(Held On Monday 27th June, 2022) **TIME : 9 : 00 AM to 12 : 00 PM**

MATHEMATICS | TEST PAPER WITH SOLUTION

SECTION-A

1. The area of the polygon, whose vertices are the non-real roots of the equation $\overline{z} = iz^2$ is :

(A) $\frac{3\sqrt{3}}{4}$ (B) $\frac{3\sqrt{3}}{2}$

(C) $\frac{3}{2}$ (D) $\frac{3}{4}$

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. $\Rightarrow$ Let $z = x + iy$, $x, y \in R$

Now $\overline{z} = iz^2$

then $x - iy = i(x^2 - y^2 + 2xyi)$

$x - iy = i(x^2 - y^2) - 2xy$

$\Rightarrow x = -2xy \;\; \& \;\; -y = x^2 - y^2$

$\Rightarrow x(1 + 2y) = 0$

$x = 0$ or $y = -\frac{1}{2}$

Put $x = 0$ in $-y = x^2 - y^2$

We get $y = y^2$

$\Rightarrow y = 0, 1$

Similarly

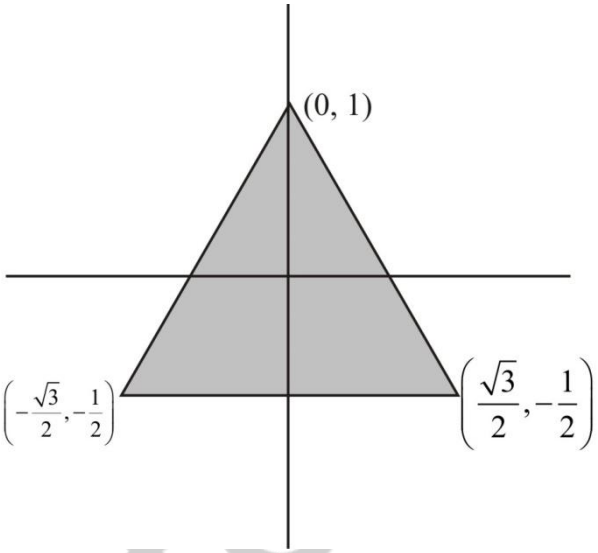
Put $y = -\frac{1}{2}$ in $-y = x^2 - y^2$

$\Rightarrow \frac{1}{2} = x^2 - \frac{1}{4}$

$\Rightarrow x^2 = \frac{3}{4}$

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

$z = \left(0, i, \frac{\sqrt{3}}{2} - \frac{1}{2}i, -\frac{\sqrt{3}}{2} - \frac{1}{2}i\right)$



$Area = \frac{1}{2}.\left(\sqrt{3}\right)\left(\frac{3}{2}\right)$

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

2. Let the system of linear equations $x + 2y + z = 2$, $\alpha x + 3y - z = \alpha$, $-\alpha x + y + 2z = -\alpha$ be inconsistent. Then α is equal to :

(A) $\frac{5}{2}$ (B) $-\frac{5}{2}$

(C) $\frac{7}{2}$ (D) $-\frac{7}{2}$

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $\Delta = \begin{vmatrix} 1 & 2 & 1 \\ 2 & 3 & -1 \\ -2 & 1 & 2 \end{vmatrix}$

$= (6 + y) - 2((2\alpha - \alpha) + 1(\alpha + 3\alpha)$

$= 7 - 2\alpha + 4\alpha$

$= 7 + 2\alpha$

$\Delta = 0 \Rightarrow \alpha = -\frac{7}{2}$

$$\Delta_1 = \begin{vmatrix} 2 & 2 & 1 \\ \alpha & 3 & -1 \\ -\alpha & 1 & 2 \end{vmatrix}$$

$= 14 + 2\alpha$

$\alpha = -x_2 = 7$

$\Delta_1 \neq 0$

3. If $x = \sum_{n=0}^{\infty} a^n, y = \sum_{n=0}^{\infty} b^n, z = \sum_{n=0}^{\infty} c^n$, where a, b, c are in A.P. and $|a| < 1, |b| < 1, |c| < 1, abc \neq 0$, then

(A) x, y, z are in A.P.

(B) x, y, z are in G.P.

(C) $\frac{1}{x}, \frac{1}{y}, \frac{1}{z}$ are in A.P.

(D) $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 1 - (a + b + c)$

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol. $x = 1 + a + a^2 = \ldots\ldots\ldots$

$$x = \frac{1}{1-a} \Rightarrow a = 1 - \frac{1}{x}$$

$$y = \frac{1}{1-b} \Rightarrow b = 1 - \frac{1}{y}$$

$$z = \frac{1}{1-c} \Rightarrow c = 1 - \frac{1}{z}$$

a, b, c are in A.P.

$\Rightarrow 1 - \frac{1}{x}, 1 - \frac{1}{y}, 1 - \frac{1}{z}$ are in A.P.

$\Rightarrow -\frac{1}{x}, -\frac{1}{y}, -\frac{1}{z}$ are in A.P.

$\Rightarrow \frac{1}{x}, \frac{1}{y}, \frac{1}{z}$ are in A.P.

4. Let $\frac{dy}{dx} = \frac{ax - by + a}{bx + cy + a}$, where a, b, c are constants, represent a circle passing through the point (2, 5). Then the shortest distance of the point (11, 6) from this circle is :

(A) 10 (B) 8

(C) 7 (D) 5

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. Let equation of circle is

$x^2 + y^2 + 2gx + 2fy + c = 0$

$$\Rightarrow \frac{dy}{dx} = \frac{-(2x + 2g)}{(2y + 2f)}$$

Comparing with $\frac{dy}{dx} = \frac{ax - by + a}{bx + cy + a}$

$\Rightarrow b = 0, a = -2, c = 2$

$\Rightarrow -2g = -2 \Rightarrow g = 1$ $\quad 2f = -2$

$f = -1$

Now circle will be

$x^2 + y^2 + 2x - 2y + c = 0$

its passes through (2, 5)

which will give c = -23

so circle will be $x^2 + y^2 + 2x - 2y - 23 = 0$

centre C = (-1, 1)

and radius 5

Now P is (11, 6)

So minimum distance of P from circle will be

$= \sqrt{(11+1)^2 + (6-1)^2} - 5$

$= 13 - 5$

$= 8$

5. Let a be an integer such that $\lim_{x \to 7} \frac{18 - [1 - x]}{[x - 3a]}$ exists, where [t] is greatest integer $\leq$ t. Then a is equal to :

(A) -6 (B) -2

(C) 2 (D) 6

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. $\lim\limits_{x\to 7}\dfrac{18-[1-x]}{[x]-3a}$

L.H.L. $\lim\limits_{x\to 7-}\dfrac{18-[1-x]}{[x]-3a}$

$=\dfrac{18-(-6)}{6-3a}$

$=\dfrac{24}{6-3a}$

R.H.L. $\lim\limits_{x\to 7+}\dfrac{18-[1-x]}{[x]-3a}$

$=\dfrac{18-(-7)}{7-3a}$

$=\dfrac{25}{7-3a}$

Now L.H.L. = R.H.L.

$\dfrac{24}{6-3a}=\dfrac{25}{7-3a}$

$\Rightarrow 168-72a=150-75a$

$\Rightarrow 18=-3a$

$\Rightarrow$ a = -6

6. The number of distinct real roots of $x^4 - 4x + 1 = 0$ is :

(A) 4 (B) 2

(C) 1 (D) 0

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. Let $f(x)=x^4-4x+1$

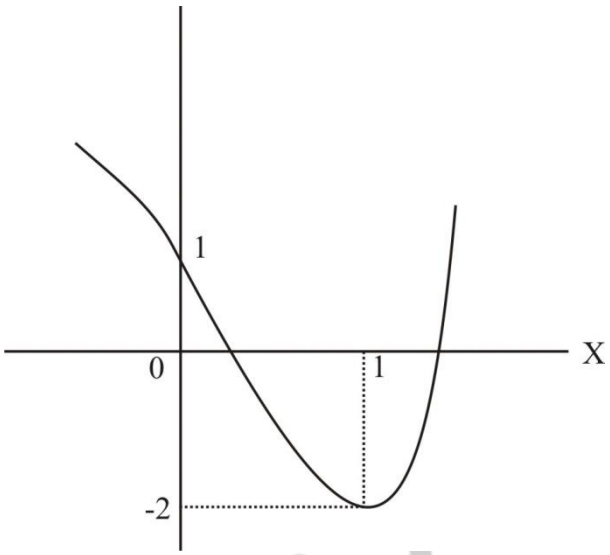
$f'(x) = 4x^3 - 4$

$f'(x) = 0 \Rightarrow x = 1$

x = 1 is point of minima.

f(1) = - 2

f(0) = 1



Hence 2 solutions.

7. The lengths of the sides of a triangle are $10 + x^2$, $10 + x^2$ and $20 - 2x^2$. If for x = k, the area of the triangle is maximum, then $3k^2$ is equal to :

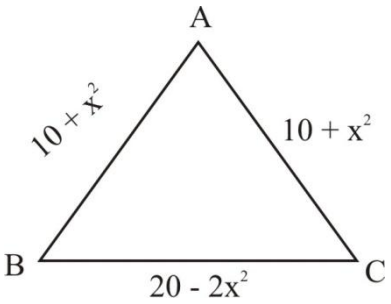
(A) 5 (B) 8

(C) 10 (D) 12

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol.



$a = 20 - 2x^2$, $b = 10 + x^2$, $c = 10 + x^2$

$=\dfrac{a+b+c}{2}$

= 20

$\Delta=\sqrt{s(s-a)(s-b)(s-c)}$

$=\sqrt{20(2x^2)(10-x^2)(10-x^2)}$

$=2\sqrt{10}\sqrt{x^2(10-x^2)^2}$

$=2\sqrt{10}\left|x(10-x^2)\right|$

$= 2\sqrt{10}\,\left|10x - x^3\right|$

$S = 10x - x^3$

$\frac{ds}{dx} = 10 - 3x^2$

$\frac{ds}{dx} = 0 \Rightarrow x^2 = \frac{10}{3}$

$3x^2 = 10$

8. If $\cos^{-1}\left(\frac{y}{2}\right) = \log_e\left(\frac{x}{5}\right)^5$, $|y| < 2$, then :

(A) $x^2y'' + xy' - 25y = 0$

(B) $x^2y'' - xy' - 25y = 0$

(C) $x^2y'' - xy' + 25y = 0$

(D) $x^2y'' + xy' + 25y = 0$

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $\cos^{-1}\left(\frac{y}{2}\right) = \log_e\left(\frac{x}{5}\right)^5$

$\cos^{-1}\left(\frac{y}{2}\right) = 5\log_e\left(\frac{x}{5}\right)$

$\frac{-1}{\sqrt{1-\frac{y^2}{4}}}.\frac{y'}{2} = 5.\frac{1}{\frac{x}{5}} \times \frac{1}{5}$

$\Rightarrow \frac{-y'}{\sqrt{4-y^2}} = \frac{5}{x}$

$-xy' = 5\sqrt{4-y^2}$

$-xy'' - y' = 5.\frac{1}{2\sqrt{4-y^2}}(-2y\ y')$

$\Rightarrow xy'' + y' = \frac{5y'.y}{\sqrt{4-y^2}}$

$xy'' + y' = 5.\left(\frac{-5}{x}\right)y$

$x^2y'' + xy' = -25y$

9. $\int \frac{(x^2+1)e^x}{(x+1)^2}dx = f(x)e^x + C$, Where C is a constant, then $\frac{d^3f}{dx^3}$ at x = 1 is equal to :

(A) $-\frac{3}{4}$ (B) $\frac{3}{4}$

(C) $-\frac{3}{2}$ (D) $\frac{3}{2}$

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. $\int\left(\frac{x^2+1}{(x+1)^2}\right)e^x.dx$

$= \int\left(\frac{x^2-1+2}{(x+1)^2}\right)e^x\,dx$

$= \int\left(\frac{x-1}{x+1} + \frac{2}{(x+1)^2}\right)e^x\,dx$

$= \int\left(f(x) + f'(x)\right)e^x\,dx$

$= f(x)\,e^x + c$

Where $f(x) = \frac{x-1}{x+1}$

$f'(x) = \frac{2}{(x+1)^2}$

$f''(x) = \frac{-4}{(x+1)^3}$

$= \frac{12}{(x+1)^4}$

$f''(1) = \frac{12}{16}$

$= \frac{3}{4}$

10. The value of the integral $\int_{-2}^{2}\frac{|x^3+x|}{\left(e^{x|x|}+1\right)}dx$ is equal to :

(A) $5e^2$ (B) $3e^{-2}$

(C) 4 (D) 6

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $f(x)=\frac{|x^3+x|}{\left(e^{x|x|}+1\right)}\,dx$

$$\int_{-2}^{2} f(x)\,dx=\int_{0}^{2}\left(f(x)+f(-x)\right)dx$$

$$=\int_{0}^{2}\left(\frac{|x^3+x|}{\left(e^{x|x|}+1\right)}+\frac{|-x^3-x|}{\left(e^{-x|-x|}+1\right)}\right)dx$$

$$=\int_{0}^{2}\left(\frac{|x^3+x|}{\left(e^{x|x|}+1\right)}+\frac{|x^3+x|}{\left(e^{-x|x|}+1\right)}\right)dx$$

$$=\int_{0}^{2}\left(\frac{x^3+x}{\left(e^{x^2}+1\right)}+\frac{x^3+x}{\left(e^{-x^2}+1\right)}\right)dx$$

$$I=\int_{0}^{2}\left(\frac{x^3+x}{1+e^{x^2}}+\frac{e^{x^2}\left(x^3+x\right)}{1+e^{x^2}}\right)dx$$

$$=\int_{0}^{2}\left(x^3+x\right)dx$$

$$=\left[\frac{x^4}{4}+\frac{x^2}{2}\right]_0^2$$

$= 4 + 2 = 6$

11. If $\frac{dy}{dx}+\frac{2^{x-y}\left(2^y-1\right)}{2^x-1}=0, x, y>0, y(1)=1$, then y(2) is equal to :

(A) $2+\log_2 3$ (B) $2+\log_2 2$

(C) $2-\log_2 3$ (D) $2-\log_2 3$

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $\frac{dy}{dx}+\frac{2^{x-y}\left(2^y-1\right)}{2^x-1}=0$,

x, y > 0, y(1) = 1, y (2) = ?

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

$$\int\frac{2^y}{2^y-1}dy=-\int\frac{2^x}{2^x-1}dx$$

$$\frac{1}{\ln 2}\int\frac{2^y\ln 2}{2^y-1}dy=-\frac{1}{\ln^2}\int\frac{2^x\ln 2}{2^x-1}dx$$

$$\frac{1}{\ln 2}\ln\left|2^y-1\right|=\frac{-1}{\ln 2}\ln\left|2^x-1\right|+C$$

At x= 1, y = 1

Putting this values in above relation we get C = 0

$$\ln\left|2^y-1\right|+\ln\left|2^x-1\right|=0$$

$$\left(2^x-1\right)\left(2^y-1\right)=1$$

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

At x = 2

$$2^y=\frac{1}{3}+1=\frac{4}{3}$$

$$y=\log_2\frac{4}{3}=\log_2 4-\log_2 3=2-\log_2 3$$

12. In an isosceles triangle ABC, the vertex A is (6, 1) and the equation of the base BC is 2x + y = 4. Let the point B lie on the line x + 3y = 7. If (α, β) is the centroid ΔABC, then $15(\alpha+\beta)$ is equal to :

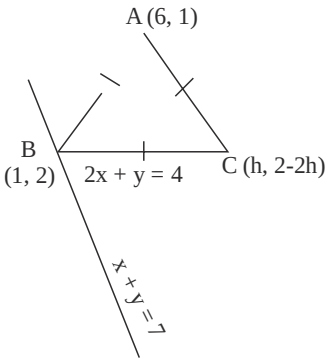
(A) 39 (B) 41

(C) 51 (D) 63

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol.



Point B (1, 2)

Now let C be (h, 4 - 2h)

(As C lies on 2x + y = 4)

$\because \Delta$ is isosceles with base BC

$\therefore AB = AC$

$$\sqrt{25+1} = \sqrt{(6-h)^2 + (2h-3)^2}$$

$$\sqrt{26} = \sqrt{36 + h^2 - 12h + 4h^2 + 9 - 12h}$$

$$26 = 5h^2 - 24h + 45 \Rightarrow 5h^2 - 24h + 19 = 0$$

$$\Rightarrow 5h^2 - 5h - 19h + 19 = 0$$

$h = \frac{19}{5}$ or h = 1

Thus $C\left(\frac{19}{5}, \frac{-18}{5}\right)$

Centroid $\left(\frac{6+1+\frac{19}{5}}{3}, \frac{1+2-\frac{18}{5}}{3}\right)$

$$\left(\frac{35+19}{15}, \frac{15-18}{15}\right)$$

$$\left(\frac{54}{15}, \frac{-3}{15}\right)$$

$$\alpha = \frac{54}{15}; \beta = \frac{-3}{15}$$

$$15(\alpha + \beta) = 51$$

13. Let the eccentricity of an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b,$ be $\frac{1}{4}$. If this ellipse passes through the point $\left(-4\sqrt{\frac{2}{5}}, 3\right)$, then $a^2 + b^2$ is equal to :

(A) 29 (B) 31

(C) 32 (D) 34

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ a > b

$$e^2 = 1 - \frac{b^2}{a^2}$$

$$\frac{1}{16} = 1 - \frac{b^2}{a^2}$$

$$\frac{b^2}{a^2} = 1 - \frac{1}{16} = \frac{15}{16} \Rightarrow b^2 = \frac{15}{16}a^2$$

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

$$\frac{16 \times \frac{2}{5}}{a^2} + \frac{9}{b^2} = 1$$

$$\frac{32}{5a^2} + \frac{9}{b^2} = 1$$

$$\frac{32}{5a^2} + \frac{9}{\frac{15}{16}a^2} = 1$$

$$\frac{80}{5a^2} = 1$$

$16 = a^2$

$b^2 = 15$

14. If two straight lines whose direction cosines are given by the relations l + m – n = 0, $3l^2 + m^2 + cnl = 0$ are parallel, then the positive value of c is :

(A) 6 (B) 4

(C) 3 (D) 2

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. l + m – n = 0

$3l^2 + m^2 + cl(l + m) = 0$

n = l + m

$3l^2 + m^2 + cl^2 + clm = 0$

$(3 + c) l^2 + clm + m^2 = 0$

$$(3+c)\left(\frac{l}{m}\right)^2 + c\left(\frac{l}{m}\right) + 1 = 0 \ldots..(1)$$

$\because$ lies are parallel.

Roots of (1) must be equal

$\Rightarrow D = 0$

$c^2 - 4(3 + c) = 0$

$c^2 - 4c - 12 = 0$

(c – 6) (c + 2) = 0

c = 6 or c = - 2

+ve value of c = 6

15. Let $\vec{a} = \hat{i} + \hat{j} - \hat{k}$ and $\vec{c} = 2\hat{i} - 3\hat{j} + 2\hat{k}$. Then the number of vectors $\vec{b}$ such that $\vec{b} \times \vec{c} = \vec{a}$ and $|\vec{b}| \in \{1, 2, \ldots.., 10\}$ is :

(A) 0 (B) 1

(C) 2 (D) 3

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. $\vec{a} = i + j - k$

$\vec{c} = 2i - 3j + 2k$

$\vec{b} \times \vec{c} = \vec{a}$

$|\vec{b}| \in \{1, 2 \ldots\ldots 10\}$

$\because \vec{b} \times \vec{c} = \vec{a}$

$\Rightarrow \vec{a}$ is perpendicular to $\vec{b}$ as well as $\vec{a}$ is perpendicular to $\vec{c}$

Now $\vec{a}.\vec{c} = 2 - 3 - 2 = -3 \neq 0$

This $\vec{b} \times \vec{c} = \vec{a}$ is not possible.

No. of vectors $\vec{b} = 0$

16. Five numbers x_1, x_2, x_3, x_4, x_5 are randomly selected from the numbers 1, 2, 3,……, 18 and are arranged in the increasing order ($x_1 < x_2 < x_3 < x_4 < x_5$). The probability that $x_2 = 7$ and $x_4 = 11$ is :

(A) $\frac{1}{136}$ (B) $\frac{1}{72}$

(C) $\frac{1}{68}$ (D) $\frac{1}{34}$

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol. No. of ways to select and arrange x_1, x_2, x_3, x_4, x_5 from 1, 2, 3……18

$n(s) = {}^{18}C_5$

$x_1 \quad (x_2) \quad x_3 \quad (x_4) \quad x_5$

$\quad\quad 7 \quad\quad\quad 11$

$n(E) = {}^6C_1 \times {}^3C_1 \times {}^7C_1$

$$P(E) = \frac{6 \times 3 \times 7}{{}^{18}C_5}$$

$$\frac{1}{17 \times 4} = \frac{1}{68}$$

17. Let X be a random variable having binomial distribution B(7, p). If P(X = 3) = 5P(X = 4), then the sum of the mean and the variance of X is :

(A) $\frac{105}{16}$ (B) $\frac{7}{16}$

(C) $\frac{77}{36}$ (D) $\frac{49}{16}$

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol. B (7, p)

n = 7 p = p

given

$P(x = 3) = 5P(x = 4)$

$${}^7C_3 \times p^3(1-p)^4 = 5.{}^7C_4 p^4(1-p)^3$$

$$\frac{{}^7C_3}{5\times {}^7C_4} = \frac{p}{1-p}$$

1 – p = 5p

6p = 1

$$p = \frac{1}{6} \Rightarrow q = \frac{5}{6}$$

n = 7

$$\text{Mean} = np = 7\times\frac{1}{6} = \frac{7}{6}$$

$$\text{Var} = npq = 7\times\frac{1}{6}\times\frac{5}{6} = \frac{35}{36}$$

Sum

$$= \frac{7}{6} + \frac{35}{36}$$

$$= \frac{42+35}{36}$$

$$= \frac{77}{36}$$

18. The value of $\cos\left(\frac{2\pi}{7}\right)+\cos\left(\frac{4\pi}{7}\right)+\cos\left(\frac{6\pi}{7}\right)$ is equal to :

(A) -1 (B) $-\frac{1}{2}$

(C) $-\frac{1}{3}$ (D) $-\frac{1}{4}$

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. $\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{6\pi}{7}$

$$= \frac{\sin\left(3\times\frac{\pi}{7}\right)}{\sin\frac{\pi}{7}}\times\cos\left(\frac{\frac{2\pi}{7}+\frac{6\pi}{7}}{2}\right)$$

$$= \frac{2\sin\left(\frac{3\pi}{7}\right)}{2\sin\frac{\pi}{7}}\times\cos\left(\frac{4\pi}{7}\right)$$

$$= \frac{\sin\left(\frac{7\pi}{7}\right)+\sin\left(\frac{-\pi}{7}\right)}{2\sin\frac{\pi}{7}}$$

$$= \frac{-\sin\frac{\pi}{7}}{2\sin\frac{\pi}{7}}$$

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

19. $\sin^{-1}\left(\sin\frac{2\pi}{3}\right)+\cos^{-1}\left(\cos\frac{7\pi}{6}\right)+\tan^{-1}\left(\tan\frac{3\pi}{4}\right)$ is equal to :

(A) $\frac{11\pi}{12}$ (B) $\frac{17\pi}{12}$

(C) $\frac{31\pi}{12}$ (D) $-\frac{3\pi}{4}$

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. $\sin^{-1}\left(\sin\frac{2\pi}{3}\right)+\cos^{-1}\left(\cos\frac{7\pi}{6}\right)+\tan^{-1}\tan\left(\frac{3\pi}{4}\right)$

$$\sin^{-1}\sin\left(\frac{2\pi}{3}\right) = \pi - \frac{2\pi}{3} = \frac{\pi}{3}$$

$$\cos^{-1}\left(\cos\frac{2\pi}{6}\right) = 2\pi - \frac{7\pi}{6} = \frac{5\pi}{6}$$

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

$$\sin^{-1}\left(\sin\frac{2\pi}{3}\right)+\cos^{-1}\cos\frac{7\pi}{6}+\tan^{-1}\tan\frac{3\pi}{4}$$

$$= \frac{11\pi}{12}$$

20. The Boolean expression $(\sim(p \wedge q)) \vee q$ is equivalent to :

(A) $q \rightarrow (p \wedge q)$ (B) $p \rightarrow q$

(C) $p \rightarrow (p \rightarrow q)$ (D) $p \rightarrow (p \vee q)$

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. (~(p^q)) ∨ q

= (~p ∨ ~q) ∨ q

= ~p ∨ ~ q ∨ q

= ~ p ∨ t

= this statement is a tautology option D

p ⇒ (p ∨ q) is also a tautology.

OR

p	q	P^q	~(p^q)	~(p^q) ∨ q	p ∨ q	$p \rightarrow (p \vee q)$
T	T	T	F	T	T	T
T	F	F	T	T	T	T
F	T	F	T	T	T	T
F	F	F	T	T	F	T

SECTION-B

21. Let $f : R \rightarrow R$ be a function defined $f(x) = \frac{2e^{2x}}{e^{2x}+e}$.

Then $f\left(\frac{1}{100}\right)+f\left(\frac{2}{100}\right)+f\left(\frac{3}{100}\right)+.....+f\left(\frac{99}{100}\right)$ is equal to_____.

Official Ans. by NTA (99)

QuestPix Ans. (99)

Sol.

$$f(x)+f(1-x) = \frac{2e^{2x}}{e^{2x}+e} + \frac{2e^{2-2x}}{e^{2-ex}+e} = \left[\frac{e^{2x}}{e^{2x}+e} + \frac{e^2}{e^2+e^{2x+1}}\right]$$

$$= 2\left[\frac{e^{2x-1}}{e^{2x-1}+1} + \frac{1}{1+e^{2x-1}}\right] = 2$$

$$f\left(\frac{1}{100}\right)+f\left(\frac{2}{100}\right)+f\left(\frac{3}{100}\right)+.....+f\left(\frac{99}{100}\right)$$

$$= \left\{f\left(\frac{1}{100}\right)+f\left(\frac{99}{100}\right)\right\}+\left\{f\left(\frac{2}{100}\right)+f\left(\frac{98}{100}\right)\right\}+.....+f\left\{\left(\frac{49}{100}\right)+f\left(\frac{51}{100}\right)\right\}+f\left(\frac{1}{2}\right)$$

$$= (2+2+2+----49\,times)+\frac{2e}{e+e}$$

$$= 98+1 = 99$$

22. If the sum of all the roots of the equation $e^{2x}-11e^{x}-45e^{-x}+\frac{81}{2}=0$ is $\log_e$ P, then p is equal to _____.

Official Ans. by NTA (45)

QuestPix Ans. (45)

Sol. $e^{2x}-11e^{x}-45e^{-x}+\frac{81}{2}=0$]

$$\left(e^{x}\right)^3-11\left(e^{x}\right)^2-45+\frac{81e^{x}}{2}=0\ ]$$

$e^{x} = t$

$2t^3-22t^2+81t-90=0$

$t_1t_2t_3 = 45$

$e^{x_1}.e^{x_2}.e^{x_3} = 45$

$e^{x_1+x_2+x_3} = 45$

$\log_e e^{x_1+x_2+x_3} = \log_e 45$

$x_1+x_2+x_3 = \log_e 45$

$\log_e P = \log_e 45$

P = 45

23. The positive value of the determinant of the matrix A, whose $Adj\left(Adj\left(A\right)\right)=\begin{pmatrix}14 & 28 & -14\\ -14 & 14 & 28\\ 28 & -14 & 14\end{pmatrix}$, is _____.

Official Ans. by NTA (14)

QuestPix Ans. (14)

Sol. $Adj\left(AdjA\right)=\begin{bmatrix}14 & 18 & -14\\ -14 & 14 & 28\\ 28 & -14 & 14\end{bmatrix}$

$$\left|Adj\left(AdjA\right)\right|=\begin{bmatrix}14 & 28 & -14\\ -14 & 14 & 28\\ 28 & -14 & 14\end{bmatrix}=14\times14\times14\begin{vmatrix}1 & 2 & -1\\ -1 & 1 & 2\\ 2 & -1 & 1\end{vmatrix}$$

$$=\left(14\right)^3\left[3-2\left(-5\right)-1\left(-1\right)\right]=\left(14\right)^3\left[14\right]=\left(14\right)^4$$

$$\left|A\right|^4=\left(14\right)^4\Rightarrow\left|A\right|=14$$

24. The number of ways, 16 identical cubes, of which 11 are blue and rest are red, can be placed in a row so that between any two red cubes there should be at least 2 blue cubes, is _____.

Official Ans. by NTA (56)

QuestPix Ans. (56)

Sol. 16 cubes < 11 Blue, 5 Red

$$x_1+x_2+x_3+x_4+x_5+x_6=11$$

$$x_1,x_6\geq0,\qquad x_2,x_3,x_4,x_5\geq2$$

$$x_2=t_1+2$$

$$x_3=t_3+2$$

$$x_4=t_4+2$$

$$x_5=t_5+2$$

$$x_1,t_2,t_3,t_4,t_5,x_6\geq0$$

No. of solutions $={}^{6+3-1}C_3={}^8C_3=56$

25. If the coefficient of x^{10} in the binomial expansion of $\left(\frac{\sqrt{x}}{5^{\frac{1}{4}}}+\frac{\sqrt{5}}{x^{\frac{1}{3}}}\right)^{60}$ is $5^k l$, where l, $k\in N$ and l is co-prime to 5, then k is equal to _____.

Official Ans. by NTA (5)

QuestPix Ans. (5)

Sol. $\left(\frac{\sqrt{x}}{5^{1/4}}+\frac{\sqrt{5}}{x^{1/3}}\right)^{60}$

$$T_{r+1}={}^{60}C_r\left(\frac{x^{1/2}}{5^{1/4}}\right)^{60-r}\left(\frac{5^{1/2}}{x^{1/3}}\right)r$$

$$={}^{60}C_r5^{\frac{3r-60}{4}}.x^{\frac{180-5r}{6}}$$

$$\frac{180-5r}{6}=10\Rightarrow r=24$$

Coeff. of $x^{10}={}^{60}C_{24}5^3=\frac{\lfloor60}{\lfloor24\lfloor36}5^3$

Powers of 5 in $={}^{60}C_{24}.5^3=\frac{5^{14}}{5^4\times5^8}\times5^3=5^5$

26. Let

$A_1=\left\{\left(x,y\right):\left|x\right|\leq y^2,\left|x\right|+2y\leq8\right\}$ and

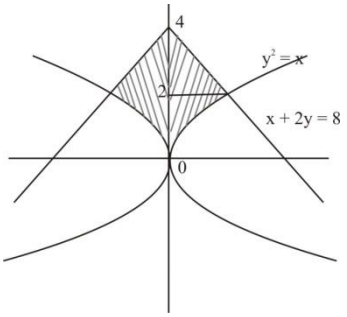
$A_2=\left\{\left(x,y\right):\left|x\right|+\left|y\right|\leq k\right\}$. If 27 (Area A_1) = 5 (Area A_2), then k is equal to :

Official Ans. by NTA (6)

QuestPix Ans. (6)

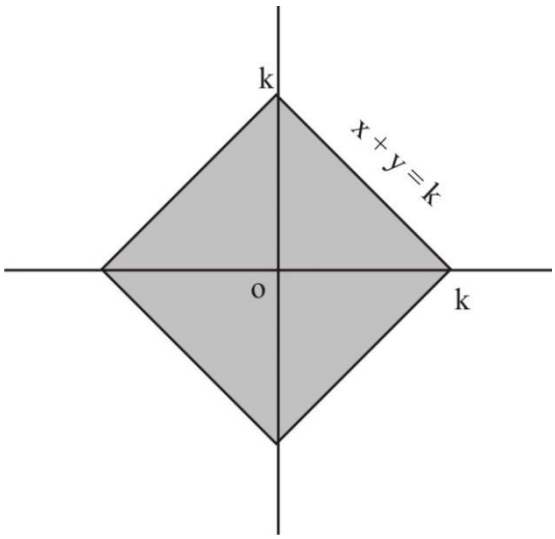
Sol. $A_1=\left\{\left(x,y\right):\left|x\right|\leq y^2,\left|x\right|+2y\leq8\right\}$ and

$A_2=\left\{\left(x,y\right):\left|x\right|+\left|y\right|\leq k\right\}$.



$$area(A_1) = 2\left[\int_0^2 y^2 dy + \int_2^4 (8-2y)dy\right]$$

$$= 2\left[\left(\frac{y^3}{3}\right)_0^2 + \left(8y - y^2\right)_2^4\right]$$



$$area(A_1) = 2 \times \frac{20}{3} = \frac{40}{3}$$

Area $(A_2) = 4 \times \frac{1}{2}k^2$

Area $(A_2) = 2k^2$

Now

27 (Area A_1) = 5 (Area A_2)

$$9 \times 4 = k^2$$

k = 6

27. If the sum of the first ten terms of the series $\frac{1}{5} + \frac{2}{65} + \frac{3}{325} + \frac{4}{1025} + \frac{5}{2501} + \ldots$ is $\frac{m}{n}$, where m and n are co-prime numbers, then m + n is equal to _____.

Official Ans. by NTA (276)

QuestPix Ans. (276)

Sol. $\frac{1}{5} + \frac{2}{65} + \frac{3}{325} + \frac{4}{1025} + \frac{5}{2501} + \ldots\ldots$

$$T_n = \frac{n}{4n^4 + 1}$$

$$= \frac{n}{(2n^2+1)^2 - (2n)^2} = \frac{n}{(2n^2+2n+1)(2n^2-2n+1)}$$

$$= \frac{1}{4}\left[\frac{1}{2n^2-2n+1} - \frac{1}{2n^2+2n+1}\right]$$

$$S_{10} = \sum_{n=1}^{10} T_n = \frac{1}{4}\left[\frac{1}{1} - \frac{1}{5} + \frac{1}{5} - \frac{1}{13} + \ldots\ldots \frac{1}{200+20+1}\right]$$

$$= \frac{1}{4}\left[1 - \frac{1}{221}\right] = \frac{1}{4} \times \frac{220}{221} - \frac{55}{221} = \frac{m}{n}$$

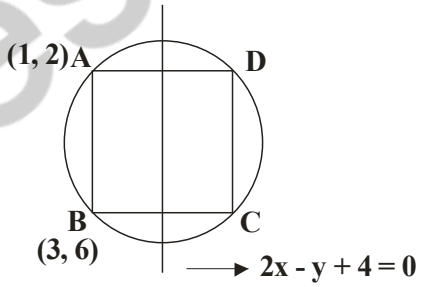
m + n = 55 + 221 = 276

28. A rectangle R with end points of the one of its dies as (1, 2) and (3, 6) is inscribed in a circle. If the equation of a diameter of the circle is 2x – y + 4 = 0, then the area of R is _____.

Official Ans. by NTA (16)

QuestPix Ans. (16)

Sol.



Eq. of line AB

y = 2x

Slope of AB = 2

Slope of given diameter = 2

So the diameter is parallel to AB

Distance between diameter and line AB

$$= \left(\frac{4}{\sqrt{2^2+12}}\right) = \frac{4}{\sqrt{5}}$$

Thus BC = $2 \times \frac{4}{\sqrt{5}} = \frac{8}{\sqrt{5}}$

$$AB = \sqrt{(1-3)^2 + (2-6)^2} = \sqrt{20} = 2\sqrt{5}$$

Area = AB × BC = $\frac{8}{\sqrt{5}} \times 2\sqrt{5} = 16$ Ans.

29. A circle of radius 2 unit passes through the vertex and the focus of the parabola $y^2 = 2x$ and touches the parabola $y = \left(x - \frac{1}{4}\right)^2 + \alpha$, where $\alpha > 0$. Then $(4\alpha - 8)^2$ is equal to _____.

Official Ans. by NTA (63)

QuestPix Ans. (63)

Sol. Vertex and focus of parabola $y^2 = 2x$ are V (0, 0) and $S\left(\frac{1}{2}, 0\right)$ resp.

Let equation of circle be

$(x - h)^2 + (y - k)^2 = 4$

$\because$ Circle passes through (0, 0)

$\Rightarrow h^2 + k^2 = 4$ .....(1)

$\because$ Circle passes through $\left(\frac{1}{2}, 0\right)$

$$\left(\frac{1}{2} - h\right)^2 + k^2 = 4$$

$$\Rightarrow h^2 + k^2 - h = \frac{15}{4} \ldots\ldots(2)$$

On solving (1) and (2)

$$4 - h = \frac{15}{4}$$

$$h = 4 - \frac{15}{4} = \frac{1}{4}$$

$$k = +\frac{\sqrt{63}}{4}$$

$k = -\frac{\sqrt{63}}{4}$ is rejected as circle with centre $\left(\frac{1}{4}, -\frac{\sqrt{63}}{4}\right)$ can't touch given parabola.

Equation of circle is

$$\left(x - \frac{1}{4}\right)^2 + \left(k - \frac{\sqrt{63}}{4}\right)^2 = 4$$

From figure

$$\alpha = 2 + \frac{\sqrt{63}}{4} = \frac{8 + \sqrt{63}}{4}$$

$$4\alpha - 8 = \sqrt{63}$$

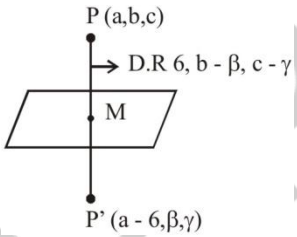
$$(4\alpha - 8)^2 = 63$$

30. Let the mirror image of the point (a, b, c) with respect to the plane 3x – 4y + 12z + 19 = 0 be (a- 6, β, γ). If a + b + c = 5, then 7 β - 9 γ is equal to _____.

Official Ans. by NTA (137)

QuestPix Ans. (137)

Sol.



$$M = \left(a - 3, \frac{\beta + b}{2}, \frac{\gamma + c}{2}\right)$$

Since M lies on $3x + 4y + 12z + 19 = 0$

$\Rightarrow 6a - 4b + 12c - 4\beta + 12\gamma + 20 = 0$ ....(1)

Since PP' is parallel to normal of the plane then

$$\frac{6}{3} = \frac{b - \beta}{-4} = \frac{c - \gamma}{12}$$

$\Rightarrow \beta = b + 8, \quad \gamma = c - 24$

$a + b + c = 5 \Rightarrow a + \beta - 8 + \gamma + 24 = 5$

$\Rightarrow a = -\beta - \gamma - 11$

Now putting these values in (1) we get

$6(-\beta - \gamma - 11) - 4(\beta - 8) + 12(\gamma + 24) - 4\beta + 12\gamma + 20 = 0$

$\Rightarrow 7\beta - 9\gamma = 170 - 33 = 137$

(Held On Monday 27th June, 2022) **TIME : 3 : 00 PM to 6 : 00 PM**

PHYSICS | TEST PAPER WITH SOLUTION

SECTION-A

31. The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be

(A) $[ML^{-1}T^{-1}]$ (B) $[ML^{-1}T^{-2}]$

(C) $[ML^{2}T^{-1}]$ (D) $[M^{-1}L^{3}T^{0}]$

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. Pascal second

$$\frac{F}{A}t = \frac{MLT^{-2}}{L^2}T = ML^{-1}T^{-1}$$

32. The distance of the Sun from earth is 1.5×10^{11} m and its angular diameter is (2000) s when observed from the earth. The diameter of the Sun will be :

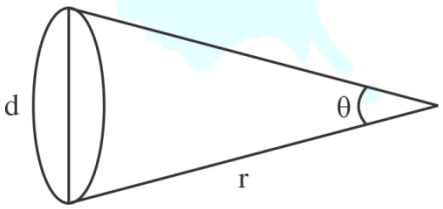
(A) 2.45×10^{10} m (B) 1.45×10^{10} m

(C) 1.45×10^{9} m (D) 0.14×10^{9} m

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol.



$$\theta = \frac{d}{r}$$

$$\frac{2000}{60\times60}\times\frac{\pi}{180} = \frac{d}{1.5\times10''}$$

$$\Rightarrow d = \frac{2000}{60\times60}\times\frac{\pi}{180}\times1.5\times10''$$

$$= \frac{\pi\times1.5}{3\times6\times18}\times10'' = 1.45\times10^{9}$$

33. When a ball is dropped into a lake from a height 4.9 m above the water level, it hits the water with a velocity v and then sinks to the bottom with the constant velocity v. It reaches the bottom of the lake 4.0 s after it is dropped. The approximate depth of the lake is :

(A) 19.6 m (B) 29.4 m

(C) 39.2 m (D) 73.5 m

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. $V^2 = 2 \times 9.8 \times 4.9$

$V = 9.8$ m/s

Depth = distance travelled in 3 seconds

$= 9.8 \times 3 = 29.4$ m

34. One end of a massless spring of spring constant k and natural length l_0 is fixed while the other end is connected to a small object of mass m lying on a frictionless table. The spring remains horizontal on the table. If the object is made to rotate at an angular velocity ω about an axis passing through fixed end, then the elongation of the spring will be:

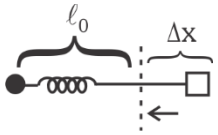
(A) $\frac{k - m\omega^2 l_0}{m\omega^2}$ (B) $\frac{m\omega^2 l_0}{k + m\omega^2}$

(C) $\frac{m\omega^2 l_0}{k - m\omega^2}$ (D) $\frac{k + m\omega^2 l_0}{m\omega^2}$

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol.



$K \Delta x = m(\ell_0 + \Delta x)w^2$

$K \Delta x = m \ell_0 w^2 + mw^2 \Delta x$

$$\Delta x = \frac{m\ell_0 w^2}{k - mw^2}$$

35. A stone tide to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of change in its velocity, as it reaches a position where the string is horizontal, is $\sqrt{x(u^2 - gL)}$. The value of x is

(A) 3 (B) 2

(C) 1 (D) 5

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. $v = \sqrt{u^2 - 2gL}$

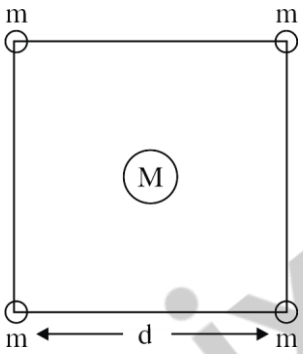
$\Delta v = \sqrt{u^2 + v^2}$

$\Delta v = \sqrt{u^2 + v^2 - 2gL}$

$\Delta v = \sqrt{2u^2 - 2gL}$

$\Delta v = \sqrt{2\left(u^2 - gL\right)}$ $x = 2$

36. Four spheres each of mass m form a square of side d (as shown in figure). A fifth sphere of mass M is situated at the centre of square. The total gravitational potential energy of the system is :



(A) $-\frac{Gm}{d}\left[(4+\sqrt{2})m + 4\sqrt{2}M\right]$

(B) $-\frac{Gm}{d}\left[(4+\sqrt{2})M + 4\sqrt{2}m\right]$

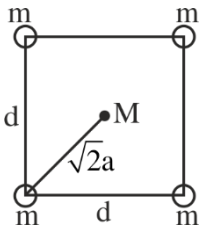
(C) $-\frac{Gm}{d}\left[3m^2 + 4\sqrt{2}M\right]$

(D) $-\frac{Gm}{d}\left[6m^2 + 4\sqrt{2}M\right]$

Official Ans. by NTA (A)

QuestPix Ans. (A)

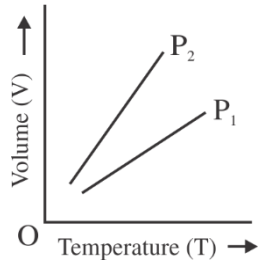
Sol.



$$-\frac{Gm^2}{d} \times 4 - \frac{Gm^2}{\sqrt{2}d} \times 2 - \frac{GMm}{d} \times 4\sqrt{2}$$

$$-\frac{Gm}{d}\left[(4+\sqrt{2})m + 4\sqrt{2}M\right]$$

37. For a perfect gas, two pressures P_1 and P_2 are shown in figure. The graph shows:



(A) $P_1 > P_2$

(B) $P_1 < P_2$

(C) $P_1 = P_2$

(D) Insufficient data to draw any conclusion

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. $PV = nRT$

$$\frac{V}{T} = \frac{nR}{P}$$

$$\frac{nR}{P_1} < \frac{nR}{P_2}$$

$$P_2 < P_1$$

38. According to kinetic theory of gases,

A. The motion of the gas molecules freezes at 0ºC

B. The mean free path of gas molecules decreases if the density of molecules is increased.

C. The mean free path of gas molecules increases if temperature is increased keeping pressure constant.

D. Average kinetic energy per molecule per degree of freedom is $\frac{3}{2}k_BT$ (for monoatomic gases)

Choose the most appropriate answer from the options given below:

(A) A and C only (B) B and C only

(C) A and B only (D) C and D only

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. $$\lambda = \frac{kT}{\sqrt{2}\pi d^2 P}$$

39. A lead bullet penetrates into a solid object and melts. Assuming that 40% of its kinetic energy is used to heat it, the initial speed of bullet is:

(Given, initial temperature of the bullet = 127ºC, Melting point of the bullet = 327ºC,

Latent heat of fusion of lead = $2.5 \times 10^4 J\ Kg^{-1}$,

Specific heat capacity of lead = 125J/kg K)

(A) 125 ms^{-1} (B) 500 ms^{-1}

(C) 250 ms^{-1} (D) 600 ms^{-1}

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. $$m \times 125 \times 200 + m \times 2.5 \times 10^4 = \frac{1}{2}mv^2 \times \frac{40}{100}$$

$V = 500$ m/s

40. The equation of a particle executing simple harmonic motion is given by $x = \sin\pi\left(t + \frac{1}{3}\right)$ m. At t = 1s, the speed of particle will be

(Given : $\pi = 3.14$)

(A) 0 cm s^{-1} (B) 157 cm s^{-1}

(C) 272 cm s^{-1} (D) 314 cm s^{-1}

Official Ans. by NTA (B)

QuestPix Ans. (B)

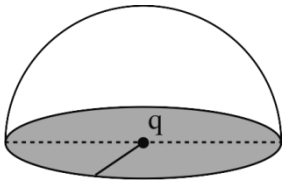
Sol. $$x = \sin\pi\left(t + \frac{1}{3}\right)$$

$$x = \sin\left(\pi t + \frac{\pi}{3}\right)$$

$$V = \frac{dx}{dt} = \cos\left(\pi t + \frac{\pi}{3}\right)\pi$$

$$= -\pi \times \frac{1}{2} = 157 \text{ cm/s}$$

41. If a charge q is placed at the centre of a closed hemispherical non-conducting surface, the total flux passing through the flat surface would be :



(A) $\frac{q}{\varepsilon_0}$ (B) $\frac{q}{2\varepsilon_0}$

(C) $\frac{q}{4\varepsilon_0}$ (D) $\frac{q}{2\pi\varepsilon_0}$

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol.

Total flux through complete spherical surface is $\frac{q}{\varepsilon_0}$.

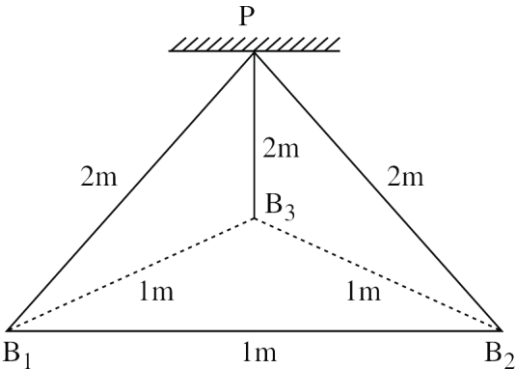
So the flux through curved surface will be $\frac{q}{2\varepsilon_0}$.

The flux through flat surface will be zero.

Remark : Electric flux through flat surface is zero but no option is given, option is available for electric flux passing through curved surface.

42. Three identical charged balls each of charge 2C are suspended from a common point P by silk threads of 2m each (as shown in figure). They form an equilateral triangle of side 1m.

The ratio of net force on a charged ball to the force between any two charged balls will be :



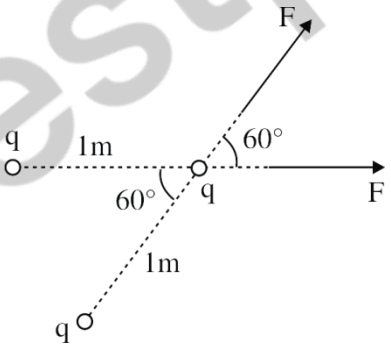
(A) 1 : 1 (B) 1 : 4

(C) $\sqrt{3}:2$ (D) $\sqrt{3}:1$

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol.



$F = \frac{k(2)(2)}{(1)^2}$

(F = Force between two charges).

$F = 4k$

$F_{net} = 2F\cos 30^\circ = 2 \cdot F \cdot \frac{\sqrt{3}}{2} = F\sqrt{3}$

(F_{net} = Net electrostatic force on one charged ball)

$\frac{F_{net}}{F} = \frac{\sqrt{3}F}{F} = (\sqrt{3})$

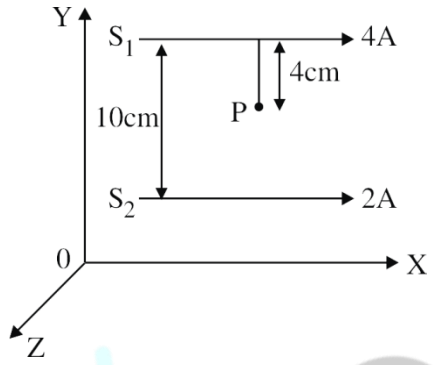
Remark: Net force on any one of the ball is zero. But no option given in options.

43. Two long parallel conductors S_1 and S_2 are separated by a distance 10 cm and carrying currents of 4A and 2A respectively. The conductors are placed along x-axis in X-Y plane. There is a point P located between the conductors (as shown in figure).

A charge particle of 3π coulomb is passing through the point P with velocity

$\vec{v} = (2\hat{i} + 3\hat{j})$m / s; where $\hat{i}$ & $\hat{j}$ represents unit vector along x & y axis respectively.

The force acting on the charge particle is $4\pi \times 10^{-5}(-x\hat{i} + 2\hat{j})$N. The value of x is :



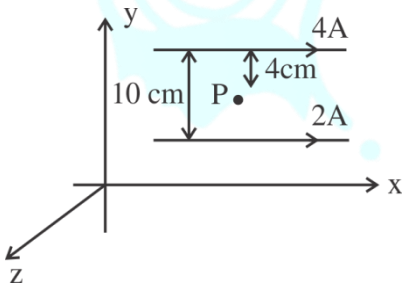
(A) 2 (B) 1

(C) 3 (D) –3

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol.



$$B_{net} = B_1 - B_2 = \frac{\mu_0 \times 4}{2\pi[.04]} - \frac{\mu_0 \times 2}{2\pi[.06]}$$

$$\vec{B}_{net} = \frac{\mu_0}{2\pi}\left[\frac{200}{3}\right](-\hat{k})$$

$$\vec{F} = q[\vec{v} \times \vec{B}]$$

$$= [3\pi]\left|(2\hat{i} + 3\hat{j}) \times \left(\frac{\mu_0}{2\pi}\right)\left(\frac{200}{3}\right) - \hat{k}\right|$$

$$= 3\pi \times \frac{\mu_0}{2\pi}\left(\frac{200}{3}\right)[2 \times \hat{j} - 3(\hat{i})]$$

$$= (4\pi \times 10^{-7})(100)(-3\hat{i} + 2\hat{j})$$

$$= 4\pi \times 10^{-5} \times [-3\hat{i} + 2\hat{j}]$$

44. If L, C and R are the self inductance, capacitance and resistance respectively, which of the following does not have the dimension of time ?

(A) RC (B) $\frac{L}{R}$

(C) $\sqrt{LC}$ (D) $\frac{L}{C}$

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $\left(\frac{L}{C}\right)$ does not have dimension of time.

RC, $\frac{L}{R}$ are time constant while $\sqrt{LC}$ is reciprocal of angular frequency or having dimension of time.

45. Given below are two statements:

Statement I : A time varying electric field is a source of changing magnetic field and vice-versa. Thus a disturbance in electric or magnetic field creates EM waves.

Statement II : In a material medium. The EM wave travels with speed $v = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$.

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

(A) Both statement I and statement II are true.

(B) Both statement I and statement II are false.

(C) Statement I is correct but statement II is false.

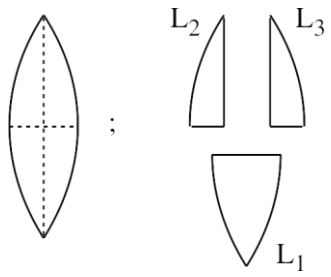
(D) Statement I is incorrect but statement II is true.

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol. The statement II is wrong as the velocity of em wave in a medium is $\frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\mu_0 \mu_r \varepsilon_0 \varepsilon_r}}$.

46. A convex lens has power P. It is cut into two halves along its principal axis. Further one piece (out of the two halves) is cut into two halves perpendicular to the principal axis (as shown in figure). Choose the incorrect option for the reported pieces.



(A) Power of $L_1 = \frac{P}{2}$

(B) Power of $L_2 = \frac{P}{2}$

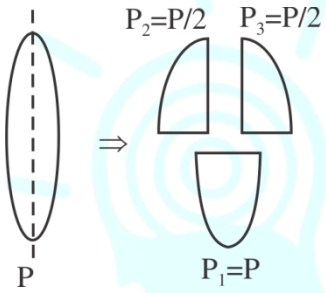
(C) Power of $L_3 = \frac{P}{2}$

(D) Power of $L_1 = P$

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol.



47. If a wave gets refracted into a denser medium, then which of the following is true?

(A) wavelength speed and frequency decreases.

(B) wavelength increases, speed decreases and frequency remains constant.

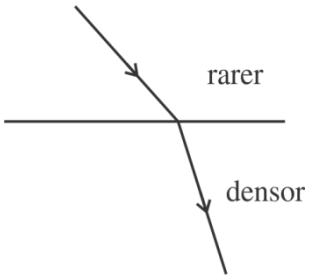
(C) wavelength and speed decreases but frequency remains constant.

(D) wavelength, speed and frequency increases.

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol.



No change in frequency but speed and wave-length decreases.

48. Given below are two statements:

Statement I : In hydrogen atom, the frequency of radiation emitted when an electron jumps from lower energy orbit (E_1) to higher energy orbit (E_2), is given as $hf = E_1 - E_2$.

Statement-II : The jumping of electron from higher energy orbit (E_2) to lower energy orbit (E_1) is associated with frequency of radiation given as $f = (E_2 - E_1)/h$

This condition is Bohr's frequency condition.

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

(A) Both statement I and statement II are true.

(B) Both statement I and statement II are false

(C) Statement I is correct but statement II is false

(D) Statement I is incorrect but statement II is true.

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. When electron jump from lower to higher energy level, energy absorbed so statement-I incorrect.

When electron jump from higher to lower energy level, energy of emitted photon

$E = E_2 - E_1$

$hf = E_2 - E_1 \Rightarrow f = \frac{E_2 - E_1}{h}$

so statement-II is correct.

49. For a transistor to act as a switch, it must be operated in

(A) Active region

(B) Saturation state only

(C) Cut-off state only

(D) Saturation and cut-off state

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. Transistor act as a switch in saturation and cut of region.

50. We do not transmit low frequency signal to long distances because

(a) The size of the antenna should be comparable to signal wavelength which is unreal solution for a signal of longer wavelength.

(b) Effective power radiated by a long wavelength baseband signal would be high.

(c) We want to avoid mixing up signals transmitted by different transmitter simultaneously.

(d) Low frequency signal can be sent to long distances by superimposing with a high frequency wave as well.

Therefore, the most suitable options will be :

(A) All statements are true

(B) (a), (b) and (c) are true only

(C) (a), (c) and (d) are true only

(D) (b), (c) and (d) are true only

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol. (a) For low frequency or high wavelength size of antenna required is high.

(b) E P R is low for longer wavelength.

(c) yes we want to avoid mixing up signals transmitted by different transmitter simultaneously.

(d) Low frequency signals sent to long distance by superimposing with high frequency.

SECTION-B

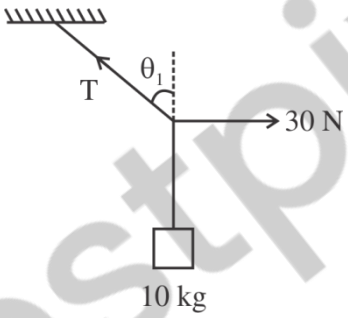
51. A mass of 10 kg is suspended vertically by a rope of length 5m from the roof. A force of 30 N is applied at the middle point of rope in horizontal direction. The angle made by upper half of the rope with vertical is $\theta = \tan^{-1}(x \times 10^{-1})$. The value of x is _____ .

(Given $g = 10\ m/s^2$)

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol.



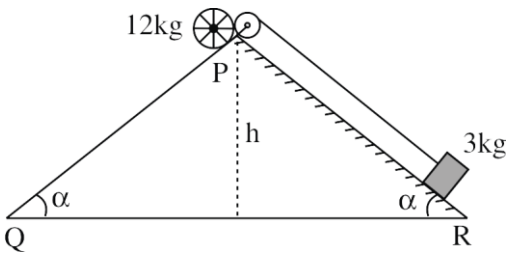
$T \sin\theta = 30$

$T \cos\theta = 100$

$\Rightarrow \tan\theta = 0.3$

52. A rolling wheel of 12 kg is on an inclined plane at position P and connected to a mass of 3 kg through a string of fixed length and pulley as shown in figure. Consider PR as friction free surface.

The velocity of centre of mass of the wheel when it reaches at the bottom Q of the inclined plane PQ will be $\frac{1}{2}\sqrt{xgh}$ m/s. The value of x is _____ .



Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Net loss in PE = Gain in KE

$$12\,gh - 3gh = \frac{1}{2}3v^2 + \frac{1}{2}12v^2 + \frac{1}{2}\left[12r^2\right]\left(\frac{v}{r}\right)^2$$

$$9gh = \frac{1}{2}\left[3+12+12\right]v^2$$

$$v^2 = \frac{2gh}{3} \Rightarrow v = \frac{1}{2}\sqrt{\frac{8}{3}gh}$$

$$x = \frac{8}{3} \simeq 3$$

53. A diatomic gas ($\gamma = 1.4$) does 400 J of work when it is expanded isobarically. The heat given to the gas in the process is _____ J.

Official Ans. by NTA (1400)

QuestPix Ans. (1400)

Sol. $Q = nC_p\Delta T = \frac{n\nu}{\nu - 1}R\Delta T$

$$Q = \frac{\nu}{\nu - 1}\omega = \frac{1.4}{0.4} \times 400 = 1400\ J$$

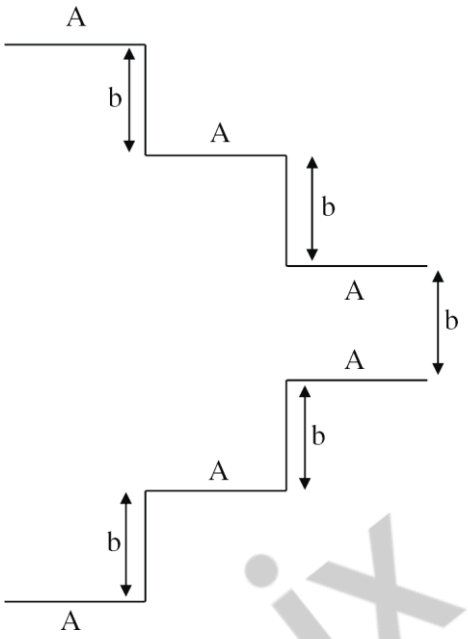
54. A particle executes simple harmonic motion. Its amplitude is 8 cm and time period is 6s. The time it will take to travel from its position of maximum displacement to the point corresponding to half of its amplitude, is _____ s.

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. $t = \frac{\Delta\phi}{\omega} = \frac{\pi/2 - \pi/6}{2\pi/6} = \frac{\pi/3}{\pi/3} = 1\ sec$

55. A paralle plate capacitor is made up of stair like structure with a palte area A of each stair and that is connected with a wire of length b, as shown in the figure. The capacitance of the arrangement is $\frac{x}{15}\frac{\varepsilon_0 A}{b}$. The value of x is _____ .



Official Ans. by NTA (23)

QuestPix Ans. (23)

Sol. Parallel combination

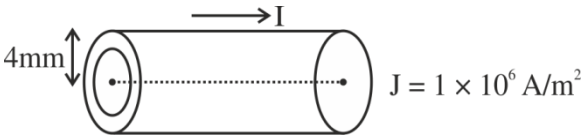
$$c_{eq} = \varepsilon_0 A\left[\frac{1}{5b} + \frac{1}{3b} + \frac{1}{b}\right] = \frac{23}{15}\frac{\varepsilon_0 A}{b}$$

56. The current density in a cylindrical wire of radius r = 4.0 mm is 1.0×10^6 A/m^2. The current through the outer portion of the wire between radial distances r/2 and r is $x\pi$ A; where x is _____ .

Official Ans. by NTA (12)

QuestPix Ans. (12)

Sol.



$$I = \int JdA$$

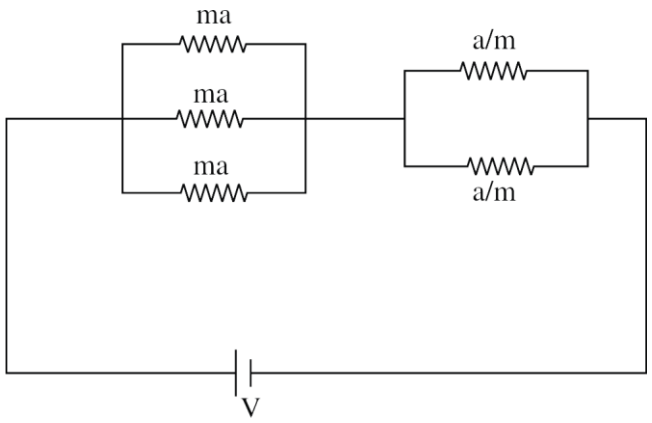
$$= \int 10^6 \times 2\pi x dx$$

$$= 10^6 \times 2\pi . x\frac{x^2}{2}\Big]_{\frac{r}{2}}^{r}$$

$$= \pi \times 10^6\left[r^2 - \frac{r^2}{4}\right] = 12\pi$$

$$x = 12$$

57. In the given circuit 'a' is an arbitrary constant. The value of m for which the equivalent circuit resistance is minimum, will be $\sqrt{\frac{x}{2}}$. The value of x is _____ .



Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. $R = \left(\frac{ma}{3}\right) + \left(\frac{a}{2m}\right)$

$\frac{dR}{dm} = \frac{a}{3} - \frac{a}{2m^2} = 0$

$\frac{a}{3} = \frac{a}{2m^2}$

$m^2 = \frac{3}{2}$

$m = \sqrt{\frac{3}{2}}$

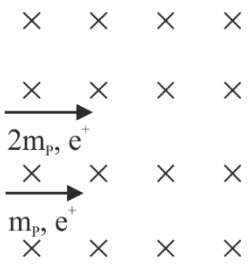
$x = 3$

58. A deuteron and a proton moving with equal kinetic energy enter into to a uniform magnetic field at right angle to the field. If r_d and r_p are the radii of their circular paths respectively, then the ratio $\frac{r_d}{r_p}$ will be $\sqrt{x}:1$ where x is _____ .

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol.



$R = \frac{mv}{q_B}$

$R_D = \frac{(2m_P)\, v_D}{e\, B}$

$R_P = \frac{(m_P)\, v_P}{e\, B}$

$\frac{R_D}{R_P} = \frac{2v_D}{v_P} = \frac{2v_D}{\sqrt{2}v_D} = \frac{\sqrt{2}}{1}$

$\frac{1}{2}(2mp)v_D^2 = \frac{1}{2}m_P.v_P^2$

$\sqrt{2}v_D = v_P$

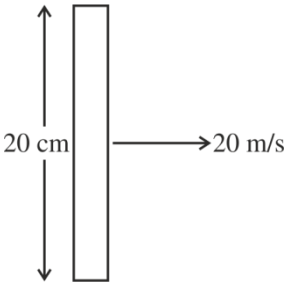
$x = 2$

59. A metallic rod of length 20 cm is palced in North-South direction and is moved at a constant speed of 20 m/s towards East. The horizontal component of the Earth's magnetic field at that place is 4×10^{-3} T and the angle of dip is 45°. The emf induced in the rod is _____ mV.

Official Ans. by NTA (16)

QuestPix Ans. (16)

Sol.



$B_H = 4 \times 10^{-3}\,T$

$\theta \to 45°$

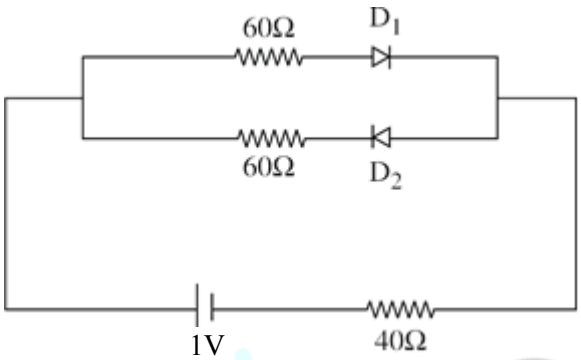
$B_V = B_H$

$\in = (\vec{V} \times \vec{B}) \cdot \vec{\ell}$

$= ((4 \times 10^{-3})(20))\frac{20}{100}$

$= 16 \times 10^{-3}\,V = 16\,mV$

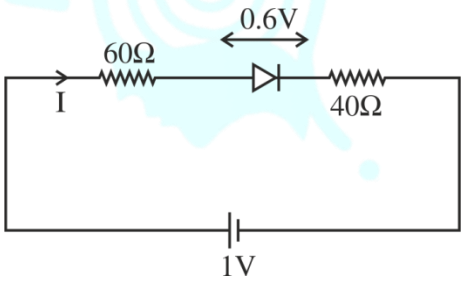
60. The cut-off voltage of the diodes (shown in figure) in forward bias is 0.6 V. The current through the resister of 40 Ω is _____ mA.



Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol.



$1 - I(60) - 0.6 - I(40) = 0$

$\frac{0.4}{100} = I$

$I = 4\ mA$

(Held On Monday 27th June, 2022) **TIME : 9 : 00 AM to 12 : 00 PM**

CHEMISTRY | TEST PAPER WITH SOLUTION

SECTION-A

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

Assertion (A) : At 10°C, the density of a 5M solution of KCl [atomic masses of K and Cl are 39 & 35.5 g mol^{-1}]. The solution is cooled to -21°C. The molality of the solution will remain unchanged.

Reason (R) : The molality of a solution does not change with temperature as mass remains unaffected with temperature.

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

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

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

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

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

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. Molality is independent of temperature and hence both assertion and reason are true.

62. Based upon VSEPR theory, match the shape (geometry) of the molecules in List-I with the molecules in List-II and select the most appropriate option

List-I (Shape)	**List-II (Molecules)**
(A) T-shaped	(I) XeF_4
(B) Trigonal planar	(II) SF_4
(C) Square planar	(III) ClF_3
(D) See-saw	(IV) BF_3

(A) (A) – I, (B) – (II), (C) – (III), (D) – (IV)

(B) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

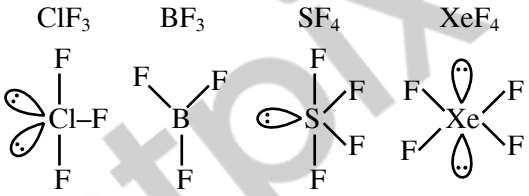
(C) (A) – (III), (B) – (IV), (C) – (II), (D) – (I)

(D) (A) – (IV), (B) – (III), (C) – (I), (D) – (II)

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol.



63. Match List-I with List-II

	List-I	**List-II**
(A)	Spontaneous process	(I) $\Delta H < 0$
(B)	Process with $\Delta P = 0$, $\Delta T = 0$	(II) $\Delta G_{T,P} < 0$
(C)	$\Delta H_{reaction}$	(III) Isothermal and isobaric process
(D)	Exothermic process	(IV) [Bond energies of molecules in reactants] - [Bond energies of product molecules

Choose the correct answer from the options given below:

(A) (A) – (III), (B) – (II), (C) – (IV), (D) – (I)

(B) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)

(C) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

(D) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. (A) For a spontaneous process $\Delta G_{T,P} < 0$

(B) $\Delta P = 0 \rightarrow$ Isobaric process

$\Delta T = 0 \rightarrow$ Isothermal process

(C) $\Delta H_{reaction}$ = (Σ Bond energies of reactants) - (Σ bond energies of products)

(D) $\Delta H < 0$ is for exothermic reaction

64. Match List-I with List-II

List-I	List-II
(A) Lyophilic colloid	(I) Liquid-liquid colloid
(B) Emulsion	(II) protective colloid
(C) Positively charged	(III) $FeCl_3$ + NaOH
(D) Negatively charged colloid	(IV) $FeCl_3$ + hot water

Choose the correct answer from the options given below:

(A) (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

(B) (A) – (III), (B) – (I), (C) – (IV), (D) – (II)

(C) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)

(D) (A) – (III), (B) – (II), (C) – (I), (D) – (IV)

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. (A) Protective colloids are lyophilic colloids

(B) Emulsions are liquid in liquid colloidal solutions

(C) $FeCl_3$ + hot water forms positively charged colloidal solution of hydrated ferric oxide.

(D) $FeCl_3$ + NaOH forms negatively charged colloidal solution due to preferential adsorption of OH^- ions

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

Assertion (A): The ionic radii of O^{2-} and Mg^{2+} are same.

Reason (R) : Both O^{2-} and Mg^{2+} are isoelectronic species

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

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

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

(C) (A) is true but (R) is false

(D) (A) is false but (R) is true

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. Ionic radius of O^{2-} is more than that of Mg^{2+}

Both O^{2-} and Mg^{2+} are isoelectronic with 10 electrons

66. Match List-I with List-II

List-I	List-II
(A) Concentration of gold ore	(I) Aniline
(B) Leaching of alumina	(II) NaOH
(C) Froth stabiliser	(III) SO_2
(D) Blister copper	(IV) NaCN

Choose the correct answer from the options given below.

(A) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)

(B) (A) – (IV), (B) – (II), (C) – (I), (D) – (III)

(C) (A) – (III), (B) – (II), (C) – (I), (D) – (IV)

(D) (A) – (II), (B) – (IV), (C) – (III), (D) – (I)

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. Gold is concentrated by cyanidation

Leaching of alumina is done by NaOH

Froth stabiliser is aniline

Blister copper has condensed SO_2 on the surface

67. Addition of H_2SO_4 to BaO_2 produces:

(A) BaO, SO_2 and H_2O (B)$BaHSO_4$ and O_2

(C) $BaSO_4$, H_2 and O_2 (D) $BaSO_4$ and H_2O_2

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

This is a common method to prepare hydrogen peroxide

68. $BeCl_2$ reacts with $LiAlH_4$ to give

(A) Be + $Li[AlCl_4]$ + H_2

(B) Be + AlH_3 + LiCl + HCl

(C) $BeH_2 + LiCl + AlCl_3$

(D) $BeH_2 + Li[AlCl_4]$

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol. $2BeCl_2 + LiAlH_4 \rightarrow 2\ BeH_2 + LiCl + AlCl_3$

This is the method to prepare BeH_2

69. Match List-I with List-II

List-I **(Si-Compounds)**	List-II **(Si-Polymeric/other products)**
(A) $(CH_3)_4Si$	(I) Chain silicone
(B) $(CH_3)Si(OH)_3$	(II) Dimeric silicone
(C) $(CH_3)_2Si(OH)_2$	(III) Silane
(D) $(CH_3)_3Si(OH)$	(IV) 2D – Silicone

Choose the correct answer from the options given below:

(A) (A) – (III), (B) – (II), (C) – (I), (D) – (IV)

(B) (A) – (IV), (B) – (I), (C) – (II), (D) – (III)

(C) (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

(D) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $(CH_3)_4Si$ is a silane

$(CH_3)Si(OH)_3$ polymerise to form 2D silicone

$(CH_3)_2Si(OH)_2$ polymerise to form chain silicone

$(CH_3)_3Si(OH)$ form dimer $(CH_3)_3Si\text{-}O\text{-}Si(CH_3)_3$

70. Heating white phosphorus with conc. NaOH solution gives mainly

(A) Na_3P and H_2O (B) H_3PO and NaH

(C) $P(OH)_3$ and NaH_2PO_4 (D) PH_3 and NaH_2PO_2

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $P_4 + 3NaOH + 3H_2O \rightarrow 3NaH_2PO_2 + PH_3$

71. Which of the following will have maximum stabilization due to crystal field?

(A) $[Ti(H_2O)_6]^{3+}$ (B) $[Co(H_2O)_6]^{2+}$

(C) $[Co(CN)_6]^{3-}$ (D) $[Cu(NH_3)_4]^{2+}$

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol. Co^{3+} has maximum effective nuclear charge and CN^- is the strongest ligand in the given options

72. Given below are two statements:

Statement I: Classical smog occurs in cool humid climate. It is a reducing mixture of smoke, fog and sulphur dioxide

Statement II: Photochemical smog has components, ozone, nitric oxide, acrolein, formaldehyde, PAN etc.

In the light of above statements, choose the **most appropriate** answer from the options give below

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

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

(C) **Statement I** is correct but **statement II** is incorrect

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

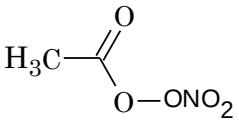
Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. Classical smog occurs in cool humid climate. It is a reducing mixture of smoke, fog and sulphur dioxide

Photochemical smog has components, ozone, nitric oxide, acrolein, formaldehyde, PAN etc.

$CH_4 + O_3 \rightarrow HCHO + H_2O + CH_2 = CH - CHO +$



(PAN - peroxyacetyl nitrate)

73. Which of the following is structure of a separating funnel?

(A) 

(B) 

(C) 

(D) 

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. It is used to separate liquid-liquid mixture which is immiscible with different densities

74. **'A'** and **'B'** respectively are:

A $\xrightarrow[(2)\,Zn-H_2O]{(1)O_3}$ Ethane-1,2-dicarbaldehyde + Glyoxal/Oxaldehyde

B $\xrightarrow[(2)\,Zn-H_2O]{(1)O_3}$ 5-oxohexanal

(A) 1-methylcyclohex-1, 3-diene & cyclopentene

(B) Cyclohex-1, 3-diene & cyclopentene

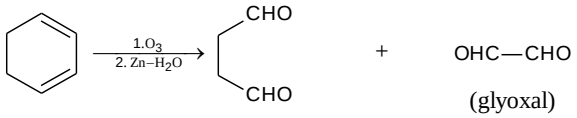
(C) 1-methylcyclohex-1,4-diene & 1-methylcyclopent-1-ene

(D) Cyclohex-1,3-diene & 1-methylcyclopent-1-ene

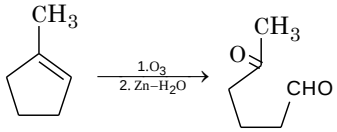
Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol.

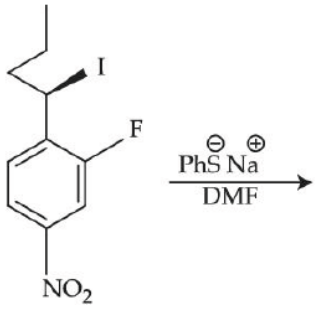


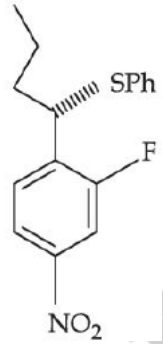
ethane-1, 2-dicarbaldehyde

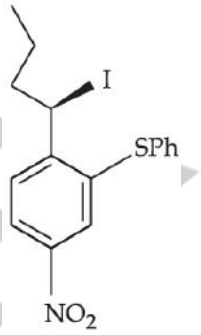


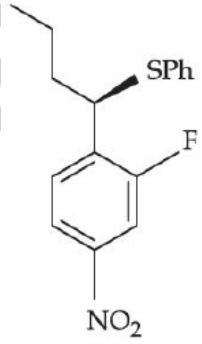
5-oxohexanal

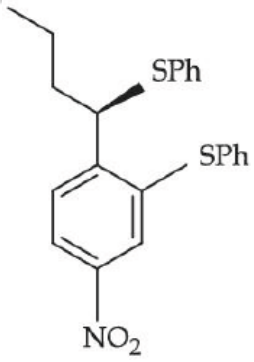
75. The major product of the following reaction is:



(A) 

(B) 

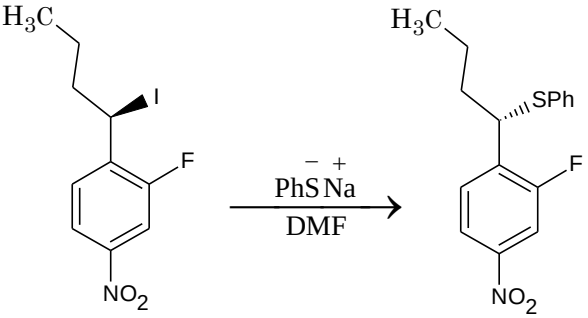
(C) 

(D) 

Official Ans. by NTA (A)

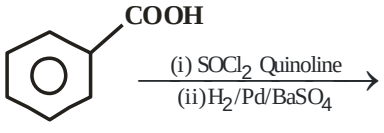
QuestPix Ans. (A)

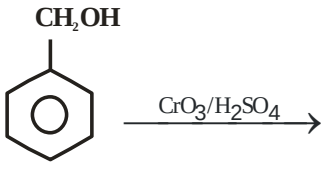
Sol.

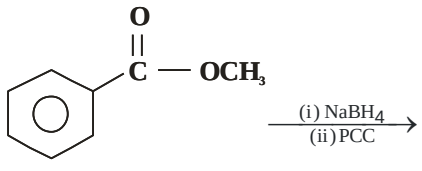


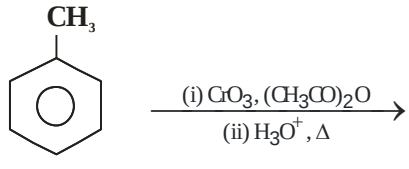
It is bimolecular nucleophilic substitution (SN^2) which occur at benzylic carbon by inversion in contiguration. This reaction cannot undergo substitution at benzene ring

76. Which of the following reactions will yield benzaldehyde as a product?

(A) 

(B) 

(C) 

(D) 

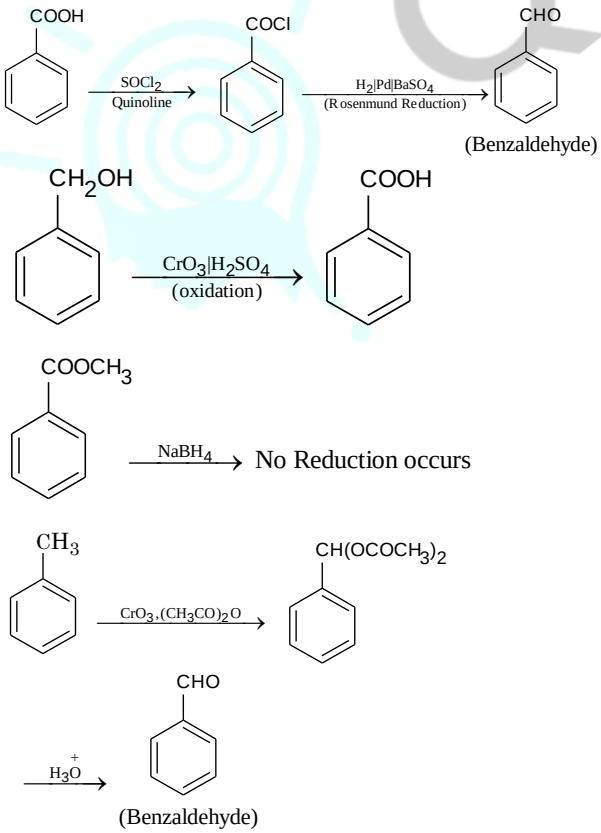
(A) (B) and (C) (B) (C) and (D)

(C) (A) and (D) (D) (A) and (C)

Official Ans. by NTA (C)

QuestPix Ans. (C)

Sol.



77. Given below are two statements:

Statements-I : In Hofmann degradation reaction, the migration of only an alkyl group takes place from carbonyl carbon of the amide to the nitrogen atom.

Statement-II : The group is migrated in Hofmann degradation reaction to electron deficient atom.

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

(A)Both **Statement-I** and **Statement-II** are correct

(B) Both **Statement-I** and **Statement-II** are incorrect

(C) **Statement-I** is correct but **Statement-II** is incorrect

(D) **Statement-I** is incorrect but **Statement-II** is correct

Official Ans. by NTA (D)

QuestPix Ans. (D)

Sol. $R - CO - NH_2 + Br_2 + NaOH \rightarrow$

$$R - NH_2 + Na_2CO_3 + NaBr + H_2O$$

$$R - CO - NH_2 + \bar{O}H \rightarrow R - CO - \bar{N}H \xrightarrow{Br_2}$$

$$R - CO - NH - Br \xrightarrow{OH^-} R - CO - \bar{N} - Br$$

$$\xrightarrow{\text{migration of } \bar{R}} R - NCO \xrightarrow{2\bar{O}H} RNH_2 + CO_3^{2-}$$

In this reaction of alkyl as well as aryl group can migrate to electron deficient nitrogen atom.

78. Match List-I with List-II

List-I **(Polymer)**	List-II **(Used in)**
(A) Bakelite	(I) Radio and television Cabinets
(B) Glyptal	(II) Electrical switches
(C) PVC	(III) Paints and Lacquers
(D) Polystyrene	(IV) Water pipes

Choose the correct answer from the options given below:

(A) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)

(B) (A) – (I), (B) – (II), (C) – (III), (D) – (IV)

(C) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)

(D) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

Official Ans. by NTA (A)

QuestPix Ans. (A)

Sol. Bakelite- It is thermosetting polymer used for making electrical switches.

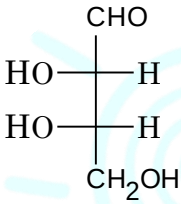
Glyptal – manufacture of paints and lacquers

PVC – manufacture of water pipes, rain coats, hand bags

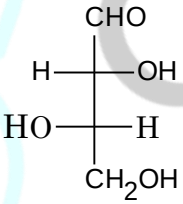
Polystyrene – manufacture of radio and television cabinets

79. L-isomer of a compound 'A' ($C_4H_8O_4$) gives a positive test with $[Ag(NH_3)_2]^+$. Treatment of 'A' with acetic anhydride yield triacetate derivative. Compound 'A' produces an optically active compound (B) and an optically inactive compound (C) on treatment with bromine water and HNO_3 respectively, compound (A) is:

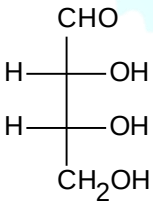
(A)



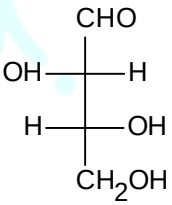
(B)



(C)



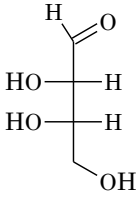
(D)



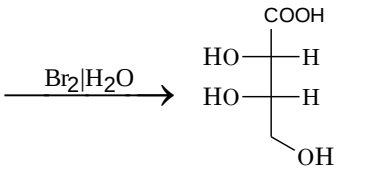
Official Ans. by NTA (A)

QuestPix Ans. (A)

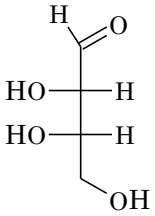
Sol.



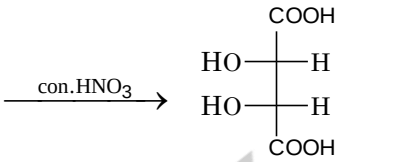
L-isomer



optically active



L-isomer

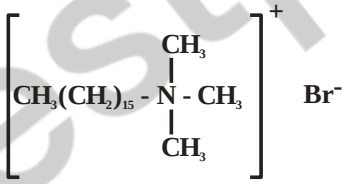


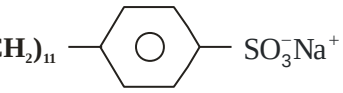
optically inactive

80. Match List-I with List-II

List-I

(A)



(B) 

(C) $C_{17}H_{35}COO^-Na^+ + Na_2CO_3 +$ Rosinate

(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$

List-II

(I) Dishwashing powder

(II) Toothpaste

(III) Laundry soap

(IV) Hair conditioner

(A) (A) – (III), (B) – (II), (C) – (IV), (D) – (I)

(B) (A) – (IV), (B) – (II), (C) – (III), (D) – (I)

(C) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)

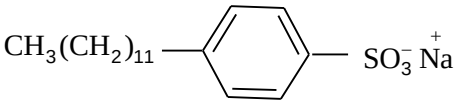
(D) (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

Official Ans. by NTA (B)

QuestPix Ans. (B)

Sol. **(A)** $\left[CH_3(CH_2)_{15}-N(CH_3)_3\right]^+ Br^-$

is cationic detergents used in hair conditioner



(B)

Is anionic detergent used in tooth pastes

(C) $C_{17}H_{35}COO^-Na^+ + Na_2CO_3 + Rosinate$ is used as laundary soap

(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)_NCH_2CH_2OH$ is non-ionic detergents formed from stearic acid and poly ethylene glycol used as liquid dishwashing detergents

SECTION-B

81. Metal deficiency defect is shown by $Fe_{0.93}O$. In the crystal, some Fe^{2+} cations are missing and loss of positive charge is compensated by the presence of Fe^{3+} ions. The percentage of Fe^{2+} ions in the $Fe_{0.93}O$ crystals is _____ . (Nearest integer)

Official Ans. by NTA (85)

QuestPix Ans. (85)

Sol. In $Fe_{0.93}O$ for every 93 Fe ions 14 are Fe^{+3} and (93 – 14) = 79 are Fe^{+2} ions

$\therefore$ **%** $Fe^{+2} = \frac{79}{93}\times 100 = 84.9\%$

$\therefore$ nearest integer = 85%

82. If the uncertainty in velocity and position of a minute particle in space are, 2.4×10^{-26} (ms^{-1}) and $10^{-7}(m)$ respectively. The mass of the particle in g is _____ (Nearest integer)

(Given : $h = 6.626 \times 10^{-34}$ Js)

Official Ans. by NTA (22)

QuestPix Ans. (22)

Sol. $\Delta V = 2.4 \times 10^{-26}$ ms^{-1}

$\Delta x = 10^{-7}$ m

$\because \Delta p.\Delta x = \frac{h}{4\pi}$

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

$\Rightarrow m\times 2.4\times 10^{-26}\times 10^{-7} = \frac{6.626\times 10^{-34}}{4\times\pi}$

$m = \frac{6.626}{9.6\times\pi}\times 10^{-1}$

m = 0.02198 kg

m = 21.98 gm

nearest integer = 22

83. 2g of a non-volatile non-electrolyte solute is dissolved in 200 g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 8. The elevation in boiling points of A and B are in the ratio $\frac{x}{y}$ (x : y). The value of y is_____ (Nearest integer)

Official Ans. by NTA (8)

QuestPix Ans. (8)

Sol. Given : $\frac{(K_b)_A}{(K_b)_B} = \frac{1}{8}$

$\therefore \frac{(\Delta T_B)_A}{(\Delta T_B)_B} = \frac{(K_b)_A.m}{(K_b)_B.m} = \frac{1}{8} = \frac{x}{y}$

$\because \frac{x}{y} = \frac{1}{8}$

$\therefore y = 8$ (nearest integer)

84. $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

In an experiment, 2.0 moles of NOCl was placed in a one-litre flask and the concentration of NO after equilibrium established, was found to be 0.4 mol/L. The equilibrium constant at 30°C is _____ $\times 10^{-4}$.

Official Ans. by NTA (125)

QuestPix Ans. (125)

Sol. $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

t=0	2M	-	-
$t=t_{eq}$	(2-x)M	x M	$\frac{x}{2}$M

$\because x = 0.4M$

$\therefore [NOCl]_{eq} = 1.6$ M

$[NO]_{eq} = 0.4$ M

$[Cl_2]_{eq} = 0.2$ M

$$\Rightarrow K_c = \frac{[NO]^2[Cl_2]}{[NOCl]^2} = \frac{[0.4]^2[0.2]}{[1.6]^2}$$

$$K_c = \frac{32}{2.56} \times 10^{-3}$$

$K_c = 12.5 \times 10^{-3}$

$K_c = 125 \times 10^{-4}$

Integer answer is 125

85. The limiting molar conductivities of NaI, $NaNO_3$ and $AgNO_3$ are 12.7, 12.0 and 13.3 mS m^2 mol^{-1}, respectively (all at 25°C). The limiting molar conductivity of AgI at this temperature is _____ mS m^2 mol^{-1}

Official Ans. by NTA (14)

QuestPix Ans. (14)

Sol. Given

(1) λ_m^∞ (NaI) = 12.7 mS m^2 mol^{-1}

(2) λ_m^∞ ($NaNO_3$) = 12.0 mS m^2 mol^{-1}

(3) λ_m^∞ ($AgNO_3$) = 13.3 mS m^2 mol^{-1}

λ_m^∞ (Ag I) = (1) + (3) - (2)

= 12.7 + 13.3 – 12.0

= 26.0 – 12.0

λ_m^∞ (Ag I) = 14.0

86. The rate constant for a first order reaction is given by the following equation:

$$\ln k = 33.24 - \frac{2.0 \times 10^4 K}{T}$$

The Activation energy for the reaction is given by _____ kJ mol^{-1}. (In Nearest integer)

(Given: R = 8.3 J K^{-1} mol^{-1})

Official Ans. by NTA (166)

QuestPix Ans. (166)

Sol. $\ln k = \ln A - \frac{E_A}{RT}$

Given: $\ln k = 33.24 - \frac{2.0 \times 10^4}{T}$

$\therefore$ on comparing $\frac{E_A}{R} = 2.0 \times 10^4$

$\therefore E_A = 2.0 \times 10^4 \times R$

$\Rightarrow E_A = 2.0 \times 10^4 \times 8.3$ J

$\Rightarrow E_A = 16.6 \times 10^4$J = 166 kJ

87. The number of statement(s) correct from the following for copper (at no. 29) is/are _____

(A) Cu(II) complexes are always paramagnetic

(B) Cu(I) complexes are generally colourless

(C) Cu(I) is easily oxidized

(D) In Fehling solution, the active reagent has Cu(I)

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. A,B,C are correct and D is incorrect because Fehling solution has Cu(II)

88. Acidified potassium permanganate solution oxidises oxalic acid. The spin-only magnetic moment of the manganese product formed from the above reaction is _____ B.M. (Nearest Integer)

Official Ans. by NTA (6)

QuestPix Ans. (6)

Sol. $2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$

Mn^{2+} has 5 unpaired electrons therefore the magnetic moment is $\sqrt{35}$ BM

89. Two elements A and B which form 0.15 moles of A_2B and AB_3 type compounds. If both A_2B and AB_3 weigh equally, then the atomic weight of A is _____ times of atomic weight of B.

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. Given : Molar mass of $A_2B = AB_3$

$\therefore (2A + B) = (A + 3B)$ $\begin{bmatrix} A \rightarrow \text{Atomic wt.of A} \\ B \rightarrow \text{Atomic wt.of B} \end{bmatrix}$

$\Rightarrow A = 2B$

$\therefore$ atomic wt. of A is 2 times of atomic wt. of B

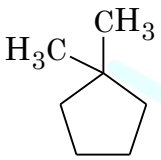
Integer answer is 2

90. Total number of possible stereoisomers of dimethyl cyclopentane is _____

Official Ans. by NTA (6)

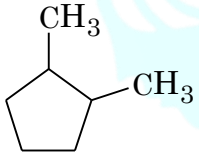
QuestPix Ans. (6)

Sol. Dimethyl cyclopentane



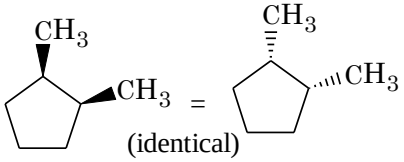
1,1-dimethylcyclopentane

no stereoisomer

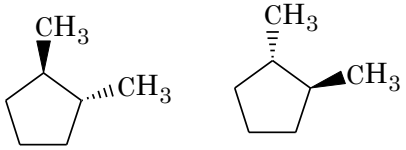


1,2-dimethylcyclopentane

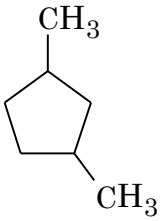
will show stereo isomerism, Its stereo isomers are



(identical)

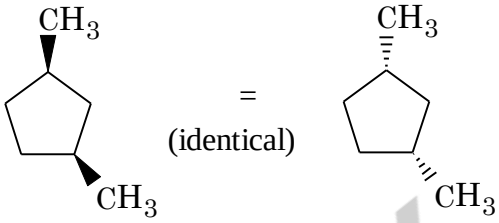


(enantiomers)

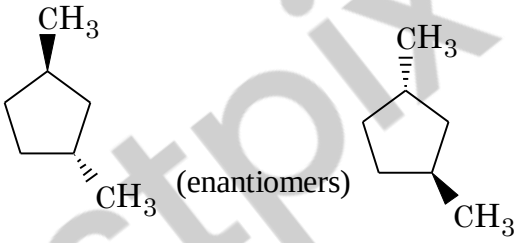


1,3-dimethylcyclopentane

will show stereo isomerism, Its stereo isomers are



(identical)



(enantiomers)