JEE–MAIN EXAMINATION – JANUARY 2025

(HELD ON TUESDAY 28th JANUARY 2025) **TIME : 3 : 00 PM TO 6 : 00 PM**

CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

51. consider the elementary reaction

$A(g) + B(g) \rightarrow C(g) + D(g)$

If the volume of reaction mixture is suddenly reduced to $\frac{1}{3}$ of its initial volume, the reaction rate will become 'x' times of the original reaction rate. The value of x is :

(1) $\frac{1}{9}$

(2) 9

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

(4) 3

Ans. **(2)**

Sol. $R_1 = K[A]^1[B]^1$

$R_1 = K\left[\frac{n_A}{V}\right]^1\left[\frac{n_B}{V}\right]^1$

$R_2 = K\left[\frac{3n_A}{V}\right]^1\left[\frac{3n_B}{V}\right]^1$

$\boxed{R_2 = 9R_1}$

52. The amphoteric oxide among V_2O_3, V_2O_4 and V_2O_5 upon reaction with alkali leads to formation of an oxide anion. The oxidation state of V in the oxide anion is :

(1) +3 (2) +7

(3) +5 (4) +4

Ans. **(3)**

Sol. $V_2O_5 + \text{alkali} \rightarrow VO_4^{3-}$

In VO_4^{3-} ion, vanadium is in +5 oxidation state

53. Match **List-I** with **List-II**

List-I (Saccharides)	**List_II (Glycosidic-linkages found)**
(A) Sucrose	(I) α 1 - 4
(B) Maltose	(II) α 1 – 4 and α 1 – 6
(C) Lactose	(III) α 1 – β 2
(D) Amylopectin	(IV) β 1 – 4

Choose the correct answer from the options given below :

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

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

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

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

Ans. **(1)**

Sol. (A) Sucrose → α_1–β_2 Glycosidic linkage

(B) Maltose → α 1–4 Glycosidic linkage

(C) Lactose → β 1–4 Glycosidic linkage

(D) Amylopectin → α 1–4 and α 1–6 Glycosidic linkage

A–III, B–I, C–IV, D–II

54. Identify product [A], [B] and [C] in the following reaction sequence :

$CH_3 - C \equiv CH \xrightarrow[H_2]{Pd/C} [A] \xrightarrow[(ii)\,Zn,H_2O]{(i)\,O_3} [B] + [C]$

(1) [A] : CH_3–CH=CH_2, [B] : CH_3CHO, [C] : HCHO

(2) [A] : CH_2=CH_2, [B] : $H_3C-\overset{\overset{O}{\|}}{C}-CH_3$ [C] : HCHO

(3) [A] : CH_3–CH=CH_2, [B] : CH_3CHO, [C] : CH_3CH_2OH

(4) [A] : $CH_3CH_2CH_3$, [B] : CH_3CHO, [C] : HCHO

Ans. **(1)**

Sol. $CH_3 - C \equiv CH \xrightarrow[H_2]{Pd/C} CH_3 - CH = CH_2[A]$

$\xrightarrow[(ii)\,Zn,H_2O]{(i)\,O_3} CH_3 - CH = O + HCHO$

[B] [C]

55. Arrange the following in increasing order of solubility product :

$Ca(OH)_2$, AgBr, PbS, HgS

(1) $PbS < HgS < Ca(OH)_2 < AgBr$

(2) $HgS < PbS < AgBr < Ca(OH)_2$

(3) $Ca(OH)_2 < AgBr < HgS < PbS$

(4) $HgS < AgBr < PbS < Ca(OH)_2$

Ans. **(2)**

Sol. Based on the Ksp values and salt analysis cation identification, we can say that order of Ksp value is:

$HgS < PbS < AgBr < Ca(OH)_2$

Ksp values

$HgS \rightarrow 4 \times 10^{-53}$

$PbS \rightarrow 8 \times 10^{-28}$

$AgBr \rightarrow 5 \times 10^{-13}$

$Ca(OH)_2 \rightarrow 5.5 \times 10^{-6}$

56. The purification method based on the following physical transformation is :

$$\underset{(X)}{\text{Solid}} \xrightarrow{\text{Heat}} \underset{(X)}{\text{Vapour}} \xrightarrow{\text{Cool}} \underset{(X)}{\text{Solid}}$$

(1) Sublimation (2) Distillation

(3) Crystallization (4) Extraction

Ans. **(1)**

Sol. Theory base

57. Identify correct conversion during acidic hydrolysis from the following :

(A) starch gives galactose.

(B) cane sugar gives equal amount of glucose and fructose.

(C) milk sugar gives glucose and galactose.

(D) amylopectin gives glucose and fructose.

(E) amylose gives only glucose.

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

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

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

(3) (B), (C) and (E) only

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

Ans. **(3)**

Sol. (A) Starch $\xrightarrow{H^+/H_2O}$ Glucose

(B) Cane sugar $\xrightarrow{H^+/H_2O}$ glucose + fructose

(Sucrose) 50% 50%

(C) Milk sugar $\xrightarrow{H^+/H_2O}$ glucose + galactose

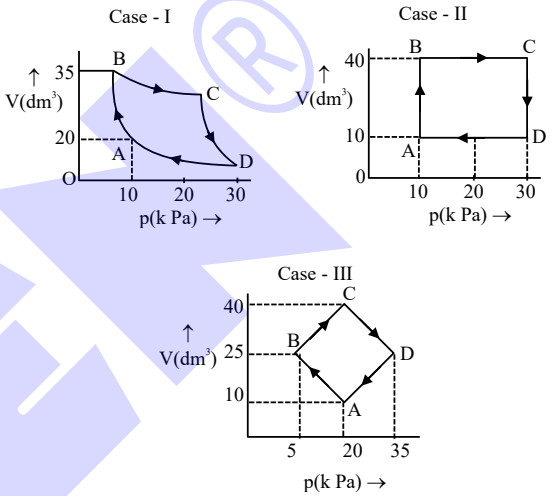
(Lactose)

(D) Amylopectin $\xrightarrow{H^+/H_2O}$ Glucose

(E) Amylose $\xrightarrow{H^+/H_2O}$ Glucose

So, correct options are B, C and E only

58.



An ideal gas undergoes a cyclic transformation starting from the point A and coming back to the same point by tracing the path A→B→C→D→A as shown in the three cases above.

Choose the *correct* option regarding ΔU.

(1) ΔU (Case-III) > ΔU (Case-II) > ΔU (Case-I)

(2) ΔU (Case-I) > ΔU (Case-II) > ΔU (Case-III)

(3) ΔU (Case-I) > ΔU (Case-III) > ΔU (Case-II)

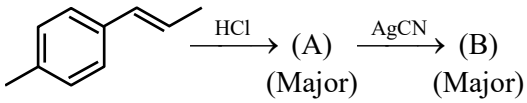
(4) ΔU (Case-I) = ΔU (Case-II) = ΔU (Case-III)

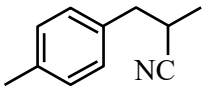
Ans. **(4)**

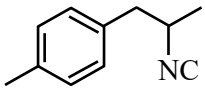
Sol. As internal energy 'U' is a state function, its cyclic integral must be zero in a cyclic process

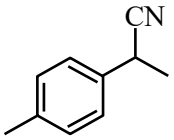
$\therefore$ ΔU case (I) = ΔU case (II) = ΔU case (III)

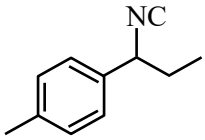
59. The product B formed in the following reaction sequence is :



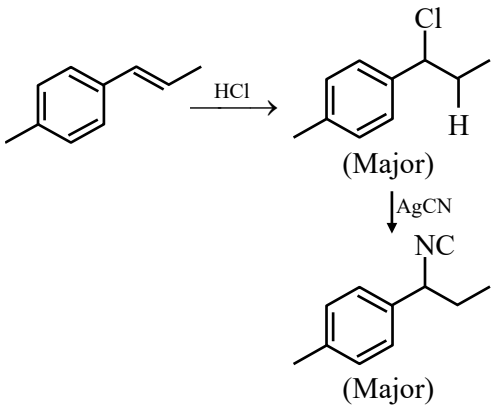
(1) 

(2) 

(3) 

(4) 

Ans. (4)

Sol. 

60. Concentrated nitric acid is labelled as 75% by mass. The volume in mL of the solution which contains 30 g of nitric acid is _____.

Given : Density of nitric acid solution is 1.25 g/mL

(1) 45 (2) 55

(3) 32 (4) 40

Ans. (3)

Sol. % w/w of $HNO_3 = 75\%$

means 100 gm of solution containing 75 g of HNO_3

$$\& \left(\frac{gm}{m_l}\right)_{solution} = 1.25 = \frac{100 gm}{V}$$

V_{ml} of 100 gm solution $= \frac{100}{1.25}$ ml

$\because$ 75 gm of HNO_3 present in $\frac{100}{1.25}$ ml solution

$\therefore$ 30 gm of HNO_3 present in

$$\frac{100}{1.25 \times 75} \times 30 = \boxed{32 \text{ ml solution}}$$

61. Match **List-I** with **List-II**.

	List-I (Complex)		**List-II (Hybridisation of central metal ion)**
(A)	$[CoF_6]^{3-}$	(I)	d^2sp^3
(B)	$[NiCl_4]^{2-}$	(II)	sp^3
(C)	$[Co(NH_3)_6]^{3+}$	(III)	sp^3d^2
(D)	$[Ni(CN)_4]^{2-}$	(IV)	dsp^2

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

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

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

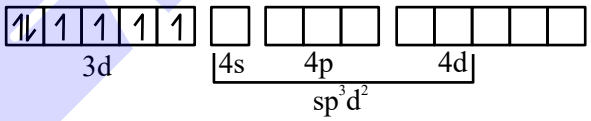
(3) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

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

Ans. (2)

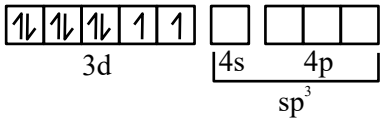
Sol. (A) $[CoF_6]^{-3}$

$Co^{3+} \rightarrow 3d^6$



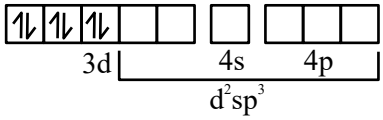
(B) $[NiCl_4]^{2-}$

$Ni^{2+} \rightarrow 3d^8$



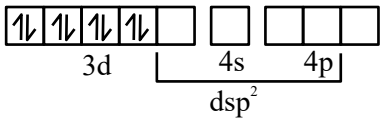
(C) $[Co(NH_3)_6]^{3+}$

$Co^{3+} \rightarrow 3d^6$

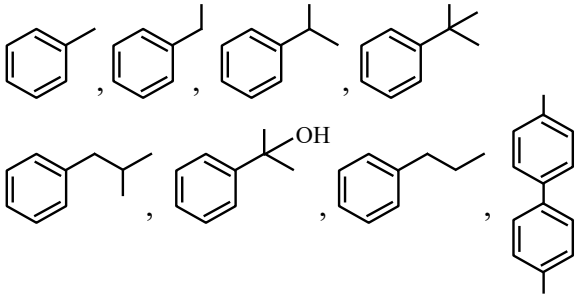


(D) $[Ni(CN)_4]^{2-}$

$Ni^{2+} \rightarrow 3d^8$



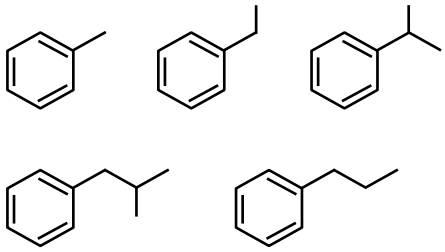
62. The total number of compounds from below when treated with hot $KMnO_4$ giving benzoic acid is :



(1) 3 (2) 4 (3) 6 (4) 5

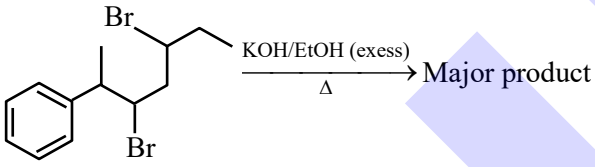
Ans. **(4)**

Sol. Compounds having at least 1 α–H will react with $KMnO_4$ and give benzoic acid.



Total 5 compounds

63. The major product of the following reaction is :



(1) 6-Phenylhepta-2,4-diene

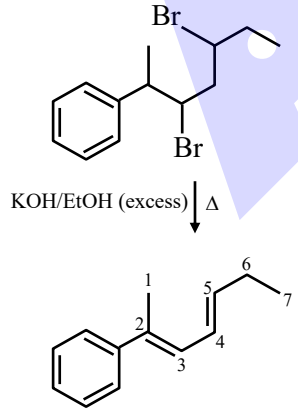
(2) 2-Phenylhepta-2,5-diene

(3) 6-Phenylhepta-3,5-diene

(4) 2-Phenylhepta-2,4-diene

Ans. **(4)**

Sol.



2-Phenylhepta-2,4-diene

64. Given below are two statements :

Statement (I) : According to the Law of Octaves, the elements were arranged in the increasing order of their atomic number.

Statement (II) : Meyer observed a periodically repeated pattern upon plotting physical properties of certain elements against their respective atomic numbers.

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

(1) **Statement I** is false but **Statement II** is true

(2) Both **Statement I** and **Statement II** are true

(3) **Statement I** is true but **Statement II** is false

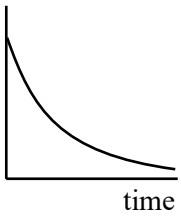
(4) Both **Statement I** and **Statement II** are false

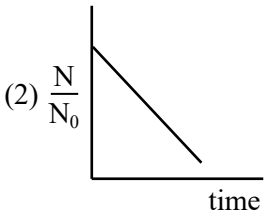
Ans. **(4)**

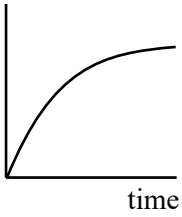
Sol. Law of octaves was arranged in the increasing order of their atomic weight.

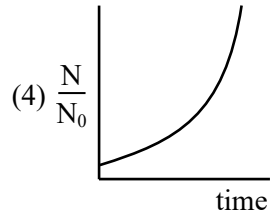
Lothar Meyer plotted the physical properties such as atomic volume , melting point and boiling point against atomic weight.

65. For bacterial growth in a cell culture, growth law is very similar to the law of radioactive decay. Which of the following graphs is most suitable to represent bacterial colony growth ?

(1) 

(2) 

(3) 

(4) 

Ans. **(4)**

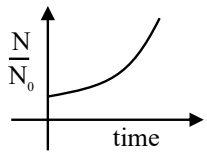
Sol. Because no. of bacteria initial = N_0

and No. of bacteria at any time t = N

Since bacterial growth is given as

$$N = N_0 e^{Kt}$$

Where K = growth constant for bacterial growth



66. Which of the following is/are not correct with respect to energy of atomic orbitals of hydrogen atom?

(A) 1s < 2p < 3d < 4s

(B) 1s < 2s = 2p < 3s = 3p

(C) 1s < 2s < 2p < 3s < 3p

(D) 1s < 2s < 4s < 3d

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

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

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

Ans. **(3)**

Sol. For single electron species energy only depends on 'n' (principal quantum number)

So energy of 2s = 2p

and energy of 3d < 4s

67. Assume a living cell with 0.9% (ω/ω) of glucose solution (aqueous). This cell is immersed in another solution having equal mole fraction of glucose and water.

(Consider the data upto first decimal place only)

The cell will :

(1) shrink since soluton is 0.5 % (ω/ω)

(2) shrink since solution is 0.45% (ω/ω) as a result of association of glucose molecules (due to hydrogen bonding)

(3) swell up since solution is 1% (ω/ω)

(4) Show no change in volume since solution is 0.9% (ω/ω)

Ans. **(BONUS)**

NTA **(4)**

Sol. Living cell = 0.9 gm in 100 gm of solution

% w/w = 0.9

Solution is have equal moles of glucose and water = 0.5

Weight of solution = 0.5 × 180 + 0.5 × 18 = 99 gm

% w/w ≃ 90%

Concentrated solution

= Cell will shrink.

68. Identify correct statements :

(A) Primary amines do not give diazonium salts when treated with $NaNO_2$ in acidc condition.

(B) Aliphatic and aromatic primary amines on heating wth $CHCl_3$ and ethanolic KOH form carbylamines.

(C) Secondary and tertiary amines also give carbylamine test.

(D) Benzenesulfonyl chloride is known as Hinsberg's reagent.

(E) Tertiary amines reacts with benzenesulfonyl chloride very easily.

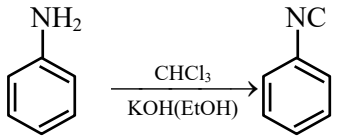
Choose the correct answer from the options given below :

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

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

Ans. **(1)**

Sol. (A) $R–NH_2 \xrightarrow[HCl]{NaNO_2} R-N_2^{\oplus}Cl^{\ominus}$

(B) 

$R–NH_2 \xrightarrow[KOH(EtOH)]{CHCl_3} R–NC$

(C) Only primary amine gives carbyl amine test

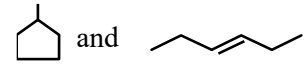
(D) $Ph–SO_2Cl$ ⟶ Hinsberg reagent

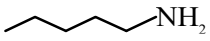
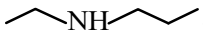
Benzene sulphonyl chloride

(E) Tertiary amine do not react with $Ph–SO_2Cl$

So correct options are (B) and (D) only

69. Given below are two statements :

Statement (I) :  and are isomeric compounds.

Statement (II) :  and  are functional group isomers.

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

(1) Both **Statement I** and **Statement II** are false

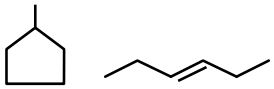
(2) Both **Statement I** and **Statement II** are true

(3) **Statement I** is true but **Statement II** is false

(4) **Statement I** is false but **Statement II** is true

Ans. (2)

Sol. **Statement-I** → True



Both are ring chain isomers

Statement-II → True

1° Amine 2° Amine

1° Amine and 2° Amine are different functional groups, hence both are functional group isomers.

70. Identify the inorganic sulphides that are yellow in colour :

(A) $(NH_4)_2S$ (B) PbS

(C) CuS (D) As_2S_3

(E) As_2S_5

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

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

(3) (A) and (B) only (4) (D) and (E) only

Ans. (4)

NTA (2)

Sol. As_2S_3 and As_2S_5 are yellow colour sulphides, $(NH_4)_2S$ is colourless, PbS is black, CuS is black in colour

SECTION-B

71. The spin only magnetic moment (μ) value (B.M.) of the compound with strongest oxidising power among Mn_2O_3, TiO and VO is _____ B.M. (Nearest integer).

Ans. (5)

Sol. Strongest oxidising power among the option is Mn_2O_3 because of E° value

$E^{\circ}_{Mn^{+3}/Mn^{+2}} = +1.57V$

$Mn^{+3} \rightarrow d^4$ configuration

$\mu = \sqrt{24}$ BM

$= 4.89$ BM

$\Rightarrow 5$

72. Consider the following data :

Heat of formation of $CO_2(g) = -393.5$ kJ mol^{-1}

Heat of formation of $H_2O(l) = -286.0$ kJ mol^{-1}

Heat of combustion of benzene $= -3267.0$ kJ mol^{-1}

The heat of formation of benzene is _____ kJ mol^{-1}. (Nearest integer)

Ans. (48)

Sol. $\Delta H_f[CO_2(g)] = -393.5$ kJ / mole

$\Delta H_f[H_2O(\ell)] = -286.0$ kJ / mole

$\Delta H_c[C_6H_6] = -3267.0$ kJ / mole

$\Delta H_f\, C_6H_6 = (?)$

$$C_6H_6 + \frac{15}{2}O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(\ell)$$

$\Delta H_R = \Delta H_C = \Sigma\Delta H_f(P) - \Sigma\Delta H_f(R)$

$-3267 = 6 \times (-393.5) + 3(-286) - \Delta H_f(C_6H_6)$

$\Delta H_f\,(C_6H_6) = 48$ kJ/mole

73. Electrolysis of 600 mL aqueous solution of NaCl for 5 min changes the pH of the solution to 12.

The current in Amperes used for the given electrolysis is ____. (Nearest integer).

Ans. **(2)**

Sol. Electrolysis of NaCl is

$$NaCl + H_2O\,(aq) \rightarrow NaOH\,(aq) + \frac{1}{2}Cl_2(g) + \frac{1}{2}H_2(g)$$

Since during electrolysis pH changes to 12

So $[OH^{\ominus}] = 10^{-2}$ and $[H^+] = 10^{-12}$

So by Faraday law

Gram amount of substance deposited = Amount of electricity passed

$$10^{-2} \times \frac{600}{1000} \times 96500 = I \times t$$

$$\frac{10^{-2} \times 600}{1000} \times 96500 = I \times 5 \times 60$$

$$I = \frac{10^{-2} \times 600 \times 96500}{1000 \times 5 \times 60}$$

I = 1.93 ampere

So, I = 2 ampere (nearest integer)

74. A group 15 element forms dπ–dπ bond with transition metals. It also forms hydride, which is a strongest base among the hydrides of other group members that form dπ–dπ bond. The atomic number of the element is _____.

Ans. **(15)**

Sol. Phosphorus belongs to 15^{th} group and forms dπ – dπ bond with transition metal and PH_3 is strongest base among the other group members excepet NH_3.

75. Total number of molecules/species from following which will be paramagnetic is _____.

O_2, O_2^+, O_2^-, NO, NO_2, CO, $K_2[NiCl_4]$, $[Co(NH_3)_6]Cl_3$, $K_2[Ni(CN)_4]$

Ans. **(6)**

Sol. $O_2 \rightarrow$ 2 unpaired electrons according to MOT

$O_2^+ \rightarrow$ 1 unpaired electrons according to MOT

$O_2^- \rightarrow$ 1 unpaired electrons according to MOT

NO $\rightarrow$ odd electron species

$NO_2 \rightarrow$ odd electron species

$K_2[NiCl_4] \rightarrow Ni^{2+} \Rightarrow 3d^8$ weak Ligand, C.N. = 4

$\Rightarrow$ Tetrahedral, Paramagnetic with 2 unpaired electrons

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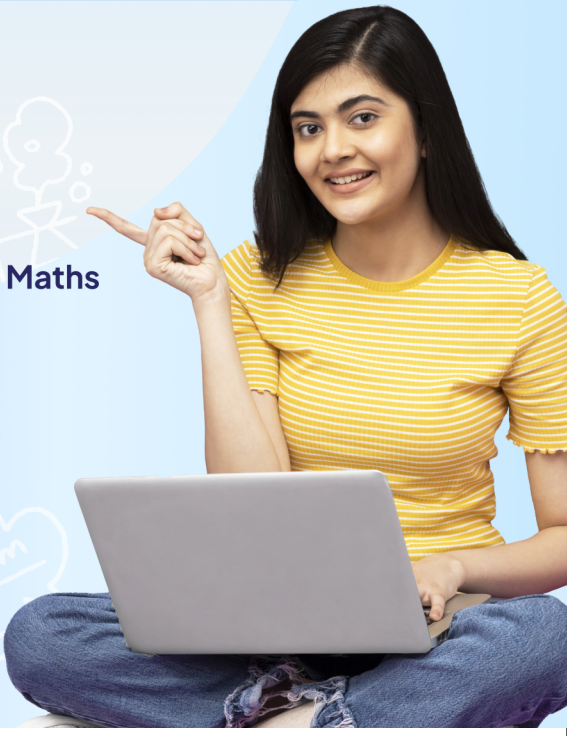

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