JEE Main February 2021

Question Paper With Text Solution

25 Feb.| Shift-1

CHEMISTRY

MATRIX

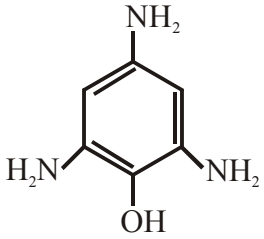
JEE Main & Advanced | XI-XII Foundation| VI-X Pre-Foundation

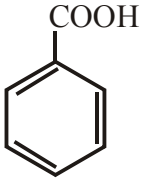
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

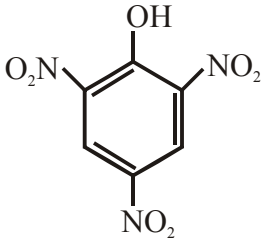
JEE MAIN FEB 2021 | 25TH FEB SHIFT-1

SECTION – A

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

A = 

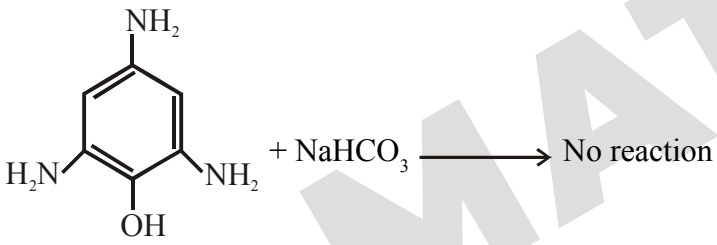
B = 

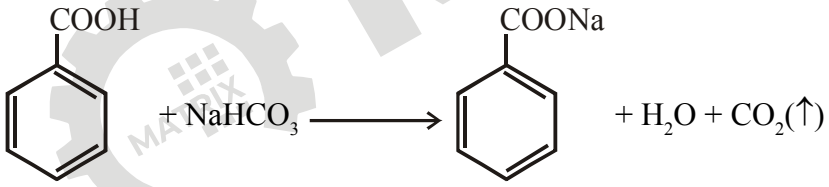
C = 

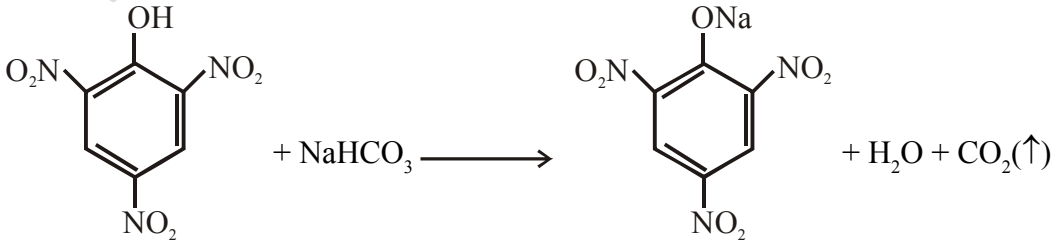
(1) B and C only (2) B only (3) C only (4) A and B only

Ans. Offical Answer NTA (1)

Sol. Compounds which are more acidic than H_2CO_3 liberate CO_2 gas with $NaHCO_3$







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

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

Ans. Offical Answer NTA (3)

Sol. V^{2+} = (Ar) $3d^3\ 4s^1$

Cr^{+} = (Ar) $3d^5\ 4s^1$

Ni^{2+} = (Ar) $3d^3\ 4s^1$

Cu^{+} = (Ar) $3d^9\ 4s^1$

Mn^{2+} = (Ar) $3d^5\ 4s^1$

CO^{+} = (Ar) $3d^7\ 4s^1$

3. The correct statement about B_2H_6 is :

(1) The two B – H – B bonds are not of same length.

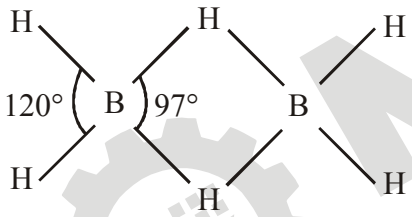
(2) All B – H – B angles are of 120°.

(3) Its fragment, BH_3, behaves as a Lewis base.

(4) Terminal B – H bonds have less *p*–character when compared to bridging bonds.

Ans. Offical Answer NTA (4)

Sol.



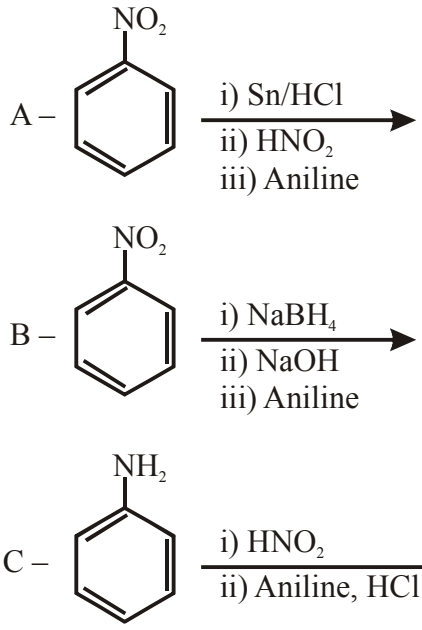
(1) Both B–H–B bonds are of same length.

(2) B–H–B angle is 83°

(3) BH_3 is a lewis acid

(4) Terminal B–H bonds have less *p*-character then compared to bridging bonds according to bent rule.

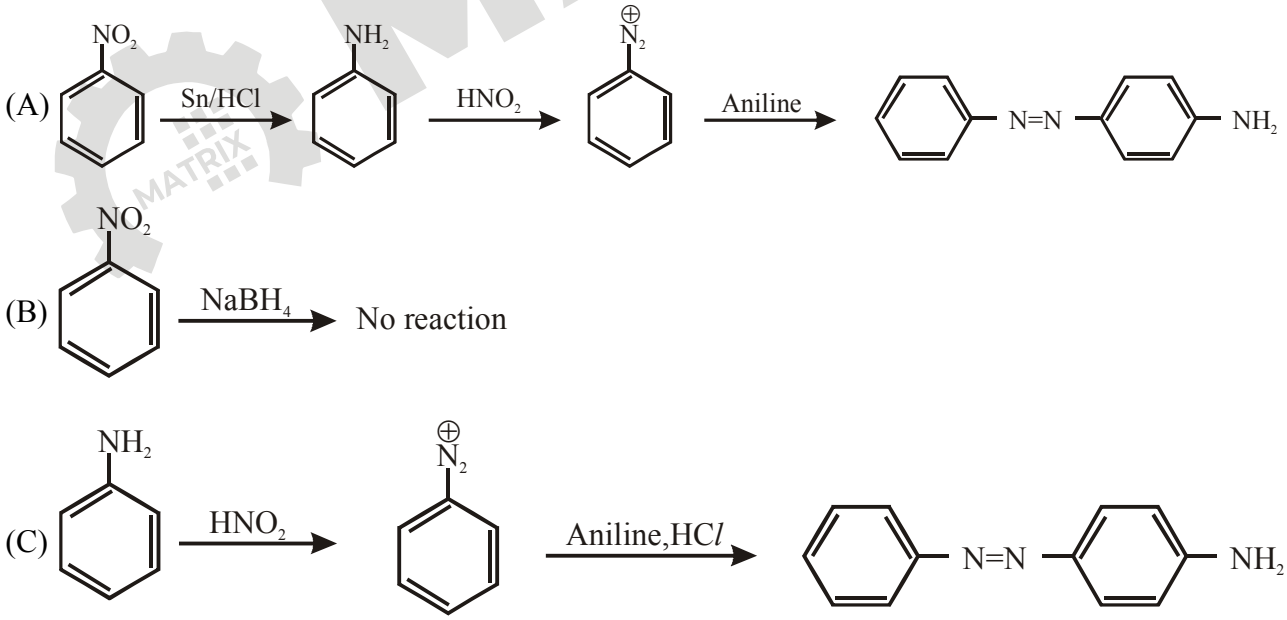
4. Which of the following reaction/s will not give p–aminoazobenzene?



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

Ans. Offical Answer NTA (1)

Sol.



5. 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) $Cl_2 + H_2O_2 \rightarrow 2HCl + O_2$

(3) $2I^- + H_2O_2 + 2H^+ \rightarrow I_2 + 2H_2O$

(4) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$

Ans. Offical Answer NTA (3)

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

(-1) (0)

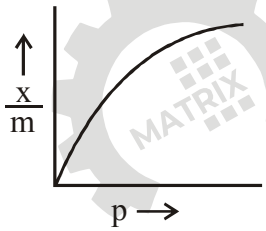
I^- is oxidised hence H_2O_2 act as an oxidising agent.

6. 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) $\frac{1}{n}$ (2) 1 (3) ∞ (4) zero

Ans. Offical Answer NTA (1)

Sol.



$\frac{x}{m} = kp^{\frac{1}{n}}$

at moderate pressure

$\frac{x}{m} \propto p$

hence $\frac{1}{n} = 1 \Rightarrow n = 1$

7. 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 true

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

(3) Both Statement I and Statement II are false

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

Ans. Offical Answer NTA (3)

Sol. Classical smog is known as reducing smog.

Ozone which is allotrope of oxygen is an important intermediate in the formation of photochemical smog but not classical smog.

Hydrocarbons and oxide of Nitrogen contribute to the formation of photochemical smog.

8. Which statement is correct?

(1) Buna–S is a synthetic and linear thermosetting polymer.

(2) Neoprene is an addition copolymer used in plastic bucket manufacturing.

(3) Synthesis of Buna–S needs nascent oxygen.

(4) Buna–N is a natural polymer.

Ans. Offical Answer NTA (3)

Sol. (1) Buna-S is a elastomer

(2) Neoprene is a homopolymer

(3) Synthesis of Buna-S needs a nascent oxygen or free radical

(4) Buna-N is a synthetic polymer

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

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

Ans. Offical Answer NTA (4)

Sol. Be $\Rightarrow \sigma 1S^2 \ {}^{*}\sigma 1S^2 \ \sigma 2S^2 \ {}^{*}\sigma 2S^2$

Bond order = 0

10. 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) 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. Offical Answer NTA (3)

Sol. +3 oxidation state of lanthanides is most stable and hence Ce^{4+} compounds are good oxidising agent.

Eu^{2+} will act as reducing agent because it will try to oxidise to more stable +3 oxidation state.

11. Ellingham diagram is a graphical representation of :

(1) ΔG vs T

(2) $(\Delta G - T\Delta S)$ vs T

(3) ΔH vs T

(4) ΔG vs P

Ans. Offical Answer NTA (1)

Sol. Ellingham diagram is the graphical

representation of ΔG and T

12. 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) 53.33 (2) 63.53 (3) 50.33 (4) 51.63

Ans. Offical Answer NTA (1)

Sol. $C_xH_yO_z + \left(x + \frac{y}{4} - \frac{z}{2}\right) O_2 \longrightarrow xCO_2 + \frac{y}{2} H_2O$

mass of 'C' in 2.64 g $CO_2 = \frac{12}{44} \times 2.64 = 0.72$ g

mass of 'H' in 1.08 g $H_2O = \frac{2}{18} \times 1.08 = 0.12$ g

mass of 'O' in compound = 1.80 – (0.72 + 0.12)

% of 'O' = $\frac{0.96}{1.80} \times 100 = 53.33\%$

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

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

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

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

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

Ans. Offical Answer NTA (3)

Sol. Lactose is composed of a molecule of

galactose joined to a molecule of glucose

by a β–1, 4- glycosidic linkage

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

(1) $CH_3CN \xrightarrow[\text{ii) } H_2O]{\text{i) DIBAL-H}}$

(2) $CH_3CH_2OH \xrightarrow{CrO_3–H_2SO_4}$

(3) $CH_3CH_2OH \xrightarrow[573\ K]{Cu}$

(4) $CH_2 = CH_2 + O_2 \xrightarrow[H_2O]{Pd(II)/Cu(II)}$

Ans. Offical Answer NTA (2)

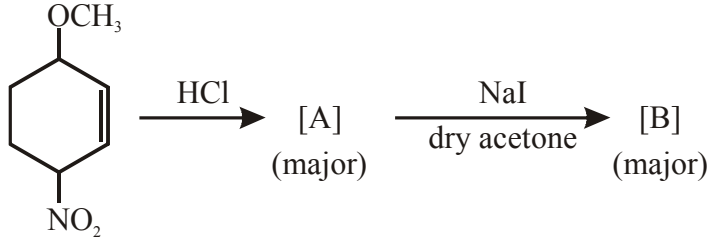
Sol. (1) $CH_3CN \xrightarrow[\text{ii) } H_2O]{\text{i) DIBAL-H}} CH_3 – CHO$

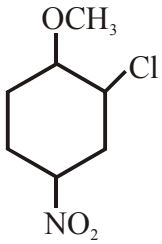
(2) $CH_3CH_2OH \xrightarrow{CrO_3–H_2SO_4} CH_3 – COOH$

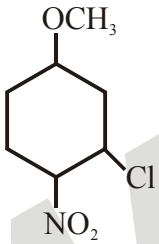
(3) $CH_3CH_2OH \xrightarrow[573\ K]{Cu} CH_3CHO$

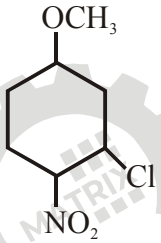
(4) $CH_2 = CH_2 + O_2 \xrightarrow[H_2O]{Pd(II)/Cu(II)} CH_3 - CHO$

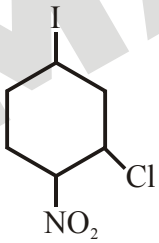
15. Identify A and B in the chemical reaction.

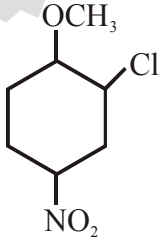


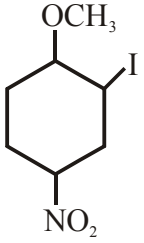
(1) A = 

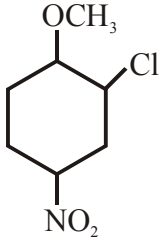
B = 

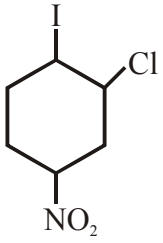
(2) A = 

B = 

(3) A = 

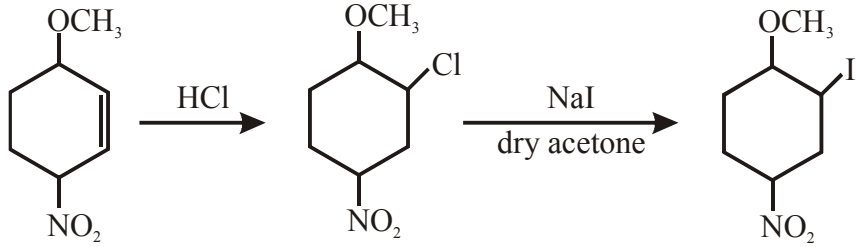
B = 

(4) A = 

B = 

Ans. Offical Answer NTA (3)

Sol.



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

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

(1) $(CH_3CH_2CO)_2O$

(2) $CH_3CH_2CH_2OH$

(3) CH_3CH_2CHO

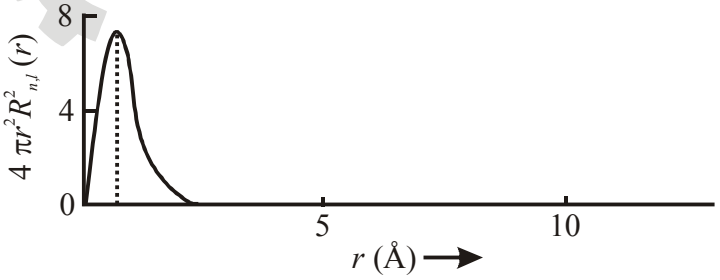
(4) $CH_3CH_2CH_3$

Ans. Offical Answer NTA (3)

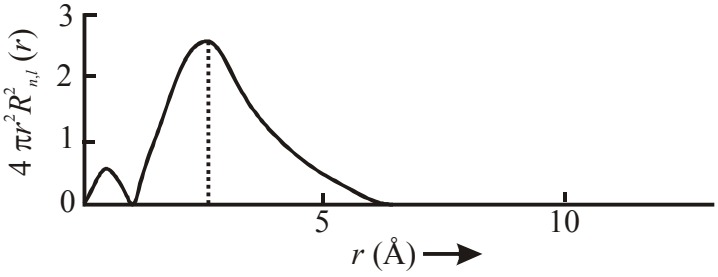
Sol. $CH_3CH_2CN \xrightarrow{H_3O^+,\ \Delta} CH_3CH_2COOH \xrightarrow{SOCl_2} CH_3CH_2COCl \xrightarrow{Pd/BaSO_4,\ H_2} CH_3CH_2CHO$

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

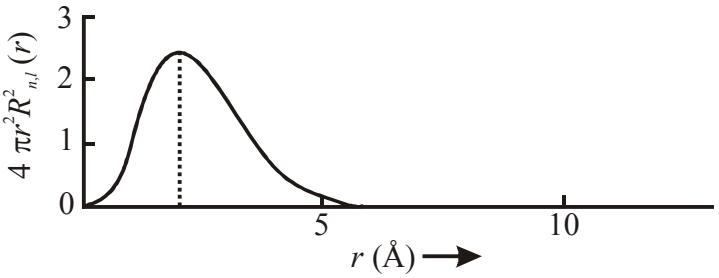
(A)



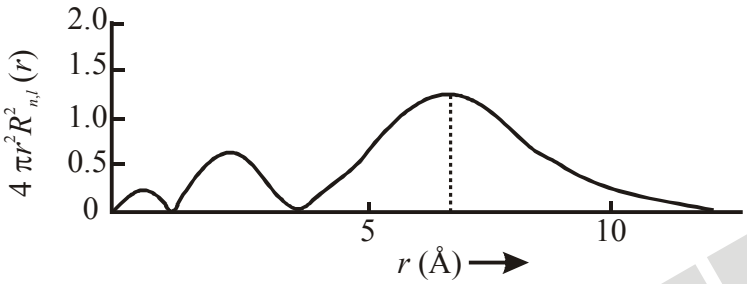
(B)



(C)



(D)



The correct plot for 3s orbital is :

(1) (C)

(2) (D)

(3) (A)

(4) (B)

Ans. Offical Answer NTA (2)

Sol. Radial node in 3S orbital

= n – l – 1 = 3 – 0 – 1 = 2

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

(1) sp^3d^2 and paramagnetic

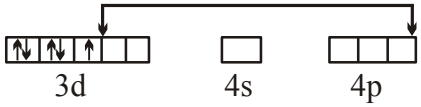
(2) d^2sp^3 and paramagnetic

(3) sp^3d^2 and diamagnetic

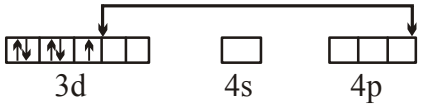
(4) d^2sp^3 and diamagnetic

Ans. Offical Answer NTA (2)

Sol. $[Mn(CN)_6]^{4-} \Rightarrow Mn^{2+} \Rightarrow$



Hybridization is d^2sp^3 & paramagnetic

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

d^2sp^3 & paramagnetic

19. 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) 2.2×10^{-16} (3) 1.9×10^{-5} (4) 1.6×10^{-6}

Ans. Offical Answer NTA (3)

Sol. $AgCN \rightleftharpoons Ag^{\oplus} + CN^{\ominus}$

S S – x $S(S - x) = 2.2 \times 10^{-16}$ .....(1)

$CN^{\ominus} + H^{\oplus} \rightleftharpoons HCN$

S – x 10^{-3} x $\frac{x}{(S-x)10^{-3}} = \frac{1}{6.2\times10^{-10}}$ .....(2)

(1) × 2

$\frac{xS}{10^{-3}} = \frac{2.2\times10^{-16}}{6.2\times10^{-10}}$]

Approximation
$S - x \to 0$
$S \to x$

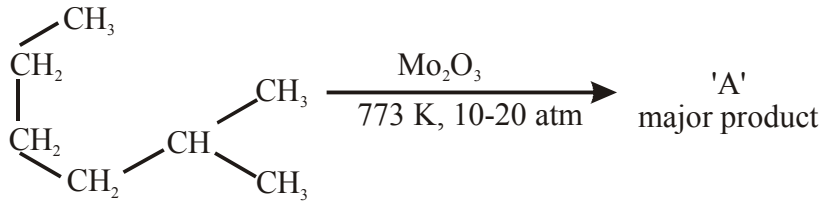
$xS = \frac{10^{-9}\times2.2}{6.2}$

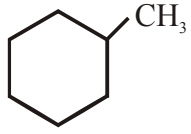
$S^2 = \frac{11}{31}\times10^{-10}$

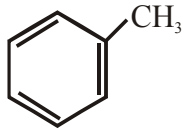
$S^2 = \frac{110}{31}\times10^{-10}$

$= 1.88 \times 10^{-5}$

20. Identify A in the given chemical reaction.



(1) 

(2) 

(3) 

(4) 

Ans. Offical Answer NTA (2)

Sol. Mo_2O_3 is a cyclisation and aromatising agent.

SECTION – B

1. The reaction of cyanamide, $NH_2CN_{(s)}$ with oxygen was run in a bomb calorimeter and ΔU was found 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 mol^{-1} K^{-1}]

Ans. Offical Answer NTA (741)

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

$\Delta ng = 1 + 1 - (3/2) = 0.5$

$\Delta H = -742.24 + 0.5 \times 8.314 \times 10^{-3} \times 298$

$= -741$

2. 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)

Ans. Offical Answer NTA (173)

Sol. $CrO_4^{2-} + S_2O_3^{2-} \rightarrow Cr(OH)_4^- + SO_4^{2-}$

$\downarrow \quad \downarrow$

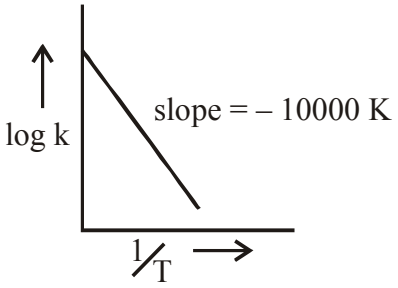
n-factor 3 8

equivalent of CrO_4^{2-} = equivalent of $S_2O_3^{2-}$

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

$V = 173.16$ mL

3. 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. Offical Answer NTA (526)

Sol. $k = Ae^{-Ea/RT}$ (Arrhenius equation)

$$\ln k = \ln A - \frac{Ea}{RT}$$

$$\log k = -\frac{Ea}{2.303RT} + \log A$$

$$-\frac{Ea}{2.303R} = -10000$$

$Ea = 2.303 \times 10000 \times R$

$$\log\left(\frac{k_2}{k_1}\right) = \frac{Ea}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\log\left(\frac{10^{-4}}{10^{-5}}\right) = \frac{2.303 \times 10000R}{2.303R}\left[\frac{1}{500} - \frac{1}{T_2}\right]$$

$T_2 = 526.316$ K

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)

Ans. Offical Answer NTA (70)

Sol. From Gay lussac law at constant volume

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

$T_2 = 342.875\ k = 69.875\ °C$

5. 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)

Ans. Offical Answer NTA (4)

Sol. Let m mol of NaOH = x

m mol of Na_2CO_3 = y

In presence of HPh :

$NaOH + HCl \rightarrow NaCl + H_2O$

$Na_2CO_3 + HCl \rightarrow NaHCO_3 + NaCl$

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

In presence of MeOH :-

$NaHCO_3 + HCl \rightarrow NaCl + H_2O$

m mol of $NaHCO_3$ = m mol of HCl

$y = \frac{1}{10} \times 1.5$ .....(2)

from equation (1) & (2)

$x = 1.60$; $y = 0.15$

Weight of $Na_2CO_3 = 0.15 \times 10^{-3} \times 106 = 1.59 \times 10^{-2}$ g

Weight % of $Na_2CO_3 = \frac{1.59\times10^{-2}}{0.4}\times100 = 3.975\ \%$

6. Among the following, the number of halide(s) which is/are inert to hydrolysis is _____.

(1) BF_3 (2) $SiCl_4$ (3) PCl_5 (4) SF_6

Ans. Offical Answer NTA (1)

Sol. SF_6 does not undergo hydrolysis due to

steric crowding

7. 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}]

Ans. Offical Answer NTA (375)

Sol. $A_2B_3 \rightleftharpoons 2A^{3+} + 3B^{2-}$

$i = 1 + (n - 1)\alpha$

$i = 1 + (5 - 1) \times 0. = 3.4$

$\Delta T_b = i K_b m$

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

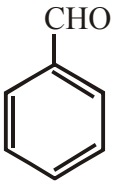
$T_b = 373 + \Delta T_b = 374.768$

8. 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 _____.

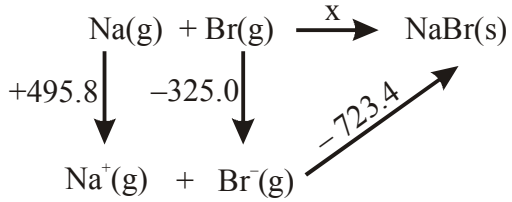
Ans. Offical Answer NTA (7)

Sol. $CH \equiv CH \xrightarrow[873\ K]{\text{Red hot Fe tube}}$  $\xrightarrow{CO,\ HCl,\ AlCl_3}$ 

9. 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}.

Ans. Offical Answer NTA (5576)

Sol.



$x = 495.8 - 325 - 728.4$

$= -557.6$

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

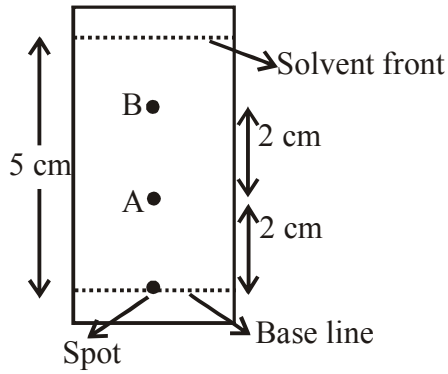


Fig : Paper chromatography for compounds A and B.

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

Ans. Offical Answer NTA (4)

Sol. $R_f = \dfrac{\text{Distance moved by the substance from base line}}{\text{Distance moved by solvent from base line}}$

$= \dfrac{2}{5} = 4 \times 10^{-1}$