JEE Main February 2021

Question Paper With Text Solution

26 Feb.| Shift-1

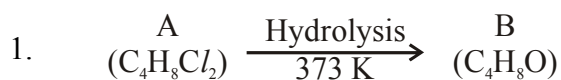# CHEMISTRY

MATRIX

JEE Main & Advanced | XI-XII Foundation| VI-X Pre-Foundation

JEE MAIN FEB 2021 | 26TH FEB SHIFT-1

SECTION – A

1. $\underset{(C_4H_8Cl_2)}{A} \xrightarrow[\text{373 K}]{\text{Hydrolysis}} \underset{(C_4H_8O)}{B}$

    B reacts with Hydroxyl amine but does not give Tollen's test. Identify A and B.
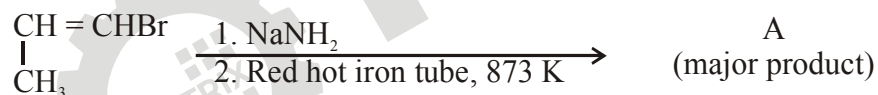
    (1) 1,1-Dichlorobutane and 2-Butanone

    (2) 1,1-Dichlorobutane and Butanal

    (3) 2,2-Dichlorobutane and Butan-2-one

    (4) 2,2-Dichlorobutane and Butanal

Ans.   Official Answer NTA : (3)

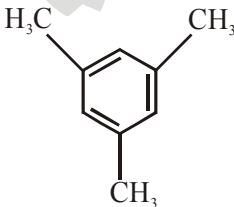Sol.

(A)
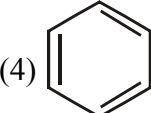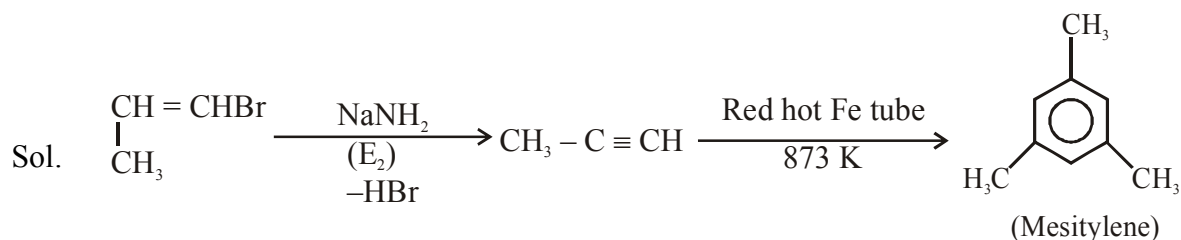(2, 2-Dichlorobutane)

(B)
(Butan-2-one)
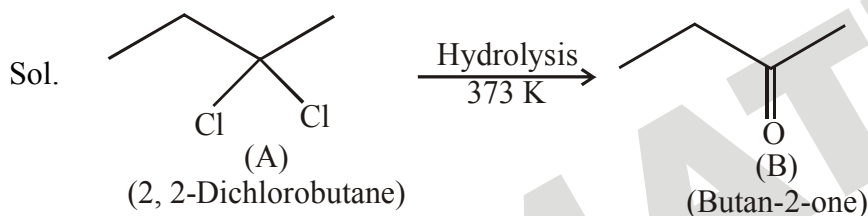
Ketones react with hydroxylamine but doesn't give Tollen's test.

2.   For the given reaction :

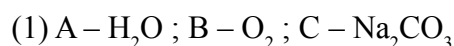$\underset{CH_3}{CH = CHBr} \xrightarrow[\text{2. Red hot iron tube, 873 K}]{\text{1. NaNH}_2} \underset{(\text{major product})}{A}$

What is 'A' ?

(1)

(2) $CH_3CH_2CH_2NH_2$

(3) $\underset{CH_3}{CH = CH - NH_2}$

(4)

Ans.   Official Answer NTA : (1)

Sol. $\underset{\underset{CH_3}{|}}{CH=CHBr} \xrightarrow[\substack{(E_2) \\ -HBr}]{NaNH_2} CH_3-C \equiv CH \xrightarrow[873\ K]{\text{Red hot Fe tube}}$ (Mesitylene)

3. Find A, B and C in the following reactions :

$NH_3 + A + CO_2 \rightarrow (NH_4)_2CO_3$

$(NH_4)_2CO_3 + H_2O + B \rightarrow NH_4HCO_3$

$NH_4HCO_3 + NaCl \rightarrow NH_4Cl + C$

(1) A – H_2O ; B – O_2 ; C – Na_2CO_3 (2) A – H_2O ; B – O_2 ; C – $NaHCO_3$

(3) A – O_2 ; B – CO_2 ; C – Na_2CO_3 (4) A – H_2O ; B – CO_2 ; C – $NaHCO_3$

Ans. Official Answer NTA : (4)

Sol. $NH_3 + \mathbf{H_2O} + CO_2 \rightarrow (NH_4)_2CO_3$

$(NH_4)_2CO_3 + H_2O + \mathbf{CO_2} \rightarrow NH_4HCO_3$

$NH_4HCO_3 + NaCl \rightarrow NH_4Cl + \mathbf{NaHCO_3}$
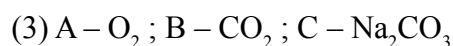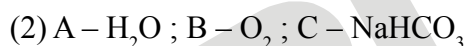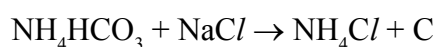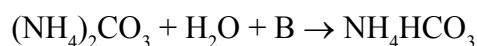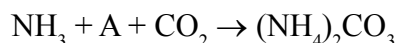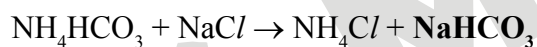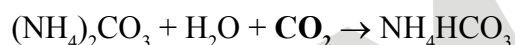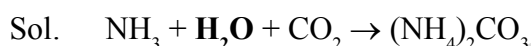
4. The presence of ozone in troposphere :

(1) Protects us from the UV radiation

(2) Protects us from the X-ray radiation

(3) Generates photochemical smog

(4) Protects us from greenhouse effect

Ans. Official Answer NTA : (3)

Sol. The presence of ozone in troposphere generates photo chemical smog.

5. On treating a compound with warm dil. H_2SO_4, gas X is evolved which turns $K_2Cr_2O_7$ paper acidified with dil. H_2SO_4 to a green compound Y. X and Y respectively are :

(1) X = SO_2, Y = Cr_2O_3 (2) X = SO_3, Y = Cr_2O_3

(3) X = SO_2, Y = $Cr_2(SO_4)_3$ (4) X = SO_3, Y = $Cr_2(SO_4)_3$

Ans. Official Answer NTA : (3)

Sol. $SO_2 + K_2Cr_2O_7 + dil.H_2SO_4 \longrightarrow \underset{\underset{'Y'}{Green}}{Cr_2(SO_4)_3} + K_2SO_4 + H_2O$
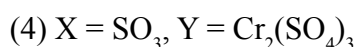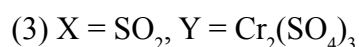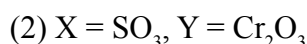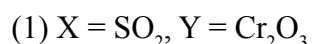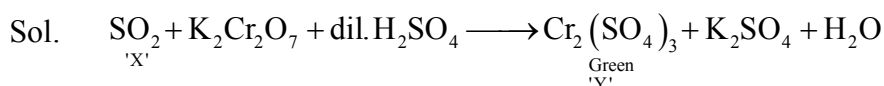
6.   Given below are two statements :

Statement I : o-Nitrophenol is steam volatile due to intramolecular hydrogen bonding.

Statement II : o-Nitrophenol has high melting point due to hydrogen bonding.

In the light of the above statements, choose the most appropriate 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) Both Statement I and Statement II are true

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

Ans.   Official Answer NTA : (4)

Sol.   (Intramolecular H–Bonding)
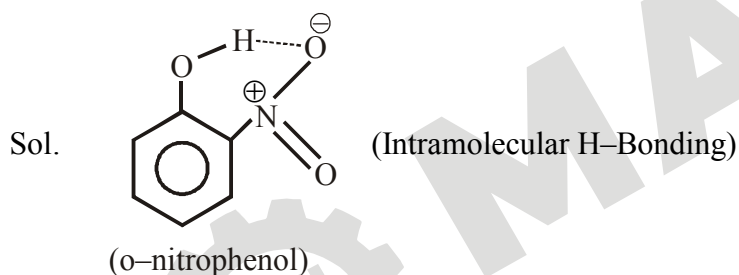
(o–nitrophenol)

Due to the presence of intramolecular hydrogen bonding in o–nitrophenol, it has lower boiling point

and it is more volatile.

The melting point of p–nitrophenol is higher than the o–nitrophenol because high packing efficiency of

p–nitrophenol.

7.   Statements about heavy water are given below :

A. Heavy water is used in exchange reactions for the study of reaction mechanisms.

B. Heavy water is prepared by exhaustive electrolysis of water.

C. Heavy water has higher boiling point than ordinary water.

D. Viscosity of H_2O is greater than D_2O.

Choose the most appropriate answer from the options given below :

(1) A, B and C only   (2) A and C only   (3) A and D only   (4) A and B only

Ans.   Official Answer NTA : (1)

Sol.   Heavy water is used in exchange reactions for the study of reaction mechanisms.

Heavy water is prepared by exhaustive electrolysis of water.

Due to more polarity of O – D bond and greater molecular mass, B.P. of D_2O is greater than H_2O.

Viscosity of D_2O is greater than H_2O.

8.   An amine on reaction with benzenesulphonyl chloride produces a compound insoluble in alkaline solution. This amine can be prepared by ammonolysis of ethyl chlroide. The correct structure of amine is :

(1)

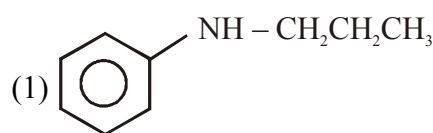$$\bigcirc\!\!\!\!\!\!\!\!\bigcirc\ NH - CH_2CH_2CH_3$$

(2) $CH_3CH_2CH_2\overset{H}{N} - CH_2CH_3$

(3) $CH_3CH_2NH_2$

(4) $CH_3CH_2NHCH_2CH_3$

Ans.   Official Answer NTA : (2).

Ans.   Official Answer by Matrix is (4).

Sol.   It is Hinsberg Test.

$$\underset{(1°\ Amine)}{R - NH_2} \xrightarrow{PhSO_2Cl} \underset{(ppt)}{R - NH - SO_2Ph} \xrightarrow{NaOH} Soluble$$

$$\underset{(2°\ Amine)}{R_2NH} \xrightarrow{PhSO_2Cl} \underset{(ppt)}{R_2N - SO_2Ph} \xrightarrow{NaOH} Insoluble$$

$$R_3N \xrightarrow{PhSO_2Cl} No\ reaction$$
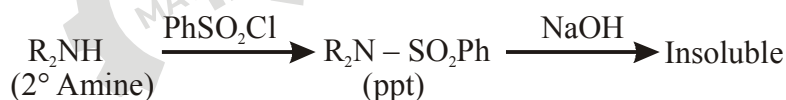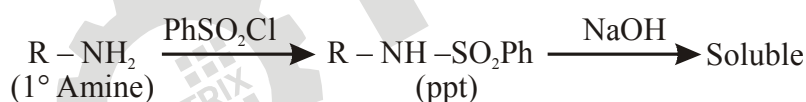
Therefore, it will be a secondary amine which can be prepared by the ammonolysis of ethyl chloride.

$$\underset{(2\ eq.)}{CH_3CH_2Cl + NH_3} \longrightarrow CH_3CH_2NHCH_2CH_3$$

9.   Compound A used as a strong oxidizing agent is amphoteric in nature. It is the part of lead storage batteries. Compound A is :

(1) $PbSO_4$ (2) Pb_3O_4 (3) PbO_2 (4) PbO

Ans.   Official Answer NTA : (3)

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Sol. PbO_2 is strong oxidising agent and amphoteric in nature. It is also used in lead storage battery.

10. The orbital having two radial as well as two angular nodes is :

(1) 4f   (2) 5d   (3) 4d   (4) 3p

Ans. Official Answer NTA : (2)

Sol. Total nodes = n – 1 = 4

$$n = 5$$

angular nodes = 2

$$l = 2$$

n = 5, $l = 2 \rightarrow$ 5d

11. Identify the major products A and B respectively in the following reactions of phenol :

Ans. Official Answer NTA : (3)

Sol.

$$\text{Phenol} \xrightarrow[273]{Br_2 \text{ in } CS_2} \text{4-bromophenol (major)} + \text{2-bromophenol (minor)}$$

$$\text{Phenol} \xrightarrow[\text{ii) } H_3O^+]{\text{i) } CHCl_3, NaOH} \text{salicylaldehyde (major)} + \text{4-hydroxybenzaldehyde (minor)}$$

(Reimer–Tiemann reaction)
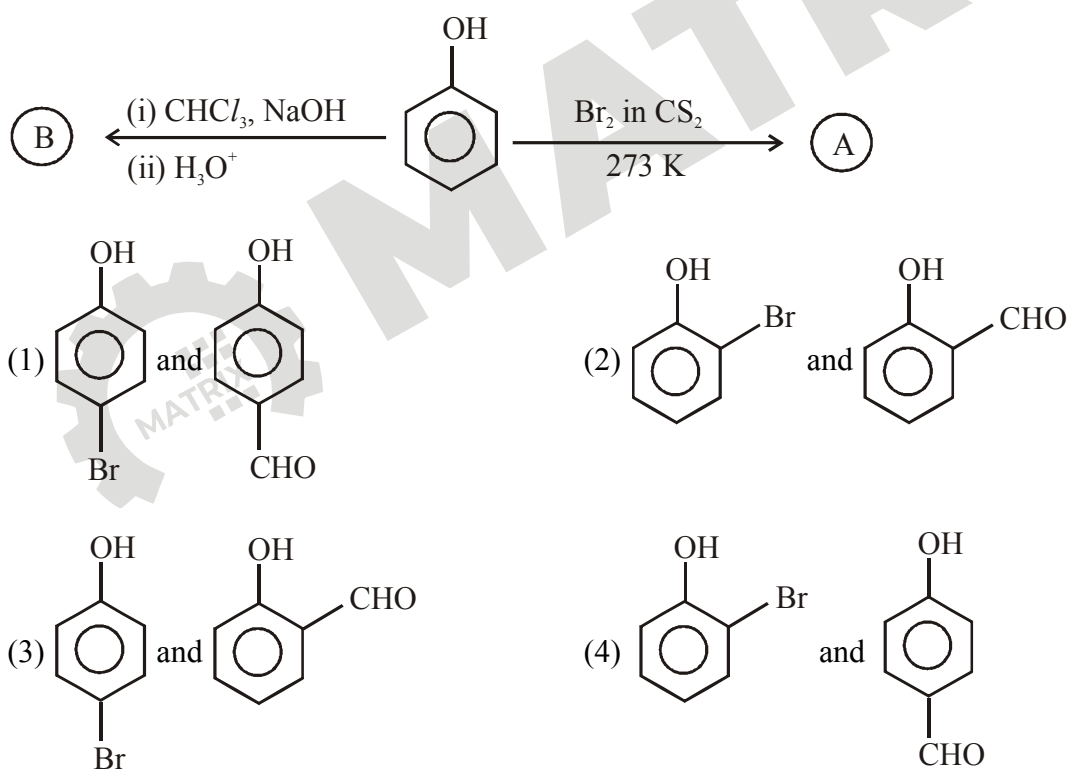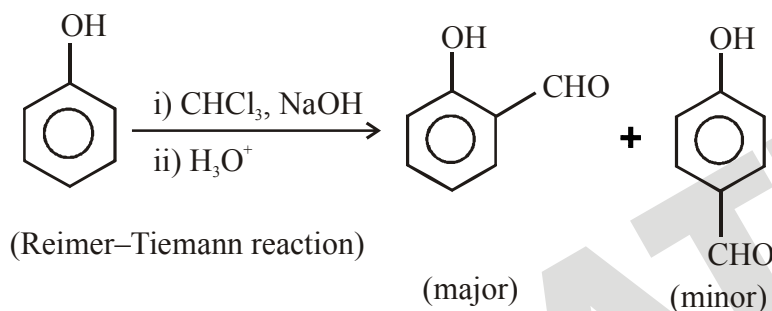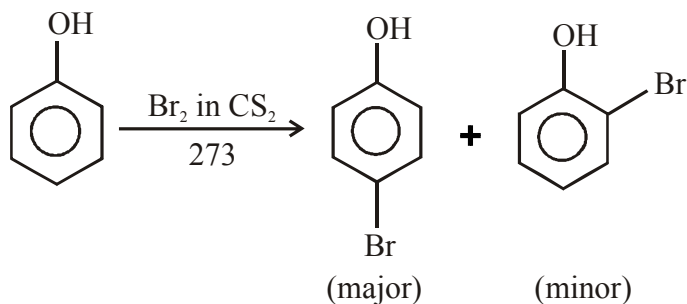
12. Which of the following vitamin is helpful in delaying the blood clotting ?

(1) Vitamin K   (2) Vitamin E   (3) Vitamin C   (4) Vitamin B

Ans. Official Answer NTA : (1)

Sol. Vitamin K is helpful in delaying the blood clotting

13. The structure of Neoprene is :

(1)

(2)

(3) $\left[\text{CH}_2\text{CH} = \text{CH} - \text{CH}_2 - \text{CH}_2 - \underset{\underset{\text{CN}}{|}}{\text{CH}}\right]_n$

(4) $\left[\text{CH}_2 - \underset{\overset{|}{\text{C}}\text{l}}{\overset{\overset{\text{C}l}{|}}{\text{C}}} = \text{CH} - \text{CH}_2\right]_n$

Ans. Official Answer NTA : (4)

Sol.

$n\text{CH}_2 = \underset{\underset{\text{Cl}}{|}}{\text{C}} - \text{CH} = \text{CH}_2 \xrightarrow{\text{Polymerization}} \left(\text{CH}_2 - \underset{\underset{\text{Cl}}{|}}{\text{C}} = \text{CH} - \text{CH}_2\right)_n$

(Chloroprene)   (Neoprene)
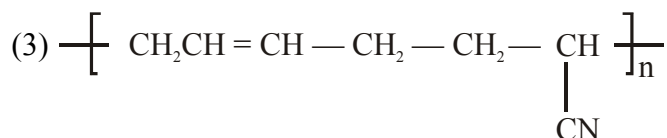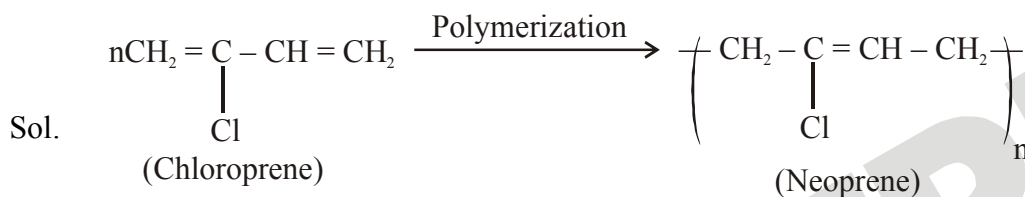
14. Match List-I with List-II.

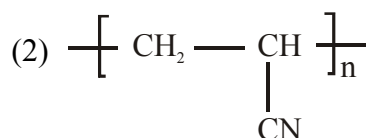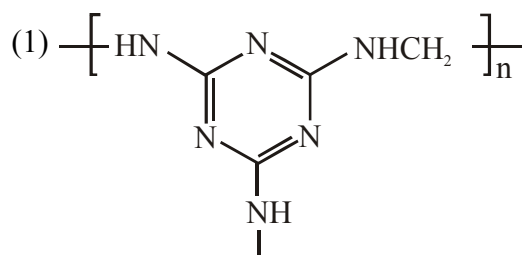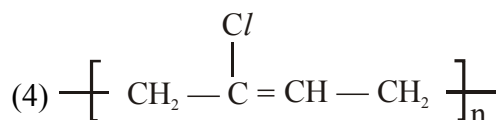List-I   List-II

(Ore)   (Element Present)

(a) Kernite   (i) Tin

(b) Cassiterite   (ii) Boron

(c) Calamine   (iii) Fluorine

(d) Cryolite   (iv) Zinc

Choose the most appropriate answer from the options given below :

(1) (a) → (i), (b) → (iii), (c) → (iv), (d) → (ii)

(2) (a) → (ii), (b) → (i), (c) → (iv), (d) → (iii)

(3) (a) → (ii), (b) → (iv), (c) → (i), (d) → (iii)

(4) (a) → (iii), (b) → (i), (c) → (ii), (d) → (iv)

Ans. Official Answer NTA : (2)

Sol.   (a) Kernite $\rightarrow Na_2B_4O_7.4H_2O$

(b) Cassiterite $\rightarrow SnO_2$

(c) Calamine $\rightarrow ZnCO_3$

(d) Cryolite $\rightarrow Na_3AlF_6$

15.   Given below are two statements :

Statements I : A mixture of chloroform and aniline can be separated by simple distillation.

Statement II : When separating aniline from a mixture of aniline and water by steam distillation aniline boils below its boiling point.

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

(1) Both Statement I and Statement II are true

(2) Statement I is false but Statement II is true

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

(4) Both Statement I and Statement II are false

Ans.   Official Answer NTA : (1)

Sol.   Difference in B.P. of aniline and chloroform is quite large hence they can be seperated by simple distillation.

B.P. of $C_6H_5NH_2 \rightarrow 457$ K

B.P. of $CHCl_3 \rightarrow 334$ K

When separating aniline from a mixture of aniline and water by steam distillation aniline boils below its boiling point.

16.   Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Dipole-dipole interactions are the only non-covalent interactions, resulting in hydrogen bond formation.

Reason R : Fluorine is the most electronegative element and hydrogen bonds in HF are symmetrical.

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

(1) A is true but R is false

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(2) Both A and R are true but R is NOT the correct explanation of A

(3) Both A and R are true and R is the correct explanation of A
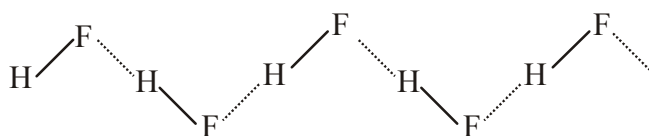
(4) A is false but R is true

Ans.   Official Answer NTA : (4)

Sol.   **Assertion :** ion–dipole attraction (non covalent) can also result in hydrogen bond formation.

Reason : Fluorine is the most electronegative element and hydrogen bonds in HF are symmetrical.

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

17.   Match List-I with List-II.

List-I   List-II

Electronic configuration of elements $\Delta_i H$ in kJ mol^{-1}

(a) $1s^2 2s^2$ (i) 801

(b) $1s^2 2s^2 2p^4$ (ii) 899

(c) $1s^2 2s^2 2p^3$ (iii) 1314

(d) $1s^2 2s^2 2p^1$ (iv) 1402

Choose the most appropriate answer from the options given below :

(1) (a) $\rightarrow$ (i), (b) $\rightarrow$ (iv), (c) $\rightarrow$ (iii), (d) $\rightarrow$ (ii)

(2) (a) $\rightarrow$ (iv), (b) $\rightarrow$ (i), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (iii)
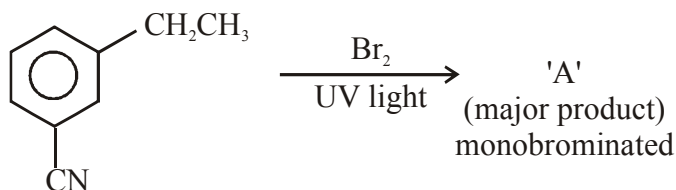
(3) (a) $\rightarrow$ (i), (b) $\rightarrow$ (iii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (ii)

(4) (a) $\rightarrow$ (ii), (b) $\rightarrow$ (iii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (i)
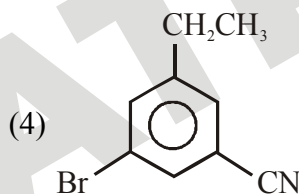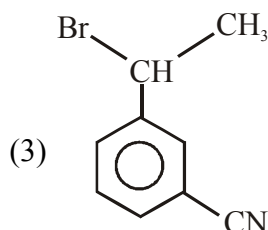
Ans.   Official Answer NTA : (4)

Sol.   Order of ionisation energy = B < Be < O < N.

18.   For the given reaction :

What is 'A' ?
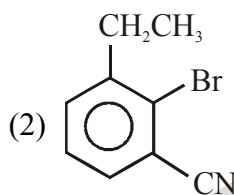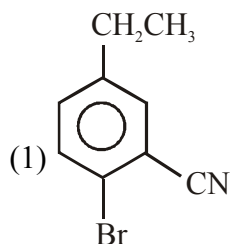
Ans.   Official Answer NTA : (3)

Sol.   Free Radical substitution occurs in the presence of sun light.
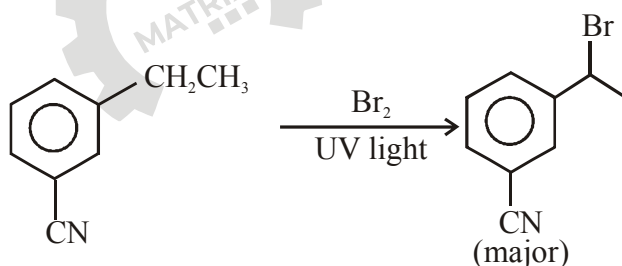
19.   Which of the following is 'a' FALSE statement ?

(1) Carius method is used for the estimation of nitrogen in an organic compound.

(2) Carius tube is used in the estimation of sulphur in an organic compound.

(3) Kjeldahl's method is used for the estimation of nitrogen in an organic compound.

(4) Phosphoric acid produced on oxidation of phosphorus present in an organic compound is precipi-

tated as $Mg_2P_2O_7$ by adding magnesia mixture.

Ans. Official Answer NTA : (1)

Sol. (1) The Carius method is used for the Quantitative determination of halogens in a chemical substance.

(2) Carius tube is used in the estimation of sulphur in an organic compound.

(3) Kjeldahl's method used for the estimation of nitrogen.

(4) Organic compound $\xrightarrow{\text{Magnesia mixture}}$ $MgNH_4PO_4$ $\xrightarrow{\text{Ignition}}$ $Mg_2P_2O_7$ $\begin{pmatrix} \text{Magnesium} \\ \text{Pyrophosphate} \end{pmatrix}$

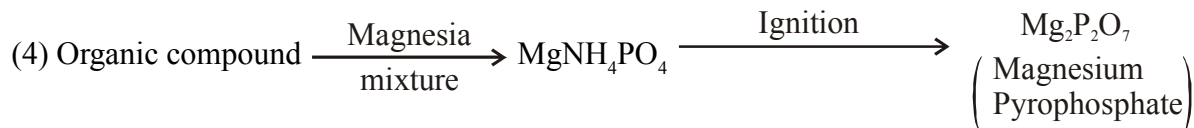Magnesia mixture = $(MgSO_4 + NH_4OH + NH_4Cl)$

20. Which one of the following lanthanoids does not form MO_2 ?

[M is lanthanoid metal]

(1) Pr   (2) Nd   (3) Dy   (4) Yb

Ans. Official Answer NTA : (4)

Sol. Yb does not form MO_2 type oxide.

SECTION – B

1. A homogeneous ideal gaseous reaction $AB_{2(g)} \rightleftharpoons A_{(g)} + 2B_{(g)}$ is carried out in a 25 litre flask at 27°C.

The initial amount of AB_2 was 1 mole and the equilibrium pressure was 1.9 atm. The value of K_p is

$x \times 10^{-2}$. The value of x is............... (Integer answer)

[R = 0.08206 dm³atm K^{-1} mol^{-1}]

Ans. Official Answer NTA : (74)

Ans. Anwer by Matrix is (72 to 74)

Sol. $AB_2 \rightleftharpoons A + 2B$

t = 0   1

t = t$_{eq}$ 1 – x   x   2x

n$_{total}$ = (1 – x) + x + 2x = 1 + 2x

@eq^m : PV = nRT

(1.9) (25) = (1 + 2x) × 0.082 × 300

(1+ 2x) = 1.93

x ≃ 0.47

$$k_P = \frac{P_A \times P_B^2}{P_{AB_2}} = \frac{\left(\frac{0.929}{1.93} \times 1.9\right)^2 \left(\frac{0.464}{1.93} \times 1.9\right)}{\left(\frac{0.535}{1.93} \times 1.9\right)}$$

$$k_P = \frac{\left(\frac{0.929 \times 1.9}{1.929}\right)^2 \times 0.464}{0.535}$$

$$k_P = 72.6 \times 10^{-2} = x \times 10^{-2}$$

2. A certain gas obeys $P(V_M - b) = RT$. The value of $\left(\frac{\partial Z}{\partial P}\right)_T$ is $\frac{xb}{RT}$. The value of x is.......... (Integer answer) (Z : compressibility factor)

Ans. Official Answer NTA : (1)

Sol. $P(V_M - b) = RT$

$$\frac{PV_M}{RT} = 1 + \frac{Pb}{RT}$$

$$Z = 1 + \frac{Pb}{RT}$$

$$\frac{\partial z}{\partial p} = 0 + \frac{b}{RT}$$

$$\frac{\partial z}{\partial p} = \frac{b}{RT}$$

$$x = 1$$

3. An exothermic reaction $X \to Y$ has an activation energy 30 kJ mol^{-1}. If energy change ΔE during the reaction is -20 kJ, then the activation energy for the reverse reaction in kJ is ....(Integer answer)

Ans. Official Answer NTA : (50)

Sol. $\Delta H = \left(E_a\right)_f - \left(E_a\right)_b$
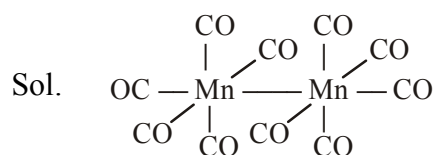
$-20 = 30 - \left(E_a\right)_b$

$\left(E_a\right)_b = 50$ kJ

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4.   Number of bridging CO ligands in $[Mn_2(CO)_{10}]$ is..........

Ans.   Official Answer NTA : (0)

Sol.

$$
\begin{array}{c}
\overset{\displaystyle CO}{\underset{\displaystyle CO}{\overset{|}{OC-Mn}}}\overset{\displaystyle\diagup CO}{\underset{\displaystyle CO}{\diagdown}}\overset{\displaystyle CO}{\underset{\displaystyle CO}{\overset{|}{Mn-CO}}}\overset{\displaystyle\diagup CO}{}
\end{array}
$$

5.   Consider the following reaction

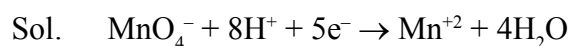$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{+2} + 4H_2O$, $E° = 1.51$ V.

The quantity of electricity required in Faraday to reduce five moles of MnO_4^- is ....

(Integer answer)

Given 25

Ans.   Official Answer NTA : (25)

Sol. $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{+2} + 4H_2O$

For 1 mole MnO_4^- $\Rightarrow$ 5 mole e^- required.

                        $\Rightarrow$ 5F electricity required.

For 5 mole MnO_4^- $\Rightarrow$ 25 F

6.   3.12 g of oxygen is adsorbed on 1.2 g of platinum metal. The volume of oxygen adsorbed per gram of the adsorbent at 1 atm and 300 K in L is ....

[$R = 0.0821$ L atm K^{-1} mol^{-1}]]

Ans.   Official Answer NTA : (2)

Sol. $n_{O_2} = \dfrac{3.12}{32}$ moles

$V_{O_2} = \dfrac{nRT}{P} = \dfrac{\dfrac{3.12}{32} \times 0.0821 \times 300}{1} = 2.4 \, l$

$\because$ 1.2gm Pt absorbs $= 2.4 \, l$

1 gm Pt will absorb $= 2 \, l$

7. For a chemical reaction $A + B \rightleftharpoons C + D$

    ($\Delta_r H° = 80$ kJ mol^{-1}) the entropy change $\Delta_r S°$ depends on the temperature T(in K) as $\Delta_r S° = 2T$

    (J K^{-1} mol^{-1}).

    Minimum temperature at which it will become spontaneous is _____ K. (Integer)

Ans.   Official Answer NTA : (200)

Sol. $\Delta G° < 0$

    $\Delta H° - T\Delta S° < 0$
    $8000 - T(2T) < 0$
    $2T^2 > 8000$
    $T > 200K$

    200 K

8. The number of significant figures in 50000.020×10^{-3} is ....

Ans.   Official Answer NTA : (7)

Sol. $\underline{50000.020} \times 10^{-3}$

    The number of significant figures = 7.

9. Dichromate ion is treated with base, the oxidation number of Cr in the product formed is ....

Ans.   Official Answer NTA : (6)

Sol. $Cr_2O_7^{2-} + 2OH^- \xrightarrow{\quad} 2CrO_4^{2-} + H_2O$
    Oxidation state of Cr in CrO_4^{2-} is +6.

10. 224 mL of $SO_{2_{(g)}}$ at 298 K and 1 atm is passed through 100 mL of 0.1 M NaOH solution. The non-volatile solute produced is dissolved in 36 g of water. The lowering of vapour pressure of solution (assuming the solution is dilute) $\left(P°_{(H_2O)} = 24 \, mm \, of \, Hg \right)$ is $x \times 10^{-2}$ mm of Hg, the value of x is.....(Integer answer)

Ans.   Official Answer NTA : (12)

Answer by Matrix is (18).

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Sol. $n_{SO_2} = \dfrac{0.224}{0.0821 \times 298} = 9.2$ mmol $n_{NaOH} = 10$ mmol

$n_{H_2O} = \dfrac{36}{18} = 2$

$SO_2 + 2NaOH \longrightarrow Na_2SO_3 + H_2O$
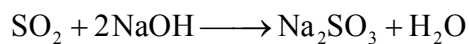
0.0092   0.01

0.0042   –   0.005   0.005

solute = Na_2SO_3 (i = 3)

$Ps = P_A{}^\circ \times X_{Solvent}$

$= (24 \text{ mmHg}) \times \left(\dfrac{n_{Solvent}}{n_{Solvent} + i \times n_{Solute}} \right)$

$= 24 \times \dfrac{2000}{2015} = 23.82$ mmHg

$\Delta P = 24 - 23.82 = 18 \times 10^{-2}$ mmHg

x = 18