

PAPER-1(B.E./B. TECH.)

JEE (Main) 2021

Questions & Solutions

Date : 25 February, 2021 (SHIFT-1) Time ; (9.00 am to 12.00 pm)

Duration : 3 Hours | Max. Marks : 300

SUBJECT : CHEMISTRY

1. Given below are two statements:

Statement I : CeO_2 can be used for oxidation of aldehydes and ketones.

Statement II : Aqueous solution of EuSO_4 is a strong reducing agent.

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) Statement I is true but statement II is false
- (3) Both statement I and statement II are true
- (4) Both statement I and statement II are false

Ans. (3)

Sol. Lanthanides have +3 as their most stable oxidation state so, Ce^{4+} is a good oxidising agent while Eu^{2+} is a good reducing agent.

2. According to molecular theory, the species among the following that does not exist is:

- (1) He_2^+
- (2) He_2^-
- (3) Be_2
- (4) O_2^{2-}

Ans. (3)

Sol. Species \rightarrow Bond order

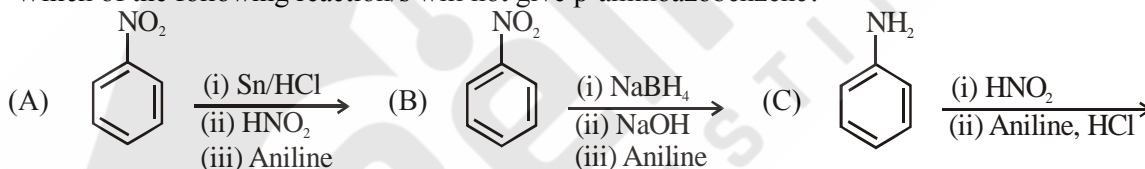
$\text{Be}_2 \rightarrow 0$ (zero) (not possible)

$\text{O}_2^{2-} \rightarrow 1$ (one)

$\text{He}_2^- \rightarrow \frac{1}{2}$ (Half)

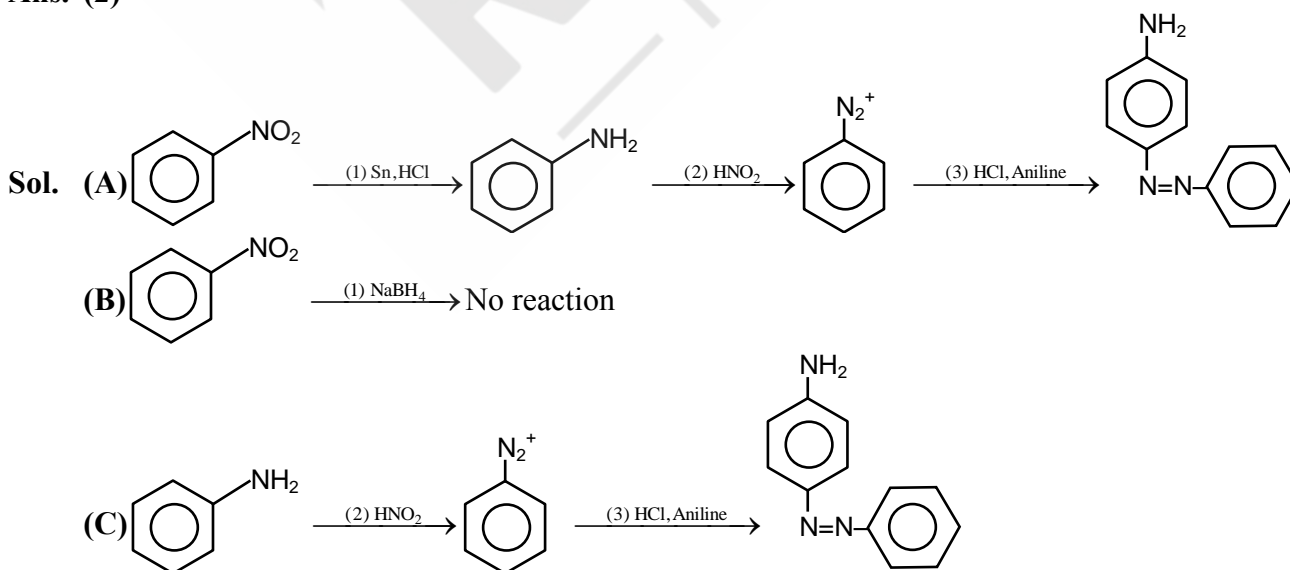
$\text{He}_2^+ \rightarrow \frac{1}{2}$ (Half)

3. Which of the following reaction/s will not give p-aminoazobenzene?



- (1) A only
- (2) B only
- (3) C only
- (4) A and B

Ans. (2)



4. Which of the following equation depicts the oxidizing nature of H_2O_2 ?

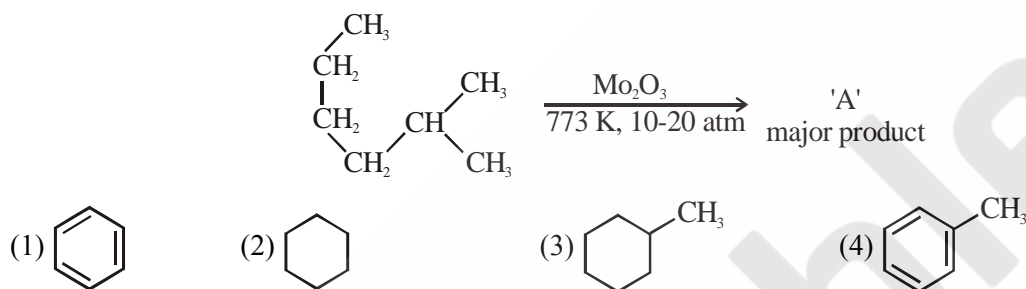
- (1) $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$
 (2) $2I^- + H_2O_2 + 2H^+ \rightarrow I_2 + 2H_2O$
 (3) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
 (4) $Cl_2 + H_2O_2 \rightarrow 2HCl + O_2$

Ans. (2)

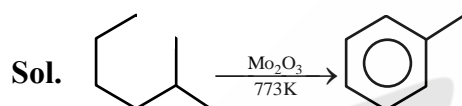
Sol. $2I^- + H_2O_2 + 2H^+ \rightarrow I_2 + 2H_2O$

In above reaction, H_2O_2 oxidises I^- to I_2 & itself gets reduced to H_2O so, this reaction depicts oxidising nature of H_2O_2 .

5. Identify A in the given chemical reaction.



Ans. (4)



It is catalytic reforming (Aromatization) of alkanes. Iso-heptane gives toluene in this process.

6. Complete combustion of 1.80 g of an oxygen containing compound ($C_xH_yO_z$) gave 2.64 g of CO_2 and 1.08 g of H_2O . The percentage of oxygen in the organic compound is:

- (1) 51.63 (2) 63.53 (3) 53.33 (4) 50.33

Ans. (3)

Sol. $n_{CO_2} = \frac{2.64}{44} = 0.06$ $n_c = 0.06$

Weight of carbon = $0.06 \times 12 = 0.72$ gram

$n_{H_2O} = \frac{1.08}{18} = 0.06$

$n_H = 0.06 \times 2 = 0.12$

Weight of hydrogen = 0.12 gram

\therefore Weight of oxygen in $C_xH_yO_z$

= $1.8 - (0.72 + 0.12)$

= 0.96 gram

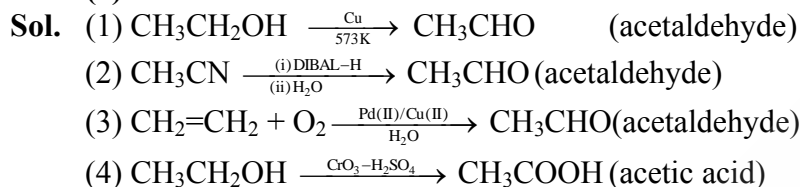
% weight of oxygen = $\frac{0.96}{1.8} \times 100$

= 53.3 %

7. Which one of the following reactions will not form acetaldehyde?



Ans. (4)



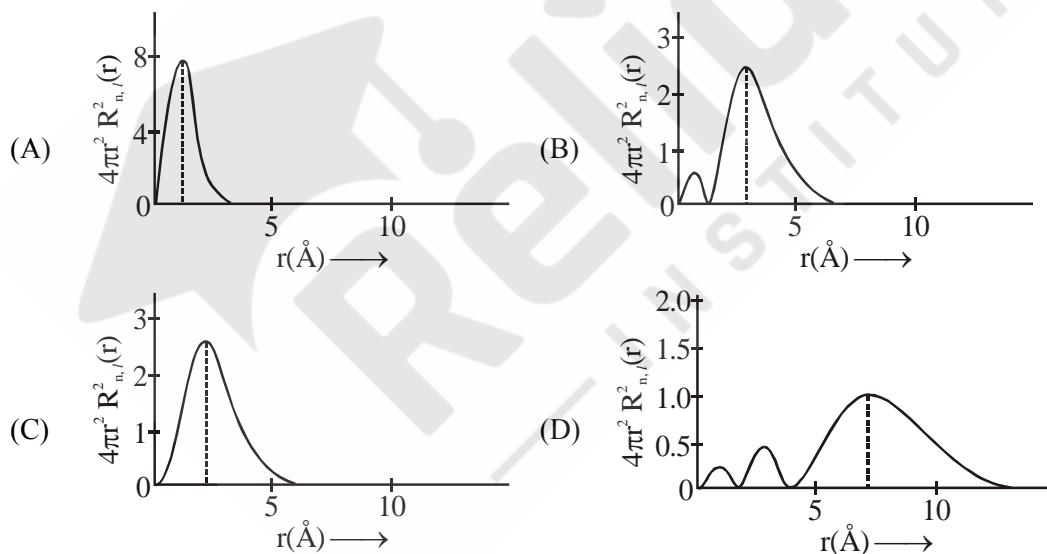
8. The correct statement about B_2H_6 is:

- (1) Terminal B–H bonds have less p-character when compared to bridging bonds.
- (2) The two B–H–B bonds are not of same length
- (3) All B–H–B angles are of 120°
- (4) Its fragment, BH_3 , behaves as a Lewis base

Ans. (1)

Sol. Terminal B – H bonds have more s-character when compared to bridging bonds. So they will have less p-character.

9. The plots of radial distribution functions for various orbitals of hydrogen atom against 'r' are given below:



The correct plot for 3s orbital is:

- (1) (B) (2) (A) (3) (D) (4) (C)

Ans. (3)

Sol. Number of radial nodes = $n - l - 1$
 for 3s orbital, $\text{RN} = 3 - 0 - 1 = 2$
 So, graph(D) [3rd option] looks best.

10. Given below are two statements:

Statement I : An allotrope of oxygen is an important intermediate in the formation of reducing smog.

Statement II : Gases such as oxides of nitrogen and sulphur present in troposphere contribute to the formation of photochemical smog.

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) Statement I is true but Statement II is false
- (3) Both Statement I and Statement II are true
- (4) Statement I is false but Statement II is true

Ans. (1)

Sol. Both statements are false.

11. In which of the following pairs, the outer most electronic configuration will be the same?

- (1) Cr^+ and Mn^{2+}
- (2) Ni^{2+} and Cu^+
- (3) Fe^{2+} and Co^+
- (4) V^{2+} and Cr^+

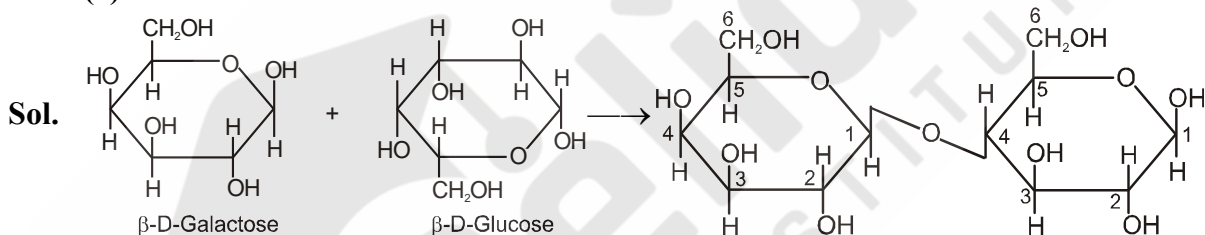
Ans. (1)

Sol. $\text{Cr}^+ \Rightarrow [\text{Ar}]3d^5$
 $\text{Mn}^{2+} \Rightarrow [\text{Ar}]3d^5$

12. Which of the glycosidic linkage between galactose and glucose is present in lactose?

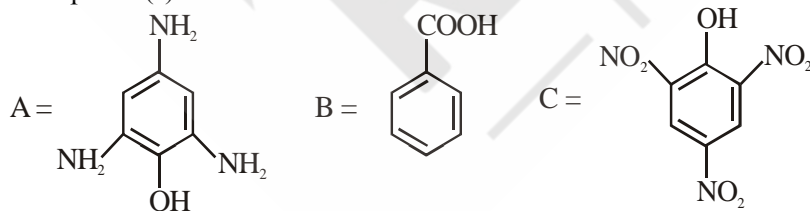
- (1) C-1 of galactose and C-4 of glucose
- (2) C-1 of glucose and C-6 of galactose
- (3) C-1 of glucose and C-4 of galactose
- (4) C-1 of galactose and C-6 of glucose

Ans. (1)



The linkage in lactose is between C-1 of Galactose and C-4 of Glucose.

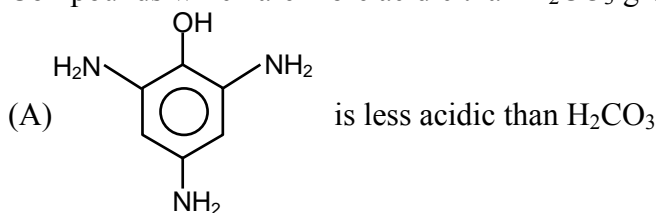
13. Compound(s) which will liberate carbon dioxide with sodium bicarbonate solution is/are:

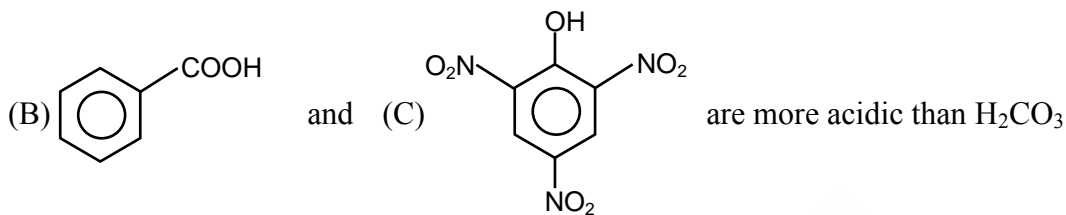


- (1) B only
- (2) C only
- (3) B and C only
- (4) A and B only

Ans. (3)

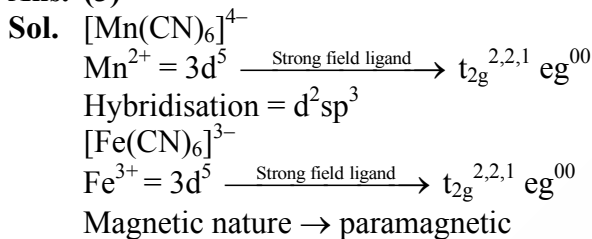
Sol. Compounds which are more acidic than H_2CO_3 give test with NaHCO_3 .





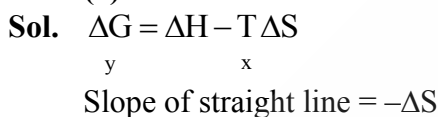
14. The hybridization and magnetic nature of [Mn(CN)₆]⁴⁻ and [Fe(CN)₆]³⁻, respectively are:
 (1) d²sp³ and diamagnetic (2) sp³d² and diamagnetic
 (3) d²sp³ and paramagnetic (4) sp³d² and paramagnetic

Ans. (3)



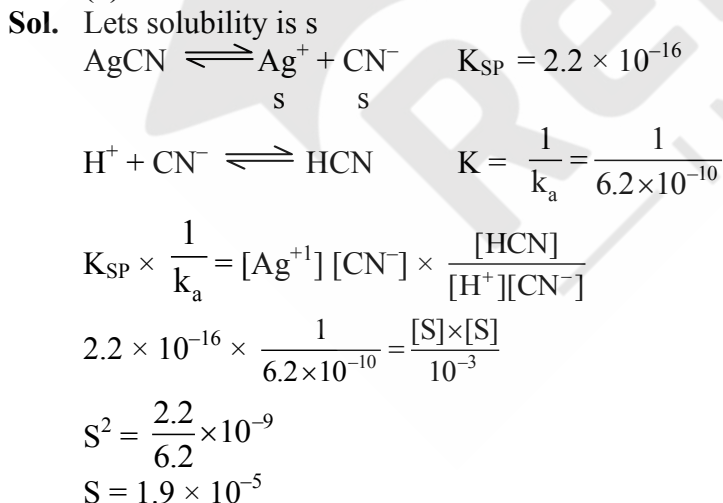
15. Ellingham diagram is a graphical representation of:
 (1) ΔH vs T (2) ΔG vs T (3) ΔG vs P (4) (ΔG – TΔS) vs T

Ans. (2)



16. The solubility of AgCN in a buffer solution of pH = 3 is x. The value of x is:
 [Assume : No cyano complex is formed; K_{sp}(AgCN) = 2.2 × 10⁻¹⁶ and K_a(HCN) = 6.2 × 10⁻¹⁰]
 (1) 0.625 × 10⁻⁶ (2) 1.9 × 10⁻⁵ (3) 2.2 × 10⁻¹⁶ (4) 1.6 × 10⁻⁶

Ans. (2)

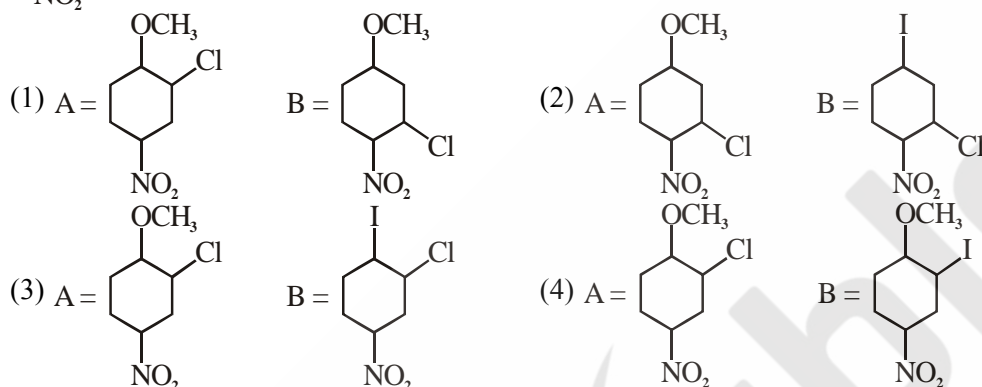
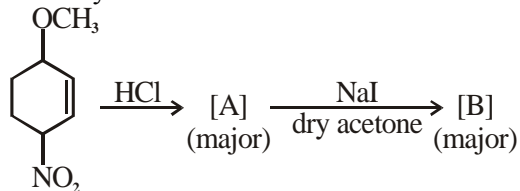


17. In Freundlich adsorption isotherm at moderate pressure, the extent of adsorption $\left(\frac{x}{m}\right)$ is directly proportional to P^x. The value of x is
 (1) zero (2) $\frac{1}{n}$ (3) 1 (4) ∞

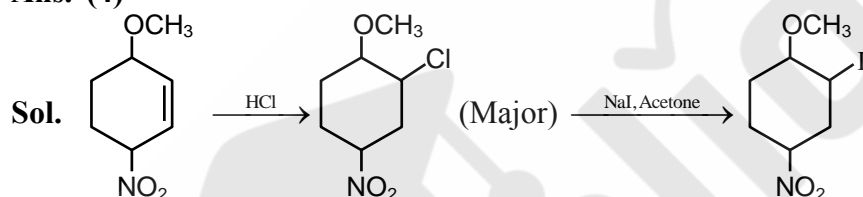
Ans. (2)

Sol. $\frac{X}{m} = kp^{1/n}$

18. Identify A and B in the chemical reaction.



Ans. (4)



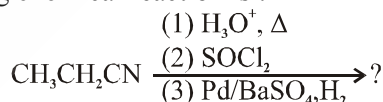
19. Which statement is correct ?

- (1) Synthesis of Buna-S needs nascent oxygen.
- (2) Neoprene is an addition copolymer used in plastic bucket manufacturing.
- (3) Buna-S is a synthetic and linear thermosetting polymer.
- (4) Buna-N is a natural polymer.

Ans. (1)

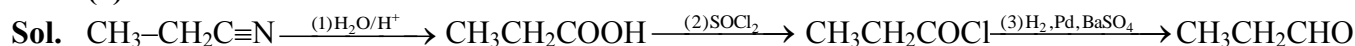
Sol. Synthesis of Buna-S needs nascent oxygen because it is prepared by free radical polymerisation reaction.

20. The major product of the following chemical reaction is :



- (1) $\text{CH}_3\text{CH}_2\text{CH}_3$ (2) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (3) $(\text{CH}_3\text{CH}_2\text{CO})_2\text{O}$ (4) $\text{CH}_3\text{CH}_2\text{CHO}$

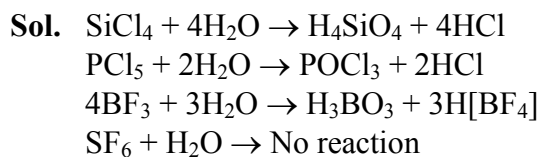
Ans. (4)



Numerical

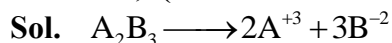
1. Among the following, the number of halide(s) which is/are inert to hydrolysis is _____.
(A) BF_3 (B) SiCl_4 (C) PCl_5 (D) SF_6

Ans. 1



2. 1 molal aqueous solution of an electrolyte A_2B_3 is 60% ionised. The boiling point of the solution at 1 atm is _____ K. (Rounded-off to the nearest integer)
 [Given K_b for $(\text{H}_2\text{O}) = 0.52 \text{ K kg mol}^{-1}$]

Ans. 375; (NTA Answer = 357)



$$\text{No. of Ions} = 2 + 3 = 5$$

$$i = 1 + (n-1)\alpha = 1 + (5-1) \times 0.6$$

$$= 1 + 4 \times 0.6 = 1 + 2.4 = 3.4$$

$$\Delta T_b = K_b \times m \times i$$

$$= 0.52 \times 1 \times 3.4 = 1.768^\circ\text{C}$$

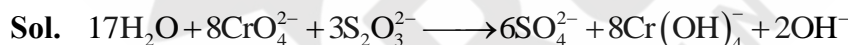
$$\Delta T_b = (T_b)_{\text{Solution}} - [(T_b)_{\text{H}_2\text{O}}]_{\text{Solvent}}$$

$$1.768 = (T_b)_{\text{Solution}} - 373.15$$

$$(T_b)_{\text{Solution}} \approx 375 \text{ K}$$

3. In basic medium CrO_4^{2-} oxidises $\text{S}_2\text{O}_3^{2-}$ to form SO_4^{2-} and itself changes into $\text{Cr}(\text{OH})_4^-$. The volume of 0.154 M CrO_4^{2-} required to react with 40 mL of 0.25 M $\text{S}_2\text{O}_3^{2-}$ is _____ mL. (Rounded-off to the nearest integer)

Ans. 173



Applying mole – mole analysis

$$\frac{0.154 \times V}{8} = \frac{40 \times 0.25}{3} \quad \therefore V \approx 173 \text{ ml}$$

4. A car tyre is filled with nitrogen gas at 35 psi at 27°C . It will burst if pressure exceeds 40 psi. The temperature in $^\circ\text{C}$ at which the car tyre will burst is _____. (Rounded-off to the nearest integer)

Ans. 70

Sol. $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$$\frac{35}{300} = \frac{40}{T_2}$$

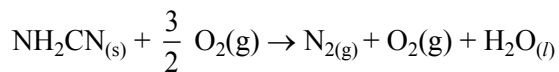
$$T_2 = \frac{40 \times 300}{35}$$

$$= 342.86 \text{ K}$$

$$= 69.85^\circ\text{C}$$

$$\approx 70^\circ\text{C}$$

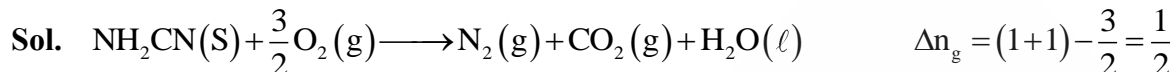
5. The reaction of cyanamide, $\text{NH}_2\text{CN}_{(s)}$ with oxygen was run in a bomb calorimeter and ΔU was found to be $-742.24 \text{ kJ mol}^{-1}$. The magnitude of ΔH_{298} for the reaction



is _____ kJ. (Rounded off to the nearest integer)

[Assume ideal gases and $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$]

Ans. 741



$$\begin{aligned} \Delta H &= \Delta U + \Delta n_g RT \\ &= -742.24 + \frac{1}{2} \times \frac{8.314 \times 298}{1000} \\ &= -742.24 + 1.24 \\ &\approx -741 \text{ kJ/mole} \end{aligned}$$

6. Using the provided information in the following paper chromatogram :

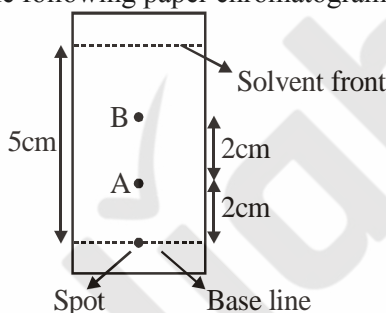


Figure : Paper chromatography for compounds A and B.

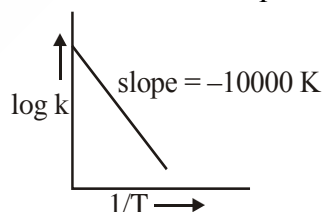
the calculated R_f value of A _____ $\times 10^{-1}$.

Ans. 4

Sol. R_f (Retarding factor) = $\frac{\text{Distance travelled by compound}}{\text{Distance travelled by solvent}}$

$$\text{Retarding factor} = \frac{2}{5} = 0.4$$

7. For the reaction, $aA + bB \rightarrow cC + dD$, the plot of $\log k$ vs $\frac{1}{T}$ is given below :



The temperature at which the rate constant of the reaction is 10^{-4} s^{-1} is _____ K.
(Rounded-off to the nearest integer)

[Given : The rate constant of the reaction is 10^{-5} s^{-1} at 500 K.]

Ans. 526

Sol. $\log_{10}k = \log_{10}A - \frac{E_a}{2.303RT}$

Slope = $\frac{-E_a}{2.303R} = -10000$

$\log_{10} \frac{k_2}{k_1} = \frac{E_a}{2.303R} \times \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$

$\log_{10} \frac{10^{-4}}{10^{-5}} = 10000 \times \left[\frac{1}{500} - \frac{1}{T} \right]$

$1 = 10000 \times \left[\frac{1}{500} - \frac{1}{T} \right]$

$\frac{1}{10000} = \frac{1}{500} - \frac{1}{T}$

$\frac{1}{T} = \frac{1}{500} - \frac{1}{10000}$

$= \frac{20-1}{10,000} = \frac{19}{10000}$

$T = \frac{10,000}{19} = 526.3K$

8. 0.4 g mixture of NaOH, Na₂CO₃ and some inert impurities was first titrated with $\frac{N}{10}$ HCl using phenolphthalein as an indicator, 17.5 mL of HCl was required at the end point. After this methyl orange was added and titrated. 1.5 mL of same HCl was required for the next end point. The weight percentage of Na₂CO₃ in the mixture is _____. (Rounded-off to the nearest integer)

Ans. 4

Sol. Let $m_{NaOH} = xg$ & $m_{Na_2CO_3} = yg$

At phenolphthalein end point : $meq_{NaOH} + meq_{Na_2CO_3} (vf = 1) = meq_{HCl}$

$\therefore \frac{x}{40} \times 1 \times 1000 + \frac{y}{106} \times 1 \times 1000 = 0.1 \times 17.5$ (1)

At methyl orange end point :

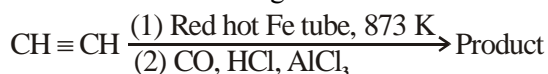
$meq_{NaHCO_3} (vf = 1) = meq_{HCl}$

$\frac{y}{106} \times 1 \times 1000 = 0.1 \times 1.5$ (2)

From (2), $y = 0.0159$ g

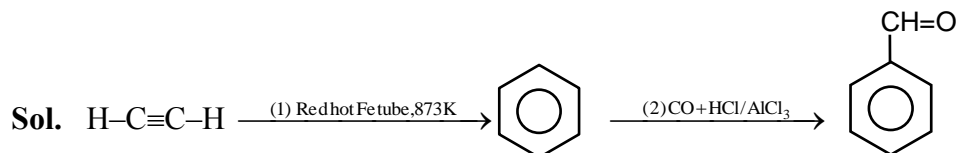
\therefore Weight % of Na₂CO₃ = $\frac{0.0159}{0.4} \times 100 = 3.975 \approx 4$

9. Consider the following chemical reaction.



The number of sp² hybridized carbon atom(s) present in the product is _____.

Ans. 7



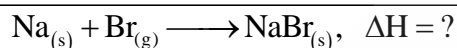
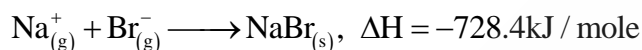
Product has 7 sp^2 hybridized carbon atoms.

10. The ionization enthalpy of Na^+ formation from $\text{Na}_{(g)}$ is $495.8 \text{ kJ mol}^{-1}$, while the electron gain enthalpy of Br is $-325.0 \text{ kJ mol}^{-1}$. Given the lattice enthalpy of NaBr is $-728.4 \text{ kJ mol}^{-1}$. The energy for the formation of NaBr ionic solid is $(-)$ _____ $\times 10^{-1} \text{ kJ mol}^{-1}$.

Ans. 5576



Sol.



$$\Rightarrow \Delta H = 495.8 - 325 - 728.4$$

$$= -557.6 \text{ kJ/mole}$$

$$= 5576 \times 10^{-1} \text{ kJ/mole}$$