FINAL JEE–MAIN EXAMINATION – MARCH, 2021

(Held On Tuesday 16th March, 2021) TIME : 3 : 00 PM to 6 : 00 PM

CHEMISTRY

TEST PAPER WITH ANSWER & SOLUTION

SECTION-A

1. The green house gas/es is (are) :

(A) Carbon dioxide

(B) Oxygen

(C) Water vapour

(D) Methane

Choose the most appropriate answer from the options given below :

(1) (A) and (C) only

(2) (A) only

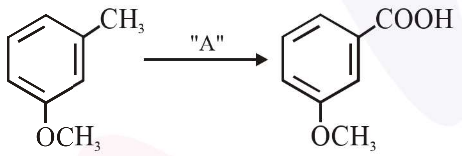
(3) (A), (C) and (D) only

(4) (A) and (B) only

Official Ans. by NTA (3)

Sol. The green house gases are CO_2, $H_2O_{(vapour)}$ & CH_4.

2.



In the above reaction, the reagent "A" is :

(1) $NaBH_4$, H_3O^+

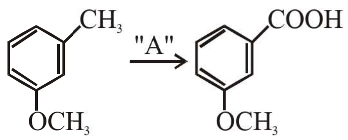
(2) $LiAlH_4$

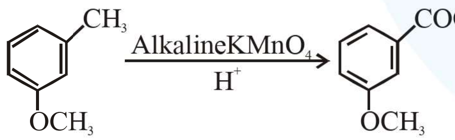
(3) Alkaline $KMnO_4$, H^+

(4) HCl, Zn-Hg

Official Ans. by NTA (3)

Sol.





;

3. Which of the following reduction reaction CANNOT be carried out with coke ?

(1) $Al_2O_3 \rightarrow Al$

(2) $ZnO \rightarrow Zn$

(3) $Fe_2O_3 \rightarrow Fe$

(4) $Cu_2O \rightarrow Cu$

Official Ans. by NTA (1)

Sol. Reduction of $Al_2O_3 \rightarrow Al$ is carried out by electrolytic reduction of its fused salts.
ZnO, Fe_2O_3 & Cu_2O can be reduce by carbon.

4. Identify the elements X and Y using the ionisation energy values given below :

	Ionization energy (kJ/mol) 1st	2nd
X	495	4563
Y	731	1450

(1) X = Na ; Y = Mg

(2) X = Mg ; Y = F

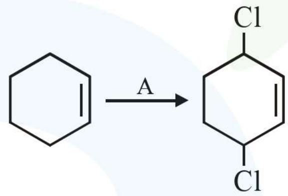
(3) X = Mg ; Y = Na

(4) X = F ; Y = Mg

Official Ans. by NTA (1)

Sol. $Na \rightarrow [Ne]\, 3s^1$ IE_1 is very low but IE_2 is very high due to stable noble gas configuration of Na^+.
$Mg \rightarrow [Ne]\, 3s^2$ IE_1 & $IE_2 \rightarrow$ Low
IE_3 is very high.

5.



Identify the reagent(s) 'A' and condition(s) for the reaction :

(1) A = HCl; Anhydrous $AlCl_3$

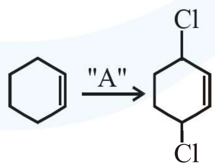
(2) A = HCl, $ZnCl_2$

(3) A = Cl_2; UV light

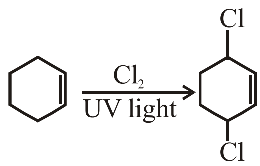
(4) A = Cl_2; dark, Anhydrous $AlCl_3$

Official Ans. by NTA (3)

Sol.



For substitution at allylic position in the given compound, the reagent used is Cl_2/uv light. The reaction is free radical halogenation.



6. The secondary structure of protein is stabilised by:
(1) Peptide bond
(2) glycosidic bond
(3) Hydrogen bonding
(4) van der Waals forces
Official Ans. by NTA (3)

Sol. The secondary structure of protein includes two type :
(a) α-Helix (b) β-pleated sheet
In α-Helix structure, the poly peptide chain is coil around due to presence of Intramolecular H-Bonding.

7. Fex_2 and Fey_3 are known when x and y are :
(1) x = F, Cl, Br, I and y = F, Cl, Br
(2) x = F, Cl, Br and y = F, Cl, Br, I
(3) x = Cl, Br, I and y = F, Cl, Br, I
(4) x = F, Cl, Br, I and y = F, Cl, Br, I
Official Ans. by NTA (1)

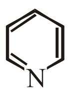
Sol. $\underset{\text{(Unstable)}}{2FeI_3} \longrightarrow \underset{\text{(Stable)}}{2FeI_2} + I_2$
Due to strong reducing nature of I^-
$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$
remaining halides of Fe^{2+} & Fe^{3+} are stable.

8. Which of the following polymer is used in the manufacture of wood laminates ?
(1) *cis*-poly isoprene
(2) Melamine formaldehyde resin
(3) Urea formaldehyde resin
(4) Phenol and formaldehyde resin
Official Ans. by NTA (3)

Sol. Urea –HCHO resin is used in manufacture of wood laminates.

9. **Statement I :** Sodium hydride can be used as an oxidising agent.
Statement II : The lone pair of electrons on nitrogen in pyridine makes it basic.
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) Statement I is false but statement II is true
(4) Both statement I and statement II are true
Official Ans. by NTA (3)

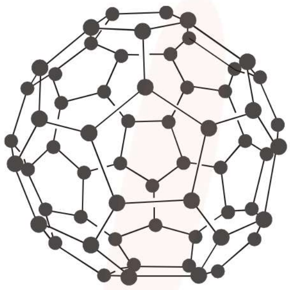
Sol. (1) NaH (sodium Hydride) is used as a reducing reagent.

(2) 

In pyridine, due to free electron on N atom, it is basic in nature.
Hence statement I is false & II is true.

10. The INCORRECT statement regarding the structure of C_{60} is :
(1) The six-membered rings are fused to both six and five-membered rings.
(2) Each carbon atom forms three sigma bonds.
(3) The five-membered rings are fused only to six-membered rings.
(4) It contains 12 six-membered rings and 24 five-membered rings.
Official Ans. by NTA (4)

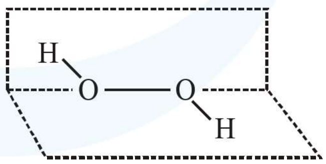
Sol. Structure of C_{60}



It contain 20 hexagons (20) and 12 pentagons (12) so option 4 is incorrect.

11. The correct statements about H_2O_2 are :
(A) used in the treatment of effluents.
(B) used as both oxidising and reducing agents.
(C) the two hydroxyl groups lie in the same plane.
(D) miscible with water.
Choose the correct answer from the options given below :
(1) (A), (B), (C) and (D)
(2) (A), (B) and (D) only
(3) (B), (C) and (D) only
(4) (A), (C) and (D) only
Official Ans. by NTA (2)

Sol.



Structure of H_2O_2
(Open book type) → Non planar

H_2O_2 is used in the treatment of effluents.

$H_2O_2 \xrightarrow{R.A.} O_2$; $H_2O_2 \xrightarrow{O.A.} H_2O$ act as both O.A & R.A.

H_2O_2 is miscible in water due to hydrogen bonding.

12. Ammonolysis of Alkyl halides followed by the treatment with NaOH solution can be used to prepare primary, secondary and tertiary amines. The purpose of NaOH in the reaction is :

(1) to remove basic impurities

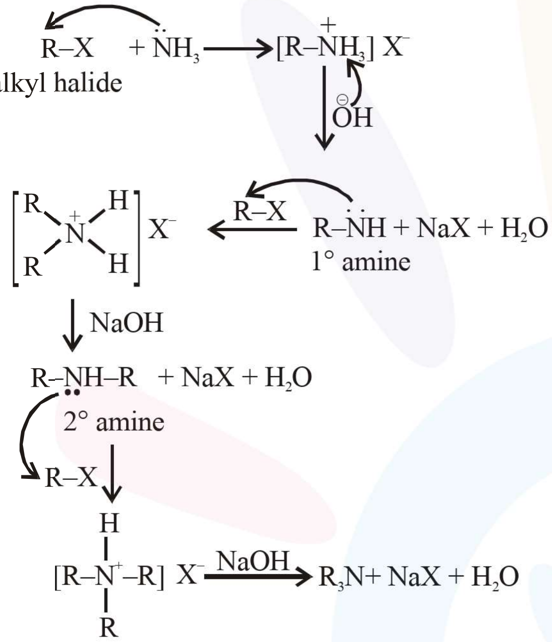
(2) to activate NH_3 used in the reaction

(3) to remove acidic impurities

(4) to increase the reactivity of alkyl halide

Official Ans. by NTA (3)

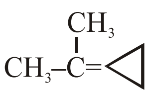
Sol.



So the purpose of NaOH in the above reactions in to remove acidic impurities.

13. An unsaturated hydrocarbon X on ozonolysis gives A. Compound A when warmed with ammonical silver nitrate forms a bright silver mirror along the sides of the test tube. The unsaturated hydrocarbon X is :

(1) $CH_3–C(CH_3)=C(CH_3)–CH_3$

(2) 

(3) $HC\equiv C–CH_2–CH_3$

(4) $CH_3–C\equiv C–CH_3$

Official Ans. by NTA (3)

Sol. (X) Unsaturated Hydrocarbon $\xrightarrow{\text{Ozonolysis}}$ (A) $\xrightarrow[\text{(Tollen's regent)}]{\text{Ammonical } AgNO_3}$ Ag↓ silver mirror

As (A) compound given positive tollen's test hence it may consist –CHO (aldehyde group). or it can be HCOOH

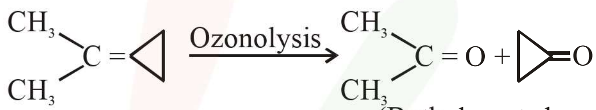
So for the given option :

(3) $CH_3–CH_2–C\equiv CH \xrightarrow{\text{Ozonolysis}} CH_3CH_2COOH + \underset{(A)}{HCOOH}$

+ve tollen's test

and for other compounds (options):

(1) $(CH_3)_2C=C(CH_3)_2 \xrightarrow{\text{Ozonolysis}} (CH_3)_2C=O$ (Does not show tollen's Test)

(2) 

(Both do not show tollen's test)

(3) $CH_3–C\equiv C–CH_3 \xrightarrow{\text{Ozonolysis}} 2CH_3–COOH$ (Does not show tollen's test)

14. Which of the following is least basic ?

(1) $(CH_3CO)\ddot{N}HC_2H_5$

(2) $(C_2H_5)_3\ddot{N}$

(3) $(CH_3CO)_2\ddot{N}H$

(4) $(C_2H_5)_2\ddot{N}H$

Official Ans. by NTA (3)

Sol. For the given compounds :

(1) $CH_3–\underset{}{\overset{O}{\overset{\|}{C}}}–\ddot{N}H–C_2H_5$; L.P. on Nitrogen is delocalised.

(2) $CH_3CH_2–\underset{CH_2CH_3}{\underset{|}{\ddot{N}}}–CH_2CH_3$; L.P. on Nitrogen is localised.

(3) $CH_3–\underset{O}{\underset{\|}{C}}–\ddot{N}H–\underset{O}{\underset{\|}{C}}–CH_3$; L.P. on Nitrogen is delocalised due to conjugation with both $–\underset{O}{\underset{\|}{C}}–$

(Hence least basic)

(4) $CH_3–CH_2–\ddot{N}H–CH_2–CH_3$; L.P. on Nitrogen is localised.

15. The characteristics of elements X, Y and Z with atomic numbers, respectively, 33, 53 and 83 are :

(1) X and Y are metalloids and Z is a metal.

(2) X is a metalloid, Y is a non-metal and Z is a metal.

(3) X, Y and Z are metals.

(4) X and Z are non-metals and Y is a metalloid

Official Ans. by NTA (2)

Sol. $X = {}_{33}As \rightarrow$ Metalloid

$Y = {}_{53}I \rightarrow$ Nonmetal

$Z = {}_{83}Bi \rightarrow$ Metal

16. Match List-I with List-II

List-I Test/Reagents/Observation(s)	List-II Species detected
(a) Lassaigne's Test	(i) Carbon
(b) Cu(II) oxide	(ii) Sulphur
(c) Silver nitrate	(iii) N, S, P, and halogen
(d) The sodium fusion extract gives black precipitate with acetic acid and lead acetate	(iv) Halogen Specifically

The correct match is :

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

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

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

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

Official Ans. by NTA (3)

Sol. Match list :-

(a) Lassaigne's Test	(iii) N, S, P and Halogen
(b) Cu(II) Oxide	(i) Carbon
(c) $AgNO_3$	(iv) Halogen specifically.
(d) Sodium fusion extract given black precipitate with acetic acid and lead acetate ($CH_3COOH/(CH_3COO)_2Pb$)	(ii) Sulphur

Option-(a)-(iii) ; (b)-(i) ; (c)-(iv) ; (d)-(ii)

17. The INCORRECT statements below regarding colloidal solutions is :

(1) A colloidal solution shows colligative properties.

(2) An ordinary filter paper can stop the flow of colloidal particles.

(3) The flocculating power of Al^{3+} is more than that of Na^+.

(4) A colloidal solution shows Brownian motion of colloidal particles.

Official Ans. by NTA (2)

Sol. * Colloidel solution exhibits colligative properties

* An ordinary filter can not stop the flow of colloidal particles.

* Flocculating power increases with increase the opposite charge of electrolyte.

* Colloidal particles show brownian motion.

18. Arrange the following metal complex/compounds in the increasing order of spin only magnetic moment. Presume all the three, high spin system.

(Atomic numbers Ce = 58, Gd = 64 and Eu = 63.)

(a) $(NH_4)_2[Ce(NO_3)_6]$ (b) $Gd(NO_3)_3$ and

(c) $Eu(NO_3)_3$

Answer is :

(1) (b) < (a) < (c)

(2) (c) < (a) < (b)

(3) (a) < (b) < (c)

(4) (a) < (c) < (b)

Official Ans. by NTA (4)

Sol. (a) ${}_{58}Ce \rightarrow [Xe]4f^2\ 5d^0\ 6s^2$

In complex $Ce^{4+} \rightarrow [Xe]\ 4f^0\ 5d^0\ 6s^0$

there is no unpaired electron so $\mu_m = 0$

(b) ${}_{64}Gd^{3+} \rightarrow [Xe]4f^7\ 5d^0\ 6s^0$

contain seven unpaired electrons so,

$\mu_m = \sqrt{7(7+2)} = \sqrt{63}$ B.M.

(c) ${}_{63}Eu^{3+} \rightarrow [{}_{54}Xe]4f^6\ 5d^0\ 6s^0$

contain six unpaired electron

so, $\mu_m = \sqrt{6(6+2)} = \sqrt{48}$ B.M.

Hence, order of spin only magnetic movement

$\boxed{b > c > a}$

19. The exact volumes of 1 M NaOH solution required to neutralise 50 mL of 1 M H_3PO_3 solution and 100 mL of 2 M H_3PO_2 solution, respectively, are :

(1) 100 mL and 100 mL
(2) 100 mL and 50 mL
(3) 100 mL and 200 mL
(4) 50 mL and 50 mL

Official Ans. by NTA (3)

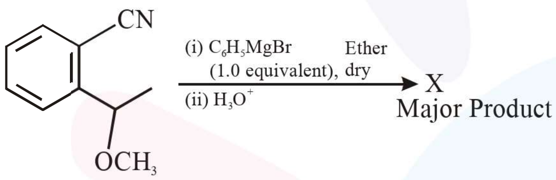
Sol. $H_3PO_3 + 2NaOH \rightarrow Na_2HPO_3 + 2H_2O$
50 ml   1M
1M   V = ?

$$\Rightarrow \frac{n_{NaOH}}{n_{H_3PO_3}} = \frac{2}{1}$$

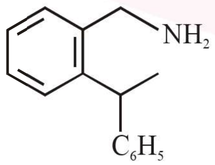
$$\Rightarrow \frac{1 \times V}{50 \times 1} = \frac{2}{1} \Rightarrow \boxed{V_{NaOH} = 100\,ml}$$

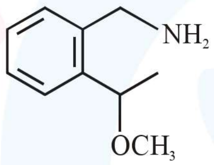
$H_3PO_2 + 2NaOH \rightarrow NaH_2PO_3 + H_2O$
100 ml   1M
2M   V = ?

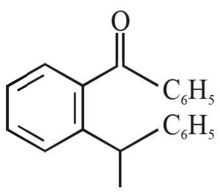
$$\Rightarrow \frac{n_{NaOH}}{n_{H_3PO_3}} = \frac{1}{1} \quad \Rightarrow \frac{1 \times V}{2 \times 100} = \frac{1}{1} \Rightarrow \boxed{V_{NaOH} = 200\,ml}$$

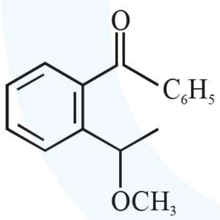
20. 

The structure of X is :

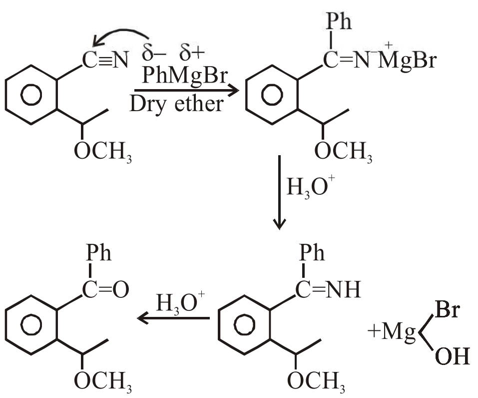
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol. 

SECTION-B

1. Ga (atomic mass 70 u) crystallizes in a hexagonal close packed structure. The total number of voids in 0.581 g of Ga is ________ $\times 10^{21}$. (Round off to the Nearest Integer).

Official Ans. by NTA (15)

Sol. HCP structure : Per atom, there will be one octahedral void (OV) and two tetrahedral voids (TV).
Therefore total three voids per atom are present in HCP structure.
→ therefore total no of atoms of Ga will be-

$$= \frac{\text{Mass}}{\text{Molar Mass}} \times N_A = \frac{0.581g}{70g/mol} \times 6.023 \times 10^{23}$$

→ Now, total Number of voids = 3 × total no. of atoms

$$= 3 \times \frac{0.581}{70} \times 6.023 \times 10^{23} = 14.99 \times 10^{21}$$

$$\simeq 15 \times 10^{21}$$

2. A 5.0 m mol dm^{-3} aqueous solution of KCl has a conductance of 0.55 mS when measured in a cell constant 1.3 cm^{-1}. The molar conductivity of this solution is ________ $mSm^2\ mol^{-1}$. (Round off to the Nearest Integer)

Official Ans. by NTA (143)
Official Ans. by ALLEN (14)

Sol. Given $conc^n$ of KCl = $\frac{m.mol}{L}$

: Conductance (G) = 0.55 mS

: Cell constant $\left(\frac{\ell}{A}\right) = 1.3\ cm^{-1}$

To Calculate : Molar conductivity (λ_m) of sol.

→ Since $\boxed{\lambda_m = \frac{1}{1000} \times \frac{k}{m}}$ ......(1)

→ Molarity = $5 \times 10^{-3}\ \frac{mol}{L}$

$$\rightarrow \text{Conductivity} = G \times \left(\frac{\ell}{A}\right) = 0.55\ mS \times \frac{1.3}{\frac{1}{100}} m^{-1}$$

$= 55 \times 1.3 \quad mSm^{-1}$

$$eq^n\ (1) \quad \lambda_m = \frac{1}{1000} \times \frac{55 \times 1.3}{\left(\frac{5}{1000}\right)} \frac{mSm^2}{mol}$$

$$\Rightarrow \lambda_m = 14.3 \frac{mSm^2}{mol}$$

3. A and B decompose via first order kinetics with half-lives 54.0 min and 18.0 min respectively. Starting from an equimolar non reactive mixture of A and B, the time taken for the concentration of A to become 16 times that of B is ______ min. (Round off to the Nearest Integer).

Official Ans. by NTA (108)

Sol. Given $t_{1/2} = 54$ min $T_{1/2} = 18$ min

A B

t = 0 'x' M t = 0 'x' M

$\Rightarrow$ To calculate : $[A_t] = 16 \times [B_t]$ ....(1) time = ?

$\Rightarrow$ For I order kinetic : $\boxed{[A_t] = \frac{A_0}{(2)^n}}$

n $\rightarrow$ no of Half lives

$\Rightarrow$ Now from the relation (1)

$[A_t] = 16 \times [B_t]$

$\Rightarrow \frac{x}{(2)^{n_1}} = \frac{x}{(2)^{n_2}} \times 16 \Rightarrow (2)^{n_2} = (2)^{n_1} \times (2)^4$

$\Rightarrow n_2 = n_1 + 4 \Rightarrow \frac{t}{(t_{1/2})_2} = \frac{t}{(t_{1/2})_1} + 4$

$\Rightarrow t\left(\frac{1}{18} - \frac{1}{54}\right) = 4 \Rightarrow t = \frac{4 \times 18 \times 54}{36}$

$\Rightarrow \boxed{t = 108 \text{ min}}$

4. In Duma's method of estimation of nitrogen, 0.1840 g of an organic compound gave 30 mL of nitrogen collected at 287 K and 758 mm of Hg pressure. The percentage composition of nitrogen in the compound is ______. (Round off to the Nearest Integer).

[Given : Aqueous tension at 287 K = 14 mm of Hg]

Official Ans. by NTA (19)

Sol. In Duma's method of estimation of Nitrogen. 0.1840 gm of organic compound gave 30 mL of nitrogen which is collected at 287 K & 758 mm of Hg.

Given ;

Aqueous tension at 287 K = 14 mm of Hg.

Hence actual pressure = (758 – 14)

= 744 mm of Hg.

Volume of nitrogen at STP = $\frac{273 \times 744 \times 30}{287 \times 760}$

V = 27.935 mL

$\because$ 22400 mL of N_2 at STP weighs = 28 gm.

$\therefore$ 27.94 mL of N_2 at STP weighs =

$\left(\frac{28}{22400} \times 27.94\right)$gm

= 0.0349 gm

Hence % of Nitrogen = $\left(\frac{0.0349}{0.1840} \times 100\right)$

= 18.97 %

Rond off. Answer = 19 %

5. The number of orbitals with n = 5, $m_1 = +2$ is ______. (Round off to the Nearest Integer).

Official Ans. by NTA (3)

Sol. For, n = 5

ℓ = (0, 1, 2, 3, 4)

If ℓ = 0, m = 0

ℓ = 1, m = {–1, 0, +1}

ℓ = 2, m = {–2, –1, 0, +1, **+2**}

ℓ = 3, m = {–3, –2, –1, 0, +1, **+2**, +3}

ℓ = 4, m = {–4, –3, –2, –1, 0, +1, **+2**, +3, +4}

5d, 5f and 5g subshell contain one-one orbital having $m_\ell = +2$

6. At 363 K, the vapour pressure of A is 21 kPa and that of B is 18 kPa. One mole of A and 2 moles of B are mixed. Assuming that this solution is ideal, the vapour pressure of the mixture is ________ kPa. (Round of to the Nearest Integer).

Official Ans. by NTA (19)

Sol. Given $P_A^0 = 21\text{kPa}$ $\Rightarrow P_B^0 = 18\text{kPa}$

$\rightarrow$ An Ideal solution is prepared by mixing 1 mol A and 2 mol B.

$\rightarrow X_A = \frac{1}{3}$ and $X_B = \frac{2}{3}$

$\rightarrow$ Acc to Raoult's low

$P_T = X_A P_A^0 + X_B P_B^0$

$\Rightarrow P_T = \left(\frac{1}{3} \times 21\right) + \left(\frac{2}{3} \times 18\right)$

$\Rightarrow P_T$ = 7 +12 = 19 KPa

7. Sulphurous acid (H_2SO_3) has $Ka_1 = 1.7 \times 10^{-2}$ and $Ka_2 = 6.4 \times 10^{-8}$. The pH of 0.588 M H_2SO_3 is __________. (Round off to the Nearest Integer)

Official Ans. by NTA (1)

Sol. H_2SO_3 [Dibasic acid]

c = 0.588 M

⇒ pH of solution Þ due to First dissociation only since $K_{a_1} >> Ka_2$

⇒ First dissociation of H_2SO_3

$$H_2SO_3(aq) \rightleftharpoons H^{\oplus}(aq) + HSO_3^-(aq) : ka_1 = 1.7 \times 10^{-2}$$

t = 0   C

t   C–x   x   x

$$\Rightarrow Ka_1 = \frac{1.7}{100} = \frac{[H^{\oplus}][HSO_3^-]}{[H_2SO_3]}$$

$$\Rightarrow \frac{1.7}{100} = \frac{x^2}{(0.58 - x)}$$

⇒ $1.7 \times 0.588 - 1.7x = 100\, x^2$

⇒ $100x^2 + 1.7x - 1 = 0$

$$\Rightarrow [H^{\oplus}] = x = \frac{-1.7 + \sqrt{(1.7)^2 + 4 \times 100 \times 1}}{2 \times 100} = 0.09186$$

Therefore pH of sol. is : pH = – log $[H^{\oplus}]$

⇒ pH = –log (0.09186) = 1.036 ≃ 1

8. When 35 mL of 0.15 M lead nitrate solution is mixed with 20 mL of 0.12 M chromic sulphate solution, ________ × 10^{-5} moles of lead sulphate precipitate out. (Round off to the Nearest Integer).

Official Ans. by NTA (525)

Sol. $3\,Pb(NO_3)_2 + Cr_2(SO_4)_3 \rightarrow 3PbSO_4 + 2Cr(NO_3)_3$

35 ml   20 ml

0.15 M   0.12 M

= 5.25 m.mol = 2.4 m.mol 5.25 m.mol

= 5.25×10^{-3} mol

therefore moles of $PbSO_4$ formed = 5.25×10^{-3}

= 525×10^{-5}

9. At 25°C, 50 g of iron reacts with HCl to form $FeCl_2$. The evolved hydrogen gas expands against a constant pressure of 1 bar. The work done by the gas during this expansion is _______ J.

(Round off to the Nearest Integer)

[Given : R = 8.314 J mol^{-1} K^{-1}. Assume, hydrogen is an ideal gas]

[Atomic mass off Fe is 55.85 u]

Official Ans. by NTA (2218)

Sol. T = 298 K, R = 8.314 $\frac{J}{mol\,K}$

→ Chemical reaction is

$Fe + 2HCl \rightarrow FeCl_2 + H_2(g)$

50g   P = 1 bar

$= \frac{50}{55.85}$ mol

$\frac{50}{55.85}$ mol

→ Work done for 1 mol gas

$= -P_{ext} \times \Delta V$

= Δng RT

= –1 × 8.314 × 298 J

→ Work done for $\frac{50}{55.85}$ mol of gas

$= -1.8314 \times 298 \times \frac{50}{55.85}$ J

= –2218.059 J

≃ –2218 J

10. $[Ti(H_2O)_6]^{3+}$ absorbs light of wavelength 498 nm during a d – d transition. The octahedral splitting energy for the above complex is _____ × 10^{-19} J. (Round off to the Nearest Integer). h = 6.626×10^{-34} Js; c = 3×10^8 ms^{-1}.

Official Ans. by NTA (4)

Sol. $\lambda_{absorbed}$ = 498 nm (given)

The octahedral spilitting energy

$$\Delta_0 \text{ or } E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{498 \times 10^{-9}}$$

$= 0.0399 \times 10^{-17}$ J

$= 3.99 \times 10^{-19}$ J

$= 4.00 \times 10^{-19}$ J (round off)