Sri Chaitanya
Educational Institutions & Techno Schools

Infinity Learn BY SRI CHAITANYA

39 YEARS OF EXCELLENCE 1986-2024

SRI CHAITANYA NATION'S 1ST CHOICE FOR IIT-JEE SUCCESS

5 STUDENTS IN TOP 10 IN JEE-ADVANCED 2024 OPEN CATEGORY

1 AIR	4 AIR	5 AIR	6 AIR	9 AIR	10 AIR
RAGHAV SHARMA Ht. No. 242053073*	RHYTHM KEDIA Ht. No. 247025176*	P KUSHAL KUMAR Ht. No. 246150349	RAJDEEP MISHRA Ht. No. 241016176*	DHRUVIN H DOSHI Ht. No. 241106162	A SIDHVIK SUHAS Ht. No. 246119101

30 RANKS IN TOP 100 IN ALL-INDIA OPEN CATEGORY

12 RANK RAGHAV SHARMA HT. NO. 242053073 *	14 RANK VEDANT SAINI HT. NO. 247004173	16 RANK BISMIT SAHOO HT. NO. 242072080 *	28 RANK SHEKHAR JHA HT. NO. 242031290 *	31 RANK ISHAAN GUPTA HT. NO. 242014288 *	34 RANK N. SIDDHARTH REDDY HT. NO. 246053446	38 RANK AKSHAR ZALA HT. NO. 241019087 *
43 RANK KESHAV SINGHAL HT. NO. 242027289 *	55 RANK SATIVADA JYOTHIRADITYA HT. NO. 246022079	57 RANK AADITYA KUMAR HT.NO. 242067130 *	68 RANK MAYANK JAIN HT. NO. 247004363	71 RANK P. V S D SAI MOHITH HT. NO. 246008172	74 RANK HIMANSHU THALOR HT. NO. 242050438 *	77 RANK MOHAMMAD EMAAD ARIF HT. NO. 242054030 *
83 RANK AMAAN KHAN HT. NO. 242026030 *	85 RANK BIBASWAN BISWAS HT. NO. 245058146 *	88 RANK FENIL MAYANK PATEL HT. NO. 241006043 *	91 RANK AMAR SINHA HT. NO. 242057008 *	93 RANK HARDIK AGGARWAL HT. NO. 242057008 *	94 RANK G. N. NIRMAL KUMAR HT. NO. 241110162 *	95 RANK UJJWAL SINGH HT. NO. 242050207 *
96 RANK ANIKET KUMAR HT. NO. 243035068	97 RANK M.E. VENKATA PARTHIV HT. NO. 246162250	99 RANK TANAY CHETAN KAKLIYA HT. NO. 242057318 *	100 RANK TVS SAI NAGA BHUSHAN HT. NO. 246016038			

NUMBER OF QUALIFIED RANKS **4187+**

HIGHLIGHTS

BELOW 100 ALL INDIA OPEN CATEGORY RANKS	30
BELOW 500 ALL INDIA OPEN CATEGORY RANKS	122
BELOW 1000 ALL INDIA OPEN CATEGORY RANKS	203
BELOW 100 ALL INDIA CATEGORY RANKS COUNT	146
BELOW 1000 ALL INDIA CATEGORY RANKS COUNT	721

Scan QR Code for Admissions

*T & C apply | Note: Any inadvertent error published in this advertisement could be brought to our notice Note: The information is as per students feedback

*IOA-415 Information so far.

Transforming Your Dreams Into Reality

040 660 60606 | www.srichaitanya.net

Sri Chaitanya IIT Academy., India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur – Hyderabad

JEE-ADVANCED-2025-P1-Model

Time:3Hr's **IMPORTANT INSTRUCTIONS** **Max Marks: 180**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 4)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 5 – 7)	Questions with Multiple Correct Choice with partial mark	+4	-2	3	12
Sec – III(Q.N : 8 – 13)	Questions with NUMERICAL VALUE Type	+4	0	6	24
Sec – IV(Q.N : 14 – 16)	Matching Type	+4	-1	3	12
Total				**16**	**60**

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 17 – 20)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 21 – 23)	Questions with Multiple Correct Choice with partial mark	+4	-2	3	12
Sec – III(Q.N : 24 – 29)	Questions with NUMERICAL VALUE Type	+4	0	6	24
Sec – IV(Q.N : 30 – 32)	Matching Type	+4	-1	3	12
Total				**16**	**60**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 33 – 36)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 37 – 39)	Questions with Multiple Correct Choice with partial mark	+4	-2	3	12
Sec – III(Q.N : 40 – 45)	Questions with NUMERICAL VALUE Type	+4	0	6	24
Sec – IV(Q.N : 46 – 48)	Matching Type	+4	-1	3	12
Total				**16**	**60**

MATHEMATICS **Max Marks: 60**

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases

1. Let $\mathbb{R}$ denote the set of all real numbers. Let $a_i, b_i \in \mathbb{R}$ for $i \in \{1,2,3\}$.

Define the functions $f:\mathbb{R}\to\mathbb{R}$, $g:\mathbb{R}\to\mathbb{R}$, and $h:\mathbb{R}\to\mathbb{R}$ by

$$f(x) = a_1 + 10x + a_2x^2 + a_3x^3 + x^4,$$

$$g(x) = b_1 + 3x + b_2x^2 + b_3x^3 + x_4,$$

$$h(x) = f(x+1) - g(x+2)$$

If $f(x) \neq g(x)$ for every $x \in \mathbb{R}$, then the coefficient of x^3 in $h(x)$ is

A) 8 **B)** 2 **C)** –4 **D)** –6

KEY:- C

SOL:- $f(x) = a_1 + 10x + a_2x^2 + a_3x^3 + x^4$

$g(x) = b_1 + 3x + b_2x^2 + b_3x^3 + x^4$ $\quad h(x) = f(x+1) - g(x+2)$

given that $f(x) \neq g(x) \forall x \in R$

if $f(x) \neq g(x) \Rightarrow f(x) - g(x) \neq 0$ for all real x.

$\Rightarrow (a_3 - b_3)x^3 + (a_2 - b_2)x^2 + 3x + a_1 - b_1 = 0$

it holds only when $a_3 - b_3 = 0$ and $(a_2 - b_2)x^2 + 7x + a_1 - b_1 = 0$ has no real roots.

$\therefore h(x) = (x+1)^4 + a_3(x+1)^3 + a_2(x+1)^2 + 10(x+1) + a_1 - (x+2)^4 + b_3(x+2)^3 + b_2(x+2)^2 + 3(x+2) + b_1$

$\therefore$ Coefficient of x^3 in $h(x) = 4 + a_3 - 8 - b_3 = -4 (\because a_3 = b_3)$

2. Three students S_1, S_2, and S_3 are given a problem to solve. Consider the following events:

U : At least one of S_1, S_2, and S_3 can solve the problem,

V : S_1 can solve the problem, given that neither S_2 nor S_3 can solve the problem,

W : S_2 can solve the problem and S_3 cannot solve the problem,

T : S_3 can solve the problem.

For any event E, let $P(E)$ denote the probability of E. If

$$P(U)=\frac{1}{2}, \qquad P(V)=\frac{1}{10}, \qquad \text{and } P(W)=\frac{1}{12},$$

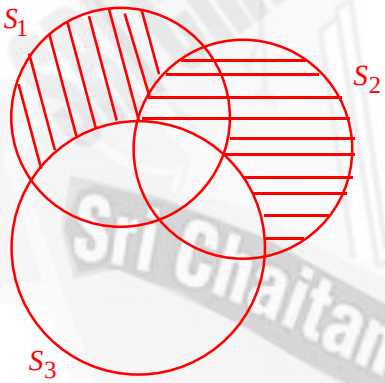
then $P(T)$ is equal to

A) $\frac{13}{16}$ **B)** $\frac{1}{3}$ **C)** $\frac{19}{60}$ **D)** $\frac{1}{4}$

KEY:- A

SOL:- $P(U)=P(S_1\cup S_2\cup S_3)=\frac{1}{5}$

$$P(V)=P\left(\frac{S_1}{S_2\cup S_3}\right)=\frac{1}{10}$$



Let $P\left(S_1\cap\left(\overline{S_2\cup S_3}\right)\right)=x$ $\quad\therefore\frac{x}{0.5+x}=\frac{1}{10}$ $\quad 10x=0.5+x$

$9x=0.5\Rightarrow x=\frac{5}{90}=\frac{1}{18}$ $\qquad P(T)=\frac{1}{2}-\frac{1}{12}-\frac{1}{18}=\frac{13}{36}$

3. Let $\mathbb{R}$ denote the set of all real numbers. Define the function $f:\mathbb{R}\to\mathbb{R}$ by

$$f(x)=\begin{cases}2-2x^2-x^2\sin\dfrac{1}{x} & \text{if} \quad x\neq 0\\ 2 & \text{if} \quad x=0\end{cases}$$

Then which one of the following statements is **TRUE**?

A) The function f is NOT differentiable at $x=0$

B) There is a positive real number δ, such that f is a decreasing function on the interval $(0,\delta)$

C) For any positive real number δ, the function f is NOT an increasing function on the interval $(-\delta,0,)$

D) $x=0$ is a point of local minima of f

KEY:- B

SOL:- $f(x)=\begin{cases}2-2x^2-x^2\sin\left(\dfrac{1}{x}\right) & , \quad x\neq 0\\ 2 & , \quad x=0\end{cases}$

Here, $f(x)$ is continuous at $x=0$ and $f(x)$ is differentiable at $x=0$.

$f'(x)=-4x-2x\sin\left(\dfrac{1}{x}\right)+\cos\left(\dfrac{1}{x}\right) \quad =-2x\left(2+\sin\left(\dfrac{1}{x}\right)+\cos\left(\dfrac{1}{x}\right)\right)$ and

$$\lim_{h\to 0^+} f(h)=\lim_{h\to 0^+}\left(2-2h^2-h^2\sin\left(\frac{1}{h}\right)\right)$$

$$=\lim_{h\to 0^+}\left(2-h^2-h^2\left(1+\sin\left(\frac{1}{h}\right)\right)\right) \qquad =2^-$$

$\Rightarrow$ So, $f(x)$ is decreasing from 0 to some positive $x=\delta$.

4. Consider the matrix

$$P=\begin{pmatrix}2 & 0 & 0\\ 0 & 2 & 0\\ 0 & 0 & 3\end{pmatrix}.$$

Let the transpose of a matrix X be denoted by X^T. Then the number of 3×3 invertible matrices Q with integer entries, such that $Q^{-1}=Q^T$ and $PQ=QP$, is

A) 32 **B)** 8 **C)** 16 **D)** 24

KEY:- C

SOL:- $P=\begin{bmatrix}2 & 0 & 0\\ 0 & 2 & 0\\ 0 & 0 & 3\end{bmatrix}$, Let $Q=\begin{bmatrix}a_1 & a_2 & a_3\\ b_1 & b_2 & b_3\\ c_1 & c_2 & c_3\end{bmatrix}$ $PQ=QP$

$$\begin{bmatrix}2 & 0 & 0\\ 0 & 2 & 0\\ 0 & 0 & 3\end{bmatrix}\begin{bmatrix}a_1 & a_2 & a_3\\ b_1 & b_2 & b_3\\ c_1 & c_2 & c_3\end{bmatrix}=\begin{bmatrix}a_1 & a_2 & a_3\\ b_1 & b_2 & b_3\\ c_1 & c_2 & c_3\end{bmatrix}\begin{bmatrix}2 & 0 & 0\\ 0 & 2 & 0\\ 0 & 0 & 3\end{bmatrix}$$

$$\Rightarrow\begin{bmatrix}2a_2 & 2a_2 & 2a_3\\ 2b_1 & 2b_2 & 2b_3\\ 3c_1 & 3c_2 & 3c_3\end{bmatrix}=\begin{bmatrix}2a_1 & 2a_2 & 3a_3\\ 2b_1 & 2b_2 & 3b_3\\ 2c_1 & 2c_2 & 3c_3\end{bmatrix}\Rightarrow a_3=0,b_3=0,c_1=0 \text{ and } c_2=0$$

$$\Rightarrow Q=\begin{bmatrix}a_1 & a_2 & 0\\ b_1 & b_2 & 0\\ 0 & 0 & c_3\end{bmatrix},Q^{-1}=Q^T\Rightarrow QQ^T=I \text{ (I denotes Identity matrix)}$$

$\Rightarrow a_1^2+a_2^2=1,b_1^2+b_2^2=1,a_1b_1+a_2b_2=0$ and $c_3^2=1\Rightarrow c_3=\pm1$ and

$a^2=1,b^2=0$ and $c^2=0,d^2=1\Rightarrow4$ (or) $a^2=0,b^2=1$ and $c^2=1,d^2=0\Rightarrow4$

Total Q's = $2\times(4+4)=16$

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

This section contains **THERE (03)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks :+4 **ONLY** if (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen;
Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;
Partial Marks: +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then choosing ONLY (A), (B) and (D) will get +4 marks; choosing ONLY (A) and (B) will get +2 marks; choosing ONLY (A) and (D) will get +2 marks; choosing ONLY (B) and (D) will get +2 marks; choosing ONLY (A) will get +1 mark; choosing ONLY (B) will get +1 mark; choosing ONLY (D) will get +1 mark; choosing no option (i.e. the question is unanswered) will get 0 marks; and choosing any other combination of options will get -2 marks.

5. Let L_1 be the line of intersection of the planes given by the equations

$$2x+3y+z=4 \text{ and } x+2y+z=5.$$

Let L_2 be the line passing through the point $P(2,-1,3)$ and parallel to L_1. Let M denote the plane given by the equation

$$2x+y-2z=6$$

Suppose that the line L_2 meets the plane M at the point Q. Let R be the foot of the perpendicular drawn from P to the plane M.

Then which of the following statements is (are) **TRUE**?

A) The length of the line segment PQ is $9\sqrt{3}$

B) The length of the line segment QR is 15

C) The area of ΔPQR is $\frac{3}{2}\sqrt{234}$

D) The acute angle between the line segments PQ and PR is $\cos^{-1}\left(\frac{1}{2\sqrt{3}}\right)$

KEY:- AC

SOL:- A vector along L_1 is parallel to $\overline{n_1}\times\overline{n_2}$ where $\overline{n_1}=2i+3j+k, \overline{n_2}=i+2j+k$

$$\therefore \overline{n_1}\times\overline{n_2}=\begin{vmatrix} i & j & k \\ 2 & 3 & 1 \\ 1 & 2 & 1 \end{vmatrix}=i(1)-j(1)+k(1)$$

and L_2 passes through $P(2,-1,3)$ and parallel to L_1

Eq. of L_2 is $\frac{x-2}{1}=\frac{y+1}{1}=\frac{z-3}{1}=\alpha$ (say)

Eq. of M is $2x+y-2z=6$

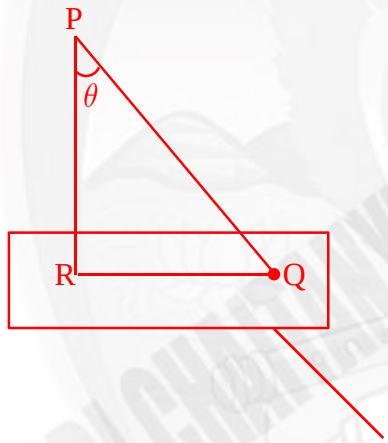
Let $Q(2+\alpha,-1-\alpha_1,3+\alpha)$, and it lies as M.

$\Rightarrow 4+2\alpha-1-\alpha-6-2\alpha=6$

$\Rightarrow -\alpha=9\Rightarrow\alpha=-9\Rightarrow Q(-7,8,-6)$

$\therefore PQ=\sqrt{81+81+81}=9\sqrt{3}$

For R, $\frac{x-2}{2}=\frac{y+1}{1}=\frac{z-3}{-2}=\frac{-(4-1-6-6)}{9}=1\Rightarrow R=(4,0,1)$



$\therefore QR=\sqrt{121+64+49}=\sqrt{234}$

$PR=\left|\frac{4-1-6-6}{3}\right|=3$

$\therefore [\Delta PQR]=\frac{1}{2}\cdot PQ\cdot QR$

$=\frac{3}{2}\sqrt{234}$

$\cos\theta=\frac{3}{9\sqrt{3}}=\frac{1}{3\sqrt{3}}\Rightarrow Q=\cos^{-1}\left(\frac{1}{3\sqrt{3}}\right)$

6. Let $\mathbb{N}$ denote the set of all natural numbers, and $\mathbb{Z}$ denote the set of all integers.

Consider the functions $f:\mathbb{N}\to\mathbb{Z}$ and $g:\mathbb{Z}\to\mathbb{N}$ defined by

$\left(\frac{1}{3},\frac{8}{3}\right)$

and

$$g(n)=\begin{cases}3+2n & \text{if} \quad n\geq 0\\ -2n & \text{if} \quad n<0\end{cases}$$

Define $(gof)(n)=g(f(n))$ for all $n\in\mathbb{N}$, and $(fog)(n)=f(g(n))$ for all $n\in\mathbb{Z}$.

Then which of the following statements is (are) **TRUE**?

A) $g\circ f$ is NOT one-one and $g\circ f$ is NOT onto

B) $f\circ g$ is NOT one-one but $f\circ g$ is onto

C) g is one-one and g is onto

D) f is NOT one-one but f is onto

KEY:- AD

SOL:- $$f(n)=\begin{cases}\frac{n+1}{2} & , \quad n=2K+1\\ \frac{4-n}{2} & , \quad n=2K\end{cases}=\begin{cases}K+1 & , \quad K\in N\cup\{0\}\\ 2-K & , \quad K\in N\end{cases}$$

$\therefore f(1)=f(2)=1\Rightarrow f$ is not one–one.

and $2-K=1,0,-1,-4,.....$ for $K=1,2,3,.....$ and

$K+1=1,2,3,4,.....$ for $K=0,1,2,.....\Rightarrow f(x)$ is onto.

$$g(n)=\begin{cases}3+2n & , \quad n\geq 0 \quad , \quad n\in I\\ -2n & , \quad n<0 \quad , \quad n\in I\end{cases}$$

$\Rightarrow 3+2n=3,5,7,.....$ for $n\geq 0, x\in I$ and

$-2n=2,4,6,8,.....$ for $n<0$ and $x\in I$

$\therefore g(n) \neq 1 \forall n \in I$

$\Rightarrow g(n)$ is not onto

$g(f(1)) = g(1)$ and $g(f(2)) = g(1)$

$\Rightarrow g(f(n))$ is not one–one

$$g(f(n)) = \begin{cases} 3+2f(n) & , \quad f(n) \geq 0 \\ -2f(n) & , \quad f(n) < 0 \end{cases}$$

$$= \begin{cases} 3+2\left(\frac{n+1}{2}\right) & , \quad n = 2K+1 \\ 3+2\left(\frac{4-n}{2}\right) & , \quad n = 2K \end{cases}$$

$$= \begin{cases} n+4 & , \quad n = 2K+1 \\ 7-n & , \quad n = 2K \end{cases} \qquad \Rightarrow g(f(n)) \text{ is always odd.}$$

$\Rightarrow g(f(n))$ is not onto

$$f(g(n)) = \begin{cases} \frac{g(n)+1}{2} & , \quad g(n) \text{ is odd natural number} \\ \frac{4-g(n)}{2} & , \quad g(n) \text{ is even natural number} \end{cases}$$

$$= \begin{cases} n+2 & , \quad n \geq 0 \\ n+2 & , \quad n < 0 \end{cases} \Rightarrow f(g(x)) = n+2 \forall n \in N \Rightarrow f(g(x)) \text{ is one–one}$$

7. Let $\mathbb{R}$ denote the set of all real numbers. Let $z_1 = 1+2i$ and $z_2 = 3i$ be two complex numbers, where $i = \sqrt{-1}$. Let

$S = \{(x, y) \in \mathbb{R} \times \mathbb{R} : |x+iy-z_1| = 2|x+iy-z_2|\}$.

Then which of the following statements is (are) **TRUE**?

A) S is a circle with centre $\left(-\frac{1}{3},\frac{10}{3}\right)$ **B)** S is a circle with centre $\left(\frac{1}{3},\frac{8}{3}\right)$

C) S is a circle with radius $\frac{\sqrt{2}}{3}$ **D)** S is a circle with radius $\frac{2\sqrt{2}}{3}$

KEY:- AD

SOL:- Let $z=x+iy, z_1=1+2i, z_2=3i$

$\therefore |z-z_1|=2|z-z_2|$

Let P, A and B are the points represented by complex numbers z, z_1 and z_2 respectively

$\therefore PA=2PB \Rightarrow P$ lies on a circle having CD as a diameter where C divides AB in the ratio 2 : 1 internally and D divides AB in the ratio 2 : 1 externally.

$\therefore C=\left(\frac{1}{3},\frac{8}{3}\right), D(-1,4)$

Centre of the circle is $S\left(\frac{-1}{3},\frac{10}{3}\right)$

Radius of circle is $r=\frac{CD}{2}=\frac{2\sqrt{2}}{3}$.

SECTION-III
(NUMERICAL VALUE)

This section contains **SIX (06)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme

Full Marks : +4 If ONLY the correct integer is entered; Zero Marks : 0 In all other cases.

8. Let the set of all relations R on the set $\{a,b,c,d,e,f\}$, such that R is reflexive and symmetric, and R contains exactly 10 elements, be denoted by S:

Then the number of elements in S is _____.

KEY:- 105

SOL:- Let A = {a, b, c, d, e, f}

If R is reflexive on $A \Rightarrow R$ contains minimum 6 elements.

We need 4 elements but R is also symmetric.

We want to pair (α,β) and (γ,δ) such that $(\alpha,\beta)\in R$ and $(\gamma,\delta)\in R \Rightarrow (\beta,\alpha)\in R$ and $(\delta,\gamma)\in R$.

$\therefore$ Total unordered pairs ${}^6C_2 = 15$

Out of these 15, need two pairs $\Rightarrow \delta = {}^{15}C_2 = 105$

9. For any two points M and N in the XY-plane, let $\overrightarrow{MN}$ denote the vector from M to N, and $\vec{0}$ denote the zero vector. Let P,Q and R be three distinct points in the XY-plane. Let S be a point inside the triangle ΔPQR such that

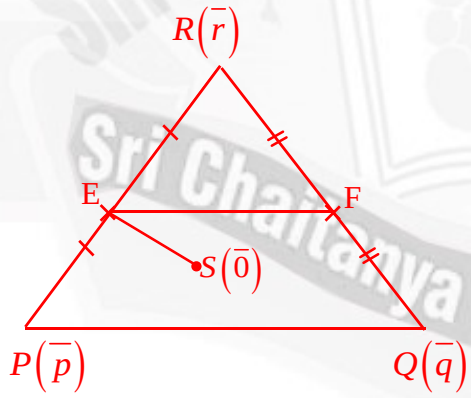
$$\overrightarrow{SP} + 5\overrightarrow{SQ} + 6\overrightarrow{SR} = \vec{0}$$

Let E and F be the mid-points of the sides PR and QR, respectively. Then the value of

$$\frac{\textit{length of the line segment } EF}{\textit{length of the line segment } ES}$$ is _____.

KEY:- 1.2

SOL:-



$\overrightarrow{SP} + 5\overrightarrow{SQ} + 6\overrightarrow{SR} = \bar{0}$

Take S as origin $\Rightarrow \bar{p} + 5\bar{q} + 6\bar{r} = \bar{0}$

$$\left|\overrightarrow{EF}\right|=\frac{1}{2}\left|\overrightarrow{PQ}\right|=\frac{1}{2}\left|\bar{p}-\bar{q}\right|$$

$$\left|\overrightarrow{ES}\right|=\left|\frac{\bar{P}+\bar{q}}{2}\right|=\frac{1}{2}\left|\bar{p}+\left(\frac{-\bar{p}-5\bar{q}}{6}\right)\right| \qquad =\frac{1}{12}\left|5\bar{p}-5\bar{q}\right|=\frac{5}{12}\left|\bar{p}-\bar{q}\right| \quad \therefore \frac{\left|\overrightarrow{EF}\right|}{\overrightarrow{ES}}=\frac{6}{5}=1.2$$

10. Let S be the set of all seven-digit numbers that can be formed using the digits 0,1 and 2 . For example, 2210222 is in S, but 0210222 is NOT in S. Then the number of elements x in S such that at least one of the digits 0 and 1 appears exactly twice in x, is equal to _____.

KEY:- 762

SOL:- Let A be the 7 digit number which contains exactly 2 zero's

$$\Rightarrow n(A)={}^6C_2\times 2^5=480$$

Let B be the 7 digit numbers which contains exactly two 1's.

$$\Rightarrow n(B)={}^6C_1\times 2^5+{}^6C_2\times 1\times 2^4=432$$

Let C be the 7 digit numbers which contains 2 zero's and two 1's.

$$\Rightarrow n(C)=\frac{\lfloor 7}{\lfloor 2\lfloor 2\lfloor 3}=\frac{\lfloor 6}{\lfloor 3\lfloor 2}=150$$

Total req. Numbers = 480 + 432 – 150 = 762

11. Let α and β be the real numbers such that

$$\lim_{x\to 0}\frac{1}{x^3}\left(\frac{\alpha}{2}\int_0^x\frac{1}{1-t^2}dt+\beta x\cos x\right)=2.$$

Then the value of $\alpha+\beta$ is_____.

KEY:- 2.4

SOL:- $lt_{x\to 0}\frac{1}{x^3}\left(\frac{\alpha}{2}\int_0^x\frac{1}{1-t^2}dt+\beta x\cos x\right)=2$

Limit takes $\left(\frac{0}{0}\right)$ form $\Rightarrow \lim\limits_{x\to 0} \frac{\frac{\alpha}{2}\left(\frac{1}{1-x^2}\right)+\beta\cos x-\beta x\sin x}{3x^2}=2$

$$\lim_{x\to 0} \frac{\frac{\alpha}{2}\left(1+x^2+x^4+.....\right)+\beta\left(1-\frac{x^2}{\lfloor 2}+\frac{x^4}{\lfloor 4}+.....\right)-\beta x\left(x-\frac{x^3}{\lfloor 3}+.....\right)}{3x^2}=2$$

$\Rightarrow \frac{\alpha}{2}+\beta=0,\ and\ \frac{\alpha}{2}-\frac{\beta}{2}-\beta=6$

$\Rightarrow \alpha+2\beta=0$ and $\alpha-3\beta=12$

$\Rightarrow \alpha=\frac{24}{5},\beta=\frac{-12}{5}$ $\Rightarrow \alpha+\beta=\frac{12}{5}=2.4$

12. Let $\mathbb{R}$ denote the set of all real numbers. Let $f:\mathbb{R}\to\mathbb{R}$ be a function such that $f(x)>0$ for all $x\in\mathbb{R}$, and $f(x+y)=f(x)f(y)$ for all $x,y\in\mathbb{R}$.

Let the real numbers $a_1,a_2,.....,a_{50}$ be in an arithmetic progression. If $f(a_{31})=64f(a_{25})$, and $\sum\limits_{i=1}^{50} f(a_i)=3\left(2^{25}+1\right)$, then the value of $\sum\limits_{i=6}^{30} f(a_i)$ is _____.

KEY:- 96

SOL:- $f(x)>0$ and $f(x+y)=f(x)f(y)\forall x,y$

$\Rightarrow f(x)=a^x(a>0)$

$a_1,a_2,.....,a_{50}$ are in A.P and $f(a_{31})=64f(a_{25})$

$\Rightarrow a^{a_1+30d}=64a^{a_1+24d}$

$\Rightarrow a^d=2$ and $\sum\limits_{i=1}^{50} f(a_i)=3\left(2^{25}+1\right)$

$$\Rightarrow a^{a_1}+a^{a_1+d}+a^{a_1+2d}+.....+a^{a_1+49d}=3\left(2^{25}+1\right)$$

$$\Rightarrow a^{a_1}\left(1+2+2^2+.....+2^{49}\right)=a^{a_1}\left(2^{50}-1\right)=3\left(2^{25}+1\right)$$

$$\Rightarrow a^{a_1}=\frac{3}{2^{25}-1}$$

$$\sum_{i=6}^{30} f\left(a_i\right)=a^{a_1+5d}+a^{a_1+6d}+.....+a^{a_1+29d}$$

$$=a^{a_1}.2^5\left(1+2+2^2+.....+2^{24}\right)$$

$$=\frac{3}{2^{25}-1}\cdot 2^5\left(\frac{2^{25}-1}{2-1}\right)=3\times 32=96$$

13. For all $x>0$, let $y_1(x), y_2(x), y_3(x)$ and be the functions satisfying

$$\frac{dy_1}{dx}-(\sin x)^2 y_1=0, \qquad y_1(1)=5,$$

$$\frac{dy_2}{dx}-(\cos x)^2 y_2=0, \qquad y_2(1)=\frac{1}{3},$$

$$\frac{dy_3}{dx}-\left(\frac{2-x^3}{x^3}\right)y_3=0, \qquad y_3(1)=\frac{3}{5e},$$

respectively. Then

$$\lim_{x\to 0^+}\frac{y_1(x)y_2(x)y_3(x)+2x}{e^{3x}\sin x}$$

is equal to_____.

KEY:-2

SOL:- $\frac{dy_1}{dx}-\sin^2 x\, y_1=0$

$$\Rightarrow \int \frac{dy_1}{y_1} = \int \sin^2 x dx = \int \frac{1-\cos 2x}{2} dx$$

$$\Rightarrow \log|y_1| = \frac{x}{2} - \frac{\sin 2x}{4} + \lambda_1 \qquad \Rightarrow y_1 = e^{\frac{1}{2}\left(x - \frac{\sin 2x}{2}\right) + \lambda_1}$$

$$\text{But, } y_1(1) = 5 \Rightarrow \lambda_1 = \log 5 - \frac{1}{2} + \frac{\sin 2}{4}$$

$$\Rightarrow y_1 = e^{\frac{1}{2}(x-1) - \frac{1}{4}(\sin 2x - \sin 2) + \log 5}$$

$$|||^{ly}, y_2 = e^{\frac{x}{2} + \frac{\sin 2x}{4} + \lambda_2}, y_2(1) = \frac{1}{3} \Rightarrow \lambda_2 = -\log 3 - \frac{1}{2} - \frac{\sin 2}{4}$$

$$y_2 = e^{\frac{1}{2}(x-1) + \frac{1}{4}(\sin 2x - \sin 2) - \log 3} \text{ and } \frac{dy_3}{dx} = \left(\frac{2-x^3}{x^3}\right) y_3$$

$$\Rightarrow \int \frac{dy_3}{y_3} = \int \left(\frac{2}{x^3} - 1\right) dx$$

$$\Rightarrow \log|y_3| = \frac{-1}{x^2} - x + \lambda_3 \Rightarrow y_3 = e^{-\frac{1}{x^2} - x + \lambda_3}$$

$$\text{But, } y_3(1) = \frac{3}{5e} \Rightarrow \lambda_3 = 1 + \log 3 - \log 5$$

$$y_3 = e^{-\frac{1}{x^2} - x + 1 + \log 3 - \log 5}$$

$$\therefore y_1 y_2 y_3 = e^{-\frac{1}{x^2}}$$

$$\lim_{x \to 0^+} \frac{y_1 y_2 y_3 + 2x}{e^{3x} \sin x} = \lim_{x \to 0^+} \frac{e^{\frac{-1}{x^2}} + 2x}{x} = 2$$

SECTION – IV
(MATCHING TYPE)

This section contains **THERE (03)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists :**List-I** and **List-II.**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the option corresponding to the correct combination is chosen;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: –1 In all other cases.

14. Consider the following frequency distribution:

Value	4	5	8	9	6	12	11
Frequency	5	f_1	f_2	2	1	1	3

Suppose that the sum of the frequencies is 19 and the median of this frequency distribution is 6.

For the given frequency distribution, let α denote the mean deviation about the mean, β denote the mean deviation about the median, and σ^2 denote the variance.

Match each entry in List-I to the correct entry in List-II and choose the correct option.

List – I		**List – II**	
P)	$7f_1+9f_2$ is equal to	1)	146
Q)	19α is equal to	2)	47
R)	19β is equal to	3)	48
S)	$19\sigma^2$ is equal to	4)	145
		5)	55

A) P → (5) Q → (3) R → (2) S → (4)
B) P → (5) Q → (2) R → (3) S → (1)
C) P → (5) Q → (3) R → (2) S → (1)
D) P → (3) Q → (2) R → (5) S → (4)

KEY:- C

SOL:-

x_i	f_i	$c \cdot f_i$	$f_i x_i$
4	5	5	20
5	f_1	$5+f_1$	$5f_i = 20$
6	1	$6+f_1$	6
8	f_2	$6+f_1+f_2$	$8f_2 = 24$
9	2	$8+f_1+f_2$	18
11	3	$11+f_1+f_2$	33
12	1	$12+f_1+f_2$	12
	$N = 12+f_1+f_2$		133

$12+f_1+f_2=19 \Rightarrow f_1+f_2=7$

$6+f_1=10 \Rightarrow f_1=4 \Rightarrow f_2=3$

$7f_1+9f_2=55 \qquad (P \to 5)$

Mean, $\bar{x}=\frac{\Sigma f_i x_i}{\Sigma f_i}=\frac{133}{19}=7$

Mean deviation about mean $(\alpha)=\frac{\Sigma f_i |x_i-\bar{x}|}{\Sigma f_i}=\frac{48}{19} \Rightarrow 19\alpha=48 \qquad (Q \to 3)$

Mean deviation about median,

$\beta=\frac{\Sigma f_i |x_i-M|}{\Sigma f_i}=\frac{49}{19} \Rightarrow 19\beta=47 \quad (R \to 2)$

Variance, $\sigma^2=\frac{\Sigma f_i x_i^2}{\Sigma f_i}-(\bar{x})^2=\frac{146}{19}$

$19\sigma^2=146 \quad (S \to 1)$

15. Let $\mathbb{R}$ denote the set of all real numbers. For a real number x, let $[x]$ denote the greatest integer less than or equal to x. Let n denote a natural number.
Match each entry in List-I to the correct entry in List-II and choose the correct option.

	List – I	List – II	
P)	The minimum value of n for which the function $f(x)=\left[\frac{10x^3-45x^2+60x+35}{n}\right]$ is continuous on the interval [1, 2] is	1)	8
Q)	The minimum value of n for which $g(x)=\left(2n^2-13n-15\right)\left(x^3+3x\right)$, $x\in\mathbb{R}$, is an increasing function on $\mathbb{R}$, is	2)	9
R)	The smallest natural number n which is greater than 5, such that $x=3$ is a point of local minima of $h(x)=\left(x^2-9\right)^n\left(x^2+2x+3\right)$, is	3)	5
S)	Number of $x_0\in\mathbb{R}$ such that $l(x)=\sum_{k=0}^{4}\left(\sin\lvert x-k\rvert+\cos\left\lvert x-k+\frac{1}{2}\right\rvert\right)$, $x\in\mathbb{R}$, is **NOT** differentiable at x_0, is	4)	6
		5)	10

A) P → (1) Q → (3) R → (2) S → (5)
B) P → (2) Q → (1) R → (4) S → (3)
C) P → (5) Q → (1) R → (4) S → (3)
D) P → (2) Q → (3) R → (1) S → (5)

KEY:- B

SOL:- P) Let $K(x)=10x^3-45x^2+60x+35$ $K^{|}(x)=30x^2-90x+60=30(x-1)(x-2)$

$\Rightarrow K(x)$ is $\downarrow$ in[1, 2] $\Rightarrow f(1)=\left[\frac{K(1)}{n}\right]=\left[\frac{60}{n}\right], f(2)=\left[\frac{55}{n}\right]$

But, f(x) is continuous in $[1,2]\Rightarrow[f(x)]$ is same integer for all $x\in[1,2]\rightarrow n=9.(P\rightarrow 2)$

Q) $g^{|}(x)=\left(2n^2-13n-15\right)\left(3x^2+3\right)=(2n-15)(n+1)\left(3x^2+3\right)>0$ for $g(x)\uparrow\Rightarrow$ mix of n is 8.

R) $h(x)=\left(x^2-9\right)^n\left(x^2+2x+3\right)$ $h(3)=0$ for $n>5$ at n = 6, $(3+\delta)>h(3)$ (δ is a small positive real number) $\Rightarrow h(x)$ has local minimum at x = 3 for n = 6 $(R\rightarrow 4)$

S) $\ell(x)=\sin|x|+\cos\left|x+\frac{1}{2}\right|+\sin|x-1|+\cos\left|x-\frac{1}{2}\right|+\ldots\ldots+\sin|x-4|+\cos\left|x-\frac{7}{2}\right|$

as $\sin|x-K|$ is non–differentiable at x = K but, $\cos|x-\lambda|$ is differentiable at $x=\lambda$

$\Rightarrow g(x)$ is non–differentiable at $x_0 = 0,1,2,3,4$ (5 points) $(S \to 3)$

16. Let $\vec{w} = \hat{i}+\hat{j}-2\hat{k}$, and $\vec{u}$ and $\vec{v}$ be two vectors, such that $\vec{u}\times\vec{v}=\vec{w}$ and $\vec{v}\times\vec{w}=\vec{u}$. Let α,β,γ and t be real numbers such that

$\vec{u} = \alpha\hat{i}+\beta\hat{j}+\gamma\hat{k}, -t\alpha+\beta+\gamma=0,\ \alpha-t\beta+\gamma=0$ and $\alpha+\beta-t\gamma=0$.

Match each entry in List-I to the correct entry in List-II and choose the correct option.

List – I		List – II	
P)	$\left\|\vec{v}\right\|^2$ is equal to	1)	0
Q)	If $\alpha=\sqrt{3}$, then γ^2 is equal to	2)	1
R)	If $\alpha=\sqrt{3}$, $(\beta+\gamma)^2$ is equal to	3)	2
S)	If $\alpha=\sqrt{2}$, then $t+3$ is equal to	4)	3
		5)	5

A) P → (2) Q → (1) R → (4) S → (5)
B) P → (2) Q → (4) R → (3) S → (5)
C) P → (2) Q → (1) R → (4) S → (3)
D) P → (5) Q → (4) R → (1) S → (3)

KEY:- A

SOL:- $\bar{u}\times\bar{v}=\bar{w}$ and $\bar{v}\times\bar{w}=\bar{u}$ $\bar{w}$ is perpendicular to both $\bar{u}$ & $\bar{v}$ and $\bar{w}$ is perpendicular to both $\bar{u}$ and $\bar{v}$ $\Rightarrow \bar{u},\bar{v}$ and $\bar{w}$ are 3 mutually perpendicular meets.

$(\bar{v}\times\bar{w})\times\bar{v}=\bar{w}=|\bar{v}|^2\bar{w}-(\bar{w}.\bar{v})\bar{v} \Rightarrow (|\bar{v}|^2-1)\bar{w}-(\bar{v}.\bar{w})\bar{v}=\bar{0}$

$\Rightarrow |\bar{v}|=1$ and $\bar{v}.\bar{w}=0$ and $|\bar{w}|=|\bar{u}||\bar{v}| \Rightarrow |\bar{u}|=\sqrt{6}$ $\bar{u}.\bar{w}=0 \Rightarrow \alpha+\beta-2r=0.$ and

$-t\alpha+\beta+\gamma=0, \alpha=t\beta+\gamma=0,\ \alpha+\beta-t\gamma=0. \Rightarrow (1+t)\alpha=(1+t)\beta=(1+t)\gamma \Rightarrow t=-1$

(a) $\alpha=\beta=\gamma$ $\therefore |\bar{u}|=\sqrt{6}=\sqrt{3\alpha^2} \Rightarrow \alpha=\sqrt{2} \Rightarrow t=2$ if $\alpha=\sqrt{3} \Rightarrow \bar{u}$ is a non-zero vector.

$\Rightarrow \alpha^2+\beta^2+\gamma^2 \neq 0 \Rightarrow \begin{vmatrix} -1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{vmatrix} = 0 \Rightarrow t=-1(\alpha)2$ for t = -1 $\Rightarrow \alpha+\beta+\gamma=0$ for t = 2

$\Rightarrow \alpha=\beta=\gamma$ if $\alpha=\beta=\gamma \Rightarrow \alpha^2=2 \Rightarrow \alpha \neq \sqrt{3}$ if $\alpha=\sqrt{3} \Rightarrow \alpha+\beta+\gamma=0$ and $\alpha+\beta+\gamma=0 \Rightarrow \gamma=0$ and $\beta=\sqrt{3}$ $\therefore P \to 2, Q \to 1, R \to Q, S \to 5$

PHYSICS **Max Marks: 60**

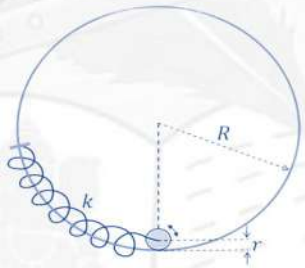
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases

17. The center of a disk of radius r and mass m is attached to a spring of spring constant k, inside a ring of radius $R > r$ as shown in the figure. The other end of the spring is attached on the periphery of the ring. Both the ring and the disk are in the same vertical plane. The disk can only roll along the inside periphery of the ring, without slipping. The spring can only be stretched or compressed along the periphery of the ring, following the Hooke's law. In equilibrium, the disk is at the bottom of the ring. Assuming small displacement of the disc, the time period of oscillation of center of mass of the disk is written as $T = \frac{2\pi}{\omega}$. The correct expression for ω is (g is the acceleration due to gravity):



A) $\sqrt{\frac{2}{3}\left(\frac{g}{R-r}+\frac{k}{m}\right)}$

B) $\sqrt{\frac{2g}{3(R-r)}+\frac{k}{m}}$

C) $\sqrt{\frac{1}{6}\left(\frac{g}{R-r}+\frac{k}{m}\right)}$

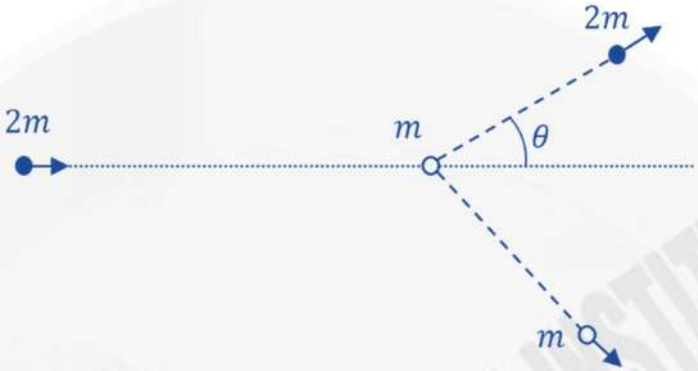
D) $\sqrt{\frac{1}{4}\left(\frac{g}{R-r}+\frac{k}{m}\right)}$

KEY:- A

SOL:- From energy conversation

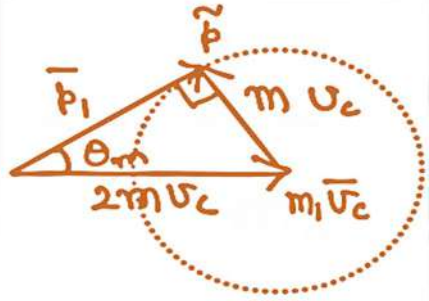
$$\frac{1}{2}\dot{m}^2\left(1+\frac{1}{2}\right)+\frac{1}{2}kx^2+\frac{mgx^2}{2(R-r)}=C \quad \Rightarrow \omega=\sqrt{\frac{2}{3}\left(\frac{k}{m}+\frac{g}{R-r}\right)}$$

18. In a scattering experiment, a particle of mass $2m$ collides with another particle of mass m, which is initially at rest. Assuming the collision to be perfectly elastic, the maximum angular deviation θ of the heavier particle, as shown in the figure, in radians is:



A) π **B)** $\tan^{-1}\left(\frac{1}{2}\right)$ **C)** $\frac{\pi}{3}$ **D)** $\frac{\pi}{6}$

KEY:- D



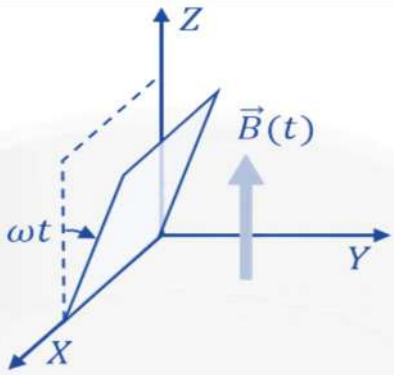
SOL:-

$\because m_1\bar{v}_c + \tilde{p} = \bar{p}_1 \;\&\; |\tilde{p}| = m_2 v_c$

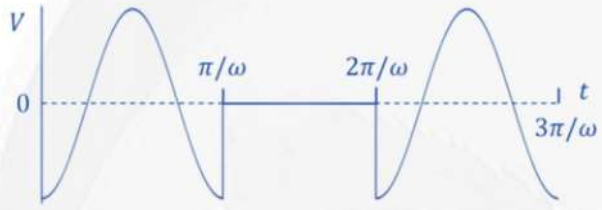
For maximum θ

$$\sin\theta_m = \frac{m_2}{m_1} \quad \Rightarrow \sin\theta_m = \frac{1}{2} \quad \Rightarrow \theta_m = \frac{\pi}{6}$$

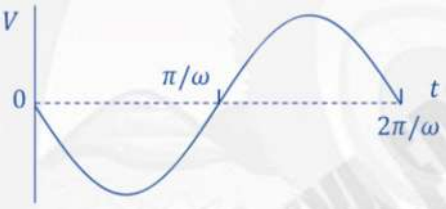
19. A conducting square loop initially lies in the XZ plane with its lower edge hinged along the X-axis. Only in the region $y \geq 0$, there is a time dependent magnetic field pointing along the Z-direction, $\vec{B}(t) = B_0(\cos\omega t)\hat{k}$, where B_0 is a constant. The magnetic field is zero everywhere else. At time $t = 0$, the loop starts rotating with constant angular speed ω about the X axis in the clockwise direction as viewed from the $+X$ axis (as shown in the figure). Ignoring self-inductance of the loop and gravity, which of the following plots correctly represents the induced e.m.f. (V) in the loop as a function of time:



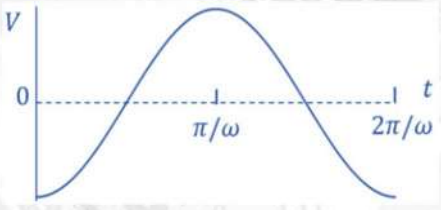
A)



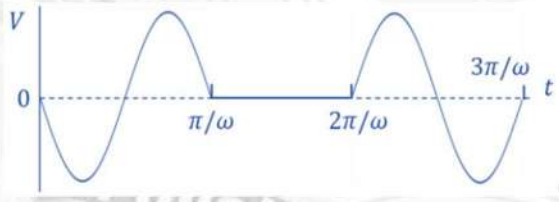
B)



C)



D)



KEY:- A

SOL:- For $0 < t < \pi/\omega$

$$\phi = BA\sin\omega t = \frac{B_0 A}{2}\sin 2\omega t$$

$$\in = -\frac{d\phi}{dt} = -B_0 A\omega\cos 2\omega t \qquad \text{For } \frac{\pi}{\omega} < t < 2\pi/\omega \qquad \phi = 0, \in = 0$$

20. Figure 1 shows the configuration of main scale and Vernier scale before measurement. Fig. 2 shows the configuration corresponding to the measurement of diameter D of a tube. The measured value of D is:

Fig. 1

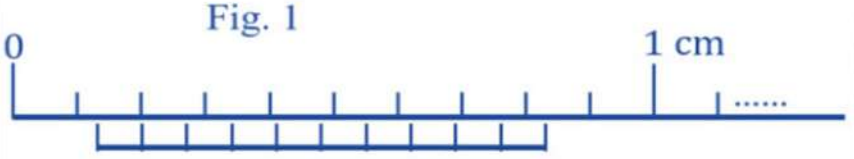


Fig. 2

A) 0.12 cm **B)** 0.11 cm **C)** 0.13 cm **D)** 0.14 cm

KEY:- C

SOL:- 1MSD = 0.1cm

7MSD = 10VSD $\therefore VC = 1\text{MSD} - 1\text{VSD} = \frac{3}{10}\text{MSD} = 0.03cm$

Measured value = MSR+VSR=0.1+0.03=0.13 cm.

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

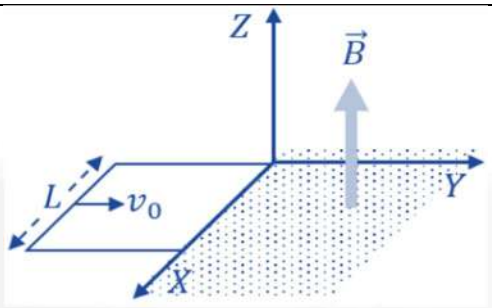
This section contains **THERE (03)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks :+4 **ONLY** if (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen;
Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;
Partial Marks: +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.
For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then choosing ONLY (A), (B) and (D) will get +4 marks; choosing ONLY (A) and (B) will get +2 marks; choosing ONLY (A) and (D) will get +2 marks; choosing ONLY (B) and (D) will get +2 marks; choosing ONLY (A) will get +1 mark; choosing ONLY (B) will get +1 mark; choosing ONLY (D) will get +1 mark; choosing no option (i.e. the question is unanswered) will get 0 marks; and choosing any other combination of options will get -2 marks.

21. A conducting square loop of side L, mass M and resistance R is moving in the XY plane with its edges parallel to the X and Y axes. The region $y \geq 0$ has a uniform magnetic field, $\vec{B} = B_0\hat{k}$. The magnetic field is zero everywhere else. At time $t = 0$, the loop starts to enter the magnetic field with an initial velocity $v_0\hat{j}$ m/s, as shown in the figure.

Considering the quantity $K = \frac{B_0^2L^2}{RM}$ in appropriate units, ignoring self-inductance of the loop and gravity, which of the following statements is/are correct:



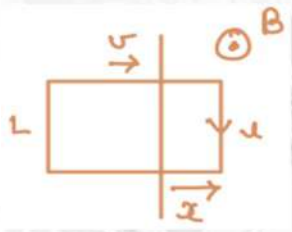
A) If $v_0 = 1.5KL$, the loop will stop before it enters completely inside the region of magnetic field.

B) When the complete loop is inside the region of magnetic field, the net force acting on the loop is zero.

C) If $v_0 = \frac{KL}{10}$, the loop comes to rest at $t = \left(\frac{1}{k}\right)\ln\left(\frac{5}{2}\right)$.

D) If $v_0 = 3KL$, the complete loop enters the region of magnetic field at time $t = \left(\frac{1}{k}\right)\ln\left(\frac{3}{2}\right)$.

KEY:- BD



SOL:-

For $x < L$ $\quad i = \frac{B_0 l v}{R}$

$$mv\frac{dv}{dx} = -\frac{B_0^2 l^2}{R}v \Rightarrow \int_{v_0}^{v} dv = -\frac{B_0^2 l^2}{mR}\int_0^x dx \qquad \Rightarrow v = v_0 - kx$$

Also, $\frac{dv}{dt} = -kv \Rightarrow \int_{v_0}^{v}\frac{dv}{v} = -k\int_0^t dt \Rightarrow v = v_0 e^{-kt} \Rightarrow t = \frac{1}{k}\ln\left(\frac{v_0}{v}\right) = \frac{1}{k}\ln\left(\frac{v_0}{v_0 - kx}\right)$

If $v_0 > KL$ loop will fully enter into region of magnetic field after time $t = \frac{1}{k}\ln\left(\frac{v_0}{v_0 - KL}\right)$

and continue to move with velocity $v_0 - KL$

22. Length, breadth and thickness of a strip having a uniform cross section are measured to be 10.5 cm, 0.05 mm, and 6.0 μm, respectively. Which of the following option(s) give(s) the volume of the strip in cm^3 with correct significant figures:

A) 3.2×10^{-5} **B)** 32.0×10^{-6} **C)** 3.0×10^{-5} **D)** 3×10^{-5}

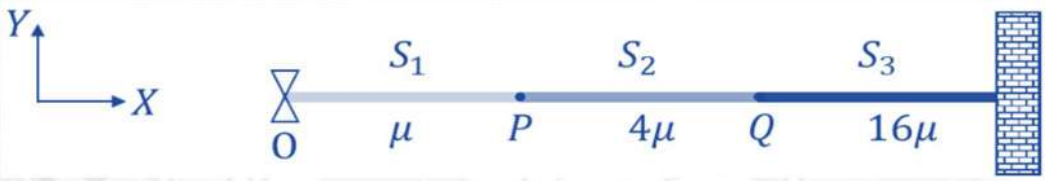
KEY:- D

SOL:- Number of significant figures in result must be equal to number of significant figures in measured value with least number of it, i.e in 0.05 mm which is 1.

23. Consider the system of three connected strings, S_1, S_2 and S_3 with uniform linear mass densities μ kg/m, 4μ kg/m and 16μ kg/m, respectively, as shown in the figure.

S_1 and S_2 are connected at the point P, whereas S_2 and S_3 are connected at the point Q, and the other end of S_3 is connected to a wall. A wave generator O is connected to the free end of S_1. The wave from the generator is represented by $y = y_0\cos(\omega t - kx)cm$ where y_0, ω and k are constants of appropriate dimensions.

Which of the following statements is/are correct:



A) When the wave reflects from P for the first time, the reflected wave is represented by $y = \alpha_1 y_0\cos(\omega t + kx + \pi)$ cm, where α_1 is a positive constant.

B) When the wave transmits through P for the first time, the transmitted wave is represented by $y = \alpha_2 y_0\cos(\omega t - kx)$ cm where α_2 is a positive constant.

C) When the wave reflects from Q for the first time, the reflected wave is represented by $y = \alpha_3 y_0\cos(\omega t - kx + \pi)$ cm, where α_3 is a positive constant.

D) When the wave transmits through Q for the first time, the transmitted wave is represented by $y = \alpha_4 y_0\cos(\omega t - 4kx)$ cm, where α_4 is a positive constant.

KEY:- AD

SOL:- Wave reflects at P by a denser media, so phase change of π will occur, Transmitted wave will be in phase with incident wave.

SECTION-III
(NUMERICAL VALUE)

This section contains **SIX (06)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme

Full Marks : +4 If ONLY the correct integer is entered; Zero Marks : 0 In all other cases..

24. A person sitting inside an elevator performs a weighing experiment with an object of mass 50 kg. Suppose that the variation of the height y (in m) of the elevator, from the ground, with time t (in s) is given by $y = 8\left[1+\sin\left(\frac{2\pi t}{T}\right)\right]$, where $T = 40\pi s$. Taking acceleration due to gravity, g= 10 m/s^2, the maximum variation of the object's weight (in N) as observed in the experiment is ____

KEY:- 2

SOL:- $y = 8\left(1=\sin\frac{t}{20}\right); \dot{y} = \frac{8}{20}\cos\left(\frac{t}{20}\right); \ddot{y} = -\frac{8}{20^2}\cos\left(\frac{t}{20}\right) \quad W = m\left(g+\ddot{y}\right)$

$\therefore$ Maximum variation in $W = 2(50)\left(\frac{8}{20^2}\right) = 2N$

25. A cube of unit volume contains 35×10^7 photons of frequency $10^{15}\,Hz$. If the energy of all the photons is viewed as the average energy being contained in the electromagnetic waves within the same volume, then the amplitude of the magnetic field is $\alpha\times10^{-9}T$. Taking permeability of free space $\mu_0 = 4\pi\times10^{-7}\,Tm/A$, Plank's constant $h = 6\times10^{-34}\,Js$ and $\pi = \frac{22}{7}$, the value of α is ____

KEY:- 22.97 - 22.98

SOL:- $\langle u\rangle = \frac{B_0^2}{2\mu_0} \Rightarrow B_0 = \sqrt{2\mu_0\langle u\rangle} = \left\{2\times4\pi\times10^{-7}\times35\times10^7\times6\times10^{-34}\times10^{15}\right\}^{1/2} = 22.978\times10^{-9}$

26. Two identical plates P and Q, radiating as perfect black bodies, are kept in vacuum at constant absolute temperatures T_P and T_Q respectively, with $T_Q < T_P$ as shown in Fig.1 The radiated power transferred per unit area from P to Q is W_0. Subsequently two more plates, identical to P and Q, are introduced between P and Q, as shown in Fig. 2. Assume that heat transfer takes place only between adjacent plates. If the power transferred per unit area in the direction from P to Q (Fig. 2) in the steady state is W_s. Then the ratio $\frac{W_0}{W_S}$ is ____

Fig. 1

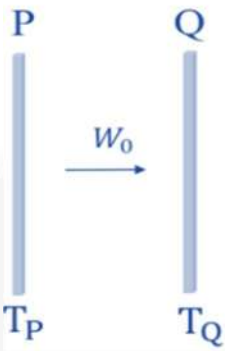
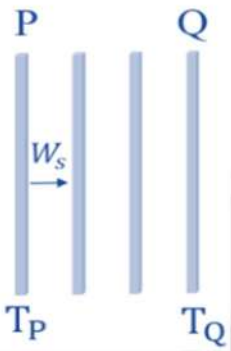


Fig. 2



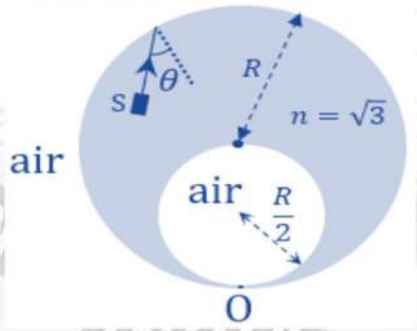
KEY:- 3

SOL:- $W_0 = \sigma A\left(T_P^4 - T_Q^4\right)$

$$W_S = \sigma\left(T_P^4 - T_1^4\right) = \sigma\left(T_1^4 - T_2^4\right) = \sigma\left(T_2^4 - T_Q^4\right)$$

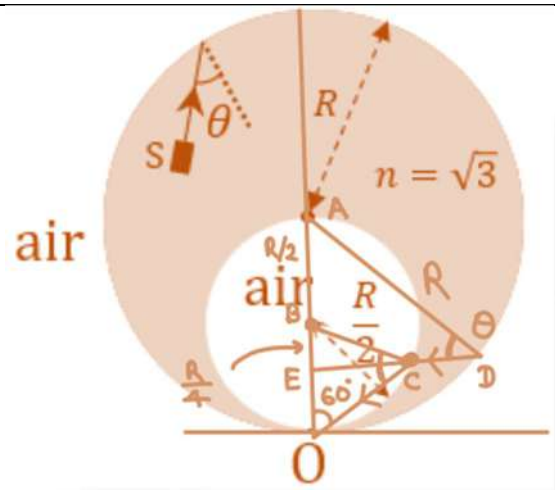
$$\Rightarrow 3W_S = \sigma\left(T_P^4 - T_Q^4\right) \Rightarrow 3W_S = W_0 \Rightarrow \frac{W_0}{W_S} = 3$$

27. A solid glass sphere of refractive index $n = \sqrt{3}$ and radius R contains a spherical air cavity of radius $\frac{R}{2}$, as shown in the figure. A very thin glass layer is present at the point O so that the air cavity (refractive index $n = 1$) remains inside the glass sphere. An unpolarized, unidirectional and monochromatic light source S emits a light ray from a point inside the glass sphere towards the periphery of the glass sphere. If the light is reflected from the point O and is fully polarized, then the angle of incidence at the inner surface of the glass sphere is θ. The value of sin θ is ____



KEY:- 0.75

SOL:-



For the light reflected at point O to be fully polarized, it must be incident at Brewster angle $\theta_B = \tan^{-1}(n) = 60^\circ$

For refraction at C at glass-air interface $r = <BCD = 60^\circ$

$i = <BCE = 30^\circ$

$\therefore CE$ is angle bisector of $<BCE$ and hence perpendicular to BD

$$\therefore \sin\theta = \frac{AE}{AD} = \frac{3R/4}{R} = \frac{3}{4} = 0.75$$

28. A single slit diffraction experiment is performed to determine the slit width using the equation, $\frac{bd}{D} = m\lambda$, where b is the slit width, D the shortest distance between the slit and the screen, d the distance between the m^{th} diffraction maximum and the central maximum, and λ is the wavelength. D and d are measured with scales of least count of 1 cm and 1 mm, respectively. The values of λ and m are known precisely to be 600 nm and 3, respectively. The absolute error (in μm) in the value of b estimated using the diffraction maximum that occurs for m=3 with d= 5 mm and D=1 m is ___

KEY:- 75.6

SOL:- $b = m\lambda\left(\frac{D}{d}\right) \Rightarrow \Delta b = m\lambda\left(\frac{d\Delta D + D\Delta d}{d^2}\right)$

$$\Rightarrow \Delta b = 3\times 600\times 10^{-9}\left(\frac{5\times 10^{-3}\times 10^{-2} + 1\times 10^{-3}}{25\times 10^{-6}}\right)$$

$$= 75.6\times 10^{-6}\, m.$$

29. Consider an electron in the $n = 3$ orbit of a hydrogen-like atom with atomic number Z. At absolute temperature T, a neutron having thermal energy k_BT has the same deBroglie wavelength as that of this electron. If this temperature is given by $T = \frac{Z^2h^2}{a\pi^2a_0^2m_Nk_B}$, (where h is the Plank's contant, k_B is the Boltzmann constant, m_N is the mass of neutron and a_0 is the first Bohr radius of hydrogen atom) then the value of α is ___

KEY:- 72

SOL:- For electron: $\lambda = \frac{2\pi r}{n} = \left(\frac{2\pi}{n}\right)\left(\frac{n^2}{Z}a_0\right) = \frac{2\pi n}{Z}a_0$

For $n = 3; \lambda = \frac{6\pi}{z}a_0$, For thermal neutrons: $\lambda = \frac{h}{\sqrt{2m_Nk_BT}}$

$$\because \frac{h}{\sqrt{2m_Nk_BT}} = \frac{6\pi}{Z}a_0 \Rightarrow 2m_Nk_BT = \frac{Z^2h^2}{36\pi^2a_0^2} \Rightarrow T = \frac{Z^2h^2}{72\pi^2a_0^2m_Nk_B}$$

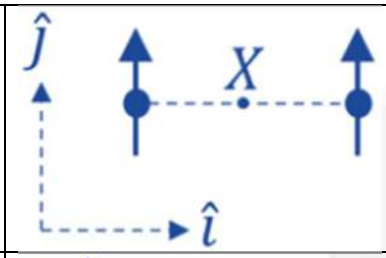
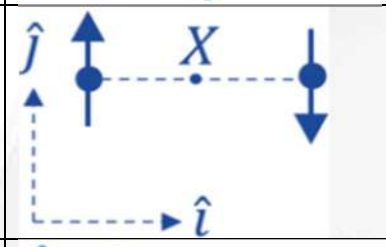
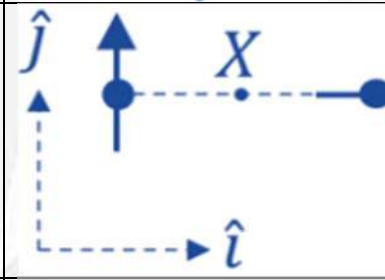
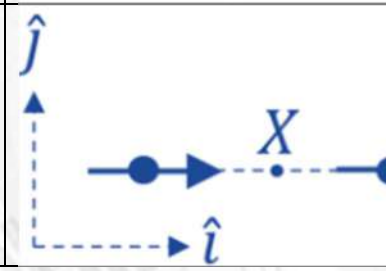
SECTION – IV
(MATCHING TYPE)

This section contains **THERE (03)** Matching List Sets.
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists :**List-I** and **List-II.**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the option corresponding to the correct combination is chosen;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: –1 In all other cases.

30. List-I shows four configurations, each consisting of a pair of ideal electric dipoles. Each dipole has a dipole moment of magnitude p, oriented as marked by arrows in the figures. In all the configurations the dipoles are fixed such that they are at a distance $2r$ apart along the x direction.

The midpoint of the line joining the two dipoles is X. The possible resultant electric fields $\vec{E}$ at X are given in List-II. Choose the option that describes the correct match between the entries in List-I to those in List-II.

List-I		List-II	
P)		1)	$\vec{E}=0$
Q)		2)	$\vec{E}=-\frac{p}{2\pi\in_0 r^3}\hat{j}$
R)		3)	$\vec{E}=-\frac{p}{4\pi\in_0 r^3}\left(\hat{i}-\hat{j}\right)$
S)		4)	$\vec{E}=\frac{p}{4\pi\in_0 r^3}\left(2\hat{i}-\hat{j}\right)$
		5)	$\vec{E}=\frac{p}{\pi\in_0 r^3}\hat{i}$

A) $P\to 3, Q\to 1, R\to 2, S\to 4$ **B)** $P\to 4, Q\to 5, R\to 3, S\to 1$

C) $P\to 2, Q\to 1, R\to 4, S\to 5$ **D)** $P\to 2, Q\to 1, R\to 3, S\to 5$

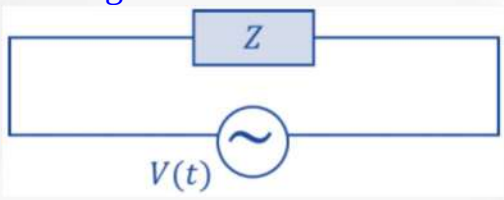
KEY:- C

SOL:- For (P), $\vec{E}=\left(\frac{1}{4\pi\in_0}\right)\frac{p}{r^3}\times 2\left(-\hat{j}\right)=\frac{p}{2\pi\in_0 r^3}\left(-\hat{j}\right)$

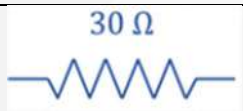
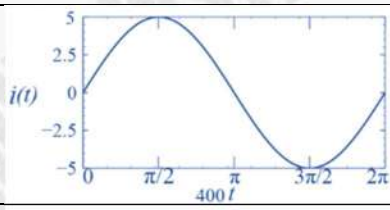
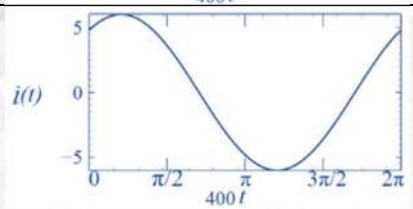
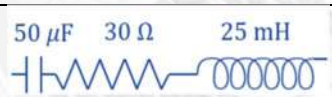
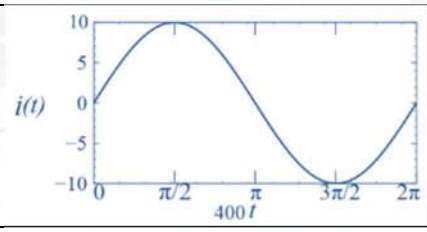
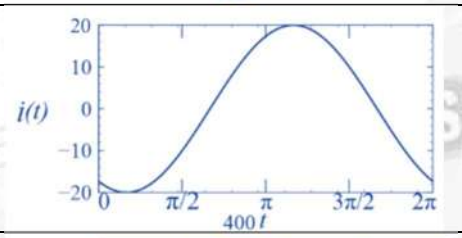
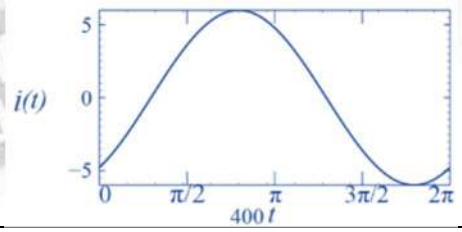
For (Q), $\vec{E}=0$, For (R), $\vec{E}=\frac{p}{4\pi\in_0 r^3}\left(2\hat{i}-\hat{j}\right)$

For (S), $\vec{E}=2\left(\frac{p}{4\pi\in_0 r^3}\right)2\left(\hat{i}\right)=\frac{p}{\pi\in_0 r^3}\hat{i}$

31. A circuit with an electrical load having impedance Z is connected with an AC source as shown in the diagram. The source voltage varies in time as $V(t) = 300\sin(400t)V$, where t is time in s. List-I shows various options for the load. The possible currents $i(t)$ in the circuit as a function of time are given in List-II.



Choose the option that describes the correct match between the entries in List-I to those in List- II.

List-I		List-II	
P)		1)	
Q)		2)	
R)		3)	
S)		4)	
		5)	

A) $P \to 3, Q \to 5, R \to 2, S \to 1$ **B)** $P \to 1, Q \to 5, R \to 2, S \to 3$

C) $P \to 3, Q \to 4, R \to 2, S \to 1$ **D)** $P \to 1, Q \to 4, R \to 2, S \to 5$

KEY:- A

SOL:- (P) $z = R;\ i = \dfrac{\tilde{v}}{R} = 10\sin 400t$

(Q) $x_L = \omega L = 40\Omega;\ z =$ $\qquad i = \dfrac{\tilde{V}}{\tilde{Z}} = 6\sin\left(400t - 53^\circ\right)$

(R) $X_c = 50\Omega; X_L = 10\Omega; Z = 50\Omega$ $\qquad i = \dfrac{\tilde{V}}{\tilde{Z}} = 6\sin\left(400t + 53^\circ\right)$

(S) $X_c = 50\Omega; R = 60\Omega; X_L = 50\Omega; Z = 60\Omega$ $i = \dfrac{\tilde{V}}{Z} = \dfrac{300}{60}\sin\left(400t\right) = 5\sin\left(400t\right)$

32. List-I shows various functional dependencies of energy (E) on the atomic number (Z). Energies associated with certain phenomena are given in List-II. Choose the option that describes the correct match between the entries in List-I to those in List- II.

List-I		List-II	
P)	$E \propto Z^2$	**1)**	energy of characteristic x-rays
Q)	$E \propto (Z-1)^2$	**2)**	electrostatic part of the nuclear binding energy for stable nuclei with mass numbers in the range 30 to 170
R)	$E \propto Z(Z-1)$	**3)**	energy of continuous x-rays
S)	E is practically independent of Z	**4)**	average nuclear binding energy per nucleon for stable nuclei with mass number in the range 30 to 170
		5)	energy of radiation due to electronic transitions from hydrogen-like atoms

A) $P \to 4, Q \to 3, R \to 1, S \to 2$ **B)** $P \to 5, Q \to 2, R \to 1, S \to 4$

C) $P \to 5, Q \to 1, R \to 2, S \to 4$ **D)** $P \to 3, Q \to 2, R \to 1, S \to 5$

KEY:- C

SOL:- (P) $E \propto Z^2$: Energy of radiation due to electronic transition from $H-$like atoms

(Q) $E \propto (Z-1)^2$:Energy of $K_\alpha -$characteristic $X-$rays

(R) $E \propto Z(Z-1)$: Every proton interacts with all remaining protons inside nucleus by coulomb interaction.

(S) E_{bn} for nuclei $30 < A < 170$ is nearly constant.

CHEMISTRY **Max Marks: 60**

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases

33. The heating of NH_4NO_2 at $60-70^0C$ and NH_4NO_3 $200-250^0C$ is associated with the formation of nitrogen containing compounds X and Y, respectively. X and Y, respectively, are

A) N_2 and N_2O **B)** NH_3 and NO_2 **C)** NO and N_2O **D)** N_2 and NH_3

KEY:- A

SOL:- $NH_4NO_2 \xrightarrow{60-70^0C} N_2 + 2H_2O$

$NH_4NO_3 \xrightarrow{200-250^0C} N_2O + 2H_2O$

34. The correct order of the wavelength maxima of the absorption band in the ultraviolet-visible region for the given complexes is

A) $\left[Co(CN)_6\right]^{3-} < \left[Co(NH_3)_6\right]^{3+} < \left[Co(NH_3)_5(H_2O)\right]^{3+} < \left[Co(NH_3)_5(Cl)\right]^{2+}$

B) $\left[Co(NH_3)_5(Cl)\right]^{2+} < \left[Co(NH_3)_5(H_2O)\right]^{3+} < \left[Co(NH_3)_6\right]^{3+} < \left[Co(CN)_6\right]^{3-}$

C) $\left[Co(CN)_6\right]^{3-} < \left[Co(NH_3)_5(Cl)\right]^{2+} < \left[Co(NH_3)_5(H_2O)\right]^{3+} < \left[Co(NH_3)_6\right]^{3+}$

D) $\left[Co(NH_3)_6\right]^{3+} < \left[Co(CN)_6\right]^{3-} < \left[Co(NH_3)_5(Cl)\right]^{2+} < \left[Co(NH_3)_5(H_2O)\right]^{3+}$

KEY:- A

SOL:- With increase in the strength of lignand wavelength of absorbed radiation decreases

35. One of the products formed from the reaction of permanganate ion with iodide ion in neutral aqueous medium is

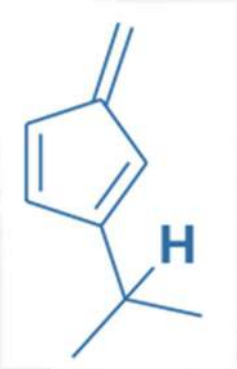
A) I_2 **B)** IO_3^- **C)** IO_4^- **D)** IO_2^-

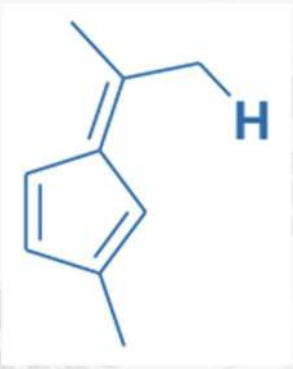
KEY:- B

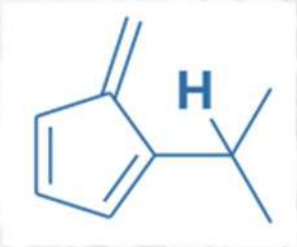
SOL:- $2KMnO_4 + KI + H_2O \longrightarrow 2MnO_2 + 2KOH + KIO_3$

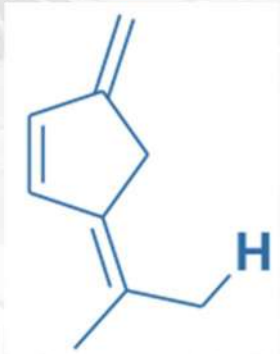
$2MnO_4^- + I^- + H_2O \longrightarrow 2MnO_2 + 2OH^- + IO_3^-$

36. Consider the depicted hydrogen (**H**) in the hydrocarbons given below. The most acidic hydrogen (**H**) is

A) 

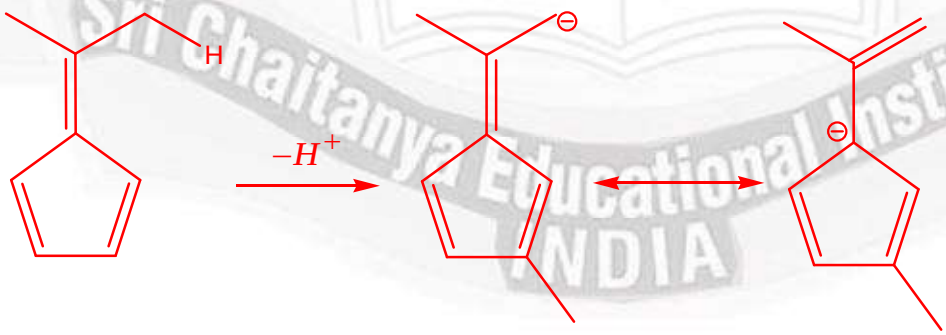
B) 

C) 

D) 

KEY:- B

SOL:-



SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

This section contains **THERE (03)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks :+4 **ONLY** if (all) the correct option(s) is(are) chosen;
Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen;
Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;
Partial Marks: +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.
For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then choosing ONLY (A), (B) and (D) will get +4 marks; choosing ONLY (A) and (B) will get +2 marks; choosing ONLY (A) and (D) will get +2 marks; choosing ONLY (B) and (D) will get +2 marks; choosing ONLY (A) will get +1 mark; choosing ONLY (B) will get +1 mark; choosing ONLY (D) will get +1 mark; choosing no option (i.e. the question is unanswered) will get 0 marks; and choosing any other combination of options will get -2 marks.

37. Regarding the molecular orbital (MO) energy levels for homonuclear diatomic molecules, the **INCORRECT** statement(s) is(are)

A) Bond order of Ne_2 is zero.

B) The highest occupied molecular orbital (HOMO) of F_2 is σ-type.

C) Bond energy of O_2^+ is smaller than the bond energy of O_2.

D) Bond length of Li_2 is larger than the bond length of B_2

KEY:- BC

SOL:- A) Bond order in NO_2 is zero since number of electrons in bonding and antibonding MOs are same

B) HOMO is F_2 is $\pi^* P_x$ and $\pi^* P_y$ not σ type

C) Bond order in O_2^+ is 2.5 but in O_2 is 2.50 bond energy in O_2^+ is more than O_2

D) Lithium atom is larger than bond atom so bond length in Li_2 is greater than B_2 through bond order is same

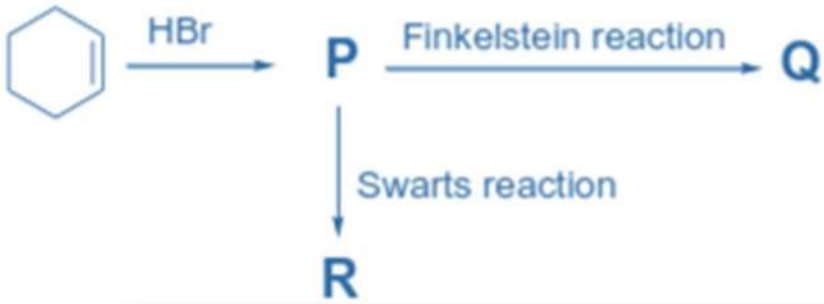
38. The pair(s) of diamagnetic ions is(are).

A) La^{3+}, Ce^{4+} **B)** Yb^{2+}, Lu^{3+} **C)** La^{2+}, Ce^{3+} **D)** Yb^{3+}, Lu^{2+}

KEY:- AB

SOL:- La^{3+} & Ce^{4+} have all paired electrons also Yb^{2+} and Lu^{3+} have all paired electrons.

39. For the reaction sequence given below, the correct statement(s) is(are)



(In the options, X is any atom other than carbon and hydrogen, and it is different in **P**, **Q** and **R**)

A) C-X bond length in P,Q and R follows the order Q>R>P.

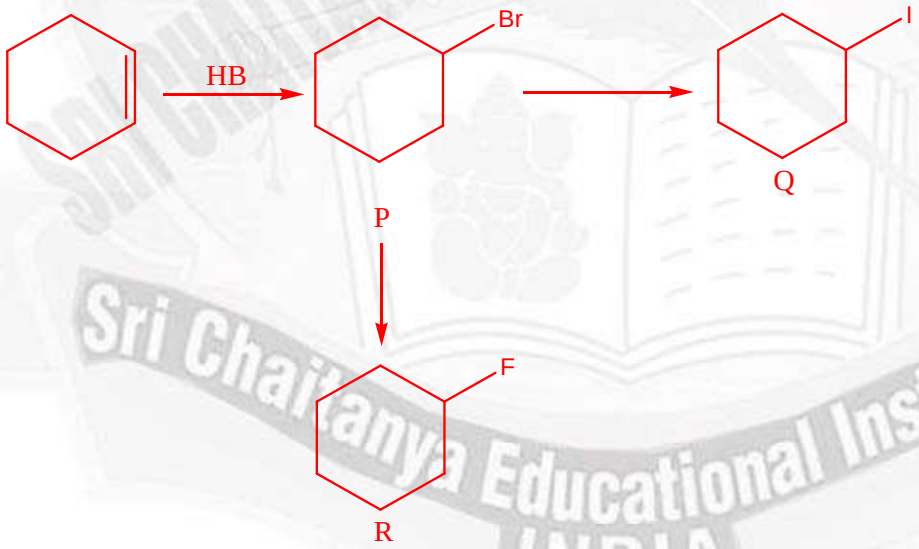
B) C-X bond enthalpy in P,Q and R follows the order P>R>Q

C) Relativity towards S_{N2} reaction in P,Q and R follows the order P>R>Q

D) pK_a value of the conjugate acids of the leaving groups in P,Q and R follows the order R>Q>P

KEY:- B

SOL:-



A) C – X bond length: C – I > C – Br > C – F
B) C – X bond energy: C – F > C – Br > C – I
C) S_N2 reactivity: Q > P > R
D) pK_a & HX: HI < HBr < HF

SECTION-III
(NUMERICAL VALUE)

This section contains **SIX (06)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme

Full Marks : +4 If ONLY the correct integer is entered; Zero Marks : 0 In all other cases.

40. In an electrochemical cell, dichromate ions in aqueous acidic medium are reduced to Cr^{3+}. The current(in amperes) that flows through the cell for 48.25 minutes to produce 1 mole of Cr^{3+} is _____.

Use: 1 Faraday = 96500 C mol^{-1}

KEY:- 100

SOL:- $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

Number of moles of electrons required for formation of 1 mole $Cr^{3+} = 3$.

$\Rightarrow \frac{it}{F} = 3 \quad \Rightarrow i = \frac{3F}{t} \quad = \frac{3 \times 96500}{48.25 \times 60} = 100$

41. At 25 °C, the concentration of H^+ ions in $1.00 \times 10^{-3} M$ aqueous solution of a weak monobasic acid having acid dissociation constant (K_a) of 4.00×10^{-11} is $X \times 10^{-7} M$. The value of X is _____.

Use: Ionic product of water $(K_w) = 1.00 \times 10^{-14}$ at 25 °C

KEY:- 2.23 – 2.24

SOL:- $HA = H^+ + A^-$

$H_2O = H^+ + OH^- \quad H^+ = A^- + OH^-$

$H^+ = \frac{K_1 C}{H^+} + \frac{K_w}{H^+} \quad \Rightarrow \left[H^+\right] = \sqrt{K_a C + K_w}$

$= \sqrt{4 \times 10^{-14} + 10^{-14}} = \sqrt{5} \times 10^{-7} \quad = 2.24 \times 10^{-7} \quad \therefore \; x = 2.24$

42. Molar volume (V_m) of a van der Waals gas can be calculated by expressing the van der Waals equation as a cubic equation with V_m as the variable. The ratio (in mol dm^{-3}) of the coefficient of V_m^2 to the coefficient of V_m for a gas having van der Waals constants $a = 6.0\ dm^6\ atm\ mol^{-2}$ and $b = 0.060\ dm^3\ mol^{-1}$ at 300 K and 300 atm is _____.

Use: Universal gas constant $(R) = 0.082\ dm^3 atm^{-1}\ mol^{-1}$

KEY:- - 7.1

SOL:- $\left(P + \frac{a}{V_m^2}\right)(V_m - b) = RT \quad \Rightarrow \quad (PV_m^2 + a)(V_m - b) = RTV_m^2$

$\Rightarrow \quad PV_m^3 - (Pb + RT)V_m^2 + aV_m - ab = 0$

Ratio of coefficient of $V_m^2\ to\ V_m$

$= -\frac{Pb + RT}{a} = -\frac{(300 \times 0.06 + 0.082 \times 300)}{6} = -7.1$

43. Considering ideal gas behavior, the expansion work done (in kJ) when 144 g of water is electrolyzed completely under constant pressure at 300 K is _____.

Use: Universal gas constant $(R) = 8.3\ J\ K^{-1} mol^{-1}$;

Atomic mass (in amu): H = 1, O = 16

KEY:- - 29.88

SOL:- $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

8 moles of water on electrolysis produces 12 moles of gas.

$W_{expansion} = -\Delta n_g . RT = -12RT \quad = -12 \times 8.3 \times 300 \times 10^{-3} \quad = -29.88\ KJ$

44. The monomer (X) involved in the synthesis of Nylon 6,6 gives positive carbylamine test. If 10moles of X are analyzed using Dumas method, the amount (in grams) of nitrogen gas evolved is _____.

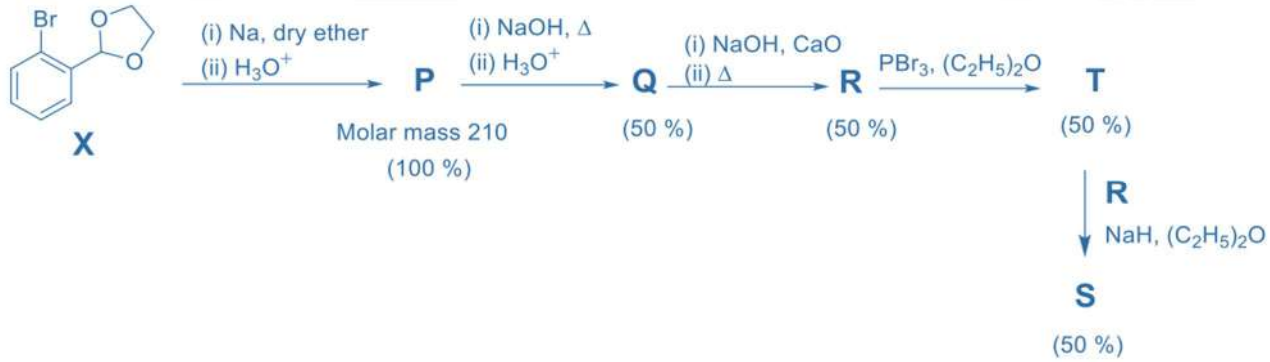
Use: Atomic mass of N (in amu) = 14

KEY:- 280

SOL:- $X = NH_2(CH_2)_4NH_2$

1 mole of X produces 1 mol N_2 mass of N_2 formed from 10 moles X = 10 × 28 = 280 g

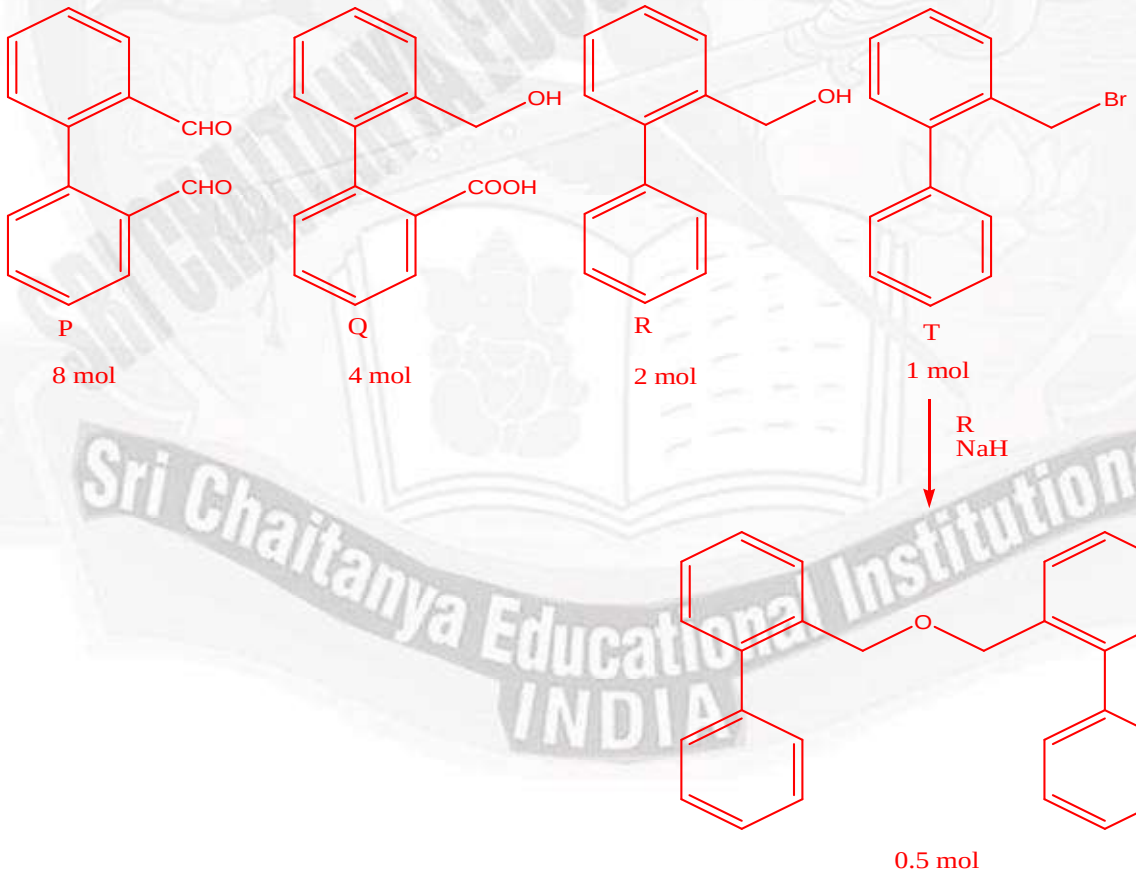
45. The reaction sequence given below is carried out with 16 moles of X. The yield of the major product in each step is given below the product in parentheses. The amount (in grams) of S produced is_____.



Use: Atomic mass (in amu): H = 1, C = 12, O = 16, Br = 80

KEY:- 175

SOL:-



SECTION – IV
(MATCHING TYPE)

This section contains **THERE (03)** Matching List Sets.
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists :**List-I** and **List-II.**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks:+3 **ONLY** if the option corresponding to the correct combination is chosen;
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks: –1 In all other cases.

46. The correct match of the group reagents in List-I for precipitating the metal ion given in List-II from solutions, is

	COLUMN-I		COLUMN-II
P)	Passing H_2S in the presence of NH_4OH	**1)**	Cu^{2+}
Q)	$(NH_4)_2CO_3$ in the presence of NH_4OH	**2)**	Al^{3+}
R)	NH_4OH in the presence of NH_4Cl	**3)**	Mn^{2+}
S)	Passing H_2S in the presence of dilute HCl	**4)**	Ba^{2+}
		5)	Mg^{2+}

A) P – 3; Q – 4; R – 2; S – 1 **B)** P – 4; Q – 2; R – 3; S – 1

C) P – 3; Q – 4; R – 1; S – 5 **D)** P – 5; Q – 3; R – 2; S – 4

KEY:- A

SOL:- P) H_2S in presence of NH_4OH precipitates $Mn^{2+}(3)MnS$

Q) $(NH_4)_2CO_3$ in the presence of NH_4OH precipitates Ba^{2+} as $BaCO_3(4)$

R) NH_4OH in the presence of NH_4Cl precipitates $Al^{3+}(2)$ as $Al(OH)_3$

S) H_2S in the presence of HCl precipitates $Cu^{2+}(1)$ as CuS

47. The major products obtained from the reactions in List-II are the reactants for the named reactions mentioned in List-I. Match each entry in List-I with the appropriate entry in List-II and choose the correct option.

	COLUMN-I		COLUMN-II
P)	Stephen reaction	**1)**	Toluene $\xrightarrow[(ii)\ H_3O^+]{(i)\ CrO_2Cl_2/CS_2}$
Q)	Sandmeyer reaction	**2)**	Benzoic acid $\xrightarrow[(iii)\ P_4O_{10},\ \Delta]{(i)\ PCl_5,\ (ii)\ NH_3}$
R)	Hoffmann bromamide degradation reaction	**3)**	Nitrobenzene $\xrightarrow[(ii)\ HCl,\ NaNO_2\ (273\text{-}278\ K),\ H_2O]{(i)\ Fe,\ HCl}$
S)	Cannizzaro reaction	**4)**	Toluene $\xrightarrow[(ii)\ Tollen's\ reagent\ (iii)\ SO_2Cl_2\ (iv)\ NH_3]{(i)\ Cl_2/h\nu,\ H_2O}$
		5)	Aniline $\xrightarrow[(ii)\ HNO_3,\ H_2SO_4,\ 288\ K\ (iii)\ aq.\ NaOH]{(i)\ (CH_3CO)_2O,\ Pyridine}$

A) P – 2; Q – 4; R – 1; S – 3 **B)** P – 2; Q – 3; R – 4; S – 1

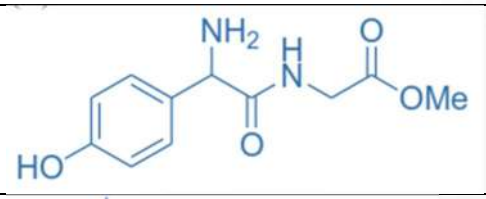
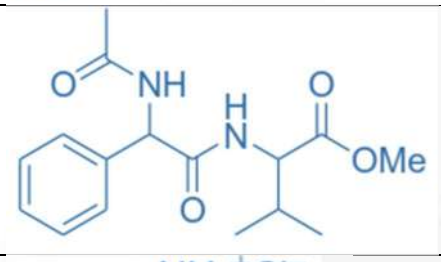
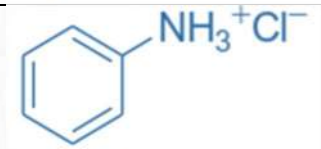
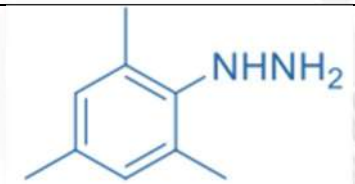
C) P – 5; Q – 3; R – 4; S – 2 **D)** P – 5; Q – 4; R – 2; S – 1

KEY:- B

SOL:- 1) PhCHO – (S) 2) PhCN – (P)

3) PhN_2Cl – (Q) 4) $PhCONH_2$ – (R)

48. Match the compounds in List-I with the appropriate observations in List-II and choose the correct option.

	COLUMN-I		COLUMN-II
P)		**1)**	Reaction with phenyl diazonium salt gives yellow dye.
Q)		**2)**	Reaction with ninhydrin gives purple color and it also reacts with $FeCl_3$ to give violet color.
R)		**3)**	Reaction with glucose will give corresponding hydrazone.
S)		**4)**	Lassiagne extract of the compound treated with dilute HCl followed by addition of aqueous $FeCl_3$ gives blood red color.
		5)	After complete hydrolysis, it will give ninhydrin test and it DOES NOT give positive phthalein dye test.

A) P – 1; Q – 5; R – 4; S – 2 **B)** P – 2; Q – 5; R – 1; S – 3

C) P – 5; Q – 2; R – 1; S – 4 **D)** P – 2; Q – 1; R – 5; S – 3

KEY:- B

SOL:- P) It is a derivative of amino acid and hence gives ninhydrin test and it has a phenolic group it gives +ve $FeCl_3$ test.

Q) It is an amino acid derivative. On hydrolysis it gives amino acids which give ninhydrin test and there is no phenol produced on hydrolysis, hence it does not give phthalein dye test

yellow dye

R)

S) It is a hydrazine and hence gives hydrazone with glucose.

Sri Chaitanya Educational Institutions | Infinity Learn

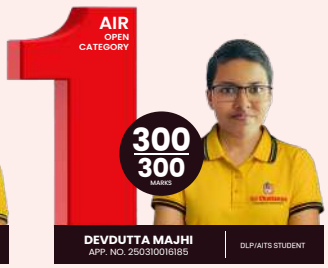
Sri Chaitanya Techno School
The right mentor for IIT (JEE), NEET, Olympiad & all Other Competitive exams

40 Years of Excellence 1986-2025

Sri Chaitanya Dominates
JEE MAIN 2025

31 Students Below 100 AIR

VANGALA AJAY REDDY | APP. NO. 250310255592 | CLASSROOM STUDENT FROM GRADE IX - XII



DEVDUTTA MAJHI | APP. NO. 250310016185 | DLP/AITS STUDENT

TOSHNIWAL SHIVEN | APP. NO. 250310391420 | DLP / AITS STUDENT

SAKSHAM JINDAL | APP. NO. 250310236696 | DLP / AITS STUDENT

Secured 31 ranks in Top 100 All INDIA Open Category


12 RANK — SAURAV, Appl. No. 250310254844*


22 RANK — LAKSHYA SHARMA, Appl. No. 250310034153*


31 RANK — BANDARI RUSHMITH, Appl. No. 250310395238


32 RANK — BHAVESH JAYANTHI, Appl. No. 250310269939


33 RANK — UJJWAL KESARI, Appl. No. 250310008860*


36 RANK — PRADISH GANDHI S, Appl. No. 250310788252*


39 RANK — S SAI RISHANTH REDDY, Appl. No. 250310565519


41 RANK — PRASANNA KS, Appl. No. 250310326957


43 RANK — KOLLIBOINA MUNI SAI, Appl. No. 250310488636


44 RANK — GORRE NITHIN REDDY, Appl. No. 250310551436


53 RANK — U RAMA CHARANREDDY, Appl. No. 250310268782


56 RANK — ARNAV NIGAM, Appl. No. 250310026446


60 RANK — SAMUDRA SARKAR, Appl. No. 250310179442*


61 RANK — SOHAN KALIDAS CHELEKAR, Appl. No. 250310202114*


64 RANK — BUDUMURU VIKRAM RAJA, Appl. No. 250310322700


66 RANK — SHAGANTI THRISHUL, Appl. No. 250310500008


70 RANK — LAXIBHARGAV MENDE, Appl. No. 250310248080


71 RANK — D CHETAN RAO, Appl. No. 250310635984


73 RANK — V PRAVAS REDDY, Appl. No. 250310253376


75 RANK — P SAI SURYA KARTHIK, Appl. No. 250310407861


76 RANK — YASH KUMAR, Appl. No. 250310204405*


81 RANK — P PRANAYA SAI MUKESH, Appl. No. 250310608114


89 RANK — ADITYA SINGH, Appl. No. 250310151728


91 RANK — JAY AGARWAL, Appl. No. 250310122371*


94 RANK — V ESWAR KARTHIK, Appl. No. 250310236425


96 RANK — SAKSHAM GARG, Appl. No. 250310026726*


97 RANK — RANVEER SINGH VIRDE, Appl. No. 250310790734

BELOW 100 ALL INDIA OPEN CATEGORY RANKS — **31**

BELOW 500 ALL INDIA OPEN CATEGORY RANKS — **95**

BELOW 10 ALL INDIA CATEGORY RANKS COUNT — **10**

BELOW 100 ALL INDIA CATEGORY RANKS COUNT — **98**

BELOW 1000 ALL INDIA CATEGORY RANKS COUNT — **579**

TOTAL QUALIFIED RANKS FOR JEE ADVANCED 2025 — 22,094

ADMISSIONS OPEN

www.srichaitanya.net | 040-66 06 06 06