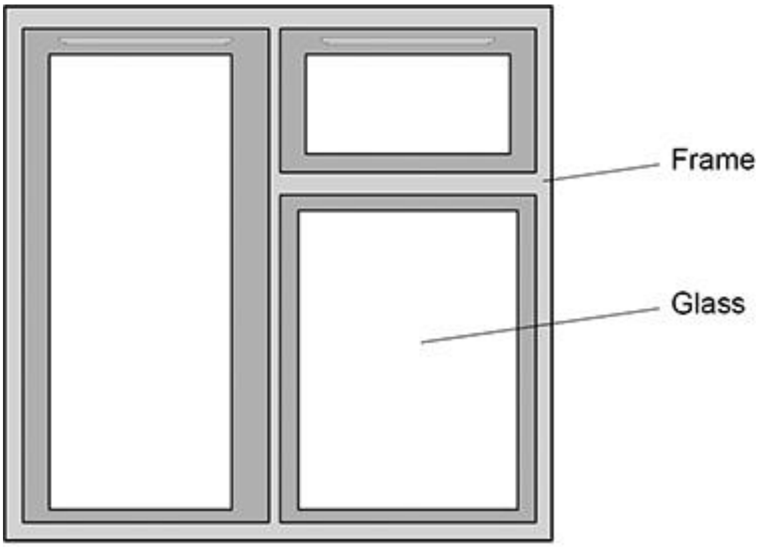
Questions are for both separate science and combined science students unless indicated in the question

Q1.

This question is about substances used to make windows and window frames.

Figure 1 shows a window.

Figure 1



(a) Glass is made by heating sand with **two** other materials.

Which **two** other materials are used to make glass?

Tick (✓) **two** boxes. **(separate only)**

Clay	☐
Graphite	☐
Limestone	☐
Sodium carbonate	☐
Sodium hydroxide	☐

(2)

Window frames need to be:

- easy to install
- resistant to damage.

The polymers poly(chloroethene) and HDPE are used to make window frames.

Table 1 shows information about poly(chloroethene) and HDPE.

Table 1

Property	**Poly(chloroethene)**	**HDPE**
Density in g/cm^3	1.4	0.92
Relative strength	72	25

(b) Suggest **one** advantage of using poly(chloroethene) compared with HDPE to make window frames.

Give **one** reason for your answer. **(separate only)**

Use **Table 1**.

Advantage ______________________________

____

Reason ______________________________

____

(2)

(c) Suggest **one** advantage of using HDPE compared with poly(chloroethene) to make window frames.

Give **one** reason for your answer. **(separate only)**

Use **Table 1**.

Advantage ______________________________

____

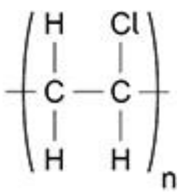
Reason ______________________________

____

(2)

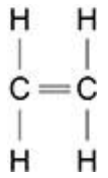
(d) **Figure 2** shows the displayed structural formula of poly(chloroethene).

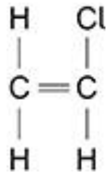
Figure 2

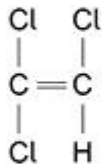


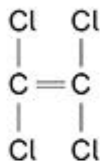
Which monomer is used to make poly(chloroethene)?

Tick (✓) **one** box. **(separate only)**









(1)

(e) Chlorine gas is used to produce poly(chloroethene).

Describe a test to identify chlorine gas.

Give the result of the test.

Test ____

____

Result ____

____

(2)

(f) Wood can be used instead of polymers to make window frames.

- Polymers are unreactive.
- Polymers are produced from crude oil.
- Wood breaks down in wet conditions.
- Wood is produced from trees.

Suggest **one** advantage of using polymers and **one** advantage of using wood to make window frames.

Advantage of polymers ____

____

Advantage of wood ____

____

(2)

Window frames can also be made from an alloy of aluminium.

(g) 6.00 kg of the alloy is used to make a window frame.

Table 2 shows the mass of each element in 6.00 kg of the alloy.

Table 2

Element	**Mass in kg**
Aluminium	5.94
Magnesium	0.04
Silicon	0.02

Calculate the percentage of aluminium in 6.00 kg of the alloy. **(separate only)**

____

____

Percentage of aluminium = _______________%

(2)

(h) Why is an alloy used instead of pure aluminium to make window frames?

____

____

(1)

(Total 14 marks)

Q2.

This question is about the rate of the reaction between hydrochloric acid and calcium carbonate.

A student investigated the effect of changing the size of calcium carbonate lumps on the rate of this reaction.

This is the method used.

1. Pour hydrochloric acid into a conical flask up to the 50 cm^3 line.
2. Add 10.0 g of small calcium carbonate lumps to the conical flask.
3. Attach a gas syringe to the conical flask.
4. Measure the volume of gas produced every 20 seconds for 100 seconds.
5. Repeat steps 1 to 4 using 10.0 g of large calcium carbonate lumps.

(a) The student used the 50 cm^3 line on the conical flask to measure the volume of hydrochloric acid.

Suggest a piece of equipment the student could use to make the measurement of volume more accurate.

____

(1)

(b) Carbon dioxide gas is produced in the reaction between hydrochloric acid and calcium carbonate.

Which test is used to identify carbon dioxide gas?

Tick (✓) **one** box.

A burning splint pops ☐

A glowing splint relights ☐

Damp litmus paper is bleached ☐

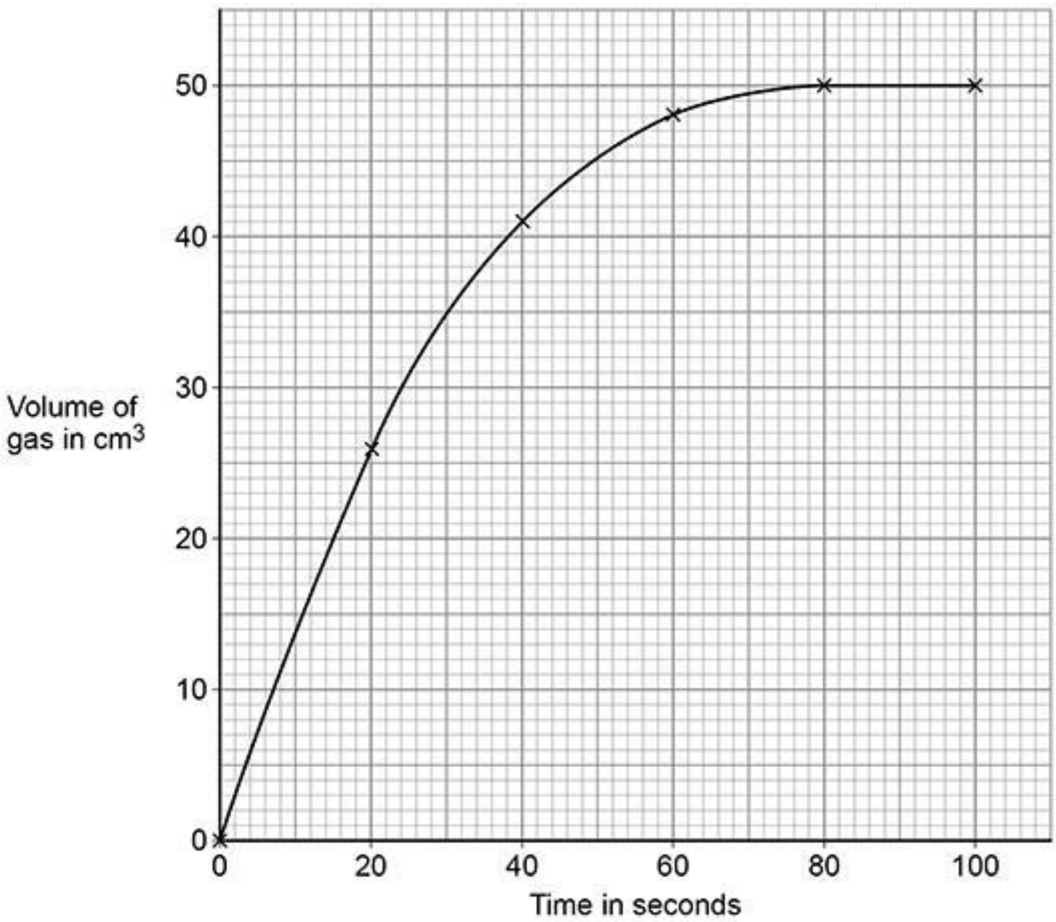
Limewater turns milky ☐

(1)

The table below shows the student's results for large calcium carbonate lumps.

Time in seconds	Volume of gas in cm^3
0	0
20	16
40	30
60	40
80	46
100	48

The graph below shows the student's results for small calcium carbonate lumps.



(c) Complete the graph above.

You should:

- plot the data for large calcium carbonate lumps from the table above on the graph paper
- draw a line of best fit for large calcium carbonate lumps.

(3)

(d) Determine the mean rate of reaction using **small** calcium carbonate lumps between 0 seconds and 60 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas produced}}{\text{time taken}}$$

Use the graph above.

___

___

___

___

Mean rate of reaction = _______________ cm^3/s

(3)

(e) Describe what happens to the volume of gas collected using **small** calcium carbonate lumps:

- between 0 and 20 seconds
- between 80 and 100 seconds.

Use the graph above.

Between 0 and 20 seconds

____

____

Between 80 and 100 seconds

____

____

(2)

(f) The balance used to weigh 10.0 g of calcium carbonate lumps caused an error.

The balance always read 0.2 g before being used.

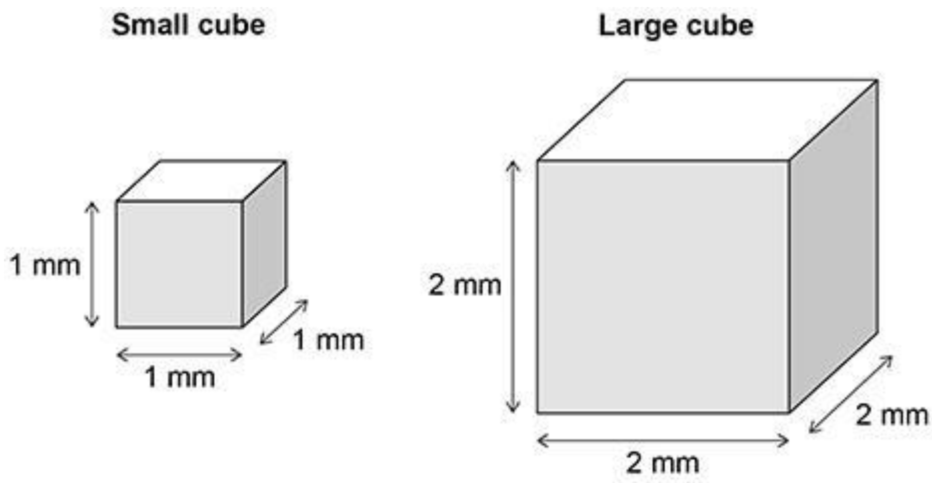
What type of error was caused by the balance?

Tick (✓) **one** box.

Human error	☐
Random error	☐
Systematic error	☐

(1)

The diagram shows the dimensions of two cubes of calcium carbonate.



(g) A cube of calcium carbonate has six faces.

Calculate the total surface area of the **large** cube of calcium carbonate.

Use the diagram above.

____

____

____

____

____

____

Total surface area = _______________ mm^2

(3)

(h) The large cube of calcium carbonate was divided into eight smaller cubes.

The eight smaller cubes have a greater total surface area than the one large cube.

Compare the rate of reaction when using the eight smaller cubes with the rate of reaction when using the large cube.

Complete the sentence.

Choose the answer from the box.

faster	**slower**	**the same**

The rate of reaction of the eight smaller cubes is _______________.

(1)

(Total 15 marks)

Q3.

This question is about algae.

A student:

- placed algae in water containing dissolved carbon dioxide
- shone bright light on the algae.

Gas bubbles were collected as the algae photosynthesised.

(a) Describe a test that would identify the gas collected.

Give the result of the test.

Test ____

Result ____

____

(2)

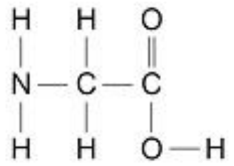
(b) Glucose is produced when algae photosynthesise.

Name **two** naturally occurring polymers produced from glucose. **(separate only)**

______________ and ______________

(2)

The diagram below shows the displayed structural formula of an amino acid called glycine.



(c) How many functional groups are there in the molecule in the diagram above ?

Tick (✓) **one** box. **(separate only)**

1 ☐ 2 ☐ 3 ☐ 4 ☐

(1)

(d) Glycine reacts by condensation polymerisation to produce a polypeptide and one other substance.

Name the other substance produced. **(separate only)**

____

(1)

(e) Scientists think that algae may have used gases in Earth's early atmosphere.

Algae need an element to produce the molecule in the diagram above which is **not** present in water or carbon dioxide.

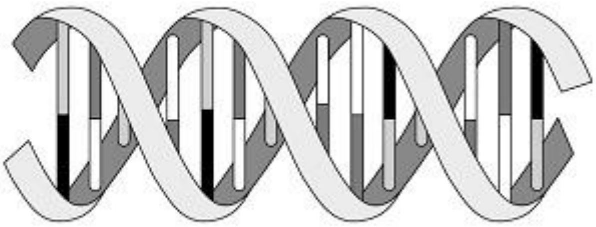
Which **two** gases from Earth's early atmosphere could have provided this element?

_______________ and _______________

(2)

(f) The development and function of algae are controlled by a naturally occurring polymer.

The image below represents the shape and structure of this polymer.



Describe the shape and structure of this polymer. **(separate only)**

____

____

____

____

____

____

(3)

(Total 11 marks)

Q4.

Some students investigated the rate of decomposition of hydrogen peroxide.

The equation for the reaction is:

hydrogen peroxide → water + oxygen

(a) Complete the sentence.

Choose an answer from the box.

a burning splint	**a glowing splint**

damp litmus paper	**limewater**

The students tested the gas produced to show that it was oxygen.

The students used

____.

(1)

Student **A** investigated the effect of the particle size of a manganese dioxide catalyst on the rate of the reaction.

This is the method used.

1. Measure 25 cm^3 hydrogen peroxide solution into a conical flask.
2. Add some fine manganese dioxide powder to the conical flask.
3. Measure the volume of oxygen produced every 30 seconds for 10 minutes.
4. Repeat steps 1 to 3 two more times.
5. Repeat steps 1 to 4 with coarse manganese dioxide lumps.

(b) The method student **A** used did **not** give repeatable results.

How could student **A** make the results repeatable?

Tick (✓) **one** box.

Student **A** should make measurements every 2 minutes.	☐
Student **A** should measure the mass of manganese dioxide.	☐
Student **A** should use 50 cm3 hydrogen peroxide.	☐
Student **A** should use a beaker instead of a conical flask.	☐

(1)

Student **B** used a method which gave repeatable results.

(c) How could student **B** improve the accuracy of these results?

Tick (✓) **one** box.

Calculate a mean but do not include any anomalous results.	☐

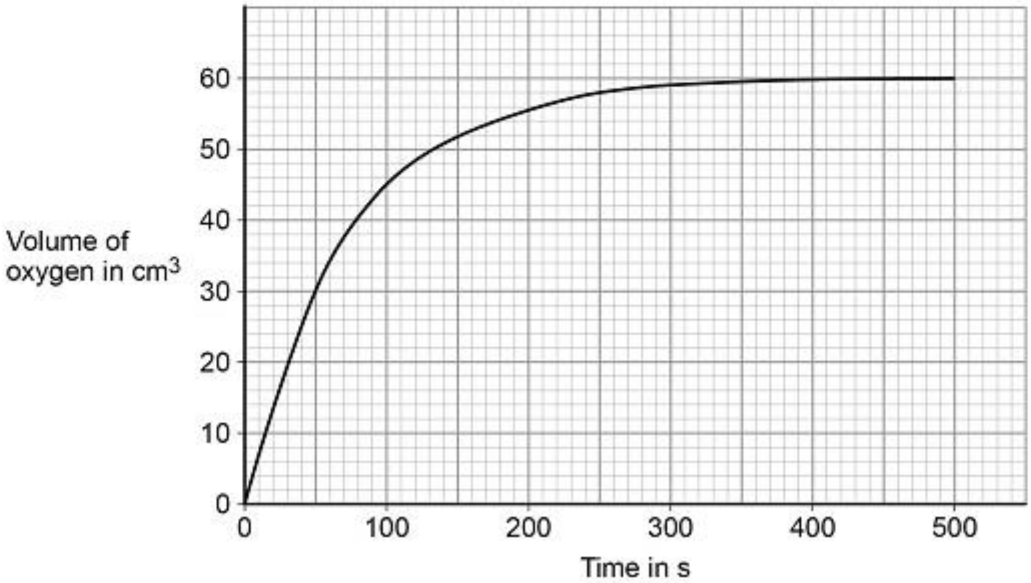
Calculate a mean but do not include the first set of results. ☐

Record the results in a table and plot the results on a bar chart. ☐

Record the results in a table and plot the results on a line graph. ☐

(1)

The figure below shows student **B**'s results for coarse manganese dioxide lumps.



(d) Calculate the mean rate of reaction between 30 and 250 seconds for coarse manganese dioxide lumps.

Use the figure and the equation:

$$\text{Mean rate of reaction} = \frac{\text{Volume of oxygen formed}}{\text{Time taken}}$$

Give your answer to 3 significant figures.

Volume of oxygen formed ___________________________________

Time taken ____

____

____

____

____

Mean rate of reaction = ________________________________ cm^3/s

(4)

(e) Fine manganese dioxide powder produces a higher rate of reaction than coarse manganese dioxide lumps.

Sketch on the figure above the results you would expect for student **B**'s experiment with fine manganese dioxide powder.

(2)

(f) Hydrogen peroxide molecules collide with manganese dioxide particles during the reaction.

Why does fine manganese dioxide powder produce a higher rate of reaction than coarse manganese dioxide lumps?

Tick (✓) **one** box.

Fine manganese dioxide powder has a larger surface area.	☐
Fine manganese dioxide powder has larger particles.	☐
Fine manganese dioxide powder produces less frequent collisions.	☐

(1)

(Total 10 marks)

Q5.

Some students investigated the rate of decomposition of hydrogen peroxide, H_2O_2

The equation for the reaction is:

$$2\,H_2O_2(aq) \rightarrow 2\,H_2O(l) + O_2(g)$$

The catalyst for the reaction is manganese dioxide.

(a) Describe a test to identify the gas produced in the reaction.

Give the result of the test.

Test ____

____

Result ____

____

(2)

Student **A** investigated the effect of the particle size of manganese dioxide on the rate of the reaction.

This is the method used.

1. Measure 25 cm^3 of 0.3 mol/dm^3 hydrogen peroxide solution into a conical flask.

2. Add a spatula of fine manganese dioxide powder to the conical flask.

3. Measure the volume of gas produced every minute for 10 minutes.

4. Repeat steps 1 to 3 with some coarse manganese dioxide lumps.

(b) The method student **A** used did not give valid results.

What **two** improvements could student **A** make to the method to give valid results?

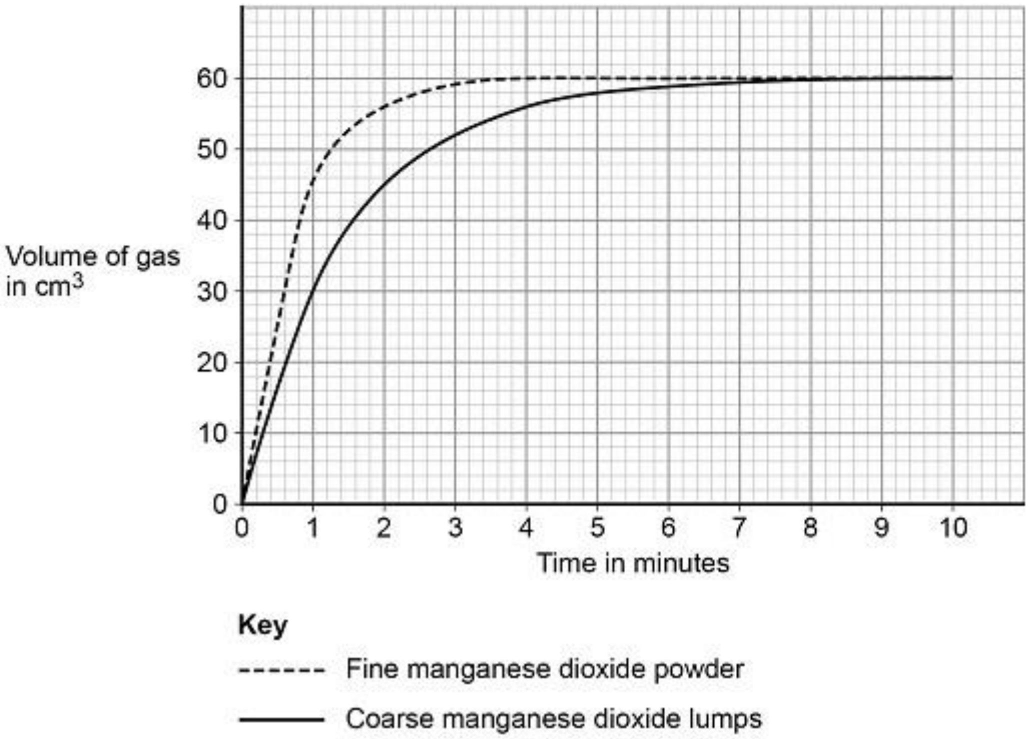
Tick (✓) **two** boxes.

Measure the increase in mass of the conical flask and contents.	☐
Measure the volume of gas produced every 2 minutes.	☐
Place the conical flask in a water bath at constant temperature.	☐
Use 0.05 mol/dm^3 hydrogen peroxide solution.	☐
Use a mass of 1 g manganese dioxide each time.	☐

(2)

Student **B** used a method which gave valid results.

The graph below shows student **B**'s results.



(c) Determine the mean rate of reaction in cm^3/s between 2 and 4 minutes for coarse manganese dioxide lumps.

Give your answer to 2 significant figures.

Use data from the graph.

____

____

____

____

Mean rate of reaction = ______________________ cm^3/s

(3)

Hydrogen peroxide molecules must collide with manganese dioxide particles for catalysis to take place.

(d) Student **B** repeated the experiment with coarse lumps of manganese dioxide.

Student **B** used the same volume of 0.2 mol/dm^3 hydrogen peroxide instead of 0.3 mol/dm^3 hydrogen peroxide.

Sketch on the graph above the curve you would expect to see.

Assume that the reaction is complete after 9 minutes.

(2)

(e) The rate of reaction is different when manganese dioxide is used as a fine powder rather than coarse lumps.

Explain why.

You should answer in terms of collision theory.

____

____

____

____

(2)
(Total 11 marks)

Q6.

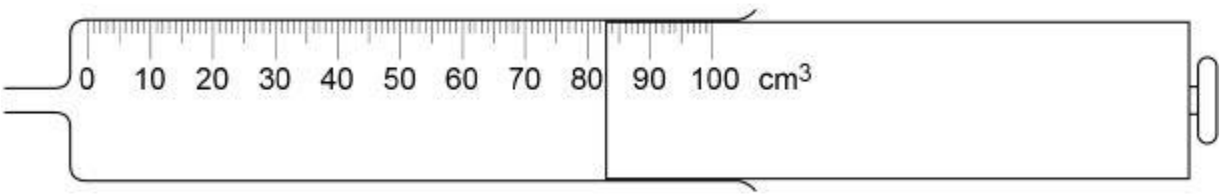
A student investigated how concentration affects the rate of reaction between magnesium and hydrochloric acid.

This is the method used.

1. Place hydrochloric acid in a conical flask.
2. Add magnesium powder.
3. Collect the gas produced in a gas syringe.
4. Measure the volume of gas every 40 seconds for 160 seconds.
5. Repeat steps 1-4 three more times.
6. Repeat steps 1-5 with hydrochloric acid of a higher concentration.

(a) **Figure 1** shows a gas syringe.

Figure 1



What is the volume of gas in the syringe?

Volume = ________________________ cm^3

(1)

(b) Which **two** variables should the student keep the same to make the investigation a fair test?

Tick **two** boxes.

Concentration of hydrochloric acid ☐

Mass of magnesium powder ☐

Temperature of hydrochloric acid ☐

Time for reaction to end ☐

Volume of gas collected ☐

(2)

The table below shows the student's results for the experiment with hydrochloric acid of a lower concentration.

Time in seconds	**Volume of gas collected in cm^3**				
	Test 1	**Test 2**	**Test 3**	**Test 4**	**Mean**
0	0	0	0	0	0
40	46	30	47	49	**X**
80	78	83	83	82	82
120	98	94	96	95	96
160	100	100	100	100	100

(c) Calculate mean value **X** in the table above.

Do **not** include the anomalous result in your calculation.

Give your answer to 2 significant figures.

____

____

____

X = ______________________ cm^3

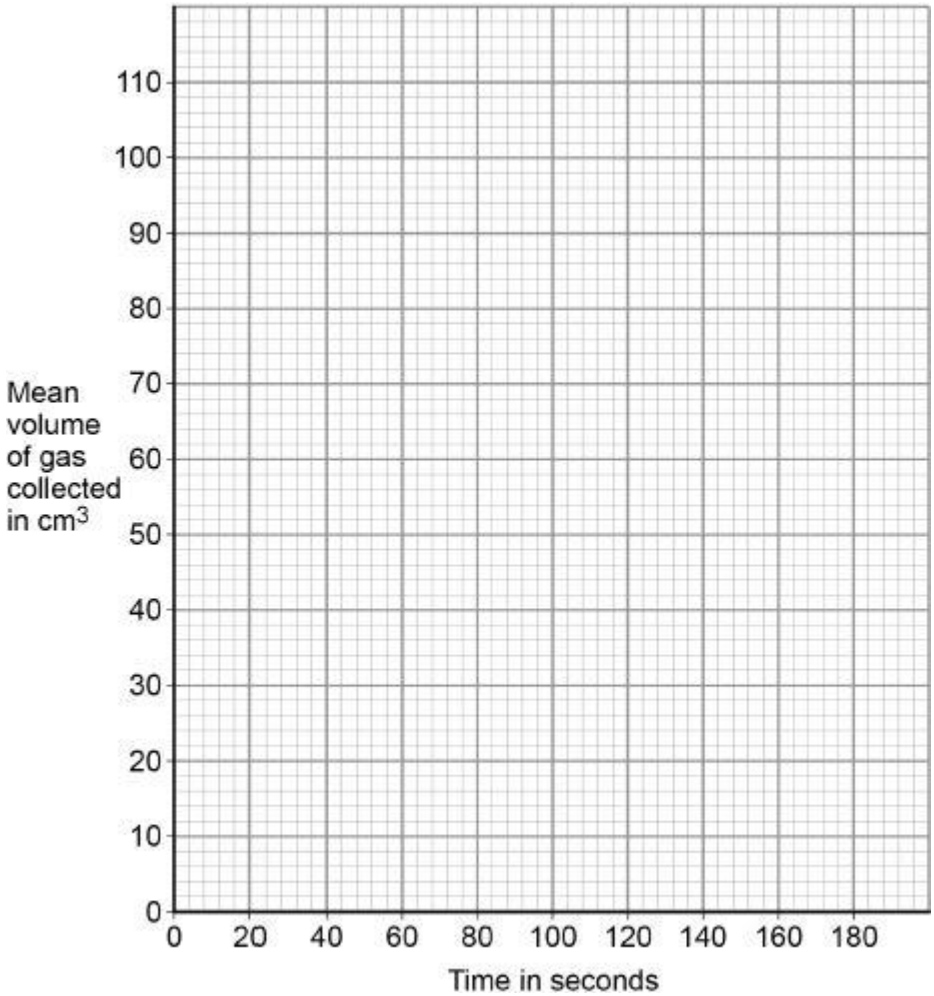
(2)

(d) Plot the data from the table above on **Figure 2**.

You should include your answer to Question **(c)**.

You do **not** need to draw a line of best fit.

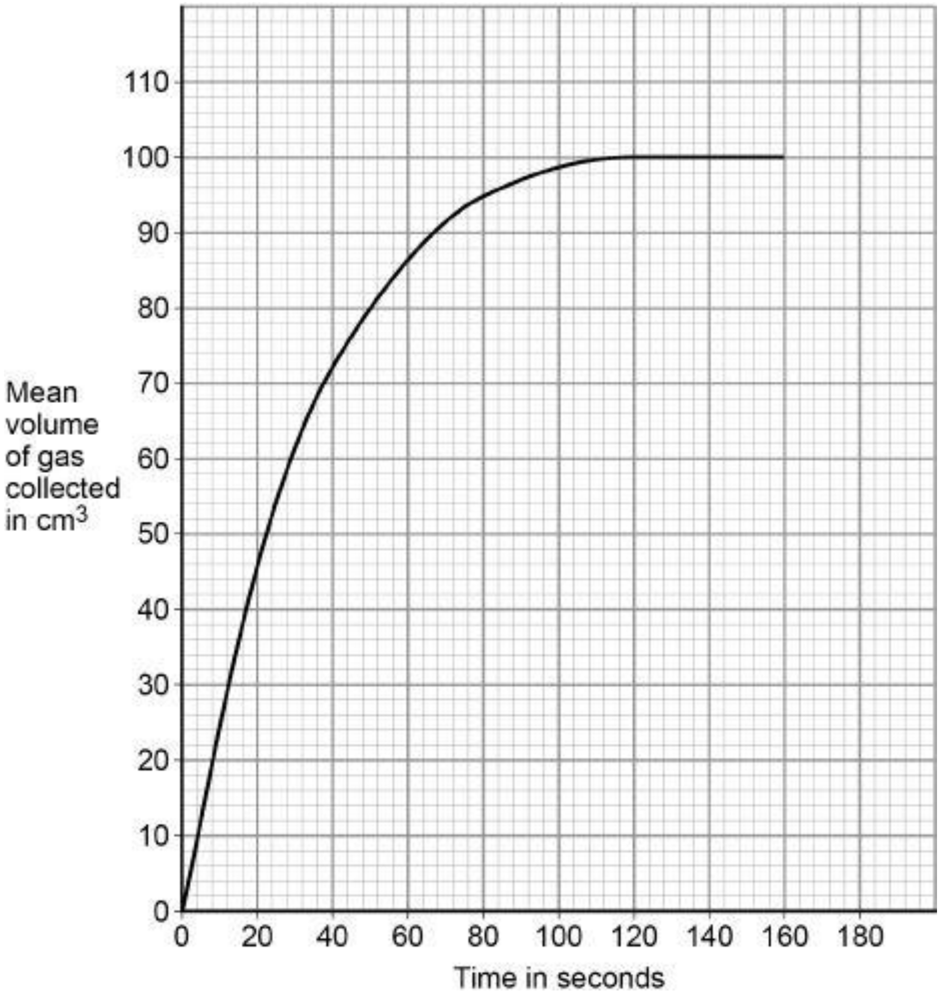
Figure 2



(2)

Figure 3 shows results of the experiment with the hydrochloric acid of a higher concentration.

Figure 3



(e) Calculate the mean rate of reaction between 0 and 50 seconds.

Use **Figure 3** and the equation:

$$\text{mean rate of reaction} = \frac{\text{mean volume of gas collected}}{\text{time taken}}$$

____

____

____

Mean rate of reaction = ______________________ cm^3/s

(2)

(f) Describe how the **rate of reaction** changes between 0 and 160 seconds.

Use **Figure 3**.

____

____

____

____

____

____

(3)

(g) The student concludes that the rate of reaction is greater when the concentration of hydrochloric acid is higher.

Why is the rate of reaction greater when the concentration of hydrochloric acid is higher?

Tick **two** boxes.

The particles are moving faster	☐
The particles have more energy	☐
The surface area of magnesium is smaller	☐
There are more particle collisions each second	☐
There are more particles in the same volume	☐

(2)

(h) The student tests the gas produced by bubbling it through limewater.

No change is seen in the limewater.

Give **one** conclusion the student can make about the gas.

____

____

(1)

(i) The student tests the gas produced using a burning splint.

Name the gas the student is testing for.

Give the result of a positive test for this gas.

Name of gas ____

Result ____

(2)
(Total 17 marks)

Q7.

Potable water is water that is safe to drink.

Seawater can be changed into potable water by desalination.

(a) Name the substance removed from seawater by desalination.

___

(1)

(b) Desalination requires large amounts of energy.

Desalination is only used when there is no other source of potable water.

Give **one** reason why.

___

___

(1)

Water from lakes and rivers can be treated to make it potable.

(c) The first stage is to filter the water from lakes and rivers.

Why is the water filtered?

___

___

(1)

(d) Chlorine gas is then added to the filtered water.

Why is chlorine gas used to treat water?

___

___

(1)

(e) Describe a test for chlorine gas.

Give the result of the test if chlorine is present.

Test ___

Result ___

(2)

Some students investigated different water samples.

The table shows some of their results.

Water	**pH**	**Mass of dissolved solid in g / dm^3**
Tap water	6.5	0.5
Seawater	8.1	35.0
Pure water		

(f) Complete the table above to show the expected results for pure water.

(2)

(g) What mass of dissolved solid is present in 100 cm^3 of the sample of tap water?

Tick (✓) **one** box.

0.05 g ☐

0.5 g ☐

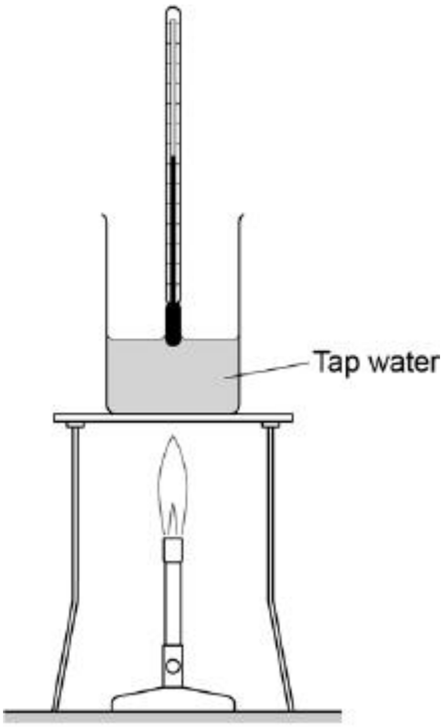
5 g ☐

50 g ☐

(1)

(h) Boiling points can be used to show whether substances are pure.

The diagram shows the apparatus the students used to find the boiling point of tap water.



The students made a mistake setting up the apparatus.

What mistake did the students make?

____

____

(1)
(Total 10 marks)

Q8.

This question is about mixtures and analysis.

(a) Which **two** substances are mixtures?

Tick **two** boxes.

Air	☐
Carbon dioxide	☐
Graphite	☐
Sodium Chloride	☐
Steel	☐

(2)

(b) Draw **one** line from each context to the correct meaning.

Context	Meaning
	A substance that has had nothing added to it
Pure substance in chemistry	A single element or a single compound
	A substance containing only atoms which have different numbers of protons
Pure substance in everyday life	A substance that can be separated by filtration
	A useful product made by mixing substances

(2)

(c) What is the test for chlorine gas?

Tick **one** box.

A glowing splint relights ☐

A lighted splint gives a pop ☐

Damp litmus paper turns white ☐

Limewater turns milky ☐

(1)

(d) A student tested a metal chloride solution with sodium hydroxide solution.

A brown precipitate formed.

What was the metal ion in the metal chloride solution?

Tick **one** box. **(separate only)**

Calcium ☐

Copper(II) ☐

Iron(II) ☐

Iron(III) ☐

(1)
(Total 6 marks)