FINAL JEE–MAIN EXAMINATION – MARCH, 2021

(Held On Thursday 18th March, 2021) TIME : 3 : 00 PM to 6 : 00 PM

CHEMISTRY — TEST PAPER WITH ANSWER & SOLUTION

SECTION-A

1. The oxidation states of nitrogen in NO, NO_2, N_2O and NO_3^- are in the order of :

(1) $NO_3^- > NO_2 > NO > N_2O$

(2) $NO_2 > NO_3^- > NO > N_2O$

(3) $N_2O > NO_2 > NO > NO_3^-$

(4) $NO > NO_2 > N_2O > NO_3^-$

Official Ans. by NTA (1)

Sol. The oxidation states of Nitrogen in following molecules are as follows

$NO_3^- \rightarrow +5$

$NO_2 \rightarrow +4$

$NO \rightarrow +2$

$N_2O \rightarrow +1$

2. In basic medium, H_2O_2 exhibits which of the following reactions ?

(A) $Mn^{2+} \rightarrow Mn^{4+}$

(B) $I_2 \rightarrow I^-$

(C) $PbS \rightarrow PbSO_4$

Choose the most appropriate answer from the options given below :

(1) (A), (C) only

(2) (A) only

(3) (B) only

(4) (A), (B) only

Official Ans. by NTA (4)

Sol. In basic medium, oxidising action of H_2O_2.

$Mn^{2+} + H_2O_2 \rightarrow Mn^{+4} + 2OH^-$

In basic medium, reducing action of H_2O_2

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

In acidic medium, oxidising action of H_2O_2.

$PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(\ell)$

Hence correct option (4)

3. In the reaction of hypobromite with amide, the carbonyl carbon is lost as :

(1) CO_3^{2-}

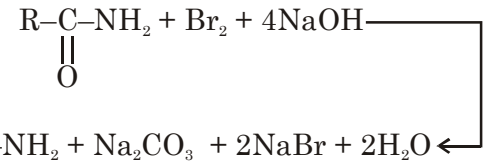
(2) HCO_3^-

(3) CO_2

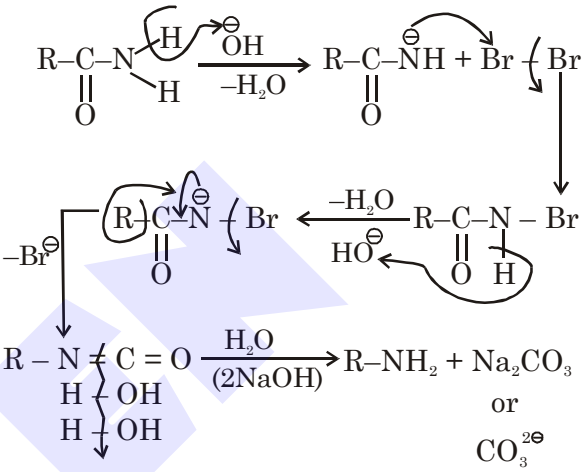
(4) CO

Official Ans. by NTA (1)

Sol.



Mechanism



4. The oxide that shows magnetic property is :

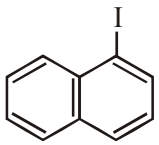
(1) SiO_2 (2) Mn_3O_4

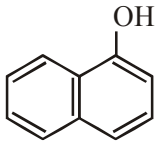
(3) Na_2O (4) MgO

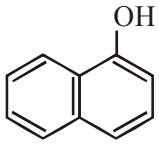
Official Ans. by NTA (2)

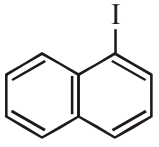
Sol. Mn_3O_4 shows magnetic properties.

5. Main Products formed during a reaction of 1-methoxy naphthalene with hydroiodic acid are:

(1)  and CH_3OH

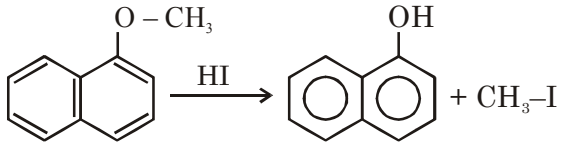
(2)  and CH_3I

(3)  and CH_3OH

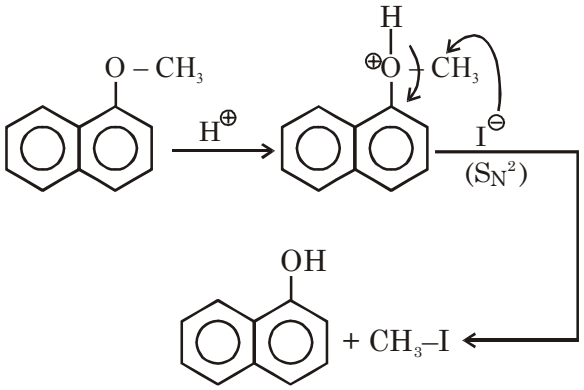
(4)  and CH_3I

Official Ans. by NTA (2)

Sol.



Mechanism



6. Deficiency of vitamin K causes :

(1) Increase in blood clotting time

(2) Increase in fragility of RBC's

(3) Cheilosis

(4) Decrease in blood clotting time

Official Ans. by NTA (1)

Sol. Due to deficiency of Vitmain K causes increases in blood clotting time.

Note : Vitamin K related to blood factor.

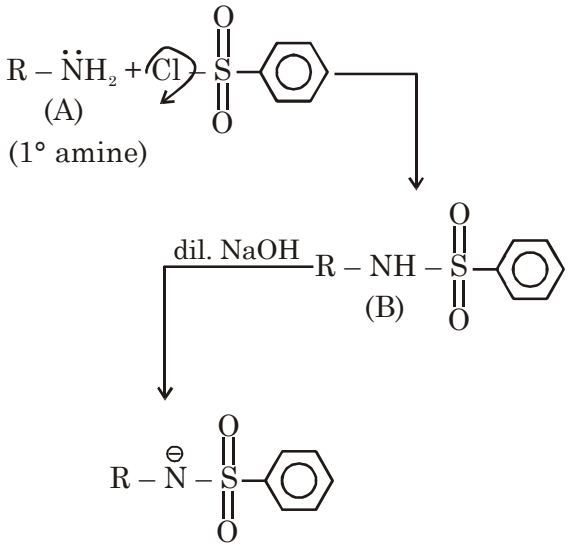
7. An organic compound "A" on treatment with benzene sulphonyl chloride gives compound B. B is soluble in dil. NaOH solution. Compound A is :

(1) C_6H_5–N–$(CH_3)_2$ (2) C_6H_5–$NHCH_2CH_3$

(3) C_6H_5–CH_2 $NHCH_3$ (4) C_6H_5–CH(–CH_3)–NH_2

Official Ans. by NTA (4)

Sol. Hinsberg reagent (Benzene sulphonyl chloride) gives reaction product with 1° amine and it is soluble in dil. NaOH.



8. The first ionization energy of magnesium is smaller as compared to that of elements X and Y, but higher than that of Z. the elements X, Y and Z, respectively, are :

(1) chlorine, lithium and sodium

(2) argon, lithium and sodium

(3) argon, chlorine and sodium

(4) neon, sodium and chlorine

Official Ans. by NTA (3)

Sol. The 1st IE order of 3rd period is

Na < Al < Mg < Si < S < P < Cl < Ar

X & Y are Ar & Cl

Z is sodium (Na).

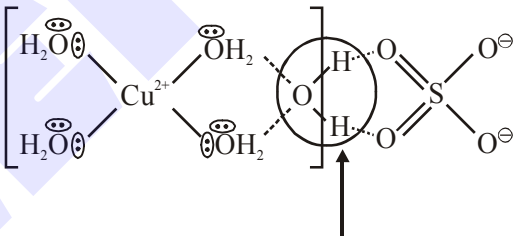
9. The secondary valency and the number of hydrogen bonded water molecule(s) in $CuSO_4 \cdot 5H_2O$, respectively, are :

(1) 6 and 4 (2) 4 and 1

(3) 6 and 5 (4) 5 and 1

Official Ans. by NTA (2)

Sol.



Hydrogen bonded water molecule = 1

Secondary valency = 4

10. Given below are two statements :

Statement I : Bohr's theory accounts for the stability and line spectrum of Li^+ ion.

Statement II : Bohr's theory was unable to explain the splitting of spectral lines in the presence of a magnetic field.

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.

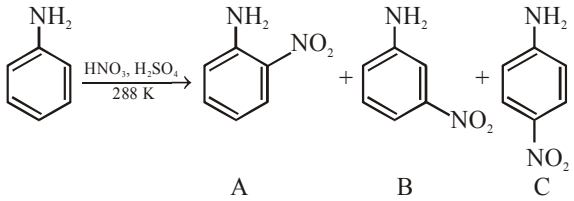
(3) Both statement I and statement II are false.

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

Official Ans. by NTA (2)

Sol. Statement-I is false since Bohr's theory accounts for the stability and spectrum of single electronic species (eg : He^{+}, Li^{2+} etc)
Statement II is true.

11.

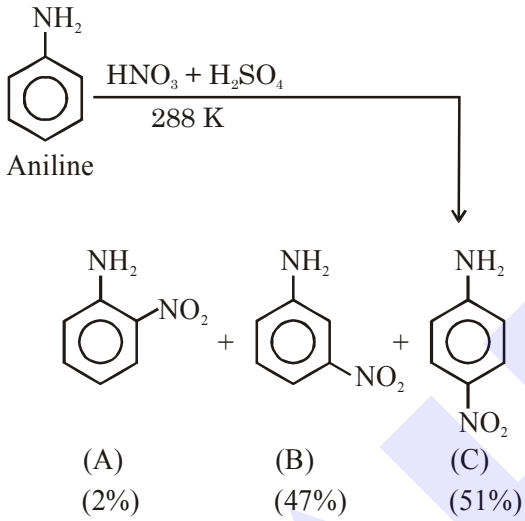


Consider the given reaction, percentage yield of :

(1) C > A > B (2) B > C > A
(3) A > C > B (4) C > B > A

Official Ans. by NTA (4)

Sol.



% yield order $\Rightarrow$ C > B > A

12. The charges on the colloidal CdS sol and TiO_2 sol are, respectively :

(1) positive and positive
(2) positive and negative
(3) negative and negative
(4) negative and positive

Official Ans. by NTA (4)

Sol. CdS sol $\rightarrow$ –ve sol
TiO_2 sol $\rightarrow$ +ve sol

13. Match List - I with List - II :

List - I (Class of Chemicals)	List - II (Example)
(a) Antifertility drug	(i) Meprobamate
(b) Antibiotic	(ii) Alitame
(c) Tranquilizer	(iii) Norethindrone
(d) Artificial Sweetener	(iv) Salvarsan

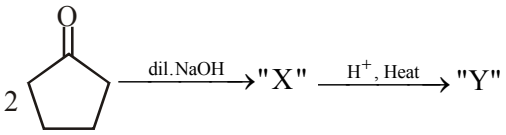
(1) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)
(2) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)
(3) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)
(4) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

Official Ans. by NTA (3)

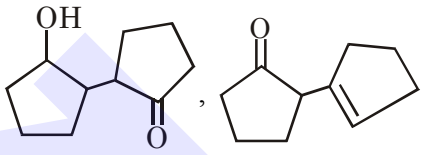
Sol. (A) Antifertility drug $\rightarrow$ (iii) Nor ethindrone
(B) Antibiotic $\rightarrow$ (iv) Salvarsan
(C) Tranquilizer $\rightarrow$ (i) Meprobamate
(D) Artificial sweetener $\rightarrow$ (ii) Alitame

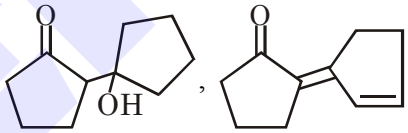
Ans. A–iii, B-iv, C-i, D-ii

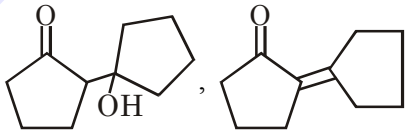
14.

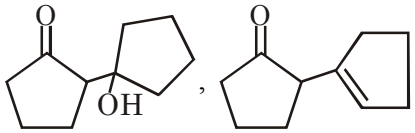


Consider the above reaction, the product 'X' and 'Y' respectively are :

(1) 

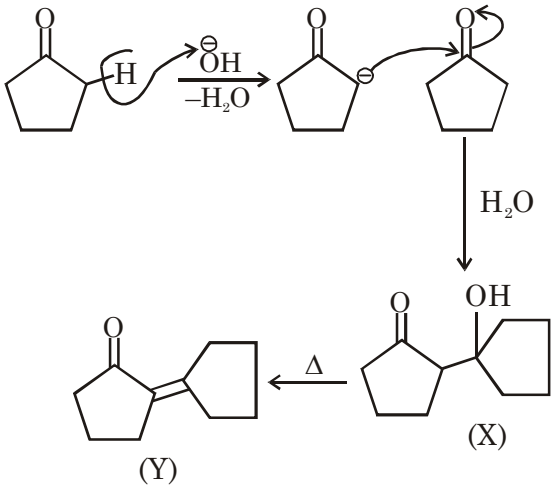
(2) 

(3) 

(4) 

Official Ans. by NTA (3)

Sol.



15. Match list-I with list-II :

List-I	List-II
(a) Be	(i) Treatment of cancer
(b) Mg	(ii) Extraction of metals
(c) Ca	(iii) Incendiary bombs and signals
(d) Ra	(iv) Windows of X-ray tubes
	(v) Bearings for motor engines.

Choose the most appropriate answer the option given below :

(1) a-iv, b-iii, c-i, d-ii
(2) a-iv, b-iii, c-ii, d-i
(3) a-iii, b-iv, c-v, d-ii
(4) a-iii, b-iv, c-ii, d-v

Official Ans. by NTA (2)

Sol. (a) Be $\rightarrow$ it is used in the Windows of X-ray tubes

(b) Mg $\rightarrow$ it is used in the Incendiary bombs and signals

(c) Ca $\rightarrow$ it is used in the Extraction of metals

(d) Ra $\rightarrow$ it is used in the Treatment of cancer

16. Given below are two statements :

Statement I : C_2H_5OH and AgCN both can generate nucleophile.

Statement II : KCN and AgCN both will generate nitrile nucleophile with all reaction conditions.

Choose the most appropriate option :

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

Official Ans. by NTA (1)

17. Given below are two statements :

Statement I : Non-biodegradable wastes are generated by the thermal power plants.

Statement II : Bio-degradable detergents leads to eutrophication.

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

(1) Both statement I and statement II are false
(2) Statement I is true but statement II is false
(3) Statement I is false but statement II is true
(4) Both statement I and statement II are true.

Official Ans. by NTA (4)

Sol. Non-biodegradable wastes are generated by the thermal power plants which produces fly ash. Detergents which are biodegradable causes problem called eutrophication which kills animal life by deprieving it of oxygen.

18. Match list-I with list-II :

List-I	List-II
(a) Mercury	(i) Vapour phase refining
(b) Copper	(ii) Distillation refining
(c) Silicon	(iii) Electrolytic refining
(d) Nickel	(iv) Zone refining

Choose the most appropriate answer from the option given below :

(1) a-i, b-iv, c-ii, d-iii (2) a-ii, b-iii, c-i, d-iv
(3) a-ii, b-iii, c-iv, d-i (4) a-ii, b-iv, c-iii, d-i

Official Ans. by NTA (3)

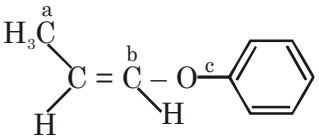
Sol. (a) Mercury $\rightarrow$ Distillation refining

(b) Copper $\rightarrow$ Electrolytic refining

(c) Silicon $\rightarrow$ Zone refining

(d) Nickel $\rightarrow$ Vapour phase refining

19. In the following molecules,

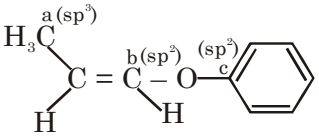


Hybridisation of carbon a, b and c respectively are :

(1) sp^3, sp, sp (2) sp^3, sp^2, sp
(3) sp^3, sp^2, sp^2 (4) sp^3, sp, sp^2

Official Ans. by NTA (3)

Sol.



20. A hard substance melts at high temperature and is an insulator in both solid and in molten state. This solid is most likely to be a / an :

(1) Ionic solid (2) Molecular solid
(3) Metallic solid (4) Covalent solid

Official Ans. by NTA (4)

Sol. Covalent or network solid have very high melting point and they are insulators in their solid and molten form.

SECTION-B

1. A reaction has a half life of 1 min. The time required for 99.9% completion of the reaction is _____ min. (Round off to the Nearest integer)

[Use : ln 2= 0.69, ln 10 = 2.3]

Official Ans. by NTA (10)

Sol. $$\frac{t_{99.9\%}}{t_{50\%}} = \frac{\frac{1}{K}\ln\frac{100}{0.1}}{\frac{1}{K}\ln 2}$$

$$= \frac{\ln 1000}{\ln 2} \times t_{50\%}$$

$$= \frac{3\ln 10}{\ln 2} \times 1$$

$$= \frac{3\times 2.3}{0.69} = 10$$

2. The molar conductivities at infinite dilution of barium chloride, sulphuric arid and hydrochloric acid are 280, 860 and 426 Scm^2 mol^{-1} respectively. The molar conductivity at infinite dilution of barium sulphate is _____S cm^2 mol^{-1}(Round off to the Nearest Integer).

Official Ans. by NTA (288)

Sol. From Kohlrausch's law

$$\Lambda_m^\infty(BaSO_4) = \lambda_m^\infty(Ba^{2+}) + \lambda_m^\infty(SO_4^{2-})$$

$$\Lambda_m^\infty(BaSO_4) = \Lambda_m^\infty(BaCl_2) + \Lambda_m^\infty(H_2SO_4) - 2\ \Lambda_m^\infty(HCl)$$

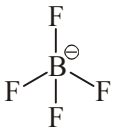
$$= 280 + 860 - 2\ (426)$$

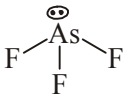
$$= 288\ Scm^2mol^{-1}$$

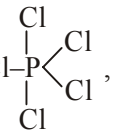
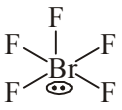
3. The number of species below that have two lone pairs of electrons in their central atom is ____(Round off to the Nearest integer)

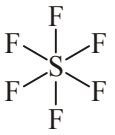
SF_4, BF_4^- , CIF_3, AsF_3, PCl_5, BrF_5, XeF_4, SF_6

Official Ans. by NTA (2)

Sol. SF_4 =  , $BF_4^{\ominus}$ = 

ClF_3 =  , AsF_3 = 

PCl_5 =  , BrF_5 = 

XeF_4 =  , SF_6 = 

Two l.p. on central atom is = ClF_3, XeF_4

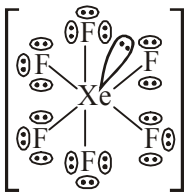
4. A xenon compound 'A' upon partial hydrolysis gives XeO_2F_2. The number of lone pair of electrons present in compound A is _____(Round off to the Nearest integer)

Official Ans. by NTA (19)

Sol. $XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4HF$

(A) (Limited water)

Structure of 'A'



Total l.p. on (A) = 19

5. The gas phase reaction

$2A(g) \rightleftharpoons A_2(g)$

at 400 K has ΔG° = + 25.2 kJ mol^{-1}.

The equilibrium constant K_C for this reaction is _____$\times 10^{-2}$. (Round off to the Nearest integer)

[Use : R = 8.3 J $mol^{-1}K^{-1}$, ln 10 = 2.3

$\log_{10}$ 2 = 0.30, 1 atm = 1 bar]

[antilog (–0.3) = 0.501]

Official Ans. by NTA (166)

Official Ans. by ALLEN (2)

Sol. Using formula

$\Delta_r G^0 = -RT\ln K_p$

$25200 = -2.3 \times 8.3 \times 400 \log(K_p)$

$K_p = 10^{-3.3} = 10^{-3} \times 0.501$

$= 5.01 \times 10^{-4}$ Bar^{-1}

$= 5.01 \times 10^{-9}$ Pa^{-1}

$$= \frac{K_C}{8.3 \times 400}$$

$K_C = 1.66 \times 10^{-5}$ m^3/mole

$= 1.66 \times 10^{-2}$ L/mol

Ans = 2

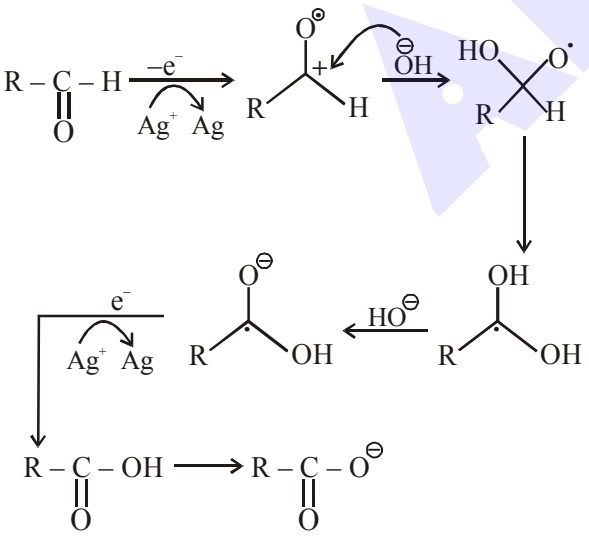
6. In Tollen's test for aldehyde, the overall number of electron(s) transferred to the Tollen's reagent formula $[Ag(NH_3)_2]^+$ per aldehyde group to form silver mirror is_____.(Round off to the Nearest integer)

Official Ans. by NTA (2)

Sol. $AgNO_3 + NaOH \rightarrow AgOH + NaNO_3$

$2AgOH \rightarrow Ag_2O + H_2O$

$Ag_2O + 4NH_3 + H_2O \rightarrow 2Ag(NH_3)_2^+ + 2\overset{\ominus}{O}H$



Total $2e^-$ transfer to Tollen's reagent

7. The solubility of $CdSO_4$ in water is 8.0×10^{-4} mol L^{-1}. Its solubility in 0.01 M H_2SO_4 solution is _____$\times 10^{-6}$ mol L^{-1}. (Round off to the Nearest integer) (Assume that solubility is much less than 0.01 M)

Official Ans. by NTA (64)

Sol. In pure water,

$K_{sp} = S^2 = (8 \times 10^{-4})^2$

$= 64 \times 10^{-8}$

In 0.01 M H_2SO_4

$H_2SO_{4(aq)} \rightarrow 2H^+_{(aq)} + SO_4^{2-}(aq.)$

$0.02 \quad 0.01$

$BaSO_{4(s)} \rightleftharpoons Ba^{2+}_{(aq.)} + SO_4^{2-}{}_{(aq)}$

$x \quad x \quad (x + 0.01)$

$K_{sp} = x\,(x + 0.01)$

$= 64 \times 10^{-8}$

$x + 0.01 \cong 0.01$ M

So, $x\,(0.01) = 64 \times 10^{-8}$

$x = 64 \times 10^{-6}$ M

8. A solute a dimerizes in water. The boiling point of a 2 molar solution of A is 100.52ºC. The percentage association of A is.____.

(Round off to the Nearest integer)

[Use : K_b for water = 0.52 K kg mol^{-1}

Boiling point of water = 100°C]

Official Ans. by NTA (50)

Official Ans. by ALLEN (100)

Sol. $\Delta T_b = T_b - T_b^0$

$100.52 - 100$

$= 0.52$ºC

$$i = \left(1 - \frac{\alpha}{2}\right)$$

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

$$0.52 = \left(1 - \frac{\alpha}{2}\right) \times 0.52 \times 2$$

$\alpha = 1$

So, percentage association = 100%.

9. 10.0 ml of Na_2CO_3 solution is titrated against 0.2 M HCl solution. The following titre values were obtained in 5 readings.

4.8 ml, 4.9 ml, 5.0 ml, 5.0 ml and 5.0 ml

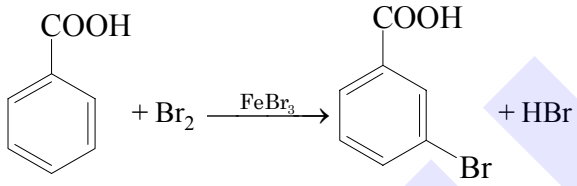
Based on these readings, and convention of titrimetric estimation of concentration of Na_2CO_3 solution is _____mM.

(Round off to the Nearest integer)

Official Ans. by NTA (50)

Sol. Most precise volume of HCl = 5 ml
at equivalence point
Meq. of Na_2CO_3 = meq. of HCl.
Let molarity of $Na2CO_3$ solution = M, then
$M \times 10 \times 2 = 0.2 \times 5 \times 1$
$M = 0.05$ mol / L
$= 0.05 \times 1000$
$= 50$ mM

10.



Consider the above reaction where 6.1 g of benzoic acid is used to get 7.8 g of m-bromo benzoic acid. The percentage yield of the product is_____.

(Round off to the Nearest integer)

[Given : Atomic masses : C = 12.0u, H : 1.0u, O : 16.0u, Br = 80.0 u]

Official Ans. by NTA (78)

Sol. Moles of Benzoic acid $= \frac{6.1}{122}$
= moles of m-bromobenzoic acid
So, weight of m-bromobenzoic acid

$= \frac{6.1}{122} \times 201\text{gm}$

$= 10.05$ gm

$\%$ yield $= \frac{\text{Actual weight}}{\text{Theoretical weight}} \times 100$

$= \frac{7.8}{10.05} \times 100$

$= 77.61\%$