

# FINAL JEE-MAIN EXAMINATION – JANUARY, 2024

(Held On Wednesday 31<sup>st</sup> January, 2024)

TIME : 3 : 00 PM to 6 : 00 PM

## CHEMISTRY

### SECTION-A

61. Match List I with List II

LIST – I (Complex ion)		LIST – II (Electronic Configuration)	
A.	$[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$	I.	$t_{2g}^2 e_g^0$
B.	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$	II.	$t_{2g}^3 e_g^0$
C.	$[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$	III.	$t_{2g}^3 e_g^2$
D.	$[\text{V}(\text{H}_2\text{O})_6]^{3+}$	IV.	$t_{2g}^6 e_g^2$

Choose the correct answer from the options given below :

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

**Ans. (4)**

**Sol:-**  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$  Contains  $\text{Cr}^{3+} : [\text{Ar}]3d^3 : t_{2g}^3 e_g^0$

$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$  Contains  $\text{Fe}^{3+} : [\text{Ar}]3d^5 : t_{2g}^3 e_g^2$

$[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$  Contains  $\text{Ni}^{2+} : [\text{Ar}]3d^8 : t_{2g}^6 e_g^2$

$[\text{V}(\text{H}_2\text{O})_6]^{3+}$  Contains  $\text{V}^{3+} : [\text{Ar}]3d^2 : t_{2g}^2 e_g^0$

62. A sample of  $\text{CaCO}_3$  and  $\text{MgCO}_3$  weighed 2.21 g is ignited to constant weight of 1.152 g. The composition of mixture is :

(Given molar mass in g mol<sup>-1</sup>)

$\text{CaCO}_3 : 100, \text{MgCO}_3 : 84$ )

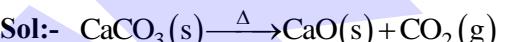
(1) 1.187 g  $\text{CaCO}_3 + 1.023$  g  $\text{MgCO}_3$

(2) 1.023 g  $\text{CaCO}_3 + 1.023$  g  $\text{MgCO}_3$

(3) 1.187 g  $\text{CaCO}_3 + 1.187$  g  $\text{MgCO}_3$

(4) 1.023 g  $\text{CaCO}_3 + 1.187$  g  $\text{MgCO}_3$

**Ans. (1)**



Let the weight of  $\text{CaCO}_3$  be x gm

$\therefore$  weight of  $\text{MgCO}_3 = (2.21 - x)$  gm

Moles of  $\text{CaCO}_3$  decomposed = moles of  $\text{CaO}$  formed

$$\frac{x}{100} = \text{moles of CaO formed}$$

$$\therefore \text{weight of CaO formed} = \frac{x}{100} \times 56$$

Moles of  $\text{MgCO}_3$  decomposed = moles of  $\text{MgO}$  formed

$$\frac{(2.21 - x)}{84} = \text{moles of MgO formed}$$

$$\therefore \text{weight of MgO formed} = \frac{2.21 - x}{84} \times 40$$

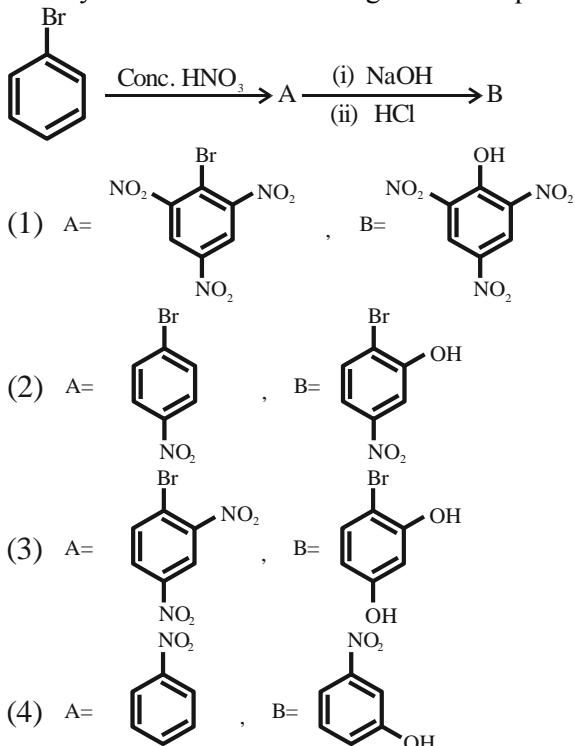
$$\Rightarrow \frac{2.21 - x}{84} \times 40 + \frac{x}{100} \times 56 = 1.152$$

$$\therefore x = 1.1886 \text{ g} = \text{weight of } \text{CaCO}_3$$

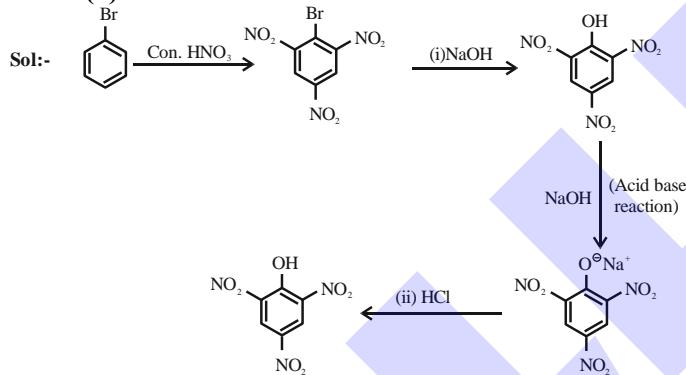
$$\& \text{ weight of } \text{MgCO}_3 = 1.0214 \text{ g}$$



63. Identify A and B in the following reaction sequence.



Ans. (1)



64. Given below are two statements :

**Statement I:**  $\text{S}_8$  solid undergoes disproportionation reaction under alkaline conditions to form  $\text{S}^{2-}$  and  $\text{S}_2\text{O}_3^{2-}$

**Statement II:**  $\text{ClO}_4^-$  can undergo disproportionation reaction under acidic condition.

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

- Statement I is correct but statement II is incorrect.
- Statement I is incorrect but statement II is correct
- Both statement I and statement II are incorrect
- Both statement I and statement II are correct

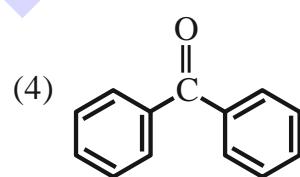
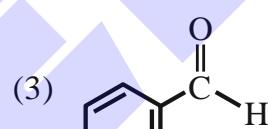
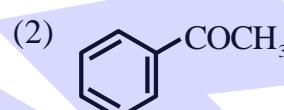
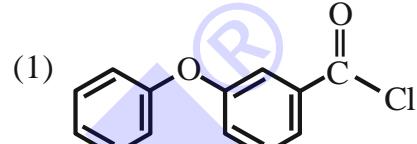
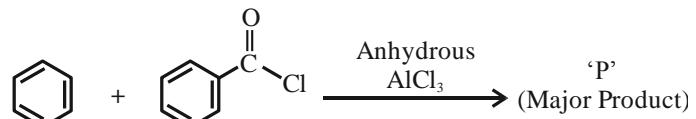
Ans. (1)

Sol:-

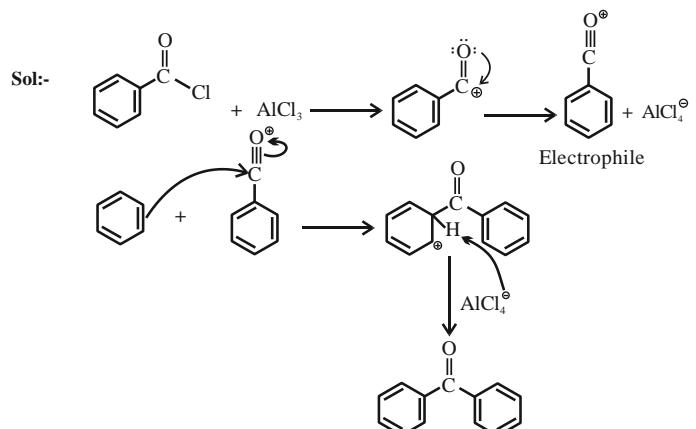


$\text{S}_2 : \text{ClO}_4^\ominus$  cannot undergo disproportionation reaction as chlorine is present in its highest oxidation state.

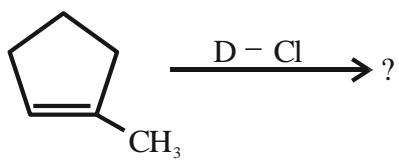
65. Identify major product 'P' formed in the following reaction.



Ans. (4)

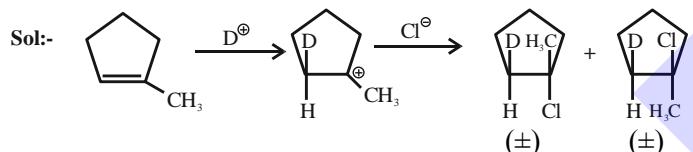


66. Major product of the following reaction is –



- (1)
- (2)
- (3)
- (4)

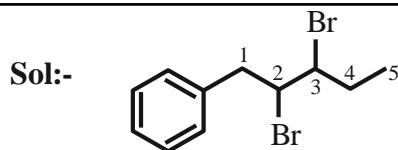
Ans. (3 or 4)



67. Identify structure of 2,3-dibromo-1-phenylpentane.

- 1.
- 2.
- 3.
- 4.

Ans. (3)



2, 3-dibromo -1-phenylpentane

68. Select the option with correct property -

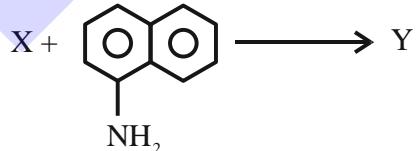
- (1)  $[Ni(CO)_4]$  and  $[NiCl_4]^{2-}$  both diamagnetic
- (2)  $[Ni(CO)_4]$  and  $[NiCl_4]^{2-}$  both paramagnetic
- (3)  $[NiCl_4]^{2-}$  diamagnetic,  $[Ni(CO)_4]$  paramagnetic
- (4)  $[Ni(CO)_4]$  diamagnetic,  $[NiCl_4]^{2-}$  paramagnetic

Ans. (4)

Sol:-  $[Ni(CO)_4] \rightarrow$  diamagnetic,  $sp^3$  hybridisation,  
number of unpaired electrons = 0

$[NiCl_4]^{2-}$ ,  $\rightarrow$  paramagnetic,  $sp^3$  hybridisation,  
number of unpaired electrons = 2

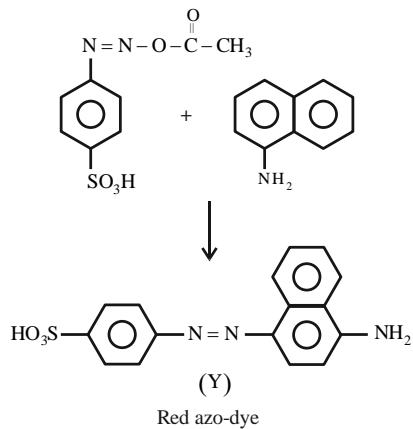
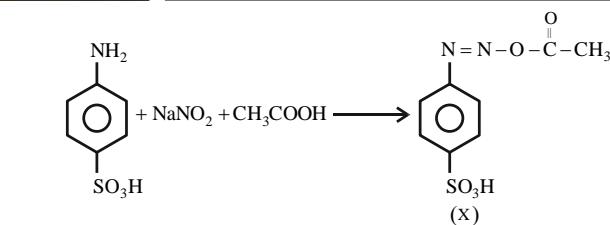
69. The azo-dye (Y) formed in the following reactions is Sulphanilic acid +  $NaNO_2 + CH_3COOH \rightarrow X$



- 1.
- 2.
- 3.
- 4.

Ans. (4)



**Sol:-**


This is known as Griess-Ilosvay test.

70. Given below are two statements :

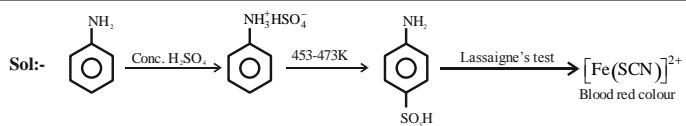
**Statement I:** Aniline reacts with con.  $\text{H}_2\text{SO}_4$  followed by heating at 453-473 K gives p-aminobenzene sulphonic acid, which gives blood red colour in the 'Lassaigne's test'.

**Statement II:** In Friedel - Craft's alkylation and acylation reactions, aniline forms salt with the  $\text{AlCl}_3$  catalyst. Due to this, nitrogen of aniline acquires a positive charge and acts as deactivating group.

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 false
3. Statement I is true but statement II is false
4. Both statement I and statement II are true

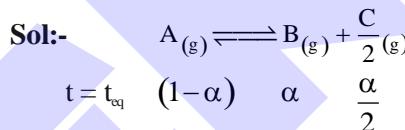
**Ans. (4)**



71.  $\text{A}_{(g)} \rightleftharpoons \text{B}_{(g)} + \frac{\text{C}}{2}_{(g)}$  The correct relationship between  $K_p$ ,  $\alpha$  and equilibrium pressure  $P$  is

- (1)  $K_p = \frac{\alpha^{1/2} P^{1/2}}{(2+\alpha)^{1/2}}$
- (2)  $K_p = \frac{\alpha^{3/2} P^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)}$
- (3)  $K_p = \frac{\alpha^{1/2} P^{3/2}}{(2+\alpha)^{3/2}}$
- (4)  $K_p = \frac{\alpha^{1/2} P^{1/2}}{(2+\alpha)^{3/2}}$

**Ans. (2)**



$$P_B = \frac{\alpha}{\left(1 + \frac{\alpha}{2}\right)} \cdot P, \quad P_A = \frac{(1-\alpha)}{\left(1 + \frac{\alpha}{2}\right)} \cdot P, \quad P_C = \frac{\frac{\alpha}{2}}{\left(1 + \frac{\alpha}{2}\right)} \cdot P$$

$$K_p = \frac{P_B \cdot P_C^{\frac{1}{2}}}{P_A}$$

$$= \frac{(\alpha)^{\frac{3}{2}} (P)^{\frac{1}{2}}}{(1-\alpha)(2+\alpha)^{\frac{1}{2}}}$$

72. Choose the correct statements from the following
- A. All group 16 elements form oxides of general formula  $\text{EO}_2$  and  $\text{EO}_3$  where E = S, Se, Te and Po. Both the types of oxides are acidic in nature.
  - B.  $\text{TeO}_2$  is an oxidising agent while  $\text{SO}_2$  is reducing in nature.
  - C. The reducing property decreases from  $\text{H}_2\text{S}$  to  $\text{H}_2\text{Te}$  down the group.
  - D. The ozone molecule contains five lone pairs of electrons.

Choose the correct answer from the options given below:

1. A and D only
2. B and C only
3. C and D only
4. A and B only

**Ans. (4)**





78. Choose the correct statements from the following

- $\text{Mn}_2\text{O}_7$  is an oil at room temperature
- $\text{V}_2\text{O}_4$  reacts with acid to give  $\text{VO}_2^{2+}$
- $\text{CrO}$  is a basic oxide
- $\text{V}_2\text{O}_5$  does not react with acid

Choose the correct answer from the options given below :

- A, B and D only
- A and C only
- A, B and C only
- B and C only

**Ans. (2)**

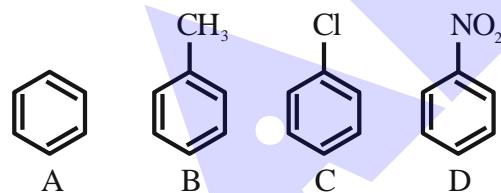
**Sol:-** (A)  $\text{Mn}_2\text{O}_7$  is green oil at room temperature.

(B)  $\text{V}_2\text{O}_4$  dissolve in acids to give  $\text{VO}_2^{2+}$  salts.

(C)  $\text{CrO}$  is basic oxide

(D)  $\text{V}_2\text{O}_5$  is amphoteric it reacts with acid as well as base.

79. The correct order of reactivity in electrophilic substitution reaction of the following compounds is :



- $\text{B} > \text{C} > \text{A} > \text{D}$
- $\text{D} > \text{C} > \text{B} > \text{A}$
- $\text{A} > \text{B} > \text{C} > \text{D}$
- $\text{B} > \text{A} > \text{C} > \text{D}$

**Ans. (4)**

**Sol:-**  $-\text{CH}_3$  shows +M and +I.

$-\text{Cl}$  shows +M and -I but inductive effect dominates.

$-\text{NO}_2$  shows -M and -I.

Electrophilic substitution  $\alpha \frac{1}{-\text{M and } -\text{I}}$   
 $\alpha + \text{M and } +\text{I}$

Hence, order is  $\text{B} > \text{A} > \text{C} > \text{D}$ .

80. Consider the following elements.

Group  $\downarrow$   $\text{A}'\text{B}' \rightarrow$  Period  
 $\text{C}'\text{D}'$

Which of the following is/are true about  $\text{A}', \text{B}', \text{C}'$  and  $\text{D}'$  ?

- Order of atomic radii:  $\text{B}' < \text{A}' < \text{D}' < \text{C}'$
- Order of metallic character :  $\text{B}' < \text{A}' < \text{D}' < \text{C}'$
- Size of the element :  $\text{D}' < \text{C}' < \text{B}' < \text{A}'$
- Order of ionic radii :  $\text{B}'^+ < \text{A}'^+ < \text{D}'^+ < \text{C}'^+$

Choose the correct answer from the options given below :

- A only
- A, B and D only
- A and B only
- B, C and D only

**Ans. (2)**

**Sol:-** In general along the period from left to right, size decreases and metallic character decrease.

In general down the group, size increases and metallic character increases.

$\text{B}' < \text{A}'$  (size)     $\text{C}' > \text{A}'$  (size)

$\text{D}' < \text{C}'$  (size)     $\text{D}' > \text{B}'$  (size)

$\text{B}' < \text{A}'$  (metallic character)

$\text{D}' < \text{C}'$  (metallic character)

$\text{B}'^+ < \text{A}'^+$  (size)

$\text{D}'^+ < \text{C}'^+$  (size)

$\therefore$  C statement is incorrect.



**SECTION-B**

81. A diatomic molecule has a dipole moment of 1.2 D. If the bond distance is  $1\text{ \AA}$ , then fractional charge on each atom is \_\_\_\_\_  $\times 10^{-1}$  esu.  
 (Given  $1\text{ D} = 10^{-18}$  esu cm)

**Ans. (0)**

$$\text{Sol:- } \mu = 1.2 \text{ D} = q \times d$$

$$\Rightarrow 1.2 \times 10^{-10} \text{ esu \AA} = q \times 1\text{ \AA}$$

$$\therefore q = 1.2 \times 10^{-10} \text{ esu}$$

82.  $r = k[A]$  for a reaction, 50% of A is decomposed in 120 minutes. The time taken for 90% decomposition of A is \_\_\_\_\_ minutes.

**Ans. (399)**

$$\text{Sol:- } r = k[A]$$

So, order of reaction = 1

$$t_{1/2} = 120 \text{ min}$$

For 90% completion of reaction

$$\Rightarrow k = \frac{2.303}{t} \log \left( \frac{a}{a-x} \right)$$

$$\Rightarrow \frac{0.693}{t_{1/2}} = \frac{2.303}{t} \log \frac{100}{10}$$

$$\therefore t = 399 \text{ min.}$$

83. A compound (x) with molar mass  $108 \text{ g mol}^{-1}$  undergoes acetylation to give product with molar mass  $192 \text{ g mol}^{-1}$ . The number of amino groups in the compound (x) is \_\_\_\_\_.

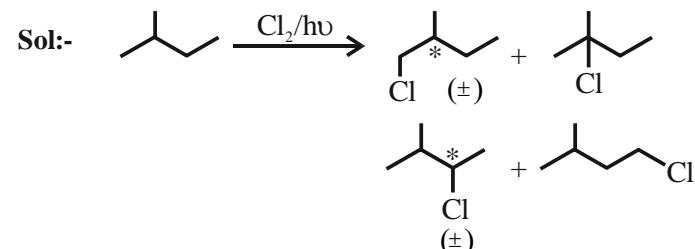
**Ans. (2)**

Gain in molecular weight after acylation with one  $-\text{NH}_2$  group is 42.

Total increase in molecular weight = 84

$$\therefore \text{Number of amino group in } x = \frac{84}{42} = 2$$

84. Number of isomeric products formed by monochlorination of 2-methylbutane in presence of sunlight is \_\_\_\_\_.

**Ans. (6)**

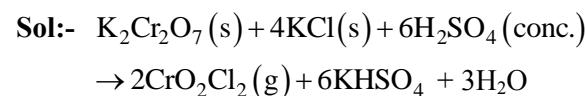
$\therefore$  Number of isomeric products = 6

85. Number of moles of  $\text{H}^+$  ions required by 1 mole of  $\text{MnO}_4^-$  to oxidise oxalate ion to  $\text{CO}_2$  is \_\_\_\_\_.

**Ans. (8)****Sol:-**

$\therefore$  Number of moles of  $\text{H}^+$  ions required by 1 mole of  $\text{MnO}_4^-$  to oxidise oxalate ion to  $\text{CO}_2$  is 8

86. In the reaction of potassium dichromate, potassium chloride and sulfuric acid (conc.), the oxidation state of the chromium in the product is (+) \_\_\_\_\_.

**Ans. (6)**

This reaction is called chromyl chloride test.

Here oxidation state of Cr is +6.

87. The molarity of 1L orthophosphoric acid ( $\text{H}_3\text{PO}_4$ ) having 70% purity by weight (specific gravity  $1.54 \text{ g cm}^{-3}$ ) is \_\_\_\_\_ M.

(Molar mass of  $\text{H}_3\text{PO}_4 = 98 \text{ g mol}^{-1}$ )

**Ans. (11)**

**Sol:-** Specific gravity (density) = 1.54 g/cc.

$$\text{Volume} = 1\text{L} = 1000 \text{ ml}$$

$$\text{Mass of solution} = 1.54 \times 1000 \\ = 1540 \text{ g}$$

% purity of  $\text{H}_2\text{SO}_4$  is 70%

$$\text{So weight of } \text{H}_3\text{PO}_4 = 0.7 \times 1540 = 1078 \text{ g}$$

$$\text{Mole of } \text{H}_3\text{PO}_4 = \frac{1078}{98} = 11$$

$$\text{Molarity} = \frac{11}{1\text{L}} = 11$$

- 88.** The values of conductivity of some materials at 298.15 K in  $\text{Sm}^{-1}$  are  $2.1 \times 10^3$ ,  $1.0 \times 10^{-16}$ ,  $1.2 \times 10$ ,  $3.91$ ,  $1.5 \times 10^{-2}$ ,  $1 \times 10^{-7}$ ,  $1.0 \times 10^3$ . The number of conductors among the materials is \_\_\_\_\_.

**Ans. (4)**

**Sol:-**

**Conductivity ( $\text{S m}^{-1}$ )**

$$\left. \begin{array}{l} 2.1 \times 10^3 \\ 1.2 \times 10 \\ 3.91 \\ 1 \times 10^3 \end{array} \right\} \text{conductors at 298.15 K}$$

$1 \times 10^{-16}$  Insulator at 298.15 K

$$\left. \begin{array}{l} 1.5 \times 10^{-2} \\ 1 \times 10^{-7} \end{array} \right\} \text{Semiconductor at 298.15 K}$$

Therefore number of conductors is 4.

- 89.** From the vitamins A, B<sub>1</sub>, B<sub>6</sub>, B<sub>12</sub>, C, D, E and K, the number vitamins that can be stored in our body is \_\_\_\_\_.

**Ans. (5)**

**Sol:-** Vitamins A, D, E, K and B<sub>12</sub> are stored in liver and adipose tissue.

- 90.** If 5 moles of an ideal gas expands from 10 L to a volume of 100 L at 300 K under isothermal and reversible condition then work, w, is  $-x$  J. The value of  $x$  is \_\_\_\_\_.

(Given R = 8.314 J K<sup>-1</sup>mol<sup>-1</sup>)

**Ans. (28721)**

**Sol:-** It is isothermal reversible expansion, so work done negative

$$W = -2.303 nRT \log\left(\frac{V_2}{V_1}\right)$$

$$= -2.303 \times 5 \times 8.314 \times 300 \log\left(\frac{100}{10}\right)$$

$$= -28720.713 \text{ J}$$

$$\equiv -28721 \text{ J}$$

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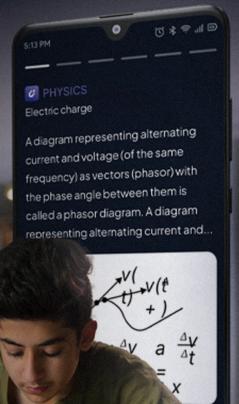


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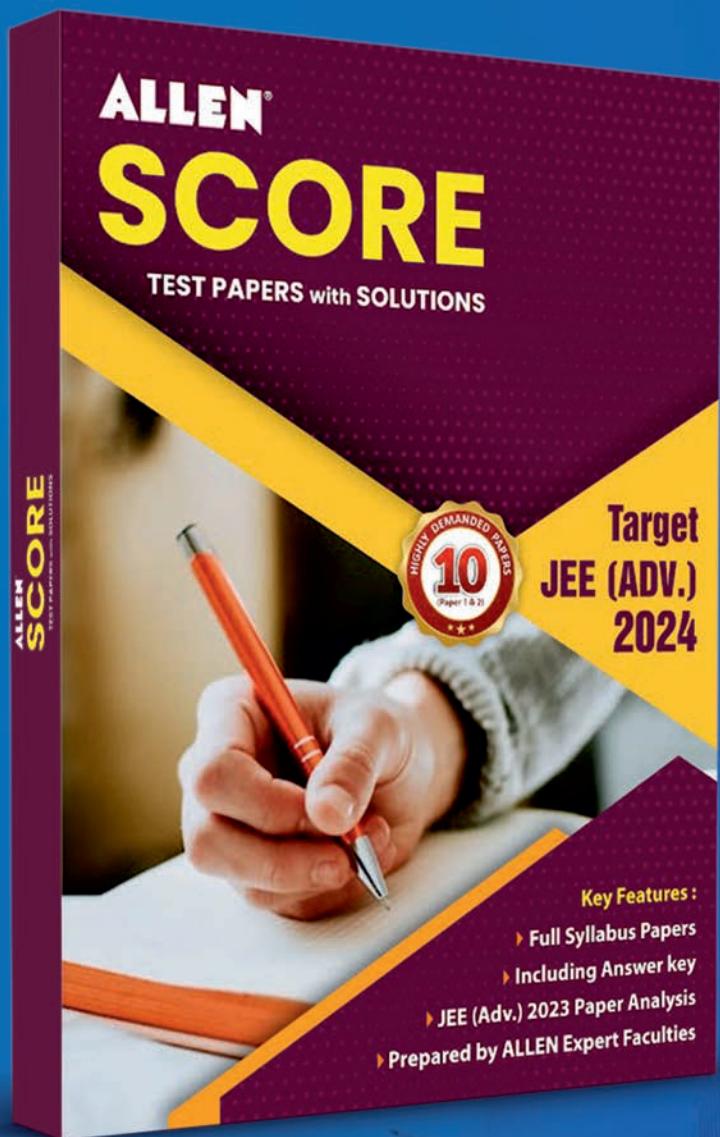


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