

PERIODIC ASSESSMENT TEST (PAT)

STUDENT SUPPORT BOOKLET (SSB)

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

CLASS	XI	COURSE NAME	VIKAAS	COURSE CODE	JA
PHASE CODE(S)	01JA,01JAZA, 02JA,IA,03JA	TOTAL PAGES	1	BATCH CODE(S)	01JA,01JAZA, 02JA,IA,03JA

Target Examination & Year:

JEE (MAIN + ADVANCED) 2025

TEST PATTERN	TEST TYPE	TEST CODE & SEQUENCE
JEE (MAIN)	CUMULATIVE TEST (CT)	MCT 04



DATE & DAY:

14th January 2024 | Sunday



Duration & Time:

3 Hrs | 11:30 AM to 02:30 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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PAT : TOPIC-WISE WEIGHTAGE SHEET (WS)

	P-1	Total		P-1	Total
Total Qs	90	90	Subject wise Qs.	30	30
Max. Marks	300	300	Subject wise Marks	100	100

PHYSICS

PHYSICS								
S.No.	Topic Name	Question Type & Sequencing				Total Qs. (Topic-wise)	Total Marks (Topic-wise)	% Weightage (Topic-wise)
		MCQ		NVQ				
		No. of Qs.	Qs. Sequencing	No. of Qs.	Qs. Sequencing			
	Class-11	20		10		30	120	100.00%
1	System of Particles, Centre of Mass, Momentum and Collision	2	1,15	1	22	3	12	10.00%
2	Rotation (Rigid Body Dynamics)	6	2,3,7,12,13,14	2	24,30	8	32	26.67%
3	Fluid	4	4,8,9,17	–	–	4	16	13.33%
4	Simple Harmonic Motion	3	5,11,18	2	27,29	5	20	16.67%
5	Rectilinear Motion	1	6	–	–	1	4	3.33%
6	Friction	1	10	–	–	1	4	3.33%
7	Newton’s laws of Motion	1	16	–	–	1	4	3.33%
8	Work, Power & Energy	2	19,20	2	26,28	4	16	13.33%
9	Circular Motion	–	–	3	21,23,25	3	12	10.00%
	Total	20		10		30	120	100%

PAT : TOPIC-WISE WEIGHTAGE SHEET (WS)

CHEMISTRY								
S.No.	Topic Name	Question Type & Sequencing				Total Qs. (Topic-wise)	Total Marks (Topic-wise)	% Weightage (Topic-wise)
		MCQ		NVQ				
		No. of Qs.	Qs. Sequencing	No. of Qs.	Qs. Sequencing			
Physical Chemistry								
	Class-11	10		5		15	60	50.00%
1	Atomic Structure	1	31	1	54	2	8	6.67%
2	Mole concept	3	32,37,40	–	–	3	12	10.00%
3	Thermodynamics	2	33,39	2	53,55	4	16	13.33%
4	Ionic Equilibrium	1	34	–	–	1	4	3.33%
5	Chemical Equilibrium	3	35,36,38	1	51	4	16	13.33%
6	Thermochemistry	–	–	1	52	1	4	3.33%
Organic Chemistry								
	Class-11	4		3		7	28	23.33%
7	GOC-I (Electronic Effect)	4	41,43,48,49	3	56,57,58	7	28	23.33%
Inorganic Chemistry								
	Class-11	6		2		8	32	26.67%
8	Chemical Bonding	6	42,44,45,46,47,50	2	59,60	8	32	26.67%
	Total	20		10		30	120	100%

PAT : TOPIC-WISE WEIGHTAGE SHEET (WS)

MATHEMATICS								
S.No.	Topic Name	Question Type & Sequencing				Total Qs. (Topic-wise)	Total Marks (Topic-wise)	% Weightage (Topic-wise)
		MCQ		NVQ				
		No. of Qs.	Qs. Sequencing	No. of Qs.	Qs. Sequencing			
	Class-11	20		10		30	120	100.00%
1	Trigonometry	3	61,65,66	1	89	4	16	13.33%
2	Binomial Theorem	2	62,63	3	82,83,90	5	20	16.67%
3	Circle	3	64,75,77	—	—	3	12	10.00%
4	Basics	2	67,68	2	85,86	4	16	13.33%
5	Quadratic Equation	2	69,70	1	84	3	12	10.00%
6	Permutation and Combination	3	71,72,73	1	81	4	16	13.33%
7	Solution of Triangle	1	74	—	—	1	4	3.33%
8	Mathematical Reasoning	1	76	—	—	1	4	3.33%
9	Straight Line	3	78,79,80	2	87,88	5	20	16.67%
	Total	20		10		30	120	100%

ANSWER KEY (AK)

PAPER											
PART-A: PHYSICS	Q.No.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	1	1	2	4	3	1	2	2	3
	Q.No.	11	12	13	14	15	16	17	18	19	20
	Ans.	2	1	2	2	3	2	3	2	1	1
	Q.No.	21	22	23	24	25	26	27	28	29	30
	Ans.	0010	0003	0006	0011	0005	0021	0010	0096	0002	0018
PART-B: CHEMISTRY	Q.No.	31	32	33	34	35	36	37	38	39	40
	Ans.	2	3	2	3	2	3	2	3	3	2
	Q.No.	41	42	43	44	45	46	47	48	49	50
	Ans.	2	4	3	2	2	3	1	3	3	3
	Q.No.	51	52	53	54	55	56	57	58	59	60
	Ans.	0003	0007	0006	0004	0004	0008	0007	0010	0005	0007
PART-C: MATHS	Q.No.	61	62	63	64	65	66	67	68	69	70
	Ans.	1	2	1	3	4	1	4	3	1	2
	Q.No.	71	72	73	74	75	76	77	78	79	80
	Ans.	2	2	2	1	1	2	1	2	2	3
	Q.No.	81	82	83	84	85	86	87	88	89	90
	Ans.	0066	0005	0040	0011	0004	0011	0020	0005	0008	0000

STUDENT'S SPACE

TEXT SOLUTIONS (TS)

PAPER

PART-A: PHYSICS

1. Velocity of particle after 5 s

$$v = u - gt$$

$$v = 100 - 10 \times 5$$

$$= 100 - 50 = 50 \text{ m/s} \quad (\text{upwards})$$

Conservation of linear momentum gives

$$Mv = m_1v_1 + m_2v_2 \quad \dots\dots(i)$$

Taking upward direction positive, the velocity v_1 will be negative.

$$\therefore v_1 = -25 \text{ m/s}, v = 50 \text{ m/s}$$

$$\text{Also } M = 1 \text{ kg}, m_1 = 400 \text{ g} = 0.4 \text{ kg}$$

$$\text{and } m_2 = (M - m_1) = 1 - 0.4 = 0.6 \text{ kg}$$

Thus, Eq. (i) becomes,

$$1 - 50 = 0.4 \times (-25) + 0.6 v_2$$

$$\text{or } 50 = -10 + 0.65 v_2$$

$$\text{or } 0.6 v_2 = 60$$

$$\text{or } v_2 = \frac{60}{0.6} = 100 \text{ m/s}$$

As v_2 is positive, therefore the other part will move upwards with a velocity 100 m/s.

- हल. 5 सेकण्ड बाद कण का वेग,

$$v = u - gt$$

$$v = 100 - 10 \times 5$$

$$= 100 - 50 = 50 \text{ मी/से} \quad (\text{ऊपर की ओर})$$

संवेग संरक्षण के सिद्धान्त से

$$Mv = m_1v_1 + m_2v_2 \quad \dots\dots(i)$$

ऊपर की दिशा धनात्मक लेने पर, वेग v_1 ऋणात्मक

होगा

$$\therefore v_1 = -25 \text{ मी/से}, v = 50 \text{ m/s मी/से}$$

$$\text{तथा } m = 1 \text{ kg}, m_1 = 400 \text{ g} = 0.4 \text{ kg}$$

$$m_2 = (m - m_1) = 1 - 0.4 = 0.6 \text{ kg}$$

समी. (i) से

$$1 \times 50 = 0.4 \times (-25) + 0.6 v_2$$

$$\text{or } 50 = -10 + 0.65 v_2$$

$$\text{or } 0.6 v_2 = 60$$

$$\text{or } v_2 = \frac{60}{0.6} = 100 \text{ मी/से}$$

2. Torque equation

बलाघूर्ण समीकरण

$$\tau_{\text{Hinge}} = I_{\text{Hinge}} \propto$$

$$mg \ell = \left(\frac{m(4\ell)^2}{12} + m\ell^2 \right) \propto$$

$$\frac{3g}{7\ell} = \propto$$

$$\text{Tangential acceleration} = \propto \ell = \frac{3g}{7\ell}$$

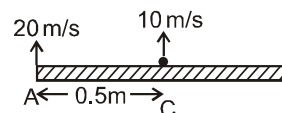
$$\text{स्पर्श रेखीय त्वरण} = \propto \ell = \frac{3g}{7\ell}$$

$$\text{Radial acceleration} = \omega^2 \ell = 0$$

$$\text{त्रिज्यीय त्वरण} = \omega^2 \ell = 0$$

$$\text{Ans. } \frac{3g}{7}$$

3. Angular velocity (कोणीय वेग) $w = \frac{20-10}{0.5} = 20 \text{ rad/sec.}$



4. $F_H = P_{\text{ave}} \times \text{vertical projected area of gate}$

द्वार के क्षेत्रफल का ऊर्ध्वाधर घटक

$$= \frac{P_A + P_B}{2} (2R \times 3R) = \left(\frac{\rho g R + \rho g 3R}{2} \right) 6R^2$$

$$= 12\rho g R^3$$

5. C.O.L.M.

रेखीय संवेग संरक्षण से (C.O.L.M.)

$$MV_{\text{max}} = (m + M)V_{\text{new}}, \quad V_{\text{max}} = A_1\omega_1$$

$$V_{\text{new}} = \frac{MV_{\text{max}}}{(m + M)}$$

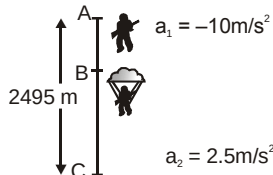
$$\text{अब, } V_{\text{new}} = A_2\omega_2$$

$$\frac{M.A_1}{(m + M)} \sqrt{\frac{K}{M}} = A_2 \sqrt{\frac{K}{(m + M)}}$$

$$A_2 = A_1 \sqrt{\frac{M}{(m+M)}}$$

$$\frac{A_1}{A_2} = \left(\frac{m+M}{M} \right)^{1/2}$$

6. Suppose the man drops at A, from A to B he is falling freely & than at B parachute opens out & he falls with a retardation of 2.5 m/s^2 .



$$\therefore AB = \frac{1}{2} \times 10 \times 10^2 = 500 \text{ m}$$

$$\therefore BC = AC - AB = 2495 - 500 = 1995 \text{ m.}$$

Velocity at B,

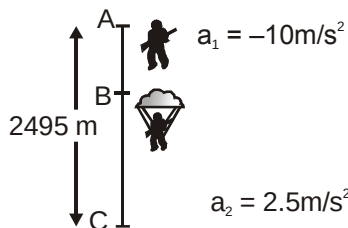
$$V_B = gt = 10 \times 10 = 100 \text{ m/s} \downarrow$$

Velocity at C,

$$V_C = \sqrt{V_B^2 + 2ay}$$

$$= \sqrt{100^2 + 2 \times 2.5 \times (-1995)} = \sqrt{25} = 5 \text{ m/s} \downarrow.$$

- हल. माना कि व्यक्ति A पर कूद जाता है तथा गुरुत्व के अधीन स्वतन्त्र रूप से गिर रहा है। जब यह B पर पहुँच जाता है तब पाराशूट खुलता है तथा 2.5 m/s^2 का मन्दन उत्पन्न होता है।



$$\therefore AB = \frac{1}{2} \times 10 \times 10^2 = 500 \text{ m}$$

$$\therefore BC = AC - AB = 2495 - 500 = 1995 \text{ m.}$$

B पर वेग,

$$V_B = gt = 10 \times 10 = 100 \text{ m/s} \downarrow$$

C पर वेग,

$$V_C = \sqrt{V_B^2 + 2ay} = \sqrt{100^2 + 2 \times 2.5 \times (-1995)} = \sqrt{25} = 5 \text{ m/s} \downarrow.$$

7. $\frac{\alpha^2}{2\beta}$

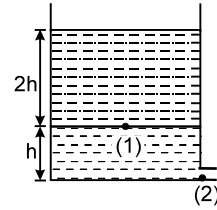
8. Pressure at (1) :

(1) पर दाब

$$P_1 = P_{\text{atm}} + \rho g (2h)$$

Applying Bernoulli's theorem between points (1) and (2)

बिन्दुओं (1) व (2) के मध्य बरनोली प्रमेय आरोपित करने पर



$$[P_{\text{atm}} + 2\rho g h] + \rho g (2h) + \frac{1}{2} (2\rho) (0)^2$$

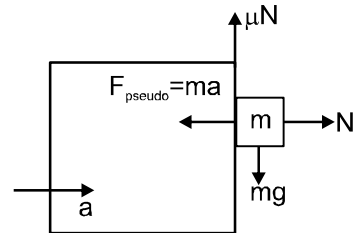
$$= P_{\text{atm}} + (2\rho) g (0) + \frac{1}{2} (2\rho) v^2$$

$$\Rightarrow v = 2\sqrt{gh} \quad \text{Ans.}$$

9. $P_0 + \frac{\rho w^2 r^2}{2} - \rho gh = P_0$

$$h = \frac{w^2 r^2}{2g}$$

- 10.



Solving from the frame of cart, we get

गाड़ी के निर्देश तंत्र से हल करने पर हमें प्राप्त होता है

$$N = ma, mg = \mu N$$

$$\Rightarrow mg = \mu ma \quad \Rightarrow a = \frac{g}{\mu}$$

11. $T = 2\pi \sqrt{m \left[\frac{4}{K} + \frac{4}{K} + \frac{4}{K} \right]} = 4\pi \sqrt{\frac{3M}{K}} \text{ s}$

12. $I_1\omega_1 = I_2\omega_2$

Since, men move towards middle of turn table I decreases hence ω_2 increases.

चूँकि, व्यक्ति केन्द्र की ओर गति करते हैं इसलिए I घटेगा फलस्वरूप ω_2 बढ़ेगा।

$$\therefore KE = \frac{L^2}{2I} ; L = \text{constant and } I$$

decreases so KE increases

अतः गतिज ऊर्जा बढ़ेगी।

13. Applying angular momentum conservation about the rotating axis

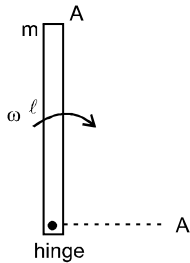
घूर्णन अक्ष के परितः कोणीय संवेग संरक्षण से

$$L_i = L_f$$

$$0 + mvR = \left(\frac{mR^2}{2} + mR^2 \right) \omega_f$$

$$\omega = \frac{2V}{3R}$$

14.



using energy conservation ऊर्जा संरक्षण से

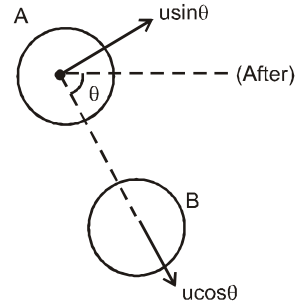
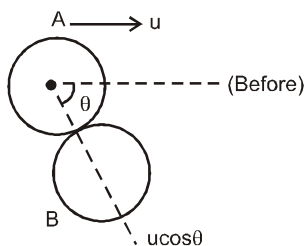
$$mg \frac{\ell}{2} = \frac{1}{2} I \omega^2$$

$$mg \frac{\ell}{2} = \frac{1}{2} \cdot \frac{m\ell^2}{3} \omega^2$$

$$\ell = 1\text{m} \quad \omega = \sqrt{\frac{3g}{\ell}}$$

$$V_A = \omega\ell = \sqrt{3g} = (\sqrt{3g})$$

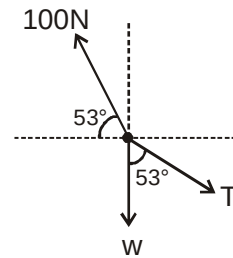
15.



$$v_B = u \cos \theta$$

$$v_A = u \sin \theta$$

16.

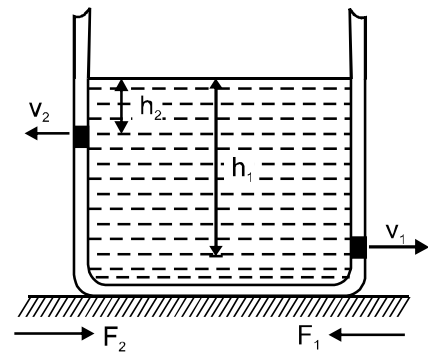


$$T \sin 53^\circ - 100 \cos 53^\circ = 0 \Rightarrow T = 75 \text{ N}$$

$$\text{Also तथा, } 100 \sin 53^\circ - T \cos 53^\circ - W = 0$$

$$\Rightarrow W = 35 \text{ N}$$

17.



$$\text{Thrust force क्षैतिज बल } F = F_1 - F_2$$

$$= \rho a v_1^2 - \rho a v_2^2$$

$$= \rho a (2gh_1) - \rho a (2gh_2)$$

$$= 2\rho a g (h_1 - h_2) = 2\rho a g h$$

18.

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{mg\ell}{I}}$$

where, ℓ is distance between point of suspension and centre of mass of the body.

Thus, for the stick of length L and mass m :

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{m \cdot g \cdot \frac{L}{2}}{(mL^2/3)}} = \frac{1}{2\pi} \sqrt{\frac{3g}{2L}}$$

when bottom half of the stick is cut of

$$f_0' = \frac{1}{2\pi} \sqrt{\frac{\frac{m}{2} \cdot g \cdot \frac{L}{4}}{\frac{m(L/2)^2}{3}}} = \frac{1}{2\pi} \times \sqrt{\frac{3g}{L}} = \sqrt{2}$$

f_0 **Ans.**

हल. $f_0 = \frac{1}{2\pi} \sqrt{\frac{mg\ell}{I}}$

यहाँ, ℓ निलम्बन बिन्दु व वस्तु के द्रव्यमान केन्द्र के बीच की दूरी है।

अतः द्रव्यमान m तथा L लम्बाई की छड़ के लिए

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{m \cdot g \cdot \frac{L}{2}}{(mL^2/3)}} = \frac{1}{2\pi} \sqrt{\frac{3g}{2L}}$$

जब छड़ को आधा काट लें तो

$$f_0' = \frac{1}{2\pi} \sqrt{\frac{\frac{m}{2} \cdot g \cdot \frac{L}{4}}{\frac{m(L/2)^2}{3}}} = \frac{1}{2\pi} \times \sqrt{\frac{3g}{L}} = \sqrt{2}$$

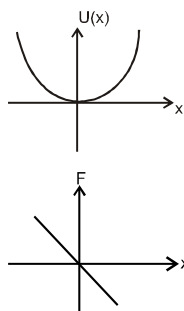
f_0 **Ans**

19. By work energy theorem

$$W_{\text{all}} = \Delta K$$

20. $F = -\frac{dU}{dx}$

$$\therefore U(x) = kx^2$$



$$F = -2kx$$

21. The horizontal force N by the wall on the man provides the needed centripetal force : $N = m R \omega^2$. The frictional force f (vertically upwards) opposes the weight mg . The man remains stuck to the wall after the floor is removed if $mg = f < \mu N$ i.e. $mg < \mu m R \omega^2$. The minimum angular speed of rotation of the cylinder is $\omega_{\min} = \sqrt{g/\mu R} = 10 \text{ s}^{-1}$.

व्यक्ति पर दीवार द्वारा लगाया गया क्षैतिज बल N आवश्यक अभिकेन्द्रीय बल प्रदान करता है: $N = m R \omega^2$ है। भार mg के विपरीत घर्षणबल f (ऊर्ध्वाधर ऊपर की ओर है। फर्श के हटाने के बाद भी बिना गिरे दीवार से चिपका रह सकता है यदि $mg = f < \mu N$ अर्थात् $mg < \mu m R \omega^2$ है। बेलन के घूमने की न्यूनतम कोणीय चाल

$$\omega_{\min} = \sqrt{g/\mu R} = 10 \text{ s}^{-1} \text{ है।}$$

22. Solve in the reference frame fixed to the wall. Before collision, velocity of ball = $3v$ towards it.

$\therefore$ After elastic collision of ball = $3v$ away from it (here we have used the result that a light mass is reversed by a heavy body at rest).

$$\text{Time of flight} = \sqrt{\frac{2h}{g}}$$

$\therefore$ Distance between wall and ball

$$= 3v \cdot \sqrt{\frac{2h}{g}}$$

हल. यहाँ हम दीवार के निर्देश तंत्र के सापेक्ष इसे हल करेंगे।

टक्कर के पहले, बॉल का वेग, = $3v$ पास आने वाला

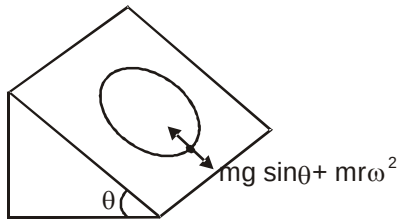
$\therefore$ प्रत्यास्थ टक्कर के बाद, बॉल का वेग = $3v$ दूर जाने वाला (स्थिर भारी वस्तु से टकराने के बाद बॉल का वेग पलट जाता है।)

$$\text{जमीन पर गिरने में लगा समय} = \sqrt{\frac{2h}{g}}$$

$\therefore$ गिरते वक्त दीवार और बॉल के बीच दूरी

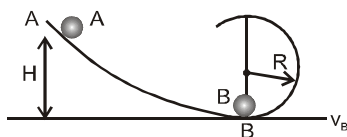
$$= 3v \cdot \sqrt{\frac{2h}{g}}$$

23. $f \geq mg \sin \theta + mr\omega^2$
 $\mu mg \cos \theta \geq mg \sin \theta + mr\omega^2$
 or या $\mu \geq \tan \theta + \frac{\omega^2 r}{g \cos \theta}$



24. For A : $5m(r\alpha) = 5mg \sin 37^\circ - T_1$
 $5mr\alpha = 3mg - T_1$ (i)
 For B : $m2r\alpha = T_2 - mg$ (ii)
 For pulley,
 $I\alpha = T_1r - T_22r$
 $I\alpha = (3mg - 5mr\alpha)r - (mg + mg 2r\alpha)2r$
 $I\alpha = 3mgr - 5mr^2\alpha - 2mgr - 4mr^2\alpha$
 $I\alpha = mgr - 9mr^2\alpha$
 $(I + 9mr^2)\alpha = mgr$
 $\alpha = \frac{mgr}{I + 9mr^2} = \frac{mgr}{11mr^2}$
 $\alpha = \frac{g}{11r}$

25.



For the just completing the circular motion,
 minimum velocity at bottom in

$$v_B = \sqrt{5gR}$$

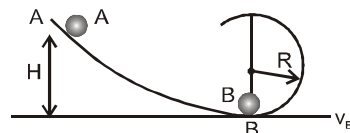
Energy conservation b/w point A and B

$$MgH + 0 = 0 + \frac{1}{2}mv_B^2$$

$$MgH = \frac{1}{2}m(5gR)$$

$$H = \frac{5R}{2}$$

हल



वृत्तीय गति को पूरा करने के लिये तल पर न्यूनतम वेग

$$v_B = \sqrt{5gR}$$

बिन्दु A तथा B के मध्य ऊर्जा संरक्षण से

$$MgH + 0 = 0 + \frac{1}{2}mv_B^2$$

$$MgH = \frac{1}{2}m(5gR)$$

$$H = \frac{5R}{2}$$

26. work done किया गया कार्य $= \int_0^2 f \cdot dx$

27. $\frac{d^2x}{dt^2} = \frac{x}{100}$ (i)

We know हम जानते है कि

$$a = \frac{d^2x}{dt^2} = -\omega^2x$$
 (ii)

From Eq. (i) and (ii), we have

समीकरण (i) व (ii) से,

$$\omega^2 = \frac{1}{100}$$

$$\omega = \frac{1}{10}$$

or या $\frac{2\pi}{T} = \frac{1}{10}$

$$\therefore T = 20\pi = 62.8$$

28. $ma \cdot 252 = \frac{1}{2}m(36-9)$

where $a = \frac{2 \times 252}{t^2}$

$$\therefore t = 96 \text{ s}$$

29. $\omega^2 A = 50$

$$5^2 A = 50$$

$$25 \times A = 50$$

$$A = 2 \text{ m}$$

30. $\sqrt{323} \cong 0018$

PART-B: CHEMISTRY

31. (a) 5 p (b) 5 s (c) 4 d (d) 4 p

Acc. to $(n + \ell)$ rule, increasing order of energy $(d) < (b) < (c) < (a)$

- हल : (a) 5 p (b) 5 s (c) 4 d (d) 4 p

$(n + \ell)$ नियम के अनुसार, ऊर्जा का बढ़ता हुआ क्रम $(d) < (b) < (c) < (a)$

32. Mole = $\frac{180}{180} = 1 \text{ mol}$

mass of solution = 1180 g

$$V = \frac{1180}{1.15 \times 1000} = \frac{118}{115} \text{ L}$$

$$M = \frac{1 \times 115}{118} = 0.97 \text{ M}$$

- हल. मोल = $\frac{180}{180} = 1 \text{ mol}$

विलयन का भार = 1180 g

$$V = \frac{1180}{1.15 \times 1000} = \frac{118}{115} \text{ L}$$

$$M = \frac{1 \times 115}{118} = 0.97 \text{ M}$$

33. $\frac{C_p}{C_v} = 1.4 = \gamma$

$$C_p - C_v = R$$

$$\gamma C_v - C_v = R$$

$$\text{or या } C_v = \frac{R}{(\gamma - 1)} \text{ and तथा}$$

$$C_p - \frac{C_p}{\gamma} = R \text{ or या } C_p = \frac{R\gamma}{\gamma - 1}$$

$$C_v = \frac{2}{0.4} = 5 \text{ cal/mol K}$$

Also (यह भी) C_v

$$\text{or या } s_v = \frac{2}{0.4 \times 32} = 0.15 \text{ cal/mol K}$$

35. When some amount of HCl is added to equilibrium, the first eq will shift in backward direction leading to decrease in

amount of O_2 . Then, the second eq. will shift in backward direction to increase the amount of O_2 . Thus, amount of N_2 gas will increase.

जब साम्य पर HCl की कुछ मात्रा मिलायी जाती है, तब प्रथम साम्य प्रतीप दिशा में विस्थापित होगा तथा O_2 की मात्रा में कमी आती है। फिर द्वितीय साम्य भी प्रतीप दिशा में विस्थापित होगा, जिससे O_2 की मात्रा में वृद्धि होगी। इस प्रकार N_2 गैस की मात्रा में वृद्धि होगी।

36. For reaction $\Delta n < 0$ so high pressure is favoured for forward reaction.

Reaction is endothermic so high temperature favours forward reaction.

अभिक्रिया के लिए $\Delta n < 0$ अतः अग्र अभिक्रिया के लिए उच्च दाब सहायक है।

अभिक्रिया ऊष्माशोषी है अतः अग्र अभिक्रिया के लिए उच्च ताप सहायक है।

37. $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$
50 gm

$$n_{CaC_2} = \frac{50}{64} = n_{C_2H_2}$$

$$\text{Volume आयतन} = \frac{50}{64} \times 22.4 \text{ L} = 17.5 \text{ L}$$

38. $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$
- | | | |
|------|------|------|
| 0.2 | 0 | 0 |
| 0.04 | 0.08 | 0.08 |

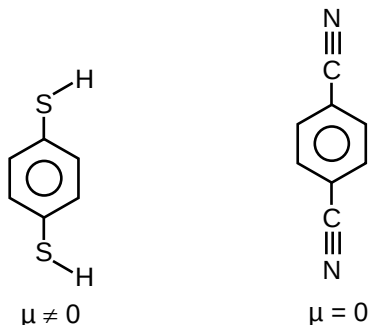
$$K_p = 4$$

39. It is an open system.
यह एक खुला निकाय है।

40. $N_2(g) + O_2(g) \rightarrow 2NO(g)$
- | | | |
|------|------|-------------------------------------|
| 5L | 15 L | $2 \times 5 (\because V \propto n)$ |
| (LR) | | = 10 L |

41. $\begin{array}{c} \text{Cl} \quad \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \quad \text{Cl} \end{array} \quad \mu = 0 \quad \begin{array}{c} \text{HOOC} \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \quad \text{COOH} \end{array} \quad \mu \neq 0$





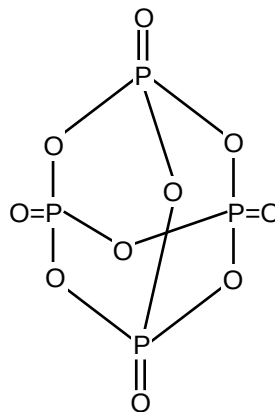
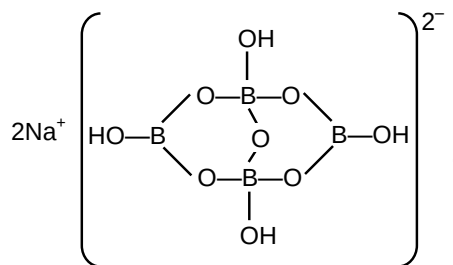
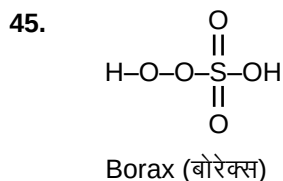
42. (1) the charge size ratio increases and thus polarising power increases.
 (2) Boiling point of $\text{H}_2\text{O} = 100^\circ\text{C}$, $\text{HF} = 20^\circ$, $\text{NH}_3 = -35^\circ\text{C}$ etc.
 (3) Electron affinity of oxygen is least in the group

हल : (1) आवेश आकार अनुपात बढ़ता है तथा इसलिए ध्रुवण शक्ति बढ़ती है।
 (2) क्वथनांक $\text{H}_2\text{O} = 100^\circ\text{C}$, $\text{HF} = 20^\circ$, $\text{NH}_3 = -35^\circ\text{C}$ इत्यादि।
 (3) ऑक्सीजन की इलेक्ट्रॉन बंधुता समूह में सबसे कम होती है।

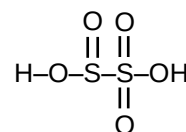
43. Positive charge is in conjugation with double bond in (1), (2) and (4).
 In (3) +ve charge is sp^2 hybridised and it will not be involved in resonance.

हल : (1), (2) तथा (4) में धनात्मक आवेश द्विबंध के साथ संयुग्मन में है।
 (3) में +ve आवेश sp^2 संकरित है तथा यह अनुनाद में निहित नहीं होगा।

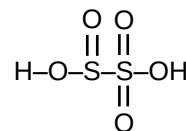
44. $[\text{Al}(\text{CH}_3)_3]_n$



$\text{H}_2\text{S}_2\text{O}_5$ (Pyrosulphurous acid)



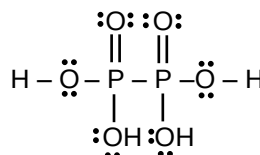
$\text{H}_2\text{S}_2\text{O}_7$ (पायरोसल्फ्यूरस अम्ल)



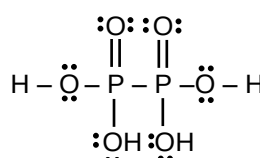
46. Bond order of NO = 2.5
 Bond order of $\text{NO}^+ = 3.0$

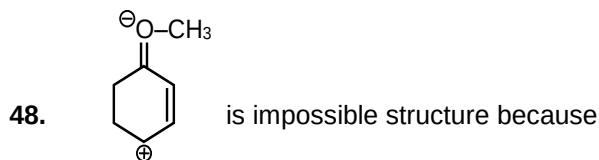
हल : NO का बंध क्रम = 2.5
 NO^+ का बंध क्रम = 3.0

47. $\text{H}_4\text{P}_2\text{O}_6 = \text{Hypophosphoric acid}$

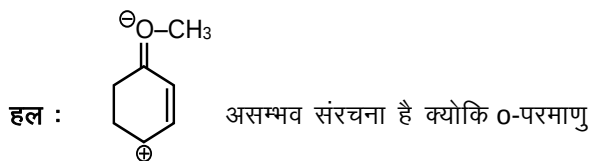


हल : $\text{H}_4\text{P}_2\text{O}_6 = \text{हाइपोफॉस्फोरिक अम्ल}$

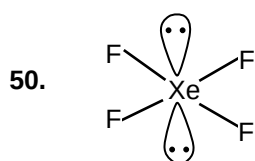
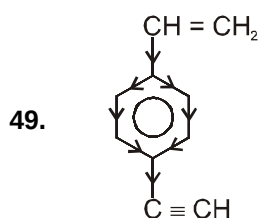




o-atom does not have 10 electron in its valence shell.



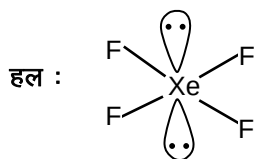
इसके संयोजकता कोश में 10 इलेक्ट्रॉन नहीं रखता है।



⇒ 4 bond pair + 2 lone pair.

⇒ Steric Number = 6

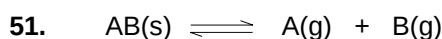
= sp^3d^2 .



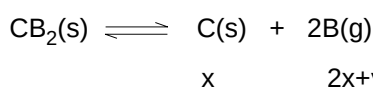
⇒ 4 बंध युग्म + 2 एकाकी युग्म.

⇒ त्रिविम संख्या = 6

= sp^3d^2 .



$$K_p = 4.8 \times 10^{-6}$$



$$K_p = 5.76 \times 10^{-6}$$

$$(2x + y)^2 = 5.76 \times 10^{-6}$$

$$(2x + y) = 2.4 \times 10^{-3}$$

$$\Rightarrow 2.4 \times 10^{-3} \times y = 4.8 \times 10^{-6}$$

$$y = 2 \times 10^{-3}$$

52. (0007)
(i, iii, iv, v, vi, vii, x)

53. (0006)
(i, iii, iv, v, vi, vii)

54. For H, $n = 2$ is first excited state. we have $2s, 2p_x, 2p_y$ and $2p_z$.

H के लिए $n = 2$ प्रथम उत्तेजित अवस्था है। हमारे पास $2s, 2p_x, 2p_y$ तथा $2p_z$ होंगे।

56. (0008)
(i, ii, iii, iv, v, vii, ix, x)

57. (0007)

58. (0010)

59. $Mn_2O_7, SO_2, NO_2, CrO_3, SiO_2$ = acidic

हल : $Mn_2O_7, SO_2, NO_2, CrO_3, SiO_2$ = अम्लीय

60. $XeF_2 - sp^3d$ $XeO_4 - sp^3$
 $XeF_4 - sp^3d^2$ $XeF_6 - sp^3d^3$
 $PCl_3 - sp^3$ $PCl_2F_3 - sp^3d$
 $SF_6 - sp^3d^2$ $SiCl_4 - sp^3$
 $SO_3^{2-} - sp^3$ $ClF_3 - sp^3d$
 $IF_7 - sp^3d^3$ $HClO_4 - sp^3$

PART-C: MATHEMATICS

62. Coeff. of $x^{10} = {}^{21}C_0 + {}^{21}C_1 + \dots + {}^{21}C_{10}$
 $\Rightarrow k = 2^{21-1} = 2^{20}$

no. of digits in $k = 7$

($\because \log_{10} k = 20 \times 0.3010 = 6.020$)

हल. x^{10} का गुणांक = ${}^{21}C_0 + {}^{21}C_1 + \dots + {}^{21}C_{10}$

$\Rightarrow k = 2^{21-1} = 2^{20}$

k के अंको की संख्या = 7

$$(\because \log_{10} k = 20 \times 0.3010 = 6.020)$$

63.

$$\left(\frac{a^4 + 3a^2 + 1}{a^2} \right) \left(\frac{b^4 + 5b^2 + 1}{b^2} \right) \left(\frac{c^4 + 7c^2 + 1}{c^2} \right)$$

$$\left(a^2 + \frac{1}{a^2} + 3 \right) \left(b^2 + \frac{1}{b^2} + 5 \right) \left(c^2 + \frac{1}{c^2} + 7 \right)$$

$$\left(\left(a - \frac{1}{a} \right)^2 + 5 \right) \left(\left(b - \frac{1}{b} \right)^2 + 7 \right) \left(\left(c - \frac{1}{c} \right)^2 + 9 \right)$$

So minimum value $\Rightarrow 5 \times 7 \times 9 = 315$

न्यूनतम मान $\Rightarrow 5 \times 7 \times 9 = 315$

64.

General equation of circle is

वृत्त का व्यापक समीकरण

$$x^2 + y^2 + 2gx + 2fy + d = 0 \quad \dots(1)$$

Putting (2,0), (0,1), (4,5) in (1), we get respectively,

समीकरण (1) में (2,0), (0,1), (4,5) रखने पर

$$4 + 4g + d = 0, \quad 1 + 2f + d = 0, \quad 41 + 8g + 10f + d = 0$$

$$\Rightarrow 4g - 2f = -3, \quad g + f = -5$$

$$\Rightarrow g = -\frac{13}{6}, \quad f = -\frac{17}{6}, \quad d = \frac{14}{3}$$

$$\Rightarrow x^2 + y^2 - \frac{13}{3}x - \frac{17}{3}y + \frac{14}{3} = 0$$

$$\Rightarrow 3(x^2 + y^2) - 13x - 17y + 14 = 0 \quad \dots(2)$$

Put (0,c) in (2), $3c^2 - 17c + 14 = 0$

$$3c^2 - 17c + 14 = 0$$

समीकरण (2) में (0,c) रखने पर

$$\Rightarrow c = 1, \frac{14}{3}$$

65.

(1)

$$\sin A \sin(60^\circ - A) \sin(60^\circ + A) = \frac{1}{4} \sin 3A$$

$$A = 25^\circ$$

$$\sin 25^\circ \sin 35^\circ \sin 85^\circ = \frac{1}{4} \sin 75^\circ$$

$$= \frac{1}{4} \cdot \frac{\sqrt{3} + 1}{2\sqrt{2}}$$

$$(2) \frac{\sin \frac{5\pi \cdot 2}{11 \cdot 2} \cos \left(\frac{10\pi}{11 \cdot 2} \right)}{\sin \frac{2\pi}{11 \cdot 2}}$$

$$\frac{\sin \frac{5\pi}{11} \cdot \cos \frac{5\pi}{11}}{\sin \frac{\pi}{11}} = \frac{\sin \frac{10\pi}{11}}{2 \sin \frac{\pi}{11}} = \frac{1}{2}$$

$$(3) \frac{\sin(33^\circ + 57^\circ) \sin(57^\circ - 33^\circ)}{\sin 21^\circ - \sin 69^\circ}$$

$$= \frac{\sin 24^\circ}{-2 \cos 45^\circ \sin 24^\circ} = -\frac{1}{\sqrt{2}}$$

$$(4) \frac{1}{2} [2 \cos 20^\circ \cos 100^\circ +$$

$$2 \cos 100^\circ \cos 140^\circ - 2 \cos 140^\circ \cos 200^\circ] = \frac{1}{2}$$

$$\frac{1}{2}$$

$$\left[-\frac{1}{2} + \cos 80^\circ - \frac{1}{2} + \cos 40^\circ - \cos 340^\circ - \frac{1}{2} \right] =$$

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

66.

$$D \geq 0$$

$$4b^2 \geq 16ac \Rightarrow b^2 \geq 4ac$$

$$\text{If यदि } b = 4 \Rightarrow 4ac \leq 16 \Rightarrow ac \leq 4$$

$$\therefore (a, c) = (1, 4), (2, 2), (4, 1), (1, 3), (3, 1),$$

$$(1, 2), (2, 1), (1, 1)$$

$$\text{If यदि } b = 3 \Rightarrow 4ac \leq 9$$

$$\therefore (a, c) = (1, 1), (1, 2), (2, 1)$$

$$\text{If यदि } b = 2 \Rightarrow ac \leq 1$$

$$\therefore (a, c) = (1, 1)$$

67.

By wavy curve method $x \in (-3, -1] \cup (2, 4]$

$$\cup \{-8\}$$

non negative integral solutions are $x = 3, 4$

हल.

हल करने पर $x \in (-3, -1] \cup (2, 4] \cup \{-8\}$

अष्टगुणात्मक पूर्णांक हल $x = 3, 4$

68.

Last term of n^{th} row

$n^{\text{वीं}}$ पंक्ति का अन्तिम पद

$$= 1 + 2 + 3 + \dots + n = \frac{1}{2} n(n+1)$$

As terms in the n th row forms an A.P. with common difference 1,
 n वीं पंक्ति समान्तर श्रेणी में है जिसका सार्वअन्तर 1 है।

First term प्रथम पद = last term अन्तिम पद -
 $(n-1)(1)$

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

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

Sumयोगफल

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

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

69. $a = k$

$$b = 2k$$

$$c = 3k$$

$$\frac{a^2 + b^2 + c^2}{a^2} = \frac{14k^2}{k^2} = 14$$

70.

$$\frac{p}{r} + \frac{r}{p} = \frac{(p+r)^2 - 2pr}{pr}$$

$$= \frac{4pr}{q^2} - 2 \quad \left(\because q = \frac{2pr}{r+p} \right)$$

$$= \frac{4b^2}{ac} - 2 \quad \left(\because b^2 q^2 = acpr \right)$$

$$= \frac{4b^2 - 2ac}{ac} = \frac{(a+c)^2 - 2ac}{ac} = \frac{a}{c} + \frac{c}{a}$$

$$(\because 2b = a + c)$$

71. Refer to answer key

72. x, y, z are amounts,

$$\begin{aligned} x \leq y + z &\Rightarrow x \leq 101 - x \\ \text{then} &\Rightarrow x \leq 50 \end{aligned}$$

$$\text{and } y, z \leq 50$$

$$x + y + z = 101$$

$$\therefore \text{no. of ways} = \text{coefficient of } x^{101} \text{ in } (1 + x + x^2 + \dots + x^{50})^3$$

$$= {}^{103}C_{101} - 3 \cdot {}^{52}C_{50}$$

हल.

$$x, y, z \text{ राशि है।}$$

$$\begin{aligned} x \leq y + z &\Rightarrow x \leq 101 - x \\ \text{तब} &\Rightarrow x \leq 50 \end{aligned}$$

$$\text{और } y, z \leq 50$$

$$x + y + z = 101$$

$$\therefore \text{ तरीको की संख्या } (1 + x + x^2 + \dots + x^{50})^3$$

$$\text{में } x^{101} \text{ का गुणांक है}$$

$$= {}^{103}C_{101} - 3 \cdot {}^{52}C_{50}$$

73.

Clearly $x = 0, 1, 2, 3, \dots, 10$. Let $x = k$; then
 $0 \leq k \leq 10$.

$$\text{When } x = k, y + z = 21 - 2k.$$

The number of non-negative integral solutions

= the number of ways to distribute $(21 - 2k)$

Identical things (each thing is the number

1) among 2 persons

$$= {}^{21-2k+2-1}C_{2-1} = {}^{22-2k}C_1 = 22 - 2k$$

$\therefore$ The required number of solutions

$$= \sum_{k=0}^{10} (22 - 2k) = 22 + 20 + 18 + \dots + 2$$

$$= 2(1 + 2 + 3 + \dots + 11) = 2 \times \frac{11 \times 12}{2} = 132$$

हल.

$$\text{स्पष्टतया } x = 0, 1, 2, 3, \dots, 10 \text{ माना } x = k \text{ तब}$$

$$0 \leq k \leq 10.$$

$$\text{जब } x = k, y + z = 21 - 2k.$$

$$\text{अऋणात्मक पूर्णांक हलों की संख्या} = (21 - 2k)$$

सब्रसम वस्तुओं को दो व्यक्तियों में बाटने के तरीके

$$= {}^{21-2k+2-1}C_{2-1} = {}^{22-2k}C_1 = 22 - 2k$$

$\therefore$ हलों की संख्या

$$= \sum_{k=0}^{10} (22 - 2k) = 22 + 20 + 18 + \dots + 2$$

$$= 2(1 + 2 + 3 + \dots + 11) = 2 \times \frac{11 \times 12}{2} = 132$$

74. $\frac{a \cos A + b \cos B + c \cos C}{a + b + c} =$

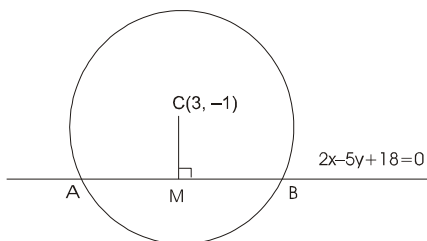
$$\frac{2(\sin 2A + \sin 2B + \sin 2C)}{2R(\sin A + \sin B + \sin C)} =$$

$$\frac{4 \sin A \sin B \sin C}{8 \cos \frac{A}{2} \cos \frac{B}{2} \cos \frac{C}{2}}$$

$$= 4 \sin \frac{A}{2} \sin \frac{B}{2} \sin \frac{C}{2} = \frac{r}{R}$$

75. $AM = MB = 3$.

$$CM = \frac{2(3) - 5(-1) + 18}{\sqrt{2^2 + 5^2}} = \sqrt{29}$$



$$R = \text{Radius त्रिज्या} \Rightarrow R^2 = CA^2 = AM^2 + CM^2$$

$$= 3^2 + 29 = 38$$

Equation of circle is वृत्त का समीकरण

$$(x - 3)^2 + (y + 1)^2 = R^2 = 38$$

$$\Rightarrow x^2 + y^2 - 6x + 2y = 28$$

78. Let slope of line $L = m$

$$\therefore \left| \frac{m - (-\sqrt{3})}{1 + m(-\sqrt{3})} \right| = \tan 60^\circ = \sqrt{3}$$

$$\Rightarrow \left| \frac{m + \sqrt{3}}{1 - \sqrt{3}m} \right| = \sqrt{3}$$

$$\text{taking positive sign, } m + \sqrt{3} = \sqrt{3} - 3m$$

$$\Rightarrow m = 0$$

$$\text{taking negative sign } m + \sqrt{3} + \sqrt{3} - 3m = 0$$

$$\Rightarrow m = \sqrt{3}$$

$$\text{As } L \text{ cuts } x\text{-axis} \Rightarrow m = \sqrt{3}$$

$$\text{so } L \text{ is } y + 2 = \sqrt{3}(x - 3)$$

हल. माना रेखा L की प्रवणता $= m$

$$\therefore \left| \frac{m - (-\sqrt{3})}{1 + m(-\sqrt{3})} \right| = \tan 60^\circ = \sqrt{3}$$

$$\Rightarrow \left| \frac{m + \sqrt{3}}{1 - \sqrt{3}m} \right| = \sqrt{3}$$

$$\text{धनात्मक चिन्ह लेने पर } m + \sqrt{3} = \sqrt{3} - 3m$$

$$\Rightarrow m = 0$$

$$\text{ऋणात्मक चिन्ह लेने पर } m + \sqrt{3} + \sqrt{3} - 3m = 0$$

$$\Rightarrow m = \sqrt{3}$$

चूंकि L , x -अक्ष को प्रतिच्छेद करती है

$$\Rightarrow m = \sqrt{3}$$

$$\text{इसलिए } L \text{ का समीकरण } y + 2 = \sqrt{3}(x - 3)$$

79. $ax^2 + 2hxy + by^2 + 2gx + 2fy + c$ can be resolved in 2 linear factors if :

$$abc + 2fgh - af^2 - bg^2 - ch^2 = 0$$

$$\therefore -12 - 2\left(-\frac{5}{2}\right)^2 + 2\left(\frac{m}{2}\right)^2 = 0$$

$$m^2 = 49$$

$$\Rightarrow m = \pm 7$$

हल

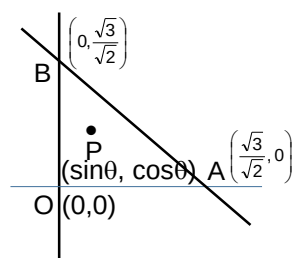
$ax^2 + 2hxy + by^2 + 2gx + 2fy + c$ को दो रेखीय गुणनखण्डों के गुणनफल में व्यक्त किया जा सकता है यदि -

$$abc + 2fgh - af^2 - bg^2 - ch^2 = 0$$

$$\therefore -12 - 2\left(-\frac{5}{2}\right)^2 + 2\left(\frac{m}{2}\right)^2 = 0$$

$$m^2 = 49 \Rightarrow m = \pm 7$$

80.



$$\therefore P \text{ will lie inside the } \triangle OAB \Rightarrow \theta \in \left(0, \frac{\pi}{2}\right)$$

$\therefore P$, $\triangle OAB$ के अन्दर स्थित होगा

$$\Rightarrow \theta \in \left(0, \frac{\pi}{2}\right)$$

$$\text{and और } \sin \theta + \cos \theta < \frac{\sqrt{3}}{2}$$

$$\Rightarrow \sin \left(\theta + \frac{\pi}{4}\right) < \frac{\sqrt{3}}{2}$$

$$\theta + \frac{\pi}{4} < \frac{\pi}{3} \text{ or } \theta + \frac{\pi}{4} > \frac{2\pi}{3}$$

$$\Rightarrow 0 < \theta < \frac{\pi}{12} \text{ or } \frac{\pi}{2} > \theta > \frac{5\pi}{12}$$

$$81. {}^5C_2 \times 2 + {}^5C_1 \times {}^4C_1 \times 2 + {}^4C_2 = 66$$

$$82. \text{ use } {}^kC_k + {}^{k+1}C_k + {}^{k+2}C_k + \dots + {}^nC_r = {}^{n+1}C_{r+1} \text{ से}$$

$$\text{sum योग} = ({}^{98}C_{30} + {}^{97}C_{30} + \dots + {}^{30}C_{30}) +$$

$$({}^{97}C_{30} + \dots + {}^{30}C_{30}) + \dots + ({}^{30}C_{30})$$

$$= {}^{99}C_{31} + {}^{98}C_{31} + \dots + {}^{31}C_{31} [\text{As } {}^{30}C_{30} = {}^{31}C_{31}]$$

$$= {}^{100}C_{32}$$

$$83. (3^{x-2} + (3^{x-2}-9)^{1/5})^7$$

$$T_6 = {}^7C_5 \cdot (3^{x-2})^2 \cdot 3^{x-2-9} = 567$$

$$\Rightarrow 3^{3x-2-9} = 27 \Rightarrow |x-2|=4 \Rightarrow x=6, -2$$

$$84. \therefore a + b + c + d = 0$$

$$\Rightarrow \text{Roots are मूल हैं } \frac{-1}{a}, \frac{-1}{b}, \frac{-1}{c}, \frac{-1}{d}$$

$$\therefore \text{Replace } x \rightarrow \frac{-1}{x}$$

$$\Rightarrow \left(-\frac{1}{x}\right)^4 - b\left(-\frac{1}{x}\right) - 3 = 0$$

$$\therefore x \text{ को } \frac{-1}{x} \text{ रखने पर}$$

$$\Rightarrow \left(-\frac{1}{x}\right)^4 - b\left(-\frac{1}{x}\right) - 3 = 0$$

$$3x^4 - bx^3 - 1 = 0$$

$$\therefore \alpha = 3, \beta = 1, \gamma = 1$$

$$85. T_r = \frac{\log_3\left(\frac{r+2}{r+1}\right)}{(\log_3(r+1)\log_3(r+2))}$$

$$T_r = \frac{\log_3(r+2) - \log_3(r+1)}{\log_3(r+1)\log_3(r+2)}$$

$$T_r = \frac{1}{\log_3(r+1)} - \frac{1}{\log_3(r+2)}$$

$$T_1 = \frac{1}{\log_3 2} - \frac{1}{\log_3 3}$$

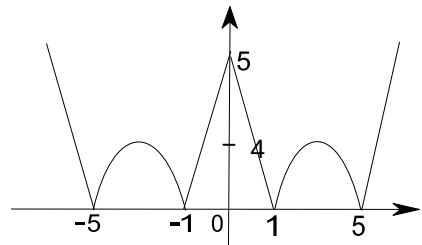
$$T_2 = \frac{1}{\log_3 3} - \frac{1}{\log_3 4}$$

⋮

$$T_{160} = \frac{1}{\log_3 160} - \frac{1}{\log_3 162}$$

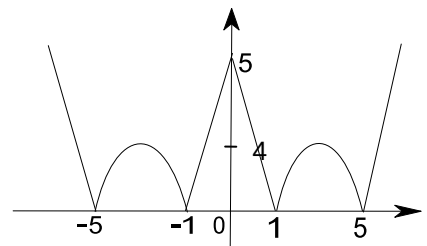
$$\text{Sum योगफल} = \frac{\log_3 162 - \log_3 2}{(\log_3 162)(\log_3 2)} = 4$$

$$86. \text{ Graph of } y = |x^2 - 6|x| + 5|$$



$$\text{integral value of } m \text{ for four solns. } \Rightarrow m = 0$$

$$\text{हल. } y = |x^2 - 6|x| + 5| \text{ का आरेख है}$$



$$\text{चार हलों के लिए } m \text{ के पूर्णांक मान } \Rightarrow m = 0$$

$$87. ax + by + c = 1$$

$$\Rightarrow ax + by + \frac{t-5a-4b}{20} = 1$$

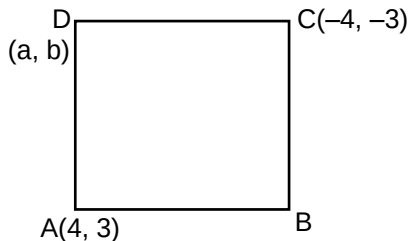
$$\Rightarrow 20ax + 20by + t - 5a - 4b = 20$$

$$\Rightarrow a(20x - 5) + b(20y - 4) + (t - 20) = 0$$

If $t = 20$, then line passes through $\left(\frac{1}{4}, \frac{1}{5}\right)$.

यदि $t = 20$ है, तो रेखा बिन्दु $\left(\frac{1}{4}, \frac{1}{5}\right)$ से गुजरती है।

88.



$$\text{Slope of DC की प्रवणता} = \frac{b+3}{a+4}$$

$$\text{Slope of DA की प्रवणता} = \frac{b-3}{a-4}$$

$$\frac{b+3}{a+4} \times \frac{b-3}{a-4} = -1$$

$$\Rightarrow a^2 + b^2 = 25$$

Possible points of B & D

B और D के संभावित बिन्दु

$$B(3, 4) \quad D(-3, 4)$$

$$B(3, -4) \quad D(-3, -4)$$

$$B(4, -3) \quad D(-4, 3)$$

$$B(5, 0) \quad D(-5, 0)$$

$$B(0, 5) \quad D(0, -5)$$

89.

$$\frac{4 \sin 9^\circ \sin 21^\circ \sin 39^\circ \sin 51^\circ \sin 69^\circ \sin 81^\circ}{\sin 54^\circ}$$

$$= \frac{4 \sin 9^\circ \cos 9^\circ \cdot \sin 39^\circ \cos 39^\circ \sin 21^\circ \cos 21^\circ}{\sin 54^\circ}$$

$$= \frac{\sin 18^\circ \cdot \sin 78^\circ \sin 42^\circ}{2 \sin 54^\circ} =$$

$$\frac{\sin 18^\circ}{4} \frac{(\cos 36^\circ - \cos 120^\circ)}{\sin 54^\circ} = \frac{1}{8}$$

90.

$$a_r = {}^{2n-1}C_r (-1)^r$$

$$\therefore a_{r-1} = {}^{2n-1}C_{r-1} (-1)^{r-1}$$

$$a_{2n-r} = {}^{2n-1}C_{2n-r} (-1)^{2n-r} = {}^{2n-1}C_{r-1} (-1)^{2n-r}$$

$$\therefore a_{r-1} + a_{2n-r} = {}^{2n-1}C_{r-1} [(-1)^{r-1} + (-1)^{2n-r}] = 0$$

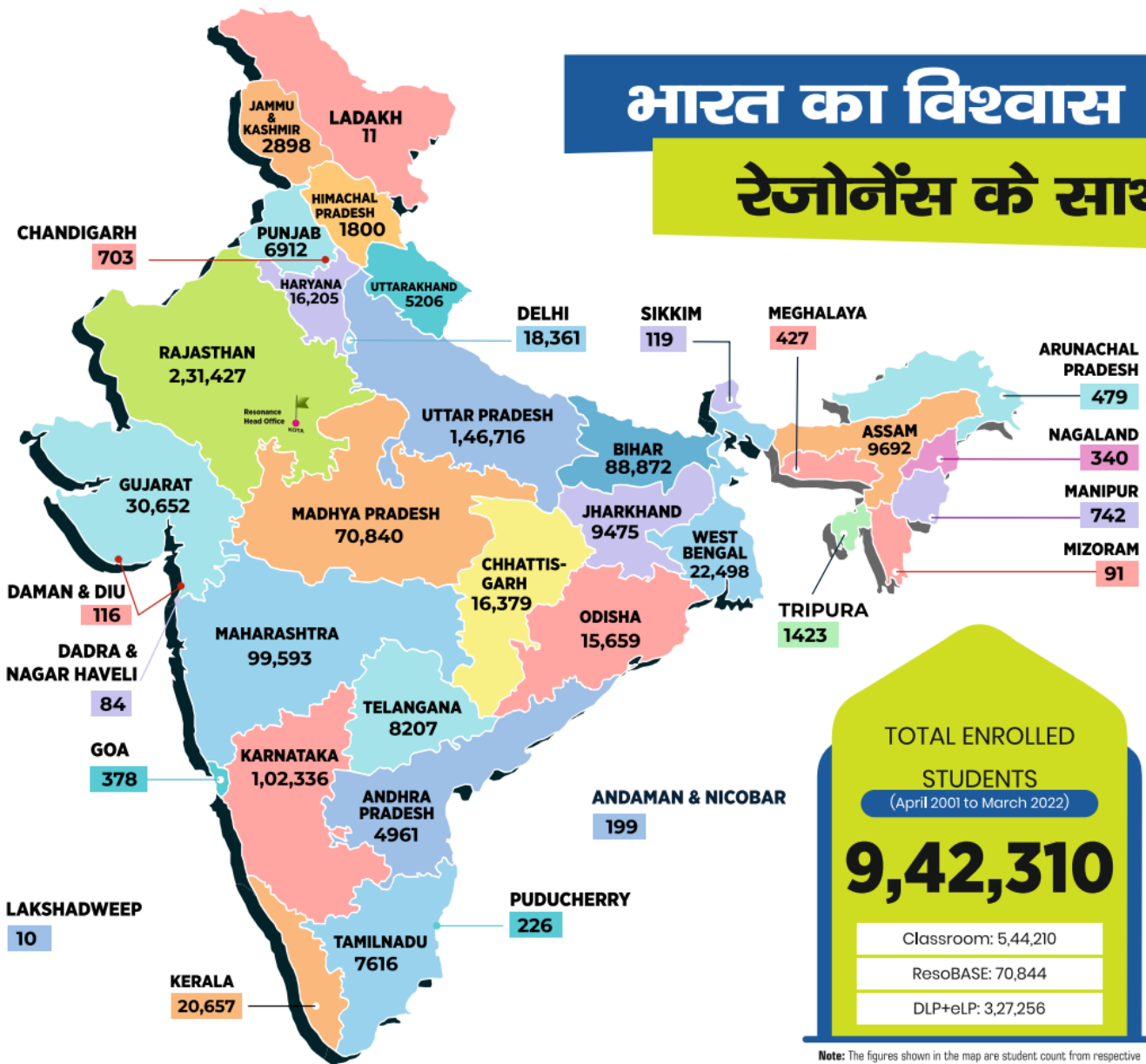
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