(Held On Sunday 29th January, 2023) **TIME : 9 : 00 AM to 12 : 00 NOON**

MATHEMATICS | TEST PAPER WITH SOLUTION

SECTION-A

1. The domain of $f(x)=\frac{\log_{(x+1)}(x-2)}{e^{2\log_e x}-(2x+3)}, x\in R$ is

(1) $\mathbb{R}-\{1-3\}$ (2) $(2,\infty)-\{3\}$

(3) $(-1,\infty)-\{3\}$ (4) $\mathbb{R}-\{3\}$

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $x-2>0 \Rightarrow x>2$

$x+1>0 \Rightarrow x>-1$

$x+1\neq 1 \Rightarrow x\neq 0$ and $x>0$

Denominator

$x^2-2x-3\neq 0$

$(x-3)(x+1)\neq 0$

$x\neq -1, 3$

So Ans $(2,\infty)-\{3\}$

2. Let $f:R\to R$ be a function such that $f(x)=\frac{x^2+2x+1}{x^2+1}$. Then

(1) f(x) is many-one in $(-\infty,-1)$

(2) f(x) is many-one in $(1,\infty)$

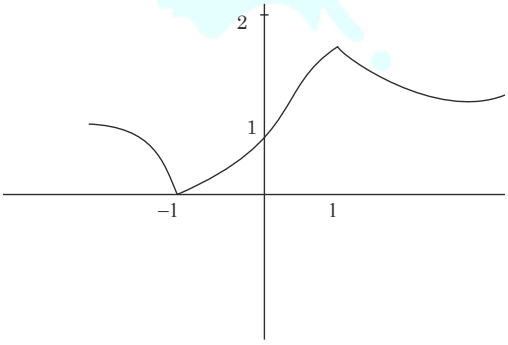
(3) f(x) is one-one in $[1,\infty)$ but not in $(-\infty,\infty)$

(4) f(x) is one-one in $(-\infty,\infty)$

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol.



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

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

3. For two non-zero complex number z_1 and z_2, if $Re(z_1z_2)=0$ and $Re(z_1+z_2)=0$, then which of the following are possible ?

(A) $Im(z_1)>0$ and $Im(z_2)>0$

(B) $Im(z_1)<0$ and $Im(z_2)>0$

(C) $Im(z_1)>0$ and $Im(z_2)<0$

(D) $Im(z_1)<0$ and $Im(z_2)<0$

Choose the correct answer from the options given below :

(1) B and D (2) B and C

(3) A and B (4) A and C

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $z_1=x_1+iy_1$

$z_2=x_2+iy_2$

$Re(z_1z_2)=x_1x_2-y_1y_2=0$

$Re(z_1+z_2)=x_1+x_2=0$

x_1 & x_2 are of opposite sign

y_1 & y_2 are of opposite sign

4. Let $\lambda\neq 0$ be a real number. Let α, β be the roots of the equation $14x^2-3\lambda x+3\lambda=0$ and α, γ be the roots of the equation $35x^2-53x+4\lambda=0$. Then $\frac{3\alpha}{\beta}$ and $\frac{4\alpha}{\gamma}$ are the roots of the equation :

(1) $7x^2+245x-250=0$

(2) $7x^2-245x+250=0$

(3) $49x^2-245x+250=0$

(4) $49x^2+245x+250=0$

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. $14x^2-31x+3\lambda=0$

$\alpha+\beta=\frac{31}{14}$ ....(1) and $\alpha\beta=\frac{3\lambda}{14}$ ....(2)

$35x^2-53x+4\lambda=0$

$\alpha+\gamma=\frac{53}{35}$ ....(3) and $\alpha\gamma=\frac{4\lambda}{35}$ ....(4)

$\frac{(2)}{(4)}\Rightarrow\frac{\beta}{\gamma}=\frac{3\times35}{4\times14}=\frac{15}{8}\Rightarrow\beta=\frac{15}{8}\gamma$

$(1)-(3)\Rightarrow\beta-\gamma=\frac{31}{14}-\frac{53}{35}=\frac{155-106}{70}=\frac{7}{10}$

$\frac{15}{8}\gamma-\gamma=\frac{7}{10}\Rightarrow\gamma=\frac{4}{5}$

$\Rightarrow\beta=\frac{15}{8}\times\frac{4}{5}=\frac{3}{2}$

$\Rightarrow\alpha=\frac{31}{14}-\beta=\frac{31}{14}-\frac{3}{2}=\frac{5}{7}$

$\Rightarrow\lambda=\frac{14}{3}\alpha\beta=\frac{14}{3}\times\frac{5}{7}\times\frac{3}{2}=5$

so, sum of roots $\frac{3\alpha}{\beta}+\frac{4\alpha}{\gamma}=\left(\frac{3\alpha\gamma+4\alpha\beta}{\beta\gamma}\right)$

$=\frac{\left(3\times\frac{4\lambda}{35}+4\times\frac{3\lambda}{14}\right)}{\beta\gamma}=\frac{12\lambda(14+35)}{14\times35\beta\gamma}$

$=\frac{49\times12\times5}{490\times\frac{3}{2}\times\frac{4}{5}}=5$

Product of roots

$=\frac{3\alpha}{\beta}\times\frac{4\alpha}{\gamma}=\frac{12\alpha^2}{\beta\gamma}=\frac{12\times\frac{25}{49}}{\frac{3}{2}\times\frac{4}{5}}=\frac{250}{49}$

So, required equation is $x^2-5x+\frac{250}{49}=0$

$\Rightarrow49x^2-245x+250=0$

5. Consider the following system of questions

$\alpha x + 2y + z = 1$

$2\alpha x + 3y + z = 1$

$3x + \alpha y + 2z = \beta$

For some $\alpha,\beta\in\mathbb{R}$. Then which of the following is NOT correct.

(1) It has no solution if $\alpha = -1$ and $\beta \neq 2$

(2) It has no solution for $\alpha = -1$ and for all $\beta\in\mathbb{R}$

(3) It has no solution for $\alpha=3$ and for all $\beta\neq2$

(4) It has a solution for all $\alpha\neq-1$ and $\beta=2$

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $D=\begin{vmatrix}\alpha & 2 & 1\\ 2\alpha & 3 & 1\\ 3 & \alpha & 2\end{vmatrix}=0\Rightarrow\alpha=-1,3$

$D_x=\begin{vmatrix}2 & 1 & 1\\ 3 & 1 & 1\\ \alpha & 2 & \beta\end{vmatrix}=0\Rightarrow\beta=2$

$D_y=\begin{vmatrix}\alpha & 1 & 1\\ 2\alpha & 1 & 1\\ 3 & 2 & \beta\end{vmatrix}=0$

$D_z=\begin{vmatrix}\alpha & 2 & 1\\ 2\alpha & 3 & 1\\ 3 & \alpha & \beta\end{vmatrix}=0$

$\beta=2,\ \alpha=-1$

$\alpha=-1,\beta=2$ Infinite solution

6. Let α and β be real numbers. Consider a 3 × 3 matrix A such that $A^2 = 3A + \alpha I$. If $A^4 = 21A + \beta I$, then

(1) $\alpha=1$ (2) $\alpha=4$

(3) $\beta=8$ (4) $\beta=-8$

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. $A^2 = 3A + \alpha I$

$A^3 = 3A^2 + \alpha A$

$A^3 = 3(3A + \alpha I) + \alpha A$

$A^3 = 9A + \alpha A + 3\alpha I$

$A^4 = (9+\alpha)A^2 + 3\alpha A$

$= (9+\alpha)(3A + \alpha I) + 3\alpha A$

$= A(27 + 6\alpha) + \alpha(9+\alpha)$

$\Rightarrow 27 + 6\alpha = 21 \Rightarrow \alpha = -1$

$\Rightarrow \beta = \alpha(9+\alpha) = -8$

7. Let x = 2 be a root of the equation $x^2 + px + q = 0$

and $f(x) = \begin{cases} \dfrac{1-\cos(x^2-4px+q^2+8q+16)}{(x-2p)^4}, & x \neq 2p \\ 0, & x = 2p \end{cases}$

Then $\lim\limits_{x\to 2p^+}[f(x)]$

where [.] denotes greatest integer function, is

(1) 2 (2) 1

(3) 0 (4) –1

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol.

$$\lim_{x\to 2p^+}\left(\frac{1-\cos\left(x^2-4px+q^2+8q+16\right)}{\left(x^2-4px+q^2+8q+16\right)^2}\right)\left(\frac{\left(x^2-4px+q^2+8q+16\right)^2}{(x-2p)^2}\right)$$

$$\lim_{h\to 0}\frac{1}{2}\left(\frac{(2p+h)^2-4p(2p+h)+q^2+82+16}{h^2}\right)^2 = \frac{1}{2}$$

Using L'Hospital's

$\lim\limits_{x\to 2p^+}[f(x)] = 0$

8. Let $f(x) = x + \dfrac{a}{\pi^2-4}\sin x + \dfrac{b}{\pi^2-4}\cos x$, $x \in \mathbb{R}$ be a function which satisfies $f(x) = x + \int_0^{\pi/2} \sin(x+y) f(y)\,dy$. Then (a + b) is equal to

(1) $-\pi(\pi+2)$ (2) $-2\pi(\pi+2)$

(3) $-2\pi(\pi-2)$ (4) $-\pi(\pi-2)$

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $f(x) = x + \int_0^{\pi/2} (\sin x\cos y + \cos x \sin y) f(y)\,dy$

$f(x) = x + \int_0^{\pi/2} \left((\cos y\ f(y)\,dy)\sin x + (\sin y\, f(y)\,dy)\cos x\right)$ **...(1)**

On comparing with

$f(x) = x + \dfrac{a}{\pi^2-4}\sin x + \dfrac{b}{\pi^2-4}\cos x,\ x \in \mathbb{R}$ then

$\Rightarrow \dfrac{a}{\pi^2-4} = \int_0^{\pi/2} \cos y\, f(y)\,dy$ **...(2)**

$\Rightarrow \dfrac{b}{\pi^2-4} = \int_0^{\pi/2} \sin y\, f(y)\,dy$ **...(3)**

Add (2) and (3)

$\dfrac{a+b}{\pi^2-4} = \int_0^{\pi/2} (\sin y + \cos y) f(y)\,dy$ .....(4)

$\dfrac{a+b}{\pi^2-4} = \int_0^{\pi/2} (\sin y + \cos y) f\left(\dfrac{\pi}{2} - y\right)dy$ ...(5)

Add (4) and (5)

$$\frac{2(a+b)}{\pi^2-4} = \int_0^{\pi/2} (\sin y + \cos y)\left(\frac{\pi}{2} + \frac{(a+b)}{\pi^2-4}(\sin y + \cos y)\right)dy$$

$$= \pi + \frac{a+b}{\pi^2-4}\left(\frac{\pi}{2}+1\right)$$

$(a+b) = -2\pi(\pi+2)$

9. Let $A = \left\{(x,y) \in \mathbb{R}^2 : y \geq 0, 2x \leq y \leq \sqrt{4-(x-1)^2}\right\}$

and $B = \left\{(x,y) \in \mathbb{R}\times\mathbb{R} : 0 \leq y \leq \min\left\{2x, \sqrt{4-(x-1)^2}\right\}\right\}$

Then the ratio of the area of A to the area of B is

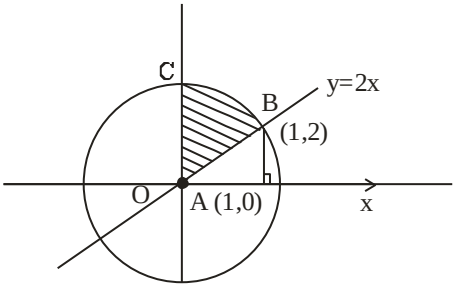
(1) $\dfrac{\pi-1}{\pi+1}$ (2) $\dfrac{\pi}{\pi-1}$

(3) $\dfrac{\pi}{\pi+1}$ (4) $\dfrac{\pi+1}{\pi-1}$

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. $y^2+(x-1)^2=4$

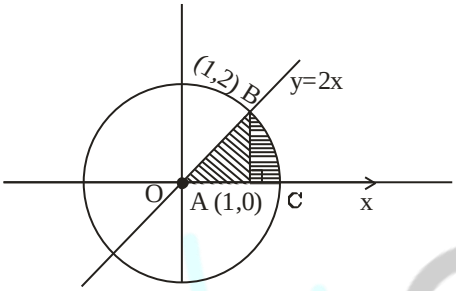


shaded portion = circular (OABC)

$-\text{Ar}(\Delta OAB)$

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

$A=(\pi-1)$



Area B = Ar (ΔAOB) + Area of arc of circle (ABC)

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

$\frac{A}{B}=\frac{\pi-1}{\pi+1}$

10. Let Δ be the area of the region

$\{(x,y)\in\mathbb{R}^2: x^2+y^2\le 21, y^2\le 4x, x\ge 1\}$. Then

$\frac{1}{2}\left(\Delta-21\sin^{-1}\frac{2}{\sqrt{7}}\right)$ is equal to

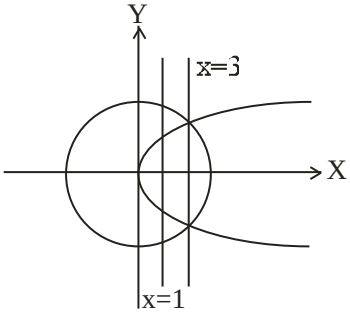
(1) $2\sqrt{3}-\frac{1}{3}$ (2) $\sqrt{3}-\frac{2}{3}$

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

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol.



Area $2\int_1^3 2\sqrt{x}\,dx+2\int_3^{\sqrt{21}}\sqrt{21-x^2}dx$

$\Delta=\frac{8}{3}\left(3\sqrt{3}-1\right)+21\sin^{-1}\left(\frac{2}{\sqrt{7}}\right)-6\sqrt{3}$

$\frac{1}{2}\left(\Delta-21\sin^{-1}\left(\frac{2}{\sqrt{7}}\right)\right)=\frac{2\sqrt{3}-\frac{8}{3}}{2}$

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

11. A light ray emits from the origin making an angle 30º with the positive x-axis. After getting reflected by the line x + y = 1, if this ray intersects x-axis at Q, then the abscissa of Q is

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

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

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. Slope of reflected ray = $\tan 60^\circ=\sqrt{3}$

Line $y=\frac{x}{\sqrt{3}}$ intersect $y+x=1$ at $\left(\frac{\sqrt{3}}{\sqrt{3}+1},\frac{1}{\sqrt{3}+1}\right)$

Equation of reflected ray is

$y-\frac{1}{\sqrt{3}+1}=\sqrt{3}\left(x-\frac{\sqrt{3}}{\sqrt{3}+1}\right)$

Put $y=0\Rightarrow x=\frac{2}{3+\sqrt{3}}$

12. Let B and C be the two points on the line $y + x = 0$ such that B and C are symmetric with respect to the origin. Suppose A is a point on $y - 2x = 2$ such that ΔABC is an equilateral triangle. Then, the area of the ΔABC is

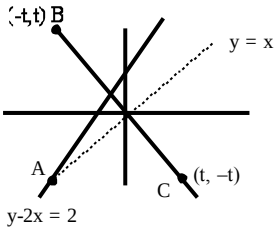
(1) $3\sqrt{3}$ (2) $2\sqrt{3}$

(3) $\frac{8}{\sqrt{3}}$ (4) $\frac{10}{\sqrt{3}}$

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol.



At A $x = y$

$Y - 2x = 2$

$(-2, -2)$

Height from line $x + y = 0$

$h = \frac{4}{\sqrt{2}}$

Area of $\Delta = \frac{\sqrt{3}}{4}\frac{h^2}{\sin^2 60} = \frac{8}{\sqrt{3}}$

13. Let the tangents at the points A (4, –11) and B(8, –5) on the circle $x^2 + y^2 - 3x + 10y - 15 = 0$, intersect at the point C. Then the radius of the circle, whose centre is C and the line joining A and B is its tangent, is equal to

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

(3) $\sqrt{13}$ (4) $\frac{2\sqrt{13}}{3}$

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. Equation of tangent at A (4, –11) on circle is

$\Rightarrow 4x - 11y - 3\left(\frac{x+4}{2}\right) + 10\left(\frac{y-11}{2}\right) - 15 = 0$

$\Rightarrow 5x - 12y - 152 = 0$ ….. (1)

Equation of tangent at B (8, –5) on circle is

$\Rightarrow 8x - 5y - 3\left(\frac{x+8}{2}\right) + 10\left(\frac{y-5}{2}\right) - 15 = 0$

$\Rightarrow 13x - 104 = 0 \Rightarrow x = 8$

put in (1) $\Rightarrow y = \frac{28}{3}$

$r = \left|\frac{3.8 + \frac{2.28}{3} - 34}{\sqrt{13}}\right| = \frac{2\sqrt{13}}{3}$

14. Let $[x]$ denote the greatest integer $\le x$. Consider the function $f(x) = \max\{x^2, 1+[x]\}$. Then the value of the integral $\int_0^2 f(x)dx$ is :

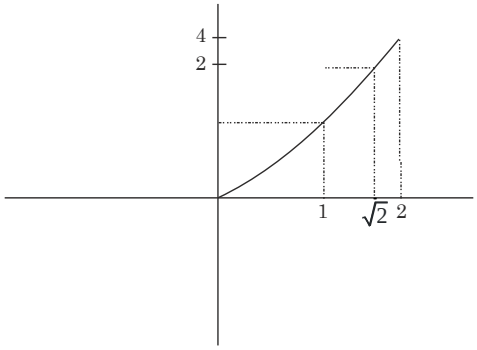
(1) $\frac{5+4\sqrt{2}}{3}$ (2) $\frac{8+4\sqrt{2}}{3}$

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

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol.



$A = \int_0^1 1.dx + \int_1^{\sqrt{2}} 2dx + \int_{\sqrt{2}}^2 x^2 dx$

$= 1 + 2\sqrt{2} - 2 + \frac{8}{3} - \frac{2\sqrt{2}}{3}$

$= \frac{5}{3} + \frac{4\sqrt{2}}{3}$

15. If the vectors $\vec{a}=\lambda\hat{i}+\mu\hat{j}+4\hat{k}$, $\vec{b}=2\hat{i}+4\hat{j}-2\hat{k}$ and $\vec{c}=2\hat{i}+3\hat{j}+\hat{k}$ are coplanar and the projection of $\vec{a}$ on the vector $\vec{b}$ is $\sqrt{54}$ units, then the sum of all possible values of $\lambda+\mu$ is equal to

(1) 0 (2) 6

(3) 24 (4) 18

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. $\begin{vmatrix}\lambda & \mu & 4\\ -2 & 4 & -2\\ 2 & 3 & 1\end{vmatrix}=0$

$\lambda(10)=\mu(2)+4(-14)=0$

$10\lambda-2\mu=56$

$5\lambda-\mu=28$ .....(1)

$\frac{\vec{a}\cdot\vec{b}}{|\vec{b}|}=\sqrt{54}$

$\frac{-2\lambda+4\mu-8}{\sqrt{24}}=\sqrt{54}$

$-2\lambda+4\mu-8=\sqrt{54\times24}$ ....(2)

By solving equation (1) & (2)

$\Rightarrow\lambda+\mu=24$

16. Fifteen football players of a club-team are given 15 T-shirts with their names written on the backside. If the players pick up the T-shirts randomly, then the probability that at least 3 players pick the correct T-shirt is

(1) $\frac{5}{24}$ (2) $\frac{2}{15}$

(3) $\frac{1}{6}$ (4) $\frac{5}{36}$

Official Ans. by NTA (3)

QuestPix Ans. (Bonus)

Sol.

Required probability $=1-\frac{D_{(15)}+{}^{15}C_1.D_{(14)}+{}^{15}C_2D_{(13)}}{15!}$

Taking $D_{(15)}$ as $\frac{15!}{e}$

$D_{(14)}$ as $\frac{14!}{e}$

$D_{(13)}$ as $\frac{13!}{e}$

We get, $1-\left(\frac{\frac{15!}{e}+15.\frac{14!}{e}+\frac{15\times14}{2}\times\frac{13!}{e}}{15!}\right)$

$=1-\left(\frac{1}{e}+\frac{1}{e}+\frac{1}{2e}\right)=1-\frac{5}{2e}\approx.08$

17. Let $f(\theta)=3\left(\sin^4\left(\frac{3\pi}{2}-\theta\right)+\sin^4(3\pi+\theta)\right)-2(1-\sin^2 2\theta)$ and $S=\left\{\theta\in[0,\pi]: f'(\theta)=-\frac{\sqrt{3}}{2}\right\}$. If $4\beta=\sum_{\theta\in S}\theta$, then $f(\beta)$ is equal to

(1) $\frac{11}{8}$ (2) $\frac{5}{4}$

(3) $\frac{9}{8}$ (4) $\frac{3}{2}$

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol.

$f(\theta)=3\left(\sin^4\left(\frac{3\pi}{2}-\theta\right)+\sin^4(3x+\theta)\right)-2(1-\sin^2 2\theta)$

$S=\left\{\theta\in[0,\pi]: f'(\theta)=-\frac{\sqrt{3}}{2}\right\}$

$\Rightarrow f(\theta)=3(\cos^4\theta+\sin^4\theta)-2\cos^2 2\theta$

$\Rightarrow f(\theta)=3\left(1-\frac{1}{2}\sin^2 2\theta\right)-2\cos^2 2\theta$

$\Rightarrow f(\theta)=3-\frac{3}{2}\sin^2 2\theta-2\cos^2\theta$

$=\frac{3}{2}-\frac{1}{2}\cos^2 2\theta=\frac{3}{2}-\frac{1}{2}\left(\frac{1+\cos4\theta}{2}\right)$

$f(\theta)=\frac{5}{4}-\frac{\cos4\theta}{4}$

$f'(\theta)=\sin4\theta$

$\Rightarrow f'(\theta)=\sin4\theta=-\frac{\sqrt{3}}{2}$

$\Rightarrow 4\theta=n\pi+(-1)^n\frac{\pi}{3}$

$\Rightarrow \theta=\frac{n\pi}{4}+(-1)^n\frac{\pi}{12}$

$$\Rightarrow \theta = \frac{\pi}{12}, \left(\frac{\pi}{4} - \frac{\pi}{12}\right), \left(\frac{\pi}{2} + \frac{\pi}{12}\right), \left(\frac{3\pi}{4} - \frac{\pi}{12}\right)$$

$$\Rightarrow 4\beta = \frac{\pi}{4} + \frac{\pi}{2} + \frac{3\pi}{4} = \frac{3\pi}{2}$$

$$\Rightarrow \beta = \frac{3\pi}{8} \Rightarrow f(\beta) = \frac{5}{4} - \frac{\cos\frac{3\pi}{2}}{4} = \frac{5}{4}$$

18. If p, q and r are three propositions, then which of the following combination of truth values of p, q and r makes the logical expression $\{(p \vee q) \wedge ((\sim p) \vee r)\} \rightarrow ((\sim q) \vee r)$ false ?

(1) p = T, q = F, r = T (2) p = T, q = T, r = F

(3) p = F, q = T, r = F (4) p = T, q = F, r = F

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol.

	p	q	r	(p ∨ q) ∧ ((~p) ∨ r)	~q ∨ r
(1)	T	F	T	T	T
(2)	T	T	F	F	F
(3)	F	T	F	T	F
(4)	T	F	F	F	T

Option (3) $(p \vee q) \wedge (\sim q \vee r) \rightarrow (\sim p \vee r)$ will be False.

19. There rotten apples are mixed accidently with seven good apples and four apples are drawn one by one without replacement. Let the random variable X denote the number of rotten apples. If μ and σ^2 represent mean and variance of X, respectively, then 10 ($\mu^2 + \sigma^2$) is equal to

(1) 20

(2) 250

(3) 25

(4) 30

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol.

X	P(x)	XP(X)	$X^2P(X)$
0	1/6	0	0
1	1/2	1/2	1/2
2	3/10	6/10	12/10
3	1/30	1/10	9/30

$$\sum xP(x) = \frac{6}{2} = \mu$$

$$\sigma^2 = \sum x^2 P(x) - \mu^2$$

$$\sigma^2 + \mu^2 = 0 + \frac{1}{2} + \frac{12}{10} + \frac{9}{30} = 2$$

$$10(\sigma^2 + \mu^2) = 20 \text{ Ans.}$$

20. Let y = f(x) be the solution of the differential equation y(x + 1) dx – x^2dy = 0, y(1) = e. Then $\lim_{x \to 0^+} f(x)$ is equal to

(1) 0 (2) $\frac{1}{e}$

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

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. $\frac{x+1}{x^2}dx = \frac{dy}{y}$

$$\ln x - \frac{1}{x} = \ln y + c$$

(1, e)

c = -2

$$\ln x - \frac{1}{x} = \ln y - 2$$

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

$$\lim_{x \to 0^+} e^{\ln x - 1} - \frac{1}{x} + 2$$

$$= e^{-\infty}$$

= 0

SECTION-B

21. Let the co-ordinates of one vertex of ΔABC be $A(0, 2, \alpha)$ and the other two vertices lie on the line $\frac{x+\alpha}{5}=\frac{y-1}{2}=\frac{z+4}{3}$. For $\alpha \in \mathbb{Z}$, if the area of ΔABC is 21 sq. units and the line segment BC has length $2\sqrt{21}$ units, then α^2 is equal to _____.

Official Ans. by NTA (9)

QuestPix Ans. (9)

Sol. A. $(O_1\ 2,\ \alpha)$

$(-\alpha_1 1,-4)$ B C $(5i+2j+3k)$

$$\left|\frac{1}{2}.2\sqrt{21}.\begin{vmatrix} i & j & k \\ \alpha & 1 & \alpha+4 \\ 5 & 2 & 3 \end{vmatrix}\frac{1}{\sqrt{25+4+9}}\right| = 21\sqrt{21}$$

$$\sqrt{(2\alpha+5)^2+(2\alpha+20)^2+(2\alpha-5)^2}=\sqrt{21}\sqrt{38}$$

$$\Rightarrow 12\alpha^2+80\alpha+450=798$$

$$\Rightarrow 12\alpha^2+80\alpha-348=0$$

$$\Rightarrow \alpha=3 \Rightarrow \alpha^2=9$$

22. Let the equation of the plane P containing the line $x+10=\frac{8-y}{2}=z$ be $ax + by + 3z = 2(a+b)$ and the distance of the plane P from the point (1, 27, 7) be c. Then $a^2 + b^2 + c^2$ is equal to ____.

Official Ans. by NTA (355)

QuestPix Ans. (355)

Sol. The line $\frac{x+10}{1}=\frac{y-8}{-2}=\frac{z}{1}$ have a point (–10, 8, 0) with d. r. (1, –2, 1)

$\because$ the plane $ax + by + 3z = 2 (a + b)$

$\Rightarrow b = 2a$

& dot product of d.r.'s is zero

$\therefore a - 2b + 3 = 0$

$\therefore a = 1$ & $b = 2$

Distance from (1, 27, 7) is

$$c=\frac{1+54+21-6}{\sqrt{14}}=\frac{70}{\sqrt{14}}=5\sqrt{14}$$

$\therefore a^2 + b^2 + c^2 = 1 + 4 + 350$

$= 355$

23. Suppose f is a function satisfying $f(x + y) = f(x) + f(y)$ for all $x, y \in \mathbb{N}$ and $f(1)=\frac{1}{5}$. If $\sum_{n=1}^{m}\frac{f(n)}{n(n+1)(n+2)}=\frac{1}{12}$, then m is equal to_____.

Official Ans. by NTA (10)

QuestPix Ans. (10)

Sol. $\because f(1)=\frac{1}{5} \therefore f(2)=f(1)+f(1)=\frac{2}{5}$

$$f(2)=\frac{2}{5}\quad f(3)=f(2)+f(1)=\frac{3}{5}$$

$$f(3)=\frac{3}{5}$$

$$\therefore \sum_{n=1}^{m}\frac{f(n)}{n(n+1)(n+2)}$$

$$=\frac{1}{5}\sum_{n=1}^{m}\left(\frac{1}{n+1}-\frac{1}{n+2}\right)$$

$$=\frac{1}{5}\left(\frac{1}{2}-\frac{1}{3}+\frac{1}{3}-\frac{1}{4}+....+\frac{1}{m+1}-\frac{1}{m+2}\right)$$

$$=\frac{1}{5}\left(\frac{1}{2}-\frac{1}{m+2}\right)=\frac{m}{10(m+2)}=\frac{1}{12}$$

$$\therefore m=10$$

24. Let $a_1, a_2, a_3, ...$ be a GP of increasing positive numbers. If the product of fourth and sixth terms is 9 and the sum of fifth and seventh terms is 24, then $a_1a_9 + a_2a_4a_9 + a_5 + a_7$ is equal to ____.

Official Ans. by NTA (60)

QuestPix Ans. (60)

Sol. $a_4 . a_6 = 9 \Rightarrow (a_5)^2 = 9 \Rightarrow a_5 = 3$

& $a_5+a_7=24 \Rightarrow a_5+a_5r^2=24 \Rightarrow (1+r^2)=8 \Rightarrow r=\sqrt{7}$

$$\Rightarrow a=\frac{3}{49}$$

$$\Rightarrow a_1a_9+a_2a_4a_9+a_5+a_7=9+27+3+21=60$$

25. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three non-zero non-coplanar vectors. Let the position vectors of four points A, B, C and D be $\vec{a}-\vec{b}+\vec{c}$, $\lambda\vec{a}-3\vec{b}+4\vec{c}$, $-\vec{a}+2\vec{b}-3\vec{c}$ and $2\vec{a}-4\vec{b}+6\vec{c}$ respectively. If $\overrightarrow{AB}$, $\overrightarrow{AC}$ and $\overrightarrow{AD}$ are coplanar, then λ is :

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $\overrightarrow{AB}=(\lambda-1)\vec{a}-2\vec{b}+3\vec{c}$

$\overrightarrow{AC}=2\vec{a}+3\vec{b}-4\vec{c}$

$\overrightarrow{AD}=\vec{a}-3\vec{b}+5\vec{c}$

$$\begin{vmatrix}\lambda-1 & -2 & 3\\ -2 & 3 & -4\\ 1 & -3 & 5\end{vmatrix}=0$$

$\Rightarrow(\lambda-1)(15-12)+2(-10+4)+3(6-3)=0$

$\Rightarrow(\lambda-1)=1\Rightarrow\lambda=2$

26. If all the six digit numbers $x_1\ x_2\ x_3\ x_4\ x_5\ x_6$ with $0<x_1<x_2<x_3<x_4<x_5<x_6$ are arranged in the increasing order, then the sum of the digits in the 72^{th} number is _____.

Official Ans. by NTA (32)

QuestPix Ans. (32)

Sol.

1	2					$={}^7C_4=35$
1	3					$={}^6C_4=15$
1	4					$={}^5C_4=5$
1	5					$={}^4C_4=1$
2	3					$={}^6C_4=15$

71 words

2 4 5 6 7 8 $\rightarrow$ 72^{th} word

2 + 4 + 5 + 6 + 7 + 8 = 32

27. Let $f:\mathbb{R}\to\mathbb{R}$ be a differentiable function that satisfies the relation f(x + y) = f(x) + f(y) –1, $\forall x, y\in\mathbb{R}$. If f '(0) = 2, then |f(–2)| is equal to _____.

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. f(x + y) = f(x) + f(y) – 1

$$f'(x)=\lim_{h\to0}\frac{f(x+h)-f(x)}{h}$$

$$f'(x)=\lim_{h\to0}\frac{f(h)-f(0)}{h}=f'(0)=2$$

$f'(x)=2\Rightarrow dy=2dx$

y = 2x + C

x = 0, y = 1, c = 1

y = 2x + 1

$|f(-2)|=|-4+1|=|-3|=3$

28. If the co-efficient of x^9 in $\left(\alpha x^3+\frac{1}{\beta x}\right)^{11}$ and the co-efficient of x^{-9} in $\left(\alpha x-\frac{1}{\beta x^3}\right)^{11}$ are equal, then $(\alpha\beta)^2$ is equal to ____.

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. Coefficient of x^9 in $\left(\alpha x^3+\frac{1}{\beta x}\right)={}^{11}C_6\cdot\frac{\alpha^5}{\beta^6}$

$\because$ Both are equal

$$\therefore\frac{11}{C_6}\cdot\frac{\alpha^5}{\beta^6}=-\frac{11}{C_5}\cdot\frac{\alpha^6}{\beta^5}$$

$$\Rightarrow\frac{1}{\beta}=-\alpha$$

$\Rightarrow\alpha\beta=-1$

$\Rightarrow(\alpha\beta)^2=1$

29. Let the coefficients of three consecutive terms in the binomial expansion of $(1 + 2x)^n$ be in the ratio 2 : 5 : 8. Then the coefficient of the term, which is in the middle of these three terms, is_____.

Official Ans. by NTA (1120)

QuestPix Ans. (1120)

Sol. $t_{r+1} = {}^{n}C_{r}(2x)^{r}$

$$\Rightarrow \frac{{}^{n}C_{r-1}(2)^{r-1}}{{}^{n}C_{r}(2)^{r}} = \frac{2}{5}$$

$$\Rightarrow \frac{\frac{n!}{(r-1)!(n-r+1)!}}{\frac{n!(2)}{r!(n-r)!}} = \frac{2}{5}$$

$$\Rightarrow \frac{r}{n-r+1} = \frac{4}{5} \Rightarrow 5r = 4n - 4r + 4$$

$$\Rightarrow 9r = 4(n+1) \qquad \ldots (1)$$

$$\Rightarrow \frac{{}^{n}C_{r}(2)^{r}}{{}^{n}C_{r+1}(2)^{r+1}} = \frac{5}{8}$$

$$\Rightarrow \frac{\frac{n!}{r!(n-r)!}}{\frac{n!}{(r+1)!(n-r-1)!}} = \frac{5}{4} \Rightarrow \frac{r+1}{n-r} = \frac{5}{4}$$

$$\Rightarrow 4r + 4 = 5n - 5r \Rightarrow 5n - 4 = 9r \quad \ldots (2)$$

From (1) and (2)

$$\Rightarrow 4n + 4 = 5n - 4 \Rightarrow n = 8$$

$$(1) \Rightarrow r = 4$$

so, coefficient of middle term is

$${}^{8}C_{4}\,2^{4} = 16 \times \frac{8 \times 7 \times 6 \times 5}{4 \times 3 \times 2 \times 1} = 16 \times 70 = 1120$$

30. Five digit numbers are formed using the digits 1, 2, 3, 5, 7 with repetitions and are written in descending order with serial numbers. For example, the number 77777 has serial number 1. Then the serial number of 35337 is_____.

Official Ans. by NTA (1436)

QuestPix Ans. (1436)

Sol. No of 5 digit numbers starting with digit 1

$= 5 \times 5 \times 5 \times 5 = 625$

No of 5 digit numbers starting with digit 2

$= 5 \times 5 \times 5 \times 5 = 625$

No of 5 digit numbers starting with 31

$= 5 \times 5 \times 5 = 125$

No of 5 digit numbers starting with 32

$= 5 \times 5 \times 5 = 125$

No of 5 digit numbers starting with 33

$= 5 \times 5 \times 5 = 125$

No of 5 digit numbers starting with 351

$= 5 \times 5 = 25$

No of 5 digit numbers starting with 352

$= 5 \times 5 = 25$

No of 5 digit numbers starting with 3531

$= 5$

No of 5 digit numbers starting with 3532

$= 5$

Before 35337 will be 4 numbers,

So rank of 35337 will be 1690

So, in descending order serial number will be

$3125 - 1690 + 1 = 1436$

(Held On Sunday 29th January, 2023) **TIME : 9 : 00 AM to 12 : 00 NOON**

PHYSICS | TEST PAPER WITH SOLUTION

SECTION-A

31. Match List I with List II :

List-I (Physical Quantity)		List-II (Dimensional Formula)	
A	Pressure gradient	I	$\lfloor M^0L^2T^{-2} \rfloor$
B	Energy density	II	$\lfloor M^1L^{-1}T^{-2} \rfloor$
C	Electric Field	III	$\lfloor M^1L^{-2}T^{-2} \rfloor$
D	Latent heat	IV	$\lfloor M^1L^1T^{-3}A^{-1} \rfloor$

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

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

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

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

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

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Pressure gradient $= \frac{dp}{dx} = \frac{[ML^{-1}T^{-2}]}{[L]}$

$= [M^1L^{-2}T^{-2}]$

Energy density $= \frac{\text{energy}}{\text{volume}} = \frac{[ML^2T^{-2}]}{[L^3]}$

$= [M^1 L^{-1} T^{-2}]$

Electric field $= \frac{\text{Force}}{\text{charge}} = \frac{[MLT^{-2}]}{[A.T]}$

$= [M^1 L^1 T^{-3} A^{-1}]$

Latent heat $= \frac{\text{heat}}{\text{mass}} = \frac{[ML^2T^{-2}]}{[M]}$

$= [M^0 L^2 T^{-2}]$

32. In a cuboid of dimension $2L \times 2L \times L$, a charge q is placed at the centre of the surface 'S' having area of 4 L^2. The flux through the opposite surface to 'S' is given by

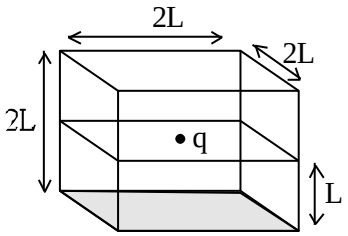
(1) $\frac{q}{12\varepsilon_0}$ (2) $\frac{q}{3\varepsilon_0}$

(3) $\frac{q}{2\varepsilon_0}$ (4) $\frac{q}{6\varepsilon_0}$

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. $\phi = \frac{Q/\varepsilon_0}{6}$



Flux passing through shaded face = $\frac{q}{6\varepsilon_0}$

33. Ratio of thermal energy released in two resistor R and 3R connected in parallel in an electric circuit is :

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

(3) 1 : 3 (4) 1 : 27

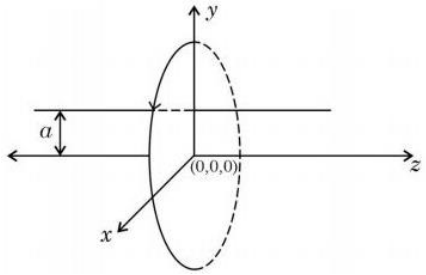
Official Ans. by NTA (1)

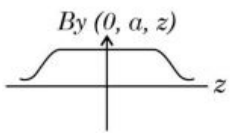
QuestPix Ans. (1)

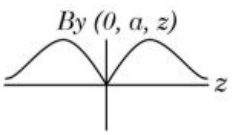
Sol. $H = \frac{V^2}{R} \times t$

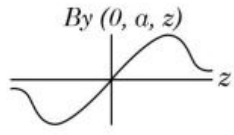
$\frac{H_1}{H_2} = \frac{\frac{V^2t}{R}}{\frac{V^2t}{3R}} = 3:1$

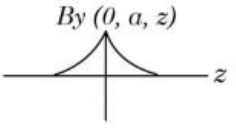
34. A single current carrying loop of wire carrying current I flowing in anticlockwise direction seen from +ve z direction and lying in xy plane in shown in figure. The plot of $\hat{j}$ component of magnetic field (By) at a distance 'a' (less than radius of the coil) and on yz plane vs z coordinate look like



(1) 

(2) 

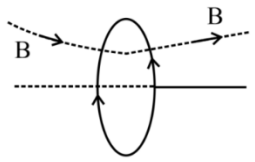
(3) 

(4) 

Official Ans. by NTA (3)

QuestPix Ans. (3)

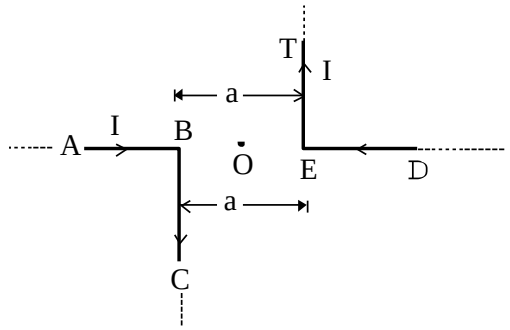
Sol.



$B_y = 0$ in plane of coil

B_y is opposite of each other in –z and +z positions.

35. The magnitude of magnetic induction at mid-point O due to current arrangement as shown in Fig will be :



(1) $\frac{\mu_0 I}{2\pi a}$ (2) 0

(3) $\frac{\mu_0 I}{4\pi a}$ (4) $\frac{\mu_0 I}{\pi a}$

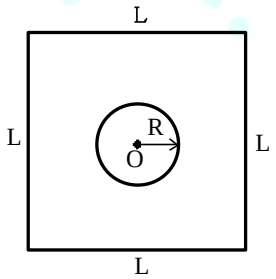
Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. Magnetic field due to current in BC and ET are outward at point 'O'

$$B_0 = \frac{\mu_0 i}{4\pi r} + \frac{\mu_0 i}{4\pi r} = \frac{\mu_0 i}{2\pi r} = \frac{\mu_0 i}{\pi a}$$

36. Find the mutual inductance in the arrangement, when a small circular loop of wire of radius 'R' is placed inside a large square loop of wire of side L (L >> R). The loops are coplanar and their centres coincide :



(1) $M = \frac{\sqrt{2}\mu_0 R^2}{L}$ (2) $M = \frac{2\sqrt{2}\mu_0 R}{L^2}$

(3) $M = \frac{2\sqrt{2}\mu_0 R^2}{L}$ (4) $M = \frac{\sqrt{2}\mu_0 R}{L^2}$

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. $\phi = Mi$

$\phi = (BA)$

$$\phi = \pi R^2 \left(4 \frac{\mu_0}{4\pi} \frac{i}{\left(\frac{L}{2}\right)} \sqrt{2} \right)$$

$$\Rightarrow M = \frac{2\sqrt{2}\mu_0 R^2}{L}$$

37. Which of the following are true?

A. Speed of light in vacuum is dependent on the direction of propagation.

B. Speed of light in a medium in independent of the wavelength of light.

C. The speed of light is independent of the motion of the source.

D. The speed of light in a medium is independent of intensity.

Choose the correct answer from the option given below :

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

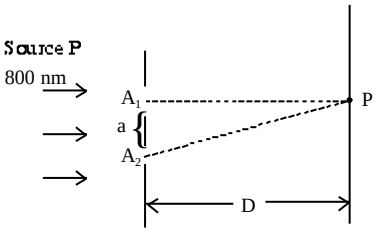
(3) B and C only (4) C and D only

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. Speed of light does not depend on the motion of source as well as intensity.

38. In a Young's double slit experiment, two slits are illuminated with a light of wavelength 800 nm. The line joining A_1P is perpendicular to A_1A_2 as shown in the figure. If the first minimum is detected at P, the value of slits separation 'a' will be :



The distance of screen from slits D = 5 cm

(1) 0.4 mm (2) 0.5 mm

(3) 0.2 mm (4) 0.1 mm

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. $A_2P - A_1P = \frac{\lambda}{2}$ (Condition of minima)

$$\sqrt{D^2 + a^2} - D = \frac{\lambda}{2}$$

$$D\left(1 + \frac{a^2}{D^2}\right)^{1/2} - D = \frac{\lambda}{2}$$

$$D\left(1 + \frac{1}{2} \times \frac{a^2}{D^2}\right) - D = \frac{\lambda}{2}$$

$$\frac{a^2}{2D} = \frac{\lambda}{2} \Rightarrow a = \sqrt{\lambda . D}$$

$$= \sqrt{800 \times 10^{-6} \times 50}$$

a= 0.2 mm

39. A stone is projected at angle 30º to the horizontal. The ratio of kinetic energy of the stone at point of projection to its kinetic energy at the highest point of flight will be :

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

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

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. $$\frac{KE_{POP}}{KE_{top}} = \frac{\frac{1}{2}M\,(u)^2}{\frac{1}{2}M\,(u\cos 30^\circ)^2} = \frac{4}{3}$$

40. A block of mass m slides down the plane inclined at angle 30º with an acceleration $\frac{g}{4}$. The value of coefficient of kinetic friction will be :

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

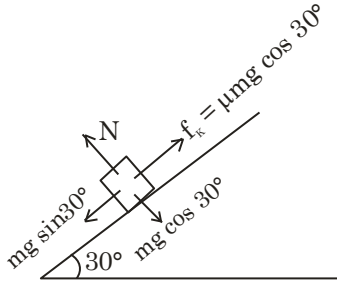
(3) $\frac{\sqrt{3}}{2}$ (4) $\frac{2\sqrt{3}-1}{2}$

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. Mg sin 30° - μmgcos 30° = ma

$$\frac{g}{2} - \frac{\sqrt{3}}{2}.\mu g = \frac{g}{4}$$



$$\frac{\sqrt{3}}{2}\mu = \frac{1}{4}$$

$$\mu = \frac{1}{2\sqrt{3}}$$

41. A car is moving on a horizontal curved road with radius 50 m. The approximate maximum speed of car will be, if friction between tyres and road is 0.34. [Take g = 10 ms^{-2}]

(1) 3.4 ms^{-1} (2) 22.4 ms^{-1}

(3) 13 ms^{-1} (4) 17 ms^{-1}

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. $f_s = \frac{mv^2}{r}$

For maximum speed in safe turning,

$f_s = f_s$ max $= \mu mg$

v_{max} (for safe turning $= \sqrt{\mu rg}$

$= \sqrt{0.34 \times 50 \times 10} \approx 13$ m/s

42. Two particles of equal mass 'm' move in a circle of radius 'r' under the action of their mutual gravitational attraction. The speed of each particle will be :

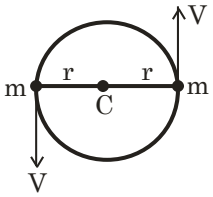
(1) $\sqrt{\frac{GM}{2r}}$ (2) $\sqrt{\frac{4GM}{r}}$

(3) $\sqrt{\frac{GM}{r}}$ (4) $\sqrt{\frac{GM}{4r}}$

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. $\frac{Gm^2}{4r^2} = \frac{mv^2}{r}$



$$v = \sqrt{\frac{Gm}{4r}}$$

43. Surface tension of a soap bubble is 2.0×10^{-2} Nm^{-1}. Work done to increase the radius of soap bubble from 3.5 cm to 7 cm will be : [Take $\pi = \frac{22}{7}$]

(1) 0.72×10^{-4} J (2) 5.76×10^{-4} J

(3) 18.48×10^{-4} J (4) 9.24×10^{-4} J

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Surface area of soap bubble = $2 \times 4\pi R^2$

Work done = change in surface energy × T_S

$= T_S \times 8\pi \times (R_2^2 - R_1^2)$

$= 2 \times 10^{-2} \times 8 \times \frac{22}{7} \times 49 \times \frac{3}{4} \times 10^{-4}$

$= 18.48 \times 10^{-4}$ J

44. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : If dQ and dW represent the heat supplied to the system and the work done on the system respectively. Then according to the first law of thermodynamics $dQ = dU - dW$.

Reason R : First law of thermodynamics is based on law of conservation of energy.

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

(1) A is correct but R is not correct

(2) A is not correct but R is correct

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

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

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. First law of thermodynamics is based on law of conservation of energy and it can be written as $dQ = dU - dW$.

where dW is work done on the system

45. A bicycle tyre is filled with air having pressure of 270 kPa at 27ºC. The approximate pressure of the air in the tyre when the temperature increases to 36ºC is

(1) 270 kPa (2) 262 KPa

(3) 278 kPa (4) 360 kPa

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Taking volume constant : $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$$\Rightarrow P_2 = \frac{P_1}{T_1} \times T_2 = \frac{270 \times (309)}{300}$$

$$= 278\,\text{kPa}$$

46. A person observes two moving trains, 'A' reaching the station and 'B' leaving the station with equal speed of 30 m/s. If both trains emit sounds with frequency 300 Hz, (Speed of sound : 330 m/s) approximate difference of frequencies heard by the person will be :

(1) 33 Hz (2) 55 Hz

(3) 80 Hz (4) 10 Hz

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $f_1 = 300\left(\frac{330-0}{330-(-30)}\right) = 275$

$f_2 = 300\left(\frac{330-0}{330-(30)}\right) = 330$

$\Delta f = 330 - 275 = 55$ Hz.

47. If the height of transmitting and receiving antennas are 80 m each, the maximum line of sight distance will be :

Given : Earth's radius = 6.4×10^6 m.

(1) 32 km (2) 28 km

(3) 36 km (4) 64 km

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. Maximum line of sight distance between two antennas, $d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R}$

$d_M = 2 \times \sqrt{2 \times 6.4 \times 10^6 \times 80} = 64$ km

48. The threshold wavelength for photoelectric emission from a material is 5500Å. Photoelectrons will be emitted, when this material is illuminated with monochromatic radiation from a

A. 75 W infra-red lamp

B. 10 W infra-red lamp

C. 75 W ultra-violet lamp

D. 10 W ultra-violet lamp

Choose the correct answer from the options given below :

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

(3) C only (4) C and D only

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. $\lambda < 5500$ Å for photoelectric emission

$\lambda_{uv} < 5500$Å

49. If a radioactive element having half-life of 30 min is undergoing beta decay, the fraction of radioactive element remains undecayed after 90 min. will be :

(1) $\frac{1}{8}$ (2) $\frac{1}{16}$

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

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. $\frac{N}{N_0}=\left(\frac{1}{2}\right)^{t/t\frac{1}{2}}=\left(\frac{1}{2}\right)^{\frac{90}{30}}$

$\frac{N}{N_0}=\left(\frac{1}{2}\right)^{3}=\frac{1}{8}$

50. Which of the following statement is not correct in the case of light emitting diodes?

A. It is a heavily doped p-n junction.

B. It emits light only when it is forward biased.

C. It emits light only when it is reverse biased.

D. The energy of the light emitted is equal to or slightly less than the energy gap of the semiconductor used.

Choose the correct answer from the options given below :

(1) C and D (2) A

(3) C (4) B

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. LED works in forward biasing and light energy maybe slightly less or equal to band gap.

SECTION-B

51. A radioactive element $^{242}_{92}X$ emits two α-particles, one electron and two positrons. The product nucleus is represented by $^{234}_{P}Y$. The value of P is ____

Official Ans. by NTA (87)

QuestPix Ans. (87)

Sol. $P=92-2-2+1-1-1$

$P=92-5$

P = 87

52. Two simple harmonic waves having equal amplitudes of 8 cm and equal frequency of 10 Hz are moving along the same direction. The resultant amplitude is also 8 cm. The phase difference between the individual waves is _____ degree.

Official Ans. by NTA (120)

QuestPix Ans. (120)

Sol. $2A\cos\left(\frac{\Delta\phi}{2}\right)=A$

$\cos\left(\frac{\Delta\phi}{2}\right)=\frac{1}{2}$

$\frac{\Delta\phi}{2}=60^{o}$

53. A body cools from 60°C to 40°C in 6 minutes. If, temperature of surroundings is 10°C. Then, after the next 6 minutes, its temperature will be ____ °C.

Official Ans. by NTA (28)

QuestPix Ans. (28)

Sol. By average form of Newton's law of cooling

$\frac{20}{6}=k(50-10)$ … (i)

$\frac{40-T}{6}=K\left(\frac{40+T}{2}-10\right)$ ….(ii)

From equation (i) and (ii)

$\frac{20}{40-T}=\frac{40}{10+T/2}$

$10+\frac{T}{2}=80-2T$

$\frac{5T}{2}=70\Rightarrow T=28^{o}C$

54. A solid sphere of mass 2kg is making pure rolling on a horizontal surface with kinetic energy 2240 J. The velocity of centre of mass of the sphere will be ____ ms^{-1}.

Official Ans. by NTA (40)

QuestPix Ans. (40)

Sol. $KE=\frac{1}{2}mv^2+\frac{1}{2}I\omega^2$

$2240=\frac{1}{2}2(v)^2+\frac{1}{2}\frac{2}{5}(2)R^2.\left(\frac{v}{R}\right)^2$

$2240=v^2+\frac{2}{5}v^2$

$\Rightarrow v=40\,m/s$

55. A 0.4 kg mass takes 8s to reach ground when dropped from a certain height 'P' above surface of earth. The loss of potential energy in the last second of fall is ____ J. [Take g = 10 m/s^2]

Official Ans. by NTA (300)

QuestPix Ans. (300)

Sol. Displacement is 8^{th} sec.

$S_8=0+\frac{1}{2}\times10\times(2\times8-1)$

$S_8=5\times15$

$\Delta U=0.4\times10\times5\times15$

$\Delta U=20\times15=300$

56. A tennis ball is dropped on to the floor from a height of 9.8 m. It rebounds to a height 5.0 m. Ball comes in contact with the floor for 0.2s. The average acceleration during contact is ____ ms^{-2}. [Given g = 10 ms^{-2}]

Official Ans. by NTA (120)

QuestPix Ans. (120)

Sol. $v_i = \sqrt{2gh_i}$

$= \sqrt{2\times10\times9.8}\downarrow$

$= 14 m/s\downarrow$

$v_f = \sqrt{2gh_f}$

$= \sqrt{2\times10\times5}\uparrow$

= 10 m/s↑

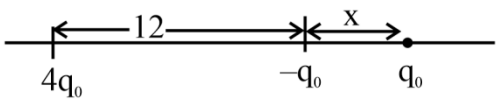
$\left|\vec{a}_{avg}\right| = \left|\frac{\Delta\vec{v}}{\Delta t}\right| = \frac{24}{0.2} = 120\, m/s^2$

57. A point charge $q_1 = 4q_0$ is placed at origin. Another point charge $q_2 = -q_0$ is placed at x = 12 cm. Charge of proton is q_0. The proton is placed on x-axis so that the electrostatic force on the proton in zero. In this situation, the position of the proton from the origin is _____ cm.

Official Ans. by NTA (24)

QuestPix Ans. (24)

Sol.



$\frac{q_0}{x^2} = \frac{4q_0}{(x+12)^2}$

$x+12 = 2x$

$x = 12$

Distance from origin = x + 12 = 24 cm.

58. In a metre bridge experiment the balance point in obtained if the gaps are closed by 2Ω and 3Ω. A shunt of $X\Omega$ is added to 3Ω resistor to shift the balancing point by 22.5 cm. The value of X is ____

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $\frac{2}{\left(\frac{3x}{3+x}\right)} = \frac{40+22.5}{60-22.5} = \frac{62.5}{37.5} = \frac{5}{3}$

$\frac{6}{5} = \frac{3x}{3+x}$

$6+2x = 5x \Rightarrow x = 2$

59. A certain elastic conducting material is stretched into a circular loop. It is placed with its plane perpendicular to a uniform magnetic field B = 0.8 T. When released the radius of the loop starts shrinking at a constant rate of 2 cm^{-1}. The induced emf in the loop at an instant when the radius of the loop is 10 cm will be ____ mV.

Official Ans. by NTA (10)

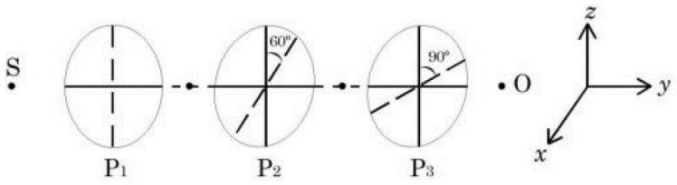
QuestPix Ans. (10)

Sol. $EMF = \frac{d}{dt}\left(B\pi r^2\right)$

$= 2B\pi r\frac{dr}{dt} = 2\times\pi\times0.1\times0.8\times2\times10^{-2}$

$= 2\pi\times1.6$ **= 10.06 [round off 10.06 = 10]**

60. As shown in figures, three identical polaroids P_1, P_2 and P_3 are placed one after another. The pass axis of P_2 and P_3 are inclined at angle of 60º and 90º with respect to axis of P_1. The source S has an intensity of $256\frac{W}{m^2}$. The intensity of light at point O is $-----\frac{W}{m^2}$.



Official Ans. by NTA (24)

QuestPix Ans. (24)

Sol. By first polaroid P1 intensity will be halved then P2 and P3 will make intensity $\cos^2(60°)$ and $\cos^2(30°)$ times respectively.

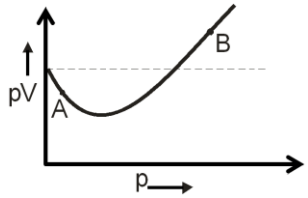
Intensity out = $\frac{256}{2}\times\frac{1}{4}\times\left(\frac{\sqrt{3}}{2}\right)^2 = \frac{256\times3}{2\times4\times4}$ **= 24**

(Held On Sunday 29th January, 2023) **TIME : 9 : 00 AM to 12 : 00 NOON**

CHEMISTRY | TEST PAPER WITH SOLUTION

SECTION-A

61. For 1 mol of gas, the plot of pV vs p is shown below. p is the pressure and V is the volume of the gas.



What is the value of compressibility factor at point A?

(1) $1-\frac{a}{RTV}$ (2) $1+\frac{b}{V}$

(3) $1-\frac{b}{V}$ (4) $1+\frac{a}{RTV}$

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. For 1 mole of real gas

$PV = ZRT$

from graph PV for real gas is less than PV for ideal gas at point A

$Z < 1$

$$Z = 1 - \frac{a}{V_m RT}$$

62. The shortest wavelength of hydrogen atom in Lyman series is λ. The longest wavelength in Balmer series of He^+ is

(1) $\frac{5}{9\lambda}$ (2) $\frac{9\lambda}{5}$

(3) $\frac{36\lambda}{5}$ (4) $\frac{5\lambda}{9}$

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. For H: $\frac{1}{\lambda} = R_H \times 1^2\left(\frac{1}{1^2}-\frac{1}{\infty^2}\right)$ ...(1)

$$\frac{1}{\lambda_{He^+}} = R_H \times 2^2 \times \left(\frac{1}{4}-\frac{1}{9}\right) \quad \text{.... (2)}$$

From (1) & (2) $\frac{\lambda_{He^+}}{\lambda} = \frac{9}{5}$

$\lambda_{He^+} = \lambda \times \frac{9}{5}$

$\lambda_{He^+} = \frac{9\lambda}{5}$

63. Which of the following salt solutions would coagulate the colloid soloution formed when $FeCl_3$ is added to NaOH solution, at the fastest rate?

(1) 10 mL of 0.2 mol dm^{-3} $AlCl_3$

(2) 10 mL of 0.1 mol dm^{-3} Na_2SO_4

(3) 10 mL of 0.1 mol dm^{-3} $Ca_3(PO_4)_2$

(4) 10 mL of 0.15 mol dm^{-3} $CaCl_2$

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. Sol. Formed is negatively charged solution, therefore Al^{3+} has highest coagulating power

64. The bond dissociation energy is highest for

(1) Cl_2

(2) I_2

(3) Br_2

(4) F_2

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. Bond energy of F_2 less than Cl_2 due to lone pair – lone pair repulsions.

Bond energy order $Cl_2 > Br_2 > F_2 > I_2$

65. The reaction representing the Mond process for metal refining is _____

(1) $Ni + 4CO \xrightarrow{\Delta} Ni(CO)_4$

(2) $2K[Au(CN)_2] + Zn \xrightarrow{\Delta} K_2[Zn(CN)_4] + 2Au$

(3) $Zr + 2I_2 \xrightarrow{\Delta} ZrI_4$

(4) $ZnO + C \xrightarrow{\Delta} Zn + CO$

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. Mond's process uses:

$Ni + 4CO \rightarrow [Ni(CO)_4]$

66. Which of the given compounds can enhance the efficiency of hydrogen storage tank?

(1) Li/P_4

(2) SiH_4

(3) $NaNi_5$

(4) Di-isobutylaluminium hydride

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Refer NCERT

67. The correct order of hydration enthalpies is

(A) K^+

(B) Rb^+

(C) Mg^{2+}

(D) Cs^+

(E) Ca^{2+}

Choose the correct answer from the options given below:

(1) C > A > E > B > D

(2) E > C > A > B > D

(3) C > E > A > D > B

(4) C > E > A > B > D

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. Hydration enthalpies:

(i) $K^+ > Rb^+ > Cs^+$: (A) > (B) > (D)

(ii) $Mg^{+2} > Ca^{+2}$: (C) > (E)

Option (D)

(C) > (E) > (A) > (B) > (D)

68. The magnetic behaviour of Li_2O, Na_2O_2 and KO_2, respectively, are

(1) diamagnetic, paramagnetic and diamagnetic

(2) paramagnetic, paramagnetic and diamagnetic

(3) paramagnetic, diamagnetic and paramagnetic

(4) diamagnetic, diamagnetic and paramagnetic

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. $Li_2O \rightarrow O^{2-} \rightarrow$ diamagnetic

$Na_2O_2 \rightarrow O_2^{2-} \rightarrow$ diamagnetic

$KO_2 \rightarrow O_2^{-} \rightarrow$ paramagnetic

69. "A" obtained by Ostwald's method involving air oxidation of NH_3, upon further air oxidation produces "B". "B" on hydration forms an oxoacid of Nitrogen along with evolution of "A". The oxoacid also produces "A" and gives positive brown ring test

(1) NO_2, N_2O_5

(2) NO_2, N_2O_4

(3) NO, NO_2

(4) N_2O_3, NO_2

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. $4NH_3 + 5O_2 \xrightarrow{\Delta} 4NO + 6H_2O$

(A)

$2NO + O_2 \longrightarrow 2NO_2$

(B)

70. The standard electrode potential (M^{3+}/M^{2+}) for V, Cr, Mn & Co are -0.26 V, - 0.41 V, + 1.57 V and +1.97 V, respectively. The metal ions which can liberate H_2 from a dilute acid are

(1) V^{2+} and Mn^{2+}

(2) Cr^{2+} and CO^{2+}

(3) V^{2+} and Cr^{2+}

(4) Mn^{2+} and Co^{2+}

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Metal cation with (–) value of reduction potential (M^{+3}/M^{+2})or with (+) value of oxidation potential (M^{+2}/M^{+3}) will liberate H_2

Therefore they will reduce H^+

i.eV^{+2} and Cr^{+2}

71. Correct statement about smog is

(1) NO_2 is present in classical smog

(2) Both NO_2 and SO_2 are present in classical smog

(3) Photochemical smog has high concentration of oxidizing agents

(4) Classical smog also has high concentration of oxidizing agents

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Photochemical smog has high concentration of oxidising agents

NO_2 is produced from NO and O_3 in the presence of sunlight

Classical smog contain smoke, fog and SO_2 and it is known as reducing smog, as chemically it is reducing mixture

72. Chiral complex from the following is :

Here en = ethylene diamine

(1) cis – $[PtCl_2 (en)_2]^{2+}$

(2) trans – $[PtCl_2(en)_2]^{2+}$

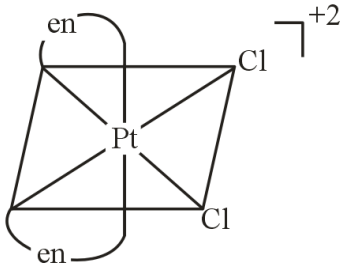
(3) cis – $[PtCl_2(NH_3)_2]$

(4) trans – $[Co(NH_3)_4 Cl_2]^+$

Official Ans. by NTA (1)

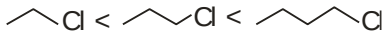
QuestPix Ans. (1)

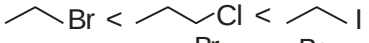
Sol.

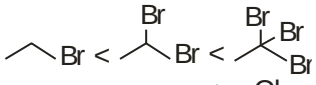


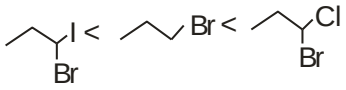
this is chiral complex form

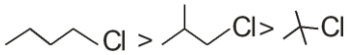
73. Identify the correct order for the given property for following compounds

(A) Boiling Point: 

(B) Density: 

(C) Boiling Point: 

(D) Density: 

(E) Boiling Point: 

Choose the correct answer from the option given below :-

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

(2) (A), (C) and (E) only

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

(4) (A), (B) and (E) only

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. Boiling point of alkyl halide increases with increase in size, mass of halogen atom and size of alkyl group

Boiling point of isomeric alkyl halide decreases with increase in branching

Density increases with increase in atomic mass of halogen atom

74. The increasing order of pK_a for the following phenols is

(1) 2, 4-Dinitrophenol

(2) 4 - Nitrophenol

(3) 2, 4, 5- Trimethylphenol

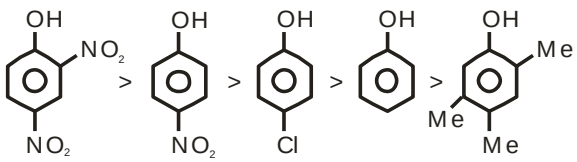
(4) Phenol

(5) 3-Chlorophenol

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. Order of acidity for following phenol is



- M and – I increases acidity

+ M and + I decreases acidity

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

List-I	List-II
Reaction	Reagents
(A) Hoffmann Degradation	(I) Conc.KOH, Δ
(B) Clemenson reduction	(II) $CHCl_3$, $NaOH/H_3O^+$
(C) Cannizaro reaction	(III) Br_2, NaOH
(D) Reimer-Tiemann reaction	(IV) Zn-Hg/HCl

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

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

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

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

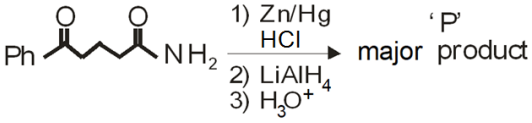
Official Ans. by NTA (3)

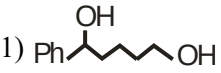
QuestPix Ans. (3)

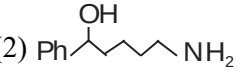
Sol.

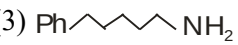
Reactions	Reagent used
(A) Hoffmann degradation	Br_2/NaOH
(B) Clemenson reduction	Zn– Hg/HCl
(C) Cannizaro reaction	conc.KOH/Δ
(D) Reimer-Tiemann reaction	$CHCl_3$, $NaOH/H_3O^+$

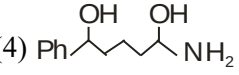
76. The major product 'P' for the following sequence of reactions is:



(1) 

(2) 

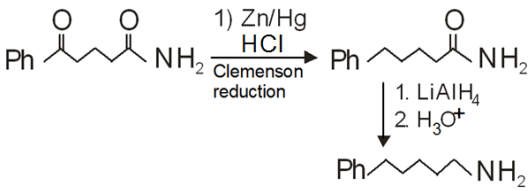
(3) 

(4) 

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol.



77. During the borax bead test with $CuSO_4$, a blue green colour of the bead was observed in oxidising flame due to the formation of

(1) Cu_3B_2 (2) Cu

(3) $Cu(BO_2)_2$ (4) CuO

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Blue green colour is due to formation of $Cu(BO_2)_2$

$CuSO_4 \xrightarrow{\Delta} CuO + SO_3$

$CuO + B_2O_3 \rightarrow Cu(BO_2)_2$

78. Match List I with List II

List I	List II
Antimicrobials	**Names**
(A) Narrow Spectrum Antibiotic	(I) Furacin
(B) Antiseptic	(II) Sulphur dioxide
(C) Disinfectants	(III) Penicillin-G
(D) Broad spectrum antibiotic	(IV) Chloramphenicol

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

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

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

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

Official Ans. by NTA (1)

QuestPix Ans. (1)

Sol. (A) Narrow spectrum antibiotic – penicillin-G

(B) Antiseptic – Furacine

(C) Disinfectants – sulphur dioxide

(D) Broad spectrum antisiotics – chloramphenicol

79. Number of cyclic tripeptides formed with 2 amino acids A and B is:

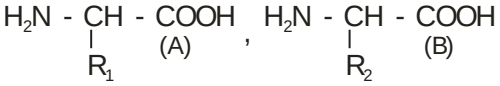
(1) 2 (2) 3

(3) 5 (4) 4

Official Ans. by NTA (4)

QuestPix Ans. (4)

Sol. Two amino acid are



Tripeptide are formed from three amino acids

80. Compound that will give positive Lassaigne's test for both nitrogen and halogen is

(1) $N_2H_4.HCl$

(2) $CH_3NH_2.HCl$

(3) NH_4Cl

(4) $NH_2OH.HCl$

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $CH_3NH_2 . HCl \xrightarrow[\text{fusion}]{Na} NaCN$ and NaCl

NaCN gives +ve test for nitrogen and

NaCl gives +ve test for halogen

SECTION-B

81. Millimoles of calcium hydroxyide required to produce 100 mL of the aqueous solution of pH 12 is $x \times 10^{-1}$. The value of x is _____ (Nearest integer). Assume complete dissociation.

Official Ans. by NTA (5)

QuestPix Ans. (5)

Sol. $\because$ pH = 12

$\therefore [H^+] = 10^{-12}$ M

$\therefore [OH^-] = 10^{-2}$ M

$\therefore [Ca(OH)_2] = 5 \times 10^{-3}$ M

$$5 \times 10^{-3} = \frac{\text{milli moles of } Ca(OH)_2}{100\,\text{mL}}$$

milli moles of $Ca(OH)_2 = 5 \times 10^{-1}$

Ans. = 5

82. The number of molecules or ions from the following, which do not have odd number of electrons are _____ .

(A) NO_2

(B) ICl_4^-

(C) BrF_3

(D) ClO_2

(E) NO_2^+

(F) NO

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. ICl_4^-, BrF_3 and NO_2^+ do not have odd number of e^-

83. Consider the following reaction approaching equilibrium at 27ºC and 1 atm pressure

$$A + B \underset{K_r=10^2}{\overset{K_f=10^3}{\rightleftharpoons}} C + D$$

The standard Gibb's energy change $\left(\Delta_r G^\circ\right)$ at 27ºC is (–) _____ kJ mol^{-1}

(Nearest integer).

(Given : R = 8.3 J K^{-1} mol^{-1} and ln 10=2.3)

Official Ans. by NTA (6)

QuestPix Ans. (6)

Sol. $\because \Delta G^\circ = -RT \ln K_{eq}$

and $K_{eq} = \dfrac{K_f}{K_b}$

$\therefore K_{eq} = \dfrac{10^3}{10^2} = 10$

$\therefore \Delta G = -RT \ln 10$

$\Rightarrow -(8.3 \times 300 \times 2.3) = -5.7$ kJ $mole^{-1} \approx 6$ kJ $mole^{-1}$(nearest integer)

Ans = 6

84. Solid Lead nitrate is dissolved in 1 litre of water. The solution was found to boil at 100.15ºC. When 0.2 mol of NaCl is added to the resulting solution, it was observed that the solution froze at –0.8º C. The solutbility product of $PbCl_2$ formed is _____ $\times 10^{-6}$ at 298 K. (Nearest integer)

Given : K_b = 0.5 K kg mol^{-1} and K_f = 1.8 kg mol^{-1}. Assume molality to be equal to molarity in all cases.

Official Ans. by NTA (13)

QuestPix Ans. (13)

Sol. Let a mole $Pb(NO_3)_2$ be added

$Pb(NO_3)_2 \rightarrow Pb^{2+} + 2NO_3^-$

a a 2a

$\Delta T_b = 0.15 = 0.5\,[3a] \Rightarrow a = 0.1$

$Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_2(s)$

t = 0 0.1 0.2

t = ∞ (0.1 – x) (0.2 – 2x)

In final solution

$$\Delta T_f = 0.8 = 1.8\left[\frac{0.3-3x+0.2+0.2}{1}\right]$$

$$\Rightarrow x = \frac{2.3}{27}$$

$$\Rightarrow K_{sp} = \left(0.1-\frac{2.3}{27}\right)\left(0.2-\frac{4.6}{27}\right)^2 = 13\times10^{-6}$$

85. Water decomposes at 2300 K

$$H_2O(g) \rightarrow H_2(g) + \frac{1}{2}O_2(g)$$

The percent of water decomposing at 2300 K and 1 bar is _____ (Nearest integer).

Equilibrium constant for the reaction is 2×10^{-3} at 2300 K

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. $H_2O(g) \rightleftharpoons H_2(g) + \frac{1}{2}O_2(g)$

$P_0[1-\alpha]$ $P_0\alpha$ $\dfrac{P_0\alpha}{2}$ partial pr. at eq.

$$P_0\left[1+\frac{\alpha}{2}\right] = 1 \quad \text{...(i)}$$

$$K_p = \frac{\left(P_{H_2}\right)\left(P_{O_2}\right)^{1/2}}{P_{H_2O}}$$

$$\frac{(P_0\alpha)\left(\frac{P_0\alpha}{2}\right)^{1/2}}{P_0[1-\alpha]} = 2\times10^{-3}$$

since α is negligible w.r.t 1 so $P_0 = 1$ and $1 - \alpha \approx 1$

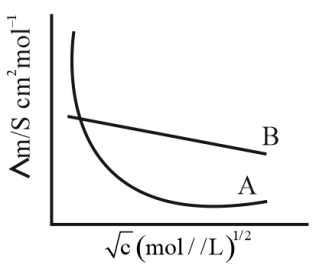
$$\frac{\alpha\sqrt{\alpha}}{\sqrt{2}} = 2\times10^{-3}$$

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

$\alpha = 2^{3/2\times2/3} \times 10^{-3\times2/3}$

$\alpha = 2 \times 10^{-2}$ $\quad \% \alpha = 2\%$

86. Following figure shows dependence of molar conductance of two electrolytes on concentration. Λ_m^0 is the limiting molar conductivity.



The number of **Incorrect** statement(s) from the following is _____

(A) Λ_m^0 for electrolyte A is obtained by extrapolation

(B) For electrolyte B, vx Λm vs $\sqrt{c}$ graph is a straight line with intercept equal to Λ_m^0

(C) At infinite dilution, the value of degree of dissociation approach zero for electrolyte B.

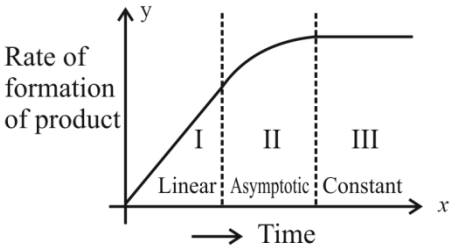
(D) Λ_m^0 for any electrolyte A or B can be calculated using λ^o for individual ions.

Official Ans. by NTA (2)

QuestPix Ans. (2)

Sol. Statement (A) and Statement (C) are incorrect

87. For certain chemical reaction $X \rightarrow Y$, the rate of formation of product is plotted against the time as shown in the figure. The number of **Correct** statement/s from the following is _____



(A) Over all order of this reaction is one

(B) Order of this reaction can't be determined

(C) In region-I and III, the reaction is of first and zero order respectively

(D) In region-II, the reaction is of first order

(E) In region-II, the order of reaction is in the range of 0.1 to 0.9.

Official Ans. by NTA (2)

QuestPix Ans. (1)

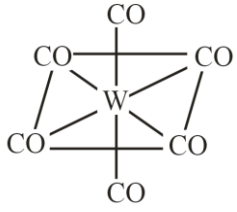
Sol. Only option (B) is correct as order cannot be determined

88. The sum of bridging carbonyls in $W(CO)_6$ and $Mn_2(CO)_{10}$ is _____ .

Official Ans. by NTA (0)

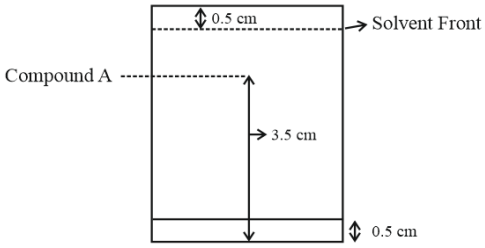
QuestPix Ans. (0)

Sol.



$[(CO)_5Mn - Mn(CO)_5]$

89. Following chromatogram was developed by adsorption of compound 'A' on a 6 cm TLC glass plate. Retardation factor of the compound 'A' is _____ $\times 10^{-1}$.



Official Ans. by NTA (6)

QuestPix Ans. (6)

Sol. $R_f = \frac{\text{Distance moved by the substance from base line}}{\text{Distance moved by the solvent from base line}}$

$= \frac{3.0\text{ cm}}{5.0\text{ cm}} = 0.6$ or 6×10^{-1}

90. 17 mg of a hydrocarbon (M.F. $C_{10}H_{16}$) takes up 8.40 mL of the H_2 gas measured at 0°C and 760 mm of Hg. Ozonolysis of the same hydrocarbon yields

$CH_3-\overset{\overset{O}{\|}}{C}-CH_3$, $H-\overset{\overset{O}{\|}}{C}-H$, $H-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-H$

The number of double bond/s present in the hydrocarbon is _____ .

Official Ans. by NTA (3)

QuestPix Ans. (3)

Sol. Moles of hydrocarbon $= \frac{17\times10^{-3}}{136} = 1.25 \times 10^{-4}$

Mole of H_2 gas

$\Rightarrow 1 \times \frac{8.40}{1000} = n \times 0.0821 \times 273$

$\Rightarrow n = 3.75 \times 10^{-4}$

Hydrogen molecule used for 1 molecule of hydrocarbon is 3

$= \frac{3.75\times10^{-4}}{1.25\times10^{-4}} = 3$