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DIVISION: JEE (MAIN+ADVANCED)
ACADEMIC SESSION: 2023-24

PERIODIC ASSESSMENT TEST (PAT)

# STUDENT SUPPORT BOOKLET (SSB)

**Answer Key (AK) | Standard Hints (SH) | Text Solutions (TS) | Weightage Sheet (WS)**

| CLASS | XII | COURSE NAME | VIJETA | COURSE CODE | JP |
|---|---|---|---|---|---|
| PHASE CODE(S) | 05JP | TOTAL PAGES | 1 | BATCH CODE(S) | 05JP |

## Target Examination & Year:

**JEE (MAIN+ADVANCED) 2024**

| TEST PATTERN | TEST TYPE | TEST CODE & SEQUENCE |
|---|---|---|
| JEE (ADVANCED) | CUMULATIVE TEST (CT) | ACT 03 |

**DATE & DAY:**
01th October 2023 | Sunday

**Duration & Time:**
Paper-1 : 3 Hrs | 11:30 AM to 02:30 PM
Paper-2 : 3 Hrs | 03:00 PM to 06:00 PM

## Contents:

- Weightage Sheet (WS) ✓
- Answer Key (AK) ✓
- Standard Hints (SH) ☐
- Text Solutions (TS) ✓
- Resonance Student's Critical Analysis of Learning for Excellence (ResoSCALE) ☐
- Student Self Assessment Sheet (SAS) ☐
- Video Solutions (VS) ☐

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# ANSWER KEY (AK)

| PAPER-1 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PART-I : MATHEMATICS | Q.No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Ans. | C | A | B | D | 13 | 38 | 3 | 6 | 9 | 5 |
| | Q.No. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | |
| | Ans. | ABCD | ABCD | A | ABC | BCD | ACD | 4 | 0 | 6 | |
| PART-II : PHYSICS | Q.No. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| | Ans. | B | B | D | A | 04.00 | 80.00 | 01.25 | 60.00 | 06.00 | 01.00 |
| | Q.No. | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | |
| | Ans. | ACD | D | CD | AD | ABC | BC | 6 | 4 | 2 | |
| PART-III : CHEMISTRY | Q.No. | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| | Ans. | B | C | D | D | 19 | 18 | 5 | 2 | 00.50 | 2 |
| | Q.No. | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | |
| | Ans. | ABC | ABC | AC | CD | C | A | 8 | 3 | 5 | |

| PAPER-2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PART-I : MATHEMATICS | Q.No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Ans. | ABD | ABD | ABCD | ABD | CD | ABCD | 08.00 | 01.00 | 768 | 144 |
| | Q.No. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | |
| | Ans. | 02.00 | 04.00 | C | D | D | B | 8 | 7 | 4 | |
| PART-II : PHYSICS | Q.No. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| | Ans. | ABD | ABC | BC | BC | ABC | CD | 70.00 | 02.22 | 01.73 | 03.00 |
| | Q.No. | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | |
| | Ans. | 50.00 | 06.00 | B | B | A | B | 3 | 2 | 4 | |
| PART-III : CHEMISTRY | Q.No. | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| | Ans. | ABCD | ACD | ABCD | A | ABC | AB | 2 | 64 | 51 | 00 |
| | Q.No. | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | |
| | Ans. | 4 | 6 | D | B | A | A | 3 | 2 | 4 | |

# TEXT SOLUTIONS (TS)

## PAPER-1

## PART-I: MATHEMATICS

**1.** 13 letters (4I, 2N, 7 diff) 9 type

All different ${}^{9}C_{5}5! = 15120$

2 alike 3 different

${}^{2}C_{1}.{}^{8}C_{3}\frac{5!}{2!} = 6720$

3 alike 2 alike 1 different

${}^{2}C_{2}.{}^{7}C_{1}\frac{5!}{2!2!} = 210$

3 alike 2 different ${}^{1}C_{1}.{}^{8}C_{2}\frac{5!}{3!} = 560$

3 alike 2 alike ${}^{1}C_{1}.{}^{1}C_{1}\frac{5!}{3!2!} = 10$

4 alike 1 different ${}^{1}C_{1}.{}^{8}C_{1}\frac{5!}{4!} = 40$

total = 22660

**हल.** 13 अक्षर (4I, 2N, 7 भिन्न) 9 type

सभी भिन्न ${}^{9}C_{5}5! = 15120$

2 एक समान, 3 भिन्न ${}^{2}C_{1}.{}^{8}C_{3}\frac{5!}{2!} = 6720$

3 एक समान, 2 एक समान 1 भिन्न ${}^{2}C_{2}.{}^{7}C_{1}\frac{5!}{2!2!}$

$= 210$

3 एक समान, 2 भिन्न ${}^{1}C_{1}.{}^{8}C_{2}\frac{5!}{3!} = 560$

3 एक समान, 2 एक समान ${}^{1}C_{1}.{}^{1}C_{1}\frac{5!}{3!2!} = 10$

4 एक समान, 1 भिन्न ${}^{1}C_{1}.{}^{8}C_{1}\frac{5!}{4!} = 40$

कुल = 22660

**2.** $\max\{|x-1|, |y-2|\} = 4$

Case–I

If $|x-1| \geq |y-2| \Rightarrow |x-1| = 4$

$\Rightarrow x = 5, x = -3$ and $-4 \leq y-2 \leq 4 \; -2 \leq y \leq 6$

Case –II

If $|x-1| \leq |y-2| \Rightarrow |y-2| = 4$

$\Rightarrow y = 6, y = -2$ and $-4 \leq x-1 \leq 4 \; -3 \leq x \leq 5$

area = 64

**3.** $\sum_{k=0}^{n} k = \frac{n(n+1)}{2}$

$$\sum_{k=0}^{n} k.{}^{n}C_{k} = n\sum_{k=1}^{n} {}^{n-1}C_{k-1} = n\cdot 2^{n-1}$$

$$\sum_{k=0}^{n} k^{2}\,{}^{n}C_{k} = n\sum_{k=1}^{n}((k-1)+1)\,{}^{n-1}C_{k-1} = n\,(n+1)2^{n-2}$$

$$\sum_{k=0}^{n} {}^{n}C_{k}\,3^{k} = (1+3)^{n} = 4^{n}$$

$$\begin{vmatrix} \frac{n(n+1)}{2} & n(n+1)2^{n-2} \\ n2^{n-1} & 4^{n} \end{vmatrix} = 0$$

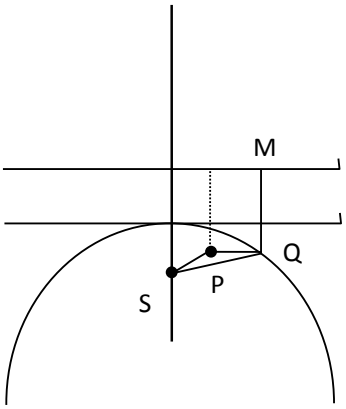
$n = 4$

$$\sum_{k=0}^{4} \frac{{}^{4}C_{k}}{k+1} = \frac{1}{5}\sum_{k=0}^{4} {}^{5}C_{k+1} = \frac{2^{5}-1}{5} = \frac{31}{5}$$

**4.** SQ = QM

SQ + QP = PQ + QM Will minimum when Q lies on line perpendicular from 'P' to directrix

$\Rightarrow (SQ + QP)_{min} = 1 - b$




**5.** Let $P(U_1) = K$, then $P(U_2)$ $= 2k$ and $P(U_3) = 3k$

$\therefore k + 2k + 3k = 1$ i.e $k = \frac{1}{6}$

Let P(R) be the probability that the ball drawn is red. Then

$P(R) = P(U_1) \times P(R/U_1) + P(U_2).P(R/U_2) + P(U_3).P(R/U_3)$

$$= \frac{1}{6}\times\frac{4}{6} + \frac{2}{6}\times\frac{3}{6} + \frac{3}{6}\times\frac{2}{6} = \frac{16}{36} = \frac{4}{9}$$

**हल.** माना $P(U_1) = K$ तब $P(U_2)$

$= 2k$ और $P(U_3) = 3k$

$\therefore k + 2k + 3k = 1$ i.e $k = \frac{1}{6}$

माना P(R) प्रायिकता है कि खीची गई गेंद लाल है तब

$P(R)=P(U_1)\times P(R/U_1)+P(U_2).P(R/U_2)+P(U_3).P(R/U_3)$

$= \frac{1}{6}\times\frac{4}{6}+\frac{2}{6}\times\frac{3}{6}+\frac{3}{6}\times\frac{2}{6}=\frac{16}{36}=\frac{4}{9}$

**6.** Let $P(U_1) = K$, then $P(U_2)$

$= 4k$ and $P(U_3) =$ $9k$

$\therefore k + 4k + 9k = 1$ i.e $k = \frac{1}{14}$

Let E be event that two balls drawn are of different colours. Then

$P(E) = P(U_1) . P(E/U_1) + P(U_2) . P(E/U_2) + P(U_3) . P(E/U_3)$

$= \frac{1}{14}\times\frac{4}{6}.\frac{2}{5}.2+\frac{4}{14}.\frac{3}{6}.\frac{3}{5}.2+\frac{9}{14}.\frac{2}{6}.\frac{4}{5}.2$

$= \frac{16+72+144}{14\times6\times5} = \frac{58}{105}$

**हल.** माना $P(U_1) = K$ तब $P(U_2) = 4k$ और $P(U_3) = 9k$

$\therefore k + 4k + 9k = 1$ i.e. $k = \frac{1}{14}$

माना E घटना है जबकि दोगेदें भिन्न भिन्न रंग की खीची गई है तब

$P(E) = P(U_1) . P(E/U_1) + P(U_2) . P(E/U_2) + P(U_3) . P(E/U_3)$

$= \frac{1}{14}\times\frac{4}{6}.\frac{2}{5}.2+\frac{4}{14}.\frac{3}{6}.\frac{3}{5}.2+\frac{9}{14}.\frac{2}{6}.\frac{4}{5}.2$

$= \frac{16+72+144}{14\times6\times5} = \frac{58}{105}$

**7.** $f''(x) > 0 \Rightarrow f'(x)$ is an increasing function

$f''(x) > 0 \Rightarrow f'(x)$ वर्धमान फलन है।

$h'(x) = \sin 2x(f'(\sin^2 x) - f'(\cos^2 x))$

$h'(x) = 0 \Rightarrow \sin 2x = 0 \Rightarrow x = 0$

or या

$f'(\sin^2 x) = f'(\cos^2 x) \Rightarrow \sin^2 x = \cos^2 x \Rightarrow \tan^2 x = 1 \Rightarrow x = \pm\frac{\pi}{4}$

**8.** h(x) is increasing वर्धमान है। $\Rightarrow h'(x) > 0$

**Case स्थिति I**

$(i)\ \sin 2x > 0 \Rightarrow x \in \left(0, \frac{\pi}{2}\right)$

$(ii)\ f'(\sin^2 x) > f'(\cos^2 x) \Rightarrow \tan^2 x > 1\} \Rightarrow x \in \left(\frac{\pi}{4}, \frac{\pi}{2}\right)$

**Case स्थिति II**

$(i)\ \sin 2x < 0 \Rightarrow x \in \left(-\frac{\pi}{2}, 0\right)$

$(ii)\ f'(\sin^2 x) < f'(\cos^2 x)$

$x \in \left(-\frac{\pi}{4}, 0\right)$

**Sol.** **(9–10)**

$R = (1 + 2x)^n$

put $x = 1$ to get sum of all the coefficients

$x = 1$ रखने पर सभी गुणाकों का योगफल है

$\therefore 3^n = 6561 = 3^8 \Rightarrow n = 8$

**(9)** for $x = \frac{1}{\sqrt{2}}$; $R = \left(\sqrt{2}+1\right)^8$ के लिए

consider मानाकि

$$\underbrace{\left(\sqrt{2}+1\right)^8+\left(\sqrt{2}-1\right)^8}_{I+f+f'} = 2\left[{}^8C_0\left(\sqrt{2}\right)^8+.....\right] = \text{even integer}$$

सम पूर्णांक

since I is integer

$\Rightarrow$ f + f ' must be an integer

चूकि I पूर्णांक है $\Rightarrow$ f + f ' पूर्णांक है

but $0 < f + f ' < 2$ परन्तु

$\Rightarrow$ $f + f ' = 1$

$\Rightarrow$ $f ' = 1 – f$

now अब $n + R – Rf$

$n + R(1 – f) = 8+\left(\sqrt{2}+1\right)^n\cdot\left(\sqrt{2}-1\right)^n = 8 +$

$1 = 9$ **Ans.**

**(10)** $T_{r+1}$ in $(1 + 2x)^8 = {}^8C_r(2x)^r$

$= {}^8C_r$ when $x = \frac{1}{2}$

$r \le \frac{9}{1+1}$

$r \le \frac{9}{2}$

$m = 4$

so इयलिए $T_{m+1} = T_5$

$\Rightarrow T_5$ is the greatest term अधिकतम पद है

$\Rightarrow$ **(B)**

**11.** $f(x) = x^{\frac{1}{x}}$

$f'(x)$

for $x \in (0, \cos 1)$ $\sin^{-1} x < 1 < \cos^{-1} x$

$$\left(\sin^{-1}x\right)^{\cos^{-1}x} < \left(\sin^{-1}x\right)^{\sin^{-1}x} < \left(\text{con}^{-1}x\right)^{\sin^{-1}x} < \left(\cos^{-1}x\right)^{\cos^{-1}x}$$

$t_2 < t_1 < t_3 < t_4$

for $x \in (\sin 1, 1)$

$\cos^{-1} < 1 < \sin^{-1} x$

$$\left(\sin^{-1}x\right)^{\sin^{-1}x} > \left(\sin^{-1}x\right)^{\cos^{-1}x} > \left(\text{con}^{-1}x\right)^{\cos^{-1}x} > \left(\cos^{-1}x\right)^{\sin^{-1}x}$$

$t_1 > t_2 > t_4 > t_3$

for $x \in \left(\cos 1, \frac{1}{\sqrt{2}}\right)$

$\sin^{-1} x < \cos^{-1} x < 1$

$$\left(\sin^{-1}x\right)^{\cos^{-1}x} < \left(\sin^{-1}x\right)^{\sin^{-1}x} < \left(\cos^{-1}x\right)^{\cos^{-1}x} < \left(\cos^{-1}x\right)^{\sin^{-1}x}$$

$t_2 < t_1 < t_4 < t_3$

for $x \in \left(\frac{1}{\sqrt{2}}, \sin 1\right)$

$\cos^{-1} x < \sin^{-1}_x < 1$

$$\left(\cos^{-1}x\right)^{\sin^{-1}x} < \left(\text{con}^{-1}x\right)^{\cos^{-1}x} < \left(\sin^{-1}x\right)^{\sin^{-1}x} < \left(\sin^{-1}x\right)^{\cos^{-1}x}$$

$t_3 < t_4 < t_1 < t_2$

**12.** (A) $n(S) = 4^9$

$n(E) = 3^3 = 27$

$P(E) = \frac{27}{4^9}$

(B) $n(S) = 4^9$

$n(E) = 4^6$

$P(E) = \frac{4^6}{4^9} = \frac{1}{64}$

(C) $n(S) = 4^4$

$n(E) = 4! = 24$

$P(E) = \frac{24}{4^4} = \frac{3}{32}$

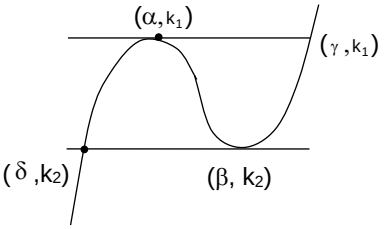
(D) $n(S) = 4! = 24$

$n(E) = D_4 = 9$

$P(E) = \frac{9}{24}$

**13.** $f'(x) = 3ax^2 + 2x - (2a + 1)$ $\begin{matrix}\alpha\\ \beta\end{matrix}$

$\alpha + \beta = \frac{-2}{3a}$ ____ (1)




$f(x) = k_1 \Rightarrow$

$ax^3 + x^2 - (2a+1)x + 2 - k_1 = 0$ $\begin{matrix}\alpha\\ \alpha\\ \gamma\end{matrix}$

$2\alpha + \gamma = -\frac{1}{a}$ ___(2)

$f(x) = k_2 \Rightarrow ax^3 + x^2 - (2a+1)x + 2 - k_2 = 0$

$2\beta + \delta = -\frac{1}{a}$ _____(3)

(2) +(3) – 2(1)

$\gamma + \delta = \frac{-2}{a} + \frac{4}{3a} = \frac{4-6}{3a} = \frac{-2}{3a}$

**14.** For $1 \le k \le n$

$$\left(1+\frac{x}{n}\right)^{\frac{k}{n}} \le \left(1+\frac{kx}{n^2}\right) \le \left(1+\frac{x}{n^2}\right)^k$$

$$\left(1+\frac{x}{n}\right)^{\frac{n+1}{2}} \le P_n \le \left(1+\frac{x}{n^2}\right)^{\frac{n(n+1)}{2}}$$

$$e^{\frac{x}{2}} \le \lim_{n\to\infty} P_n \le e^{\frac{x}{2}} \Rightarrow f(x) = e^{\frac{x}{2}}$$

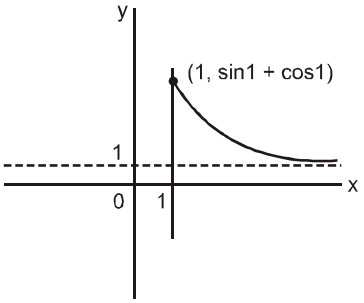
**15.** $f(x) = x \cos\frac{1}{x}$ , $x \ge 1$

$\Rightarrow f'(x) = \frac{1}{x} \sin\frac{1}{x} + \cos\frac{1}{x}$

$\Rightarrow f''(x) = -\frac{1}{x^3}\cos\left(\frac{1}{x}\right)$

Now $\lim_{x\to\infty} f'(x) = 0 + 1 = 1$

$\Rightarrow$ option 'B' is correct




$x \in [1, \infty)$

$\Rightarrow \quad \frac{1}{x} \in (0, 1]$

$\Rightarrow \quad f''(x) < 0$

$\Rightarrow$ option 'D' is correct

As $f'(1) = \sin 1 + \cos 1 > 1$

$f'(x)$ is strictly decreasing and $\lim\limits_{x\to\infty} f'(x) = 1$

so graph of $f'(x)$ is as below

Now in $[x, x + 2]$, $x \in [1, \infty)$, $f(x)$ is continuous and differentiable

so by LMVT, $f'(x) = \frac{f(x+2)-f(x)}{2}$

as $f'(x) > 1$ for all $x \in [1, \infty)$

$\Rightarrow \quad \frac{f(x+2)-f(x)}{2} > 1$

$\Rightarrow \quad f(x + 2) - f(x) > 2$

for all $x \in [1, \infty)$

**हल.** **(B,C,D)**

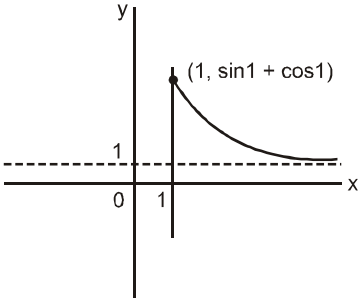
$f(x) = x \cos \frac{1}{x}, x \geq 1$

$\Rightarrow f'(x) = \frac{1}{x} \sin \frac{1}{x} + \cos \frac{1}{x}$

$\Rightarrow f''(x) = -\frac{1}{x^3} \cos\left(\frac{1}{x}\right)$

अब $\lim\limits_{x\to\infty} f'(x) = 0 + 1 = 1$

$\Rightarrow$ विकल्प B सही




$x \in [1, \infty) \quad \Rightarrow \quad \frac{1}{x} \in (0, 1]$

$\Rightarrow f''(x) < 0 \quad \Rightarrow$ विकल्प D सही

$f'(1) = \sin 1 + \cos 1 > 1$

$f'(x)$ एकदिष्ट ह्रासमान है और $\lim\limits_{x\to\infty} f'(x) = 1$

अतः $f'(x)$ का ग्राफ दिये अनुसार है।

अब $[x, x + 2]$, $x \in [1, \infty)$ में $f(x)$ सतत् तथा अवकलनीय है।

अतः LMVT से $f'(x) = \frac{f(x+2)-f(x)}{2}$

सभी $x \in [1, \infty)$ के लिए $f'(x) > 1$

$\Rightarrow \quad \frac{f(x+2)-f(x)}{2} > 1$

$\Rightarrow \quad f(x + 2) - f(x) > 2$

सभी $x \in [1, \infty)$ के लिए

**16.** $\because f(x) = \frac{(x-1)^2.e^x}{(1+x^2)^2}$

$\therefore f'(x)$

$=$

$$\frac{(1+x^2)^2.((x-1)^2e^x + 2(x-1)e^x) - (x-1)^2e^x.2(1+x^2).2x}{(1+x^2)^4}$$

$\therefore f'(x) = \frac{(x-1)(x^3-3x^2+5x+1)e^x}{(x^2+1)^3}$

$\Rightarrow$ $f(x)$ has two points of local extremum i.e. $x = 1$ and $x = \alpha$, $\alpha \in (-1, 0)$

$\Rightarrow$ $f(x)$ स्थानीय चरम के बिन्दु है।

तथा $x = 1$ और $x = \alpha$, $\alpha \in (-1, 0)$

**17.** $\{x\} \in [0, 1) \Rightarrow [x] \in (100, 125]$

$\Rightarrow \sum \{x_i\} = 12$

**18.**

| $n^{th}$ | $(n-1)^{st}$ | $(n-2)^{nd}$ | $(n-3)^{rd}$ |
|---|---|---|---|
| A | A | $\overline{A}$ | $P_{n-3}$ |
| A | $\overline{A}$ | $P_{n-2}$ | |
| $\overline{A}$ | $P_{n-1}$ | | |

$$P_n = \frac{1}{6}.\frac{1}{6}.\frac{5}{6}.P_{n-3} + \frac{1}{6}.\frac{5}{6}P_{n-2} + \frac{5}{6}P_{n-1}$$

$$216P_n - 5P_{n-3} - 30P_{n-2} - 180P_{n-1} = 0$$

**19.** $\lim\limits_{x\to0}\dfrac{(1+bx)-(1+ax)(1+x)^{1/2}}{\sqrt{1+x}\,(1+bx)\,x^3}$

$$= \lim_{x\to0}\frac{(1+bx)-(1+ax)\left(1+\frac{1}{2}x-\frac{1}{8}x^2+\frac{x^3}{16}\right)}{x^3}$$

$$= \lim_{x\to0}\frac{x\left(b-\frac{1}{2}-a\right)+x^2\left(\frac{1}{8}-\frac{a}{2}\right)+x^3\left(-\frac{1}{16}+\frac{a}{8}\right)}{x^3}$$

for limit to exist

$$b-\frac{1}{2}-a=0$$

$$\frac{a}{2}-\frac{1}{8}=0 \Rightarrow a=\frac{1}{4} \Rightarrow b=\frac{3}{4}$$

$$\Rightarrow \ell = \frac{2a-1}{16} \quad \ell = -\frac{1}{32}$$

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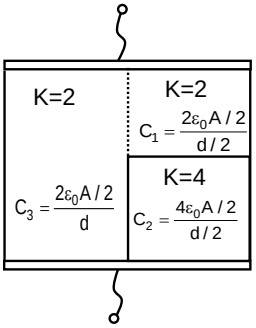
## PART-II: PHYSICS

**21.** 100 μC

**22.** $C_1$ and $C_2$ will be in series.




$$\frac{1}{C_{eq}}=\frac{d}{2\varepsilon_0A}+\frac{d}{4\varepsilon_0A}=\frac{3}{4}\frac{d}{\varepsilon_0A}$$

$$C_{1\leftrightarrow2}=\frac{4\varepsilon_0A}{3d}$$

And $C_3$ will be in parallel to their resultant.

$$C_{eq}=C_{1\leftrightarrow2}+C_3=\frac{4\varepsilon_0A}{3d}+\frac{\varepsilon_0A}{d}=\frac{7\varepsilon_0A}{3d}$$

$$\frac{k_{eq}\varepsilon_0A}{d}=\frac{7}{3}\frac{\varepsilon_0A}{d}\Rightarrow k_{eq}=\frac{7}{3}$$

**23.** Erf of one row = 0.15 × 5000 = 750 volt
Internal resistance of one row
= 0.25 × 5000 = 1250
There are 100 rows, so

$$E_{eq}=\frac{\frac{\varepsilon}{r}+\frac{\varepsilon}{r}+.....100\,\text{times}}{\frac{1}{r}+\frac{1}{r}+.....100\,\text{times}}=750\text{ volt}$$

$$r_{eq}=\frac{1250}{100}=12.5\Omega$$

The current in ext. resistor

$$i=\frac{\varepsilon_{net}}{r_{net}}=\frac{750}{500+12.5}\approx\frac{750}{500}=1.5\text{ A}$$

**26.** During the collision we apply momentum conservation.

$P_i = P_f \Rightarrow$ (0.02) (80) = (0.3 + 0.02) $V_c$

$V_c$ = 5 m/sec

After the collision apply energy conservation

$$KE\downarrow = U\uparrow \Rightarrow \frac{1}{2}(m_{total})V_c^2=m_{total}gh_{cm}$$

$$\Rightarrow \quad h_{cm}=\frac{V_c^2}{2g}=\frac{(5)^2}{2\times10}=\frac{5}{4}\text{m}$$

We should also check

$\sqrt{2g\ell}=\sqrt{2\times10\times5}=10\text{m/sec}$,

and velocity of the system at the lowest position is $V_c$ = 5 m/sec since $V_c<\sqrt{2g\ell}$, so the pendulum will not able to cross the 90º position, so $h_{max}=\frac{V_c^2}{2g}=\frac{5}{4}$m is correct.

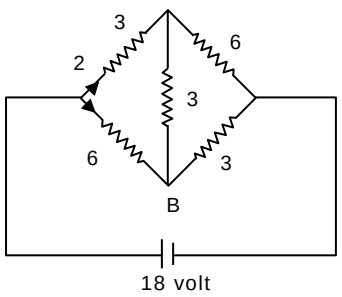
**27.** $KE_{loss}=\dfrac{m_1m_2}{2(m_1+m_2)}(u_1-u_2)^2(1-e^2)$

$$KE_{loss}=\frac{(0.3)(0.02)}{2(0.3+0.02)}(80-0)^2(1-0^2)$$

$KE_{loss}$ = 60 J

**28.** 06.00

**29.**




$V_A - V_B = E$ = 6 volts (वोल्ट)

$r_{AB}$ = 2+2 = 4 Ω (by replacing cell by plain wire).

$r_{AB}$ (सैल को एक चालक तार द्वारा प्रतिस्थापित करने पर)

$$\Rightarrow \qquad i = \frac{E}{r+S} = \frac{6}{4+2} = 1A$$

**30.** (A) $E = \frac{1}{2}CV^2$

As potential difference source between the plates is connected, p.d. remains constant. But capacitance C becomes KC hence energy stored is increased by factor K.

(B) Electric field V/d is not changed.

(C) Charge on each plate is increased by factor K hence force between them increases by factor $K^2$. For effect of the medium, they must completely lie in the medium.

(D) Q = CV

Hence charge becomes KQ as C becomes KC and V remainin unchanged.

(A) $E = \frac{1}{2}CV^2$

यदि बैटरी संयोजित है तो प्लेटों के मध्य विभवान्तर समान रहेगा लेकिन धारिता KC हो जाएगी तथा संधारित्र में संग्रहित ऊर्जा K गुना बढ़ जाएगी।

(B) विद्युत क्षेत्र V/d परिवर्तित नहीं होगा।

(C) प्रत्येक प्लेट पर आवेश K गुना बढ़ जाता है इसलिये उनके मध्य बल $K^2$ गुना बढ़ जाता है। माध्यम के प्रभाव के लिये इनकों पूर्णतः माध्यम में रखा होना चाहिये।

(D) Q = CV

अतः आवेश KQ तथा धारिता KC हो जाएगी तथा V अपरिवर्तित रहेगा।

**32.** $\frac{F}{A} = y\left(\frac{d\ell}{\ell}\right) \qquad \Rightarrow \frac{d\ell}{\ell} = \left(\frac{F}{YA}\right)$

$$= \frac{5000}{(10^9)\left(1x10^{-4}\right)} = +5\%$$

$$\nu = \frac{-dr/r}{d\ell/\ell} \Rightarrow \frac{dr}{r} = -\nu\,\frac{d\ell}{\ell} = -(0.2)\text{ x }(+5\%)$$

$$\Rightarrow \frac{dr}{r} = -1\% \qquad \Rightarrow \frac{dA}{A} = -2\%$$

Vol. आयतन = $A\ell \Rightarrow \frac{d(Vol)}{Vol} = \frac{dA}{A} + \frac{d\ell}{\ell}$ = (–2%) + (5%) = +3%

and resistance तथा प्रतिरोध $R = \frac{\rho\ell}{A}$

$$\Rightarrow \frac{dR}{R} = \frac{d\ell}{\ell} - \frac{dA}{A} = (+5\%) - (-2\%) = +7\%$$

**33.** $\frac{4}{3}\pi r^3 \times 8 = \frac{4}{3}\pi R^3 \Rightarrow 2r = R$

Terminal velocity सीमान्त वेग

$$v_T = \frac{2r^2(\rho-\sigma)g}{9\eta},$$

$$v_T' = v_T = \frac{2R^2(\rho-\sigma)g}{9\eta} = 4v_T$$

$F_d' = 6\eta\pi R v_T' = 8F_d$

**34.** When $S_1$ is closed, only C is charged.

Charge through the battery Q = CV

= 120 μC

As $S_1$ is opened and $S_2$ is closed, charge is redistributed between $C_1$ and $C_2$. Let these be $Q_1$ and $Q_2$.

$Q_1 + Q_2 = 120\ \mu C$ ... (1)

Using KVL in closed loop

$$\frac{Q_1}{C_1} - \frac{Q_2}{C_2} = 0 \quad \Rightarrow \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

Solving $Q_1 = 80\ \mu C$ $Q_2 = 40\ \mu C$

$$\Delta H = \left[\frac{Q^2}{2\ C_1}\right] - \left[\frac{Q_1^2}{2\ C_1} + \frac{Q_2^2}{2\ C_2}\right] = 400 \times 10^{-6}\ J$$

जब $S_1$ बन्द है, केवल C आवेशित है

बैटरी से गुजरने वाला आवेश Q = CV

= 120 μC

चूंकि $S_1$ खुला है तथा $S_2$ बन्द है, आवेश $C_1$ तथा $C_2$ के बीच पुनः वितरित हो जाता है। माना यह $Q_1$ तथा $Q_2$ है।

$Q_1 + Q_2 = 120\ \mu C$ ... (1)

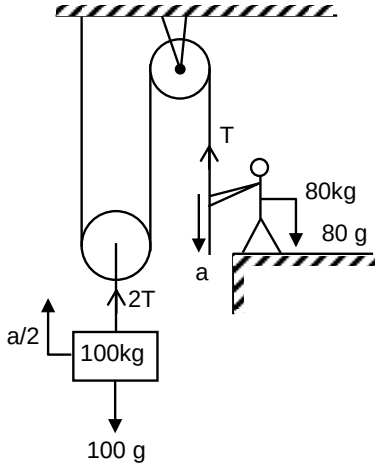
बन्द लूप में KVL काम में लेने पर

$$\frac{Q_1}{C_1} - \frac{Q_2}{C_2} = 0 \quad \Rightarrow \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

$Q_1 = 80\ \mu C$ हल करने पर $Q_2 = 40\ \mu C$

$$\Delta H = \left[\frac{Q^2}{2\ C_1}\right] - \left[\frac{Q_1^2}{2\ C_1} + \frac{Q_2^2}{2\ C_2}\right] = 400 \times 10^{-6}\ J$$

**35.**

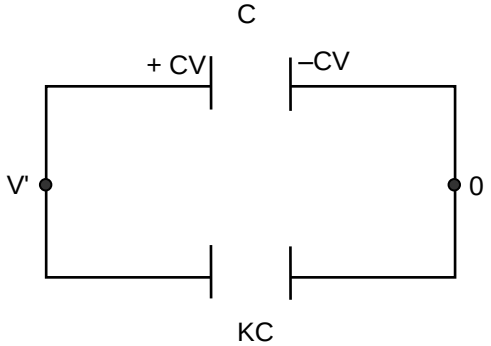



NLM for the block :
ब्लॉक के लिए NLM

$$2T - (100)g = (100)\left(\frac{a}{2}\right)$$

$T = 500 + 25\ a$
(i) pressing force on the floor
फर्श पर दबाव बल
$= 80\ g - T < 200$
$T > 600$
$500 + 25a > 600$
$a > 4$
(ii) To prevent from lifting up :
उठने से रोकने के लिए
$T < 80\ g$
$500 + 25a < 800$
$a < 12$
So to prevent yielding of floor as well as lifting up, $a \in (4, 12)$
फर्श के अपरूपण एवं व्यक्ति के उठने से रोकने के लिए , $a \in (4, 12)$

**36.**




$C(K+1)V' = CV$
$(\alpha V' + 1)\ V' = V$
$\alpha V'^2 + V' - 300 = 0$
$V' = 12\ V$

**37.** Equating the dimension of LHS and RHS
LHS तथा RHS की विमाओं को बराबर करने पर

$$\frac{L^3}{T} = \frac{\left(\frac{M^1L^1T^{-2}}{L^2}\right)(L)^n}{(M^1L^{-1}T^{-1})(L)}$$

get n = 4
प्राप्त होता है n = 4

**38.** 2

---

## PART-III: CHEMISTRY

**39.** $a = 200\ pm = 200 \times 10^{-10}\ cm$
$= 2 \times 10^{-8}\ cm$
volume $= (2 \times 10^{-8})^3$
No. of atoms $= \frac{Z \times A}{d \times a^3}$
$= \frac{4 \times 100}{10 \times (2 \times 10^{-8})^3} = 5 \times 10^{24}$

**हल.** $a = 200\ pm = 200 \times 10^{-10}\ cm$
$= 2 \times 10^{-8}\ cm$
आयतन $= (2 \times 10^{-8})^3$
परमाणुओं की संख्या $= \frac{Z \times A}{d \times a^3}$
$= \frac{4 \times 100}{10 \times (2 \times 10^{-8})^3} = 5 \times 10^{24}$

**40.** Mole of camphor
$= (30.4\ g)(1\ mol/152\ g) = 0.2\ mol$
Mass of benzene
$= (100\ cm^3)(0.8\ g\ cm^{-3}) = 0.08\ kg$
molality of camphor in solution
$= 0.2\ mol\ camphor/0.08\ kg\ benzene$
$= 2.5\ mol\ kg^{-1}$
$\Delta T_f = K_f\ m = (4.0^oC\ kg\ mol^{-1})(2.5\ mol\ kg^{-1})$
$= 10.0\ ^oC$
Since pure benzene freezes at $5.0^oC$,
the solution will freeze at $-5.0^oC$.

**हल.** कपूर के मोल

= (30.4 g)(1 mol/152 g) = 0.2 mol

बेन्जीन का द्रव्यमान

= (100 $cm^3$)(0.8 g $cm^{-3}$) = 0.08 kg

विलयन में कपूर की मोललता

= 0.2 मोल कपूर /0.08 kg बेन्जीन

= 2.5 mol $kg^{-1}$

$\Delta T_f = K_f m = (4.0^oC \text{ kg mol}^{-1})(2.5 \text{ mol kg}^{-1})$

= 10.0 $^oC$

चूँकि शुद्ध बेन्जीन 5.0ºC पर जमता है,

विलयन –5.0ºC पर जमेगा।

**45.** Number of $Ca^{+2}$ ions = $\frac{1}{8}\times 8 = 1$

Number of $Ti^{4+}$ = 1

Number of $O^{-2}$ ions = $6\times\frac{1}{2} = 3$

Total no. of atoms = 5

**हल.** $Ca^{+2}$ आयनों की संख्या = $\frac{1}{8}\times 8 = 1$

$Ti^{4+}$ की संख्या = 1

$O^{-2}$ आयनों की संख्या = $6\times\frac{1}{2} = 3$

परमाणुओं की कुल संख्या = 5

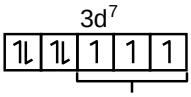
**46.** $BaTiO_3$, $CaTiO_3$

**49.** (A) $Fe^{2+}$ changes to brown-coloured ring complex by charge transfer.

(B) $NO \longrightarrow NO^+ + e^-$

$Fe^{2+} + e^- \longrightarrow Fe^+$

(C) $Fe^+ \rightarrow [Ar]$




3 unpaired electrons

Magnetic moment

= $\sqrt{n(n+2)}$

= $\sqrt{3\times 5}$ = $\sqrt{15}$ = 3.87 B.M.

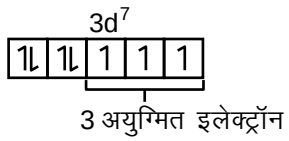
(D) $\rightarrow$ $sp^3d^2$ hybridisation

**हल.** (A) $Fe^{2+}$ आवेश स्थानान्तरण द्वारा भूरे रंग के वलय संकुल में परिवर्तित होता है।

(B) $NO \longrightarrow NO^+ + e^-$

$Fe^{2+} + e^- \longrightarrow Fe^+$

(C) $Fe^+ \rightarrow [Ar]$




3 अयुग्मित इलेक्ट्रॉन

चुम्बकीय आघूर्ण = $\sqrt{n(n+2)}$

= $\sqrt{3\times 5}$ = $\sqrt{15}$ = 3.87 B.M.

(D) $\rightarrow$ $sp^3d^2$ संकरण

**50.** Since system is conducting frictionless piston

Hence $T_A = T_B$ and $P_A = P_B$

Since volume is different hence $n_B = 3n_A$

**हल.** यद्यपि निकाय में चालक घर्षणरहित पिस्टन उपस्थित है।

अतः $T_A = T_B$ तथा $P_A = P_B$

यद्यपि आयतन भिन्न–भिन्न है तब $n_B = 3n_A$

**51.** Diamagnetic substance shows decrease in weight.

प्रतिचुम्बकीय पदार्थ भार में कमी दर्शाते हैं।

**52.** $H_2O_2 \longrightarrow O_2$

v.f. = 2

$C_2O_4^{2-} \longrightarrow CO_2$

v.f. = (4 – 3) × 2 = 2

(C) $[Fe(CN)_6]^{4-} \longrightarrow [Fe(CN)_6]^{3-}$

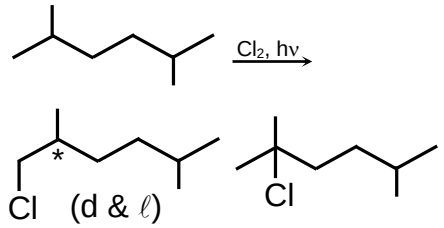
v.f. = (3 – 2) × 1 = 1

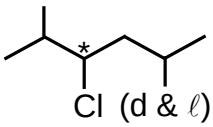
(D) $NO_3^- \longrightarrow NH_3$

v.f. = 5 – (– 3) = 8

**55.** a = 12, b = 3 (a – b – 1) = 8

**57.**





Cl (d & ℓ)

Total monochloro products are 5.

कुल मोनोक्लोरो उत्पाद 5 प्राप्त होते है।

## PAPER-2

## PART-I: MATHEMATICS

**1.** given function is discontinuity when

दिया गया फलन असतत् होगा तब

Now, if अब यदि a = 1

$\Rightarrow \quad \sin\pi x = 0 \quad \Rightarrow \quad x = 1, 2, 3, 4, 5$

If यदि $a = 3 \quad \Rightarrow \quad \sin\pi x = -2$;

not possible सम्भव नहीं

if $a = 0.5 \Rightarrow \quad \sin\pi x = \frac{1}{2}$

$\Rightarrow$ x has 6 values, 2 each for one cycle of period 2.

यदि $a = 0.5 \Rightarrow \quad \sin\pi x = \frac{1}{2}$

$\Rightarrow$ x के 6 मान, आवर्त 2 के प्रत्येक चक्र के लिए 2.

ifयदि $a = 0 \quad \Rightarrow \quad \sin\pi x = 1$

$\Rightarrow \quad x = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \frac{9}{2}, \frac{11}{2}$

**2.** $\because f'(x) = \lim\limits_{h\to0} \frac{f(x+h)-f(x)}{h}$

$$= \lim_{h\to0} \frac{f(x)+f(h)+2x.h(x+h)-\frac{1}{3}-\left(f(x)+f(0)-\frac{1}{3}\right)}{h}$$

$= \lim\limits_{h\to0} \frac{f(h)-f(0)}{h} + 2x^2$

$= f'(0) + 2x^2$ ..... (1)

$\because \lim\limits_{h\to0} \frac{3f(h)-1}{6h} = \frac{2}{3}$

$\Rightarrow \lim\limits_{h\to0} \frac{f(h)-\frac{1}{3}}{2h} = \frac{2}{3}$

$\Rightarrow \frac{1}{2} \lim\limits_{h\to0} \frac{f(h)-f(0)}{h} = \frac{2}{3} \Rightarrow \frac{f'(0)}{2} = \frac{2}{3}$

$\Rightarrow f'(0) = \frac{4}{3}$ put is (1) में रखने पर

$\therefore f'(x) = \frac{4}{3} + 2x^2$

$\therefore f(x) = \frac{4}{3}x + \frac{2x^3}{3} + C$

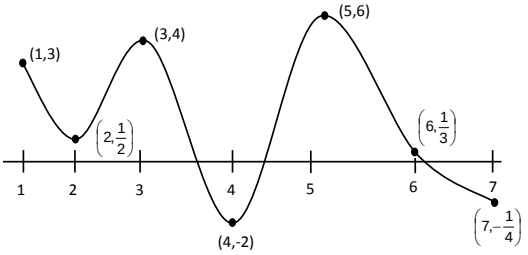
$\because f(0) = C = \frac{1}{3}$

$f(x) = \frac{2x^3+4x+1}{3}$

$\therefore f(2) = \frac{16+8+1}{3} = \frac{25}{3}$

$\therefore [f(2)] = 8$

**3.**




(A) number of zeros of f (x) f'(x) in [1, 7] are 7 so using Rolle's Theorem

Minimum of zeros its derivative f '(x) + f(x) f '' (x) will be 6

(B) Let $g(x) = e^{-x} f'(x)$ as g(x) has minimum 4 zeros in [1, 7]

Hence $g'(x) = e^{-x} f''(x) - e^{-x} f'(x) = 0$ at minimum 3 points

$\Rightarrow \quad e^{-x}(f''(x) - f(x)) = 0$

$\Rightarrow \quad f''(x) - f(x) = 0$

(C) $f'(x) = f'(x)f^2(x)$

$\Rightarrow \quad f'(x)(f^2(x) - 1) = 0$

$\Rightarrow \quad f'(x) = 0$ or $f(x) = \pm1$

$f'(x) = 0 \rightarrow$ 4 points

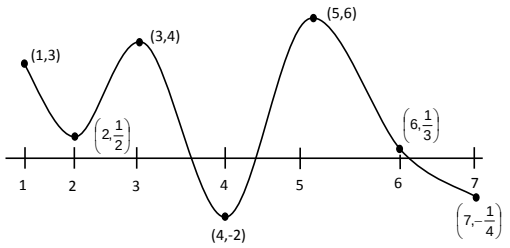
$f(x) = 1 \rightarrow$ 5 points

$f(x) = -1 \rightarrow$ 2 points = 11 points

(D) $h(x) = e^{-x}f(x)$ has 3 zeros in [1, 7] hence h'' (x) will have at least one zero in [1, 7] $h''(x) = e^{-x}$ (f ''(x) – 2 f '(x) + f(x)) = 0

$\Rightarrow$ f ''(x) – 2 f '(x) + f(x) = 0

**हल.**




(A) [1, 7] में f (x) f'(x) के शून्यों की न्यूनतम संख्या 7 है इसलिए रो प्रेमय से f '(x) + f(x) f " (x) अवकलनों के शून्यों की न्यूनतम संख्या 6 होगी

(B) माना $g(x) = e^{-x} f'(x)$, g(x) के [1, 7] में 4 शून्य है।

अतः $g'(x) = e^{-x} f''(x) - e^{-x} f'(x) = 0$ न्यनतम 3 बिन्दु पर

$\Rightarrow e^{-x}(f''(x) - f(x)) = 0$

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

(C) $f'(x) = f'(x)f^2(x)$

$\Rightarrow f'(x)(f^2(x) - 1) = 0$

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

$f'(x) = 0 \rightarrow$ 4 बिन्दु

f(x) = 1 $\rightarrow$ 5 बिन्दु  f(x) = –1 $\rightarrow$ 2 बिन्दु = 11 बिन्दु

(D) $h(x) = e^{-x}f(x)$ के 3 शून्य है [1, 7] अतः h" (x) के [1, 7]

$h''(x) = e^{-x}(f''(x) - 2f'(x) + f(x)) = 0$

$\Rightarrow f''(x) - 2f'(x) + f(x) = 0$

**4.** Let $\Delta = \begin{vmatrix} x^2 & (y+z)^2 & yz \\ y^2 & (z+x)^2 & zx \\ z^2 & (x+y)^2 & xy \end{vmatrix}$

$C_2 \rightarrow C_2 - 2C_3$

$\Delta = \begin{vmatrix} x^2 & (y^2+z^2) & yz \\ y^2 & (z^2+x^2) & zx \\ z^2 & (x^2+y^2) & xy \end{vmatrix}$

$\Delta = (x^2+y^2+z^2)(x-y)(y-z)(z-x)(x+y+z)$

**5.** Given =

$\frac{1}{5}\left({}^{N}C_0.5^n - {}^{n}C_1.5^{7-1} ..... + {}^{n}C_{n-1}.5\right)$

$= \frac{1}{5}\left((5-1)^n + 1\right) = \frac{4^n+1}{5}$

$= \frac{\left(2^n\right)^2 + 2.2^n + 1 - 2.2^n}{5}$

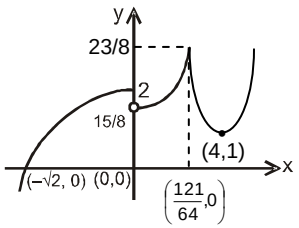
$= \frac{\left(2^n+1\right)^2 - \left(2^{\frac{n+1}{2}}\right)^2}{5} = \frac{\left(2^n - 2^{\frac{n+1}{2}} + 1\right)\left(2^n + 2^{\frac{n+1}{2}} + 1\right)}{5}$

Since  $n \geq 5$ and odd $n = 2k + 1$  $k \geq 2$

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

for $k \geq 2$ both factors are greater than 5. so after cancellation it has two factors other than 1.

**6.**




**8.** $(PQ)^2 = 9 + (16 - \sqrt{91})^2$

$(PR)^2 = 9 + (16 + \sqrt{91})^2$

$\Rightarrow (PQ)^2 + (PR)^2 = 712$

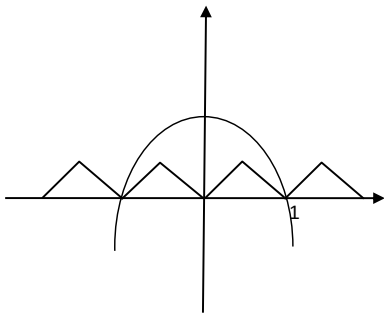
$\Rightarrow \alpha = 7, \beta = 1, \gamma = 2$

**9.** ${}^4C_1 . {}^4C_1 \cdot 3! \cdot 2^3 = 768$

**10.** $\frac{8!\ 4!}{(2!)^4\, 4!} - {}^4C_1 . {}^4C_1 \cdot 3! \cdot 2^3 - {}^4C_2 . {}^4C_2 \cdot 2! \cdot 2! \cdot 2 - 4!$

= 1440

**12.**




**Sol.** **(13 –14)**

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

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

Let $\text{cosec}^{-1}\left(x^2+1\right) = \theta \Rightarrow \text{cosec}\theta = \left(x^2+1\right)$

where $0 < \theta \le \frac{\pi}{2}$

$$= \sin^{-1}\left(3\sin\theta - 4\sin^3\theta\right)$$

$$= \sin^{-1}\sin(3\theta),\ 0 < 3\theta \le \frac{3\pi}{2}$$

$$= \begin{cases} 3\theta\ ;\ 0 < 3\theta \le \frac{\pi}{2} \\ \pi - 3\theta\ ;\ \frac{\pi}{2} < 3\theta \le \frac{3\pi}{2} \end{cases}$$

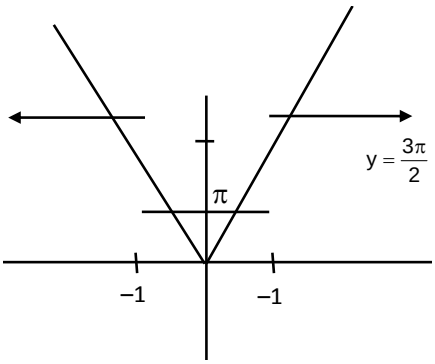
$$f(x) = \begin{cases} 3\text{cosec}^{-1}\left(x^2+1\right); |x| \ge 1 \\ \pi - 3\text{cosec}^{-1}\left(x^2+1\right); |x| < 1 \end{cases}$$

$$g(x) = \begin{cases} \frac{3\pi}{2}\ ; |x| \ge 1 \\ \pi\ \ ; |x| < 1 \end{cases}$$

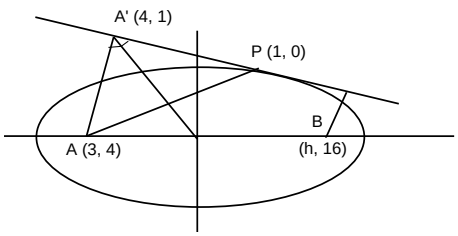
**13.** Required value = $\pi + \frac{3\pi}{2} + \pi = \frac{7\pi}{2}$

**14.** $y = \tan\left(\tan^{-1}|4x|\right)$ , $x \ne 0$

$y = |4x|$ , $x \ne 0$




**Sol.** **(15 –16)**




Centre 'C' $\equiv \left(\frac{h+3}{2}, 10\right)$

Foot of perpendicular from

'A' to $x - 3y - 1 = 0$ is

$$\frac{x-3}{1} = \frac{y-4}{-3} = -\frac{(3-12-1)}{1+9}$$

$x = 4 \quad y = 1 \quad \Rightarrow A' \equiv (4, 1)$

Mid point of AP, $M \equiv (2, 2)$

A', M and C are collinear

$$\begin{vmatrix} \frac{h+3}{2} & 10 & 1 \\ 4 & 1 & 1 \\ 2 & 2 & 1 \end{vmatrix} = 0$$

$$\left(\frac{h+3}{2}\right)(1-2) + 10(2-4) + 1(8-2) = 0$$

$$\left(\frac{h+3}{2}\right)(-1) - 20 + 6 = 0$$

$h + 3 = -28$

$h = -31$

$C \equiv (-14, 10)$

$a = A'C = \sqrt{405}$

**17.** At $x = 0$, $y = 4$

$e^x y = x^3 + 2x^2 + 4$

$y''(0)$

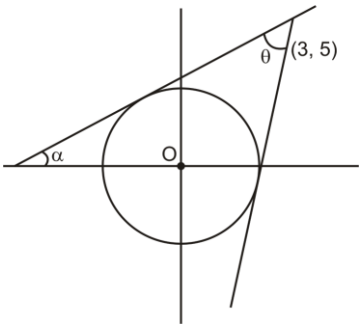
Because

$y''(0)$, $(e^{\sin x} - 1)^4 +$

$(\cos x + 1)^3 e^{\sin x} + (e^x - e^{-x})^3$ is always gives zero at $x = 0$

**18.** Focus of parabola is (3, 5) and focal chord is $mx - y + 5 - 3m = 0$

परवलय की नाभि (3, 5) है तथा नाभीय जीवा $mx - y + 5 - 3m = 0$ होगी।




$$\therefore \left|\frac{5-3m}{\sqrt{1+m^2}}\right| = 3 \Rightarrow m = \frac{8}{15} \text{ or } \infty$$

$$\therefore \tan\alpha = \frac{8}{15} \Rightarrow \theta = \frac{\pi}{2} - \alpha$$

$$= \cot^{-1}\left(\frac{8}{15}\right) = \tan^{-1}\left(\frac{15}{8}\right)$$

**19.** for $|A| \ne 0$

Case – I : Exactly one element is zero

स्थिति-I : ठीकएक अवयव शून्य है।

$^5C_3 \times \lfloor 4 = 240$

Case – II : No element is zero

स्थिति-II : कोई अवयव शून्य नही।

$$A = \begin{vmatrix} a & b \\ c & d \end{vmatrix}$$

$|A| = ad - bc = 0$

$ad = bc = 6 \quad \boxed{8}$

$ad = bc = 12 \quad \boxed{8}$

$\Rightarrow {}^5C_4 \times \lfloor 4 - 16 = 120 - 16$

$= 104$

Total = 344

---

## PART-II: PHYSICS

**21.** In the initial state, charge on each capacitor is shown in figure-1.

प्रारम्भिक अवस्था में, प्रत्येक संधारित्र पर आवेश चित्र-1 के अनुसार है।

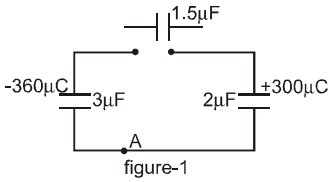


figure-1

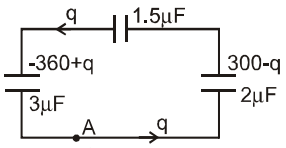


figure-2

Let charge q flow anticlockwise in the circuit before it achieves steady state as shown in figure-2.

Applying KVL to figure 2.

परिपथ में आवेश q चित्रानुसार वामावर्त दिशा में बहता है। तो चित्र-2 के अनुसार यह स्थायी अवस्था प्राप्त करता है।

चित्र-2 में KVL लगाने पर

$$\frac{-360+q}{3} + \frac{q}{1.5} = \frac{300-q}{2} \Rightarrow q = 180\ \mu C$$

$\therefore$ Final charge on 1.5 μF capacitor is q = 180 μC and final charge on 2 μF capacitor is 300 – q = 120 μC.

संधारित्र 1.5 μF पर अन्तिम आवेश q = 180 μC है तथा 2 μF संधारित्र पर अन्तिम आवेश 300 – q = 120 μC.

**22.** For voltmeter, series resistance

$$R_s = \frac{V}{I_G} - G$$

वोल्टमीटर के लिए, श्रेणीक्रम प्रतिरोध

$$R_s = \frac{V}{I_G} - G$$

$$(10V \text{ range}) = \frac{10}{50\times10^{-6}} - 100 = 200k\Omega$$

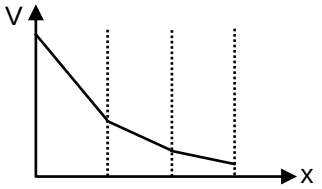
For ammeter, parallel resistance

अमीटर के लिए, समान्तर प्रतिरोध

$$S = \frac{I_G.G}{I - I_G}$$

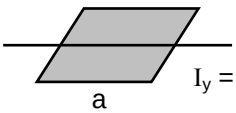
$$(5\ mA \text{ range}) = \frac{50\times10^{-6}\times100}{5\times10^{-3}} = 1\Omega.$$

**23.**

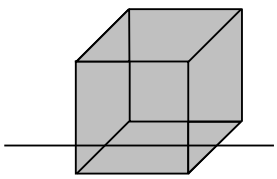



**25.** (A) perpendicular theorem is valid only for 2-D object, Not for 3-D objects.

लम्बवत् प्रमेय केवल द्विविमीय वस्तु के लिए लागु होती है। त्रिविमीय के लिए नहीं

(B) 

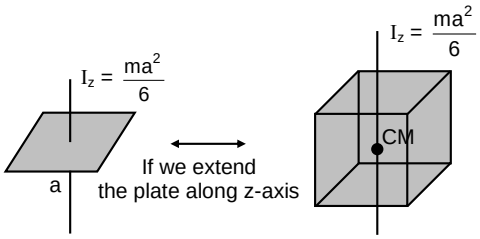
$I_y = \frac{ma^2}{12}$

$\longleftrightarrow$ 
$I_y \neq \frac{ma^2}{12}$

because the other leyers are not symmetrical with respect to y-axis.

क्योंकि अन्य परते y-अक्ष के सापेक्ष सममित नहीं है।

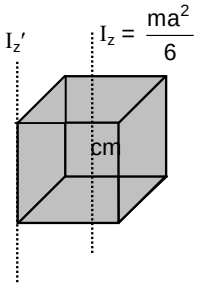
(C)




Because all the layers are symmetrical with respect to z-axis.

क्योंकि अन्य परते z-अक्ष के सापेक्ष सममित है।

(D)




Using parallel axis theorem समान्तर अक्ष की प्रमेय से

$$I_z' = I_z + m\left(\frac{a}{\sqrt{2}}\right)^2 = \frac{ma^2}{6} + \frac{ma^2}{2} = \frac{2ma^2}{3}$$

So $I_{AB}$ will also be $\frac{2ma^2}{3}$

अतः $I_{AB} = \frac{2ma^2}{3}$ होगा

**26.** At steady-state

Power supplied by battery = Power dissipated as heat to surroundings.

साम्यावस्था पर

बैटरी द्वारा प्रदान की गई शक्ति = वातावरण में उत्सर्जित शक्ति

$V(i_{ss}) = 45\ (T_{ss} - 20°)$

$(500)\ (4.5) = 45\ (T_{ss} - 20°)$

$\Rightarrow \quad T_{ss} = 70°C$

**27.** $R_{ss} = R_{20}\ (1 + \alpha \Delta T)$

$\Rightarrow R_{70} = R_{20}\ (1 + \alpha\,(50))$

$R_{70°} = \frac{500}{4.5} = 111\ \Omega$

and $R_{20°} = \frac{500}{5} = 100\ \Omega$

$111 = 100\ (1 + \alpha\ (50))$

$\alpha = 2.2 \times 10^{-3}$ /°C

**28.** 01.73

**29.** Potential at point P = 0

$$\frac{k(-Q)}{\sqrt{h^2 + k^2}} + \frac{kQ}{\sqrt{3}\sqrt{(h-2)^2 + k^2}} = 0$$

$$\frac{1}{h^2 + k^2} = \frac{1}{3[(h-2)^2 + k^2]}$$

$3[h^2 + 4 - 4h + k^2] = h^2 + k^2$

$2h^2 + 2k^2 - 12h + 12 = 0 \Rightarrow h^2 + k^2 - 6h + 6 = 0$

Equation of equipotential circle.

$X^2 + y^2 - 6x + 6 = 0$

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

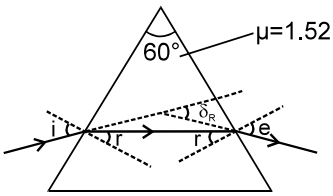
$(x - 3)^2 + (y - 0)^2 + 6 - 9 = 0$

$(x - 3)^2 + (y - 0)^2 = 3$

Centre = 3, 0

Radius = $\sqrt{3}$

**30.**




$\mu_R = 1.52$

$\mu_v = 1.6$

Minimum deviation condition for red is

r = 30°

लाल रंग के लिये न्यूनतम विचलन की अवस्था में r = 30°

$\Rightarrow \quad$ (1) sin i = (1.52) sin30°

i = 50º, $\quad \delta_R = (50º)\ 2 - 60° \quad = 40°$

**31.** For violet light

(1) sin 50° = (1.6) sin r

$\therefore \quad r = 28.4°$

$r' = 31.6° \quad (\because\ r + r' = A)$

(1) sin e = (1.6) sin 31.6°

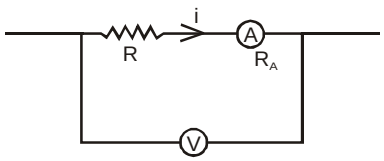
$\therefore \quad e = 56°,$

$\Rightarrow \quad \delta_v = i + e - A = 50º + 56° - 60°$

$= 46°$

$\therefore \quad$ angular width = $\delta_v - \delta_R \quad = 6°$

**32.**




Reading of Ammeter अमीटर का पाठ्यांक = i

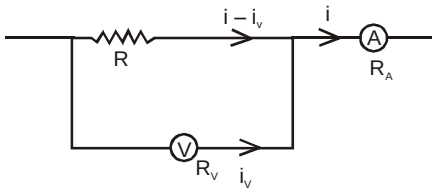
Reading of voltmeter वोल्टमीटर पाठ्यांक = P.d. across voltmeter वोल्टमीटर पर विभव पतन

= P.d. across $(R + R_A)$ system = $i (R + R_A)$

= निकाय $(R + R_A)$ पर विभव पतन = $i (R + R_A)$

$\Rightarrow$ Measured resistance

मापित प्रतिरोध $= \frac{V}{i} = \frac{i(R+R_A)}{i} = R + R_A$




- Reading of Ammeter अमीटर पाठ्यांक = i

and व $i_v R_V = (i - i_v) R \Rightarrow i_V = \frac{i\ R}{R + R_v}$

- Reading of Voltmeter
वोल्टमीटर पाठ्यांक

$V = i R_{eq} = i \times \frac{RR_v}{(R + R_v)}$

measured resistance मापित प्रतिरोध

$= \frac{v}{i} = \frac{iRR_v/(R+R_v)}{i} = \frac{RR_v}{R+R_v}$

**33.** If R is very large (~ K Ω)
यदि R अत्यधिक है (~ K Ω)

Then measured resistance from arrangement (a) will be
तो विन्यास (a) से मापित प्रतिरोध होगा।

$R_{measured} = R + R_A \approx R$

So (a) will be preferred अतः (a) ज्यादा उपयुक्त होगा

If R is very small (~ few Ohm) यदि R अत्यल्प है (~ कुछ ओम)

then measured resistance from (b) will be
तो विन्यास (b) से मापित प्रतिरोध होगा।

$R_{measured}$ = where जहां $R/R_v$ is negligible नगण्य है।

so, $R_{measured}$ R

So (b) will be preferred अतः (b) ज्यादा उपयुक्त है।

**34.** If we increase the temperature by $\Delta T$,
यदि हम तापमान $\Delta T$ से बढ़ाते है

Compressive force generated is $F = YA \alpha \Delta T$
उत्पन्न सम्पीड़न बल है $F = YA \alpha \Delta T$

For buckling $F = YA \alpha \Delta T \geq$ critical load of buckling
मुड़ने के लिए $F = YA \alpha \Delta T \geq$ मुड़ने का क्रान्तिक भार

$(Y) (\pi r^2) \alpha \Delta T \geq \frac{\pi^3 Y r^4}{L^2}$

$\Rightarrow \quad \Delta T \geq . \frac{\pi^2 r^2}{\alpha L^2}$

**35.** $\left(\frac{2mg\ell^2}{3\pi^3 Y}\right)^{1/4}$

**36.** $E < 10^6 \quad \Rightarrow \quad \frac{10^3}{d} < 10^6$

$d > 10^{-3}\ m^2 \quad \Rightarrow \quad C = \frac{k\varepsilon_0 A}{d}$

$d = \frac{k\varepsilon_0 A}{C} > 10^{-3}$

$A > \frac{10^{-3} \times C}{k\varepsilon_0}$

$\Rightarrow A > \frac{10^{-3} \times 50 \times 10^{-12}}{(6\pi) \times \left(\frac{1}{36\pi} \times 10^{-9}\right)} = 300\ mm^2$

---

## PART-III: CHEMISTRY

**39.** Surface area $= 4a^2 = 16$, $a = 2Å = 2R$

**हल.** पृष्ठीय क्षेत्रफल $= 4a^2 = 16$, $a = 2Å = 2R$

**40.** $P_S = X_A P_A^\circ + X_B P_B^\circ$

$Y_B P_T = X_B P_B^\circ$

$P_S$ = 450 mm of Hg.

$Y_B$ = 1/3

If vapours are removed and condensed then again redistilled :

$$Y_A \to X'_A = \frac{2}{3}, \quad Y_B \to X'_B = \frac{1}{3},$$

$$P'_s = \frac{1400}{3} \text{mm of Hg}$$

So, $Y'_A P'_s = X'_A P^\circ_A$ $\quad$ $Y'_A$ = 4/7

Since at 300 K, $P_S$ = 450 mm of Hg < $P_{atm}$ = 760 mm of Hg

**हल.** $P_S = X_A P^\circ_A + X_B P^\circ_B$ $\quad$ $P_S$ = 450 mm Hg.

$Y_B P_T = X_B P^\circ_B$ $\quad$ $Y_B$ = 1/3

यदि वाष्पों को हटाया जाता है व संघनित किया जाता है तथा फिर पुनः आसवित किया जाता है–

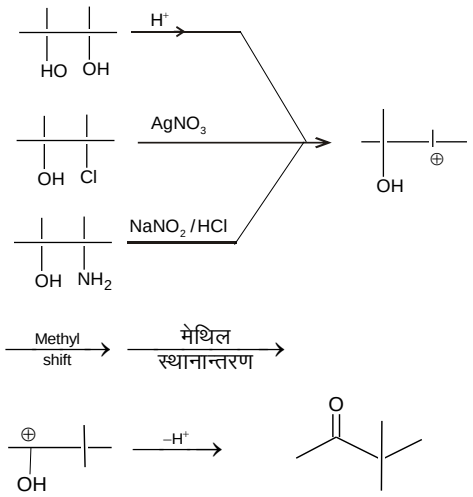
$$Y_A \to X'_A = \frac{2}{3}, \quad Y_B \to X'_B = \frac{1}{3}$$

$$P'_s = \frac{1400}{3} \text{ mm Hg.}$$

So, $Y'_A P'_s = X'_A P^\circ_A$ $\quad$ $Y'_A$ = 4/7

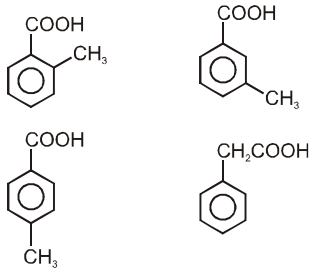
क्योंकि 300 K पर, $P_S$ = 450 mm Hg < $P_{atm}$ = 760 mm Hg

**43.**

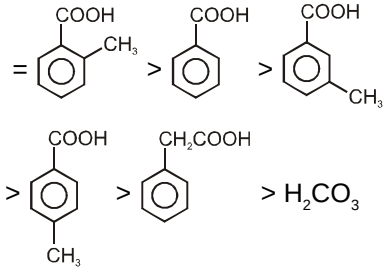



**44.** M.F. = $C_8H_8O_2$

Isomers (समावयवी) =




Acid strength order (अम्लीय सार्म्थय का क्रम)







$> H_2CO_3$

**45.** $Al_2O_3 + 3C \longrightarrow$

$3CO + 2Al$ $\quad$ $\Delta G^\circ_R$ = ?

$$\frac{4}{3}Al + O_2 \longrightarrow \frac{2}{3}Al_2O_3$$

$\Delta G^\circ$ = –910

$2C + O_2 \longrightarrow 2CO$

$\Delta G^\circ$ = –430

$$\Delta G^\circ_R = \frac{3}{2}(-430) - \frac{3}{2}(-910) = 720 \text{ kJ}$$

**46.** The temperature at where $\Delta G^\circ$ is more –ve, there will more affinity for oxygen.

वह ताप जहाँ पर, $\Delta G^\circ$ का मान अधिक ऋणात्मक होगा, वहाँ ऑक्सीजन के प्रति अधिक बंधुता होगी।

**47.** Lowering in vapur pressure = mole fraction of solute

वाष्पदाब में अवनमन = विलेय का मोल प्रभाज

$$\frac{P^0_A - P_s}{P^0_A} = \frac{3S}{3S + 55.56}$$

for $MCl_2$ the solubility is as

$$MCl_2 \rightleftharpoons \underset{S}{M^{+2}} + \underset{2S}{2Cl^-}$$

$MCl_2$ के लिए विलेयता

Since the solution is very dilute

$3S + 55.56 \approx 55.56$

चूंकि विलयन अत्यंत तनु है।

$3S + 55.56 \approx 55.56$

$$\frac{31.82 - 31.78}{31.82} = \frac{3S}{55.56}$$

$$\therefore \quad S = 2.328 \times 10^{-2}$$

Thus, the $K_{sp} = S \times (2S)^2$

इस प्रकार, $K_{sp} = S \times (2S)^2$

$$= \left(2.33 \times 10^{-2}\right)\left(2 \times 2.33 \times 10^{-2}\right)^2$$

$$= 5.1 \times 10^{-5}$$

**48.** Since 1000g of 3 molal aqueous solution of Urea will start freezing at (–5.58°C)

यद्यपि, 3 मोल, यूरीया का 1000g जलीय विलयन, निम्न ताप पर जमना प्रारम्भ करता है (–5.58°C)

$\Delta T_f = 1.86 \times 3$

= 5.58ºC

**51.** The big difference between these two reactions is that of entropy change. The first reaction has a $\Delta S°$ value close to zero, because their is the same number of molecules on both sides of the equation. The second one has a positive $\Delta S°$ because four molecules come together but seven molecules are produced. This helps to make reaction 2 more favourable.

**हल.** इन दो अभिक्रियाओं के मध्य बड़ा अन्तर एन्ट्रॉपी परिवर्तन का है। प्रथम अभिक्रिया शून्य के निकट $\Delta S°$ मान रखती है, क्योंकि यहाँ समीकरण की दोनो दिशाओं पर अणुओं की समान संख्या है। द्वितीय अभिक्रिया धनात्मक $\Delta S°$ मान रखती है क्योंकि चार अणु एक साथ आते है लेकिन सात अणु उत्पादित होते हैं। यह अभिक्रिया 2 को अधिक अनुकूल बनाने में सहायता करता है।

**52.** (B) $edta^{-4}$

**53.** pKa of phenol = 9.98

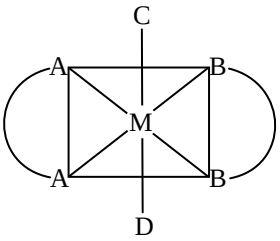
pKa of catechol = 9.48

फिनॉल का pKa = 9.98

कैटेकॉल का pKa = 9.48

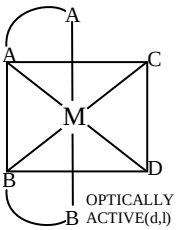
**54.** (A) 2

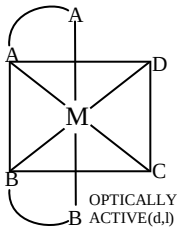
**55.** It is [M(AA)(BB)CD] type of complex, here C,D are monodentate ligands.




Plane of symmetry and

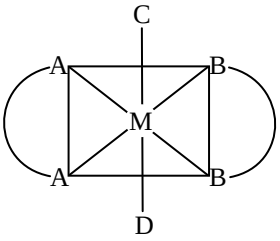
thus no chiral pair



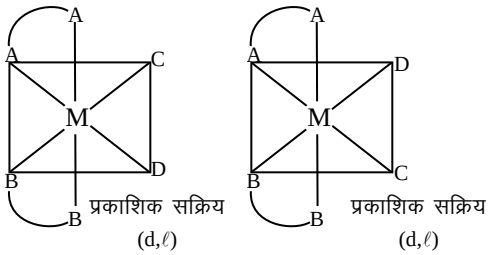

Possible geometric isomers = 3

**हलः** यह [M(AA)(BB)CD] प्रकार का संकुल है, यहाँ C व D एकल दन्तुक लिगेण्ड है।



सममितता का तल तथा इसलिए किरैल युग्म

अनुपस्थित




सम्भव ज्यामिति समावयवी = 3

**56.** (i) $H_2(g)$ at $2T_C$ $(2T_C < T_B) \Rightarrow$ (III)

(ii) $CH_4(g)$ at $4T_C$ $(4T_C > T_B) \Rightarrow$ (I)

(iii) $CO_2(g)$ at room temperature $\Rightarrow$ (III)

(iv) He(g) at room temperature $\Rightarrow$ (I)

(v) $N_2(g)$ at $\frac{1}{2} T_B \Rightarrow$ (III)

(vi) $C_2H_6(g)$ at $\frac{27}{8} T_C$ $(\frac{27}{8} T_C = T_B) \Rightarrow$ (II)

a = 2 b = 1 c = 3

$$\frac{3a+2b+4c}{10} = \frac{6+2+12}{10} = 2$$

**हल:** (i) $2T_C$ $(2T_C < T_B)$ पर $H_2(g) \Rightarrow$ (III)

(ii) $4T_C$ $(4T_C > T_B)$ पर $CH_4(g) \Rightarrow$ (I)

(iii) कमरे के ताप पर $CO_2(g) \Rightarrow$ (III)

(iv) कमरे के ताप पर He(g) $\Rightarrow$ (I)

(v) $\frac{1}{2}$ $T_B$ पर $N_2(g) \Rightarrow$ (III)

(vi) $\frac{27}{8} T_C$ $(\frac{27}{8} T_C = T_B)$ पर $C_2H_6(g) \Rightarrow$ (II)

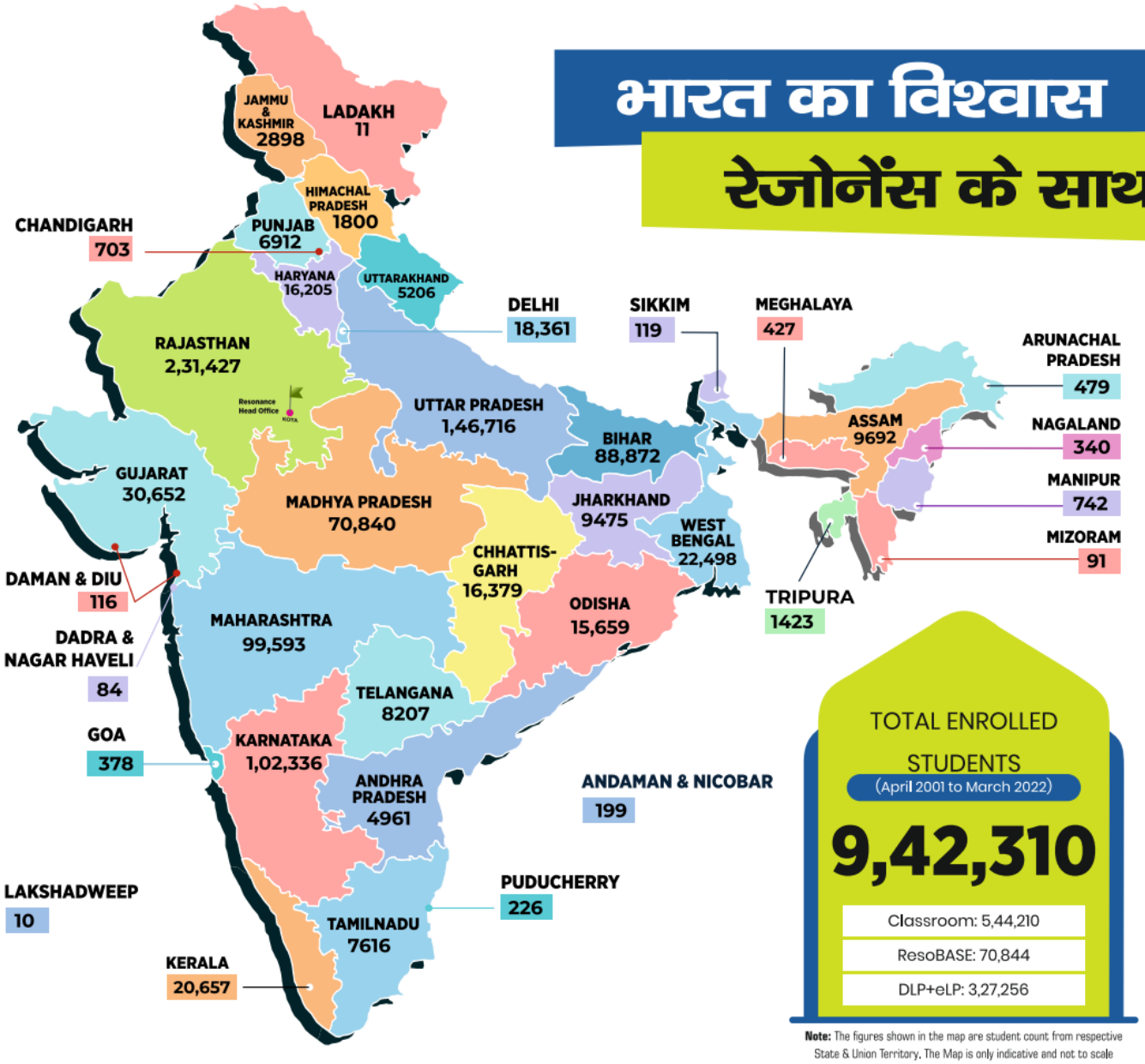
a = 2 b = 1 c = 3

$$\frac{3a+2b+4c}{10} = \frac{6+2+12}{10} = 2$$

**---- TEXT SOLUTIONS (TS) END ----**

Resonance®
Educating for better tomorrow

# भारत का विश्वास
# रेजोनेंस के साथ




TOTAL ENROLLED STUDENTS
(April 2001 to March 2022)

**9,42,310**

- Classroom: 5,44,210
- ResoBASE: 70,844
- DLP+eLP: 3,27,256

**Note:** The figures shown in the map are student count from respective State & Union Territory. The Map is only indicative and not to scale

## Resonance : The Legacy of 21 Years (2001-2022) of Academic Excellence

- **JEE (Adv.) / IIT-JEE** ▸ **50 हजार +** SELECTIONS SINCE 2002
  229 AIRs in TOP-100 (Classroom + DLP)
- **JEE (Main) / AIEEE** ▸ **2.40 लाख+** SELECTIONS SINCE 2009
  136 AIRs in TOP-100 (Classroom + DLP)
- **NEET (UG) / AIPMT** ▸ **19 हजार+** SELECTIONS SINCE 2012
  19 AIRs in TOP-100 (Classroom + DLP)

- **NTSE** SINCE 2006 ▸ **2440** Scholars
- **KVPY** SINCE 2006 ▸ **2859** Fellowship Winners
- **OLYMPIADS** SINCE 2006 ▸ **52** Medalists (Gold/Silver/ Bronze) in International Olympiads
- **CA & CS** SINCE 2013 ▸ **4179** Selections — 5 Times AIR-1 in CA & CS Exams
- **CLAT, SET & GPTU** SINCE 2014 ▸ **77** Selections — AIR-1 in GPTU