Name and class ..... Date: .....

LONGMAN GCSE CHEMISTRY WORKSHEETS

4: Finding the percentage purity of iron wire

This sheet shows how you might measure the percentage purity of a piece of iron wire. It involves a titration calculation involving an unfamiliar reaction. Don't worry about this. You will be guided through the calculation in small steps.

1.40 g of iron wire was placed in a flask and about 50 cm^3 of dilute sulphuric acid (an excess) was added. The iron reacts to form iron(II) sulphate and hydrogen.

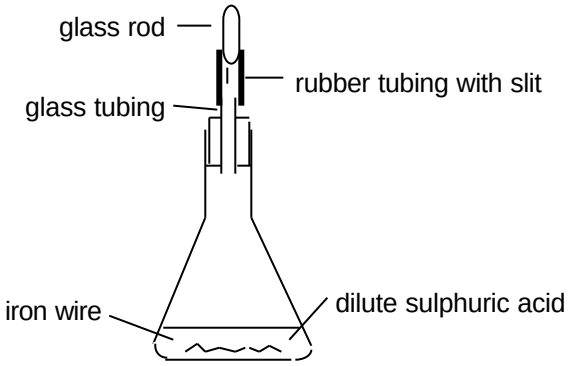
$$Fe_{(s)} + H_2SO_{4(aq)} \rightarrow FeSO_{4(aq)} + H_{2(g)}$$

The iron(II) sulphate contains iron(II) ions and so, from the point of view of the iron,

$$Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$$

Notice that each mole of iron gives 1 mole of iron(II) ions.

In the diagram, the piece of rubber tubing with a slit in it lets hydrogen escape but stops any air entering the flask. This prevents oxygen in the air oxidising the iron(II) ions into iron(III) ions.



When the reaction has finished, the contents of the flask are made up to exactly 250 cm^3 of solution using pure water. A 25 cm^3 portion of this diluted solution is placed in a clean flask and is acidified with an equal volume of dilute sulphuric acid.

Purple potassium manganate(VII) solution is run in from a burette, becoming colourless as it reacts with the iron(II) ions present. You can tell you have reached the end point of the titration when the solution in the flask turns pink. The last drop of potassium manganate(VII) solution added hasn't got any more iron(II) ions to react with and so keeps its colour.

Summary of results:

Mass of impure iron wire = 1.40 g
Total volume of solution after initial reaction and dilution = 250 cm^3
Volume of diluted solution used in titration = 25 cm^3
Concentration of potassium manganate(VII) solution = 0.0200 mol dm^{-3}
Volume of potassium manganate(VII) solution used in titration = 24.0 cm^3

Ionic equation for reaction

$$5Fe^{2+}_{(aq)} + MnO_4^-{}_{(aq)} + 8H^+_{(aq)} \rightarrow 5Fe^{3+}_{(aq)} + Mn^{2+}_{(aq)} + 4H_2O_{(l)}$$

(The MnO_4^- ion comes from the potassium manganate(VII) solution, $KMnO_4$. Each mole of $KMnO_4$ contains 1 mole of MnO_4^- ions.)

The calculation

1. Calculate the number of moles of potassium manganate(VII), and therefore of manganate(VII) ions, MnO_4^-, there are in 24.0 cm^3 of the 0.0200 mol dm^{-3} solution.

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2. Look at the equation to work out how many moles of iron(II) ions that amount of MnO_4^- ions would react with.

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3. That tells you the number of moles of iron(II) ions in 25 cm^3 of the iron(II) sulphate solution. How many moles of iron(II) ions were there in the whole 250 cm^3 of the diluted reaction mixture?

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4. Each 1 mole of iron(II) ions came from 1 mole of iron in the original iron wire. Calculate the mass of pure iron in the wire. (Relative atomic mass: Fe = 56)

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5. Since there was 1.40 g of impure iron wire at the start, calculate the percentage purity of the iron.

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