The estimation of iron(ii) and iron(iii) in a mixture containing both essay sampl...

Science, Chemistry

I have been given a solution that contains between 1. 1g and 1. 3g of iron ions; they are in a mixture of both Fe^{2+} and Fe^{3+}. My aim is to work out the percentage of each of them in the solution. With my research I have found out that the best method would be to find out how many grams of Fe^{2+} ions there are first. I must then convert all the Fe^{3+} ions in to Fe^{2+} ions by reducing them with granulated zinc and H_2SO_4. This would enable me to then work out the total mass of all the iron ions in the solution.

Total Mass – Mass of Fe^{2+} = Mass of Fe^{3+}

After I know the mass of each different iron ion in the solution I can then convert these into percentages.

Equipment

200cm3 of Fe^{2+}/Fe^{3+} solution

H_2SO_4 (1 mol dm-3)

$KMnO_4$ (0. 0100 mol dm-3)

Clamp stand

Beaker

Eye protection

Burette

White tile

Graduated pipette

Accuracy

I am using 20cm3 of my solution each time as opposed to using 10cm3 as this will give me a lower percentage error. I will make sure all equipment I use is clean. When measuring out any amounts of solutions or acids I will always use a graduated pipette as these are the most accurate ones I can use. I will use the white tile as it will enable me to detect the slightest colour change.

Safety

It is vital that all actions are carried out safely to make sure that no harm comes to me or anyone near the experiment. To do this I will:

* Make sure that I am wearing goggles at all times.

* Make sure there is no loose clothing on me that could knock anything over.

* Make sure I do not leave any of my equipment until they have been safely put away to ensure that no one else comes to any harm.

* Wear a white lab coat to make sure there are no spillages on any of my clothes.

* I will make sure I read all the hazard cards on all the liquids used as these are the hazards:

H_2SO_4 – Sulphuric acid has a high exothermic reaction with water which means that any burn done by this liquid can be worse than other strong acids. Contact with the skin can cause tissue damage due to dehydration as the exothermic reaction happens. The solution I am using is of 1 mol dm^{-3} and is labelled as an irritant. If any spillages on skin happen then the area of contact should be bathed in cold water for about 15 minutes, if the acid gets on any clothing they should be removed instantly.

$KMnO_4$ – Inhalation or ingestion can cause vomiting and coughing and the person must see a doctor straight away. If inhaled then move to well ventilated area with fresh air, if swallowed give large quantities of water and do not induce vomiting.

Procedure to work out the mass of Fe^{2+} ions

1. Set up the burette, clamp stand, 200cm^3 beaker and white tile as in the picture on the right.

2. Make sure the tap is close on the burette and then fill it to the top amount line with $KMnO_4$.

3. I will then add 20cm^3 of my iron solution to the beaker.

4. The solution needs to be added to an acid, this is due to the fact that it will stop any atmospheric oxidation of iron (II) to iron (III). Therefore I will add 10cm^3 of H_2SO_4 to the beaker as well.

5. I will then turn the tap on the burette to let out the $KMnO_4$. I will do this slowly so I can record the amount on the burette being let out. I will also stir the beaker at the same time.

6. In my first titre I am looking for the rough amount of $KMnO_4$ needed to make the colour change happen.

7. After I have found the rough amount needed I will do a lot more accurate ones, letting out the $KMnO_4$ drop by drop when close the amount.

8. I will not stop doing titrations until I have 3 concurrent results that are all within one decimal place. I will record all my results in a table like this:

Titration

Titre

1

2

3

4

Procedure to work out the total mass of iron ions

1. Set up the burette, clamp stand, 200cm3 beaker and white tile as in the picture on the right.

2. Make sure the tap is close on the burette and then fill it to the top amount line with $KMnO_4$.

3. I will add 20cm3 of my solution of iron ions to the beaker.

4. This time I need to make sure that all the ions in the solution are Fe^{2+}. To do this I must reduce the Fe^{3+}. I will do this by reacting my solution with an acid and a metal catalyst. The acid I will be using is 10cm3 of H_2SO_4 and the metal I will be using as a catalyst is 1 spatula of granulated zinc. I will mix these together.

5. I will then turn the tap on the burette to let out the $KMnO_4$. I will do this slowly so I can record the amount on the burette being let out. I will also stir the beaker at the same time.

6. In my first titre I am looking for the rough amount of $KMnO_4$ needed to make the colour change happen.

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Titration

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2

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Working out the mass percentage of Fe^{2+} and Fe^{3+}

To work out the masses I must first find the number of moles in the $KMnO_4$. I can do this as I know the volume that I will have titrated and the concentration of it. The equation I will use is:

Moles = Concentration * (Volume/1000)

I will then look at the balanced equation and see how many moles Fe^{2+} are made with the moles of $KMnO_4$. The equation is:

$KMnO_4^- + 5Fe^{2+} >>> KMn^{2+} + 5Fe^{3+}$

I can then see that 1 mole of $KMnO_4$ makes 5 of Fe^{2+} so would times the moles of $KMnO_4$ by 5.

I will then times it by 10 as I have a $200cm^3$ solution but have only used 1/10th of that. I will then use the equation:

Mass = Moles * Mr

I will now have the mass of Fe^{2+}

I will then reduce the Fe2+ to Fe3+ and use the exact same calculations as above to work out the total mass, but use the titre recordings from the second lot of titrations.

To get the final percentage I will do the equation:

(Mass of Fe2+/Total Mass)*100

This will give the the percentage of Fe2+ in the solution. To get the percentage of Fe3+ I need to do the equation:

100% – percentage of Fe2+ = Fe3+%

Bibliography

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Hazard cards for acids

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