CHEMISRTY GUIDE P525-3

Q1 You are provide with the following

- FA_1 which is a solution containing potassiumiadate (KIO_3) and oxalic acid($H_2C_2O_4H_2O$)
- FA_2 which is 0.1M sodium thiosulphate
- FA_3 which is 0.05M sodium hydroxide solution

You are required to determine the percentage composition of FA1

Theory:

The hydrogen ion can be analyzed by titration with standard base

$$OH^+_{(aq)} + H^+_{(aq)} \rightarrow H_2O_{(l)}$$

While the iodate ions can be reduced to iodide by reaction with excess acidified potassium iodide.

$$IO^-_{3(aq)} + 5I^+_{(aq)} + 6H^+_{(aq)} \rightarrow 3I_{2(aq)} + 3H_2O_{(l)}$$

And the liberated iodine analyzed by reaction with standard sodium thiosulphate solution.

$$I_{2(aq)} + 2S_2O^{2-}_{3(aq)} \rightarrow S_4O^{2-}_{6(aq)} + 2I^+_{(aq)}$$

Procedure 1

Pipette 10cm^3 of FA_1 into a conical flask add 2-3 drops of phenolphalein indicator and shake well. Titrate this solution with fa3 from the burette repeat the titration until you obtain consistent readings and record your results in table A

Results for table A:

Volume of pipette used 10.0 cm^3

Final burette reading(cm^3)	20.00	40.00	25.00
Initial burette reading(cm^3)	0.00	20.00	5.00
Volume of FA_3 used (cm^3)	20.00	20.00	20.00

Values used to calculate average volume of FA_3 used, 20.00 , 20.00

Average volume of FA_3 $\frac{20.00+20.00}{2} = 20.00cm^3$

Questions

(a) Calculate the molar concentration of FA_1 with respect to H^+ ions hence mass per litre of oxalic acid.

$100cm^3\ of\ FA_3\ contain\ 0.05moles\ of\ OH^-$

$20cm^3\ of\ FA_3\ contain \left(\frac{0.05\times20}{1000}\right) moles\ of\ OH^-$

$mole\ ratio\ of\ OH^-:OH^+$ is 1:1

$moles\ of OH^+$ that reacted $= \left(\frac{0.05\times20}{1000}\right) moles$

$1cm^3\ of\ FA_2\ contain \left(\frac{0.05\times20}{1000}\right) moles\ of\ H^+$

$1000cm^3\ of\ FA_2\ contain \left(\frac{0.05\times20}{1000}\times\frac{1000}{10}\right) moles\ of\ H^+$

$= 0.1M$

$H_2C_2O_4 \rightarrow 2H^+ + C_2O_4^{2-}$

2 $moles\ of\ H^+$ are produced by 1 mole of $H_2C_2O_4$

$0.1 mole\ of\ H^+$ are produced by $\left(\frac{0.1\times1}{2}\right) moles$

$= 0.05M$

$R.F.M\ of H_2C_2O_4.2H_2O = (1\times2)+(12\times2)+(16\times4)+(2\times12)$

$1\ mole\ of\ H_2C_2O_4.2H_2O\ weigh\ 126g$

$0.05 moles\ of H_2C_2O_4.2H_2O\ weigh\ (0.05\times126)g$

$= 6.4gl^{-1}$

Procedure II

Empty the burette, wash it clean and rinse it with distilled water. Then fill it with FA_2.pipette $10cm^3$ of FA_1 into a conical flask, add 10cm3 of 2M sulphuric acid by use of a measuring cylinder and add $10cm^3$ of 10% potassium iodide then shake well and titrate the liberated iodide with FA_2 from the burette until the solution is pale black colour of the solution just becomes Colourless

Repeat the titration to obtain consistent results and record your results in the table B-below

Results for table B:

Volume of pipette used ____10.0____ cm^3

Final burette reading(cm^3)	11.20	21.20	31.20
Initial burette reading(cm^3)	0.00	10.00	20.00
Volume of fa2 used(cm^3)	11.20	11.20	11.20

Values of FA_2 used to calculate average volume used 11.20 , 11.20

Average volume of fa2 $\frac{11.20+11.20}{2} = 11.20$

Questions:

(b) Calculate the molar concentration of FA_2 with respect to IO_3 ions hence mass per litre of potassium iodate

$1000cm^3\ of\ FA_2\ contain\ 0.1\ moles\ of\ S_2O_3^{2-}$

$11.2cm^3\ of\ FA_2\ contain \left(\frac{0.1\times11.2}{1000}\right) moles\ of\ S_2O_3^{2-}$

$mole\ ratio\ of\ S_2O_3^{2-}: I_2\ is\ \ 2:1$

$moles\ of\ I_2\ that\ reacted = \left(\frac{1}{2}\times\frac{0.1\times11.2}{1000}\right) moles$

$mole\ ratio\ of\ I_2 : IO_3^-\ is\ \ 3:1$

$moles\ \ of\ IO_3^-\ that\ reacted = \left(\frac{1}{3}\times\frac{1}{2}\times\frac{0.1\times11.2}{1000}\right) moles$

$10cm^3\ of\ FA_1\ contain \left(\frac{1}{3}\times\frac{1}{2}\times\frac{0.1\times11.2}{1000}\right) moles\ of\ IO_3^-$

$1000cm^3\ of\ FA_1\ contain \left(\frac{1}{3}\times\frac{1}{2}\times\frac{0.1\times11.2}{1000}\times\frac{1000}{10}\right) moles\ of\ IO_3^-$

$= 0.0186915M$

$R.F.M\ of\ KIO_3 = 39 + 127 + (16\times3) = 124$

$1\ mole\ of\ KIO_3\ weigh\ 214g$

$0.0186915g\ of\ \ KIO_3\ weigh\ (214\times0.0186915)g$

$= 4gl^{-1}$

(C) Calculate percentage composition by mass of FA_1

$total\ mass = 6.4 + 4 = 10.4g$

$percenatge\ of\ oxalic\ acid = \left(\frac{6.4}{10.4}\times100\right)$

$= 61.5\%$

$percentage\ of\ potassiumiodate = \left(\frac{4}{10.4} \times 100\right)$

$= 38.5\%$

2. You are provided with substance E, that contains two cations and two anions, carryout the following tests to identify the ions in E .Identify any gas evolved

TEST	OBSERVATION	DEDUCTION
(a)Heat aspatula endful of E strongly in the dry test tube	– White Powderly solid – Yellow residue when hot turn white on cooling – Colourless gas turn moist blue litmus paper red and lime water milky – Purple/violet vapour formed a black sublimate	Non transition metal ion $ZnO\ \ Zn^{2+}$ $CO_2\ \ CO_2C_2O_4^{2-}\ \ CH_3COO$ $I_2\ from\ I^-$
(b)Place 2 spatula endfuls of E in a test tube, add 3 drops of concentrated sulphuric acid and heat	– Purple/violet fumes form a black sublimate – Bubbles of Colourless gas which turn moist blue litmus paper red and lime water milky	$I^-\ oxidised\ to\ I_2$ $CO_2\ \ CO_3^{2-}$
(c)Place two spatula endful of E in atestube, add water to dissolve and filter, keep the residue, divide the filtrate into three portions	– White suspension – White residue – Colourless filtrate	Non transition metal ion Non transition metal ion
(i)To the 1st portion, add lead(II) nitrate solution and then dilute nitric acid	Yellow ppt	I^-
(ii)To the 2nd portion, add silver nitrate solution then dilute nitric acid	Pale yellow ppt Soluble in the acid	I^-
(iii) To the third portion add bleaching powder and then 3 drops of dilute sulphuric acid solution followed by carbon tetra chloride. shake	Violet/purple solution in the organic layer	$I^-\ oxidised\ to\ I_2$

and leave it to settle		
(d) To the spatula endful of E add dilute nitric acid to dissolve, then add excess sodium hydroxide solution hydroxide solution and filter. Keep the residue and the filtrate.	– Effervescence occurs – Colourless gas turn blue litmus paper red and lime water milky – Colourless solution – White ppt insoluble in excess – White residue – Colorless filtrate	CO_2 $CO_3^{2-} comfirmed$ Non transition metal ion Mg^{2+} Ca^{2+} or Ba^{2+} Mg^{2+} Ca^{2+} or Ba^{2+} Zn^{2+} Pb^{2+} or Al^{3+}
(e)To the filtrate, add dilute nitric acid until it is just acidic and divide the resultant solution into three portions	White ppt soluble in excess	Al^{3+} Pb^{2+} or Zn^{2+}
(i)To the first portion, add sodium hydroxide solution drop wise until in excess.	White ppt soluble in excess	Zn^{2+} Pb^{2+} Al^{3+}
(ii) To the second portion add aqueous ammonia till in excess	White ppt soluble in excess	Zn^{2+}
(iii)Using the third portion carryout a test of your own choice to confirm the cation in the filtrate	White ppt soluble in excess aqueous ammom	$Zn^{2+} comfirmed$
(f) To the residue in (d) add dilute nitric acid to dissolve. Divide the resultant solution into four parts	Colorless solution was formed	Mg^{2+} Ca^{2+} or Ba^{2+}
(i)To the first part ,add sodium hydroxide drop wise drop until in excess	White ppt insoluble in excess	Mg^{2+} Ca^{2+} or Ba^{2+}
(ii)To the second part, add aqueous ammonia solution drop wise until in excess	White ppt insoluble in excess	Mg^{2+} or Ba^{2+}
(iii)To the third part, add dilute sulphuric acid	White ppt	Ba^{2+}
(iv)To the fourth part, add, ammonia oxalate solution followed by ethanoic acid	White ppt soluble in the acid	Ba^{2+}

cations in E are Ba^{2+} and Zn^{2+}

Anions in E are I^- and CO_3^{2-}

3. You are provided with solid T which is an organic compound. You are required to carry out the tests below to determine the nature of T

TEST	OBSERVATIONS	DEDUCTIONS
(a)Burn a little of T on a spatula end	T burnt with yellow soily flame	Aromatic compound
(b) Add sodium hydroxide solution to a little of T in attest tube and shake well.	Solid T dissolved to form a Colourless solution	T is a phenol or a carboxylic acid
(c) To a little of T in a test tube add about 5cm^3 of water and heat. Test the mixture with litmus paper; divide the mixture into five parts.	– T is sparingly soluble in solid water – It dissolves on heating – Solution turns blue litmus paper red	– Polar organic compound of high molecular mass – T is a phenol or carboxylic acid
(i)To the first part, add sodium carbonate solution	Effervescence occurs	T is a carboxylic acid
(ii)To the second part, add neutral iron(III) chloride solutions	Purple/ violet solution was formed	T is a phenol
(iii)To the third part add bradys reagent	No observable change	Carbonyl compound absent
(iv)To the fourth part add sodium hydroxide solution then three drops of concentrated sulphuric acid followed by ethanoic acid and warm. Pour the mixture in cold water.	Sweet fruity smell was produced	Ester formed so T is phenol
(V)To the fifth part add an equal volume of ethanol and then three drops of concentrated sulphuric acid and warm	Sweet fruity smell was produced	Ester formed so T is carboxylic acid

Comment on the nature of T

T is an aromatic carboxylic acid with a hydroxyl group attached to the benzene ring

END