A2 Chemistry

Experiment 1 – Redox Titration

As this is a redox reaction there are two half equations:

$5C_2O_4^{2-} - 10e^- \rightarrow 10CO_2$ and $2MnO_4^- + 16H^+ + 10e^- \rightarrow 2Mn^{2+} + 8H_2O$

Combining these 2 half equations we get:

$5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \rightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$

Therefore to find the concentration of the ethanedioic acid I can titrate with Potassium Permanganate which acts as an oxidising agent, with Ethanedioic acid acting as a reducing agent. The sulphuric acid will act as an acid catalyst, providing extra H^+. H2SO4 IN EXCESS

The Sulphuric acid is in excess to ensure all the ethanedioic acid will react with the $KMnO_4$ until the equivalence point is reached. I will use a 0.05mol dm^{-3} concentration of $KMnO_4$.

Method:

- Set up titration apparatus, and fill the burette with 0.05M Potassium Permanganate, fill up to zero on the burette, use a funnel and place apparatus on a stool if necessary.
- Ensure that the acid mixture is properly mixed by shaking. Then fill a graduated pipette with 25cm^3 of the acid mixture and pipette this into a 250cm^3 conical flask.
- You will not need to add any indicator as $KMnO_4$ is self indicating; the end point has been reached when a permanent pale pink colour appears.
- This reaction will only take place above 60 degrees Celsius, therefore heat the conical flask before titrating to a little over 60 degrees, using a Bunsen burner. Use an insulator to hold the conical flask when heated.
- Carry out the titration as normal, ensuring that temperature is above 60 degrees using a thermometer. If needed stop titration and heat until over 60 degrees again and then continue. Repeat enough times until you have at least 2 consistent results within

0.1cm^3 of each other, which strengthens reliability of results. Ensure you go drop wise as you approach the end point.

- Record your results in a suitable table as shown below.

Cm^3	Trial Run	Run 1	Run 2	Run 3
Final Volume				
Initial Volume	0.00			
Volume used				

Work out concentration of the ethanedioic acid

Now that I Know the volume of $KMnO_4$ that was required for the redox reaction, I can work out the number of moles of $KMnO_4$

Concentration x Volume = Moles, therefore 0.05 x average titre=moles of $KMnO_4$

From the equation I know that the Molar ratio between $KMnO_4$ and $H_2C_2O_4$ is:

$5C_2O_4^{2-}$ $2MnO_4^-$, therefore 5:2 ratio. So if I divide moles of $KMnO_4$ by 2 and then multiply by 5 this gives the moles of $H_2C_2O_4$. And finally to get the concentration of $H_2C_2O_4$ simply do moles/volume, so moles of $H_2C_2O_4$ / 0.025dm^3 = concentration of $H_2C_2O_4$

Experiment 2

I can use a gas collection to find the overall concentration of the acid mixture, and as I already have the concentration of $H_2C_2O_4$, I can simply minus that from the total concentration to get the concentration of the H_2SO_4.

Both strong and weak acids will react with a metal, therefore I will react the acid mixture with magnesium metal.

Quantities of chemicals to use

As I have been told that the concentrations are approximately 0.1 mol dm^{-3} $H_2C_2O_4$ and 0.2 mol dm^{-3} H_2SO_4, I can say that the total

concentration is approximately 0.1+0.2=0.3 mol dm^{-3}. I am going to use 25cm^3 of the acid mixture, therefore total moles of acid mixture is 0.3 x 0.025 = 0.0075 moles

$H_2SO_4 + Mg \rightarrow MgSO_4 + H_2$ and $H_2C_2O_4 + Mg \rightarrow MgC_2O_4 + H_2$

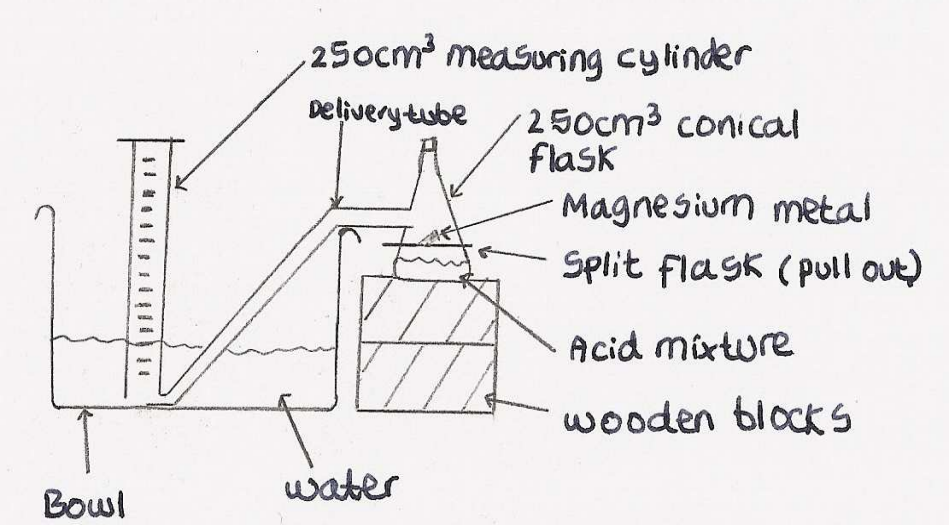
I need these in one equation so I can get the molar ratios, therefore I formed this ionic equation. $4H^+ + 2Mg \rightarrow 2Mg^{2+} + 2H_2$

The molar ratio between the acid mixture hydrogen is 4:2(2:1), therefore (0.0075/2)x24000=90cm^3, this is less than 250cm^3, so will fit into the measuring cylinder. I must ensure the Magnesium is in excess. So if I use approximately 0.1grams, moles of Mg = 0.1/24.3=0.0042moles but 1:2 ratio so multiply by 2 to get 0.0084moles, therefore there is more moles Mg than acid so it is in excess.

Method:

- Set up the apparatus as shown in the diagram and fill the bowl with water until approximately 1/3 full.
- Using a graduated Pipette measure out 25cm^3 of the acid mixture and place this into a 250cm^3 conical flask.
- Place weighing boat on the scale and press tear button, then add 0.1 grams Magnesium.
- Place the magnesium metal on the split flask and then release it ensuring the bung is properly fitted to the flask to ensure that no gas can escape.
- Ensure the upside down measuring cylinder is on top of the end of the delivery tube so that it collects all the gas.
- Allow gas collection to take place, however you may need to leave it several hours as there is also a weak acid involved meaning it will dissociate slowly. However to ensure it goes to completion wait until there is no more fizzing and no more gas appearing in measuring cylinder.
- Once finished record the volume of gas collected and use this to work out moles of gas produced.

Diagram:



Safety

Ethanedioic acid is a highly poisonous carboxylic acid. It is corrosive and may cause burns. If it comes to contact with skin rinse with plenty of water immediately. Wear a lab coat to prevent exposure to skin.

Specimen calculation

If 22cm^3 of $KMnO_4$ was needed for the redox titration, then 0.022 x 0.05= 1.1x10^{-3} moles of $KMnO_4$.

Using 5:2 ratio of $5C_2O_4^{2-}$ $2MnO_4^-$ moles of $H_2C_2O_4$ is (1.1x10^{-3} /2) x5=2.75x10^{-3} moles, and finally to get concentration 2.75x10^{-3} /0.025=0.11 mol dm^{-3}. Which is almost 0.1mol dm^{-3} as suggested the concentration was approximately.

The above was all from experiment 1, and now to get the concentration of the Sulphuric acid was experiment 2.

If the volume of gas collected was 80cm^3, then moles of Hydrogen would be (80/1000)/24=0.0033moles, however 4:2 ratio with acid so multiply by 2 to get 0.0066moles, and as I used 25cm^3 acid, concentration is 0.0066/(25/1000)=0.27mol dm^{-3}. To get the H_2SO_4

concentration minus the $H_2C_2O_4$ concentration (0.11), 0.27-0.11=0.16mol dm^{-3}, this is close to 0.20mol dm^{-3}