S.6 CHEMISRTY HOLIDAY WORK

REDOX REACTIONS AND CALCULATIONS

Oxidation – reduction reaction (or Redox) reactions involve electron transfer . The oxidizing agent accepts electrons and is being reduced while reducing agent losses electron and is being oxidized . Sometimes oxidizing agent is called oxidant while reducing agent is called reductant.

In working out the equation for a redox reaction , it is important to first write half equations and then add them together.

A half equation is one which involves electron.

Examples of half- equation reactions

(a) (i) Iron(III) salts are reduced to iron (II) salts in presence of a reducing agent.

$$Fe^{3+}(aq) + e \longrightarrow Fe^{2+}(aq)$$

(ii) Similarly iron(II) salts are oxidized to iron(III) salts in the presence of an oxidizing agent.

$$Fe^{2+}(aq) \longrightarrow Fe^{3+}(aq) + e$$

(b) (i) When chlorine gas is an oxidizing agent and thus it is being reduced by accepting electrons

$$Cl_2(g) + 2e \longrightarrow 2Cl^-(aq)$$

NB Chlorine gas reacts with iron(II) salts but not iron(III) salts because it accepts electrons which were donated by iron(II) ions

$$2Fe^{2+}(aq) + Cl_2(g) \longrightarrow 2Fe^{3+}(aq) + 2Cl^-(aq)$$

This equation is an overall equations between two half equations(one oxidation half equation and the other reduction half equation)

(ii) Bromine and Iodine are oxidizing agents and thereforeare reduced to bromide ions and iodide ions respectively.

$$Br_2(l) + 2e \longrightarrow 2Br^-(aq)$$
$$I_2(aq) + 2e \longrightarrow 2I^-(aq)$$

(c) Sulphur dioxide and sulphite ions are reducing agents and thus are being oxidized to sulphate ions

$$SO_2(g) + 2H_2O(l) \longrightarrow SO_4^{2-}(aq) + 4H^+(aq) + 2e$$
$$SO_3^{2-}(aq) + H_2O(l) \longrightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e$$

(d) Potassium manganate(VII) is an oxidizing agent . In acidic medium, manganite(VII) ions are reduced to manganese(II) ions .

$$MnO_4^-(aq) + 8H^+(aq) + 5e \longrightarrow Mn^{2+}(aq) + 4\,H_2O(l)$$

(e) Potassium dichromate(VI) is an oxidizing agent. In acidic medium , dichromate(VI) ions are reduced to chromium (III) ions

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

(f) (i) Potassium chlorate(V) is an oxidizing agent. In acidic medium , chlorate(V) ions are reduced to chloride ions

$$ClO_3^-(aq) + 6H^+(aq) + 6e \longrightarrow Cl^-(aq) + 3H_2O(l)$$

(ii) Potassium iodate(V) and potassium bromate(V) are also oxidizing agents. In acidic medium ,bromate(V) and iodate(V) ions are oxidized to bromide ions and iodide ions respectively.

$$BrO_3^-(aq) + 6H^+(aq) + 6e \longrightarrow Br^-(aq) + 3H_2O(l)$$
$$IO_3^-(aq) + 6H^+(aq) + 6e \longrightarrow I^-(aq) + 3H_2O(l)$$

(g) Chloride ions , bromide ions and iodide ions can act as reducing agents and therefore are oxidized to halogen molecules.

$$2Cl^-(aq) \longrightarrow Cl_2(g) + 2e$$
$$2Br^-(aq) \longrightarrow Br_2(l) + 2e$$
$$2I^-(aq) \longrightarrow I_2(aq) + 2e$$

Note

Chlorate(V) ions , bromate(V) ions and iodate(V) ions can oxidize iodide ions ion acidic medium to iodine and themselves are reduced to halide ions

$$YO_3^-(aq) + 6I^-(aq) + 6H^+(aq) \longrightarrow Y^-(aq) + 3I_2(aq) + 3H_2O(l)$$

(where Y = Cl , Br, I)

If Y = I then equation becomes

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \longrightarrow 3I_2(aq) + 3H_2O(l)$$

(h) Thiosulphate ions are oxidized to tetra thionate ions

$$2S_2O_3^{2-}(aq) \longrightarrow S_4O_6^{2-}(aq) + 2e$$

(i) Oxalate ions are oxidized to carbon dioxide .

$$C_2O_4^{2-}(aq) \longrightarrow 2CO_2(g) + 2e$$

(j) Nitrite ions are oxidized to nitrate ions

$$NO_2^-(aq) + H_2O(l) \longrightarrow NO_3^-(aq) + 2H^+(aq) + 2e$$

(k) Bismuthate ions in acidic medium are reduced to bismuth(III) ions

$$BiO_3^-(aq) + 6H^+(aq) + 2e \longrightarrow Bi^{3+}(aq) + 3H_2O(l)$$

(l) Lead(IV) Oxide in acidic medium is reduced to lead(II) ions

$$PbO_2(s) + 4H^+(aq) + 2e \longrightarrow Pb^{2+}(aq) + 2H_2O(l)$$

(m) Hydrogen peroxide can act as a reducing agent and as well as an oxidizing agent.

(i) Hydrogen peroxide in acidic medium is reduced to water.

$$H_2O_2(aq) + 2H^+(aq) + 2e \longrightarrow 2H_2O(l)$$

(ii) Hydrogen peroxide in neutral medium is oxidized to oxygen

$$H_2O_2(aq) \longrightarrow O_2(g) + 2H^+(aq) + 2e$$

Note: When a reduction half- equation is combined with an oxidation half-equation , an overall redox equation can be written.

For example:

1. When manganese (II) sulphate was mixed with sodium bismuthate solution in presence of concentrated nitric acid , a purple solution of manganite(VII) ions was formed. This because a mixture of sodium bismuthate and concentrated nitric acid acts as a strong oxidising agent and thus will oxidize manganese (II) ions to manganite(VII) ions.

Half –equations

$$Mn^{2+}(aq) + 4H_2O(l) \longrightarrow MnO_4^-(aq) + 8H^+(aq) + 5e \quad \text{(oxidation)}$$

$$BiO_3^-(aq) + 6H^+(aq) + 2e \longrightarrow Bi^{3+}(aq) + 3H_2O(l) \quad \text{(reduction)}$$

Combining two half equations

$$2Mn^{2+}(aq) + 5BiO_3^-(aq) + 2H_2O(l) \longrightarrow 2MnO_4^-(aq) + 5Bi^{3+}(aq) + 4H^+(aq)$$

2. When sulphur dioxide gas was bubbled through acidified potassium manganite(VII) the purple solution turns colourless. This is because sulphur dioxide is a reducing agent and reduces manganite(VII) ions to manganses(II) ions.

Half equations :

$$SO_2(g) + 2H_2O(l) \longrightarrow SO_4^{2-}(aq) + 4H^+(aq) + 2e$$

$$MnO_4^-(aq) + 8H^+(aq) + 5e \longrightarrow Mn^{2+}(aq) + 4H_2O(l)$$

Combining two half - equations

$$2MnO_4^-(aq) + 5SO_2(g) + 2H_2O \longrightarrow 2Mn^{2+}(aq) + 5SO_4^{2-}(aq) + 4H^+(aq)$$

3. When sodium sulphite solution was added to acidified solution of potassium dichromate, orange solution turns green. This is because sulphite ions reduce dichromate ions to chromium(III) ions . Write half equations and hence write an overall redox equation for the reaction.

REDOX TITRATIONS

POTASSIUM MANGANATE(VII) TITRATIONS:

When potassium manganate(VII) acts as an oxidizing agent in acidic solution , it is reduced to manganese(II) ions.

Potassium manganate(VII) is not sufficiently pure to be used as a primary standard and its solution must be standardized by titrating against a primary standard such as sodiumethanedioate.

Questions.

1. A $25.0cm^3$ portion of sodium ethanedioate solution of concentration $0.2moldm^{-3}$ was acidified with dilute sulphuric acid. The mixture was heated up to 70^oC and the hot mixture was titrated with potassium manganate(VII) solution and $17.20cm^3$ was required to reach the endpoint.

(a) write an equation for the reaction

(b) Calculate the molarity of potassium manganate(VII) solution and hence determine the concentration of the solution in grams per litre.(answer = 0.116M)

2. 8.492g of hydrated ammonium ferrous sulphte crystals , $(NH_4)_2SO_4.FeSO_4.nH_2O$ were dissolved in water and the solution made up to $250cm^3$. $25.0cm^3$ of this solution was acidified with dilute sulphuric acid and required $22.5cm^3$ of 0.015M potassium manganate(VII) solution. Calculate the value of n.(answer = 12))

3. A solution of hydrogen peroxide was diluted 20.0 times. A $25.0cm^3$ portion of the diluted solution was acidified and required $45.7cm^3$ of 0.015M potassium manganate(VII) solution.

Calculate the

(a) concentration in $moldm^{-3}$ of the diluted solution (answer = 0.0684M)

(b) volume strength of the original hydrogen peroxide solution. (answer = 15.4V))

4. A $25.0cm^3$ portion of a solution containing iron(II) ions and iron(III) ions was acidified and required $15.0cm^3$ of 0.02Mpotassium manganate(VII) solution. A second $25.0cm^3$ portion of the mixture of iron(II) and iron(III) was reduced with excess zinc and $19.0cm^3$ of 0.02M potassium manganate(VII) was required to reach the end point. Calculate the molar concentration of

(a) iron(II) ions and (answer = $0.060moldm^{-3}$)

(b) iron(III) ions in the mixture.(answer = $0.0160moldm^{-3}$)

POTASSIUM DICHROMATE TITRATIONS

Potassium dichromate(VI) can be obtained in a high state of purity , and its solution s are stable. It is used as a primary standard. Redox indicator is used in dichromate(VI) titrations and the colour change at the end point is from bluish green to violet. Redox indicator is made by dissolving 2.0g of barium N- phenyl phenyl amine- 4- sulphonate in $250cm^3$ of concentrated phosphoric acid.

QUESTIONS

1. 2.225g of an impure iron wire was dissolved in excess dilute sulphuric acid and the resultant solution was diluted to $250cm^3$. $25.0cm^3$ of this solution required $31.0cm^3$ of 0.0185M potassium dichromate(VI) solution using redox indicator.

(a) Write equations for the reactions that took place.

(b) Calculate the percentage of purity of the iron wire.

(answer =86.7%)

2. 1.90g of a metal sulphite , X_2SO_3 was dissolve in distilled water and the solution made up to 250cm^3. 20.0cm^3 of this solution required 16.0cm^3 of 0.02M potassium dichromate(VI) solution. Calculate the relative atomic mass of metal X and hence identify X.(answer = 39)

3. A solution of potassium dichromate was standardized by titrating with sodium ethanedioate solution. If 47.0cm^3 of the dichromate solution was required to oxidize 25.0 cm^3 of ethanedioate solution of concentration 0.0925moldm^{-3}. Determine the molar concentration of potassium dichromate(VI) solution.(answer = 0.0164M)

SODIUM THIOSULPHATE TITRATIONS

Sodium thiosulphate($Na_2S_2O_3$) reduces iodine to iodide ions and thiosulphate ions themselves are oxidized to sodium tetrathionate ($Na_2S_4O_6$).

$$2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

Sodium thiosulphate pentahydrate , $Na_2S_2O_3.\ 5H_2O$ is not used as a primarystandard because the it undergoes efflorescence and its solution turns cloudy on exposure to air due to the disproportionation reaction between the few hydrogen ions from carbonic acid formed and thiosulphate ions to form insoluble sulphur.

$$CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$$

$$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$$

$$S_2O_3^{2-}(aq) + 2H^+(aq) \longrightarrow S(s) + SO_2(g) + H_2O(l)$$

Therefore a solution sodium thiosulphate must be standardized using a standard solution of iodine. However iodine is sparingly soluble in water. It dissolves readily in potassium iodide solution because it forms a soluble complex ,tri-iodide ions with iodide ions.

$$I_2(s) + I^-(aq) \rightleftharpoons I_3^-(aq)$$

An equilibrium is set up between iodine and tri-iodide ions and if iodine molecules are removed from the solution by a reaction , tri-iodide ions dissociate to form more iodine molecules . A solution of iodine in potassium iodide can be titrated as though it were a solution of iodine in water.

When sufficient amount of thiosulphate is added to a solution of iodine , the colour of iodine (brown) fades to a pale yellow . Then 2cm^3 (or 6drops) of starch solution to act as indicator are added to give a deep blue colour with the iodine. Addition of thiosulphate is continued drop by drop , until the blue colour just turns colourless. Although in the reaction involving liberating iodine from iodide ions and acidified dichromate(VI) ions , chromium(III) ions are formed that give a pale blue solution at the end point.

Apart from preparing a standard solution of iodine from iodine crystals and potassium iodide, iodine can liberated from a redox reaction between an oxidizing agent and iodide ions in acidic medium. Such oxidizing agents include potassium dichromat(VI) ,$K_2Cr_2O_7$, potassium manganate(VII) , $KMnO_4$, potassium chlorate(V), $KClO_3$, potassium bromate(V) , $KBrO_3$, potassium iodate(V), KIO_3 , sodium hypochlorite (sodium chlorate(I)) (JIK) , NaOCl or NaClO, copper(II) salt , hydrogen peroxide etc

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6I^-(aq) \longrightarrow 2Cr^{3+}(aq) + 3I_2(aq) + 7H_2O(l)$

$2MnO_4^-(aq) + 16H^+(aq) + 10I^-(aq) \longrightarrow 2Mn^{2+}(aq) + 5I_2(aq) + 4H_2O(l)$

$YO_3^-(aq) + 6H^+(aq) + 6I^-(aq) \longrightarrow Y^-(aq) + 3I_2(aq) + 3H_2O(l)$

Where Y = Cl , Br)

$IO_3^-(aq) + 6H^+(aq) + 5I^-(aq) \longrightarrow 3I_2(aq) + 3H_2O(l)$

$OCl^-(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow Cl^-(aq) + I_2(aq) + H_2O(l)$

$2Cu^{2+}(aq) + 4I^-(aq) \longrightarrow Cu_2I_2(s) + I_2(aq)$

$H_2O_2(aq) + 2H^+(aq) + I^-(aq) \longrightarrow I_2(aq) + 2H_2O(l)$

NOTE

1. Among the oxidizing agents that oxidize iodide ions to iodine are primary standards and they include potassium dichromate(VI) , potassium chlorate(V) , potassium iodate(V) , potassium bronmate(V)
2. When carry out calculation on redox , do not base your calculations on any of the following : potassium iodide , sulphuric acid , hydrochloric acid , ethanoic acid. Because these reagents are always in excess

QUESTIONS

1. 2.855g of iodine and 6g of potassium iodide are dissolved in distilled water and the solution made up to $250cm^3$. A $25.0cm^3$ portion of this solution required $17.7cm^3$ of sodium thiosulphate using starch indicator. Calculate the molar concentration of sodium thiosulphate solution.
   (answer = 0.126M)
2. 1.015g of potassium iodate(V) are dissolved in distilled water and the solution made up to $250cm^3$. To a $25.0cm^3$ portion are added an excess of potassium iodide and dilute sulphuric acid. The liberated iodine required $29.8cm^3$ of sodium thiosulphate solution. Calculate the concentration of sodium thiosulphate in $moldm^{-3}$ (answer= $0.0950moldm^{-3}$)
3. A domestic bleach in solution(JIK) is diluted by pipetting $10.cm^3$ of the jik solution and making this volume up to $250cm^3$. A $25cm^3$ portion of this solution is added excess potassium iodide solution and ethanoic acid and the liberated iodine required $21.3cm^3$ of 0.0950M sodium thiosulphate solution.Calculate the percentage of available chlorine in JIK.
   (density of the JiK solution = $1gcm^{-3}$)
   Equations involved include
   $ClO^-(aq) + 2H^+(aq) + Cl^-(aq) \longrightarrow Cl_2(g) + H_2O(l)$
   $ClO^-(aq) + 2I^-(aq) + 2H^+(aq) \longrightarrow I_2(aq) + Cl^-(aq) + H_2O(l)$
   $2S_2O_3^{2-}(aq) + I_2(aq) \qquad S_4O_6^{2-}(aq) + 2I^-(aq)$

(answer = 7.2%)

4. A sample of 4.256g of hydrated copper(II) salt is dissolved in water and the solution made up to 250cm^3. A 25.0cm^3 portion is added to an excess of potassium iodide solution. The iodine liberated required 18.0cm^3 of a 0.0950M sodium thiosulphate solution. Calculate the percentage of copper in the crystals.(Cu = 63.5) (answer = 25.6%)
5. A 25.0cm^3 sample of house hold bleach is diluted to 250cm^3. A 25cm^3 portion of the solution is added to an excess of potassium iodide solution and ethanoic acid and titrated against 0.2M sodium thiosultate solution and 18.5cm^3 of sodium thiosulphate was required to reach the end point. Calculate molar concentration of sodium chlorate(I) in the bleach. (answer = 0.74M)
6. 10cm^3 of a solution of hydrogen peroxide is diluted with water to 250cm^3. 25cm^3 of the sample reacted with excess potassium iodide in the presence of dilute sulphuric acid and required 30cm^3 of 0.2M sodium thiosulphate solution for complete reaction.
   (a) Name the indicator used to make the end point and describe the colour change.
   (b) Calculate
      (i) Molarity of the original hydrogen peroxide
      (ii) The volume strength of the original hydrogen peroxide.

PRACTICAL QUESTIONS

Your answers must be in the spaces provided.

1. You are provided with the following

FA1 which is 0.05M sodium hydroxide solution

FA2 which is o.02M potassium manganate(VII) solution

FA3 which is a mixture of 2.9g of ethanedioic and metal oxalate ($M_2C_2O_4$) dissolve in 250cm^3 of solution.

You are required to determine the atomic mass of M in $M_2C_2O_4$

Procedure

(a) Pipette $10cm^3$ of **FA3** into a conical flask and add 2-3 drops of phenolphthalein indicator. Titrate the mixture with **FA1** from the burette until the end point.**DO NOT POUR AWAY** the resultant solution. Record your results in **table 1**

(b) Add $20cm^3$ of 2M sulphuric acid to the resultant solution in (a) and heat the mixture to nearly boiling and titrate the hot solution with **FA2** from the burette until the end point. Record your results in **table II.**

(c) Repeat procedures (a) and (b) two more times to obtain consistent results.

Volume of pipette used……………………… cm^3

Table 1

Burette readings	1	2	3
Final burette reading (cm^3)	22.80	44.80	27.00
Initial burette reading (cm^3)	0.00	22.80	5.00
Volume of **FA1**(cm^3)			

Titre values used to calculate the average volume of **FA1** used

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Average volume of **FA1** used ……………………….. cm^3

Table II

Burette readings	1	2	3
Final burette reading (cm^3)	20.90	39.90	29.00
Initial burette reading (cm^3)	0.00	20.90	10.00
Volume of **FA2**(cm^3)			

Titre values used to calculate the average volume of **FA2** used

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Average volume of **FA2**used ……………………….. ……cm^3

Questions

(a) Calculate the number of moles of

(i) ethanedioic acid in 10cm^3 of **FA3**

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(ii) metal ethanedioate in 10cm^3 of **FA3.**

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(b) Determine the value of M in $M_2C_2O_4$(H= 1 , C = 12 , O = 16)

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2. You are provided with the following

FA1 which is a solution containing 1.457g of halate(V) ion, YO_3^- in $0.5dm^3$ of solution.

FA2 which is 0.027M sodium thiosulphate solution.

You are required t determine the relative atomic mass of Yin the halate(V) ion

Procedure:

Pipette $10cm^3$ of FA1 into a conical flask and add an equal volume of 1M hydrochloric acid followed by $5.0cm^3$ of 0.5M potassium iodide solution. Titrate the mixture with FA2 from the burette until the solution turns pale yellow. Add $2cm^3$ of starch solution and continue the titration until the solution just turns colourless.

Volume of the pipette used …………………cm^3

Final burette reading (cm^3)	37.50	47.00	42.00
Initial burette reading(cm^3)	0.00	10.00	5.00
Volume of FA2 used(cm^3)			

Titre values used to calculate the average volume of FA2 used

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Average volume of FA2 = …………………………………… cm^3

Questions

Calculate

(a) molar concentration of halate(V) ion

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(b) the relative atomic mass of Y in YO_3^-

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3. You are provided with the following

FA1 which is sodium thiosulphate solution

FA2 which is a solution made by dissolving 6.4g of a mixture of potassium iodate(V) and potassium iodide per litre of solution

Solid **P** which potassium dichromate

1M sulphuric acid

10% potassium iodide solution.

You are required to determine the

(a) molar concentration
(b) percentage of potassium iodate(V) in FA2

Theory

Acidified dichromate(VI) ions react iodide ions according to the following equation.

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6I^-(aq) \longrightarrow 2Cr^{3+}(aq) + 3I_2(aq) + 7H_2O(l)$$

Acidified iodate(V) ions react with iodide ions according to the following equation

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \longrightarrow 3I_2(aq) + 3H_2O(l)$$

The liberated iodine in both case is reduced by thiosulphate ions according to the following equation.

$$2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

Procedure

PART A

Weigh accurately about 1.2g of P and dissolve in about 100cm^3 of 1Msulphuric acid in a beaker. Transfer the solution in 250cm^3 volumetric flask and make up to the mark with distilled water. Shake to mix thoroughly and label the solution **FA3**

Pipette 25cm^3(or 20 cm^3) of **FA3** into a conical flask and add 10cm^3 of potassium iodide solution and titrate the mixture with **FA1**from the burette until the solution becomes yellowish green. Then add $2cm^3$ of starch indicator and continue the titration until the solution just turns pale blue. Repeat the titration until you obtain consistent results. Record your results in the table below.

RESULTS

Mass of weighing bottle +**P** = …………………g
Mass of weighing bottle alone = ……………………g
Mass of **P** = ……………………g
Volume of the pipette used ……20.0……………cm^3

Final burette reading (cm^3)	20.50	40.10	24.60
Initial burette reading(cm^3)	0.00	20.50	5.00
Volume of FA1 used(cm^3)			

Titre values used to calculate the average volume of FA1used

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Average volume of FA1 = …………………………………… cm^3

Questions

Calculate molar concentration of **FA1**

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PART B

Pipette 25cm^3 (or 20cm^3) of FA2 into a conical flask , add an equal volume of 1M sulphuric acid and titrate with solution of FA1 from the burette until the solution turns pale yellow. Add 2cm^{3}of starchindicator and continue the titration until the solution just turns colourless. Repeat the titration until you obtain consistent results. Record your results in the table below.

RESULTS

Volume of the pipette used ………20.0…………cm^3

Final burette reading (cm^3)	7.50	13.50	19.50
Initial burette reading(cm^3)	0.00	7.50	13.50
Volume of FA1 used(cm^3)			

Titre values used to calculate the average volume of FA1 used

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Average volume of FA1 = …………………………………….. cm^3

Questions

(a) Calculate

(i) number of moles of potassium iodate(V) that reacted with **FA1**

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(ii) percentage by mass of potassium iodide that reacted.

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4.0 You are provided with the following :

FA1 which is a solution containing 4.0g of a mixture of potassium dichromate(VI) and potassium iodate(V) in 250cm^3 of solution.

FA2 which is a 0.2M sodium thiosulphate solution.

FA3 which is a 0.1M iron(II) salt solution

0.5M potassium iodide solution

1M phosphoric acid

You are required to determine the percentage by mass of potassium iodate(V) in **FA1.**

THEORY

Both iodate(V) ions and dichromate(VI) ions react with iodide ions in acidic medium to liberate iodine which can be titrated against a standard solution of sodium thiosulphate according to the following equations

$IO_3^-(aq) + 6H^+(aq) + 5I^-(aq) \longrightarrow 3I_2(aq) + 3H_2(l)$

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6I^-(aq) \longrightarrow 2Cr^{3+}(aq) + 3I_2(aq) + 7H_2O(aq)$

$2S_2O_3^{23-}(aq) + I_2(aq) \longrightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$

Iron(II) ions react with dichromat(VI) ions according to the following equation.

$6Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) + 14H^+(aq) \longrightarrow 6Fe^{3+}(aq) + 2Cr^{3+}(aq) + 7H_2O(l)$

PROCEDURE:

PART 1

Pipette 10cm^3 of **FA1**into a clean conical flask, add 15cm^3 of 0.5M potassium iodide solution followed by 15cm^3 of 1M sulphuric acid .Titrate the mixture with **FA2** from the burette until the solution turns greenish yellow. Add 2cm^3 of starch indicator and continue the titration until the solution just turns pale blue. Repeat the titration until you obtain consistent results.

RESULTS

Volume of the pipette used ………10.0…………cm^3

Final burette reading (cm^3)	20.50	40.10	30.10
Initial burette reading(cm^3)	0.00	20.50	10.50
Volume of **FA2** used(cm^3)			

Titre values used to calculate the average volume of **FA2**used

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Average volume of **FA2** = …………………………………… cm^3

Questions

(a) Calculate

(i) number of moles of iodine that reacted with **FA2**

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(ii) total number of moles iodate(V) ions and dichromate(VI) ions in **FA1**

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PART 2

Pipette $20cm^3$ of **FA3** into a clean conical flask , add $10cm^3$ of 1M phosphoric acid followed $15cm^3$ of 1M sulphuric acid . Add 2-3 drops of **REDOX** indicator **R** and titrate the mixture with **FA1** from the burette until the solution just turns violet. Repeat the titration until you obtain consistent results.

Record your results in the table below.

RESULTS

Volume of the pipette used ………20.0…………cm^3

Final burette reading (cm^3)	14.50	27.80	41.10
Initial burette reading(cm^3)	0.00	14.50	27.80
Volume of **FA1** used(cm^3)			

Titre values used to calculate the average volume of **FA1**used

……………………………………………………………… cm^3

Average volume of **FA1** = ……………………………………. cm^3

Questions

(b) Calculate the

(i) number of moles of dichromate(VI) ions that reacted with **FA1** (03marks)

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(ii) percentage by mass of potassium iodate(V) in **FA1**.(3½marks)

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5. You are provided with the following:

FA1 which is potassium manganate(VII) solution of unknown concentration.
FA2 which is 0.1M sodium thiosulphate solution.

FA3 which is 0.2M ethanedioic acid solution

Solid T which is impure manganese(IV) oxide

10% potassium iodide solution

1M sulphuric acid

You are required to standardize FA1 and use it to determine the percentage impurity in T

The equations for the reactions that take place include:

$2MnO_4^-(aq) + 10I^-(aq) + 16H^+(aq) \longrightarrow 2Mn^{2+}(aq) + 5I_2(aq) + 8H_2O(l)$

$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \longrightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$

$MnO_2(s) + 4H^+(aq) + C_2O_4^{2-}(aq) \longrightarrow Mn^{2+}(aq) + 2CO_2(g) + 2H_2O(l)$

$2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$

PROCEDURE

PART 1

Pipette 25.0cm^3 (or 20cm^3) of FA1into a conical flask , add 15cm^3 of 10% potassium iodide followed by 15cm^3 of 1M sulphuric acid. Titrate the mixture with FA2 from the burette until the solution turns pale yellow. Add 2cm^3 of starch indicator and continue with the titration until the solution turns colourless.

RESULTS

Volume of the pipette used ………20.0…………cm^3

Final burette reading (cm^3)	20.70	41.10	25.40
Initial burette reading (cm^3)	0.00	20.70	5.00
Volume of **FA2** used (cm^3)			

Titre values used to calculate the average volume of **FA2**used

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Average volume of **FA2** = …………………………………… cm^3

Question

(a) Calculate the molar concentration of potassium manganate (VII) solution in **FA1**

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PART 2

Weigh accurately about 0.2g of **T i**n a conical flask and add $100cm^3$ of **FA3**and heat the mixture until the solid just dissolves. Cool the mixture and transfer into $250cm^3$ volumetric flask and make up to the mark with distilled water. Shake to mix thoroughly and label the solution **FA4**

Pipette $10.0cm^3$ of**FA4** into a conical flask and add $15cm^3$ of1M sulphuric acid . Heat the mixture up to 70^oC and titrate the hot mixture with FA1 from the burette until the end point. Repeat the titration until you obtain consistent results. Record your results in the table below.

RESULTS

Mass of weighing bottle +**T** = ………………….g
Mass of weighing bottle alone = ……………………g
Mass of **T** = ……………………g
Volume of the pipette used ……10.0……………cm^3

Final burette reading (cm^3)	14.70	28.60	42.50
Initial burette reading(cm^3)	0.00	14.70	28.60
Volume of FA1 used(cm^3)			

Titre values used to calculate the average volume of **FA1**used

…………………………………………………………… cm^3

Average volume of **FA1** = …………………………………… cm^3

Questions

(a) Calculate the

(i) number of moles of excess ethanedioic acid in $100cm^3$of **FA3**

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(ii) number of moles of ethanedioic acid that reacted with **T**.

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(b) Determine the percentage impurity in **T.** (Mn= 55 , O = 16)

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