FINAL JEE–MAIN EXAMINATION – FEBRUARY, 2021

(Held On Thursday 25th February, 2021) TIME : 9 : 00 AM to 12 : 00 NOON

CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

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) Statment 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

Official Ans. by NTA (3)

Sol. The +3 oxidation state of lanthanide is most stable and therefore lanthanide in +4 oxidation state has strong tendence to gain e^- and converted into +3 and therefore act as strong oxidizing agent.

eg Ce^{+4}

And there fore CeO_2 is used to oxidized alcohol aldehyde and ketones.

Lanthanide in +2 oxidation state has strong tendency to loss e^- and converted into +3 oxidation state therefore act as strong reducing agent.

$\therefore$ $EuSO_4$ act as strong 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-}

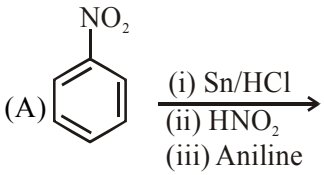
Official Ans. by NTA (3)

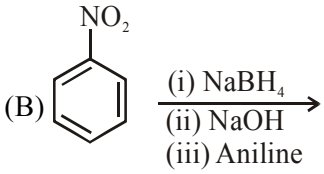
Sol.

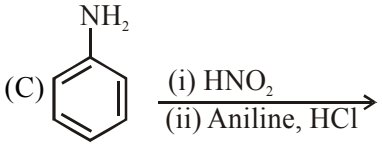
Chemical Species	Bond Order
He_2^+	0.5
He_2^-	0.5
Be_2	0
O_2^{2-}	1

According to M.O.T. If bond order of chemical species is zero then that chemical species does not exist.

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





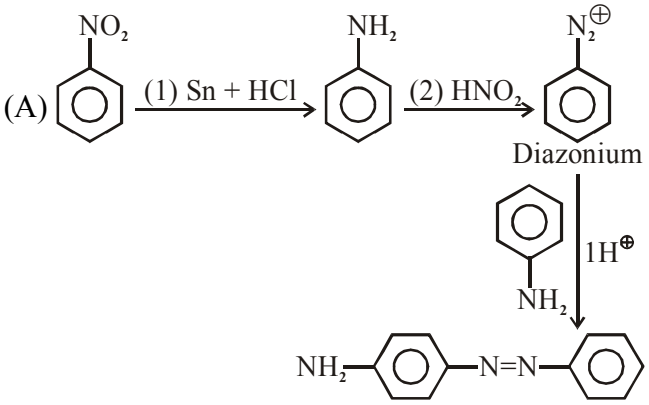


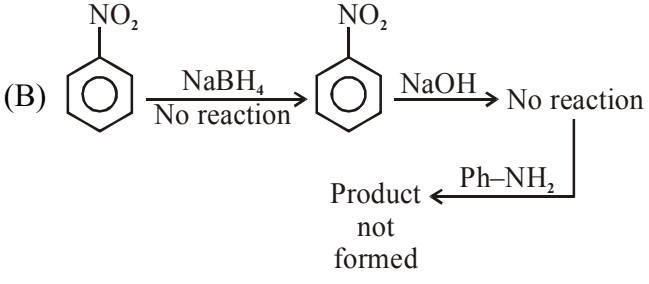
(1) A only (2) B only

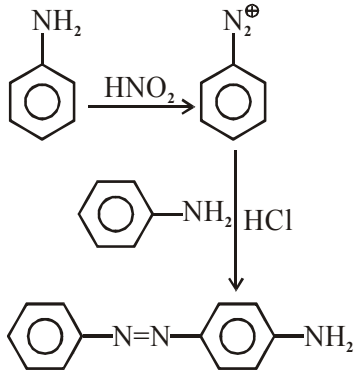
(3) C only (4) A and B

Official Ans. by NTA (2)

Sol. In basic or neutral medium N–N coupling favourable while in slightly acidic medium C–N coupling favourable.



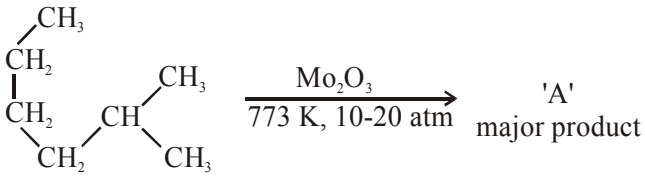


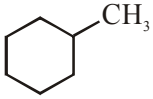
(C) 

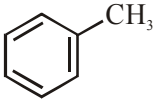
4. Which of the following equation depicts the oxidizing nature of H_2O_2?
(1) $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$
(2) $2I^- + H_2O_2 + 2H^+ \rightarrow I_2 + 2H_2O$
(3) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
(4) $Cl_2 + H_2O_2 \rightarrow 2HCl + O_2$
Official Ans. by NTA (2)

Sol. I^- is oxidised to I_2 by H_2O_2
Hence answer is (2)

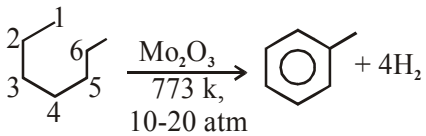
5. Identify A in the given chemical reaction.



(1) 
(2) 
(3) 

(4) 

Official Ans. by NTA (4)

Sol. 

Mo_2O_3 at 773 K temperature and 10-20-atm pressure is aromatising agent.

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
Official Ans. by NTA (3)

Sol. $n_c = n_{co_2} = \frac{2.64}{44} = 0.06$

$n_H = 2 \times n_{H_2O} = \frac{1.08}{18} \times 2 = 0.12$

$m_0 = 1.80 - 12 \times \frac{2.64}{44} - \frac{1.08}{18} \times 2$

$= 1.80 - 0.72 - 0.12 = 0.96$ gm

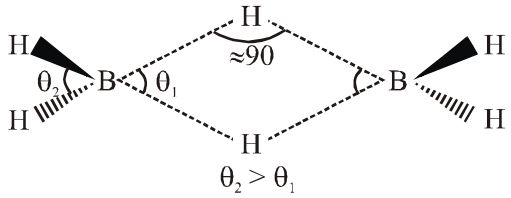
$\%0 = \frac{0.96}{1.80} \times 100 = 53.33\%$

Hence answer is (3)

7. Which one of the following reactions will not form acetaldehyde?
(1) $CH_3CH_2OH \xrightarrow[573K]{Cu}$
(2) $CH_3CN \xrightarrow[(ii)H_2O]{(i)DIBAL-H}$
(3) $CH_2=CH_2 + O_2 \xrightarrow[H_2O]{Pd(II)/Cu(II)}$
(4) $CH_3CH_2OH \xrightarrow{CrO_3-H_2SO_4}$
Official Ans. by NTA (4)

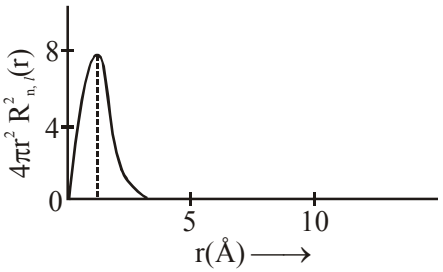
Sol. $CH_3-CH_2-OH \xrightarrow[\text{Strong oxidising agent}]{CrO_3 \cdot H_2SO_4} CH_3-\overset{O}{\overset{\|}{C}}-OH$ (Carboxylic acid is formed by complete oxidation)

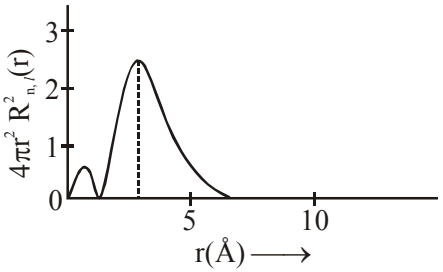
8. The correct statement about B_2H_6 is:
(1) Terminal B–H bonds have less p-character when compared to bridging bonds.
(2) The two B–H–B bonds are not of same length
(3) All B–H–B angles are of 120°
(4) Its fragment, BH_3, behaves as a Lewis base
Official Ans. by NTA (1)

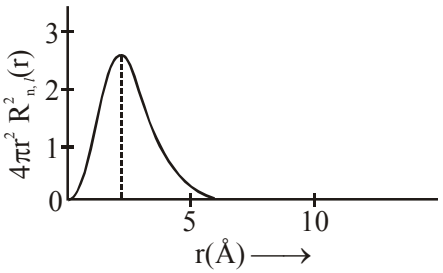
Sol. 

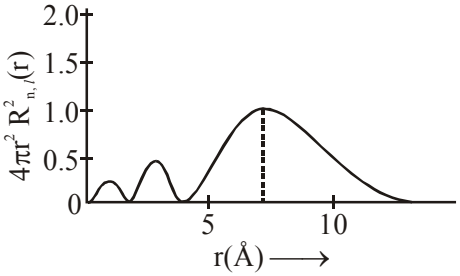
- $\theta_2 > \theta_1$, ∴ B–H (terminal) having less p-character as compare to bridge bond.
- Both B–H–B bridge bond having same bond length.
- B–H–B bond angle is ≈90°
- BH_3 is e^- deficient species and therefore act as lewis acid

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

(A) 

(B) 

(C) 

(D) 

The correct plot for 3s orbital is:

(1) (B) (2) (A)

(3) (D) (4) (C)

Official Ans. by NTA (3)

Sol. Number of radial nodes = $n - \ell - 1$

$= 3 - 0 - 1 = 2$

Therefor corresponding graph is (D)

Hence answer is (3)

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

Official Ans. by NTA (1)

Sol. Reducing smog is a mixture of smoke, fog and sulphur dioxide.

Tropospheric pollutants such as hydrocarbon and nitrogen oxide contirbute to the formation of photochemical smog.

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^{+}

Official Ans. by NTA (1)

Sol.

Option – 1	$Mn^{+2}[Ar]3d^5, Cr^{+}[Ar]3d^5$
Option – 2	$Ni^{+2}[Ar]3d^8, Cu^{+}[Ar]3d^{10}$
Option – 3	$Fe^{+2}[Ar]3d^6, Co^{+}[Ar]3d^7 4s^1$
Option – 4	$V^{+2}[Ar]3d^3, Cr^{+}[Ar]3d^5$

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

(1) C-1 of galactose and C-4 of glucose

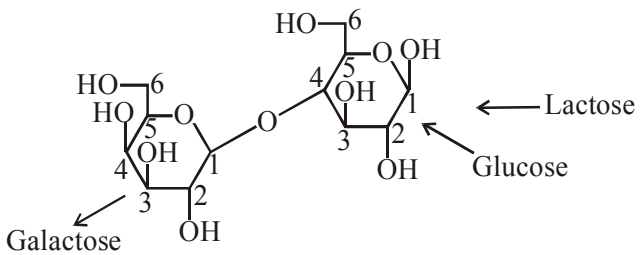
(2) C-1 of glucose and C-6 of galactose

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

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

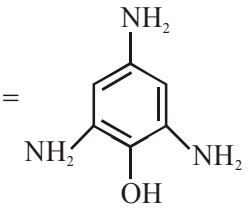
Official Ans. by NTA (1)

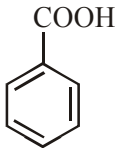
Sol.

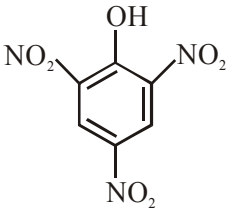


In lactose linkage is formed between C_1 of galactose and C_4 of gluocse.

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

A = 

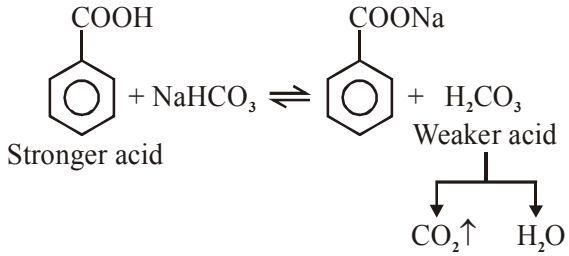
B = 

C = 

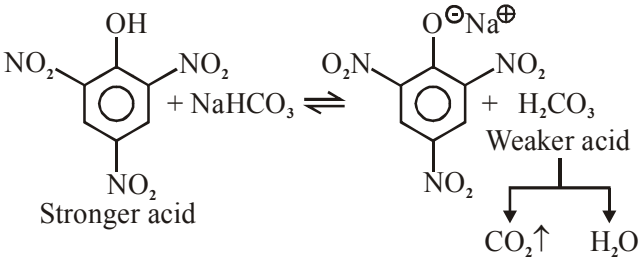
(1) B only (2) C only

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

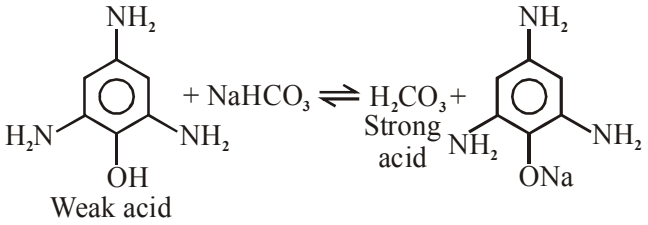
Official Ans. by NTA (3)

Sol. 

equilibrium favours forward direction and $CO_2\uparrow$ is librated.



Equilibrium favours forward direction and $CO_2\uparrow$ is librated.



Equilibrium favours back word direction and $CO_2\uparrow$ is not librated.

14. The hybridization and magnetic nature of $[Mn(CN)_6]^{4-}$ and $[Fe(CN)_6]^{3-}$, respectively are:

(1) d^2sp^3 and diamagnetic

(2) sp^3d^2 and diamagnetic

(3) d^2sp^3 and paramagnetic

(4) sp^3d^2 and paramagnetic

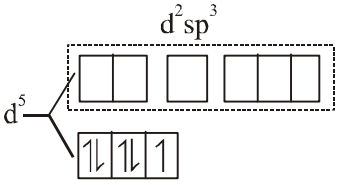
Official Ans. by NTA (3)

Sol. $[Mn(CN)_6]^{4-}$

Mn^{+2} d^5

CN^- – SFL

$\Delta_0 > P$



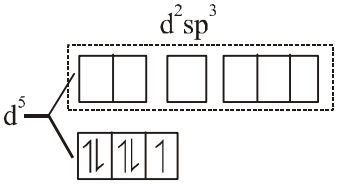
$\therefore$ hybridisation is d^2sp^3 and due to presence of unpaired e^- complex is paramagnetic in nature

$[Fe(CN)_6]^{3-}$

Fe^{+3} d^5

CN^- – SFL

$\Delta_0 > P$



$\therefore$ hybridisation is d^2sp^3 and due to presence of unpaired e^- complex paramagnetic in nature

15. Ellingham diagram is a graphical representation of:

(1) ΔH vs T (2) ΔG vs T

(3) ΔG vs P (4) $(\Delta G - T\Delta S)$ vs T

Official Ans. by NTA (2)

Sol. Ellingham diagram is a graphical representation of ΔG vs T when metal heated with oxygen to form metal oxide

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; $K_{sp}(AgCN) = 2.2 \times 10^{-16}$ and $K_a(HCN) = 6.2 \times 10^{-10}$]

(1) 0.625×10^{-6} (2) 1.9×10^{-5}

(3) 2.2×10^{-16} (4) 1.6×10^{-6}

Official Ans. by NTA (2)

Sol. $\frac{K_{sp}}{Ka} = \frac{s^2}{(H^+)}$; $s = \sqrt{\frac{K_{sp}}{K_a}(H^+)}$

$$s = \sqrt{\frac{2.2\times10^{-16}}{6.2\times10^{-10}}\times10^{-3}}$$

$s = 1.9 \times 10^{-5}$

Hence answer is (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) ∞

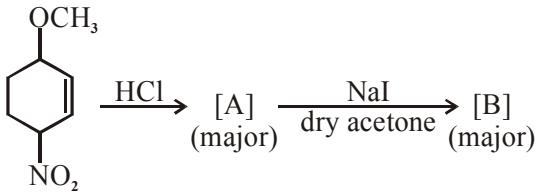
Official Ans. by NTA (2)

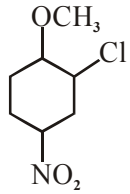
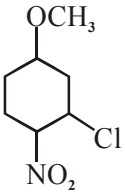
Sol. As per Freundlich adsorption isotherm

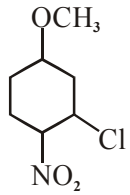
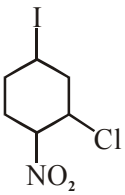
$$\left(\frac{x}{m}\right) = KP^{\frac{1}{n}} \rightarrow x = \frac{1}{n}$$

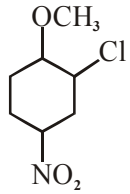
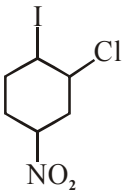
Hence answer is (2)

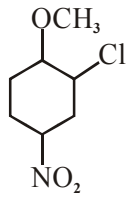
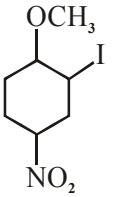
18. Identify A and B in the chemical reaction.



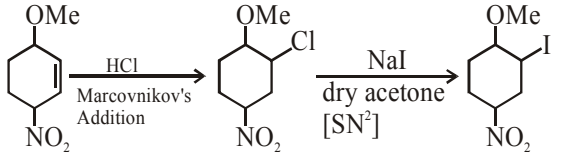
(1) A =  B = 

(2) A =  B = 

(3) A =  B = 

(4) A =  B = 

Official Ans. by NTA (4)

Sol. 

$\Rightarrow$ I[st] reaction marcovnikov's addition of HCl on double bond while 2[nd] reaction is halide substitution by finkelstein reaction.

19. Which statement is correct ?

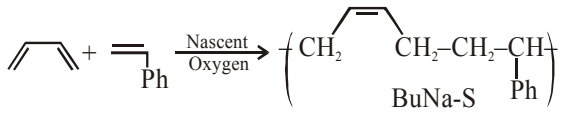
(1) Synthesis of Buna-S needs nascent oxygen.

(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.

Official Ans. by NTA (1)

Sol. 

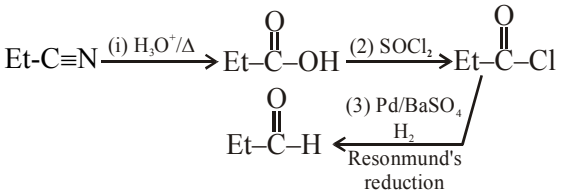
20. The major product of the following chemical reaction is :

$$CH_3CH_2CN \xrightarrow[(3)\ Pd/BaSO_4,H_2]{(1)\ H_3O^+,\ \Delta \\ (2)\ SOCl_2} ?$$

(1) $CH_3CH_2CH_3$ (2) $CH_3CH_2CH_2OH$

(3) $(CH_3CH_2CO)_2O$ (4) CH_3CH_2CHO

Official Ans. by NTA (4)

Sol. 

Final product of reaction is propanaldehyde.

SECTION-B

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

Official Ans. by NTA (1)

Sol. SF_6 is inert towards hydrolysis

$\therefore$ answere is (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 (H_2O) = 0.52 K kg mol^{-1}]

Official Ans. by NTA (375)

Sol. $\Delta T_b = iK_bm$

$= (1 + 4\alpha) \times 0.52 \times 1$

$= 3.4 \times 0.52 \times 1 = 1.768$

$T_b = 1.768 + 313.15 = 374.918$ K

$= 375$K

Hence answer is (375)

3. In basic medium CrO_4^{2-} oxidises $S_2O_3^{2-}$ to form SO_4^{2-} and itself changes into $Cr(OH)_4^-$. The volume of 0.154 M CrO_4^{2-} required to react with 40 mL of 0.25 M $S_2O_3^{2-}$ is _____ mL. (Rounded-off to the nearest integer)

Official Ans. by NTA (173)

Sol. $\overset{+6}{Cr}O_4^{2-} + \overset{+2}{S_2}O_3^{2-} \rightarrow \overset{+6}{S}O_4^{2-} + \overset{+3}{Cr}(OH)_4^-$

gm equi. of $CrO_4^{2-} = S_2O_3^{2-}$

$0.154 \times 3 \times v = 0.25 \times 40 \times 8$

$v = 173.16 = 173$ ml

Hence answer is (173)

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 °C at which the car tyre will burst is _____. (Rounded-off to the nearest integer)

Official Ans. by NTA (70)

Sol. $P \propto T$

$$\frac{P_2}{P_1} = \frac{T_2}{T_1} \Rightarrow \frac{40}{35} = \frac{T_2}{300}$$

$T_2 = 342.854$ K

$= 69.70°C \simeq 70°C$

Hence answer is (70)

5. The reaction of cyanamide, $NH_2CN_{(s)}$ with oxygen was run in a bomb calorimeter and ΔU was found to be –742.24 kJ mol^{-1}. The magnitude of ΔH_{298} for the reaction

$$NH_2CN_{(s)} + \frac{3}{2}O_2(g) \rightarrow N_{2(g)} + O_2(g) + H_2O_{(l)}$$

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

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

Official Ans. by NTA (741)

Sol. $\Delta H = \Delta U + \Delta n_g RT$

$$= -742.24 + \frac{1}{2} \times \frac{8.314}{1000} \times 298$$

$= -741$ kJ/mol

Hence answer is (741)

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

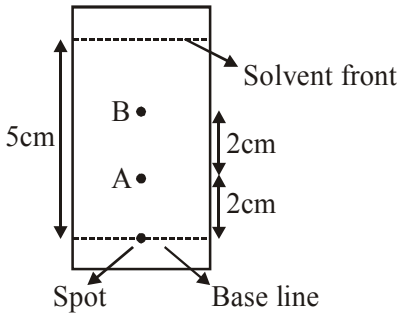


Figure : Paper chromatography for compounds A and B.

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

Official Ans. by NTA (4)

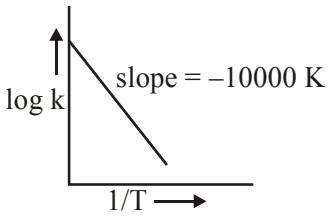
Sol. $R_f = \frac{\text{Distance travelled by compound}}{\text{Distance travelled by solvent}}$

on chromatogram distance travelled by cmopound is $\rightarrow$ 2 cm

Distance travelled by solvent = 5 cm

So $R_f = \frac{2}{5} = 4 \times 10^{-1} = 0.4$

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.]

Official Ans. by NTA (526)

Sol. $\log K = \log A - \frac{Ea}{2.303RT}$

$$|\text{Slope}| = \frac{Ea}{2.303R} = 10,000$$

$$\log\left(\frac{K_2}{K_1}\right) = \frac{Ea}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\log\left(\frac{10^{-4}}{10^{-5}}\right) = 10,000\left[\frac{1}{500} - \frac{1}{T_2}\right]$$

$T_2 = 526.31 \simeq 526K$

Hence answer is (526)

8. 0.4 g mixture of NaOH, Na_2CO_3 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 Na_2CO_3 in the mixture is _____. (Rounded-off to the nearest integer)

Official Ans. by NTA (4)

Sol. Upto first end point

gm equi. of $(NaOH + Na_2CO_3)$ = HCl

$$x + y \times 1 = \frac{1}{10} \times 17.5$$

$$x + y = 1.75 \quad \ldots(1)$$

Upto second end point

$NaOH + Na_2CO_3 \equiv HCl$

$$x + y \times 2 = \frac{1}{10} \times 19$$

$$x + 2y = 1.9 \quad \ldots(2)$$

$$y = 0.15$$

$$\%Na_2CO_3 = \frac{0.15 \times 10^{-3} \times 106}{0.4} \times 100$$

$$= 3.975\%$$

$$= 4\%$$

Hence answer is (4)

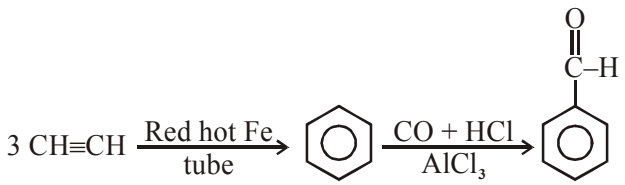
9. Consider the following chemical reaction.

$$CH \equiv CH \xrightarrow[(2)\ CO,\ HCl,\ AlCl_3]{(1)\ \text{Red hot Fe tube, 873 K}} \text{Product}$$

The number of sp^2 hybridized carbon atom(s) present in the product is _____.

Official Ans. by NTA (7)

Sol.

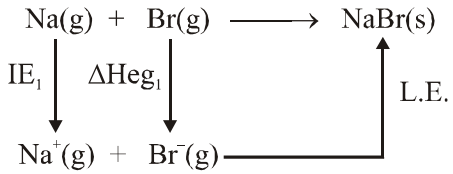


In benzaldehyde total number of sp^2 'C' are 7.

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

Official Ans. by NTA (5576)

Sol.



$$\Delta H_{formation} = IE_1 + \Delta Heg_1 + LE$$

$$= 495.8 + (-325) + (-728.4)$$

$$= -557.6$$

$$= -5576 \times 10^{-1} \text{ KJ/mol.}$$

Note: The above calculation is not for $\Delta H_{formation}$ but for $\Delta H_{Reaction}$.

But on the basis of given data it is the best ans.