AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.4.2 REACTIONS OF ACIDS (PACK 1)

SCORE	PERCENTAGE
/389	%

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Q1.

This question is about elements in Group 1.

A teacher burns sodium in oxygen.

(a) Complete the word equation for the reaction.

sodium + oxygen ⟶ _____

(1)

(b) What is the name of this type of reaction?

Tick **one** box.

Decomposition ☐

Electrolysis ☐

Oxidation ☐

Precipitation ☐

(1)

(c) The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution?

Tick **one** box.

1	☐	4	☐	7	☐	13	☐

(1)

(d) The solution contains a substance with the formula NaOH

Give the name of the substance.

_____

(1)

(e) All alkalis contain the same ion.

What is the formula of this ion?

Tick **one** box.

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H^+ ☐

Na^+ ☐

OH^- ☐

O^{2-} ☐

(1)

(f) A solution of NaOH had a concentration of 40 g/dm^3

What mass of NaOH would there be in 250 cm^3 of the solution?

_____

_____

_____

_____

Mass = _____ g

(2)

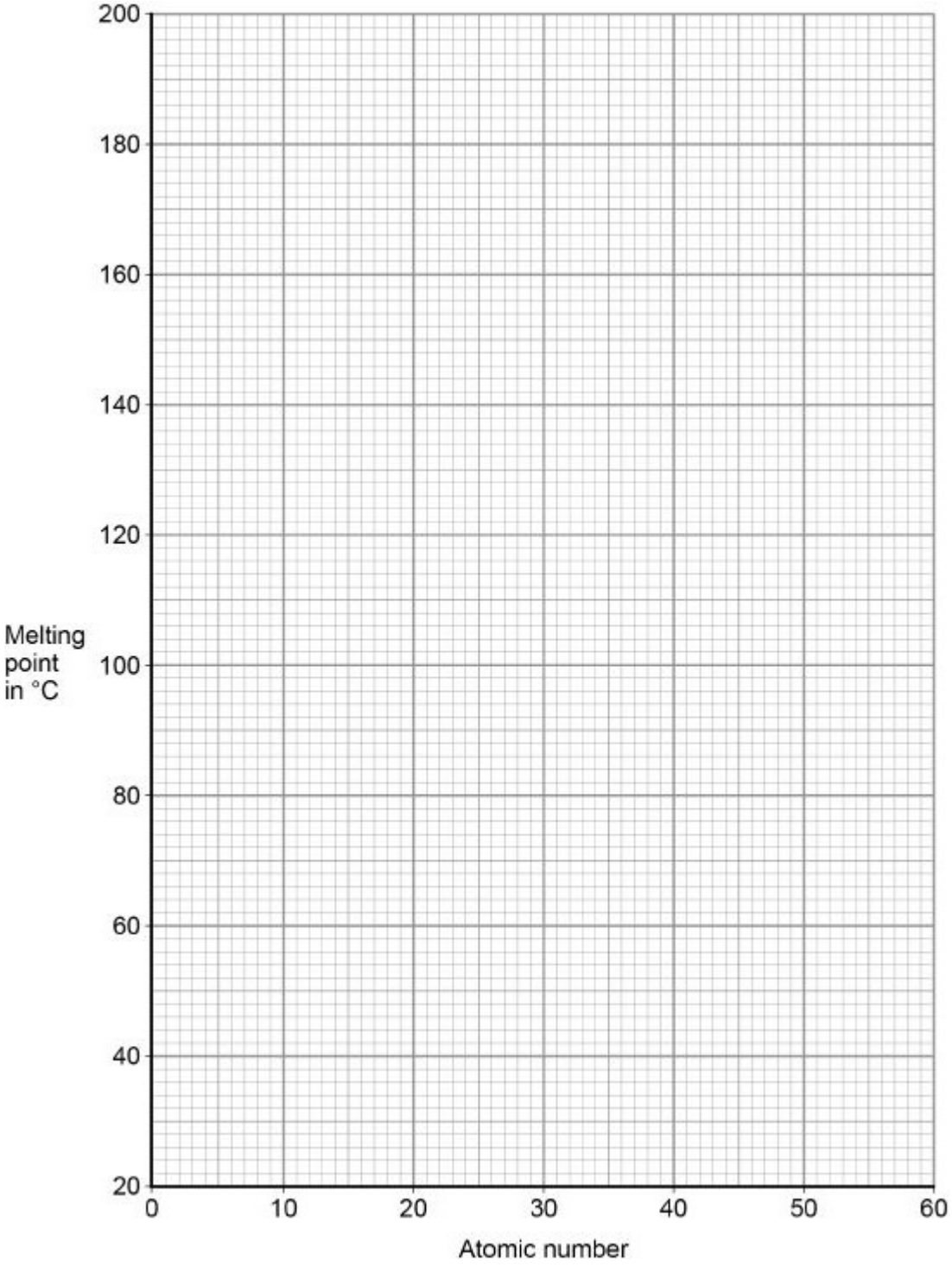
(g) The melting points of the elements in Group 1 show a trend.

The table below shows the atomic numbers and melting points of the Group 1 elements.

Element	**Atomic number**	**Melting point in °C**
Lithium	3	181
Sodium	11	98
Potassium	19	63
Rubidium	37	**X**
Caesium	55	29

Plot the data from the table on the graph below.

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(2)

(h) Predict the melting point, **X**, of rubidium, atomic number 37

Use the graph above.

Melting point = _____ °C

(1)

(Total 10 marks)

Q2.

Soluble salts are formed by reacting metal oxides with acids.

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(a) Give **one** other type of substance that can react with an acid to form a soluble salt.

_____

(1)

(b) Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

_____

(1)

(c) Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

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_____

_____

(6)

(Total 8 marks)

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Q3.

This question is about acids and alkalis.

(a) Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

_____

_____

_____

_____

(2)

(b) A 1.0×10^{-3} mol/dm^3 solution of hydrochloric acid has a pH of 3.0

What is the pH of a 1.0×10^{-5} mol/dm^3 solution of hydrochloric acid?

pH = _____

(1)

A student titrated 25.0 cm^3 portions of dilute sulfuric acid with a 0.105 mol/dm^3 sodium hydroxide solution.

(c) The table below shows the student's results.

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**
Volume of sodium hydroxide solution in cm^3	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:

$$2\ NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2\ H_2O$$

Calculate the concentration of the sulfuric acid in mol/dm^3

Use only the student's concordant results.

Concordant results are those within 0.10 cm^3 of each other.

_____

_____

_____

_____

_____

_____

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_____

_____

_____

_____

Concentration of sulfuric acid = _____ mol/dm^3

(5)

(d) Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

_____

_____

_____

_____

(2)

(e) Calculate the mass of sodium hydroxide in 30.0 cm^3 of a 0.105 mol/dm^3 solution.

Relative formula mass (M_r): NaOH = 40

_____

_____

_____

_____

Mass of sodium hydroxide = _____ g

(2)

(Total 12 marks)

Q4.

This question is about metal oxides.

When sodium is heated in oxygen, sodium oxide is produced.

(a) Balance the equation for the reaction.

_____ Na + O_2 ⟶ 2 Na_2O

(1)

(b) Why is this an oxidation reaction?

_____

_____

(1)

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(c) Sodium oxide is added to water and shaken.
Universal indicator is added.
The pH of the solution is 14

What is the colour of the universal indicator?

Tick (✔) **one** box.

Green ☐

Purple ☐

Red ☐

Yellow ☐

(1)

(d) Aluminium oxide reacts with hydrochloric acid to produce a salt.

What is the name of the salt produced?

Tick (✔) **one** box.

Aluminium chloride ☐

Aluminium nitrate ☐

Aluminium sulfate ☐

Aluminium sulfide ☐

(1)

A student investigates the solubility of four metal oxides and four non-metal oxides in water.

The student tests the pH of the solutions formed.

The table shows the student's results.

Type of oxide	Oxide	Solubility in water	pH of solution
Metal oxides	Sodium oxide	Soluble	14
	Calcium oxide	Soluble	10
	Magnesium oxide	Slightly soluble	9

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	Zinc oxide	Insoluble	No solution formed
Non-metal oxides	Carbon dioxide	Soluble	5
	Sulfur dioxide	Soluble	2
	Phosphorus oxide	Soluble	1
	Silicon dioxide	Insoluble	No solution formed

The student makes two conclusions.

Conclusion 1: 'All metal oxides produce alkaline solutions.'

Conclusion 2: 'All non-metal oxides produce acidic solutions.'

(e) Explain why the student's conclusions are only partly correct.

Use information from the table above.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(f) Give an improved conclusion for metal oxides.

Use the table above.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

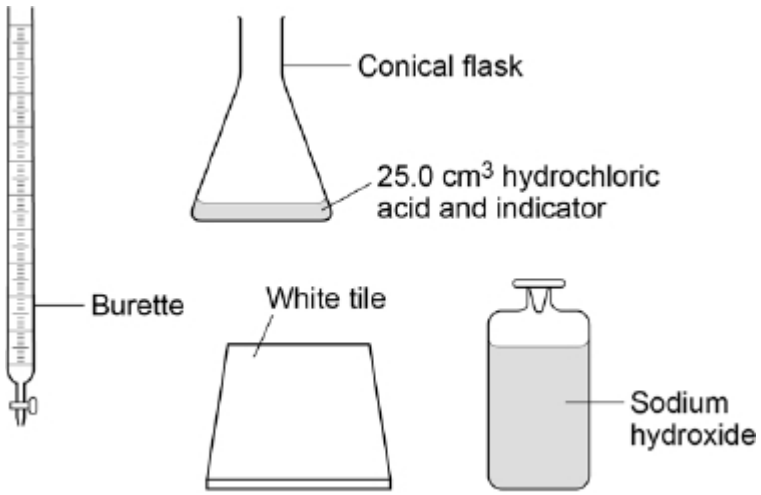
(Total 9 marks)

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Q5.

Sodium hydroxide reacts with hydrochloric acid.

The diagram shows apparatus that can be used to find the volume of sodium hydroxide reacting with 25.0 cm^3 hydrochloric acid.



(a) Describe a method to find the exact volume of sodium hydroxide that reacts with 25.0 cm^3 of hydrochloric acid.

(6)

The reaction produces a solution of sodium chloride.

A student wants to obtain sodium chloride crystals from the sodium chloride solution.

This is the method used.

1. Add solid charcoal to the sodium chloride solution to remove the indicator colour.
2. Remove the solid charcoal.
3. Evaporate the solution to dryness over a Bunsen burner.

(b) Charcoal is not soluble in water.

Suggest a method the student could use to remove the solid charcoal in **Step 2**.

_____

_____

(1)

(c) The student obtains a powdery white solid.

Suggest how the student could improve **Step 3** of the method to obtain larger crystals instead of powder.

_____

_____

(1)

(Total 8 marks)

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Q6.

A scientist produces zinc iodide (ZnI_2).

This is the method used.

1. Weigh 0.500 g of iodine.
2. Dissolve the iodine in ethanol.
3. Add an excess of zinc.
4. Stir the mixture until there is no further change.
5. Filter off the excess zinc.
6. Evaporate off the ethanol.

(a) Ethanol is flammable.

Suggest how the scientist could carry out **Step 6** safely.

_____

_____

(1)

(b) Explain why the scientist adds excess zinc rather than excess iodine.

_____

_____

_____

_____

_____

_____

(3)

(c) Calculate the minimum mass of zinc that needs to be added to 0.500 g of iodine so that the iodine fully reacts.

The equation for the reaction is:

$$Zn + I_2 \longrightarrow ZnI_2$$

Relative atomic masses (M_r): Zn = 65 I = 127

_____

_____

_____

_____

_____

_____

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Minimum mass of zinc = _____ g

(3)

A different scientist makes zinc iodide by the same method.

The scientist obtains 12.5 g of zinc iodide.

The percentage yield in this reaction is 92.0%.

(d) What is the maximum theoretical mass of zinc iodide produced in this reaction?

_____

_____

_____

_____

_____

_____

Maximum theoretical mass = _____ g

(3)

(e) Suggest **one** reason why the percentage yield in this reaction is **not** 100%.

_____

_____

(1)

(f) The scientist makes a solution of zinc iodide with a concentration of 0.100 mol / dm^3

Calculate the mass of zinc iodide (ZnI_2) required to make 250 cm^3 of this solution.

Relative atomic masses (A_r): Zn = 65 I = 127

_____

_____

_____

_____

_____

_____

Mass = _____ g

(3)

(Total 14 marks)

Q7.

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Cells contain chemicals which react to produce electricity.

(a) Why can a rechargeable cell be recharged?

_____

_____

(1)

(b) Give **two** factors that affect the voltage produced by a cell.

1. _____

2. _____

(2)

(c) Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.

$$H_2 \quad + \quad OH^- \quad \longrightarrow \quad H_2O \quad + \quad e^-$$

(1)

(d) Why is the fuel cell in Question (c) described as an alkaline fuel cell?

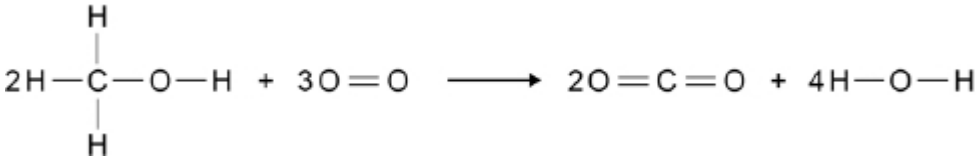
_____

_____

(1)

(e) Another type of fuel cell uses methanol instead of hydrogen.

The diagram represents the reaction in this fuel cell.



The table shows the bond energies for the reaction.

	C–H	**C–O**	**O–H**	**O=O**	**C=O**
Bond energy in kJ / mol	412	360	464	498	805

Calculate the overall energy change for the reaction.

Use the diagram and the table above.

_____

_____

_____

_____

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_____

_____

Overall energy change = _____ kJ / mol

(3)

(Total 8 marks)

Q8.

Citric acid is a weak acid.

(a) Explain what is meant by a weak acid.

_____

_____

_____

_____

(2)

A student titrated citric acid with sodium hydroxide solution.

This is the method used.

1. Pipette 25.0 cm^3 of sodium hydroxide solution into a conical flask.
2. Add a few drops of thymol blue indicator to the sodium hydroxide solution.
   Thymol blue is blue in alkali and yellow in acid.
3. Add citric acid solution from a burette until the end-point was reached.

(b) Explain what would happen at the end-point of this titration.

Refer to the acid, the alkali and the indicator in your answer.

_____

_____

_____

_____

_____

_____

(3)

(c) Explain why a pipette is used to measure the sodium hydroxide solution but a burette is used to measure the citric acid solution

_____

_____

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_____

_____

(2)

(d) The table shows the student's results.

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**
Volume of citric acid solution in cm^3	13.50	12.10	11.10	12.15	12.15

The equation for the reaction is:

$$C_6H_8O_7 + 3\ NaOH \longrightarrow C_6H_5O_7Na_3 + 3\ H_2O$$

The concentration of the sodium hydroxide was 0.102 mol / dm^3

Concordant results are those within 0.10 cm^3 of each other.

Calculate the concentration of the citric acid in mol / dm^3
Use only the concordant results from the table in your calculation.
You must show your working.

_____

_____

_____

_____

_____

_____

_____

Concentration = _____ mol / dm^3

(5)

(Total 12 marks)

Q9.

Lithium carbonate reacts with dilute hydrochloric acid.

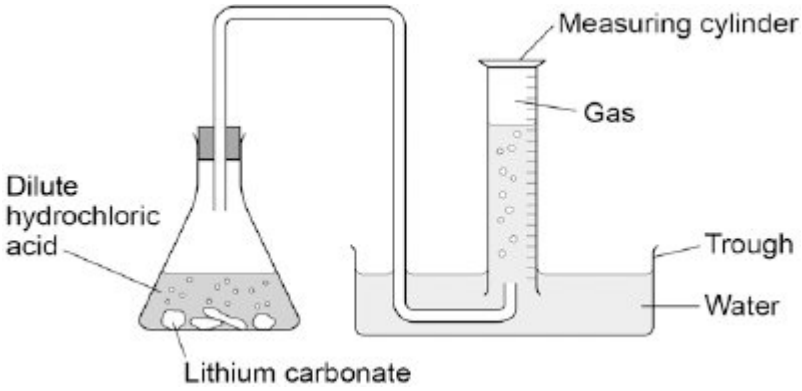
A group of students investigated the volume of gas produced.

This is the method used.

1. Place a known mass of lithium carbonate in a conical flask.
2. Measure 10 cm^3 of dilute hydrochloric acid using a measuring cylinder.
3. Pour the acid into the conical flask.
4. Place a bung in the flask and collect the gas as shown in **Figure 1**.

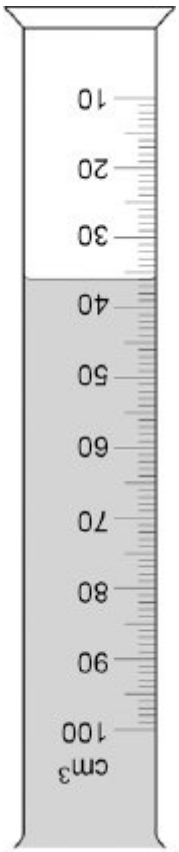
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Figure 1



(a) **Figure 2** shows the measuring cylinder.

Figure 2



What volume of gas has been collected?

Volume = _____ cm^3

(1)

(b) The table below shows the students' results.

Mass of lithium carbonate in g	**Volume of gas in cm^3**
0.0	0
0.1	22

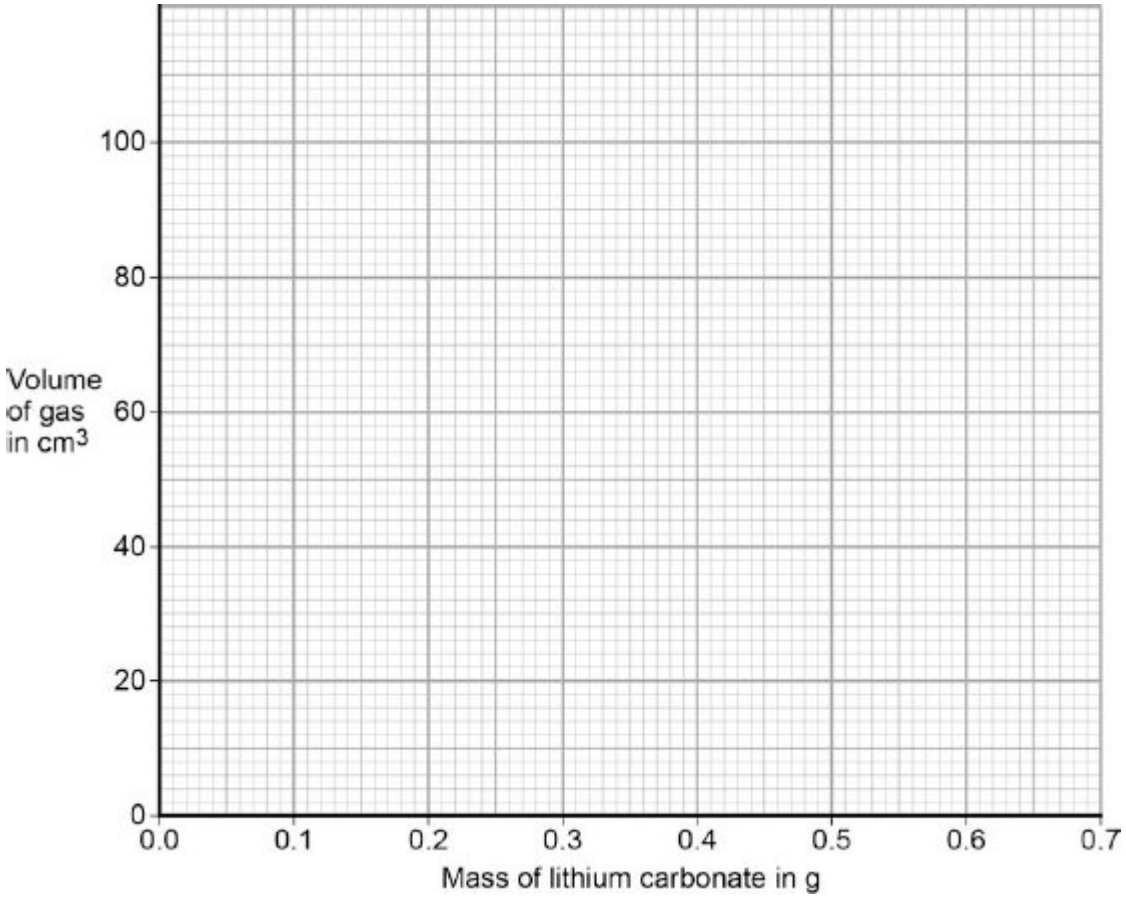
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0.2	44
0.3	50
0.4	88
0.5	96
0.6	96
0.7	96

On **Figure 3**:

- Plot these results on the grid.
- Complete the graph by drawing **two** straight lines of best fit.

Figure 3



(4)

(c) What are **two** possible reasons for the anomalous result?

Tick **two** boxes.

Too much lithium carbonate was added. ☐

The bung was not pushed in firmly enough. ☐

There was too much water in the ☐

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trough.

The measuring cylinder was not completely over the delivery ☐

The conical flask was too small. ☐

(2)

(d) Describe the pattern the graph shows up to 0.4 g of lithium carbonate added.

_____

_____

_____

_____

(2)

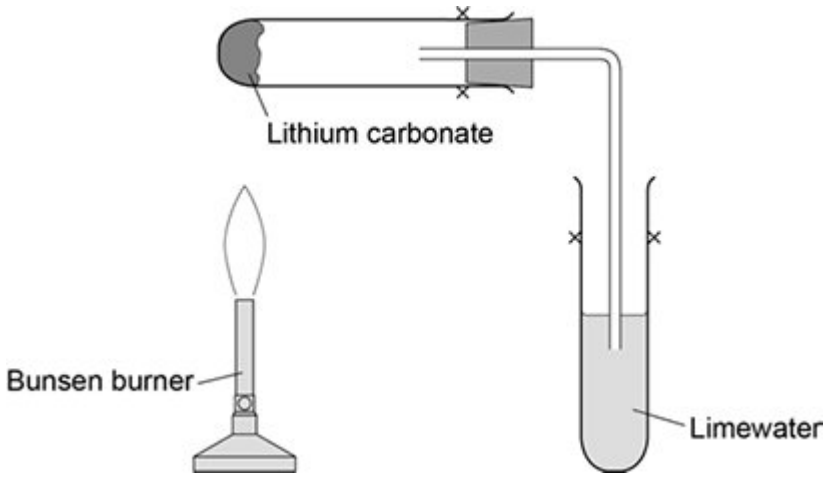
(e) Lithium carbonate decomposes when heated.

The equation shows the decomposition of lithium carbonate.

Li_2CO_3 (s) → Li_2O (s) + CO_2 (g)

Figure 4 shows the apparatus a student used to decompose lithium carbonate.

Figure 4



Why does the limewater bubble?

_____

_____

(1)

(f) The student repeated the experiment with potassium carbonate.
The limewater did not bubble.

Suggest why there were **no** bubbles in the limewater.

_____

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_____

(1)

(Total 11 marks)

Q10.

The figure below shows magnesium burning in air.



© Charles D Winters/Science Photo Library

(a) Look at the figure above.

How can you tell that a chemical reaction is taking place?

_____

_____

(1)

(b) Name the product from the reaction of magnesium in the figure.

_____

(1)

(c) The magnesium needed heating before it would react.

What conclusion can you draw from this?

Tick **one** box.

The reaction is reversible ☐

The reaction has a high activation energy ☐

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The reaction is exothermic ☐

Magnesium has a high melting point ☐

(1)

(d) A sample of the product from the reaction in the figure above was added to water and shaken.

Universal indicator was added.

The universal indicator turned blue.

What is the pH value of the solution?

Tick **one** box.

1 ☐

4 ☐

7 ☐

9 ☐

(1)

(e) Why are nanoparticles effective in very small quantities?

Tick **one** box.

They are elements ☐

They are highly reactive ☐

They have a low melting point ☐

They have a high surface area to volume ratio ☐

(1)

(f) Give **one** advantage of using nanoparticles in sun creams.

_____

_____

(1)

(g) Give **one** disadvantage of using nanoparticles in sun creams.

_____

_____

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(1)

(h) A coarse particle has a diameter of 1×10^{-6} m.
A nanoparticle has a diameter of 1.6×10^{-9} m.

Calculate how many times bigger the diameter of the coarse particle is than the diameter of the nanoparticle.

_____

_____

_____

_____

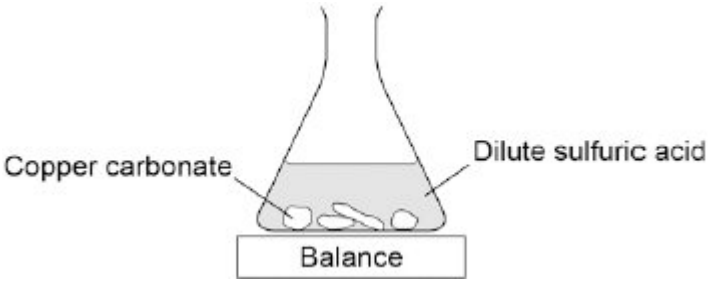
(2)

(Total 9 marks)

Q11.

A student investigated the reaction of copper carbonate with dilute sulfuric acid.

The student used the apparatus shown in the figure below.



(a) Complete the state symbols in the equation.

$$CuCO_3 (___) + H_2SO_4 (aq) \rightarrow CuSO_4 (aq) + H_2O (___) + CO_2 (g)$$

(2)

(b) Why did the balance reading decrease during the reaction?

Tick **one** box.

The copper carbonate broke down. ☐

A salt was produced in the reaction. ☐

A gas was lost from the flask. ☐

Water was produced in the reaction. ☐

(1)

(c) Describe a safe method for making pure crystals of copper sulfate from copper carbonate and dilute sulfuric acid. Use the information in the figure above to help you.

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In your method you should name all of the apparatus you will use.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(d) The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

The equation for the reaction of copper carbonate and sulfuric acid is:

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$$

Relative formula masses : $CuCO_3 = 123.5$; $H_2SO_4 = 98.0$; $CuSO_4 = 159.5$

Calculate the percentage atom economy for making copper sulfate from copper carbonate.

_____

_____

_____

_____

_____

Atom economy = _____ %

(3)

(e) Give **one** reason why is it important for the percentage atom economy of a reaction to be as high as possible.

_____

_____

(1)

(Total 13 marks)

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Q12.

Rock salt is a mixture of sand and salt.

Salt dissolves in water. Sand does **not** dissolve in water.

Some students separated rock salt.

This is the method used.

1. Place the rock salt in a beaker.
2. Add 100 cm^3 of cold water.
3. Allow the sand to settle to the bottom of the beaker.
4. Carefully pour the salty water into an evaporating dish.
5. Heat the contents of the evaporating dish with a Bunsen burner until salt crystals start to form.

(a) Suggest **one** improvement to step 2 to make sure all the salt is dissolved in the water.

_____

_____

(1)

(b) The salty water in step 4 still contained very small grains of sand.

Suggest **one** improvement to step 4 to remove all the sand.

_____

_____

(1)

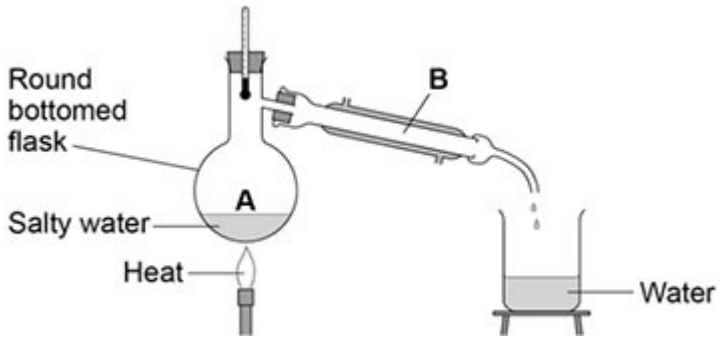
(c) Suggest **one** safety precaution the students should take in step 5.

_____

_____

(1)

(d) Another student removed water from salty water using the apparatus in the figure below.



Describe how this technique works by referring to the processes at **A** and **B**.

_____

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_____

_____

_____

(2)

(e) What is the reading on the thermometer during this process?

_____ °C

(1)

(Total 6 marks)

Q13.

A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid.

In both reactions one of the products is copper chloride.

(a) Describe how a sample of copper chloride crystals could be made from copper carbonate and dilute hydrochloric acid.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) A student wanted to make 11.0 g of copper chloride.

The equation for the reaction is:

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$$

Relative atomic masses, A_r: H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

_____

_____

_____

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_____

Mass of copper carbonate = _____ g

(4)

(c) The percentage yield of copper chloride was 79.1 %.

Calculate the mass of copper chloride the student actually produced.

_____

_____

Actual mass of copper chloride produced = _____ g

(2)

(d) Look at the equations for the two reactions:

Reaction 1 $CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l) + CO_2(g)$

Reaction 2 $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

Reactive formula masses: CuO = 79.5; HCl = 36.5; $CuCl_2$ = 134.5; H_2O = 18

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

Calculate the percentage atom economy for Reaction 2.

_____

_____

_____

_____

_____

_____

Percentage atom economy = _____ %

(3)

(e) The atom economy for Reaction 1 is 68.45 %.
Compare the atom economies of the two reactions for making copper chloride.

Give a reason for the difference.

_____

_____

(1)

(Total 14 marks)

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Q14.

Sodium carbonate reacts with dilute hydrochloric acid:

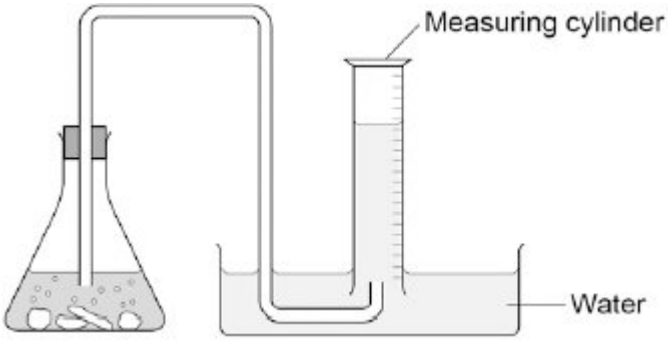
$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

A student investigated the volume of carbon dioxide produced when different masses of sodium carbonate were reacted with dilute hydrochloric acid.

This is the method used.

1. Place a known mass of sodium carbonate in a conical flask.
2. Measure 10 cm^3 of dilute hydrochloric acid using a measuring cylinder.
3. Pour the acid into the conical flask.
4. Place a bung in the flask and collect the gas until the reaction is complete.

(a) The student set up the apparatus as shown in the figure below.



Identify the error in the way the student set up the apparatus.

Describe what would happen if the student used the apparatus shown.

_____

_____

_____

_____

(2)

(b) The student corrected the error.

The student's results are shown in the table below.

Mass of sodium carbonate in g	**Volume of carbon dioxide gas in cm^3**
0.07	16.0
0.12	27.5
0.23	52.0
0.29	12.5
0.34	77.0

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0.54	95.0
0.59	95.0
0.65	95.0

The result for 0.29 g of sodium carbonate is anomalous.

Suggest what may have happened to cause this anomalous result.

_____

_____

(1)

(c) Why does the volume of carbon dioxide collected stop increasing at 95.0 cm^3?

_____

_____

(1)

(d) What further work could the student do to be more certain about the minimum mass of sodium carbonate needed to produce 95.0 cm^3 of carbon dioxide?

_____

_____

(1)

(e) The carbon dioxide was collected at room temperature and pressure.
The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3.

How many moles of carbon dioxide is 95.0 cm^3?

Give your answer in three significant figures.

_____

_____

_____

_____

_____ mol

(2)

(f) Suggest **one** improvement that could be made to the apparatus used that would give more accurate results.

Give a reason for your answer.

_____

_____

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_____

_____

(2)

(g) One student said that the results of the experiment were wrong because the first few bubbles of gas collected were air.

A second student said this would make no difference to the results.

Explain why the second student was correct.

_____

_____

_____

_____

_____

_____

(2)

(Total 11 marks)

Q15.

Sodium hydroxide neutralises sulfuric acid.

The equation for the reaction is:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

(a) Sulfuric acid is a strong acid.

What is meant by a strong acid?

_____

_____

_____

(2)

(b) Write the ionic equation for this neutralisation reaction. Include state symbols.

_____

(2)

(c) A student used a pipette to add 25.0 cm^3 of sodium hydroxide of unknown concentration to a conical flask.

The student carried out a titration to find out the volume of 0.100 mol / dm^3 sulfuric acid needed to neutralise the sodium hydroxide.

Describe how the student would complete the titration.

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You should name a suitable indicator and give the colour change that would be seen.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) The student carried out five titrations. Her results are shown in the table below.

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of 0.100 mol / dm^3 sulfuric acid in cm^3	27.40	28.15	27.05	27.15	27.15

Concordant results are within 0.10 cm^3 of each other.

Use the student's concordant results to work out the mean volume of 0.100 mol / dm^3 sulfuric acid added.

_____

_____

_____

_____

Mean volume = _____ cm^3

(2)

(e) The equation for the reaction is:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the sodium hydroxide.

Give your answer to three significant figures.

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_____

_____

_____

_____

_____

_____

_____

Concentration = _____ mol / dm^3

(4)

(f) The student did another experiment using 20 cm^3 of sodium hydroxide solution with a concentration of 0.18 mol / dm^3.

Relative formula mass (M_r) of NaOH = 40

Calculate the mass of sodium hydroxide in 20 cm^3 of this solution.

_____

_____

_____

_____

Mass = _____ g

(2)

(Total 16 marks)

Q16.

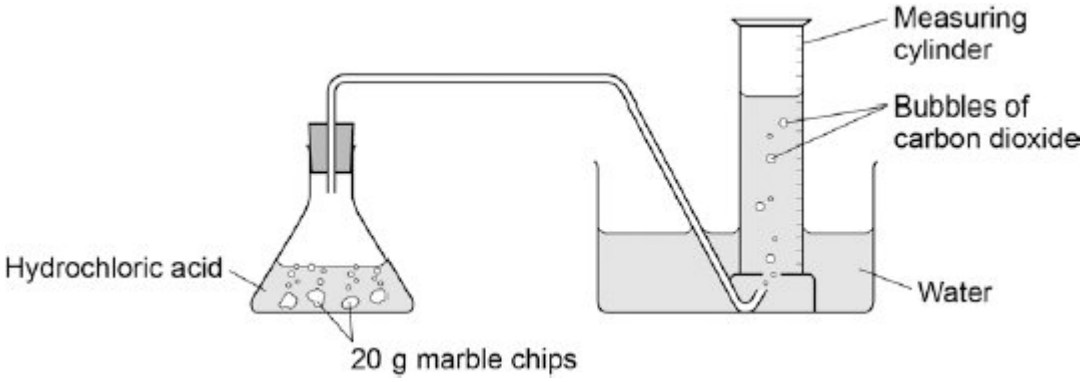
Marble chips are mainly calcium carbonate ($CaCO_3$).

A student investigated the rate of reaction between marble chips and hydrochloric acid (HCl).

Figure 1 shows the apparatus the student used.

Figure 1

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(a) Complete and balance the equation for the reaction between marble chips and hydrochloric acid.

_____ + _____ → $CaCl_2$ + _____ + _____

(2)

(b) The table below shows the student's results.

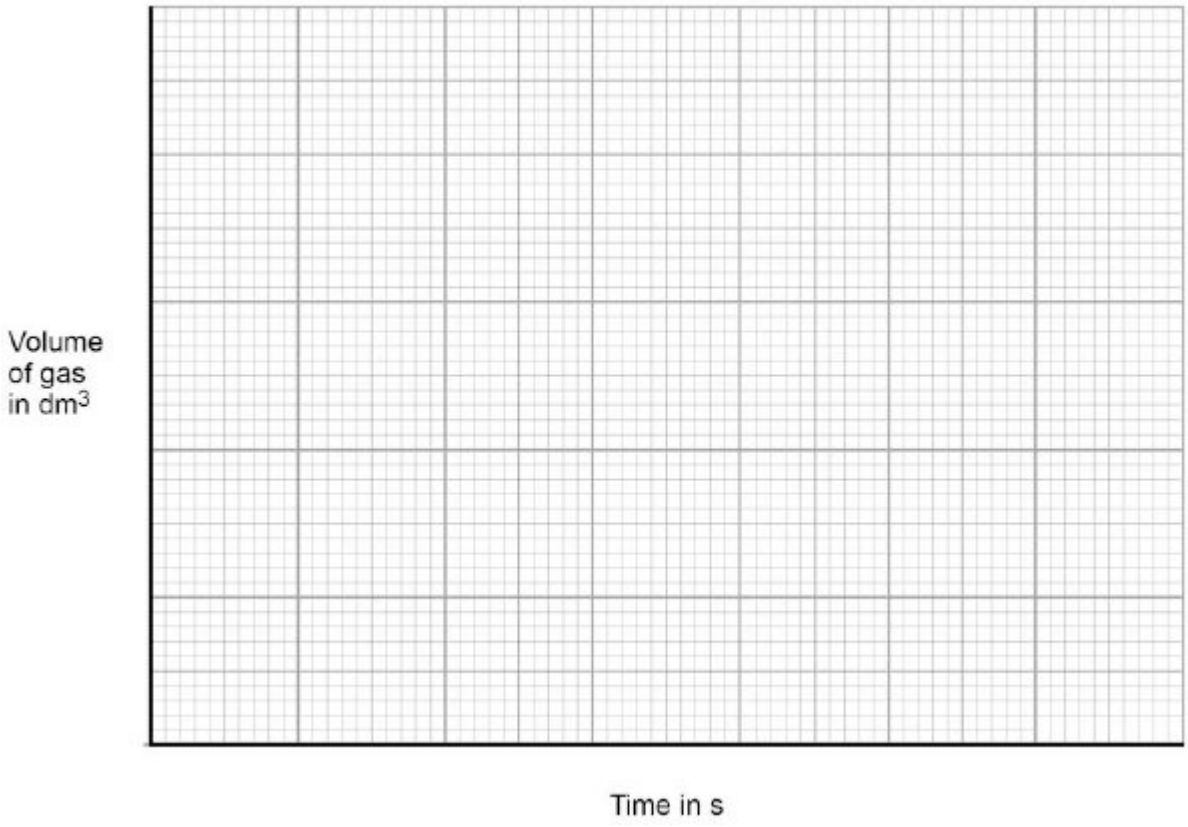
Time in s	**Volume of gas in dm^3**
0	0.000
30	0.030
60	0.046
90	0.052
120	0.065
150	0.070
180	0.076
210	0.079
240	0.080
270	0.080

On **Figure 2**:

- Plot these results on the grid.
- Draw a line of best fit.

Figure 2

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(4)

(c) Sketch a line on the grid in **Figure 2** to show the results you would expect if the experiment was repeated using 20 g of smaller marble chips.

Label this line **A**.

(2)

(d) Explain, in terms of particles, how and why the rate of reaction changes during the reaction of calcium carbonate with hydrochloric acid.

_____

_____

_____

_____

_____

_____

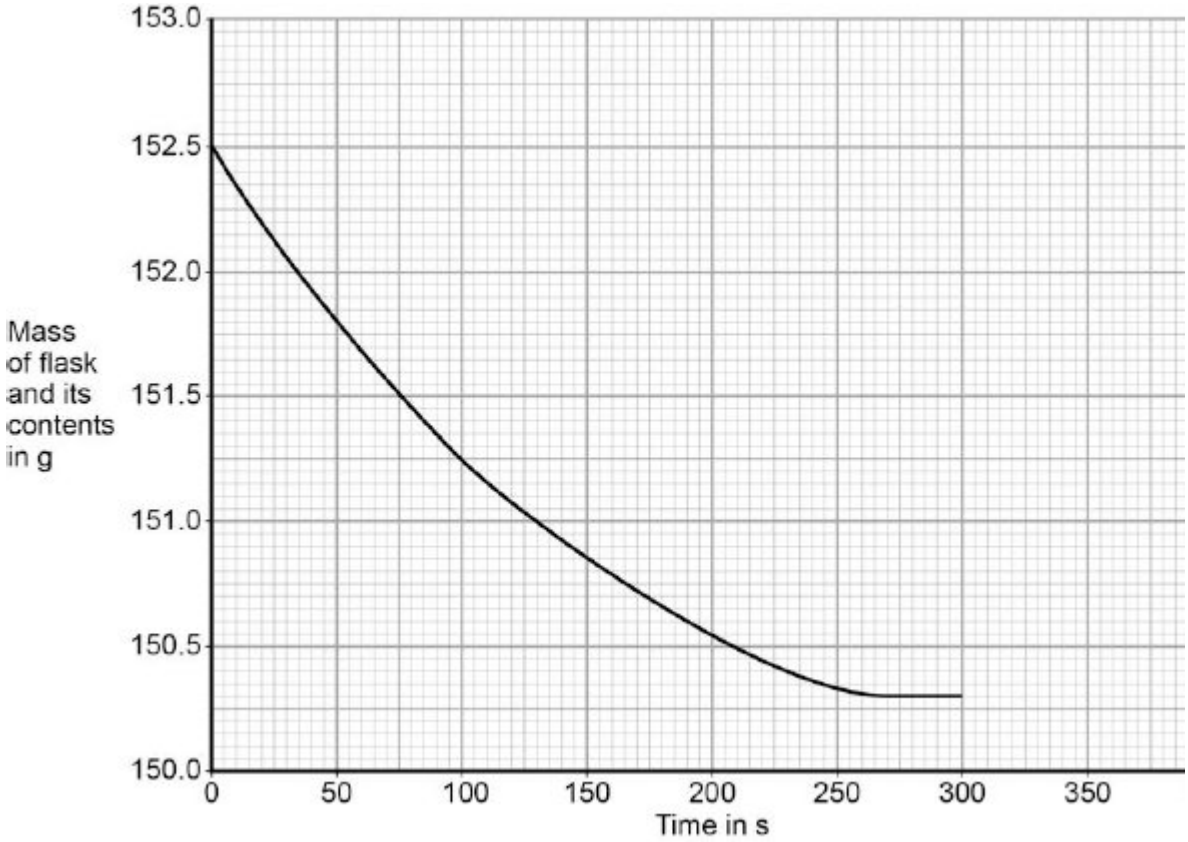
(4)

(e) Another student investigated the rate of reaction by measuring the change in mass.

Figure 3 shows the graph plotted from this student's results.

Figure 3

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Use **Figure 3** to calculate the mean rate of the reaction up to the time the reaction is complete.

Give your answer to three significant figures.

_____

_____

_____

_____

_____

_____

_____

_____

Mean rate of reaction = _____ g / s

(4)

(f) Use **Figure 3** to determine the rate of reaction at 150 seconds.

Show your working on **Figure 3**.

Give your answer in standard form.

_____

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_____

_____

_____

_____

Rate of reaction at 150 s = _____ g / s

(4)

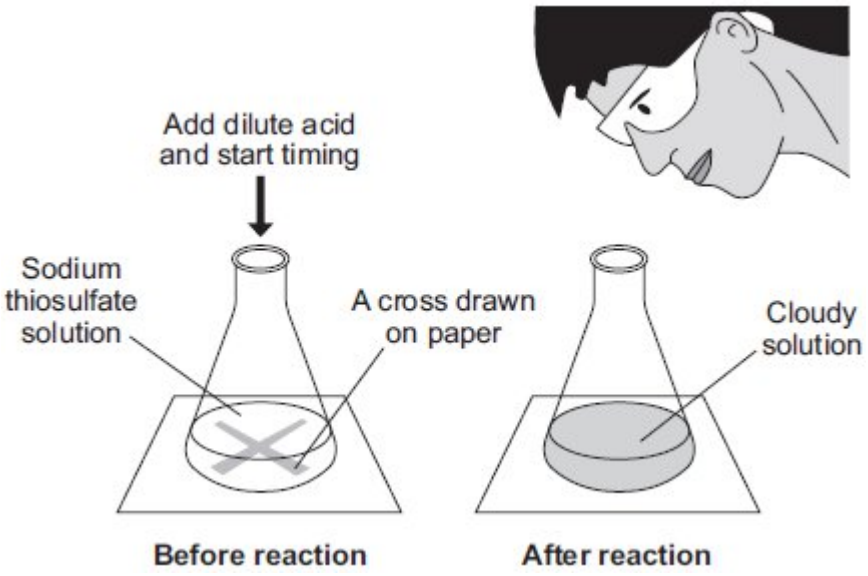
(Total 20 marks)

Q17.

A student investigated the effect of temperature on the rate of a reaction.

Figure 1 shows an experiment.

Figure 1



The student:

- put 50 cm^3 sodium thiosulfate solution into a conical flask
- heated the sodium thiosulfate solution to the required temperature
- put the flask on a cross drawn on a piece of paper
- added 5 cm^3 dilute hydrochloric acid and started a stopclock
- stopped the stopclock when the cross could no longer be seen
- repeated the experiment at different temperatures.

The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

sodium thiosulfate	hydrochloric acid		sodium chloride	water	sulfur dioxide	sulfur

(a) Which product is a gas?

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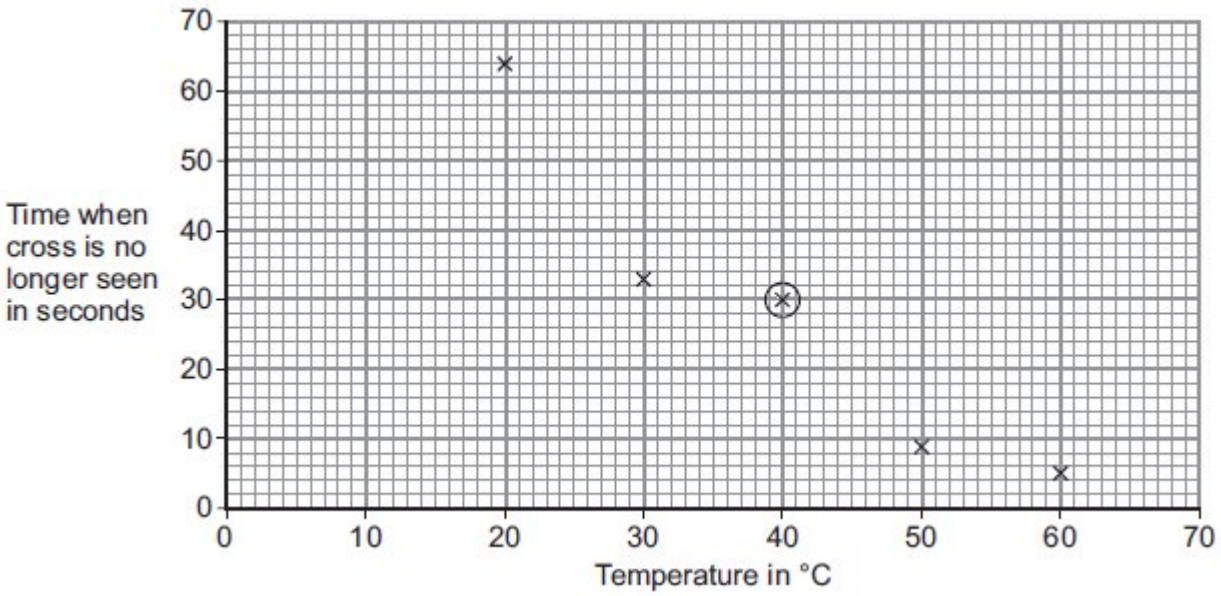
_____

(1)

(b) **Figure 2** shows the results of this experiment at five different temperatures.

The circled result point is anomalous.

Figure 2



(i) Draw a line of best fit on **Figure 2** to show how the reaction time varied with reaction temperature.

(1)

(ii) Give a possible reason for the anomalous result at 40 °C.

_____

_____

(1)

(iii) The reaction at 20 °C produced 0.32 g of sulfur in 64 seconds.

Calculate the rate of the reaction at 20 °C using the equation:

$$\text{Rate of reaction} = \frac{\text{mass of sulfur}}{\text{time}}$$

_____

_____

_____

_____

Rate of reaction = _____ grams per second

(2)

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(iv) Give **two** reasons why the rate of the reaction increases as the temperature increases.

Tick (✔) **two** boxes.

The particles move faster.	☐
The particles collide less often.	☐
All the particles have the same energy.	☐
The particles collide with more energy.	☐
The number of particles increases.	☐

(2)

(v) Use the correct answer from the box to complete the sentence.

activation	**collision**	**exothermic**

The minimum amount of energy particles must have to react is called

the _____ energy.

(1)

(Total 8 marks)

Q18.

This question is about ammonia and fertilisers.

(a) Ammonia is produced by a reversible reaction.

The equation for the reaction is:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Complete the sentence.

The forward reaction is exothermic, so the reverse reaction

is _____

(1)

(b) Calculate the percentage by mass of nitrogen in ammonia (NH_3).
Relative atomic masses (A_r): H = 1; N = 14
You **must** show how you work out your answer.

_____

_____

_____

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_____

_____

_____

Percentage by mass of nitrogen = _____ %

(3)

(c) A neutral solution can be produced when ammonia reacts with an acid.

(i) Give the pH of a neutral solution.

pH _____

(1)

(ii) Which of these ionic equations shows a neutralisation reaction?

Tick (✔) **one** box.

$H^+ + OH^- \longrightarrow H_2O$ ☐

$NH_4^+ + OH^- \longrightarrow NH_4OH$ ☐

$H^+ + Cl^- \longrightarrow HCl$ ☐

$H^+ + H_2O \longrightarrow H_3O^+$ ☐

(1)

(iii) Name the salt produced when ammonia reacts with hydrochloric acid.

_____

(1)

(d) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

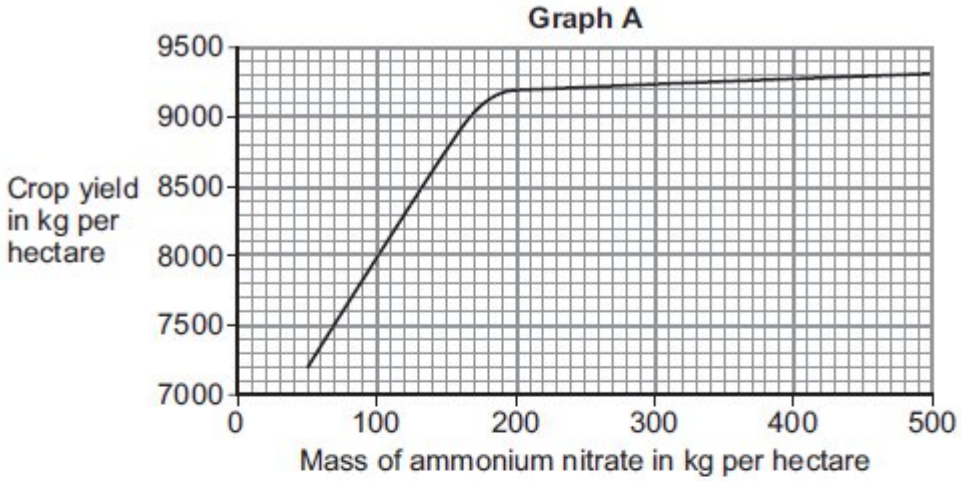
Farmers use ammonium nitrate as a fertiliser for crops.

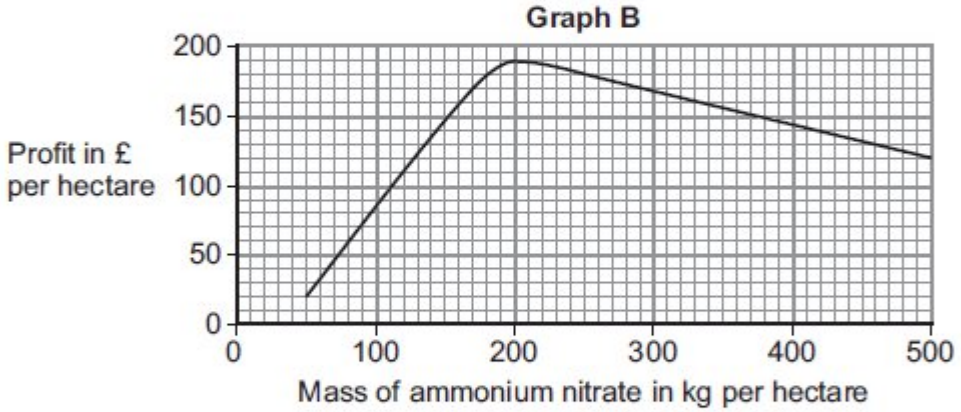
Rainwater dissolves ammonium nitrate in the soil.

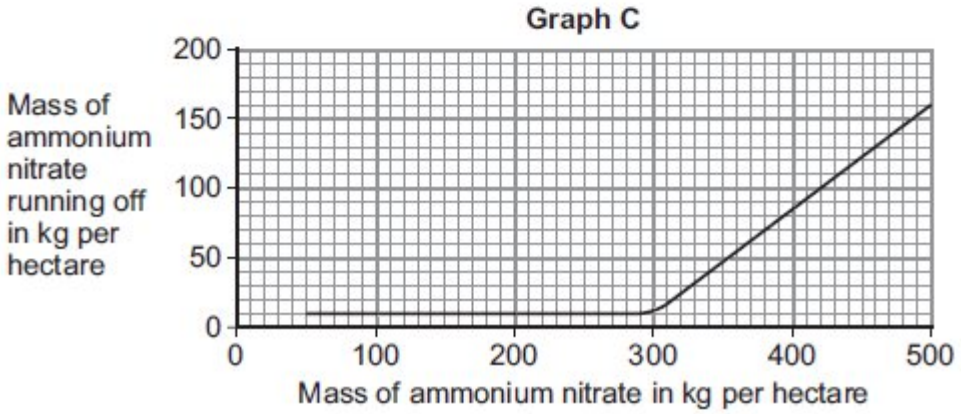
Some of the dissolved ammonium nitrate runs off into rivers and lakes.

The graphs **A**, **B** and **C** below show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

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Suggest how much ammonium nitrate farmers should use per hectare.

Give reasons for your answer.

Use information from graphs **A**, **B** and **C**.

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_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

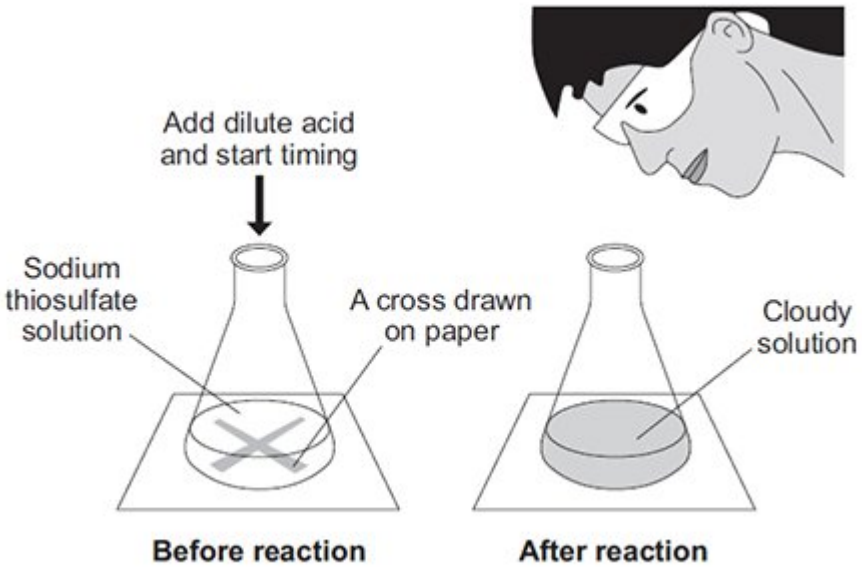
_____

(6)

(Total 13 marks)

Q19.

A student investigated the effect of temperature on the rate of a reaction.
The picture below shows an experiment.



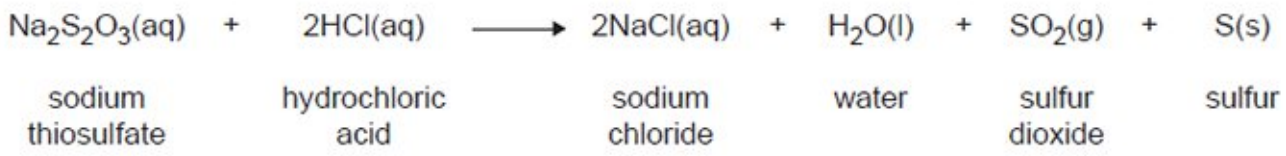
The student:

- put sodium thiosulfate solution into a conical flask
- heated the sodium thiosulfate solution to the required temperature
- put the flask on a cross drawn on a piece of paper

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- added dilute hydrochloric acid and started a stopclock
- stopped the stopclock when the cross could no longer be seen
- repeated the experiment at different temperatures.

The equation for the reaction is:



(a) Explain why the solution goes cloudy.

_____

_____

_____

_____

(2)

(b) Give **two** variables the student must control to make the investigation a fair test.

1. _____

2. _____

(2)

(c) State the effect that increasing the temperature of the sodium thiosulfate solution has on the rate of the reaction.
Explain this effect in terms of particles and collisions.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) Suggest how the student should change the method to investigate the rate of reaction at 5°C.

_____

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_____

(1)

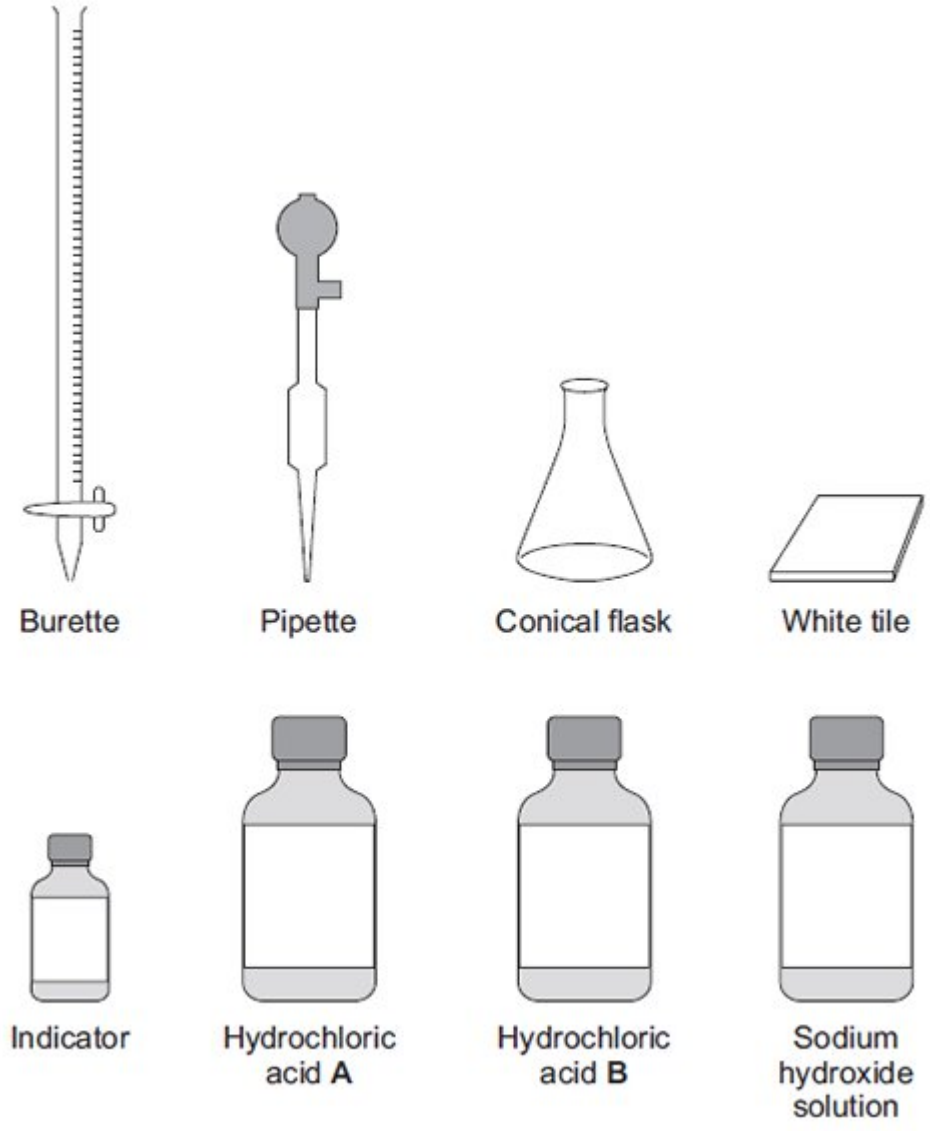
(Total 9 marks)

Q20.

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

A student has to check if two samples of hydrochloric acid, **A** and **B**, are the same concentration.

Describe how the student could use the apparatus and the solutions in the diagram below to carry out titrations.



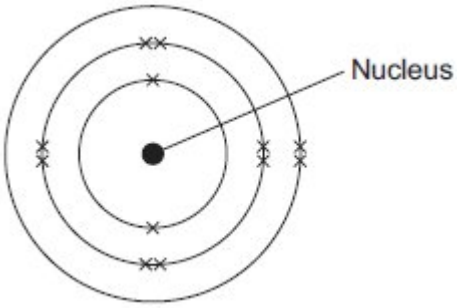
(Total 6 marks)

Q21.

This question is about magnesium.

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(a) (i) The electronic structure of a magnesium atom is shown below.



Use the correct answer from the box to complete each sentence.

electrons	neutrons	protons	shells

The nucleus contains protons and _____ .

The particles with the smallest relative mass that move around the nucleus are called _____ .

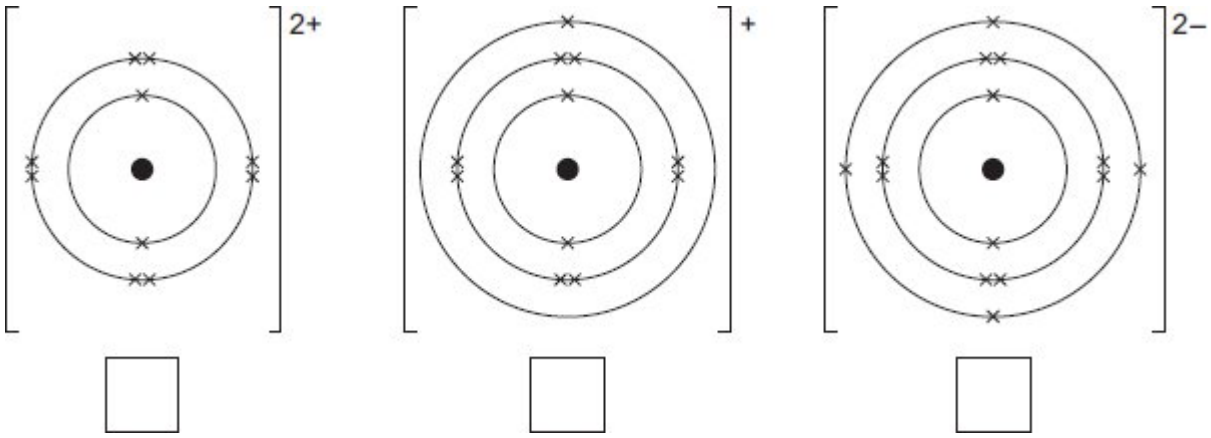
Atoms of magnesium are neutral because they contain the same number of electrons and _____ .

(3)

(ii) A magnesium atom reacts to produce a magnesium ion.

Which diagram shows a magnesium ion?

Tick (✓) **one** box.



(1)

(b) Magnesium and dilute hydrochloric acid react to produce magnesium chloride solution and hydrogen.

$$Mg(s) + 2\,HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

(i) State **two** observations that could be made during the reaction.

1. _____

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_____

2. _____

_____

(2)

(ii) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Describe a method for making pure crystals of magnesium chloride from magnesium and dilute hydrochloric acid.

In your method you should name the apparatus you will use.

You do **not** need to mention safety.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 12 marks)

Q22.

Dilute nitric acid reacts with potassium hydroxide solution.

The equation for the reaction is:

$$HNO_3 + KOH \longrightarrow KNO_3 + H_2O$$

A student investigated the temperature change in this reaction.

This is the method the student used.

Step 1 Put 25 cm^3 of dilute nitric acid in a polystyrene cup.
Step 2 Use a thermometer to measure the temperature of the dilute nitric acid.
Step 3 Use a burette to add 4 cm^3 of potassium hydroxide solution to the dilute nitric acid and stir the mixture.
Step 4 Use a thermometer to measure the highest temperature of the mixture.

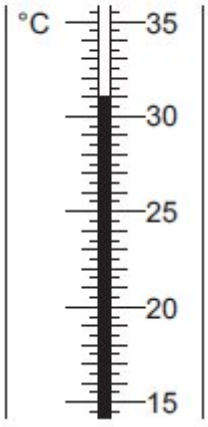
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Step 5 Repeat steps 3 and 4 until 40 cm^3 of potassium hydroxide solution have been added.

The dilute nitric acid and the potassium hydroxide solution were both at room temperature.

(a) **Figure 1** shows part of the thermometer after some potassium hydroxide solution had been added to the dilute nitric acid.

Figure 1



What is the temperature shown on the thermometer?

The temperature shown is _____ °C

(1)

(b) Errors are possible in this experiment.

(i) Suggest **two** causes of random error in the experiment.

_____

_____

_____

_____

(2)

(ii) Another student used a glass beaker instead of a polystyrene cup.

This caused a systematic error.

Why does using a glass beaker instead of a polystyrene cup cause a systematic error?

_____

_____

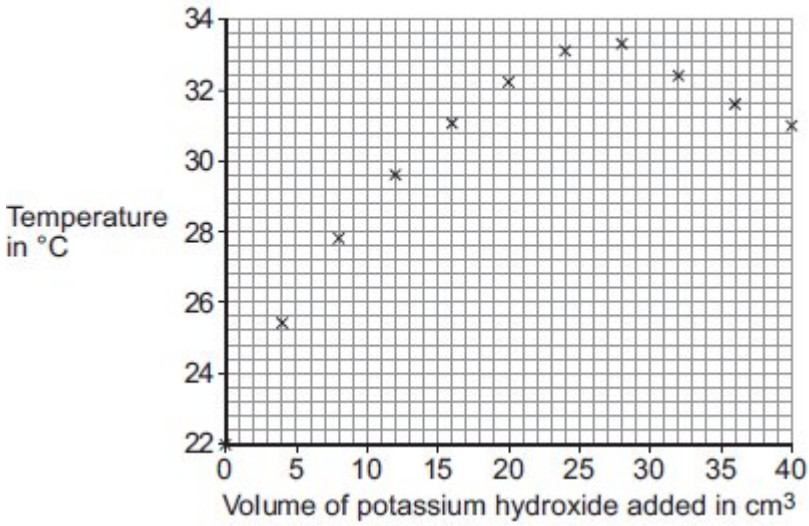
_____

(1)

(c) The results of the student using the polystyrene cup are shown in **Figure 2**.

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Figure 2



(i) How do the results in **Figure 2** show that the reaction between dilute nitric acid and potassium hydroxide solution is exothermic?

_____

_____

(1)

(ii) Explain why the temperature readings decrease between 28 cm^3 and 40 cm^3 of potassium hydroxide solution added.

_____

_____

_____

(2)

(iii) It is difficult to use the data in **Figure 2** to find the exact volume of potassium hydroxide solution that would give the maximum temperature.

Suggest further experimental work that the student should do to make it easier to find the exact volume of potassium hydroxide solution that would give the maximum temperature.

_____

_____

_____

_____

(2)

(d) The student did further experimental work and found that 31.0 cm^3 of potassium hydroxide solution neutralised 25.0 cm^3 of dilute nitric acid.

The concentration of the dilute nitric acid was 2.0 moles per dm^3.

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$$HNO_3 + KOH \longrightarrow KNO_3 + H_2O$$

Calculate the concentration of the potassium hydroxide solution in moles per dm^3.

_____

_____

_____

_____

_____

_____

Concentration = _____ moles per dm^3

(3)

(e) The student repeated the original experiment using 25 cm^3 of dilute nitric acid in a polystyrene cup and potassium hydroxide solution that was twice the original concentration.

She found that:

- a smaller volume of potassium hydroxide solution was required to reach the maximum temperature
- the maximum temperature recorded was higher.

Explain why the maximum temperature recorded was higher.

_____

_____

_____

_____

(2)

(Total 14 marks)

Q23.

This question is about salts.

(a) Salt (sodium chloride) is added to many types of food.

Sodium chloride is produced by reacting sodium with chlorine.

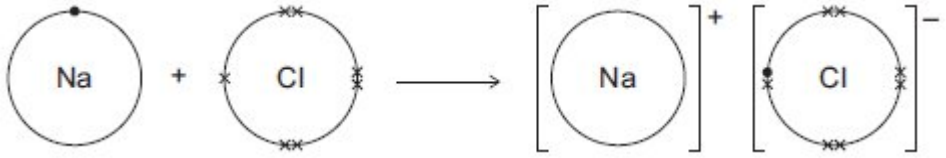
sodium + chlorine $\longrightarrow$ sodium chloride

The diagram shows what happens to atoms of sodium and chlorine in this reaction.

The dots (•) and crosses (×) represent electrons.

Only the outer electrons are shown.

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Describe, in terms of electrons, what happens when a sodium atom reacts with a chlorine atom to produce sodium chloride.

_____

_____

_____

_____

_____

_____

(3)

(b) Lack of iodine can affect the learning ability of children.

One idea is that salt (sodium chloride) should have iodine added.

(i) Iodine consists of simple molecules.

What is a property of substances that have simple molecules?

Tick (✓) **one** box.

Have no overall electric charge	☐
Have high boiling points	☐
Have giant covalent structures	☐

(1)

(ii) Which one of the following questions cannot be answered by science alone?

Tick (✓) **one** box.

How much sodium chloride is in food?	☐

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What harm does a lack of iodine do? ☐

Should iodine be added to salt in food? ☐

Give **one** reason why this question cannot be answered by science alone.

_____

_____

(2)

(c) A student produced the salt ammonium nitrate by adding an acid to ammonia solution.

(i) Name the acid used.

_____

(1)

(ii) Use the correct answer from the box to complete the sentence.

an acid	**an alkali**	**a salt**

Ammonia solution (ammonium hydroxide) is _____ .

(1)

(iii) The student added a few drops of a solution which changed colour when the reaction was complete.

Complete the sentence.

The solution added is an _____ .

(1)

(d) Farmers buy solid ammonium nitrate in poly(ethene) sacks.

(i) How is solid ammonium nitrate made from a solution of ammonium nitrate?

Tick (✓) **one** box.

Crystallisation ☐

Decomposition ☐

Electrolysis ☐

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(1)

(ii) Why do farmers use ammonium nitrate on their fields?

_____

_____

(1)

(iii) The properties of poly(ethene) depend on the reaction conditions when it is made.

State **one** reaction condition that can be changed when making poly(ethene).

_____

_____

(1)

(Total 12 marks)

Q24.

This question is about compounds.

(a) The table gives information about the solubility of some compounds.

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from the table to answer these questions.

(i) Name a soluble compound that contains silver ions.

_____

(1)

(ii) Name a soluble compound that contains carbonate ions.

_____

(1)

(b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

_____

(1)

(c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

(i) State how solid lead nitrate can be obtained from lead nitrate solution.

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_____

_____

(1)

(ii) Balance the equation for the reaction.

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

(1)

(iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

_____

(1)

(d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

_____

_____

_____

_____

_____

_____

Empirical formula = _____

(4)

(Total 10 marks)

Q25.

Some pollutants cause acid rain.

A student tested 25.0 cm^3 samples of three types of rainwater, **P, Q** and **R**.
The student titrated the samples with sodium hydroxide solution (an alkali).

The student recorded the volume of sodium hydroxide solution needed to neutralise the rainwater. The student's results are shown in **Table 1**.

Table 1

	Volume of sodium hydroxide needed to neutralise the rainwater in cm^3				
Type of rainwater	**Titration 1**	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**

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P	18.0	15.5	14.5	15.0	15.0
Q	13.0	10.0	11.0	10.5	10.5
R	23.0	19.5	18.5	19.0	19.0

(a) (i) The student calculated the mean value for rainwater **R** as 19.0 cm^3.

Show how the student calculated the mean value for rainwater **R**.

_____

_____

_____

_____

(2)

(ii) Write down **P, Q** and **R** in order of their acidity.

Most acidic _____

_____

Least acidic _____

(2)

(b) A second student repeated the experiment and recorded the results in **Table 2**.

Table 2

	Volume of sodium hydroxide needed to neutralise the rainwater in cm^3	
Type of rainwater	**Titration 1**	**Titration 2**
P	17	15
Q	11	9
R	20	18

Use **Table 1** and **Table 2** to suggest **two** improvements the second student could make to obtain more accurate results.

_____

_____

_____

_____

(2)

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(c) The results of the two students show that the experiment is reproducible.

Give the reason why.

_____

_____

(1)

(Total 7 marks)

Q26.

This question is about organic compounds.

(a) Ethanol is an alcohol.
One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

_____

_____

(2)

(b) Which gas is produced when sodium reacts with ethanol?

Tick (✓) **one** box.

Carbon dioxide ☐

Carbon monoxide ☐

Hydrogen ☐

Oxygen ☐

(1)

(c) Ethanoic acid (CH_3COOH) can be produced from ethanol (CH_3CH_2OH).

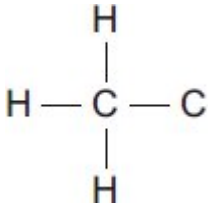
(i) What type of reaction produces ethanoic acid from ethanol?

_____

(1)

(ii) Complete the displayed structure of ethanoic acid.

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(1)

(iii) Solutions of ethanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of ethanoic acid has a higher pH than the solution of hydrochloric acid.

_____

_____

_____

_____

(2)

(d) Ethanol and ethanoic acid react in the presence of a catalyst to form an ester.

(i) Name the ester made from ethanol and ethanoic acid.

_____

(1)

(ii) What type of chemical is used as a catalyst in this reaction?

_____

(1)

(iii) Esters are used in perfumes because they smell pleasant and are volatile.

What does volatile mean?

_____

(1)

(Total 10 marks)

Q27.

This question is about chemical analysis.

(a) A student has solutions of three compounds, **X, Y** and **Z**.

The student uses tests to identify the ions in the three compounds.

The student records the results of the tests in the table.

	Test			
Compound	**Flame**	**Add sodium**	**Add**	**Add nitric acid**

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	test	hydroxide solution	hydrochloric acid and barium chloride solution	and silver nitrate solution
X	no colour	green precipitate	white precipitate	no reaction
Y	yellow flame	no reaction	no reaction	yellow precipitate
Z	no colour	brown precipitate	no reaction	cream precipitate

Identify the **two** ions present in each compound, **X, Y** and **Z**.

X _____

Y _____

Z _____

(3)

(b) A chemist needs to find the concentration of a solution of barium hydroxide. Barium hydroxide solution is an alkali.

The chemist could find the concentration of the barium hydroxide solution using two different methods.

Method 1

- An excess of sodium sulfate solution is added to 25 cm^3 of the barium hydroxide solution. A precipitate of barium sulfate is formed.
- The precipitate of barium sulfate is filtered, dried and weighed.
- The concentration of the barium hydroxide solution is calculated from the mass of barium sulfate produced.

Method 2

- 25 cm^3 of the barium hydroxide solution is titrated with hydrochloric acid of known concentration.
- The concentration of the barium hydroxide solution is calculated from the result of the titration.

Compare the advantages and disadvantages of the two methods.

_____

_____

_____

_____

_____

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_____

_____

_____

_____

_____

(5)

(Total 8 marks)

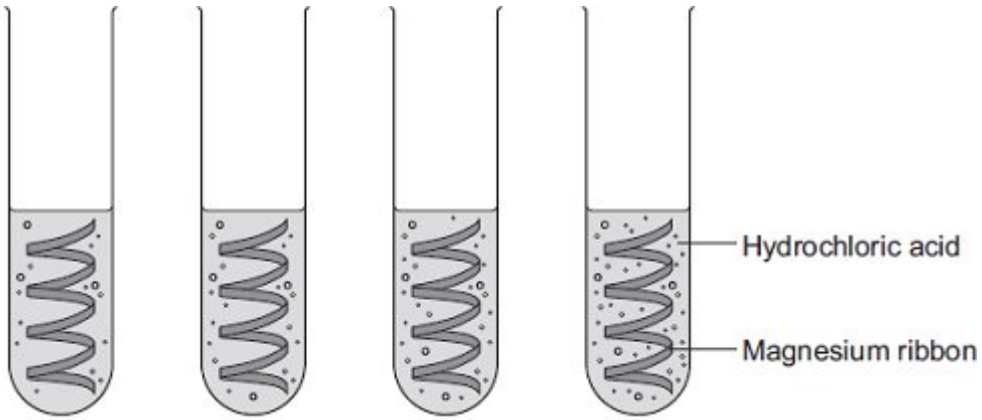
Q28.

A student investigated the rate of reaction of magnesium and hydrochloric acid.

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

The student studied the effect of changing the concentration of the hydrochloric acid.

She measured the time for the magnesium to stop reacting.



Concentration of hydrochloric acid in moles per dm^3	0.5	1.0	1.5	2.0

(a) The student changed the concentration of the hydrochloric acid.

Give **two** variables that the student should control.

1. _____

2. _____

(2)

(b) (i) The rate of reaction increased as the concentration of hydrochloric acid increased.

Explain why.

_____

_____

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_____

_____

(2)

(ii) Explain why increasing the temperature would increase the rate of reaction.

_____

_____

_____

_____

_____

_____

(3)

(c) (i) The student had a solution of sodium hydroxide with a concentration of 0.100 moles per dm^3.

She wanted to check the concentration of a solution of hydrochloric acid.

She used a pipette to transfer 5.00 cm^3 of the hydrochloric acid into a conical flask.

She filled a burette with the 0.100 moles per dm^3 sodium hydroxide solution.

Describe how she should use titration to obtain accurate results.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(ii) Sodium hydroxide neutralises hydrochloric acid as shown in the equation:

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

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The student found that 27.20 cm^3 of 0.100 moles per dm^3 sodium hydroxide neutralised 5.00 cm^3 of hydrochloric acid.

Calculate the concentration of the hydrochloric acid in moles per dm^3.

Give your answer to three significant figures.

_____

_____

_____

_____

_____

_____

Concentration of hydrochloric acid = _____ moles per dm^3

(3)

(Total 14 marks)

Q29.

Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, SO_2

(a) Why is it important that sulfur dioxide is **not** released into the atmosphere?

Tick (✔) **one** box.

Sulfur dioxide causes acid rain. ☐

Sulfur dioxide causes global dimming. ☐

Sulfur dioxide causes global warming. ☐

(1)

(b) Sulfur dioxide dissolves in water.

What colour is universal indicator in a solution of sulfur dioxide?
Give a reason for your answer.

_____

_____

_____

_____

(2)

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(c) Sulfur dioxide is a gas at room temperature.

The bonding in sulfur dioxide is covalent.

Explain, in terms of its structure and bonding, why sulfur dioxide has a low boiling point.

_____

_____

_____

_____

_____

_____

(3)

(d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Sulfur dioxide is produced when fossil fuels are burned.

It is important that sulfur dioxide is not released into the atmosphere.

Three of the methods used to remove sulfur dioxide from gases produced when fossil fuels are burned are:

- wet gas desulfurisation (**W**)
- dry gas desulfurisation (**D**)
- seawater gas desulfurisation (**S**).

Information about the three methods is given in the bar chart and in **Table 1** and **Table 2**.

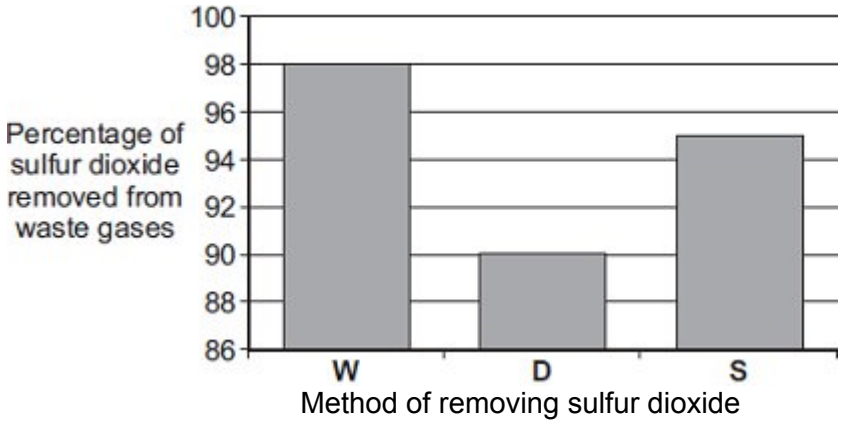


Table 1

Method	Material used	How material is obtained

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W	Calcium carbonate, $CaCO_3$	Quarrying
D	Calcium oxide, CaO	Thermal decomposition of calcium carbonate: $CaCO_3 \longrightarrow CaO + CO_2$
S	Seawater	From the sea

Table 2

Method	What is done with waste material
W	Solid waste is sold for use in buildings. Carbon dioxide is released into the atmosphere.
D	Solid waste is sent to landfill.
S	Liquid waste is returned to the sea.

Evaluate the three methods of removing sulfur dioxide from waste gases.

Compare the three methods and give a justified conclusion.

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(6)
(Total 12 marks)

Q30.

Lead nitrate solution reacts with potassium iodide solution.

The reaction produces a solid.

Figure 1 shows the reaction occurring.

Figure 1



Lead Iodide By Der Kreole (own work) (CC-BY-3.0) via Wikimedia Commons

(a) (i) Give the name of this type of reaction.

Tick (✓) **one** box.

Combustion ☐

Neutralisation ☐

Precipitation ☐

(1)

(ii) Write the missing state symbols in the chemical equation.

$Pb(NO_3)_2$(aq) + 2KI(___) ⟶ PbI_2(___) + $2KNO_3$(aq)

(2)

(iii) Complete the word equation for the reaction.

lead nitrate + _____ ⟶ lead iodide + _____

(2)

(iv) How is solid lead iodide separated from the solution?

Draw a ring around the correct answer.

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Distillation **Electrolysis** **Filtration**

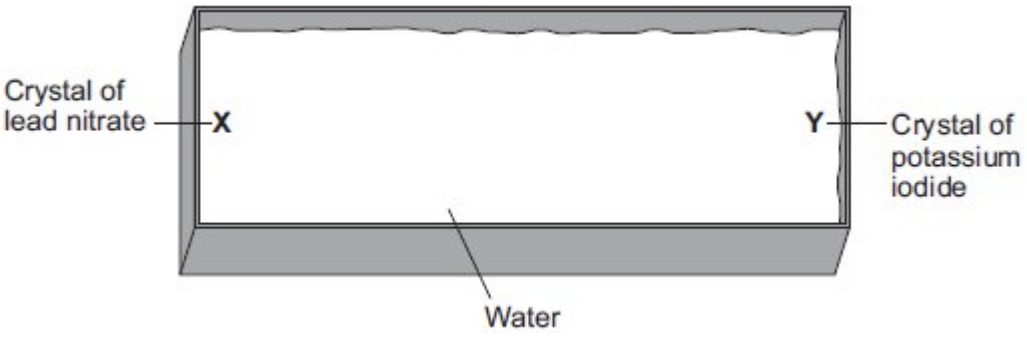
(1)

(b) A group of students investigated the movement of particles.

The students filled a container with water.

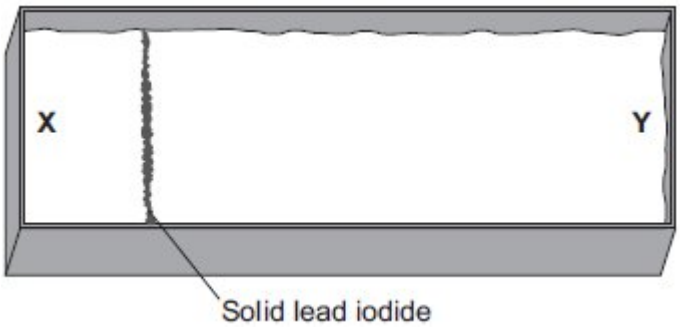
The students added a crystal of lead nitrate at position **X** and a crystal of potassium iodide at position **Y**, as shown in **Figure 2**.

Figure 2 – view from above



After 3 minutes solid lead iodide started to form at the position shown in **Figure 3**.

Figure 3 – view from above



(i) Tick (✓) the correct box to complete the sentence.

Lead ions and iodide ions move through the water by

diffusion. ☐

evaporation. ☐

neutralisation. ☐

(1)

(ii) What conclusion can you make about the speed of movement of lead ions compared with iodide ions?

Give a reason for your answer.

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_____

_____

_____

_____

(2)

(iii) The students repeated the experiment at a higher temperature.

The solid lead iodide formed after a shorter period of time.

Explain why, in terms of particles.

_____

_____

_____

_____

(2)

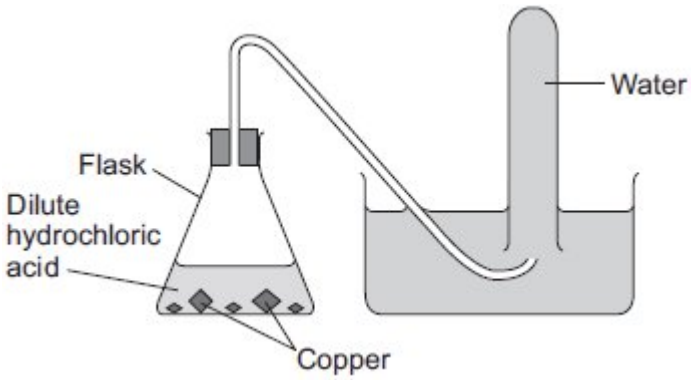
(Total 11 marks)

Q31.

A student was trying to produce hydrogen gas.

Figure 1 shows the apparatus she used.

Figure 1



(a) No gas was produced.

The student's teacher said that this was because the substances in the flask did **not** react.

(i) Suggest why the substances in the flask did **not** react.

_____

_____

_____

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(1)

(ii) Which two substances could the student have put in the flask to produce hydrogen safely?

Tick (✓) **one** box.

Gold and dilute hydrochloric acid ☐

Potassium and dilute hydrochloric acid ☐

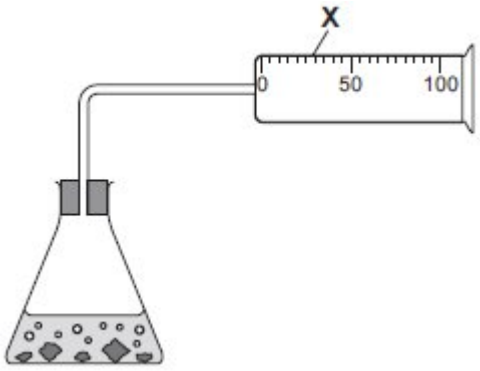
Zinc and dilute hydrochloric acid ☐

(1)

(b) Another student did produce hydrogen from two substances.

Figure 2 shows the apparatus the student used to collect and measure the volume of the hydrogen gas.

Figure 2



Give the name of the apparatus labelled **X**.

_____

(1)

(c) The student did the experiment four times. Her results are shown in the table below.

Experiment	Volume of hydrogen collected in one minute in cm^3
1	49
2	50
3	35
4	48

(i) One of the results is anomalous.

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Which result is anomalous? Write your answer in the box. ☐

Give a reason for your choice.

_____

(2)

(ii) Calculate the mean volume of hydrogen collected in one minute.

_____

_____

Mean volume = _____ cm^3

(2)

(iii) Give a reason why the experiment should be repeated several times.

_____

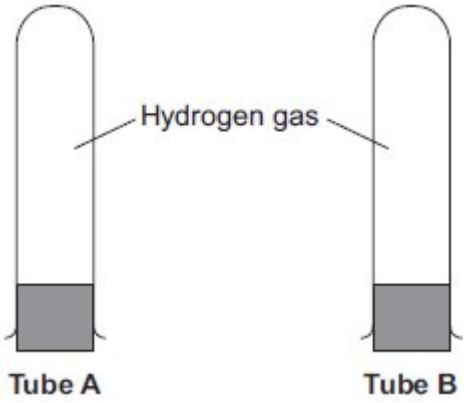
_____

_____

(1)

(d) A teacher collected two tubes full of hydrogen gas, as shown in **Figure 3**.

Figure 3



She tested tube **A** with a lighted splint as soon as she took the bung out.

She tested tube **B** with a lighted splint a few seconds after taking the bung out.

(i) Suggest why tube **B** gave a much louder pop than tube **A**.

_____

_____

_____

_____

(1)

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(ii) Complete and balance the chemical equation for the reaction that takes place when the hydrogen reacts in this test.

H_2 + O_2 ⟶

(2)

(Total 11 marks)

Q32.

Calcium chloride ($CaCl_2$) is a soluble salt.

Calcium chloride can be made by reacting dilute hydrochloric acid with either solid calcium oxide or solid calcium carbonate.

(a) Name the type of reaction that takes place when dilute hydrochloric acid reacts with calcium oxide.

_____

(1)

(b) Write a balanced symbol equation for the reaction of dilute hydrochloric acid with calcium oxide.

_____

(2)

(c) A student added solid calcium oxide to dilute hydrochloric acid in a beaker.

The student added solid calcium carbonate to dilute hydrochloric acid in another beaker.

Describe **one** difference between the two reactions that the student would **see**.

_____

_____

(1)

(d) Describe how crystals of calcium chloride can be made from calcium carbonate and dilute hydrochloric acid.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

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(e) A student dissolved some crystals of a salt in water.

The student added sodium hydroxide solution to the salt solution.

The student added sodium hydroxide solution until it was in excess.

(i) Describe what the student would **see** if the salt contained calcium ions.

_____

_____

_____

(2)

(ii) Why does the result you have described in part (e)(i) **not** prove that the salt contains calcium ions?

_____

_____

(1)

(iii) Describe an additional test the student could do that would prove the salt contains calcium ions.

_____

_____

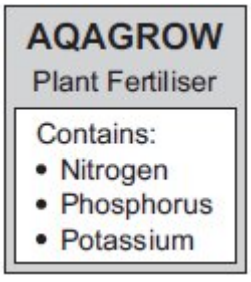
_____

(2)

(Total 13 marks)

Q33.

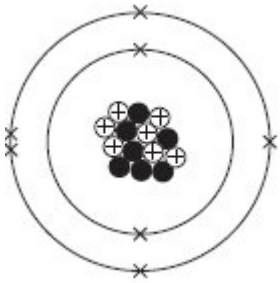
Fertilisers contain elements that plants need.



(a) **Figure 1** represents a nitrogen atom.

Figure 1

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Complete each sentence.

(i) The mass number of this nitrogen atom is _____ .

(1)

(ii) Atoms of nitrogen with different numbers of neutrons are called

_____ .

(1)

(iii) Compared with a proton, the mass of an electron is

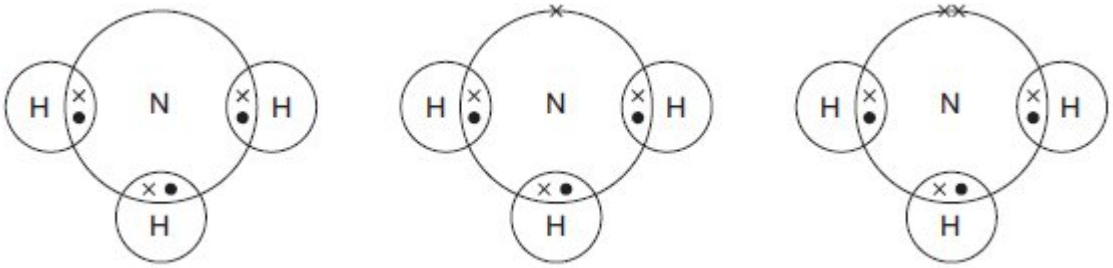
_____ .

(1)

(b) Fertilisers can be made from ammonia.

(i) Which diagram, **A**, **B**, or **C**, represents the electronic structure of an ammonia molecule?

A **B** **C**



(1)

The electronic structure of an ammonia molecule is shown in diagram ☐

(ii) What is the correct formula of ammonia?

Draw a ring around the correct answer.

N_3H **NH_3** **NH^3**

(1)

(c) A student made ammonium nitrate by reacting ammonia solution with an acid.

(i) Name the acid used to make ammonium nitrate.

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_____

(1)

(ii) Complete the sentence.

The student added a few drops of _____, which changed colour when the ammonia solution had neutralised the acid.

(1)

(iii) The student added charcoal and filtered the mixture.

This produced a colourless solution of ammonium nitrate.

How is solid ammonium nitrate obtained from the solution?

_____

(1)

(iv) A farmer put ammonium nitrate fertiliser onto a field of grass.

Suggest what would happen to the grass.

_____

_____

(1)

(d) Some fertilisers contain potassium chloride.

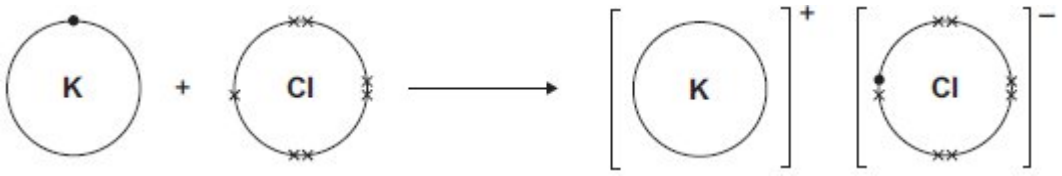
Potassium reacts with chlorine to produce potassium chloride.

Figure 2 shows how this happens.

The dots (•) and crosses (x) represent electrons.

Only the outer shell is shown.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with chlorine to produce potassium chloride.

_____

_____

_____

_____

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_____

_____

_____

_____

_____

_____

(4)

(Total 13 marks)

Q34.

The label shows the ingredients in a drink called Cola.

Cola

Ingredients:

Carbonated water
Sugar
Colouring
Phosphoric acid
Flavouring
Caffeine

(a) (i) The pH of carbonated water is 4.5.

The pH of Cola is 2.9.

Name the ingredient on the label that lowers the pH of Cola to 2.9.

_____

(1)

(ii) Which ion causes the pH to be 2.9?

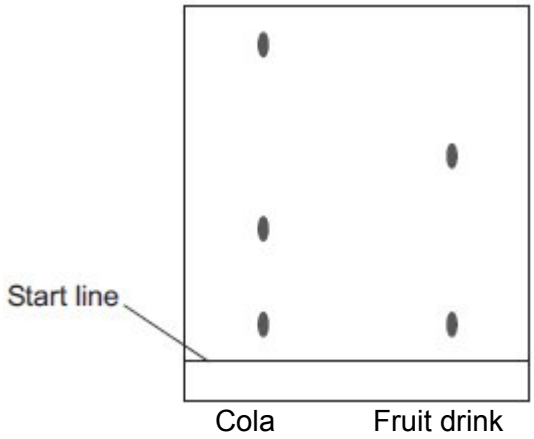
_____

(1)

(b) A student investigated the food colouring in Cola and in a fruit drink using paper chromatography.

The chromatogram in the figure below shows the student's results.

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(i) Complete the sentence.

The start line should be drawn with a ruler and _____ .

Give a reason for your answer.

_____

_____

(2)

(ii) Suggest **three** conclusions you can make from the student's results.

_____

_____

_____

_____

_____

_____

(3)

(c) Caffeine can be separated from the other compounds in the drink by gas chromatography.

Why do different compounds separate in a gas chromatography column?

_____

_____

(1)

(d) Caffeine is a stimulant.

Large amounts of caffeine can be harmful.

(i) Only **one** of the questions in the table **can** be answered by science alone.

Tick (✓) **one** question.

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Question	Tick (✓)
Should caffeine be an ingredient in drinks?	
Is there caffeine in a certain brand of drink?	
How much caffeine should people drink?	

(1)

(ii) Give **two** reasons why the other questions **cannot** be answered by science alone.

Reason 1 _____

_____

Reason 2 _____

_____

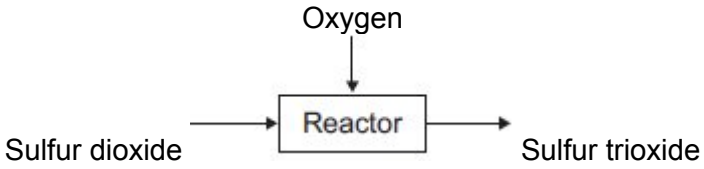
(2)

(Total 11 marks)

Q35.

Figure 1 represents a reaction in the production of sulfuric acid.

Figure 1



(a) Complete and balance the equation for the reaction.

_____ $SO_2(g)$ + _____ (g) ⇌ _____ $SO_3(g)$

(2)

(b) The conditions can affect the rate of the reaction.

(i) The pressure of the reacting gases was increased.

State the effect of increasing the pressure on the rate of reaction.

Explain your answer in terms of particles.

_____

_____

_____

_____

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_____

_____

(3)

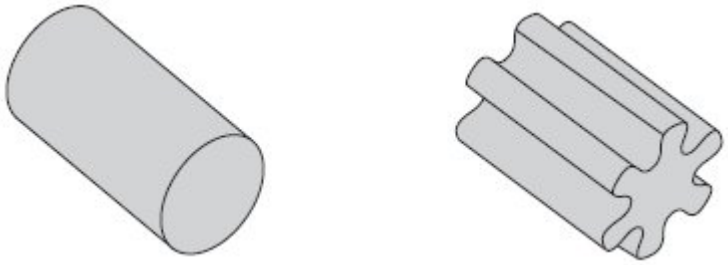
(ii) A catalyst is used for the reaction.

The gases pass through a layer containing pieces of the catalyst.

Figure 2 shows the shapes of pieces of catalyst.

Figure 2

A **B**



Suggest and explain why shape **B** is more effective as a catalyst than shape **A**.

_____

_____

_____

_____

(2)

(c) The reaction is carried out at a high temperature to provide the reactants with the **activation energy**.

What is meant by the **activation energy**?

_____

_____

_____

(1)

(d) Sulfuric acid reacts with metals to produce salts.

(i) A student concluded that potassium would **not** be a suitable metal to react with sulfuric acid.

Explain why.

_____

_____

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_____

_____

(2)

(ii) A student reacted zinc metal with sulfuric acid to produce a salt and another product.

Complete the equation for this reaction.

$Zn + H_2SO_4 \longrightarrow$ _____ + _____

(2)

(iii) The student wanted to increase the rate of the reaction between the zinc and sulfuric acid.

State **one** way, other than using a catalyst, that the student could increase the rate of the reaction.

_____

_____

(1)

(Total 13 marks)

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