JEE (ADVANCED) 2019 PAPER-1

[PAPER WITH SOLUTION]

HELD ON SUNDAY 27TH MAY, 2019

CHEMISTRY

SECTION 1 (Maximum Marks : 12)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : **+3** If ONLY the correct option is chosen.
  Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).
  Negative Marks : **–1** In all other cases.

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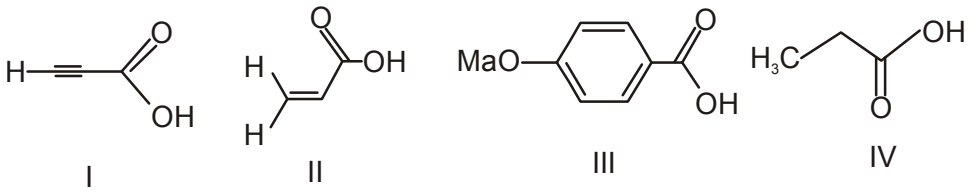
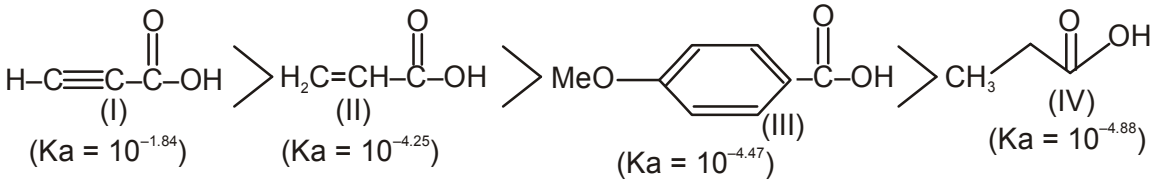
1. The correct order of acid strength of the following carboxylic acids is :



1. I > III > II > IV
2. I> II > III > IV
3. II > I > IV > III
4. III > II > I > IV

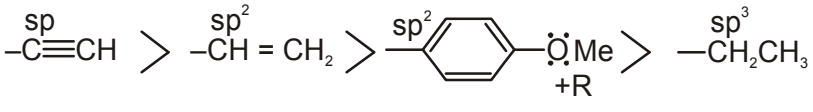
Ans. **(2)**

Sol. Acidic strength

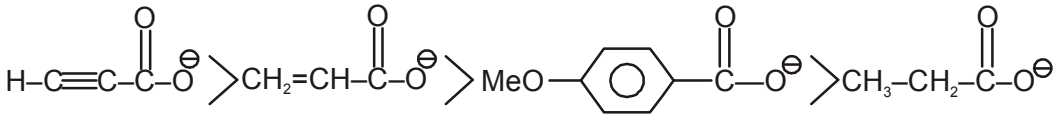


Reasons:

$\because$ –I effect of



$\therefore$ Stability of conjugate anion



2. The green colour produced in the borax bead test of a chromium (III) salt is due to :

1. $Cr_2(B_4O_7)_3$ 2. Cr_2O_3 3. CrB 4. $Cr(BO_2)_3$

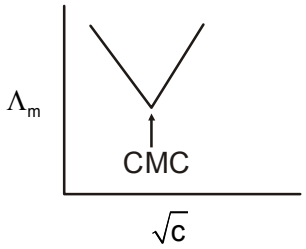
Ans. (4)

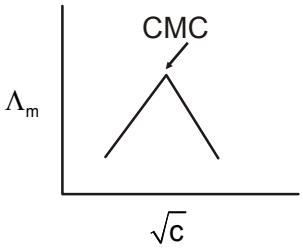
Sol. $Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7 + 10H_2O$

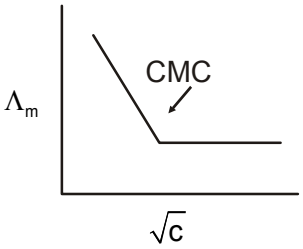
$Na_2B_4O_7 \xrightarrow{\Delta} \underbrace{NaBO_2 + B_2O_3}_{\text{Bead material}}$

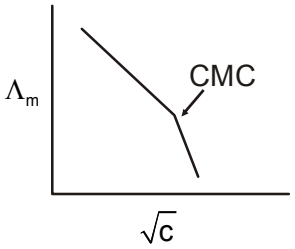
$\therefore \quad Cr_2O_3 + B_2O_3 \longrightarrow \underset{\text{green}}{2Cr(BO_2)_3}$

3. Molar conductivity (Λ_m) of aqueous solution of sodium stearate, which behaves as a strong electrolyte, is recorded at varying concentrations (c) of sodium stearate. Which one of the following plots provides the correct representation of micelle formation in the solution ? (critical micelle concentration (CMC) is marked with an arrow in the figures.

1. 

2. 

3. 

4. 

Ans. (4)

Sol. Initially Λ_m decreases with increase in $\sqrt{C}$ but after CMC, further increase in $\sqrt{C}$ will cause Miscelle formation and hence number of free ions will fall substantially and that's why Λ_m will decrease even more.

4. Calamine, malachite, magnetite and cryolite, respectively, are :

1. $ZnCO_3$, $CuCO_3.Cu(OH)_2$, Fe_3O_4, Na_3AlF_6
2. $ZnCO_3$, $CuCO_3$, Fe_2O_3, Na_3AlF_6
3. $ZnSO_4$, $Cu(OH)_2$, Fe_3O_4, Na_2AlF_6
4. $ZnSO_4$, $CuCO_3$, Fe_2O_3, AlF_3

Ans. **(1)**

Sol. Calamine — $ZnCO_3$

Malachite — $CaCO_3.Cu\ (OH)_2$

Cryolite — $Na_3[AlF_6]$

Magnetite — Fe_3O_4

SECTION 2 (Maximum Marks : 32)

- This section contains **EIGHT (08)** questions.
- Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct option(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

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

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

1. Which of the following statement(s) is (are) correct regarding the root mean square speed (U_{rms}) and average translational kinetic energy (E_{av}) of a molecule in a gas at equilibrium ?

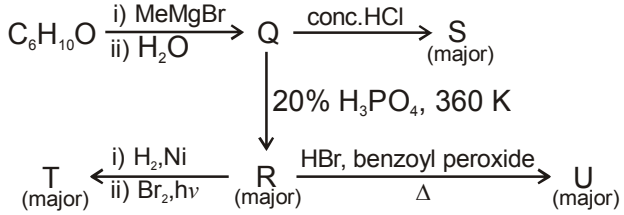
1. U_{rms} is inversely proportional to the square root of its molecular mass
2. U_{rms} is doubled when its temperature is increased four times
3. E_{av} is doubled when its temperature is increased four times
4. E_{av} at a given temperature does not depend on its molecular mass.

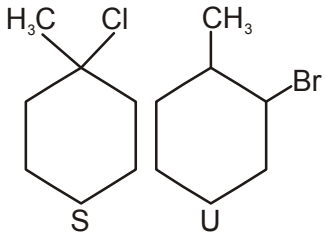
1. (1,2,4)

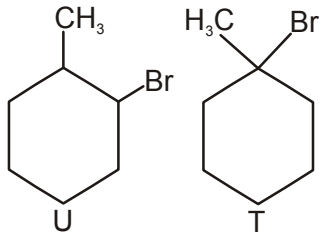
$$U_{rms} \propto \left(\frac{T}{M}\right)^{1/2}$$

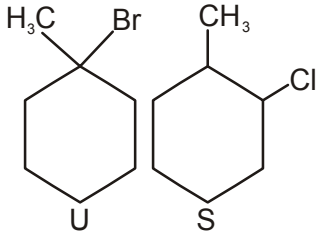
$$(E_{av}) \propto (T)$$

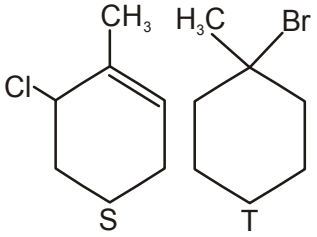
2. Choose the correct option(s) for the following set of reactions.



1. 

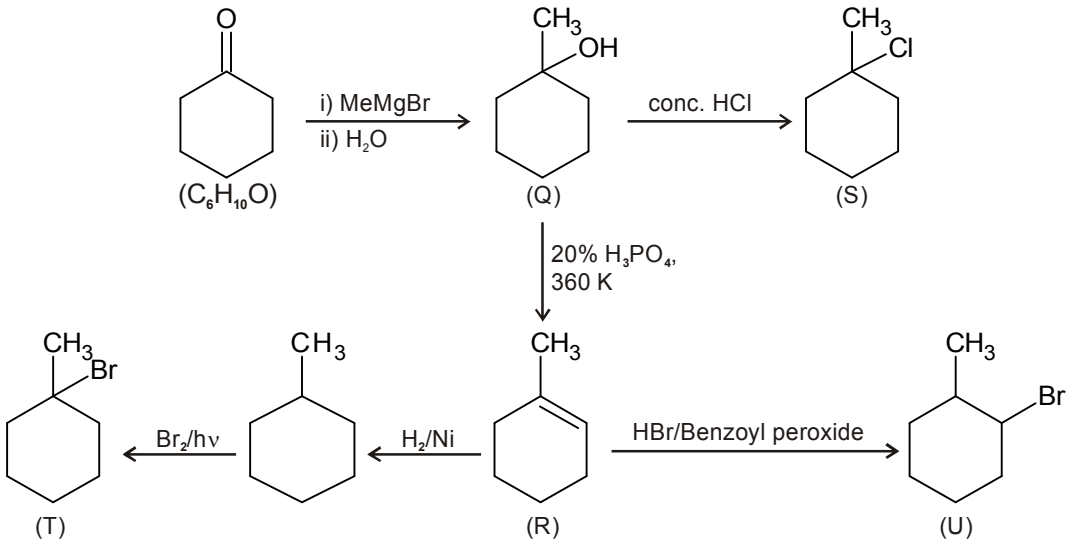
2. 

3. 

4. 

Ans. (1,2)

Sol.

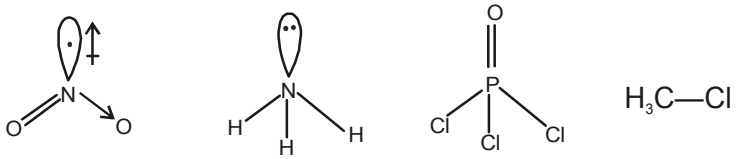


3. Each of the following options contains a set of four molecules. Identify the option(s) where all four molecules possess permanent dipole moment at room temperature.

1. NO_2, NH_3, $POCl_3$, CH_3Cl
2. SO_2, C_6H_5Cl, H_2Se, BrF_5
3. BF_3, O_3, SF_6, XeF_6
4. $BeCl_2$, CO_2, BCl_3, $CHCl_3$

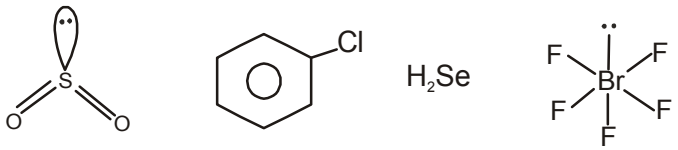
Ans. (1, 2)

Sol. (1)



$\mu \neq 0$ $\mu \neq 0$ $\mu \neq 0$ $\mu \neq 0$

(2)



$\mu \neq 0$ $\mu \neq 0$ $\mu \neq 0$ $\mu \neq 0$

4. Which of the following statement(s) is (are) true?

1. Monosaccharides cannot be hydrolysed to give polyhydroxy aldehydes and ketones
2. Hydrolysis of sucrose gives dextrorotatory glucose and laevorotatory fructose
3. The two six-membered cyclic hemiacetal forms of D–(+)– glucose are called anomers

4. Oxidation of glucose with bromine water gives glutamic acid

Ans. (1,2,3)

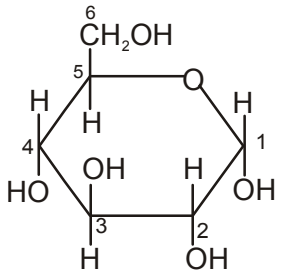
Sol.

(1) Monosaccharides cannot be hydrolysed further to give simplex unit of polyhydroxy aldehyde or ketone example, Glucose, Fructose etc

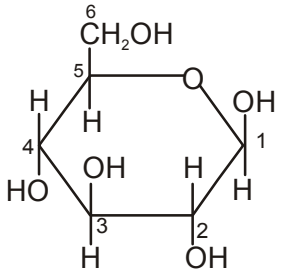
(2) Sucrose is disaccharide which gives two monosaccharides units on hydrolysis

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{(d)Glucose}}{C_6H_{12}O_6} + \underset{(\ell)\text{Fructose}}{C_6H_{12}O_6}$$

(3)



α-D-(+)Glucopyranose

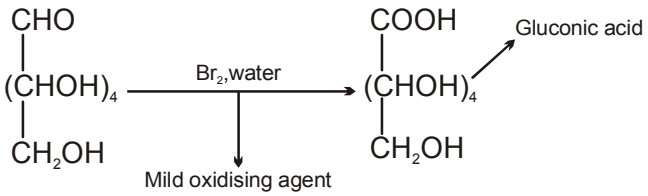


β-D-(+)Glucopyranose

These are six membered cyclic hemiacetal rings.

The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C_1 called anomeric carbon such isomers $\alpha-$form and $\beta-$form are called anomers.

(4)



5. Fusion of MnO_2 with KOH in presence of O_2 produces a salt W. Alkaline solution of W upon electrolytic oxidation yields another salt X. The manganese containing ions present in W and X respectively are Y and Z. Correct statement(s) is(are) :

1. Y is diamagnetic in nature while Z is paramagnetic
2. Both Y and Z are coloured and have tetrahedral shape
3. In both Y and Z π-bonding occurs between p-orbitals of oxygen and d-orbitals of manganese
4. In aqueous acidic solution. Y undergoes, disproportionation reaction to give Z and MnO_2.

Ans. (2,3,4)

Sol. $MnO_2 + KOH + O_2 \longrightarrow \underset{\text{green}}{K_2\overset{+6}{Mn}O_4}(W)$

$K_2MnO_4 + \text{Electrolytic oxidation} \xrightarrow{\text{alk.solution}} \underset{\text{(purple)}}{K\overset{(X)}{Mn}O_4}$

$Mn^{+6} \xrightarrow[\text{(disproportionate)}]{H^+} \underset{(Z)}{Mn^{+7}} + \overset{+4}{Mn}O_2$

$Y = Mn^{+6} \longrightarrow 3d^1$

$Z = Mn^{+7} \longrightarrow 3d^0$

6. Choose the reaction(s) from the following options for which the standard enthalpy of reaction is equal to the standard enthalpy of formation.

1. $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$
2. $\frac{3}{2}O_2(g) \longrightarrow O_3(g)$
3. $2C(g) + 3H_2(g) \longrightarrow C_2H_6(g)$
4. $\frac{1}{8}S_8(s) + O_2(g) \longrightarrow SO_2(g)$

Ans. (2,4)

Sol. The standard enthalpy change for the formation of one mole of a compound from its element in their most stable state of reference state is called molar enthalpy of formation.

Reference state taken at 25ºC and 1 bar pressure.

7. A tin chloride Q undergoes the following reactions (not balanced)

$Q + Cl^- \rightarrow X$
$Q + Me_3N \rightarrow Y$
$Q + CuCl_2 \rightarrow Z + CuCl$

X is a monoanion having pyramidal geometry. Both Y and Z are neutral compounds. Choose the correct option(s) :

1. There is a coordinate bond in Y
2. The central atom in Z has one lone pair of electrons
3. The oxidation state of the central atom in Z is +2
4. The central atom in X is sp^3 hybridized

Ans. (1,4)

Sol. $\underset{(Q)}{SnCl_2} + Cl^- \longrightarrow \underset{(X)}{\overset{\bullet\bullet}{Sn}Cl_3^-}$

$\underset{3d^o}{SnCl_2} + \overset{\bullet\bullet}{N}(Me)_3 \longrightarrow (Me)_3N: \xrightarrow[(Y)]{} SnCl_2$

$\underset{\text{(Reducing agent)}}{SnCl_2} + CuCl_2 \longrightarrow \underset{(Z)}{SnCl_4} + CuCl$

8. In the decay sequence.

$$^{238}_{92}U \xrightarrow{-x_1} {}^{234}_{90}Th \xrightarrow{-x_2} {}^{234}_{91}Pa \xrightarrow{-x_3} {}^{234}Z \xrightarrow{-x_4} {}^{230}_{90}Th$$

X_1, X_2, X_3 and X_4 are particles/radiation emitted by the respective isotopes. The correct option(s) is(are)

1. Z is an isotope of uranium
2. x_1 will deflect towards negatively charged plate
3. x_2 is β^-
4. x_3 is γ ray

Ans. (1,2,3)

Sol. $^{238}_{92}U \xrightarrow{-X_1} {}^{234}_{90}Th \xrightarrow{-X_2} {}^{234}_{91}Pa \xrightarrow{-X_3} {}^{234}_{92}Z \xrightarrow{-X_4} {}^{230}_{90}Th$

$X_1 = \alpha - \text{decay}; \quad X_3 = \beta - \text{decay}$

$X_2 = \beta^- - \text{decay}; \; X_4 = \alpha - \text{decay}$

$^{238}_{92}U$ & $^{234}_{92}Z$ are isotopes.

X_i is $\alpha -$particle(He^{2+}) so deflected toward negative plate.

SECTION 3 (Maximum Marks : 18)

- This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value of to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : **+3** If ONLY the correct numerical value is entered.

  Zero Marks **: 0** In all other cases.

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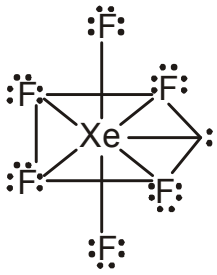
1. At 143 K, the reaction of XeF_4 with O_2F_2; produces a xenon compound Y. The total number of lone pair(s) of electrons present on the whole molecule of Y is_____

Ans. (19.00)

Sol. $XeF_4 + \underset{\substack{\text{(Stronger fluoronating}\\ \text{agent)}}}{O_2F_2} \xrightarrow{143K} XeF_6 + O_2$



Total lone pair = 19.00

2. For the following reaction the equilibrium constant K_c at 298 K is 1.6×10^{17}

$$Fe^{2+}(aq) + S^{2-}(aq) \rightleftharpoons FeS(s)$$

When equal volumes of 0.06 M Fe^{2+} (aq) and 0.2 M S^{2-} (aq) solutions are mixed, the equilibrium concentration of Fe^{2+} (aq) is found to be Y × 10^{-17} M. The value of Y is_____

2. (8.93)

	$Fe^{2+}(aq)$ +	$S^{2-}(aq) \rightleftharpoons$	$FeS; K_C = 1.6\times10^{17}$
	V(L), 0.06M	V(L), 0.2M	
	0.06V mole	0.2V mole	
$t = 0$; After mixing	0.03 M	0.1M	
$t = t_{eq.}$;	$0.03 - x$ M	$0.10 - x$	

$\because$ $K_C = 1.6\times10^{17} > 10^3$

$\therefore$ Concentration of reactant can be neglected in comparison to concentration of product.

$\therefore$ $x \simeq 0.03$

$[Fe^{2+}] = ?,\ [S^{2-}] = 0.07$ M

$$K_C = \frac{[FeS(s)]}{[Fe^{2+}][S^{2-}]};\ [Fe^{2+}] = \frac{1}{K_C\cdot[S^{2-}]}$$

$$[Fe^{2+}] = \frac{1}{1.6\times10^{17}\times0.07} = 8.9285\times10^{-17}$$

or, $Y\times10^{-17} = 8.9285\times10^{-17}$

$\therefore$ $Y = 8.93$

3. Consider the kinetic data given in the following table for the reaction A+B+C $\rightarrow$ Product

Experminent No.	[A] (mol dm^{-3})	[B] (mol dm^{-3})	[C] (moldm^{-3})	Rate of reaction (mol dm^{-3} s^{-1})
1	0.2	0.1	0.1	6.0×10^{-5}
2	0.2	0.2	0.1	6.0×10^{-5}
3	0.2	0.1	0.2	1.2×10^{-5}
4	0.3	0.1	0.1	9.0×10^{-5}

The rate of the reaction for [A]=0.15 mol dm^{-3} [B] = 0.25 mol dm^{-3} and [C] = 0.15 mol dm^{-3} is found to be Y × 10^{-5}. The value of Y is _____

3. (6.75)

Reaction : $A + B + C \longrightarrow$ Product

Rate of reaction = $K[A]^x[B]^y[C]^Z$

$6\times10^{-5} = K[0.2]^x[0.1]^y[0.1]^Z$ **.....(i)**

$6\times10^{-5} = K[0.2]^x[0.2]^y[0.1]^Z$ **.....(ii)**

$1.2\times10^{-4} = K[0.2]^x[0.1]^y[0.2]^Z$ **.....(iii)**

$9\times10^{-5} = K[0.3]^x[0.1]^y[0.1]^Z$ **.....(iv)**

From (i) and (ii) ; $\frac{6\times10^{-5}}{6\times10^{-5}} = \left(\frac{1}{2}\right)^y$; $y = 0$

From (i) and (iii) ; $\frac{6\times10^{-5}}{12\times10^{-5}} = \left(\frac{1}{2}\right)^z$; $z = 1$

From (i) and (iv) ; $\frac{6\times10^{-5}}{9\times10^{-5}} = \left(\frac{2}{3}\right)^x$; $x = 1$

From (i) $6\times10^{-5} = K[0.2][0.1]$; $K = 3\times10^{-3}$

$\because$ $[A] = 0.15M, [B] = 0.25M, [C] = 0.151$

$Rate = K[A]^1[B]^0[C]^1$

$= 3\times10^{-3}\times0.15\times1\times0.15$

$= 6.75\times10^{-5}\times10^{-5} M/sec = Y\times10^{-5}$

Y = 6.75

4. On dissolving 0.5g of a non-volatile non-ionic soluble to 39g of benzene, its vapour pressure decreases from 650 mm Hg to 640 mm Hg. The depression of freezing point of benzene (in K) upon addition of the solute is _____.

(Given data: Molar mass and the molal freezing point depressing constant of benzene are 78g mol^{-1} and 5.12 K kg mol^{-1} respectively)

4. (1.03)

$\frac{P^o - P_S}{P_S} = \frac{n}{N}$

or, $\frac{650-640}{640} = \frac{\frac{0.5}{M}}{\frac{39}{78}}$

or, $\frac{10}{640} = \frac{0.5}{M}\times2$

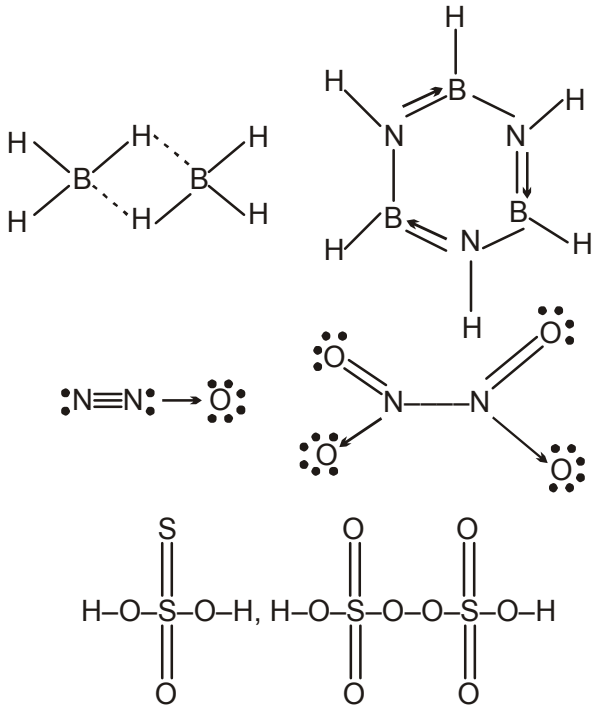
$\therefore$ M = 64 $\Rightarrow$ molar mass of solute.

Now, $\Delta T_f = K_f \cdot m$

$= 5.12\times\frac{0.5\times1000}{64\times39} = 1.02564 \simeq 1.03$

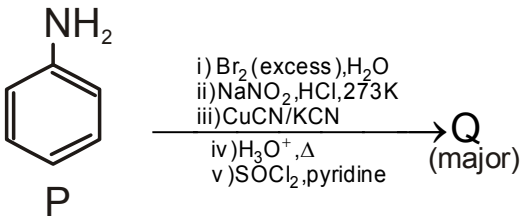
5. Among B_2H_6, $B_3N_3H_6$, N_2O, N_2O_4, $H_2S_2O_3$ and $H_2S_2O_8$, the total number of molecules containing covalent bond between two atoms of the same kind is_____

5. (4.00)

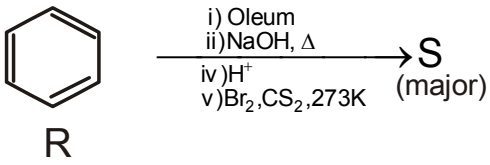


6. Schemes 1 and 2 describe the conversion of P to Q and R to S, respectively. Scheme 3 describes the synthesis of T from Q and S. The total number of Br atoms in a molecule of T is__

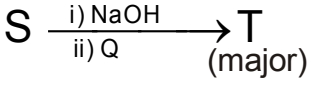
Scheme -1 :



Scheme – 2 :

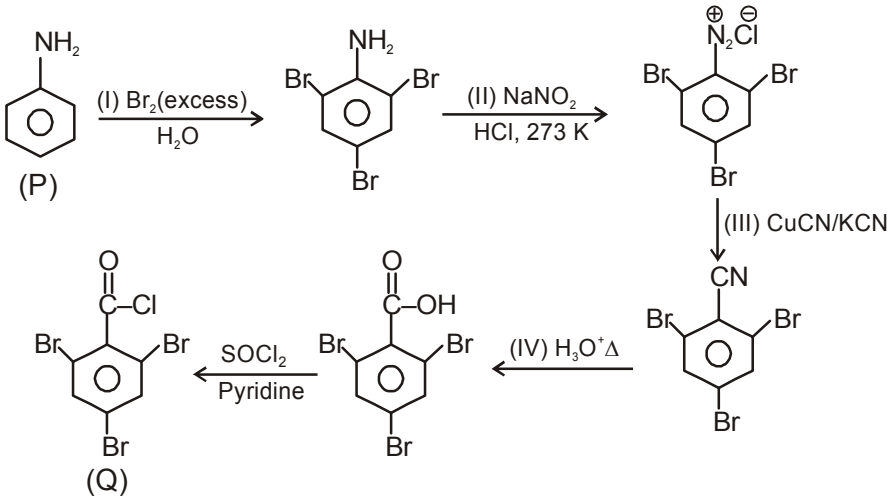


Scheme – 3 :

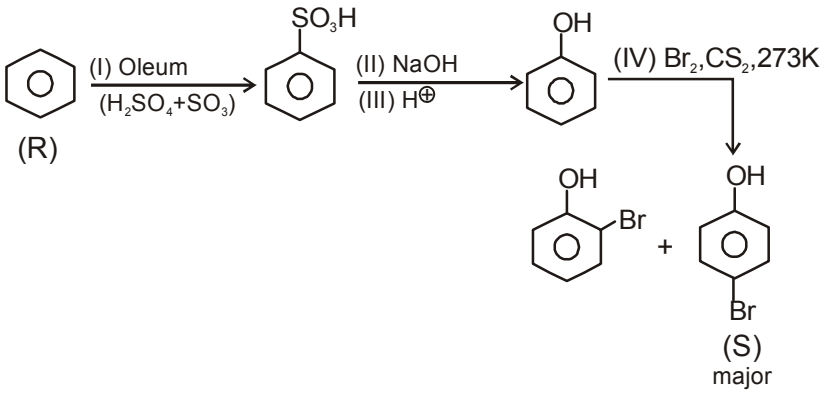


Ans. (4)

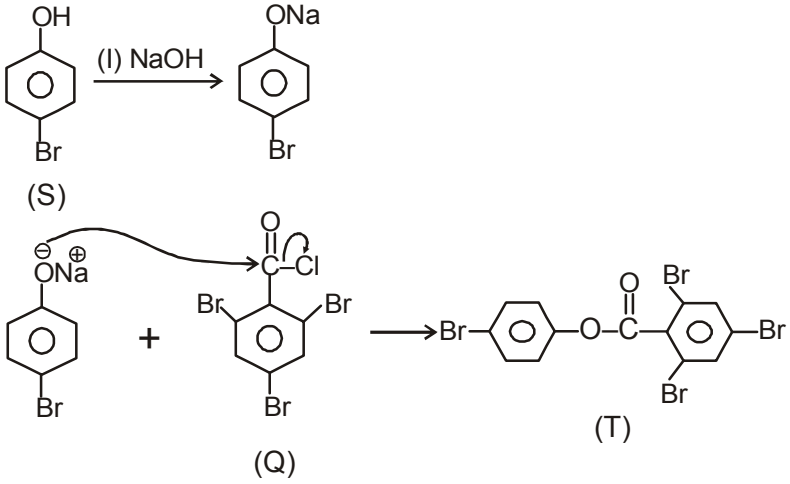
Sol. Scheme - I



Scheme – 2



Scheme – 3



Total no. of Br atom in (T) molecule is 4