac{1}{2}m\omega^2 x^2$$

so, $\frac{K}{U} = \frac{A^2 - x^2}{x^2}$

$$\Rightarrow \quad \frac{0.5}{0.4} = \frac{A^2 - 16}{16}$$

$$\Rightarrow \quad A = 6 \text{ cm}$$

57. An alternating emf $E = 110\sqrt{2}\sin 110t$ volt is applied to a capacitor of 2μF, the rms value of current in the circuit is _____mA.

एक प्रत्यावर्ती वि.वा.बल $E = 110\sqrt{2}\sin 110t$ वोल्ट को 2μF के संधारित्र पर आरोपित किया जाता है, परिपथ में धारा का वर्ग माध्य मूल मान _____mA है।

Ans. **22**

Sol. $x_C = \frac{1}{\omega_C} = \frac{1}{100\times 2\times 10^{-6}} = \frac{10^4}{2} = 5000\Omega$

$$i_{rms} = \frac{V_{rms}}{x_C} = \frac{110}{5000} = \frac{110}{5}\text{mA} = 22\text{mA}$$

58. Two slits are 1 m apart and the screen is located 1 m away from the slits. A light of wavelength 500 nm is used. The width. of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern is _____ × 10^{-4} m.

दो झिर्रियों को 1 मिमी की दूरी पर तथा पर्दे को झिर्रियों से 1 मी की दूरी पर रखा गया है। 500 nm तरंगदैर्ध्य के प्रकाश का उपयोग किया गया है। एकल झिर्री पैटर्न के केन्द्रीय उच्चिष्ठ में द्विझिर्री पैटर्न के 10 उच्चिष्ठ प्राप्त करने के लिए प्रत्येक झिर्री प्रारूप की चौड़ाई _____ × 10^{-4} मी है।

Ans. **2**

Sol. $10 \times B = W$

$$10 \times \frac{\lambda D}{d} = \frac{2\lambda D}{b}$$

$$b = \frac{2d}{10}$$

$$= \frac{2 \times 1}{10} = 0.2\,mm$$

$$= 2 \times 10^{-4}\ m$$

59. Small water droplets of radius 0.01 mm are formed in the upper atmosphere and falling with a terminal velocity of 10 cm/s. Due to condensation, if 8 such droplets are coalesced and formed a larger drop, the new terminal velocity will be _____ cm/s.

ऊपरी वायुमण्डल में 0.01 मिमी त्रिज्या की पानी की छोटी बूँदों का निर्माण होता है तथा 10 सेमी/से के सीमान्त वेग से नीचे गिरती हैं। संघनन के कारण यह 8 बूँदें मिलकर एक बड़ी बूँद बनाती है तब नया सीमान्त वेग _____ सेमी/से होगा।

Ans. **40**

Sol. $8\frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$R = 2r$

terminal velocity $v = \frac{2}{9}\frac{r^2(\rho - \sigma)}{\eta}$

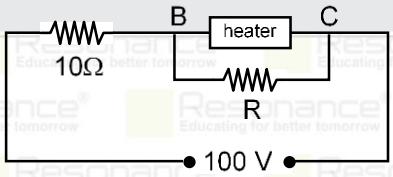
$v \propto r^2$

$$\frac{v_2}{v_1} = \frac{R^2}{r^2} \Rightarrow v_2 = 4v_1$$

$v_2 = 40$ cm/s

60. A heater is designed to operate with a power of 1000 W in a 100 V line. It is connected in combination with a resistance of 10Ω and a resistance R, to a 100 V mains as shown in figure. For the heater to operate at 62.5W, the value of R should be _____Ω.

100 V की लाइन में 1000 W शक्ति के साथ कार्य करने के लिए एक हीटर बनाया गया है। चित्र के अनुसार यह 10Ω व R प्रतिरोध के संयोजन से जोड़ा गया है। 62.5W पर हीटर को काम करने के लिए R का मान _____Ω होना चाहिए।



Ans. **5**

Sol. $R_{heater} = \frac{v^2}{P} = \frac{100\times100}{1000} = 10\Omega$

in given circuit $V_{heater} = \sqrt{62.5\times10} = 25V$

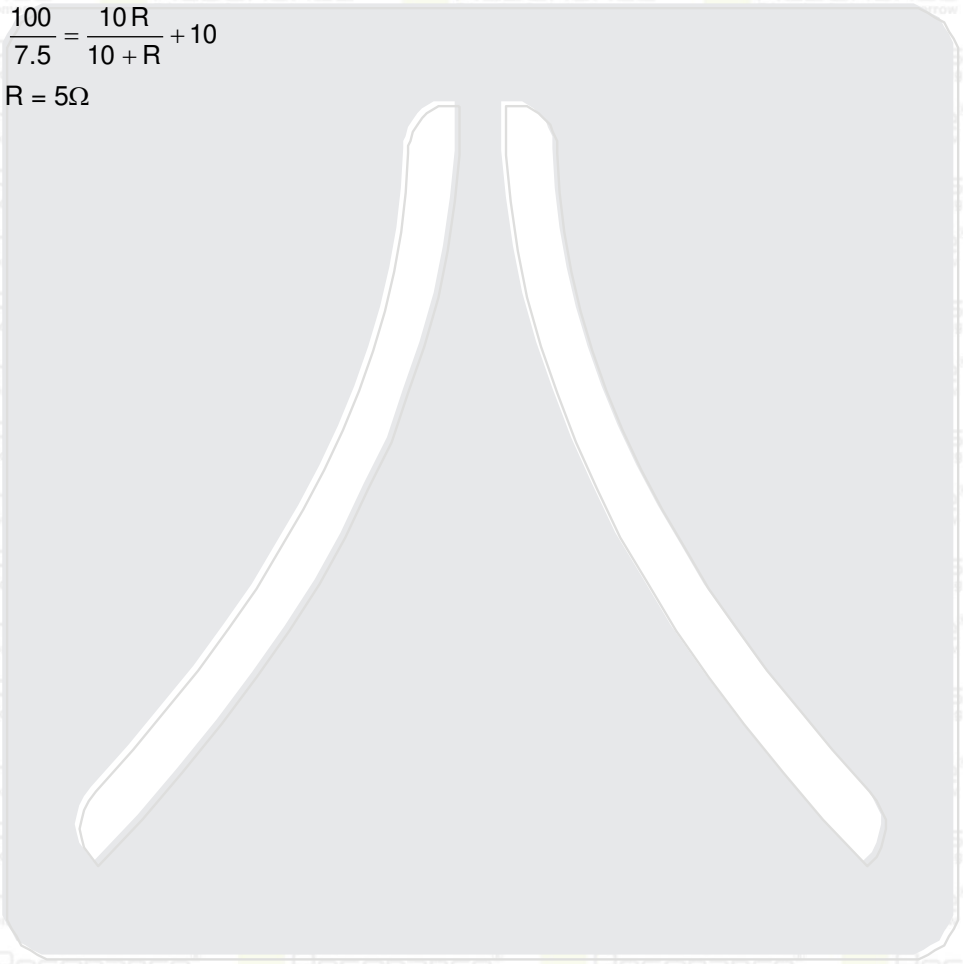
so, $V_{10\Omega} = 75$ V

$i = \frac{75}{10} = 7.5\,A$

$R_{eq} = \frac{V}{i} = \frac{100}{7.5}$

$\Rightarrow \quad \frac{100}{7.5} = \frac{10R}{10+R} + 10$

$\Rightarrow \quad R = 5\Omega$



PART : CHEMISTRY

61. Identify the correct statement about p-block element and their compounds.
(A) Non metals have higher electronegativity than metals.
(B) Non metals have lower ionisation enthalpy than metals.
(C) Compounds formed between highly reactive nonmetals and highly reactive metals are generally ionic.
(D) The non-metal oxides are generally basic in nature.
(E) The metal oxides are generally acidic or neutral in nature.
Choose the correct answer from the options given below :
(1) (B) and (D) only (2) (A) and (C) only (3) (B) and (E) only (4) (D) and (E) only

Ans. **NTA (2)**

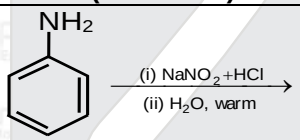
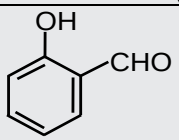
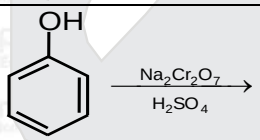
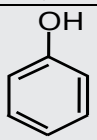
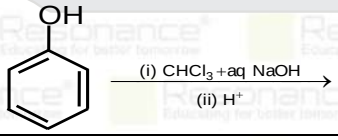
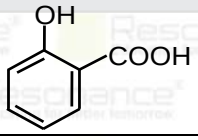
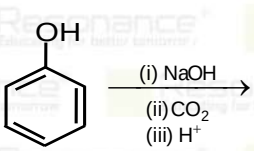
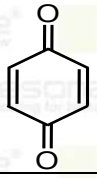
Sol. (A) p-Block have metal, Non-metal and metalloid elements.
On moving L to R in a period as E.N. increases Non-metallic nature increase.
(B) Non-metals have high I.E. as compare to metals
(C) High reactive non-metal have high E.N. and high reactive metals have low E.N. so Bond b/w these type of element leads ionic bond formation.
(D) Non-metal oxides are generally acidic in nature.
(E) metal oxide are generally basic in nature some are amphoteric

62. The correct sequence of acidic strength of the following aliphatic acids in their decreasing order is :
CH_3CH_2COOH, CH_3COOH, $CH_3CH_2CH_2COOH$, HCOOH
(1) $CH_3CH_2CH_2COOH > CH_3CH_2COOH > CH_3COOH > HCOOH$
(2) $CH_3COOH > CH_3CH_2COOH > CH_3CH_2CH_2COOH > HCOOH$
(3) $HCOOH > CH_3CH_2CH_2COOH > CH_3CH_2COOH > CH_3COOH$
(4) $HCOOH > CH_3COOH > CH_3CH_2COOH > CH_3CH_2CH_2COOH$

Ans. **NTA (4)**

Sol. +I effect decreases Ka value.

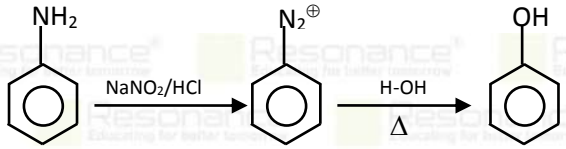
63. Match List-I with List-II.

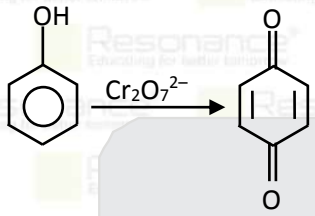
List - I (Reactions)		List – I (Products)	
(A)		(I)	
(B)		(II)	
(C)		(III)	
(D)		(IV)	

Choose the correct answer from the options given below :
(1) (A) → (IV) ; (B) → (II) ; (C) → (III) ; (D) → (I) (2) (A) → (II) ; (B) → (IV) ; (C) → (I) ; (D) → (III)
(3) (A) → (I) ; (B) → (IV) ; (C) → (II) ; (D) → (III) (4) (A) → (III) ; (B) → (II) ; (C) → (I) ; (D) → (IV)

Ans. **NTA (2)**

Sol.





(C) Riemer Teimann Formylation
(D) Kolbe carboxylation

64. Given below are two statements :
Statement – I : Kjeldahl method is applicable to estimate nitrogen in pyridine.
Statement – II : The nitrogen present in pyridine can easily be converted into ammonium sulphate in Kjeldahl method.
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) Statement I is false but Statement II is true
(4) Both Statement I and Statement II are true

Ans. **NTA (2)**

Sol. Kjeldahl method is not applicable to $-NO_2$, $-N=O$, N present in ring.

65. The reaction :

$$\frac{1}{2}H_{2(g)} + AgCl_{(s)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)} + Ag_{(s)}$$

occurs in which of the following galvanic cell :
(1) Pt | $H_{2(g)}$ | $KCl_{(soln.)}$ | $AgCl_{(s)}$ | Ag
(2) Pt | $H_{2(g)}$ | $HCl_{(soln.)}$ | $AgCl_{(s)}$ | Ag
(3) Pt | $H_{2(g)}$ | $HCl_{(soln.)}$ | $AgNO_{3(aq.)}$ | Ag
(4) Ag | $AgCl_{(s)}$ | $KCl_{(soln.)}$ | $AgNO_{3(aq.)}$ | Ag

Ans. **NTA (1)**

Sol. **Ans. (2)**

$$\frac{1}{2}H_2 + AgCl_{(s)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)} + Ag_{(s)}$$

(0) (+1) (+1) (0)

at (A) oxidation $\frac{1}{2}H_2 \longrightarrow H^+ + e^-$

at (C) Reduction $Ag^+ + e^- \longrightarrow Ag$

$$AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)}$$

$$\frac{1}{2}H_2 + AgCl_{(s)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)} + Ag_{(s)}$$

(0) (+1) (+1) (0)

Gallvanic cell is : $Pt_{(s)}$ | $H_{2(g)}$ | $HCl_{(aq)}$ |$AgCl_{(s)}$ |$Ag_{(s)}$

66. The emf of cell $Tl|\underset{(0.001\,M)}{Tl^+}||\underset{(0.01\,M)}{Cu^{2+}}|Cu$ is 0.83 V at 298 K. It could be increased by :

(1) decreasing concentration of both Tl^+ and Cu^{2+} ions
(2) increasing concentration of Tl^+ ions
(3) increasing concentration of Cu^{2+} ions
(4) increasing concentration of both Tl^+ and Cu^{2+} ions

Ans. **NTA (3)**

Sol. According to given electrochemical cell :

At (A) oxidation $(Tl \longrightarrow Tl^+ + e^-) \times 2$

At (C) Reduction $(Cu^{2+} + 2e^- \longrightarrow Cu)$

Net reaction $2Tl_{(s)} + Cu^{2+} \longrightarrow Cu + 2Tl^+$

From Nernest equation

$$E_{Cell} = E^0_{Cell} - \frac{0.0591}{n} \log \frac{(Tl^+)^2}{(Cu^{+2})^1} \quad n = 2$$

E_{Cell} increases by decreasing $[Tl^+]$ and increasing $[Cu^{2+}]$

67. Given below are two statements :

Statement-I : Fusion of MnO_2 with KOH and an oxidising agent gives dark given green K_2MnO_4.

Statement-II : Manganate ion on electrolytic oxidation in alkaline medium gives permanganate ion.

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

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

Ans. **NTA (4)**

Sol. Commercially potassium permanganate is prepared by the alkaline oxidative fusion of MnO_2 followed by the electrolytic oxidation of manganate (Vl).

$$\underset{}{MnO_2} \xrightarrow[\text{with air or } KNO_3]{\text{Fused with KOH, oxidised}} \underset{\text{manganate ion}}{MnO_4^{2-}} \qquad \underset{\text{manganate}}{MnO_4^{2-}} \xrightarrow[\text{alkaline solution}]{\text{Electrolytic oxidation in}} \underset{\text{permanganate ion}}{MnO_4^-}$$

So that Both Statement I and Statement II are true

68. Match List-I with List-II.

List - I (Complex ion)		List – I (Spin only magnetic moment in B.M.)	
(A)	$[Cr(NH_3)_6]^{3+}$	(I)	4.90
(B)	$[NiCl_4]^{2-}$	(II)	3.87
(C)	$[CoF_6]^{3-}$	(III)	0.0
(D)	$[Ni(CN)_4]^{2-}$	(IV)	2.83

Choose the correct answer from the options given below :

(1) (A) → (II) ; (B) → (III) ; (C) → (I) ; (D) → (IV) (2) (A) → (IV) ; (B) → (III) ; (C) → (I) ; (D) → (II)
(3) (A) → (II) ; (B) → (IV) ; (C) → (I) ; (D) → (III) (4) (A) → (I) ; (B) → (IV) ; (C) → (II) ; (D) → (III)

Ans. **NTA (3)**

Sol.

	List - I (Complex ion)	Metal ion	Configuration	Spin only magnetic moment in B.M. = $\sqrt{n(n+2)}$
(A)	$[Cr(NH_3)_6]^{3+}$	Cr^{+3}	d^3 : t_{2g}^{111} eg^{00}	$\sqrt{15}$ = 3.87
(B)	$[NiCl_4]^{2-}$	Ni^{+2}	d^8 : t_{2g}^{211} eg^{22}	$\sqrt{8}$ = 2.83
(C)	$[CoF_6]^{3-}$	Co^{+3}	d^6 : t_{2g}^{211} eg^{11}	$\sqrt{24}$ = 4.90
(D)	$[Ni(CN)_4]^{2-}$	Ni^{+2}	d^8 : d_{xz}^2 d_{yz}^2 , d_z^2 d_{xy}^2 $d_{x^2y^2}^0$	$\sqrt{0}$ = 0.0

So option (3) (A) → (II) ; (B) → (IV) ; (C) → (I) ; (D) → (III)

69. For a reaction A $\xrightarrow{K_1}$ B $\xrightarrow{K_2}$ C

If the rate of formation of B is set to be zero then the concentration of B is given by :

(1) (K_1/K_2) [A] (2) (K_1K_2) [A] (3) $(K_1 + K_2)$ [A] (4) $(K_1 – K_2)$ [A]

Ans. **NTA (1)**

Sol. For reaction A $\xrightarrow{K_1}$ B $\xrightarrow{K_2}$ C

Rate of formation of (B) = $\frac{d[B]}{dt}$ = $(K_1(A)) + (-K_2(B))$

According to question if $\frac{d[B]}{dt} = 0$

$K_1[A] – K_2[B] = 0$; $[B] = \frac{K_1[A]}{K_2}$

70. Given below are two statements :

Statement - I : S_N2 reactions are 'stereospecific', indicating that they result in the formation of only one stereo-isomer as the product.

Statement - II : S_N1 reactions generally result in formation of product as racemic mixture.

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

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

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

Ans. **NTA (3)**

Sol. S_N2 has rear side attack hence stereospecific inverted product is obtained S_N1 reaction has $C^{\oplus}$ intermediate hence gramic pro. are abstained

71. When ψ_A and ψ_B are the wave functions of atomic orbitals, then σ^* is represented by :

(1) $\psi_A – 2\psi_B$ (2) $\psi_A + 2\psi_B$ (3) $\psi_A + \psi_B$ (4) $\psi_A – \psi_B$

Ans. **NTA (4)**

Sol. Formation of MO by LCAO principal : A + B
according to 2 type of combination : $\psi_A\ \psi_B$
(i) constructive interference
(ii) distructive interference

A + B



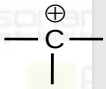
ψ_A + ψ_B

(i)  $\psi_A + \psi_B$ = bonding M.O. (σ, π)

(ii)  $\psi_A - \psi_B$ = Anti bonding M.O. (σ^*, π^*)

72. The shape of carbocation is :
(1) diagonal (2) diagonal pyramidal (3) tetrahedral (4) trigonal planar

Ans. **NTA (4)**

Sol.  Trigonal planar

73. Given below are two statements :
Statement-I : All the following compounds react with p-toluenesulfonyl chloride.
$C_6H_5NH_2$ $(C_6H_5)_2NH$ $(C_6H_5)_3N$
Statement-II : Their products in the above reaction are soluble is aqueous NaOH.
In the light of the above statements, choose the correct answer from the options given below:
(1) Both **Statement I** and **Statement II** are true (2) Both **Statement I** and **Statement II** are false
(3) **Statement I** is true but **Statement II** is false (4) **Statement I** is false but **Statement II** is true

Ans. **NTA (2)**

Sol. 3º amine does not react with hinsberg reagent only i amine product is soluble in aq. NaOH hence both statement in Q are false.

74. In qualitative test for identification of presence of phosphorous, the compound is heated with an oxidising agent. Which is further treated with nitric acid and ammonium molybdate respectively. The yellow coloured precipitate obtained is :
(1) $(NH_4)_3PO_4.12(NH_4)_2MoO_4$ (2) $MoPO_4.21NH_4NO_3$
(3) $Na_3PO_4.12MoO_3$ (4) $(NH_4)_3PO_4.12MoO_3$

Ans. **NTA (4)**

75. Match **List-I** with **List-II**.

	List-I (Test)		**List-II (Identification)**
(A)	Bayer's test	(I)	Phenol
(B)	Ceric ammonium nitrate test	(II)	Aldehyde
(C)	Phthalein dye test	(III)	Alcoholic-OH group
(D)	Schiff's test	(IV)	Unsaturation

Choose the **correct** answer from the options given below :
(1) (A) - (IV), (B) - (III), (C) - (I), (D) - (II) (2) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)
(3) (A) - (IV), (B) - (I), (C) - (II), (D) - (III) (4) (A) - (III), (B) - (I), (C) - (IV), (D) - (II)

Ans. **NTA (1)**

Sol. Bayer Test C=C, C≡C
Fact based.

76. Given below are two statements :

Statement-I : a Buffer solution is the mixture of a salt and an acid or a base mixed in any particular quantities.

Statement-II : Blood is naturally occurring buffer solution whose pH is maintained by H_2CO_3/HCO_3^- concentrations.

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

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

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

Ans. **NTA (3)**

Sol. **Statement-I :** Buffer solution is the mixture of weak acid or weak base with their respective salt with strong base or strong acid or with conjugate base or conjugate acid in particular quantities in which WA or WB > respective salts) not in any quantities

Statement-II : Blood is a buffer solution of combination of H_2CO_3 + HCO_3^- .

So Statements-I is False and Statement-II is true.

77. The equilibrium $Cr_2O_7^{2-} \rightleftharpoons 2CrO_4^{2-}$ is shifted to the right in :

(1) an acidic medium (2) a weakly acidic medium

(3) a neutral medium (4) a basic medium

Ans. **NTA (4)**

Sol. The chromates and dichromates are interconvertible in aqueous solution depending upon pH of the solution. The oxidation state of chromium in chromate and dichromate is the same.

$2\,CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$

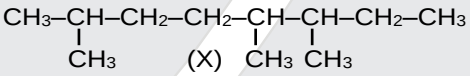
$Cr_2O_7^{2-} + 2OH^- \rightarrow 2\,CrO_4^{2-} + H_2O$

$Cr_2O_7^{2-} \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} 2CrO_4^{2-}$

So in basic medium this equilibrium shifted to right side.

It is a PH change reaction not redox reaction

78. IUPAC name of following hydrocarbon(X) is :

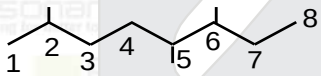


(1) 3,4,7-Trimethyloctane (2) 2-Ethyl-3,6-dimethylheptane

(3) 2,5,6-Trimethyloctane (4) 2-Ethyl-2,6-diethylheptane

Ans. **NTA (3)**

Sol.



79. Which one the following compounds will readily react with dilute NaOH ?

(1) $(CH_3)_3COH$ (2) $C_6H_5CH_2OH$ (3) C_6H_5OH (4) C_2H_5OH

Ans. **NTA (3)**

Sol. Phenols are Acidic hence readily reacts with base

80. Identify the **incorrect** statements about group 15 elements :

(A) Dinitrogen is a diatomic gas which acts like and inert gas at room temperatuere.

(B) The common oxidation states of these elements are –3, +3 and +5.

(C) Nitrogen has unique ability to form $p\pi - p\pi$ multiple bonds.

(D) The stability of +5 oxidation states increases down the group.

(E) Nitrogen shows a maximum covalency of 6.

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

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

Ans. **NTA (3)**

81. $\Delta_{vap}H^o$ for water is +40.79 kJ mol^{-1} at 1 bar and 100°C, Change in internal energy for this vapourisation under same condition is _____ kJ mol^{-1}. (Integer answer)
(Given R = 8.3 JK^{-1} mol^{-1})

Ans. **NTA (38)**

Sol. $H_2O(g) \rightleftharpoons H_2O(g)$

ΔH_{Vap} = +40.79 kJ/mole at T = 100°C, P = 1 bar = 373.15 K

$\Delta H = \Delta E + \Delta_{ng}RT$

$+40.79 \times 10^3 = \Delta E + 1 \times 8.3 \times 37.315$

$\Delta E = 40.79 \times 10^3 - 3097.4 = (40.79 - 3.0974) \times 10^3$

$\Delta E = 37.6926 - 38$ kJ/mole

82. Wavenumber for a radiation having 5800 Å wavelength is x × 10 cm^{-1}. The value of x is _____.

Ans. **NTA (1724)**

Sol. Wave number $\bar{\nu} = \frac{1}{\lambda}$

$$\bar{\nu} = \frac{1}{5800 \times 10^{-8}} = 17241.3 \text{ cm} = 1724.13 \times 10 \text{ cm}^{-1}$$

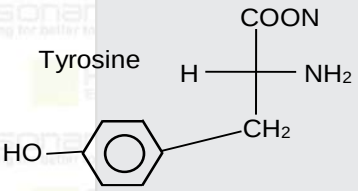
$\bar{\nu} = 1724 \times 10$ cm^{-1}

83. The total number of carbon atoms present in tyrosine, an amino acid, is _____.

Ans. **NTA (9)**

Sol.

Tyrosine



84. Total number of unpaired electrons in the complex ion $[Co(NH_3)_6]^{3+}$ and $[NiCl_4]^{2-}$ is _____.

Ans. **NTA (2)**

Sol.

	Complex ion	Metal ion	e-Configuration	No. of unpaired electron
(A)	$[Co(NH_3)_6]^{3+}$	Co^{+3}	$d^6 : t_{2g}^{222}\ eg^{00}$	(0)
(B)	$[NiCl_4]^{2-}$	Ni^{+2}	$d^8 : e^{22}\ t_2^{211}$	(2)

Total no. of unpaired electrons = 0 + 2 = 2

85. Number of molecules having bond order 2 from the following molecules is _____.
C_2, O_2, Be_2, Li_2, Ne_2, N_2, He_2,

Ans. **NTA (2)**

Sol. $C_2 : \sigma1s^2\sigma^*1s^2\sigma2s^2\sigma^*2s^2\pi2p_x^2 = \pi2p_y^2\ \sigma2p_z^0$

$$\text{Bond order} = \frac{n_b - n_a}{2} = \frac{8-4}{2} = 2$$

$O_2 : \sigma1s^2\sigma^*1s^2\sigma2s^2\sigma^*2s^2\sigma2p_z^2\ \pi2p_x^2 = \pi2p_x^2\ \pi^*2p_y^1 = \pi^*2p_y^1$

$$\text{Bond order} = \frac{n_b - n_a}{2} = \frac{10-6}{2} = 2$$

$Be_2 : \sigma1s^2\sigma^*1s^2\sigma2s^2\sigma^*2s^2$

$$\text{Bond order} = \frac{n_b - n_a}{2} = \frac{4-4}{2} = 0$$

$Li_2 : \sigma1s^2\sigma^*1s^2\sigma2s^2\sigma^*2s^0$

Bond order = $\frac{n_b - n_a}{2} = \frac{4-2}{2} = 1$

Ne_2 : $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi^* 2p_x^2\ \pi 2p_y^2 = \pi^* 2p_y^2\ \sigma^* 2p_z^2$

Bond order = $\frac{n_b - n_a}{2} = \frac{10-10}{2} = 0$

N_2 : $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2\ \sigma 2p_z^2$

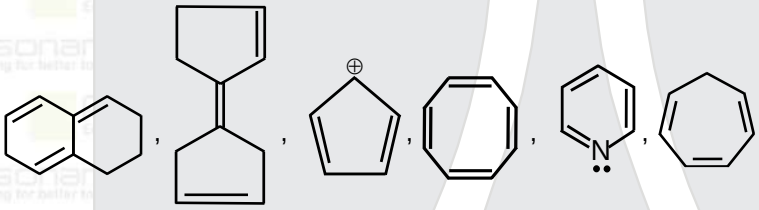
Bond order = $\frac{n_b - n_a}{2} = \frac{10-4}{2} = 3$

He_2 : $\sigma 1s^2 \sigma^* 1s^2$

Bond order = $\frac{n_b - n_a}{2} = \frac{2-2}{2} = 0$

Only molecule C_2, O_2 have bond order = 2 Ans. (2)

86. The number of aromatic compounds among the following compound is _____.



Ans. **NTA (1)**

Sol.  is Aromatic

87. Molality of an aqueous solution of urea is 4.44 m. Mole fraction of urea in solution is $x \times 10^{-3}$. Value of x is _____. (Integer answer)

Ans. **NTA (74)**

Sol. **Method – 1**

Molality = 4.44 m, Mole fraction of solute x = ? Solvent = H_2O

$M.M_{H_2O}$ = 18 g/mol

$$m = \frac{X_{solute} \times 1000}{(1 - X_{solute}) \times (mm)_{solvent}}$$

$$= 4.44 = \frac{X_{solute} \times 1000}{(1 - X_{solute}) \times 18}$$

$X_{solute} = 74 \times 10^{-3}$

Method – 2

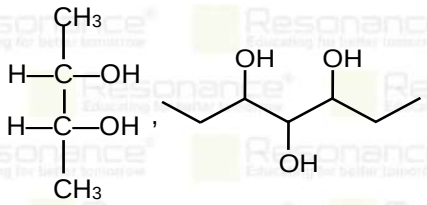
Molality = 4.44 m means , 4.44 mole of solute (urea) dissolve in 1000 gm of $H_2O_{(l)}$

So, n_1 = 4.44 mole $n_2 = \frac{1000}{18} = 55.5$ mole

$$x_1 = \frac{n_1}{n_1 + n_2} = \frac{4.44}{4.44 + 55.5}$$

$$x_1 = \frac{4.44}{59 + 94} = 74 \times 10^{-3}$$

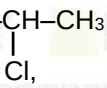
88. Total number of optically active compounds from the following is _____.



,

,

$CH_3–CH_2–CH_2–CH_2–OH$,



,

$CH_3–CH_2–CH_2–CH_2–Cl$,

$(CH_3)_2CH–CH_2–CH_2–Cl$

Ans. **NTA (1)**
RESO (1 or 2)

89. A solution is prepared by adding 1 mole ethyl alcohol in 9 mole water. The mass percent of solute in the solution is _____ (Integer answer) (Given : Molar mass in g mol^{-1} Ethyl alcohol : 46 water : 18)

Ans. **NTA (22)**

Sol. $n_{C_2H_5OH} = 1$ $\quad n_{H_2O} = 9$

$w_{C_2H_5OH} = 1 \times MM_{C_2H_5OH} = 1 \times 46 = 46$ gm

$W\ H_2O = 9 \times MM_{H_2O} = 9 \times 18 = 162$ gm

Mass % of C_2H_5OH = w/w % = $\frac{w_1}{w_1 + w_2} \times 100$

$= \frac{46}{46+162} \times 100 = 22.11\ \% \approx 22$

90. Two moles of benzaldehyde and one mole of acetone under alkaline conditions using aqueous NaOH after heating gives x as the major product. The number of π bonds in the product x is _____.

Ans. **NTA (9)**

Sol.

