1 Magnesium reacts with dilute hydrochloric acid, HC*l*.

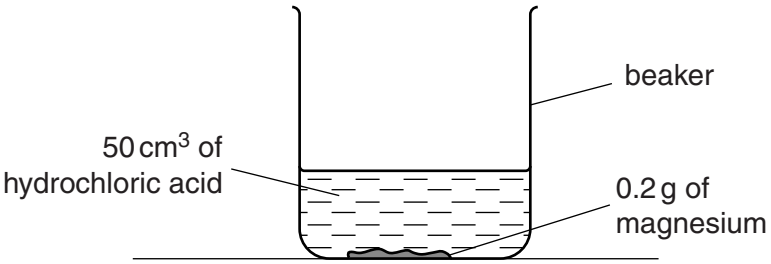
Magnesium chloride and hydrogen, H_2, are made.

(a) Write down the **balanced symbol** equation for this reaction.

..... **[2]**

(b) Peter and Rachel investigate the reaction between magnesium and hydrochloric acid.

Look at the apparatus they use.



They time how long it takes for all of the magnesium to react (the reaction time).

Look at their results.

experiment	temperature of acid	concentration of acid	magnesium ribbon or powder	reaction time in seconds	mean rate of reaction in g/s
A	cold	dilute	ribbon	240	8.33×10^{-4}
B	cold	concentrated	ribbon	120	
C	warm	dilute	ribbon	100	2.00×10^{-3}
D	cold	dilute	powder	50	4.00×10^{-3}

(i) Look at the results for experiment **B**.

Calculate the mean rate of reaction in experiment **B**.

Give your answer to **three** significant figures.

.....

.....

rate of reaction = ... g/s **[1]**

(ii) Peter and Rachel can use a model called **collision theory** to explain how factors affect the rate of a reaction.

They know the rate of reaction increases when

- the temperature of the acid increases
- magnesium powder is used instead of magnesium ribbon.

Explain why, using collision theory.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

[Total: 9]

2 Martin investigates the corrosion of different metals and alloys.

He places pieces of the metals or alloys in different concentrations of sulfuric acid.

He does his experiment at three different temperatures.

Look at his results.

Temperature in °C	Sulfuric acid concentration in %	Resistance to corrosion		
		Niobium	Zirconium	Hastelloy
20	10	excellent	excellent	poor
	40	excellent	excellent	good
	70	excellent	excellent	excellent
	90	good	poor	excellent
40	10	poor	excellent	poor
	40	poor	excellent	poor
	70	poor	excellent	poor
	90	poor	poor	poor
60	10	poor	excellent	poor
	40	poor	excellent	poor
	70	poor	good	poor
	90	poor	poor	poor

(a) Martin concludes that:

- all three metals or alloys are more resistant to corrosion at lower concentrations of sulfuric acid
- all three metals or alloys are more resistant to corrosion at lower temperatures.

Is he correct?

Use information from the table to explain your answer.

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..... **[2]**

(b) Martin does another experiment.

He investigates how the pH of an acid affects the rate of corrosion of one alloy.

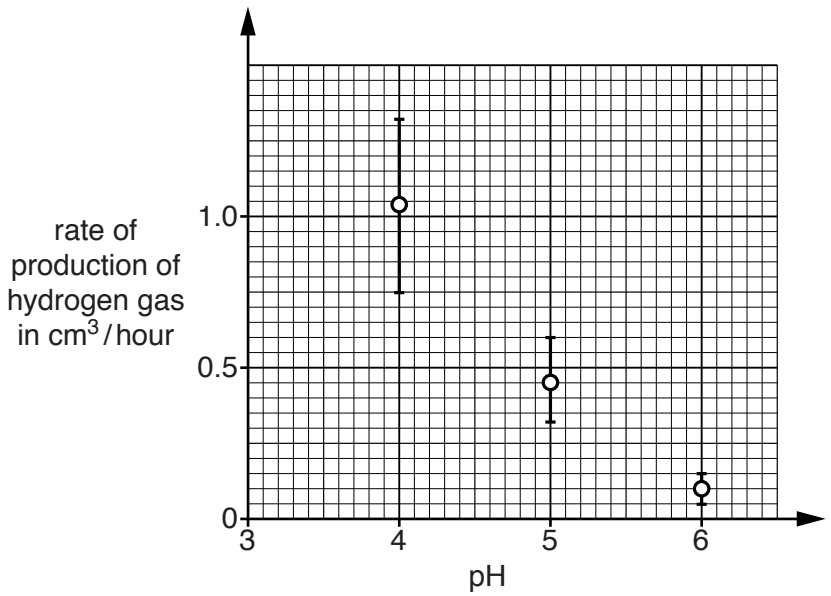
The alloy reacts with the acid to produce hydrogen gas.

Martin measures the rate at which the hydrogen gas is made.

He does this at three different pH values.

He repeats his experiment five times at each pH and then plots a graph of his results.

Look at his graph.



(i) What was the **highest** rate of production of hydrogen gas that Martin measured at pH 5?

answer ..... cm^3/hour **[1]**

(ii) At which pH did Martin get the most **repeatable** results?

..... **[1]**

(c) Aluminium, A*l*, reacts with sulfuric acid, H_2SO_4.

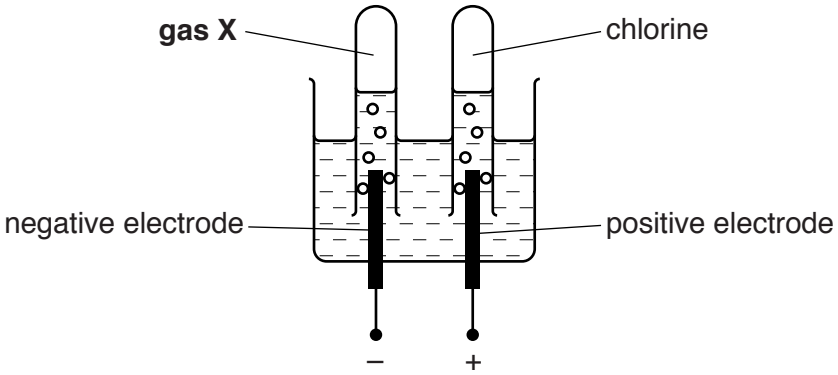
Aluminium sulfate, $Al_2(SO_4)_3$, and hydrogen, H_2, are made.

Write a **balanced symbol** equation for this reaction.

..... **[2]**

3 Anita investigates the electrolysis of concentrated sodium chloride solution (brine).

Look at the diagram. It shows the apparatus she uses.



(a) What is the name of gas **X**?

Choose your answer from the list.

carbon dioxide

hydrogen

hydrogen chloride

oxygen

answer ..... **[1]**

(b) It is important to use **inert electrodes** in the electrolysis of sodium chloride solution.

Explain why.

.....

..... **[1]**

(c) During the electrolysis of sodium chloride solution, the chloride ions are turned into chlorine molecules.

(i) Complete the equation for this reaction.

..... Cl^- − ..... e^- → Cl_2 **[1]**

(ii) Is this reaction **oxidation** or **reduction**?

Explain how you can tell from the equation.

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..... **[1]**

4 This question is about fertilisers.

(a) Farmers add fertilisers to the soil.

Some people think that farmers should not use fertilisers.

Write down a reason **for** and a reason **against** the use of fertilisers.

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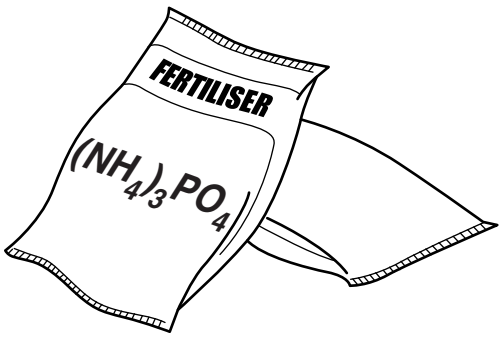
..... **[2]**

(b) Ammonium phosphate, $(NH_4)_3PO_4$, is a fertiliser.



(i) Complete the table to show the number of each **type of atom** in the formula $(NH_4)_3PO_4$.

Atom	Number
N	.....
H	.....
P	.....
O	.....

[2]

(ii) Ammonium phosphate solution is made by reacting an acid with an alkali in a **neutralisation** reaction.

Describe how pure, dry crystals of ammonium phosphate can be made, including the names of the **acid** and **alkali** needed.

The quality of written communication will be assessed in your answer to this question.

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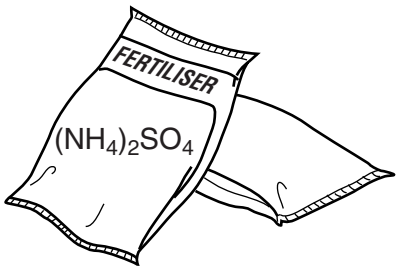
..... **[6]**

5 This question is about fertilisers.

(a) Ammonium sulfate, $(NH_4)_2SO_4$, is used as a fertiliser.



Complete the table to show the number of **atoms of each element** in the formula for ammonium sulfate.

Element	Number of atoms
nitrogen	……...
hydrogen	……...
sulfur	……...
oxygen	……...

[1]

(b) Ammonium sulfate is made by reacting an acid with an alkali.

Name the acid and alkali needed.

Describe how the acid and alkali are used to make a sample of ammonium sulfate.

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..... **[3]**

(c) Nitric acid is used to manufacture fertilisers.

Ammonia, NH_3, and oxygen, O_2 are used to manufacture nitric acid, HNO_3.

Water is the other product.

The reaction between ammonia and oxygen uses the following conditions:

- a temperature of 900 °C
- atmosphe ic pressure
- a platinum catalyst.

Construct the **balanced symbol** equation for the manufacture of nitric acid and explain the **advantages** and **disadvantages** of using these conditions.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

[Total: 10]

6 During the electrolysis of sodium bromide solution, bromide ions make bromine molecules.

(a) Complete the equation for this reaction.

…… Br^- – ……e^- $\rightarrow$ Br_2

[1]

(b) Explain why this reaction is an example of **oxidation**.

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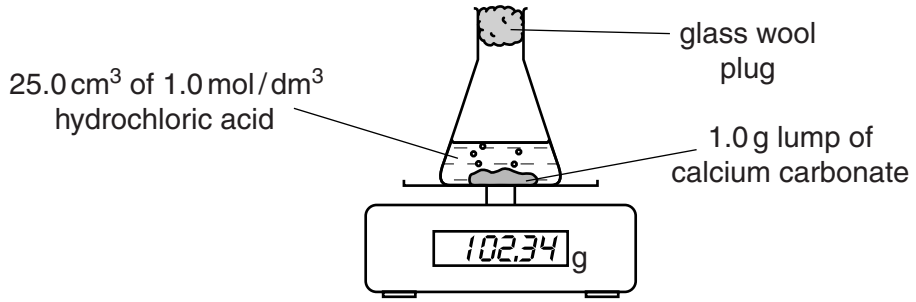
..... **[1]**

[Total: 2]

7 Debbie places a 1.0 g lump of calcium carbonate into a flask.

She adds 25.0 cm^3 of 1.0 mol/dm^3 hydrochloric acid to the flask.

She puts the flask on top of an electronic balance.



This apparatus can be used to find the mass of carbon dioxide made during the reaction.

(a) Debbie repeats the experiment.

This time she uses 25.0 cm^3 of 1.0 mol/dm^3 **ethanoic acid** instead of hydrochloric acid.

The reaction is much slower because ethanoic acid is a weak acid.

Explain why weak acids react **more slowly** than strong acids.

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..... **[1]**

(b) Debbie wants to measure the **volume** of carbon dioxide made during the reaction.

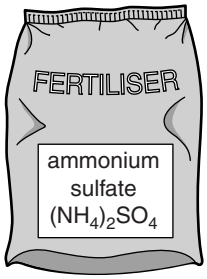
Draw a labelled diagram of the apparatus she should use.

[2]

[Total: 3]

8 This question is about fertilisers.

(a) Ammonium sulfate is used as a fertiliser.



The formula for ammonium sulfate is $(NH_4)_2SO_4$.

(i) Write down the number of **different elements** in ammonium sulfate.

answer ..... **[1]**

(ii) Write down the number of **atoms** in this formula.

answer ..... **[1]**

(b) Amy and Chris decide to make some **solid ammonium sulfate** by neutralisation.

They use an acid and an alkali.

Name the acid and alkali they use and describe the experimental method they use.

The quality of written communication will be assessed in your answer to this question.

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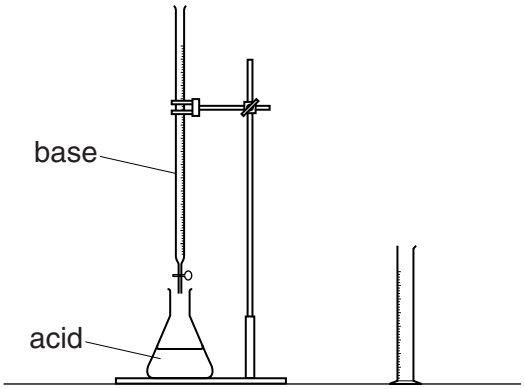
..... **[6]**

[Total: 8]

9 Jade and Philip are making fertilisers by neutralisation.



(a) Complete the **word** equation for neutralisation.

acid + base → ..... + water **[1]**

(b) Jade and Philip want to make potassium nitrate.

Which **acid** and which **base** should they use?

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..... **[2]**

(c) Jade and Philip also make ammonium phosphate.

The formula of ammonium phosphate is

$$(NH_4)_3PO_4$$

What is the total number of **atoms** in this formula?

..... **[1]**

[Total: 4]