

1. The “Really Useful Chemicals Factory” makes sulphuric acid using the contact process.

The contact process involves three stages. The first stage involves producing sulphur dioxide by burning sulphur in excess air.

(a) Write a word equation for the first stage of the contact process.

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(1)

(b) The second stage involves producing sulphur trioxide from the sulphur dioxide. This reaction is carried out in the presence of a vanadium (V) oxide catalyst.

(i) Write a symbol equation for this second stage of the contact process.

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(2)

(ii) What does a catalyst do?

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(1)

(c) The conversion of sulphur dioxide into sulphur trioxide is a reversible, exothermic reaction. At the “Really Useful Chemicals Factory” this conversion takes place at a temperature of 450°C and results in a 95% conversion rate of sulphur dioxide into sulphur trioxide. A change in temperature affects both the rate of reaction and the yield of sulphur trioxide.

(i) State one disadvantage of using a temperature higher than 450°C.

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(1)

(ii) State the effect of an increase in pressure on the position of the equilibrium.

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(1)



(d) Sulphuric acid is used as a catalyst in the preparation of esters, a group of compounds found in flavourings and perfumes. Complete the word and symbol equations for the preparation of the ester methyl ethanoate.



(3)

Q1

(Total 9 marks)

2. A fisherman has noticed that there are less fish in the river than in previous years and thinks the river may be polluted.

You work for an environmental science laboratory. Part of your work is to analyse samples of river water to see what substances are present in them. The fisherman has some samples of the river water and wants your help in identifying any pollutant present.

(a) One of the other scientists you work with thinks the pollutant in the water may be potassium sulphate. She suggests you carry out a flame test and also carry out a test using dilute hydrochloric acid and barium chloride solution.

(i) State whether the above tests are qualitative or quantitative tests.

..... (1)

(ii) Define what is meant by the term qualitative.

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 (2)

(iii) Complete the table to show the colours you would expect to see when flame tests are carried out on substances containing the following metal ions.

Metal Ion	Colour
Na ⁺	yellow
K ⁺	
Ca ²⁺	
Cu ²⁺	

(3)



(iv) Explain why your colleague suggested the above tests.

Flame Test

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Hydrochloric acid and barium chloride test

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(2)

Before testing the sample river water you decide to carry out the tests using a sample of potassium sulphate crystals from a bottle in the laboratory.

(v) Describe how you would carry out the two tests.

Flame Test

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(4)

Hydrochloric acid and barium chloride test

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(2)

(vi) Describe the results you would obtain from the hydrochloric acid and barium chloride test.

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(1)

(vii) Suggest why it would be difficult to obtain reliable flame test results from the sample of river water.

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(1)

(viii) In a quality control laboratory results need to be accurate and reliable. Explain why.

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(2)

(Total 18 marks)

Q2

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3. In 1869, Mendeleev arranged the elements in the form of the periodic table. Before this many other scientists tried to make sense of all the information about the elements.

In 1817, the German chemist Dbereiner put forward his idea that elements were grouped in threes called 'Triads'. Calcium, strontium and barium have similar chemical and physical properties and form one triad. Also the relative atomic mass of strontium (88) is almost midway between those of calcium (40) and barium (137).

- (a) (i) Suggest one trend in physical properties of these three elements from calcium to barium.

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(1)

- (ii) These three elements have a similar chemical reaction with water. Name the common gaseous product which is formed when any of these three elements react with water.

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(1)

Complete and balance the equation for the reaction between lithium and water.



- (iii) What is the molar volume of gas obtained from the reaction at room temperature and pressure?

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(1)

One of the products from the reaction of sodium and water is used to manufacture soap.

- (b) Name the organic series that reacts with this product to form soap.
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(1)



(c) Give an example of a compound in this series and its formula.

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(2)

(d) State an advantage of using a detergent instead of soap in a hard water area.

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(1)

(e) Illustrate and label a diagram below to show the detergent action of a surfactant in removing oil or grease.

(4)

Q3

(Total 13 marks)

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4. A chemist working in a quality control laboratory carried out titrations using 20.00 cm³ samples of dilute sulphuric acid solutions of unknown concentration, titrating against 0.2 mol dm⁻³ sodium hydroxide solution.

The results are shown in the table.

Table A

	1st titration	2nd titration	3rd titration
2nd burette reading cm ³	12.70	24.90	
1st burette reading cm ³	0.00	12.70	24.90
Total volume of NaOH used cm ³	12.70		12.20

- (a) Complete the table. (2)

- (b) Using the results in the table, explain why it was necessary to carry out three titrations.

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(2)

- (c) State two pieces of glass apparatus (other than a burette) needed to carry out a titration.

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(2)



(d) The equation for the reaction is



The concentration of sodium hydroxide (NaOH) solution used in the titration is 0.2 mol dm^{-3} . Using the results from the 3rd titration, calculate the concentration in mol dm^{-3} of the sulphuric acid (H_2SO_4) solution.

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(4)

Q4

(Total 10 marks)



5. (a) Sulphuric acid is used to make copper sulphate, which is used in the purification of copper.

Copper sulphate can be made by warming copper oxide with sulphuric acid. The equation for the reaction is



Calculate the maximum mass of copper oxide which can react with 9.8g sulphuric acid in this reaction.

[Relative atomic masses H = 1; O = 16; S = 32; Cu = 64]

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(4)



(b) (i) Draw a labelled diagram of a cell which could be used to produce pure copper from a strip of impure copper.

(4)

(ii) Complete the equation for the reaction taking place at the cathode of the cell.



(1)

(iii) Explain why this reaction can be described as reduction of copper ions.

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(1)

Q5

(Total 10 marks)

TOTAL FOR PAPER: 60 MARKS

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