1 **(a** Insoluble compounds are made by precipitation.

(i) Complete the word equation for the preparation of zinc carbonate.

..... + sodium carbonate → zinc carbonate + ...

....

[2]

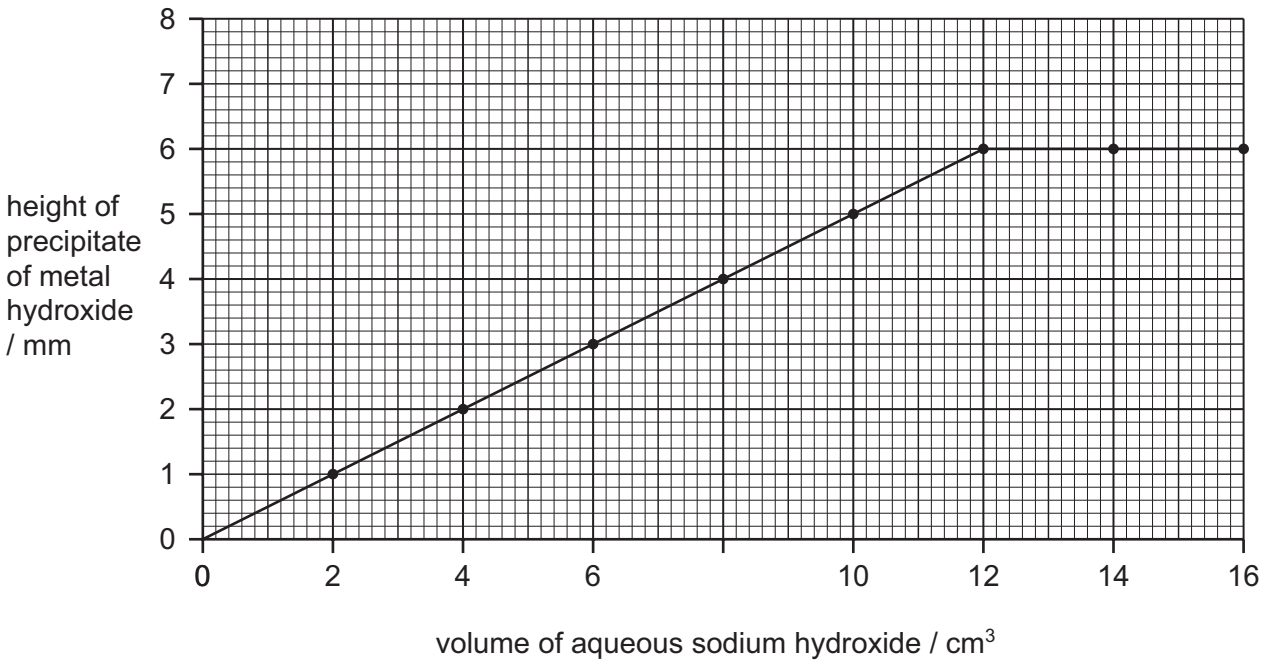
(ii) Complete the following symbol equation.

$Pb(NO_3)_2$ + ... $NaCl$ → ..... + ... [2]

(iii) Write an ionic equation for the precipitation of the insoluble salt, silver(I) chloride.

..... [2]

(b) 2.0 cm^3 portions of aqueous sodium hydroxide were added to 4.0 cm^3 of aqueous iron(III) chloride. Both solutions had a concentration of 1.0 mol/dm^3. After each addition, the mixture was stirred, centrifuged and the height of the precipitate of iron(III) hydroxide was measured. The results are shown on the following graph.



(i) Complete the ionic equation for the reaction.

Fe^{3+} + ...OH → ..... [1]

(ii) On the same grid, sketch the graph that would have been obtained if iron(II) chloride had been used instead of iron(III) chloride? [2]

(iii) If aluminium chloride had been used instead of iron(III) chloride, the shape of the graph would be different. How are the shapes of these two graphs different and why?

difference in shape .....

.....

reason for difference .....

..... [2]

2 The salt copper(II) sulphate can be prepared by reacting copper(II) oxide with sulphuric acid.

Complete the list of instructions for making copper(II) sulphate using **six** of the words below.

blue dilute filter

saturated white oxide

Instructions

1 Add excess copper(II) oxide to _____ sulphuric acid in a beaker and boil it.

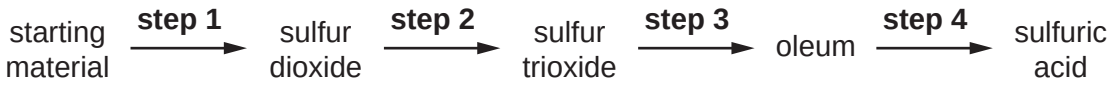
2 _____ to remove the unreacted copper(II) oxide.

3 Heat the solution until it is _____.

4 _____ the solution to form _____

coloured crystals of copper (II) _____. [6]

3 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.



(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

..... [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

.....

.....

.....

.....

.....

.....

..... [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$$H_2SO_4 + SO_3 \rightarrow .....$$

[1]

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

.....

.....

..... [2]

(ii) Give the **names** of all products formed.

.....

..... [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

..... [1]

(ii) What type of reaction has occurred?

..... [1]

[Total: 12]

4 **(a)** The reactions between metals and acids are redox reactions.

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$$

(i) Which change in the above reaction is oxidation, Zn to Zn^{2+} or $2H^+$ to H_2? Give a reason for your choice.

.....

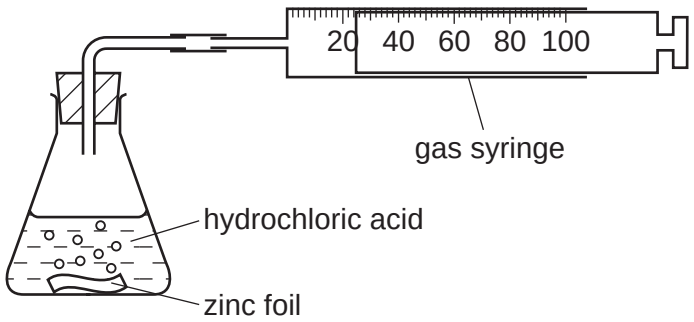
..... [2]

(ii) Which reactant in the above reaction is the oxidising agent? Give a reason for your choice.

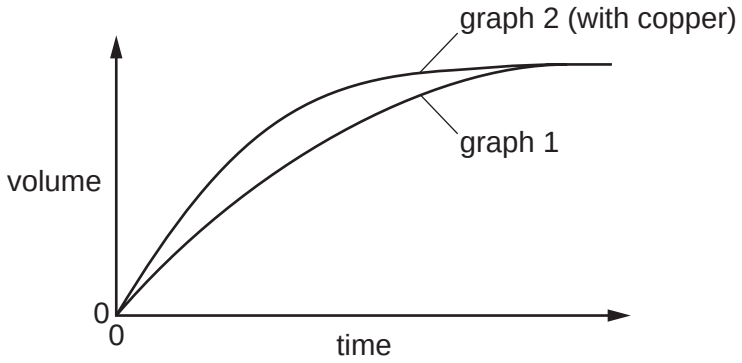
.....

..... [2]

(b) The rate of reaction between a metal and an acid can be investigated using the apparatus shown below.



A piece of zinc foil was added to 50 cm^3 of hydrochloric acid, of concentration 2.0 mol/dm^3. The acid was in excess. The hydrogen evolved was collected in the gas syringe and its volume measured every minute. The results were plotted and labelled as graph 1.



The experiment was repeated to show that the reaction between zinc metal and hydrochloric acid is catalysed by copper. A small volume of aqueous copper(II) chloride was added to the acid before the zinc was added. The results of this experiment were plotted on the same grid and labelled as graph 2.

(i) Explain why the reaction mixture in the second experiment contains copper metal. Include an equation in your explanation.

.....

..... [2]

(ii) Explain how graph 2 shows that copper catalyses the reaction.

.....

.....

..... [3]

(c) If the first experiment was repeated using ethanoic acid, CH_3COOH, instead of hydrochloric acid, how and why would the graph be different from graph 1?

.....

.....

.....

..... [4]

(d) Calculate the maximum mass of zinc which will react with $50\,cm^3$ of hydrochloric acid, of concentration $2.0\,mol/dm^3$.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Show your working.

[3]

[Total: 16]

5 Scandium, proton number 21, is not a typical transition element.

(a) Scandium is a low density metal which has only one oxidation state in its compounds. Scandium compounds are white solids which form colourless solutions. Titanium, the next metal in the period, is a far more typical transition element. How would the properties of titanium differ from those of scandium?

.....

.....

.....

..... [3]

(b) Scandium fluoride is an ionic compound. The valency of scandium in scandium fluoride is three.

Draw a diagram which shows the formula of this compound, the charges on the ions and the arrangement of the valency electrons around the negative ions.

Use × to represent an electron from a fluorine atom.
Use ○ to represent an electron from a scandium atom.

[3]

(c) Scandium oxide is insoluble in water. Describe how you could show that it is an amphoteric oxide.

.....

.....

.....

..... [3]

[Total: 9]