Section Four Structured questions

1 For each of the following experiments, state ONE observable change and write a chemical equation for the reaction involved.

a) Magnesium strip is added to dilute hydrochloric acid.

b) Iron(II) hydroxide is added to dilute sulphuric acid.

c) Sodium carbonate solution is added to concentrated hydrochloric acid.

d) Dilute sodium hydroxide solution is added to copper(II) sulphate solution.

e) Calcium chloride solution is added to sodium sulphate solution.

f) Sodium carbonate solution is added to nickel(II) sulphate solution.

(14 marks)

2 Consider the following chemicals:
sodium hydrogencarbonate, dilute sulphuric acid, sodium chloride solution and sodium hydroxide solution

a) Which chemical can be used as a constituent in baking powder? Explain your answer with an appropriate equation.

b) Which chemical can remove rust? Explain your answer with an appropriate equation.

c) Which chemical can be used to remove silver ions from a solution of silver nitrate and zinc sulphate? Explain your answer with an appropriate equation.

d) Which chemical can be used to distinguish between iron(II) sulphate solution and iron(III) sulphate solution? Explain your answer with appropriate equations.

(13 marks)

3 There are four unlabelled bottles of chemicals. They are either one of the following:
iron(II) nitrate solution, copper(II) nitrate solution, zinc nitrate solution and lead(II) nitrate solution.
Suggest how you can distinguish all of them with aqueous ammonia solution only. Illustrate your answer with appropriate equations.

(8 marks)

4 Six compounds are classified into two groups as shown in the table below:

Gas	Liquid
ammonia	copper(II) hydroxide
carbon dioxide	zinc hydroxide
nitrogen dioxide	potassium hydroxide

a) Which is / are coloured compound(s)? State its / their colour(s).

b) Which solid will give an alkaline solution when dissolved in water? Explain your answer.

c) Which compound(s) is / are acidic in nature?

d) Suggest simple methods to prepare carbon dioxide and ammonia in the laboratory.

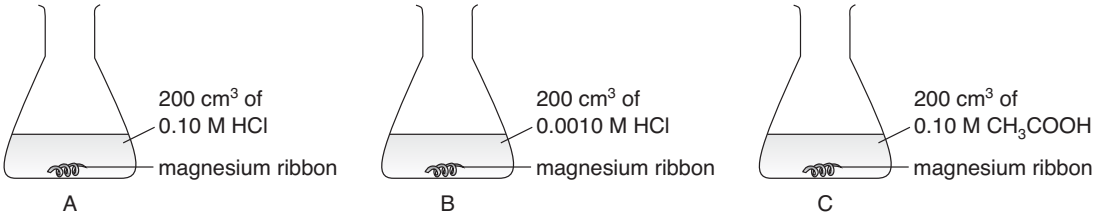
e) Suggest a test to identify ammonia.

f) Suggest a test to distinguish between 1 M potassium hydroxide solution and 1 M ammonia solution. State the expected observations and explain your answer briefly.

g) A student suggested that if some potassium hydroxide solution was spilt onto the hand, vinegar should be used to neutralize the potassium hydroxide solution on the affected area. Explain why the action is *inappropriate* and suggest a proper action.

(15 marks)

5 To determine the effect of concentration of hydrogen ions on reaction rate, magnesium ribbons of the same mass were put into 0.10 M hydrochloric acid (pH = 1), 0.0010 M hydrochloric acid (pH = 3) and 0.10 M ethanoic acid (pH = 3) respectively.



a) Write an ionic equation for the reaction between magnesium and dilute hydrochloric acid.

b) Suggest a method which allows you to collect the gas given off.

c) How can you compare the rate of the above reactions?

d) Why was the same volume of acid used in each conical flask?

e) Explain why it is NOT appropriate to use sodium instead of magnesium in this experiment.

f) i) Arrange the acids in order of increasing initial rate of reaction with magnesium. Explain your answer.

ii) Suggest TWO factors that affect the pH value of an acid.

g) Describe, giving the names of the apparatus used, how 0.0010 M hydrochloric acid can be prepared from 0.10 M hydrochloric acid.

(12 marks)

6 Sally is a student who likes chemistry very much. Last week, she tried an experiment at home. The details are as follows:

> She got come baking powder and vinegar from the kitchen. From a dictionary, she knew that the chemical names of constituents of vinegar and baking powder are ethanoic acid and sodium hydrogencarbonate respectively. She made a dilute solution of the vinegar and added it to the baking powder.

a) What would happen when a piece of pH paper is dipped into vinegar?

b) Apart from using pH paper, suggest another method to determine the pH value of vinegar.

c) i) What is the meaning of the term “weak acid”?

ii) Is ethanoic acid a strong acid or a weak acid?

d) What would you expect to see when the baking powder is added to the dilute solution of vinegar?

e) Write an equation for the reaction between vinegar and baking powder.

f) Sally tried to construct an experimental set-up to investigate the electrical conductivity of

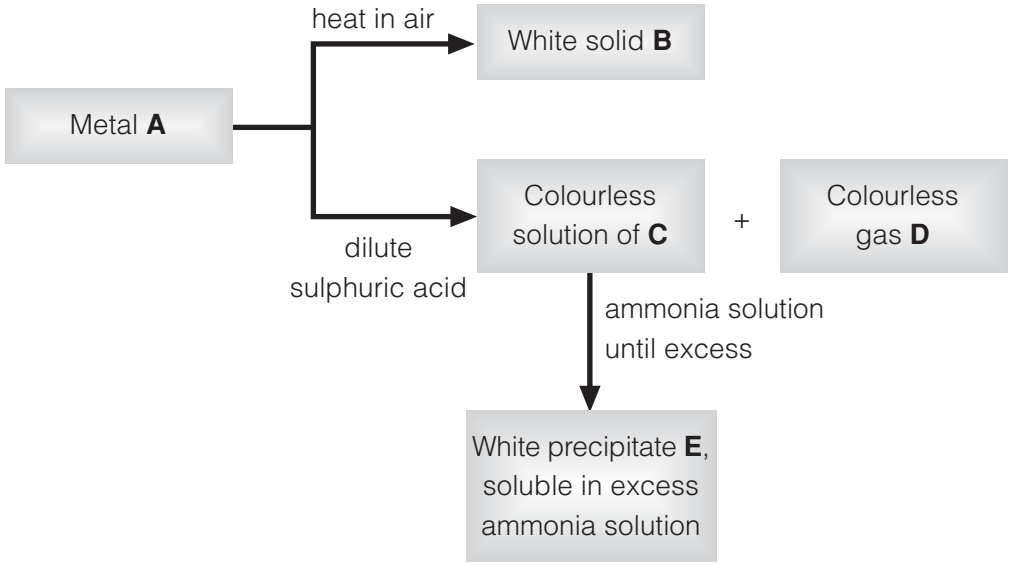
vinegar.

i) Draw a diagram to show the experimental set-up.

ii) Is ethanoic acid an electrolyte? Explain your answer.

(12 marks)

7 Study the following reaction scheme of metal A.



a) Give the names of A, B, C, D and E.

b) Write an equation for each of the following reactions:

i) A is heated in air.

ii) A is added to dilute sulphuric acid.

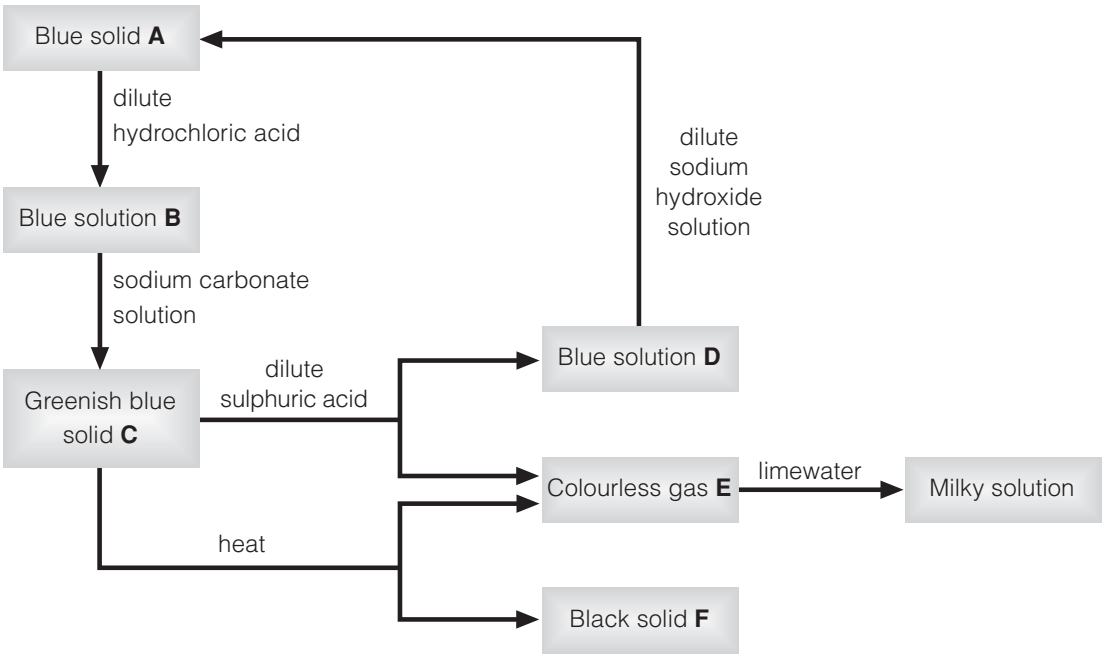
iii) Solution of C is mixed with ammonia solution.

c) Suggest an industrial method from which metal A can be obtained from solid B.

d) Suggest a chemical test to identify gas D.

(10 marks)

8 Consider the following reaction scheme:



a) i) Name solid A.

ii) Write an ionic equation for the reaction between solid A and dilute hydrochloric acid.

b) i) What is solid C?

ii) Write an ionic equation for the formation of solid C from solution B and sodium carbonate solution.

iii) Write a chemical equation for the formation of gas E and solid F from the thermal decomposition of solid C.

c) i) Name solution D.

ii) Write an equation for the reaction between solution D and dilute sodium hydroxide solution.

iii) (1) Name a reagent that can convert solid F to solution D.

(2) Write a chemical equation for the conversion.

d) Describe briefly how large crystals of solid can be obtained from solution D.

(13 marks)

9 The following tests were conducted to find out the identity of cations and anions of two ionic compounds, X and Y.

Test		Compound X	Compound Y
1	Flame test	Bluish-green flame	No characteristic flame colour
2	Add dilute sodium hydroxide solution to sample solution	Blue precipitate is formed.	A pungent smelling gas is given off when the mixture is heated; the gas turns moist red litmus paper blue.
3	Add dilute hydrochloric acid to sample solution	No observable change	Gas bubbles are given off; the gas turns limewater milky
	Followed by barium chloride solution	White precipitate is formed.	No observable change

a) From the above tests, suggest cations that may be present in X and Y respectively. Explain your answer with the aids of appropriate equations.

b) Consider compound X.

i) Give an ionic equation to account for the formation of the white precipitate in *Test 3*.

ii) Give a possible formula of X.

c) Consider compound Y.

i) Draw an experimental set-up for testing the gas given off from the reaction between Y and dilute hydrochloric acid in *Test 3*.

ii) Suggest what the gas is and write an equation for the reaction between the gas and limewater.

iii) Give a possible formula of Y and write an ionic equation for the reaction between the solution of Y and dilute hydrochloric acid.

(12 marks)

10 A student proposed the following methods to accomplish tasks. The proposed methods were considered *inappropriate*.

For each task,

i) State ONE reason why the method is *inappropriate*;

ii) Suggest an appropriate method to accomplish it.

a) Task: To prepare hydrogen gas from an acid.
Proposed method: Add magnesium to citric acid crystals.

b) Task: To neutralize the acidity in soil.
Proposed method: Add sodium hydroxide pellets to soil.

c) Task: To prepare a standard acid solution.
Proposed method: Weigh a sample of concentrated sulphuric acid accurately to prepare the standard solution.

(6 marks)

11 A teacher asked a class to prepare some insoluble salts. The following solutions were provided.

Copper(II) sulphate solution
Lead(II) nitrate solution
Magnesium chloride solution
Sodium carbonate solution

a) One student planned to prepare copper(II) carbonate.

i) Which TWO of the solutions should be used to prepare copper(II) carbonate?

ii) Write an ionic equation for the reaction involved.

iii) Describe how the student could prepare a pure, dry sample of copper(II) carbonate from the two solutions suggested.

b) Another student planned to prepare lead(II) sulphate. The student planned to use lead(II) nitrate solution and one other solution from the list.

i) Suggest the other solution this student should use.

ii) Write an ionic equation for the reaction involved.

iii) 100.0 cm^3 of 0.250 M lead(II) nitrate solution were mixed with excess of the solution suggest in (i). Calculate the mass of lead(II) sulphate obtained.

(Relative atomic masses: O = 16.0, S = 32.1, Pb = 207.2)

c) Suggest another insoluble salt that could be prepared from the solutions provided to the class.

(10 marks)

12 A description of the preparation of a pure crystalline sample of hydrated copper(II) sulphate is given below.

Step 1 A 25 cm^3 sample of dilute sulphuric acid is heated gently. A small quantity of copper(II) oxide is added to the hot acid with stirring. Copper(II) oxide is added until it is in excess.

Step 2 The excess copper(II) oxide is filtered off from the solution.

Step 3 The filtrate is heated until crystals just started to form and then left to cool.

Step 4 The crystals are collected and washed with a small amount of distilled water. Then the crystals are dried without heating with filter paper.

a) i) Explain the importance of each of the five underlined phrases in the preparation of pure crystalline hydrated copper(II) sulphate.

ii) Describe briefly any differences that would be observed if the solution in *Step 3* were cooled

(1) slowly.

(2) rapidly.

iii) Write an equation and state the expected observation(s) for the reaction between copper(II) oxide and dilute sulphuric acid.

iv) Draw a labelled diagram for the experimental set-up used in filtering excess copper(II) oxide from the copper(II) sulphate solution.

v) A student followed the above description and tried to prepare crystalline sample of hydrated copper(II) sulphate. However, he could not obtain any solid after one day. Suggest an explanation.

b) Describe what will be observed when ammonia solution is added drop by drop with stirring to copper(II) sulphate solution until it is in excess.

(15 marks)

13 A student prepared a hydrated salt $CaCl_2 \bullet 6H_2O$ in the following way:

Step 1 Excess calcium carbonate was added to dilute hydrochloric acid in a beaker.

Step 2 The excess calcium carbonate was removed from the solution.

Step 3 The solution was concentrated and then left in the air.

Step 4 Some crystals were formed after standing overnight.

Step 5 The crystals were collected and washed with distilled water.

a) Explain the term "hydrated salt".

b) Write an ionic equation for the reaction between calcium carbonate and dilute hydrochloric acid.

c) Suggest a reason for adding excess calcium carbonate in the preparation.

d) Suggest how one can know that excess calcium carbonate had been added in *Step 1*.

e) Draw an experimental set-up for concentrating the solution in *Step 3*.

f) Explain why it is unwise to evaporate the solution to dryness in order to obtain the hydrated salt.

g) Explain why it is necessary to wash the crystals with distilled water.

h) Suppose 100.0 cm^3 of 2.0 M hydrochloric acid were used in the preparation, calculate the maximum mass of hydrated salt that would be obtained.
(Relative atomic masses: H = 1.0, O = 16.0, Cl = 35.5, Ca = 40.1)

(12 marks)

14 A student tries to prepare five substances using the reagents listed below. For each case, decide whether it is appropriate to prepare the substance by mixing the reagents.
If it is appropriate, write a chemical equation for the reaction involved.
If it is *inappropriate*, state the reason and suggest other suitable reagents for preparing the substance. Then write a chemical equation for the reaction involved.

	Substance to be prepared	Reagents used
a)	Copper(II) chloride	copper, dilute hydrochloric acid
b)	Calcium sulphate	calcium carbonate, dilute sulphuric acid
c)	Hydrogen	magnesium, dilute hydrochloric acid
d)	Zinc sulphate	zinc nitrate solution and sodium sulphate solution
e)	Potassium chloride	potassium, dilute hydrochloric acid

(13 marks)

15 a) i) Write an equation for the reaction between dilute sodium hydroxide solution and dilute nitric acid.

ii) What volume of 0.200 M sodium hydroxide solution is required to neutralize 150.0 cm^3 of 0.120 M nitric acid?

b) 0.200 M ammonia solution is used to neutralize 150.0 cm^3 of 0.120 M nitric acid.

i) Compare the strength of ammonia solution and sodium hydroxide solution.

ii) Write an equation for the neutralization reaction between ammonia solution and dilute nitric acid.

iii) Is there any difference between the volume of 0.200 M sodium hydroxide solution used and that of 0.200 M ammonia solution used to neutralize 150.0 cm^3 of 0.120 M nitric acid?

c) Compare the heat released in the neutralizations in (a) (ii) and (b).

(7 marks)

16 A standard solution of oxalic acid with a molarity of 0.0500 M was prepared.

a) What is the meaning of "standard solution"?

b) You are provided with pure oxalic acid crystals ($H_2C_2O_4 \bullet 2H_2O$), distilled water, a weighing bottle, a beaker, a 250.0 cm^3 volumetric flask and an electronic balance. Describe how you can prepare a standard solution of oxalic acid with a molarity of 0.0500 M.

c) i) Name the apparatus used to transfer 25.0 cm^3 of the standard solution of oxalic acid accurately.

ii) Suggest how the apparatus in (i) should be cleaned before it is used.

d) 25.0 cm^3 of 0.0500 M oxalic acid were titrated against potassium hydroxide solution. Phenolphthalein was used as an indicator. 22.4 cm^3 of 0.112 M potassium hydroxide solution were required for complete neutralization.

i) State the colour change of the indicator at the end point.

ii) Why was a white tile placed under the conical flask during titration?

iii) Determine the basicity of oxalic acid.

iv) Write an equation for the neutralization reaction.

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

(13 marks)

17 a) Antacid tablets are used to relieve stomach ache. They usually contain magnesium hydroxide as the active ingredient.

i) Explain how antacid tablets can relieve stomach ache with the help of an equation.

ii) Explain why magnesium hydroxide instead of calcium carbonate is used as the active ingredient in antacid nowadays.

iii) Explain why the antacid tablets should be chewed before swallowing.

b) Waste solution discharged from some factories is acidic and contains metal ions that may lead to pollution.

i) How do metal ions lead to pollution?

ii) Use copper(II) ions as an example, suggest how metal ions can be removed from the waste solution. Write an ionic equation for the reaction involved.

iii) Besides pollution, suggest another reason why copper(II) ions are removed from the waste solution.

iv) The waste solution from a factory contains 0.15 M hydrochloric acid. 300 g of slaked lime are needed per minute in order to completely neutralize the hydrochloric acid present in the waste solution. Calculate the rate of discharge of the waste solution in dm^3 per minute.
(Relative atomic masses: H = 1.0, O = 16.0, Ca = 40.1)

(13 marks)

18 A student was given 14.04 g of a dibasic acid (H_2X). The dibasic acid was dissolved in water and made up to a 250.0 cm^3 solution. 25.0 cm^3 of the solution with indicator were then titrated against 0.450 M sodium hydroxide solution until the end point was reached. The results are shown in the following table.

Titration / **Burette reading**	**1**	**2**	**3**	**4**
Final (cm^3)	50.00	32.70	40.80	45.40
Initial (cm^3)	17.20	0.50	8.80	13.60

a) What is the meaning of the term “dibasic acid”? Give an example of dibasic acid.

b) Write a chemical equation for the reaction between the dibasic acid solution and sodium hydroxide solution.

c) Suggest an indicator for the titration. State the colour change of the indicator at the end point.

d) Draw an experimental set-up for the titration. Label all the apparatus used.

e) Find the reasonable average volume of sodium hydroxide solution used for titration.

f) Calculate the molar mass of the dibasic acid.
(Relative atomic masses: H = 1.0, O = 16.0, Na = 23.0)

(12 marks)

19 a) 7.50 g of an impure sample of sodium carbonate required 31.2 cm^3 of 2.00 M nitric acid for complete reaction.

i) Write a chemical equation for the reaction.

ii) What is the percentage purity of the sample?

iii) What assumption has been made in your calculation?

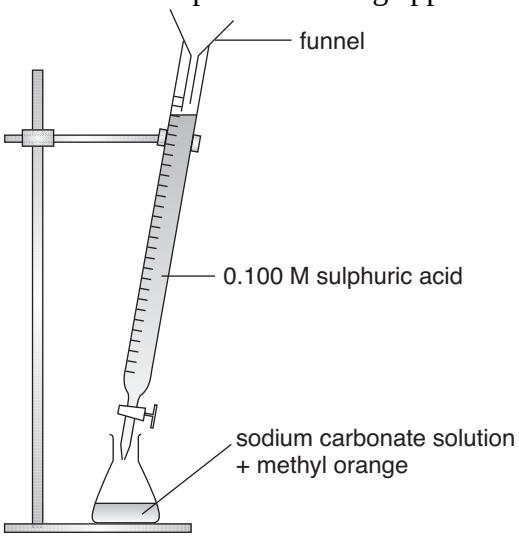
b) 3.35 g of a sample of hydrated sodium carbonate crystals, $Na_2CO_3 \bullet nH_2O$, were dissolved in water and the solution made up to 250.0 cm^3. Using methyl orange as an indicator in titration, 25.0 cm^3 of this solution required 27.0 cm^3 of 0.100 M sulphuric acid for complete reaction.

i) Write a chemical equation for the reaction.

ii) State the colour change of the methyl orange indicator at the end point.

iii) Calculate the value of n.

iv) A student set up the following apparatus to carry out the above titration:

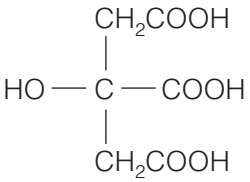


Point out THREE errors in the experimental set-up.

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

(13 marks)

20 The sour taste of citrus fruits is mainly due to citric acid which is a solid weak acid at room temperature. Its structure is shown in the diagram below:



a) Explain the term “weak acid”.

b) If you are provided with 0.1 M citric acid and 0.1 M hydrochloric acid, suggest a test to distinguish between these two acids.

c) What will be observed when a magnesium ribbon is added to citric acid dissolved in methylbenzene (an non-aqueous solvent)? Explain the expected observation.

d) i) What is meant by the term “basicity” of an acid?

ii) What is the basicity of citric acid?

e) i) Calculate the mass of citric acid required to prepare 100.0 cm^3 of 0.200 M citric acid

solution.

ii) What is the volume of 0.460 M potassium hydroxide solution required to completely neutralize 25.0 cm^3 of the solution prepared in (i)?

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

(11 marks)

21 Commercial glass cleaners usually contain ammonia. A student carried out an experiment to determine which brand of glass cleaner (X or Y) is better buy. The table below shows some of the information about these two brands.

Brand	Price	Volume	Concentration of ammonia
X	\$4.00	200 cm^3	3.96g dm^{-3}
Y	\$8.00	500 cm^3	?

To determine the concentration of ammonia in brand Y, the student titrated 25.0 cm^3 of brand Y glass cleaner against 0.220 M hydrochloric acid. 24.4 cm^3 of the acid were required for complete neutralization.

a) Write a chemical equation for the reaction between ammonia solution and hydrochloric acid. (DO NOT write an ionic equation.)

b) i) Name an apparatus for containing brand Y glass cleaner during the titration.

ii) How should the apparatus named in (i) be washed before titration?

c) Calculate the concentration of ammonia in brand Y in g dm^{-3}.

d) Determine which brand of glass cleaner is better buy. Show your reasoning.

e) State ONE reason for using ammonia solution instead of sodium hydroxide solution in window cleaners.

(Relative atomic masses: H = 1.0, N = 14.0)

(9 marks)

22 a) Sodium nitrate is a salt which can be prepared by reacting an acid with an alkali using titration method.

i) Name an acid and an alkali which react to give sodium nitrate.

ii) Explain why titration method is suitable for the preparation of sodium nitrate.

b) Lead(II) bromide is a salt which can be prepared by precipitation.

i) Name suitable reagents for the preparation of lead(II) bromide.

ii) Explain why the precipitation method is suitable for the preparation of lead(II) bromide.

iii) What are the steps required to obtain pure dry sample of lead(II) bromide from the reaction mixture?

(9 marks)

23 A domestic cleaner contains concentrated sulphuric acid as the active ingredient. A titration experiment was carried out to determine the concentration of sulphuric acid in the domestic cleaner.

25.0 cm^3 of the cleaner were diluted to 1 000.0 cm^3 with distilled water. 25.0 cm^3 of the diluted cleaner were then titrated against 1.00 M sodium hydroxide solution. 20.6 cm^3 of 1.00 M sodium hydroxide solution were required for complete neutralization.

a) Describe how the end point in this titration can be determined.

b) Suggest ONE reason for diluting the cleaner before titration.

c) Calculate the concentration, in g dm^{-3}, of sulphuric acid in the cleaner.

d) Suggest ONE disadvantage of using the cleaner for cleaning.

e) State ONE safety precaution needed when using the cleaner. Explain your answer.

f) Describe briefly how you would prepare a burette containing the sodium hydroxide solution for titration.

(Relative atomic masses: H = 1.0, O = 16.0, S = 32.1)

(12 marks)

24 Consider the following titration experiment.

Step 1 Place 25.0 cm^3 of 0.600 M sodium hydroxide solution in a clean conical flask.

Step 2 Add a few drops of phenolphthalein to the sodium hydroxide solution.

Step 3 Fill a burette with dilute sulphuric acid.

Step 4 Run the acid into the sodium hydroxide solution until the indicator just changes colour.

Result: 15.0 cm^3 of sulphuric acid are used.

a) What apparatus is usually used to transfer 25.0 cm^3 of sodium hydroxide solution into the conical flask?

b) Suggest how the apparatus suggested in (a) should be cleaned before the delivery of sodium hydroxide solution.

c) Draw a labelled diagram for the experimental set-up for this titration experiment.

d) What is the colour change of the indicator at the end point?

e) i) Write a chemical equation for the neutralization.

ii) Calculate the molarity of the sulphuric acid.

f) i) Name the salt formed in this experiment.

ii) Describe briefly how you can obtain crystals of the salt from the above sodium hydroxide solution and sulphuric acid.

(15 marks)

25 A student proposed the following method to determine the concentration of citric acid in a sample of lemon juice by titration with sodium hydroxide solution.

Step 1 Prepare a standard sodium hydroxide solution by dissolving a known mass of sodium hydroxide pellets in distilled water and make it up to 250.0 cm^3.

Step 2 Transfer a known volume of the sample of lemon juice to a clean conical flask using a measuring cylinder.

Step 3 Fill a burette, which has been rinsed with distilled water beforehand, with the standard sodium hydroxide solution prepared.

Step 4 Titrate the lemon juice in the flask with the standard sodium hydroxide solution

using a suitable indicator.

Step 5 Using this titration result, calculate the concentration of citric acid in the sample.

a) Point out FOUR *inappropriate* practices in the method and explain why they are inappropriate.

b) For each inappropriate practice, suggest an appropriate action.

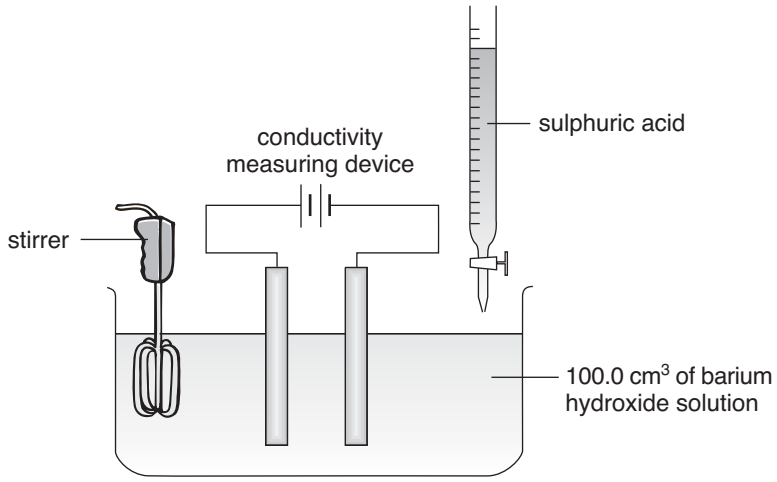
(12 marks)

26 This question is about an insoluble salt, barium sulphate $BaSO_4$.

Barium sulphate can be made as a white precipitate by the reaction between barium hydroxide solution and sulphuric acid.

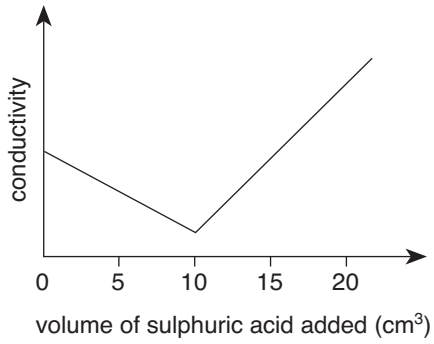
a) Write a chemical equation for the reaction.

b) The progress of the reaction between barium hydroxide solution and sulphuric acid can be followed by measuring the electrical conductivity of the reaction mixture.



During the experiment, the sulphuric acid was added 1.0 cm^3 at a time. The conductivity was measured after each addition.

The results obtained are shown in the graph below.



i) During the experiment, there were changes in the numbers and types of ions present in the solution in the container.
Explain the shape of the graph using such changes.

ii) What was the volume of sulphuric acid required to neutralize 100.0 cm^3 of barium hydroxide solution?

iii) The concentration of the sulphuric acid was 1.00 mol dm^{-3}. What was the concentration of the barium hydroxide solution?

c) Hospital patients are given a ‘barium meal’ before an X-ray of their stomach is taken. The

'barium meal' contains pure barium sulphate.

Write down ONE reason why the above method is suitable for preparing barium sulphate for medical use.

(8 marks)

27 The following experiment was conducted to determine the percentage by mass of calcium carbonate in an impure sample.

Step 1 1.05 g of the sample were weighed.

Step 2 25.0 cm^3 of 0.860 M nitric acid were added to react with the sample.

Step 3 The excess acid was titrated against 0.600 M sodium hydroxide solution. 22.0 cm^3 of the alkali were required to reach the end point.

a) Write a chemical equation for the reaction in *Step 2*.

b) i) Suggest a suitable acid-alkali indicator for *Step 3*.

ii) State the colour change of the indicator at the end point of the titration.

c) Calculate the percentage by mass of calcium carbonate in the sample.

d) Can dilute sulphuric acid replace dilute nitric acid in this experiment? Explain your answer.

(Relative atomic masses: C = 12.0, O = 16.0, Ca = 40.1)

(10 marks)

28 A chemist carried out an experiment to determine the percentage by mass of nitrogen in a sample of nitrogenous fertilizer, which contained ammonium ions as the only source of nitrogen. The experiment consisted of three stages:

Stage 1 4.65 g of the sample were dissolved in distilled water and then made up to 250.0 cm^3.

Stage 2 25.00 cm^3 of this solution were heated with 25.0 cm^3 of 0.250 M sodium hydroxide solution until no more ammonia gas was evolved.

Stage 3 The resulting solution was titrated against 0.300 M hydrochloric acid. 10.8 cm^3 of the acid were required to reach the end point.

a) Write an ionic equation for the reaction that occurred in *Stage 2*.

b) Calculate the percentage by mass of nitrogen in the fertilizer.

c) Briefly describe the procedure that should be followed to prepare a burette containing the hydrochloric acid for the titration.

(10 marks)

29 25 cm^3 of 0.15 M sulphuric acid were added to excess freshly cleaned magnesium ribbons in a reaction vessel. The vessel was connected to a gas syringe so that the gas given off by the reaction could be collected and measured at regular time intervals. The following table shows the results obtained.

Time (min)	0	1	2	3	4	5	6	7	8	9	10
Volume of gas collected (cm^3)	0	40	60	70	77	82	86	88	89	90	90

a) Draw a labelled diagram for a possible experimental set-up for this experiment.

b) Suggest how you can prepare freshly cleaned magnesium ribbons.

c) Write an ionic equation for the reaction.

d) i) Plot a graph to show the relationship between the volume of gas collected and time.

ii) Explain the shape of the curve plotted.

e) Explain how the following changes will affect the experimental results.

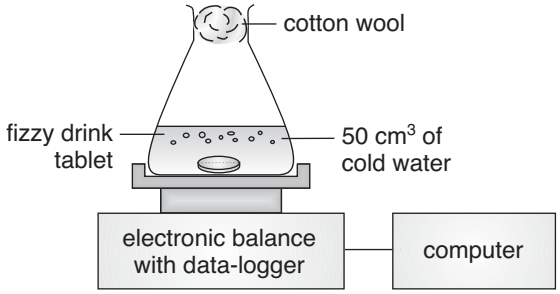
i) Use excess calcium granules to replace excess magnesium ribbons.

ii) Use magnesium powder of the same mass to replace magnesium ribbons.

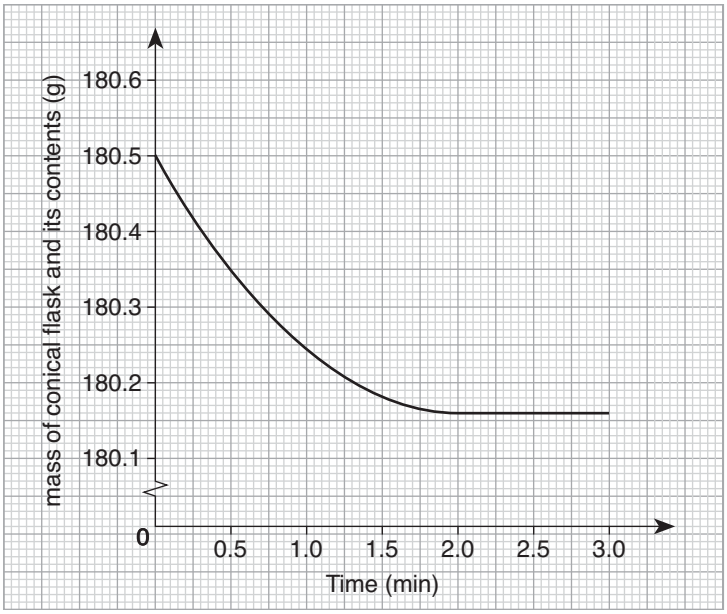
iii) Use 50 cm^3 of 0.15 M ethanoic acid to replace 25 cm^3 of 0.15 M sulphuric acid.

(17 marks)

30 An experiment was designed to investigate the rate at which a certain brand of fizzy drink tablet, which contain sodium hydrogencarbonate, dissolved in water at room conditions. Carbon dioxide was evolved in the experiment. The set-up shown below was used.



The graph below shows the results obtained in the experiment.



a) What other active ingredient, apart from sodium hydrogencarbonate, would be present in the tablet?

b) Write an ionic equation for the reaction that occurs when the tablet is dissolved in water.

c) The sodium hydrogencarbonate in the tablet reacted completely at the end of the experiment. Calculate the mass of sodium hydrogencarbonate in the tablet.

d) Suggest ONE advantage of using a data-logger in this experiment.

e) State ONE method by which the rate of evolution of gas can be increased.

(Relative atomic mass: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

(7 marks)

31 A student performs two experiments to study the reactions between (1) calcium and excess water and (2) calcium and excess hydrochloric acid. He uses 0.4 g of calcium in both experiments and the volumes of hydrogen liberated at 10-second intervals are tabulated as shown below (all gases are measured under the same conditions).

Time	0	10	20	30	40	50	60	70	80	90	100	110
Volume of H_2 given off in experiment (1) (cm^3)	0	17	34	76	134	184	216	220	222	224	224	224
Volume of H_2 given off in experiment (2) (cm^3)	0	88	144	182	207	222	224	224	224	224	224	224

a) i) Write equations for the reactions between calcium and (1) water and (2) dilute hydrochloric acid respectively.

ii) Suggest an observable change when calcium reacts with water.

b) Using "time" as the x-axis and "volume of hydrogen given off" as the y-axis, plot the results for both experiments on the same graph.

c) Which reaction, (1) or (2), is faster initially? Why?

d) Which reaction, (1) or (2), has a higher reaction rate at the 50th second? Explain your answer with reference to the shape of the curve.

e) When is calcium completely used up in each experiment?

f) Why are the final volumes of hydrogen collected the same in both experiments?

(13 marks)

32 Magnesium ribbons react with 1 M hydrochloric acid to liberate a colourless gas.

a) Write a balanced equation, including state symbols, for the reaction.

b) Draw electron diagrams of the products formed (showing electrons in the *outermost shells* only).

c) Suggest an experimental method to monitor the progress of the reaction. Draw a labelled diagram to show the experimental set-up.

d) How do you know that the reaction has completed?

e) How will the reaction rate and the amount of products formed be affected when the reaction mixture is put into a hot water bath?

f) How will the reaction rate be changed if magnesium powder of the same mass is used instead of magnesium ribbons? Explain your answer.

g) How will the reaction rate be changed if 1 M sulphuric acid is used instead of 1 M hydrochloric acid? Explain your answer.

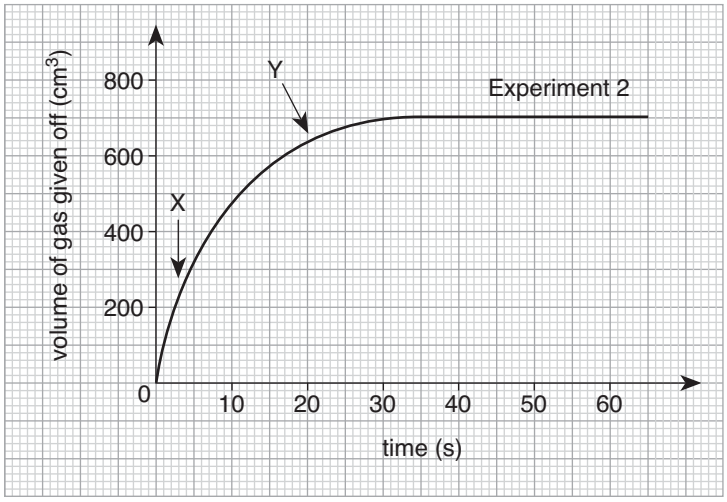
(14 marks)

33 A student carried out the following experiments at room temperature and pressure to study the rate of reaction between magnesium and sulphuric acid:

Experiment	**Reaction**

1	0.7 g magnesium + 100 cm^3 of 1 M H_2SO_4
2	0.7 g magnesium + 200 cm^3 of 1 M H_2SO_4
3	0.7 g magnesium + 100 cm^3 of 2 M H_2SO_4

For experiment 2, a plot of the volume of gas given off against time was obtained:



a) Write an equation for the reaction between magnesium and sulphuric acid.

b) Suggest a method for measuring the volume of the gas liberated.

c) Explain why the slope of the curve is steeper at X than at Y in *Experiment 2*.

d) When was the reaction completed in *Experiment 2*?

e) Copy the graph of experiment 2 in your answer book and draw on the same graph the expected curves for *Experiment 1* and *3*. Explain your answer.

f) In *Experiment 4*, 0.7 g magnesium was added to 100 cm^3 of 1 M ethanoic acid.

i) How would the time required for complete reaction differ from that for *Experiment 1*? Explain your answer.

ii) Deduce the total volume of hydrogen given off compared with that in *Experiment 1*. Explain your answer.

(Relative atomic mass of Mg = 24.3)

(13 marks)

34 The reaction between sodium thiosulphate solution and hydrochloric acid can be represented by the following equation:

$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + SO_2(g) + S(s)$

To investigate the effect of the concentration of sodium thiosulphate solution on the rate of the above reaction at 25 ^oC, 30 cm^3 of 0.4 M sodium thiosulphate solution were placed in a beaker. The beaker was then placed over a piece of paper with a black cross mark. 20 cm^3 of 2.5 M hydrochloric acid were then added to the beaker. The time required for the cross to disappear was recorded.

The experiment was repeated with different volumes of 0.4 M sodium thiosulphate solution and water according to the table below.

Experiment	**Volume if 0.4 M sodium thiosulphate solution (cm^3)**	**Volume of water (cm^3)**	**Time required (s)**	**1/t (s^{-1})**
1	30	0	21.6	0.046

2	20	10	30.2	0.033
3	15	15	38.3	0.026
4	10	20	55	0.018
5	5	25	100.1	0.010

a) Explain why
   i) the paper with the cross was placed under the beaker.
   ii) water was added in experiments 2, 3, 4 and 5.
   iii) the same volume of 2.5 M hydrochloric acid was used in each experiment.

b) Plot a graph of 1/t against the volume of 0.4 M sodium thiosulphate solution used.

c) Deduce the relationship between the rate of reaction and the concentration of sodium thiosulphate solution with reference to the graph.

d) How will the graph change if the temperature for the experiment is increased to 35 ^{o}C?

(9 marks)

35 Briefly describe how you would test for the presence of ammonium ion, iron(III) ion and water in a sample of iron alum $(NH_4)_2SO_4 \bullet Fe_2(SO_4)_3 \bullet 20H_2O$.
(You are required to give paragraph-length answer to this question. In this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.)

(9 marks)

36 Describe the procedure for determining the exact concentration of a sample of sodium carbonate solution (known to be approximately 0.1 M) using 0.200 M nitric acid. (NO diagram is required.)
(You are required to give paragraph-length answer to this question. In this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.)

(9 marks)

37 A sample of sodium carbonate is contaminated with sodium nitrate. Describe how you would conduct an experiment to determine the percentage by mass of sodium carbonate in the sample.
(You are required to give paragraph-length answer to this question. In this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.)

(9 marks)

38 Describe how large crystals of sodium chloride can be prepared from dilute sodium hydroxide solution and dilute hydrochloric acid.
(You are required to give paragraph-length answer to this question. In this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.)

(9 marks)

39 You are provided with the following chemicals and materials:
calcium carbonate granules, 1 M hydrochloric acid, distilled water, test tubes, measuring cylinder, balloons, stop-watches

Use the above materials to design an experiment to demonstrate two factors which affect the rate of a reaction. You should give a brief description of how the two factors affect the rate of a reaction.
(You are required to give paragraph-length answer to this question. In this question, 7 marks will be awarded for chemical knowledge and 3 marks for effective communication.)

(10 marks)

40 You are provided with the following antacids:

Brand	**Active ingredient**
A	Sodium hydrogencarbonate
B	Magnesium hydroxide
C	Calcium carbonate

Plan an experiment to determine which antacid is the most effective. Include variables that needed to be controlled.
(You are required to give paragraph-length answer to this question. In this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.)

(9 marks)