AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.5.1.1

Energy transfer during exothermic and endothermic reactions

Past-paper questions

Tier	**Foundation**
Question groups	**64**
Available paper years	**2007–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 01

January 2007 | CHY1F | Original Q4 | Legacy

4 Limestone contains calcium carbonate.

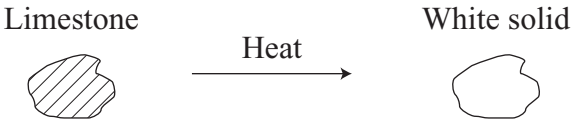
(a) Calcium carbonate has the formula $CaCO_3$.

Complete the sentence by writing in the correct numbers.

The formula of calcium carbonate is made up of 1 calcium atom, ... carbon atom(s) and ..... oxygen atom(s).

(2 marks)

(b) When limestone is heated it forms two other compounds.



$$\mathbf{CaCO_3} \rightarrow \mathbf{CaO} + \mathbf{CO_2}$$

(i) State **one** safety precaution that you should take when heating limestone.

.....

(1 mark)

(ii) Name the white solid produced.

.....

(1 mark)

(iii) Why does a piece of limestone lose mass as it is heated?

.....

.....

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 01 · continued

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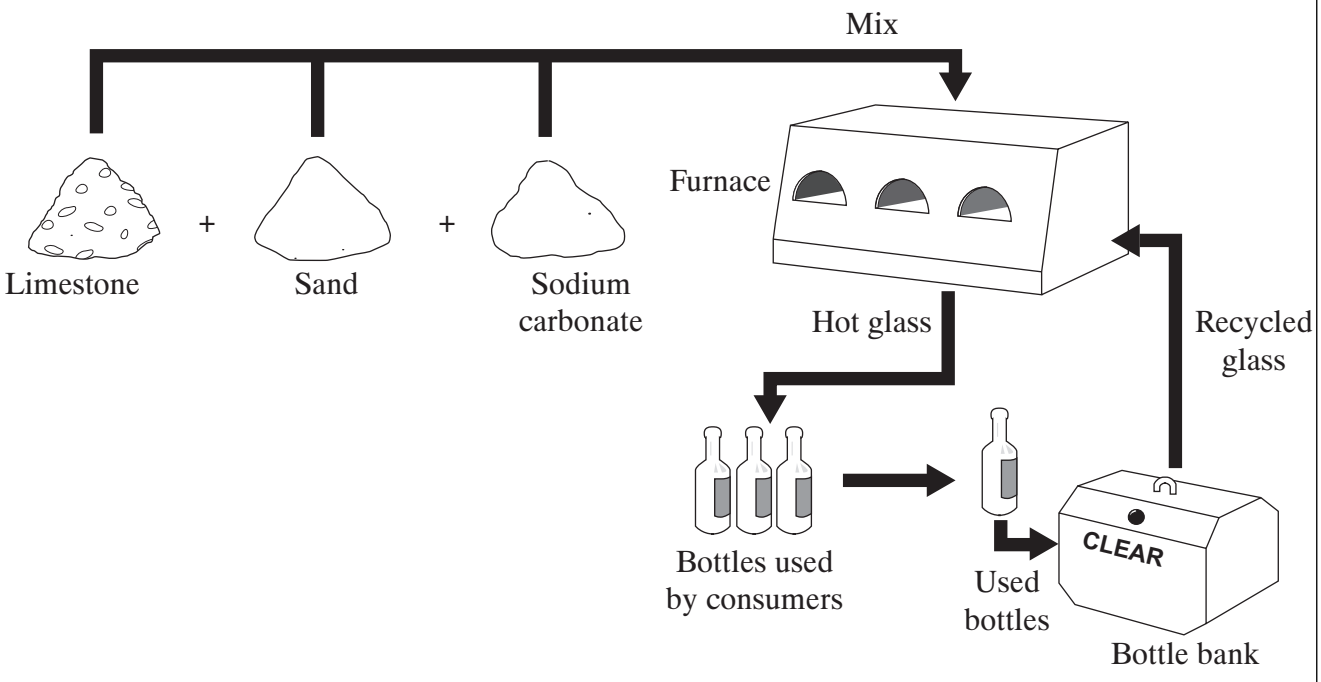
(c) Limestone is used to manufacture glass. Glass is made by heating a mixture of limestone, sand and sodium carbonate in a furnace.
The reaction requires a high temperature. If some recycled glass is added, the reaction takes place at a lower temperature.



Suggest **two** reasons why people are encouraged to recycle glass.

1 .....

.....

2 .....

.....

(2 marks)

Question 4 continues on the next page

Question 01 · continued

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(d) A company wants to quarry limestone. There are some houses near the quarry.



Residents in the houses say that they do not want a quarry next to them.

(i) Suggest **two** reasons why they do not want the quarry next to them.

1 .....

.....

2 .....

.....

(2 marks)

(ii) Suggest **one** possible benefit to the residents of having a quarry near their houses.

.....

.....

(1 mark)

10

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 02

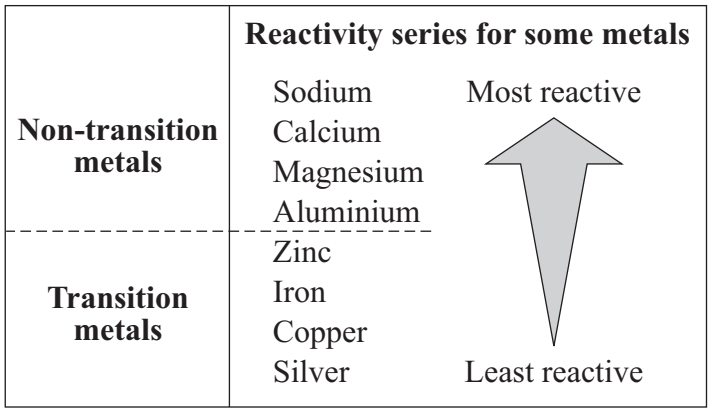
June 2007 | CHY1A | Original Q7 | Legacy

QUESTION SEVEN

The table shows what happens to some metal carbonates when they are heated in a Bunsen burner flame.

Name of carbonate	What happens when heated
Sodium carbonate	melts at 851°C but decomposes only at much higher temperatures
Calcium carbonate	decomposes at 825 °C
Magnesium carbonate	decomposes at 350 °C
Zinc carbonate	decomposes at 300 °C
Silver carbonate	decomposes at 220 °C

The information below may help you to answer some parts of this question.



7A What pattern, if any, can be seen in these results for the action of heat on metal carbonates?

1 All metal carbonates decompose when they are heated in a Bunsen burner flame.

2 Carbonates of the more reactive metals decompose at higher temperatures.

3 Carbonates of the transition metals decompose at higher temperatures.

4 There is no pattern to the results.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 02 · continued June 2007 | CHY1A | Original Q7 | Legacy

7B Potassium carbonate melts at 891°C but does not decompose.

What is the probable position of potassium in the reactivity series?

1 below silver

2 between silver and copper

3 between calcium and sodium

4 above sodium

7C What is produced by all metal carbonates when they decompose?

1 oxygen

2 hydrogen

3 a metal oxide

4 a hydrocarbon

7D 3.10 grams of copper carbonate are heated in a test tube until completely decomposed.
1.10 grams of carbon dioxide are collected and a black compound is left in the test tube.

What is the mass of the black compound?

1 1.10 grams

2 2.00 grams

3 3.41 grams

4 4.20 grams

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 03

January 2008 | CHY2F | Original Q3 | Legacy

3 Distress flares are used to attract attention in an emergency.



Flares often contain magnesium. Magnesium burns to form magnesium oxide.

(a) The distress flare burns with a bright flame because the reaction is very *exothermic*.

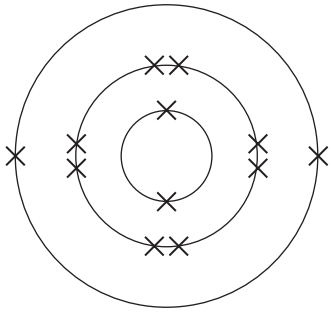
Complete the following sentence using the correct words from the box.

gives out heat	**stores heat**	**takes in heat**

An *exothermic* reaction is one which ..... .

(1 mark)

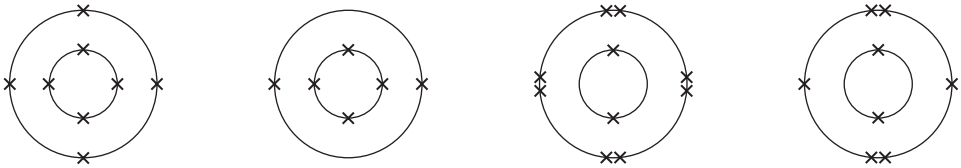
(b) The diagram shows the electronic structure of a magnesium atom.
The atomic (proton) number of magnesium is 12.



Magnesium atom

The atomic (proton) number of oxygen is 8.

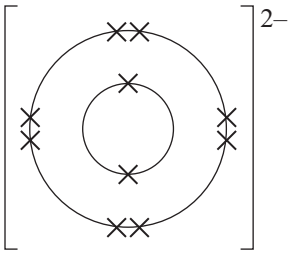
Which diagram, **A**, **B**, **C** or **D**, shows the electronic structure of an oxygen atom?



A **B** **C** **D**

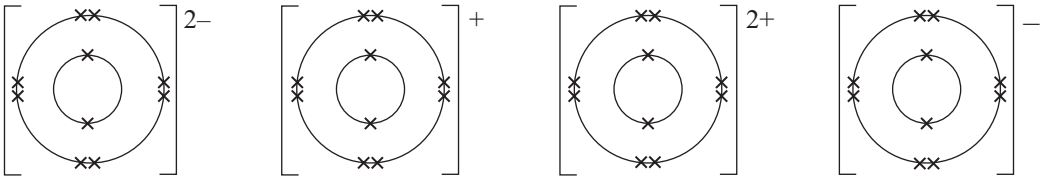
Diagram .....
(1 mark)

(c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen. The diagram shows the electronic structure of an oxide ion.



Oxide ion

Which diagram, **J**, **K**, **L** or **M**, shows the electronic structure of a magnesium ion?



J **K** **L** **M**

Diagram .....
(1 mark)

(d) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Draw a ring around the name of the salt formed when magnesium oxide reacts with hydrochloric acid.

magnesium chloride **magnesium hydroxide** **magnesium sulfate**

(1 mark)

4

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 04

January 2008 | CHY2F | Original Q6 | Legacy

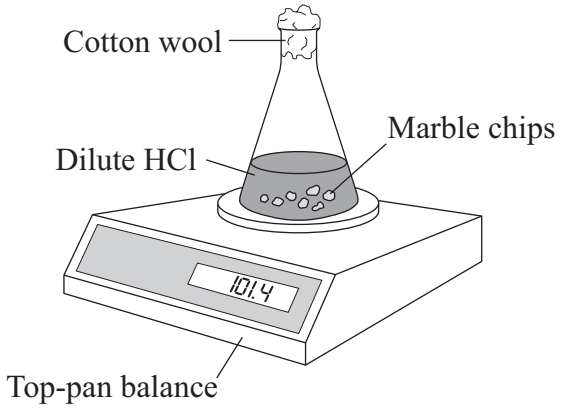
6 A student investigated the rate of reaction between marble and hydrochloric acid.

The student used an excess of marble.

The reaction can be represented by this equation.

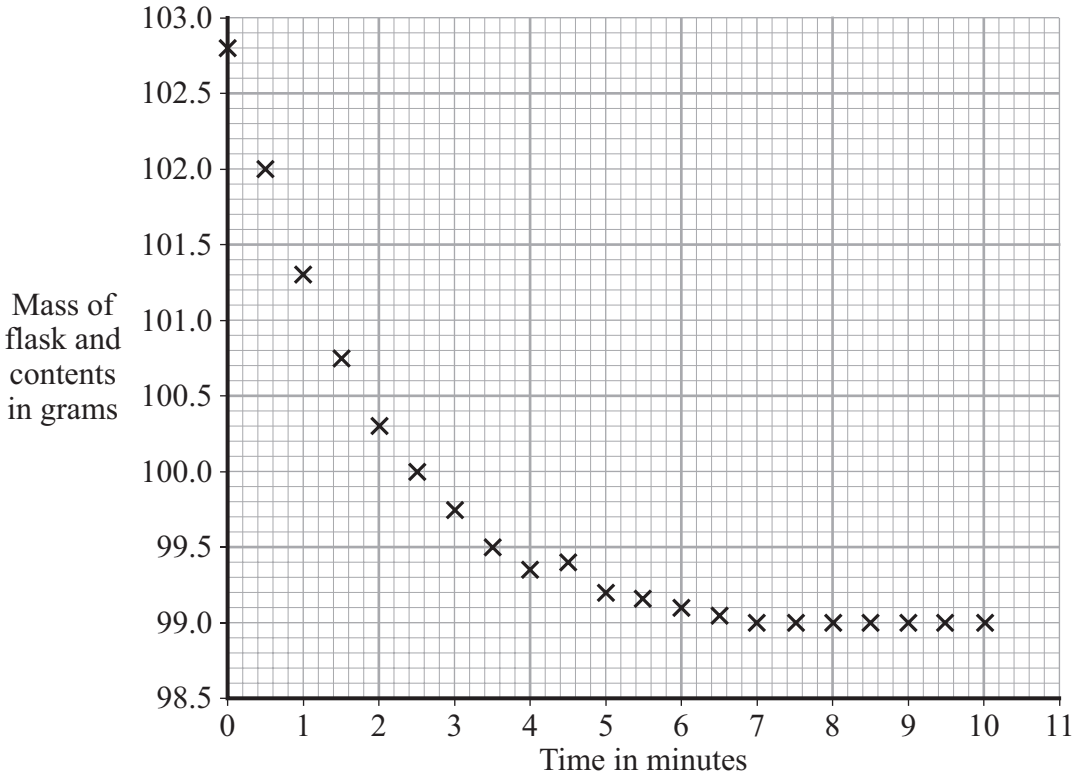
$CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$ (aq) + H_2O (l) + CO_2 (g)

The student used the apparatus shown in the diagram.



The student measured the mass of the flask and contents every half minute for ten minutes.

The results are shown on the graph. Use the graph to answer the questions.



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 04 · continued

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(a) **Complete the graph** opposite by drawing a line of best fit.

(1 mark)

(b) Why did the mass of the flask and contents decrease with time?

.....

.....

(1 mark)

(c) After how many minutes had all the acid been used up?

..... minutes

(1 mark)

(d) The student repeated the experiment at a higher temperature. All other variables were kept the same as in the first experiment. The rate of reaction was much faster.

(i) Draw a line **on the graph** opposite to show what the results for this second experiment might look like.

(2 marks)

(ii) Why does an increase in temperature increase the rate of reaction?

.....

.....

.....

.....

.....

.....

(3 marks)

8

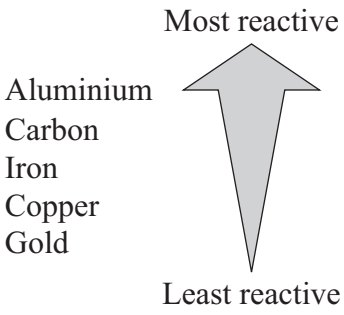
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 05

March 2008 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

This is the order of reactivity for five elements.



Match metals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A iron

B aluminium

C copper

D gold

	What we can say about the metal
1	It will **not** react with oxygen or water even at high temperatures.
2	It is made in the blast furnace by the reduction of its oxide with carbon.
3	It can be extracted from its molten ore with electricity but **not** with carbon.
4	It can be extracted from its ore with carbon and is purified by electrolysis.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 06

June 2008 | CHY1F | Original Q7 | Legacy

7 Limestone is mainly calcium carbonate.

7 (a) Quicklime is produced by heating limestone.

7 (a) (i) Complete the word equation for this reaction by writing the chemical name of the solid and the gas produced.

calcium carbonate → ..... + ...

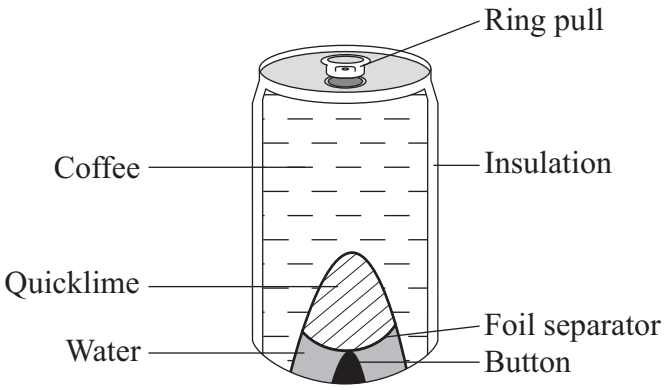
(2 marks)

7 (a) (ii) What is the name for this type of chemical reaction?

.....

(1 mark)

7 (b) Quicklime is used in self-heating cans.
The diagram shows a self-heating can designed to raise the temperature of coffee to 60 °C.



The button on the base of the can is pushed. The foil separator breaks, allowing water to mix with the quicklime. After about 3 minutes, the can is opened by the ring pull. Insulating materials are used inside the walls of the can to prevent either the lips or the fingers from being burned.

7 (b) (i) Explain why the coffee becomes hot.

.....

.....

.....

.....

(2 marks)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 06 · continued

for mark

7 (b) (ii) Suggest **two** reasons why it is **not** possible to re-use this self-heating can.

1 .....

.....

2 .....

.....

(2 marks)

7

Turn over for the next question

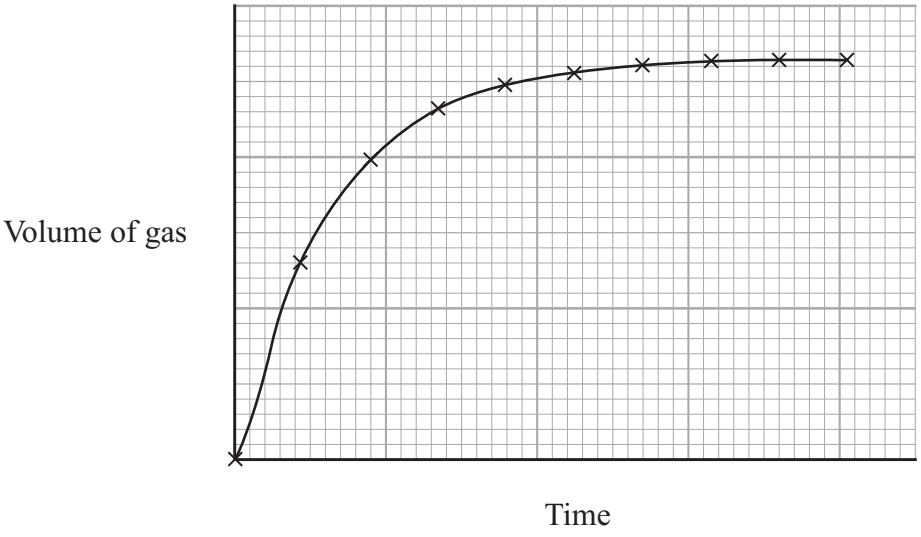
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 07

June 2008 | CHY2F | Original Q2 | Legacy

2 Pieces of zinc react with dilute acid to form hydrogen gas.

The graph shows how the volume of hydrogen gas produced changes with time.



2 (a) Describe, as fully as you can, how the volume of gas produced changes with time.

.....

.....

.....

.....

(2 marks)

2 (b) A student wants to make the reaction take place faster.
Some suggestions are given in the table.

Put ticks (✓) next to the **two** suggestions that would make the reaction take place faster.

Suggestions	(✓)
Use bigger pieces of zinc.	
Use a more concentrated acid.	
Use zinc powder.	
Decrease the temperature of the acid.	

(2 marks)

4

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 08

June 2008 | CHY2F | Original Q4 | Legacy

4 Instant cold packs are used to treat sports injuries.



One type of cold pack has a plastic bag containing water. Inside this bag is a smaller bag containing ammonium nitrate.

The outer bag is squeezed so that the inner bag bursts. The pack is shaken and quickly gets very cold as the ammonium nitrate dissolves in the water.

4 (a) **One** of the statements in the table is correct.

Put a tick (✓) next to the correct statement.

Statement	(✓)
The bag gets cold because heat energy is given out to the surroundings.	
The bag gets cold because heat energy is taken in from the surroundings.	
The bag gets cold because plastic is a good insulator.	

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 08 · continued

for mark

4 (b) Draw a ring around the word that best describes the change when ammonium nitrate dissolves in water.

electrolysis **endothermic** **exothermic**

(1 mark)

4 (c) Suggest and explain why the pack is shaken after the inner bag has burst.

.....

.....

.....

.....

(2 marks)

4

Turn over for the next question

4.5.1.1 Energy transfer during exothermic and endothermic reactions

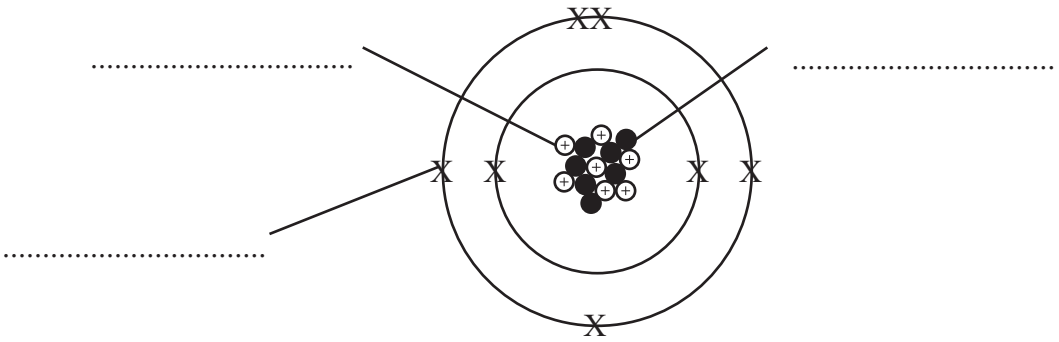
Question 09

June 2008 | CHY2F | Original Q5 | Legacy

5 (a) The diagram represents an atom of nitrogen.

5 (a) (i) Use words from the box to label the diagram.

electron	**neutron**	**nucleus**	**proton**



(2 marks)

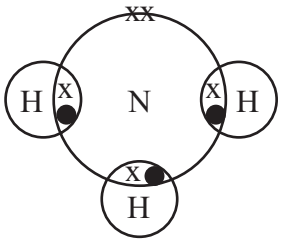
5 (a) (ii) Draw a ring around the mass number of this atom.

5 **7** **14** **21**

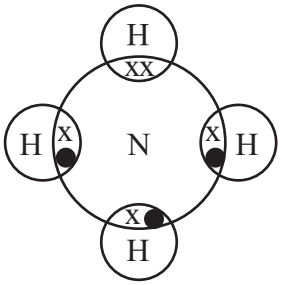
(1 mark)

5 (b) Nitrogen can react with hydrogen to make ammonia, NH_3.

A



B



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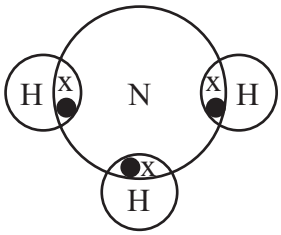
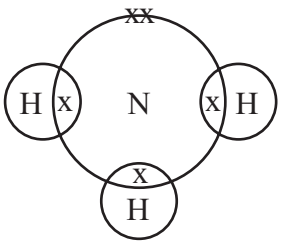


D



Which diagram, **A**, **B**, **C** or **D**, best represents an ammonia molecule?

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 09 · continued

for mark

5 (c) Ammonia is made using the Haber process. The word equation for this reaction is shown below.

nitrogen + hydrogen $\rightleftharpoons$ ammonia

5 (c) (i) Which **two** of the statements in the table do you know are true **only** by looking at the word equation?

Put a tick (✓) next to these **two** true statements.

Statement	(✓)
The reaction is very fast.	
Ammonia can break up to form nitrogen and hydrogen.	
Ammonia is made from nitrogen and hydrogen.	
The reaction that makes ammonia is endothermic.	

(2 marks)

5 (c) (ii) Draw a ring around the name of the raw material from which nitrogen is obtained.

air **methane** **oil** **water**

(1 mark)

5 (d) Some of the ammonia produced is neutralised by nitric acid to make a salt. This salt is used as a fertiliser.

Put a tick (✓) next to the name of the salt produced when ammonia is neutralised with nitric acid.

Name of salt	(✓)
ammonia nitrate	
ammonia nitride	
ammonium nitrate	
ammonium nitride	

(1 mark)

8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

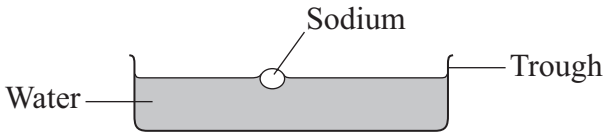
Question 10

June 2008 | CHY3F | Original Q2 | Legacy

2 (a) Read a student's report about the reaction between sodium and water.

The reaction between sodium and water

A small piece of sodium was added to some water in a trough.



The sodium floated and started to react.

The sodium moved along the surface of the water and melted to give a ball of molten metal.

The ball became smaller and smaller until it had all gone.

A gas was given off and a colourless solution was left.

The word equation for this reaction is:

sodium + water → sodium hydroxide + hydrogen

Use the information from the student's report to answer these questions.

2 (a) (i) Which information shows that sodium has a low density?

.....

(1 mark)

2 (a) (ii) Which information shows that the reaction is exothermic?

.....

(1 mark)

2 (a) (iii) Name the gas given off.

.....

(1 mark)

2 (b) The periodic table on the Data Sheet may help you to answer these questions.

2 (b) (i) Sodium is in Group 1.

Name a Group 1 element that is more reactive than sodium.

.....

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 10 · continued

for mark

2 (b) (ii) Here are some statements about Group 1 elements.
Only **two** of these statements are correct.
Put a tick (✓) next to the **two** correct statements.

Statement	(✓)
They are halogens	
They are metals	
They form covalent compounds	
They form ions with a +1 charge	

(2 marks)

2 (c) Dimitri Mendeleev put forward his periodic table in 1869.

Complete these sentences by drawing a ring around the correct answer.

2 (c) (i) Mendeleev arranged the elements in order of their [atomic weight / density / reactivity] .

(1 mark)

2 (c) (ii) The table is called a periodic table because elements with [identical / the same / similar] properties occur at regular intervals.

(1 mark)

2 (c) (iii) The vertical columns are known as [groups / periods / rows] .

(1 mark)

2 (d) How did Mendeleev overcome the problem of undiscovered elements when he designed his table?

.....

(1 mark)

10

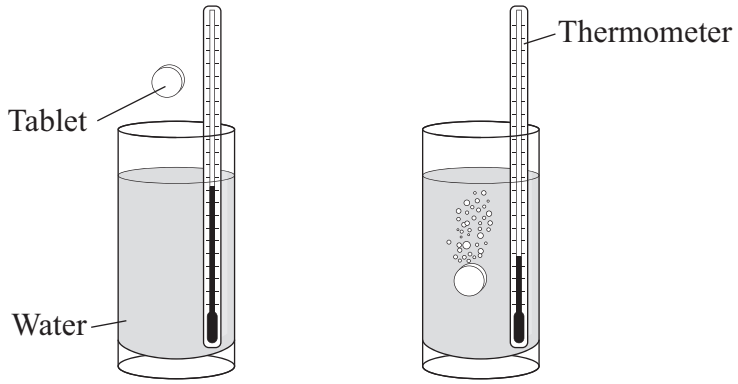
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 11

June 2009 | CHY2F | Original Q2 | Legacy

2 An indigestion tablet contains sodium hydrogencarbonate and citric acid.

When the tablet is added to cold water a chemical reaction takes place and there is a lot of fizzing.



2 (a) The formula of the gas that causes the fizzing is CO_2

Name this gas ..... . *(1 mark)*

2 (b) This chemical reaction is endothermic.

2 (b) (i) Tick (✓) the statement which describes what happens to the temperature of the solution.

Statement	Tick (✓)
The temperature of the solution will increase.	
The temperature of the solution will decrease.	
The temperature of the solution will stay the same.	

(1 mark)

2 (b) (ii) Tick (✓) the statement which describes what happens to the energy during the reaction.

Statement	Tick (✓)
Energy is given out to the surroundings.	
Energy is taken in from the surroundings.	
No energy is given out to or taken from the surroundings.	

(1 mark)

3

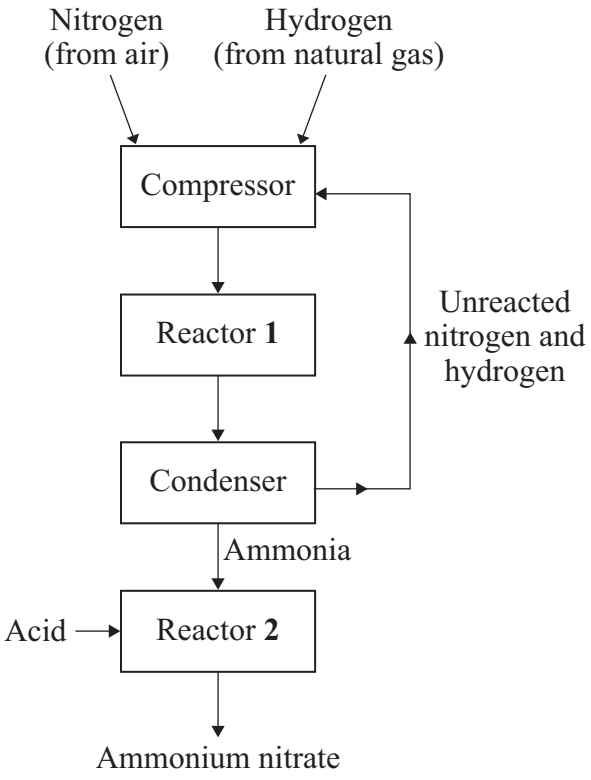
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 12

June 2009 | CHY2F | Original Q3 | Legacy

3 Ammonium nitrate is an important chemical. The diagram shows the main stages in the manufacture of ammonium nitrate.

Study the diagram and then answer the questions.



Draw a ring around the correct answer in each box to complete the sentences.

3 (a) The compressor increases the [pressure / temperature / volume] to 200 atmospheres.

(1 mark)

3 (b) In reactor **1** ammonia is made by reacting [air / natural gas / nitrogen] with [air. / hydrogen. / natural gas.]

(2 marks)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 12 · continued

for mark

3 (c) In the condenser the mixture is [cooled / heated / reduced] and the ammonia is separated as a liquid. *(1 mark)*

3 (d) In reactor **2** ammonium nitrate is made by reacting ammonia with [hydrochloric / sulfuric / nitric] acid. *(1 mark)*

5

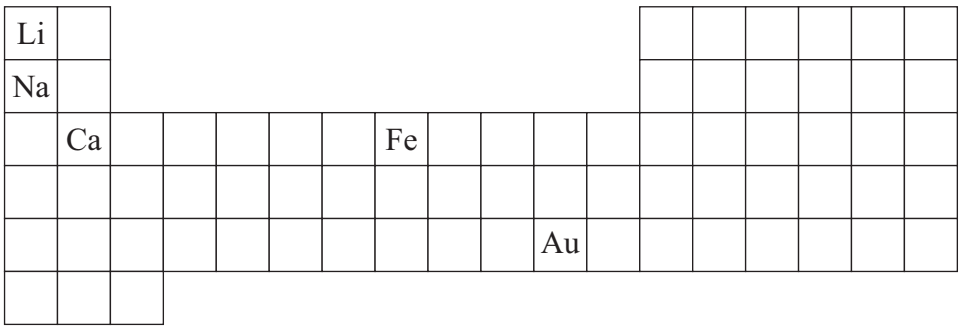
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 13

November 2009 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows part of the periodic table.



Match elements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table below.

A Calcium (Ca)

B Lithium (Li)

C Gold (Au)

D Iron (Fe)

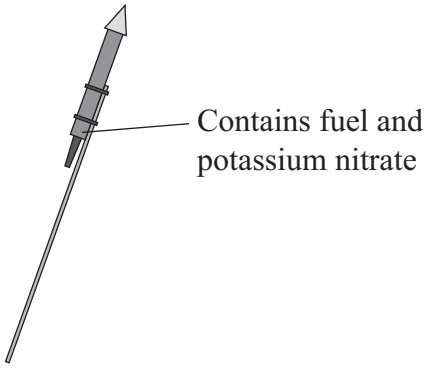
1	It will not react with oxygen or water even at high temperatures.
2	It forms the oxide known as quicklime.
3	It has properties most similar to those of sodium (Na).
4	It is a transition element found in the Earth as an oxide.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 14

January 2010 | CHY2F | Original Q5 | Legacy

5 Firework rockets contain fuel and potassium nitrate.



The potassium nitrate provides oxygen for the fuel to react.

5 (a) The table shows how a student worked out the relative formula mass (M_r) of potassium nitrate.

Some of the numbers are missing.

Relative atomic masses (A_r): N = 14; O = 16; K = 39.

Name of atom (symbol)	Number of atoms	A_r	Mass
potassium (K)	1	39	39
nitrogen (N)	1	14	14
oxygen (O)		16	
		The M_r of potassium nitrate =	101

5 (a) (i) The mass of oxygen is not shown in the table.

Draw a ring around the correct mass of oxygen.

16 **32** **48**

(1 mark)

5 (a) (ii) Draw a ring around the number of oxygen atoms in the formula of potassium nitrate.

1 **2** **3**

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 14 · continued

for mark

5 (b) When the fuel reacts with the oxygen an *exothermic* reaction takes place.

What does *exothermic* mean?

.....

.....

.....

.....

(2 marks)

5 (c) The fuel contains carbon. Carbon reacts with oxygen to make carbon dioxide.

Which **two** statements in the table explain why carbon dioxide is a gas at room temperature?

Tick (✓) the **two** statements.

Statement	**Tick (✓)**
It has a giant structure	
It has a low boiling point.	
It is made of small molecules.	
It is made of ions.	

(2 marks)

6

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 15

6 Hydrogen fluoride is used to make hydrofluoric acid.

6 (a) A company makes hydrogen fluoride by reacting solid calcium fluoride with sulfuric acid. The reaction takes place in a rotating kiln.

calcium fluoride + sulfuric acid → calcium sulfate + hydrogen fluoride

The company want this reaction to take place quickly.

6 (a) (i) Rotating the kiln makes the reaction take place faster.

Suggest why.

.....

.....

(1 mark)

6 (a) (ii) Draw a ring around the correct word in each box.

To make the reaction take place **faster**:

the temperature should be [higher / lower] so that the particles have [less / more] energy

the solid calcium fluoride should be [powder / lumps] to give a [small / big] surface area

the sulfuric acid solution should be [dilute / concentrated] to give [less / more] collisions between the particles each second.

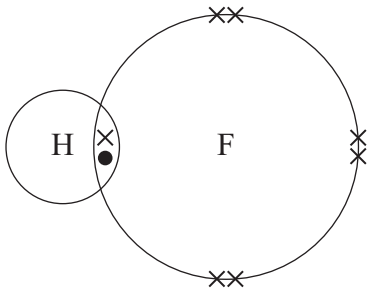
(3 marks)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 15 · continued

for mark

6 (b) The diagram represents a molecule of hydrogen fluoride.



The hydrogen and fluorine atoms are joined by a covalent bond.

Use the correct word from the box to complete the sentence.

electrons	**neutrons**	**protons**

In a covalent bond the atoms share ..... .

(1 mark)

6 (c) Hydrogen fluoride is dissolved in water to make an acidic solution of hydrofluoric acid.

Draw a ring around the symbol of the ion that makes the solution acidic.

$\mathbf{H^+}$ $\mathbf{OH^-}$ $\mathbf{F^-}$

(1 mark)

6

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 16

January 2010 | CHY3F | Original Q3 | Legacy

3 During a thunderstorm lightning strikes the Eiffel Tower.



In lightning the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen oxide. This reaction has a high *activation energy* and is *endothermic*.

3 (a) Nitrogen and oxygen in the air do not react easily.

What makes nitrogen and oxygen react during thunderstorms?

.....

(1 mark)

3 (b) Complete the word equation for the reaction of nitrogen with oxygen.

nitrogen + ... → .....

(1 mark)

3 (c) In an *endothermic* reaction, energy is taken in from the surroundings.

Draw a ring around the correct answer to complete the sentence.

In an *endothermic* reaction, the energy needed to break existing bonds is

less than
more than
the same as

the energy released from forming new bonds.

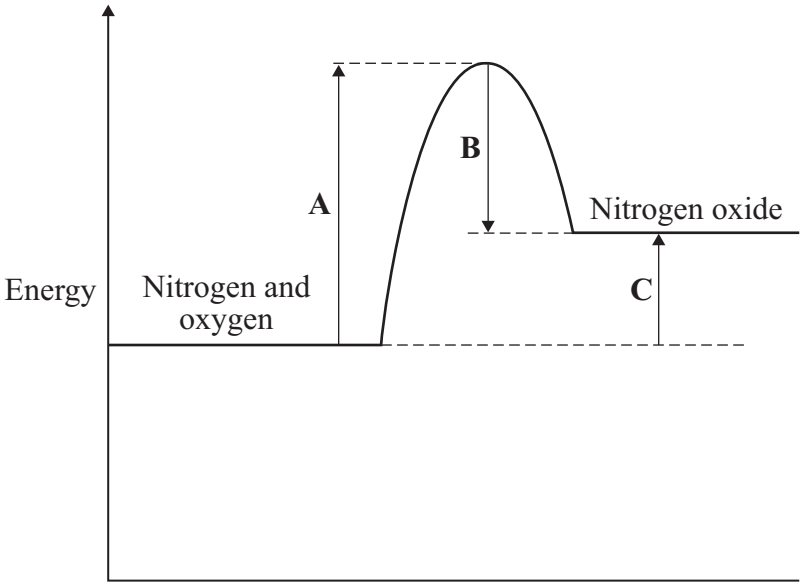
(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 16 · continued

for mark

3 (d) The energy level diagram for this reaction is shown.



Use the energy level diagram to help you to answer these questions.

3 (d) (i) Which energy change, **A**, **B** or **C**, represents the *activation energy*?

(1 mark)

3 (d) (ii) Which energy change, **A**, **B** or **C**, shows that this reaction is *endothermic*?

(1 mark)

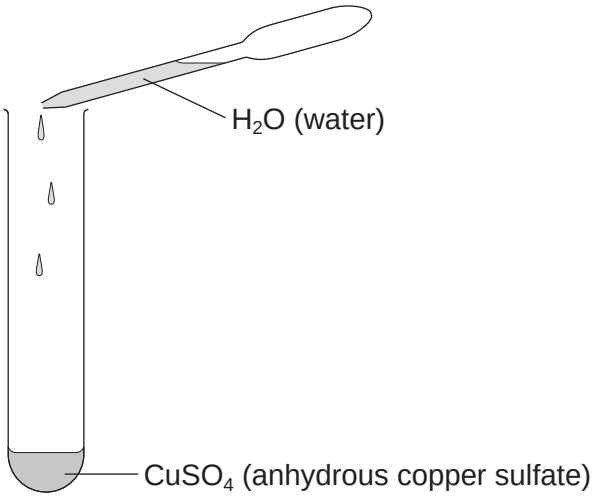
5

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 17

June 2010 | CHY2F | Original Q1 | Legacy

1 The diagram shows how anhydrous copper sulfate can be used to test for water.



$$\underset{\text{white}}{CuSO_4} + \underset{\text{colourless}}{5H_2O} \rightleftharpoons \underset{\text{blue}}{CuSO_4.\,5H_2O}$$

1 (a) What colour change will you see when water is added to the $CuSO_4$?

Colour changes from .....to .....

(1 mark)

1 (b) Draw a ring around the meaning of the symbol $\rightleftharpoons$

endothermic **exothermic** **reversible**

(1 mark)

2

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 18

June 2010 | CHY2F | Original Q3 | Legacy

3 The picture shows a student with two glow sticks.



Glow sticks contain several chemicals. When a glow stick is bent the chemicals mix. A chemical reaction takes place which causes light to be given out.

A student investigated three glow sticks. One was placed in water at 5 ºC, one in water at 40 ºC and one in water at 70 ºC.

The results are shown in the table.

Temperature in ºC	Effect on glow stick	
	Brightness of light	Time it gave out light, in hours
5	dim	7
40	bright	3
70	very bright	1

3 (a) How did increasing the temperature affect the brightness of the glow stick?

.....

.....

(1 mark)

3 (b) How did increasing the temperature affect the time it gave out light?

.....

.....

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 18 · continued

3 (c) The student was asked why an **increase** in temperature changes the rate of the chemical reaction. The student listed five ideas. Only **three** of them are correct.

Put ticks (✓) next to the **three** correct ideas.

Ideas	Tick (✓)
The particles will collide more often.	
The particles will be more concentrated.	
The particles will move faster.	
The particles will have more energy.	
The particles will get bigger.	

(3 marks)

3 (d) Suggest **one** way the student could improve this investigation.

.....

.....

(1 mark)

6

4.5.1.1 Energy transfer during exothermic and endothermic reactions

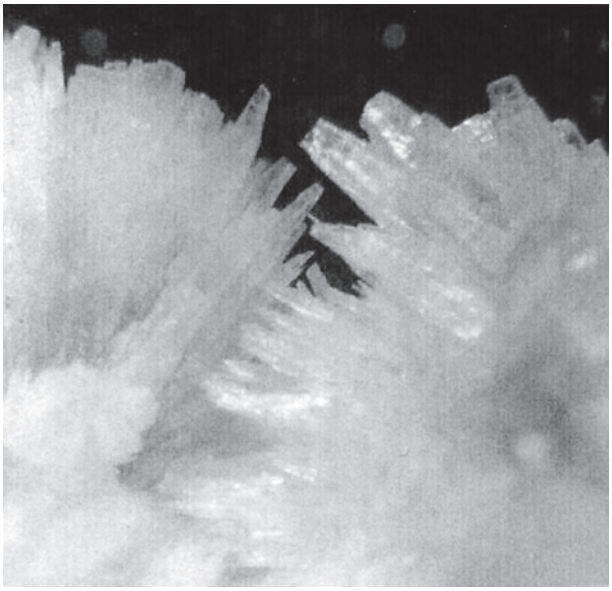
Question 19

June 2010 | CHY2F | Original Q7 | Legacy

7 (a) Read the article about the mineral strontianite.

Strontianite is a mineral that was discovered near the village of Strontian in Scotland. At first some scientists thought that strontianite was barium carbonate.

Strontianite



In 1790, Professor Adair Crawford and William Cruikshank were both lecturers in chemistry and doctors of medicine. They investigated the properties of strontianite. They found that strontianite had different properties from barium carbonate. They concluded that strontianite contained a new element.

After this, other scientists also showed that strontianite and barium carbonate had different properties. Strontianite is now known to be strontium carbonate.

7 (a) (i) What evidence did Crawford and Cruikshank use to prove that strontianite was **not** barium carbonate?

.....

.....

(1 mark)

7 (a) (ii) Crawford and Cruikshank's conclusion was immediately accepted by other scientists. Suggest why.

.....

.....

(1 mark)

7 (a) (iii) How was the reliability of the work of Crawford and Cruikshank confirmed?

.....

.....

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 19 · continued June 2010 | CHY2F | Original Q7 | Legacy

7 (b) One of Crawford and Cruikshank's experiments was repeated in a school laboratory. Samples of strontianite and barium carbonate were reacted with hydrochloric acid to produce strontium chloride and barium chloride.

Solid strontium chloride and solid barium chloride were separately added to water. The change in temperature of the water was measured.

The results of the experiments are shown below.

	Experiment 1 Strontium chloride dissolved in water	**Experiment 2** Barium chloride dissolved in water
Temperature of water before adding the chloride in ºC	19.5	19.6
Temperature of water after adding the chloride in ºC	21.2	17.5

7 (b) (i) State **one** variable that should be controlled to make it a fair test.

.....

.....

(1 mark)

7 (b) (ii) Which experiment, **1** or **2**, is endothermic?

Explain how you know.

Experiment ☐ because .....

.....

(1 mark)

7 (b) (iii) The results prove that strontium chloride and barium chloride must be different even if all of the variables had not been controlled when they were dissolved. Explain why.

.....

.....

(1 mark)

7 (c) In 1808, Humphry Davy was the first person to extract strontium. He did this by the electrolysis of molten strontium chloride. Strontium formed at the negative electrode.

Suggest why strontium ions are attracted to the negative electrode.

.....

.....

(1 mark)

7

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 20

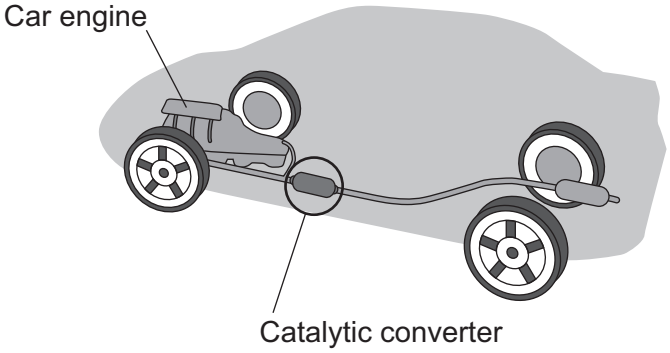
January 2011 | CHY2F | Original Q5 | Legacy

5 Read the information about car engines.

Burning petrol in air is an exothermic reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.



5 (a) Draw a ring around the correct answer to complete each sentence.

5 (a) (i) The exothermic reaction makes the temperature of the engine

decrease.

increase.

stay the same.

(1 mark)

5 (a) (ii) This is because during exothermic reactions

energy is taken in from the surroundings.

energy is given out to the surroundings.

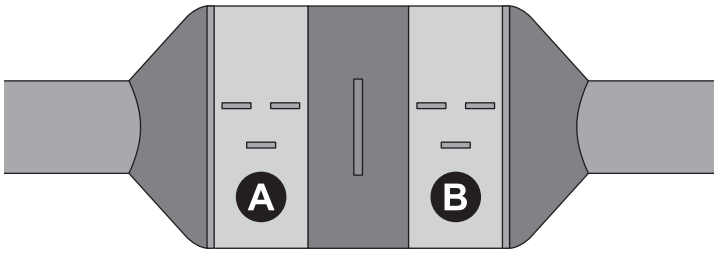
there is no energy change.

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 20 · continued

5 (b) The diagram shows a catalytic converter which removes harmful substances.
The catalytic converter has two parts, **A** and **B**, which contain different catalysts.



5 (b) (i) The equation for the reaction that takes place in part **A** is:

$$2NO \rightarrow N_2 + O_2$$

Which **one** of the substances shown in the equation is a compound?

Give the formula of this compound.

.....

(1 mark)

5 (b) (ii) The equation for the reaction that takes place in part **B** is:

$$2CO + O_2 \rightarrow 2CO_2$$

Why is it important to stop carbon monoxide (CO) from being released into the air?

.....

.....

(1 mark)

5 (c) The table lists some statements about catalysts. Only **two** statements are correct.

Tick (✓) the **two** correct statements.

Statement	Tick (✓)
A catalyst can speed up a chemical reaction.	
A catalyst is used up in a chemical reaction.	
Different reactions need different catalysts.	
A catalyst does **not** change the rate of a chemical reaction.	

(2 marks)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 20 · continued

5 (d) Modern catalytic converters contain nanosized particles of catalyst.
Less catalyst is needed when nanosized catalyst particles are used.

5 (d) (i) Complete the sentence.

The size of nanosized particles is ..... than normal sized particles.
(1 mark)

5 (d) (ii) The catalysts contain platinum.

Suggest why a manufacturer of catalytic converters would want to use less catalyst.

.....

.....
(1 mark)

8

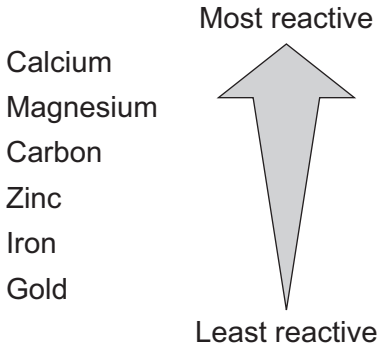
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 21

March 2011 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

This is the order of reactivity for some elements.



Match elements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A Carbon

B Gold

C Magnesium

D Zinc

1	It is a non-metal element.
2	It does not react with oxygen or water even at high temperatures.
3	It is more reactive than iron but **can** be extracted from its oxide by mixing with carbon and heating the mixture.
4	It is less reactive than calcium but **cannot** be extracted from its oxide by mixing with carbon and heating the mixture.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 22

March 2011 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

This question is about vegetable oils.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A bromine

B hydrogen

C nickel

D water

An emulsion forms when oil is shaken with . . . **1** . . . .

Unsaturated oils can be detected because they decolourise . . . **2** . . . .

Unsaturated oils harden when they react with . . . **3** . . . .

This hardening of unsaturated oils needs a temperature of 60 °C and a . . . **4** . . . catalyst.

Turn over for the next question

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 23

June 2011 | CHY1F | Original Q4 | Legacy

4 An ore contains zinc carbonate ($ZnCO_3$).

4 (a) Complete the table to show the number of atoms of each element in the formula of zinc carbonate.

Zinc has been done for you.

Element	Number of atoms in the formula $ZnCO_3$
Zinc, Zn	1
Carbon, C	
Oxygen, O	

(2 marks)

4 (b) Draw a ring around the correct answer to complete the sentence and the word equation.

4 (b) (i) Zinc carbonate decomposes in a similar way to calcium carbonate

when [water is added. / cooled. / heated.]

(1 mark)

4 (b) (ii) zinc carbonate ⟶ zinc oxide + [carbon dioxide / hydrogen / oxygen]

(1 mark)

Question 4 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

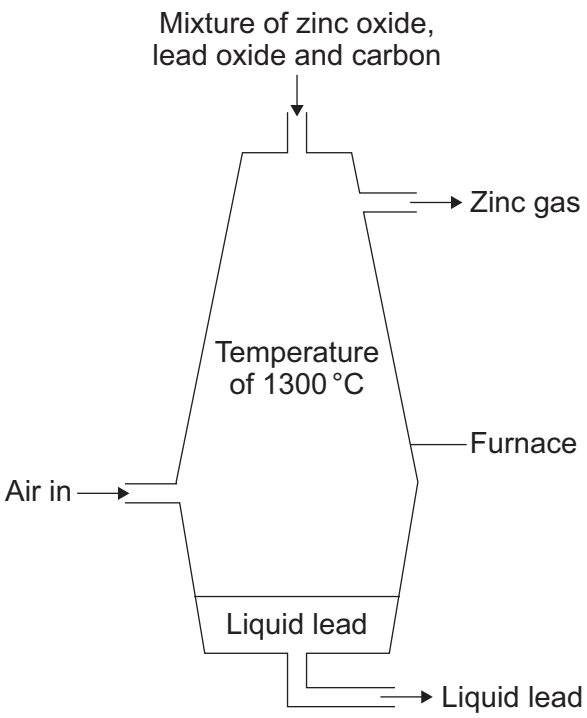
Question 23 · continued

4 (c) Another ore contains a mixture of zinc carbonate and lead carbonate.

The metals zinc and lead are produced from this ore in two stages:

Stage 1 decomposing the carbonates to produce a mixture of zinc oxide and lead oxide.

Stage 2 mixing the oxides with carbon and heating in a furnace.



Some of the reactions in the furnace are:

zinc oxide + carbon → zinc + carbon dioxide

lead oxide + carbon → lead + carbon dioxide

carbon + oxygen → carbon dioxide

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 23 · continued

Use the information given to help you to answer these questions.

4 (c) (i) Draw a ring around the correct answer to complete the sentence.

The reaction between carbon and oxygen that heats the furnace is called

- combustion.
- decomposition.
- evaporation.

(1 mark)

4 (c) (ii) Tick (✓) **one** reason why carbon reacts with zinc oxide to produce zinc.

Reason	Tick (✓)
carbon is less reactive than zinc	
carbon is more reactive than zinc	
carbon is similar in reactivity to zinc	

(1 mark)

4 (c) (iii) In the furnace zinc is a gas but lead is a liquid.

Suggest why.

.....

.....

.....

.....

(2 marks)

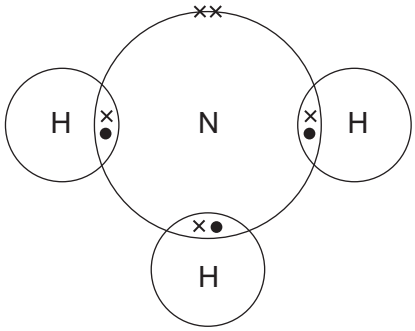
8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 24

June 2011 | CHY2F | Original Q1 | Legacy

1 The diagram shows how the atoms are bonded in ammonia.



1 (a) Draw a ring around the correct answer.

1 (a) (i) The formula of an ammonia molecule is

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

(1 mark)

1 (a) (ii) The particles represented by the dots (•) and crosses (×) in the diagram are

electrons **neutrons** **protons**

(1 mark)

1 (a) (iii) The bonds between the nitrogen and hydrogen atoms in ammonia are

covalent **ionic** **metallic**

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 24 · continued

1 (b) Ammonia is made by reacting nitrogen with hydrogen in the Haber process.
The equation for this reaction is shown below.

nitrogen + hydrogen $\rightleftharpoons$ ammonia

1 (b) (i) Use words from the box to complete the sentences.

air	**limestone**	**iron ore**	**natural gas**

Nitrogen is obtained from ..... .

Hydrogen is obtained from ..... .

(2 marks)

1 (b) (ii) Draw a ring around the correct answer to complete the sentence.

The symbol $\rightleftharpoons$ means that the reaction is

exothermic.
endothermic.
reversible.

(1 mark)

1 (b) (iii) A catalyst is used in the Haber process.

Draw a ring around the name of this catalyst.

iron **magnesium** **sodium**

(1 mark)

1 (c) Ammonium nitrate is a fertiliser that can be made by reacting ammonia with an acid.

Draw a ring around the name of the acid used in this reaction.

hydrochloric acid **nitric acid** **sulfuric acid**

(1 mark)

Question 1 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 24 · continued

1 (d) Humberstone was a town in the desert of Northern Chile in South America. It was built for the people who worked in the nearby sodium nitrate mines.

The sodium nitrate was used as a fertiliser.

The sodium nitrate was exported by ship to countries all around the world.

Today the mines have closed and nobody lives in Humberstone.



One of the reasons for the mines closing was the invention of the Haber process.

Haber process factories can be built anywhere in the world.

1 (d) (i) How did the invention of the Haber process affect the people of Humberstone?

.....

.....

(1 mark)

1 (d) (ii) Suggest **two** advantages of making ammonium nitrate in the UK rather than importing sodium nitrate from Chile.

1 .....

.....

2 .....

.....

(2 marks)

11

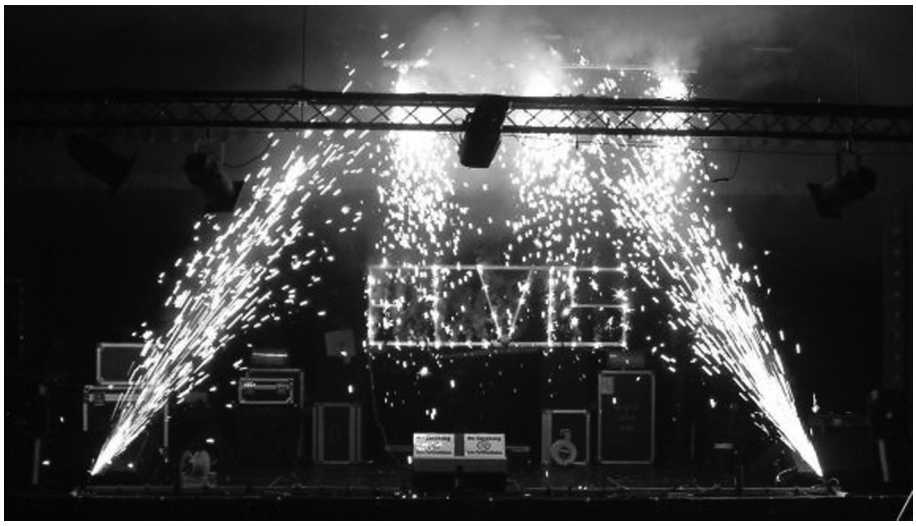
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 25

June 2011 | CHY2F | Original Q5 | Legacy

5 Read the information in the box.

Flash powder is used to produce special effects at pop concerts.



Flash powder contains aluminium. The powder burns with a bright white flame and gives out lots of heat and light. It also produces white smoke.

The flash powder is placed on stage in a special container. At the bottom of the container there is a thin piece of wire. When the flash is needed, electricity is passed through the wire. The wire gets hot and starts the aluminium burning.

5 (a) When aluminium burns the reaction is exothermic.

Give **one** piece of information from the box which shows that the reaction is exothermic.

.....

(1 mark)

5 (b) The hot wire provides energy to start the aluminium burning.

Draw a ring around the name given to the energy needed to start a chemical reaction.

activation energy **potential energy** **solar energy**

(1 mark)

5 (c) When aluminium burns it reacts with oxygen to make aluminium oxide.

Complete the word equation for this reaction.

aluminium + ... → .....

(1 mark)

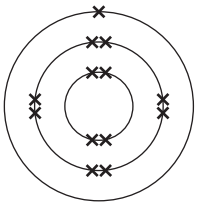
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 25 · continued

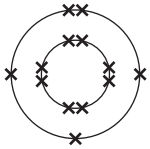
5 (d) An aluminium atom has 13 electrons.

Which diagram, **A, B** or **C**, represents the electronic structure of an aluminium atom?

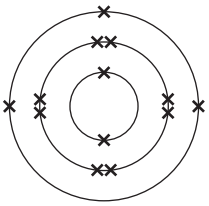
A



B



C



The electronic structure of an aluminium atom is diagram ☐

(1 mark)

5 (e) The white smoke produced is aluminium oxide.

Aluminium oxide contains aluminium ions (Al^{3+}) and oxide ions (O^{2-}).

Draw a ring around the correct word in each box to complete each sentence.

5 (e) (i) Electrons have [a negative / no / a positive] charge.

(1 mark)

5 (e) (ii) When an aluminium atom (Al) turns into an aluminium ion (Al^{3+})

it [gains / loses / shares] three electrons.

(1 mark)

5 (e) (iii) When an oxygen atom (O) turns into an oxide ion (O^{2-})

it [gains / loses / shares] [one / two / three] electrons.

(2 marks)

8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 26

June 2011 | CHY3F | Original Q2 | Legacy

2 Hydrogen peroxide decomposes slowly to give water and oxygen.

The reaction is *exothermic.*

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

2 (a) In an *exothermic* reaction, energy is given out.

Draw a ring around the correct answer to complete the sentence.

In an *exothermic* reaction, the temperature

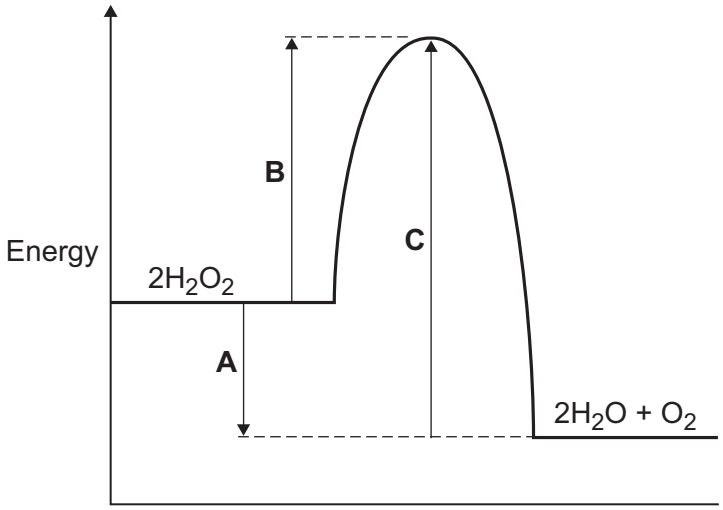
goes down.

goes up.

stays the same.

(1 mark)

2 (b) The energy level diagram for this reaction is shown below.



The energy changes, **A**, **B** and **C**, are shown on the diagram.

Use the diagram to help you answer these questions.

2 (b) (i) Which energy change, **A**, **B** or **C**, is the activation energy?

(1 mark)

2 (b) (ii) Which energy change, **A**, **B** or **C**, shows that this reaction is exothermic?

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 26 · continued

2 (b) (iii) Hydrogen peroxide decomposes quickly when a small amount of manganese(IV) oxide is added.

Draw a ring around the correct answer to complete each sentence.

Hydrogen peroxide decomposes quickly because

manganese(IV) oxide is

- a catalyst.
- an element.
- a solid.

The manganese(IV) oxide has lowered the

- activation energy.
- boiling point.
- temperature.

(2 marks)

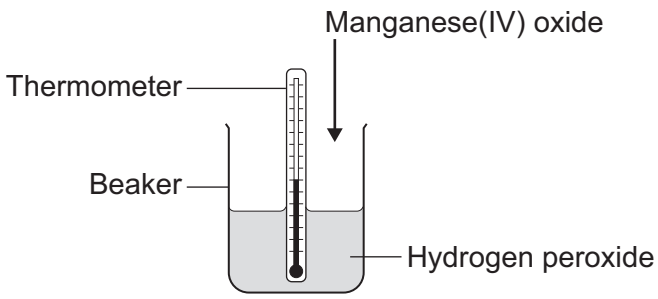
Question 2 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 26 · continued

2 (c) A student did an experiment to find the amount of energy produced when hydrogen peroxide solution is decomposed using manganese(IV) oxide.

The apparatus the student used is shown in the diagram.



The student first measured the temperature of the hydrogen peroxide. Then the student added the manganese(IV) oxide, stirred the mixture and recorded the highest temperature.

2 (c) (i) Suggest why the student stirred the mixture before recording the highest temperature.

.....

.....

(1 mark)

2 (c) (ii) The biggest error in this experiment is heat loss.

Suggest how the student could change the apparatus so that less heat is lost.

.....

.....

(1 mark)

7

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 27

June 2012 | CH2FP | Original Q1 | Legacy

1 (a) The symbol equation for the decomposition of hydrogen peroxide is:

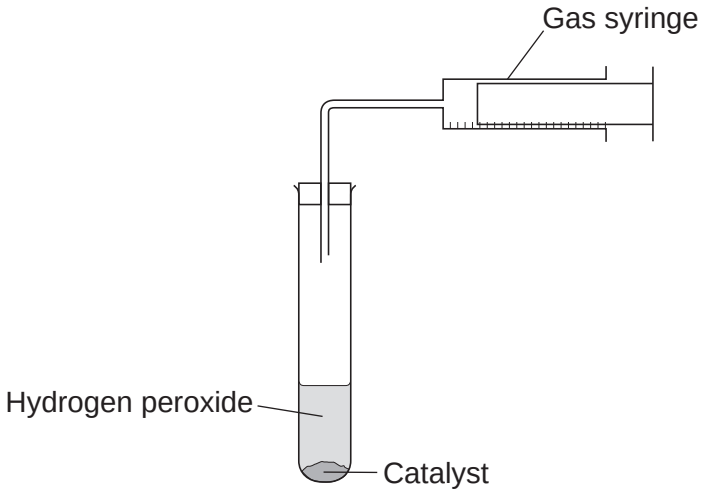
$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Complete the word equation for the decomposition of hydrogen peroxide.

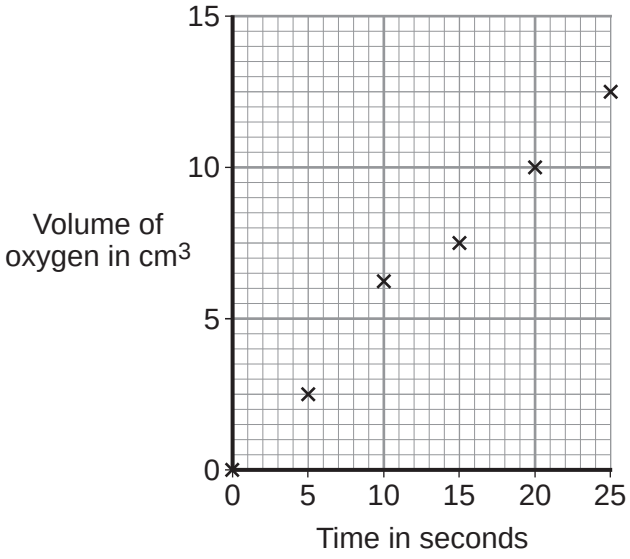
Hydrogen peroxide → ..... + ...

(1 mark)

1 (b) A student did an experiment to see how quickly hydrogen peroxide decomposes. The student used the apparatus shown below to measure the volume of oxygen.



1 (b) (i) Draw a straight line of best fit to complete the graph.



(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 27 · continued

1 (b) (ii) Draw a circle around the anomalous point on the graph.

(1 mark)

1 (b) (iii) What is the volume of oxygen given off after 15 seconds? ..... cm^3

(1 mark)

1 (b) (iv) How did the volume of oxygen change between 0 and 25 seconds?

.....

(1 mark)

1 (c) The student wanted to make the reaction faster.

Draw a ring around the correct answer to complete each sentence.

1 (c) (i) To make the reaction faster, the temperature should be

higher.

lower.

the same.

(1 mark)

1 (c) (ii) To make the reaction faster, the hydrogen peroxide should be

more dilute.

more concentrated.

the same.

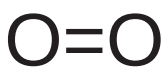
(1 mark)

Question 1 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 27 · continued June 2012 | CH2FP | Original Q1 | Legacy

1 (d) The diagram represents the bonding in oxygen.



Draw a ring around the correct answer to complete each sentence.

1 (d) (i) When two oxygen atoms bond, the atoms [share / transfer / delocalise] electrons.

(1 mark)

1 (d) (ii) The oxygen atoms are joined by [ionic / metallic / covalent] bonds.

(1 mark)

1 (d) (iii) Oxygen is made of [simple molecules. / a giant lattice. / macromolecules.]

(1 mark)

1 (e) When hydrogen peroxide decomposes water is produced.
Which **two** statements in the table explain why water is a liquid at room temperature?

Tick (✓) the **two** statements.

Statement	Tick (✓)
Water has a boiling point of 100 °C.	
Water is made of ions.	
Water has a melting point lower than room temperature.	
Water has a giant covalent structure.	

(2 marks)

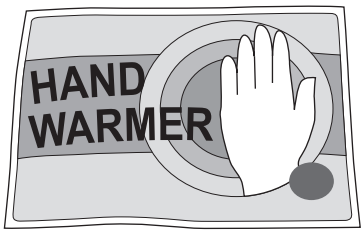
12

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 28

June 2012 | CH2FP | Original Q3 | Legacy

3 Hand warmers use chemical reactions.



3 (a) The table shows temperature changes for chemical reactions **A**, **B** and **C**.

Reaction	Starting temperature in °C	Final temperature in °C	Change in temperature in °C
A	18	25	+ 7
B	17	.....	+ 5
C	18	27	+ 9

What is the final temperature for reaction **B**? Write your answer in the table.

(1 mark)

3 (b) (i) What name is given to reactions that heat the surroundings? .....

(1 mark)

3 (b) (ii) Which reaction, **A**, **B** or **C**, would be best to use in a hand warmer?

Reaction ☐

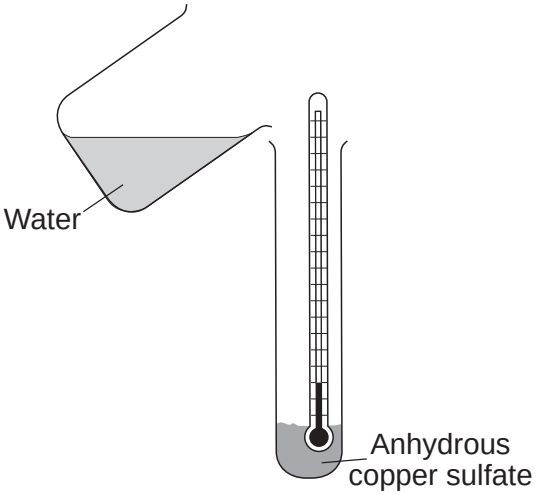
Give a reason why you chose this reaction.

.....

.....

(2 marks)

3 (c) A student added water to some anhydrous copper sulfate.



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 28 · continued

The equation for the reaction is shown.

anhydrous copper sulfate + water ⇌ hydrated copper sulfate

$CuSO_4$ + 5 H_2O ⇌ $CuSO_4.5H_2O$

The student measured the temperature before and after the reaction.

3 (c) (i) The measurements showed that this reaction can be used for a hand warmer.

Draw a ring around the correct answer to complete the sentence.

When water is added to anhydrous copper sulfate the temperature

of the mixture

- increases.
- decreases.
- stays the same.

(1 mark)

3 (c) (ii) Anhydrous copper sulfate is white.

What colour is seen after water is added to the anhydrous copper sulfate?

.....

(1 mark)

3 (c) (iii) What does the symbol ⇌ mean?

.....

(1 mark)

3 (c) (iv) The student heated a tube containing hydrated copper sulfate.

Name the solid substance produced.

.....

(1 mark)

8

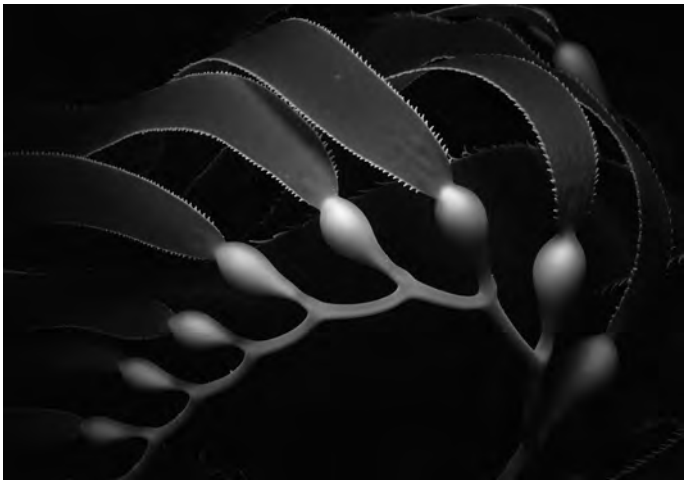
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 29

January 2013 | CH2FP | Original Q3 | Legacy

3 Kelp is a seaweed.

Kelp can be burned to give out energy.



3 (a) Draw a ring around the correct answer to complete the sentence.

Reactions which give out energy are

endothermic.

exothermic.

reversible.

(1 mark)

3 (b) Which **two** of the following questions **cannot** be answered by scientific experiments alone?

Tick (✓) **two** boxes.

Question	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal when burned?	
Should people use kelp instead of oil as an energy source?	
Will kelp be more popular than coal in the next 10 years?	

(2 marks)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 29 · continued

3 (c) Potassium iodide can be produced from kelp.

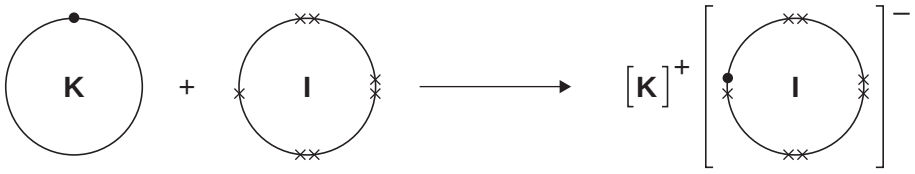
3 (c) (i) Potassium can be reacted with iodine to produce potassium iodide.

potassium + iodine → potassium iodide

The diagram shows how this happens.

Only the outer electrons are shown.

The dots (●) and crosses (×) are used to represent electrons.



Use the diagram to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with iodine to produce potassium iodide.

To get full marks you should use the words atom, electron and ion in your answer.

.....

.....

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(4 marks)

Question 3 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 29 · continued

3 (c) (ii) Potassium iodide reacts with lead nitrate.

$$2\,KI(aq) + Pb(NO_3)_2(aq) \rightarrow 2\,KNO_3(aq) + PbI_2(s)$$

Why is this reaction a precipitation?

.....

.....

(1 mark)

3 (c) (iii) How can the precipitate be removed from the reaction mixture?

.....

.....

(1 mark)

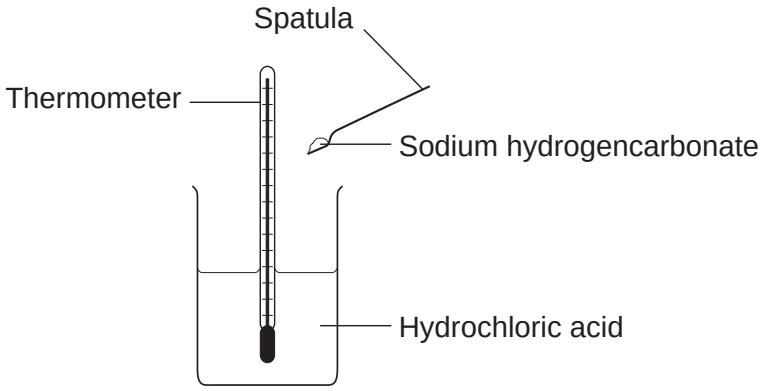
9

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 30

June 2013 | CH2FP | Original Q7 | Legacy

7 (a) Some students did an experiment to find the temperature change when hydrochloric acid reacts with sodium hydrogencarbonate.



The results are in the table.

Number of spatula measures of sodium hydrogencarbonate	Start temperature in °C	Final temperature in °C	Change in temperature in °C
2	20	16	4
4	20	14	6
6	19	11	8
8	20	10	10
10	19	9	10
12	20	10	10

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 30 · continued

7 (a) (i) Describe, as fully as you can, the trends shown in the students' results.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

7 (a) (ii) State the type of energy transfer for this reaction.

.....

.....

(1 mark)

Question 7 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 30 · continued

7 (b) Sodium hydrogencarbonate is used as baking powder for making cakes.

When the cake mixture is baked the sodium hydrogencarbonate decomposes.

The equation for the reaction is:

$$2\,NaHCO_3(s) \xrightarrow{\text{Heat}} Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

7 (b) (i) The cake mixture rises when baked.



Use the equation to suggest why.

.....

.....

(1 mark)

7 (b) (ii) The same reaction can be reversed to produce sodium hydrogencarbonate from sodium carbonate.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2\,NaHCO_3$$

Do the reactants need to be heated?

Give a reason for your answer.

.....

.....

(1 mark)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 30 · continued

7 (c) (i) Calculate the relative formula mass of sodium hydrogencarbonate ($NaHCO_3$).

Relative atomic masses (A_r): H=1; C=12; O=16; Na=23

.....

.....

.....

Relative formula mass (M_r) = ...

(2 marks)

7 (c) (ii) Calculate the percentage by mass of carbon in sodium hydrogencarbonate.

.....

.....

Percentage of carbon = ... %

(1 mark)

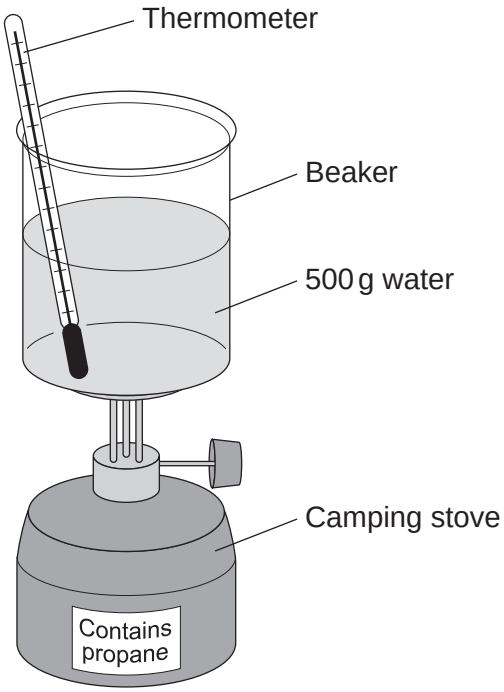
9

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 31

June 2013 | CH3FP | Original Q4 | Legacy

4 A camping stove uses propane gas.



4 (a) A student did an experiment to find the energy released when propane is burned.

The student:

- put 500 g water into a beaker
- measured the temperature of the water
- heated the water by burning propane for 1 minute
- measured the temperature of the water again.

The student found the temperature change was 20 °C.

The student can calculate the energy released, in joules (J), using the equation:

energy released (J) = mass of water (g) × 4.2 × temperature change (°C)

4 (a) (i) Use the student's result to calculate the energy released in joules (J).

.....

.....

Energy released = ... J

(2 marks)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 31 · continued

4 (a) (ii) State **two** safety precautions that the student should take during the experiment.

1 .....

.....

2 .....

.....

(2 marks)

4 (a) (iii) Tick (✓) **two** boxes which describe how the student could make his result more accurate.

	Tick (✓)
Stir the water before measuring the temperature.	
Heat the water until it boils.	
Place a lid on the beaker.	
Use a larger beaker for the water.	

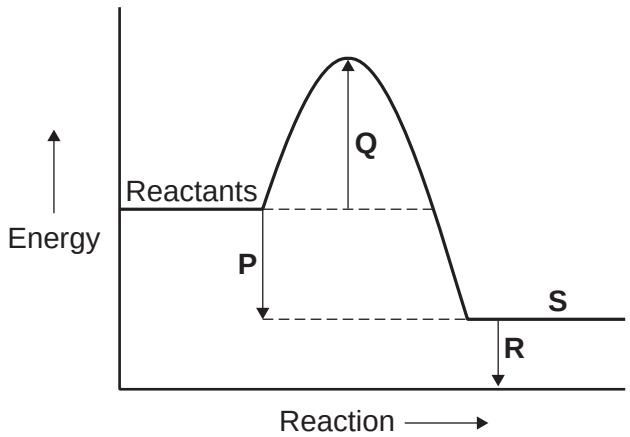
(2 marks)

Question 4 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 31 · continued June 2013 | CH3FP | Original Q4 | Legacy

4 (b) The change in energy when propane is burned can be shown in an energy level diagram.



Draw **one** line from each description to the correct letter.

Description	Letter
products	P
activation energy	Q
energy released by the reaction	R
	S

(3 marks)

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 31 · continued

4 (c) Propane and hydrogen are both used as fuels.

Some information about propane and hydrogen is given in the table.

Fuel	Resource	Products formed when fuel burned
propane	crude oil	carbon dioxide and water
hydrogen	water	water

Use the information in the table to suggest **two** disadvantages that propane has as a fuel compared to hydrogen.

1 .....

.....

2 .....

.....

(2 marks)

11

4.5.1.1 Energy transfer during exothermic and endothermic reactions

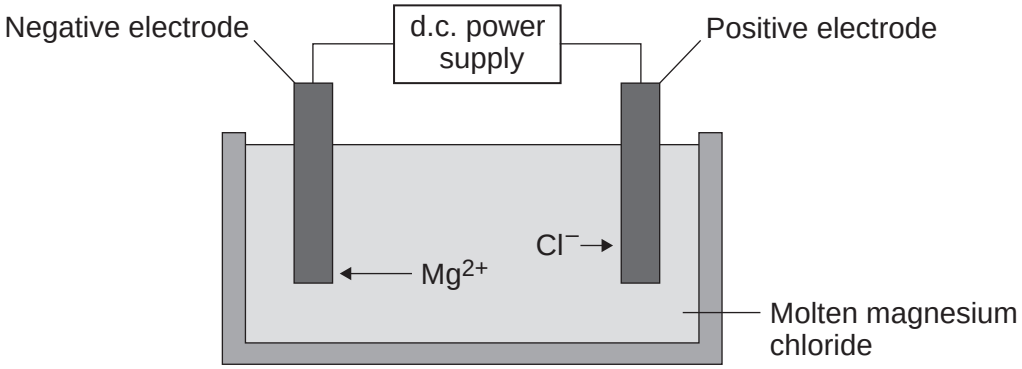
Question 32

June 2014 | CH2FP | Original Q5 | Legacy

5 Some students investigated reactions to produce magnesium.

5 (a) The students used electrolysis to produce magnesium from magnesium chloride, as shown in **Figure 7**.

Figure 7



5 (a) (i) Magnesium chloride contains magnesium ions and chloride ions.

Why does solid magnesium chloride **not** conduct electricity?

[1 mark]

.....

.....

5 (a) (ii) One of the products of the electrolysis of molten magnesium chloride is magnesium.

Name the other product.

[1 mark]

.....

5 (a) (iii) Why do magnesium ions (Mg^{2+}) move to the negative electrode?

[1 mark]

.....

.....

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 32 · continued

5 (a) (iv) At the negative electrode, the magnesium ions (Mg^{2+}) gain electrons to become magnesium atoms.

How many electrons does each magnesium ion gain?

[1 mark]

.....

5 (b) The students did the experiment four times and weighed the magnesium produced.

Table 1 shows their results.

Table 1

Experiment	Mass of magnesium produced in grams
1	1.13
2	0.63
3	1.11
4	1.09

5 (b) (i) There is an anomalous result.

Suggest **one** possible reason for the anomalous result.

[1 mark]

.....

.....

5 (b) (ii) Calculate the mean mass of magnesium produced, taking account of the anomalous result.

[2 marks]

.....

.....

.....

Mean mass = ... g

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 32 · continued

5 (c) The formula of magnesium chloride is $MgCl_2$

The relative formula mass of magnesium chloride is 95.

The relative atomic mass of magnesium is 24.

5 (c) (i) Use the equation to calculate the percentage mass of magnesium in magnesium chloride.

$$\text{Percentage mass of magnesium} = \frac{\text{mass of magnesium}}{\text{mass of magnesium chloride}} \times 100\%$$

[2 marks]

.....

.....

.....

Percentage mass of magnesium in magnesium chloride = ... %

5 (c) (ii) Draw a ring around the relative mass of chlorine in $MgCl_2$

[1 mark]

71 **95** **119**

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 32 · continued

5 (d) Magnesium is also produced from the reaction of magnesium oxide with silicon.

5 (d) (i) The equation for the reaction is:

$$2\ MgO(s) + Si(s) \rightleftharpoons SiO_2(s) + 2\ Mg(s)$$

What is the meaning of this symbol $\rightleftharpoons$?

Draw a ring around the correct answer.

[1 mark]

neutralisation reaction **precipitation reaction** **reversible reaction**

5 (d) (ii) The forward reaction is endothermic.

Draw a ring around the correct answer to complete the sentence.

[1 mark]

In an endothermic reaction the temperature of the surroundings

- decreases.
- increases.
- stays the same.

12

4.5.1.1 Energy transfer during exothermic and endothermic reactions

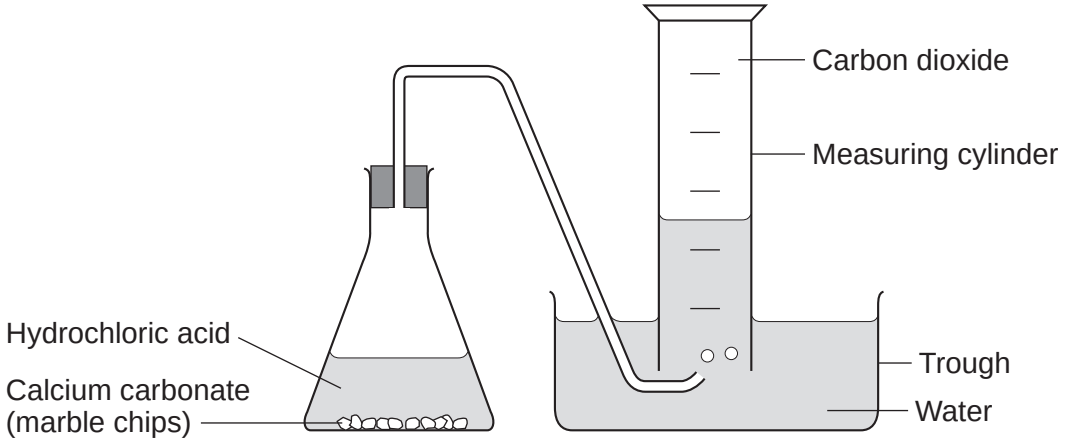
Question 33

June 2015 | CH2FP | Original Q5 | Legacy

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

The student used the apparatus shown in **Figure 8**.

Figure 8



The student:

- recorded the volume of gas collected every 5 seconds
- repeated the experiment using hydrochloric acid at different temperatures.

The equation for the reaction is:

$$CaCO_3(s) + 2\,HCl(aq) \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

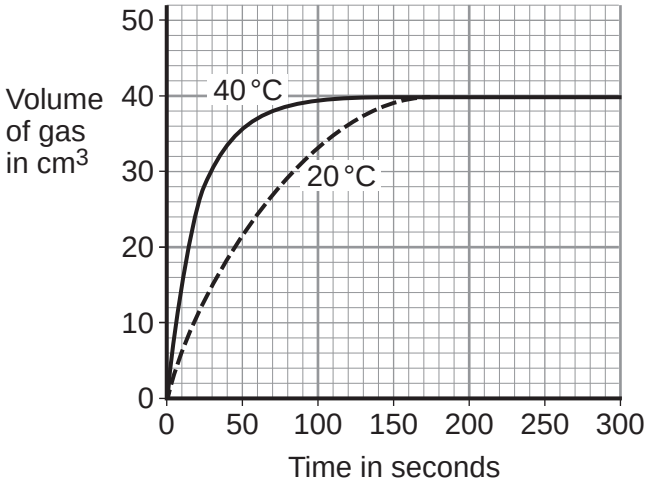
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 33 · continued

5 (a) The student plotted results for the hydrochloric acid at 20 °C and 40 °C on a graph.

Figure 9 shows the student's graph.

Figure 9



Use information from **Figure 9** to answer these questions.

5 (a) (i) State **one** conclusion the student could make about the effect of temperature on the rate of the reaction.

[1 mark]

.....

.....

5 (a) (ii) Give **one** reason why the student could make this conclusion.

[1 mark]

.....

.....

5 (a) (iii) For the hydrochloric acid at 60 °C the student had collected 30 cm^3 after 15 seconds.

Calculate the average rate of reaction from 0 to 15 seconds.

[1 mark]

.....

.....

Rate of reaction = ... cm^3 per second

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 33 · continued

5 (b) The student then investigated how the surface area of marble chips affected the rate of reaction.

5 (b) (i) Which **two** variables should the student keep constant?

[2 marks]

Tick (✓) **two** boxes.

- Amount of water in the trough ☐
- Concentration of acid ☐
- Mass of marble chips ☐
- Size of marble chips ☐
- Volume of measuring cylinder ☐

5 (b) (ii) Explain, in terms of particles and collisions, the effect that increasing the surface area of the marble chips has on the rate of reaction.

[2 marks]

.....

.....

.....

.....

5 (c) Calcium carbonate is a catalyst for the industrial production of biodiesel.

Give **one** reason why using a catalyst reduces costs.

[1 mark]

.....

.....

8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 34

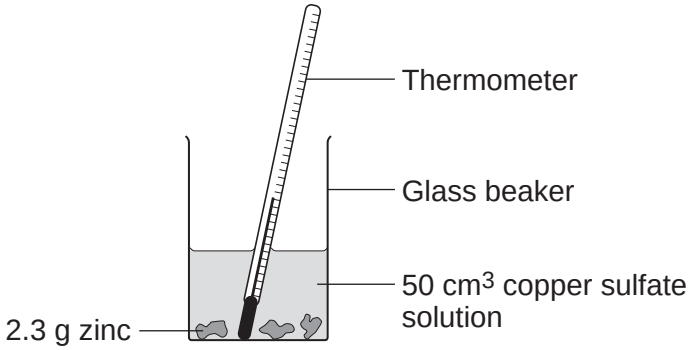
June 2015 | CH2FP | Original Q6 | Legacy

6 A student investigated the temperature change when zinc reacts with copper sulfate solution.

The student used a different concentration of copper sulfate solution for each experiment.

The student used the apparatus shown in **Figure 10**.

Figure 10



The student:

- measured 50 cm^3 copper sulfate solution into a glass beaker
- measured the temperature of the copper sulfate solution
- added 2.3 g zinc
- measured the highest temperature
- repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:

$$Zn(s) + CuSO_4(aq) \longrightarrow Cu(s) + ZnSO_4(aq)$$

zinc + copper sulfate solution ⟶ copper + zinc sulfate solution

6 (a) The thermometer reading changes during the reaction.

Give **one** other change the student could **see** during the reaction.

[1 mark]

.....

.....

Question 6 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 34 · continued

6 (b) Suggest **one** improvement the student could make to the apparatus in **Figure 10**.

Give a reason why this improves the investigation.

[2 marks]

Improvement .....

.....

Reason .....

.....

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

The student's results are shown in **Table 2**.

Table 2

Experiment number	Concentration of copper sulfate in moles per dm^3	Increase in temperature in °C
1	0.1	5
2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 34 · continued

Describe **and** explain the trends shown in the student's results.

[6 marks]

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Extra space .....

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9

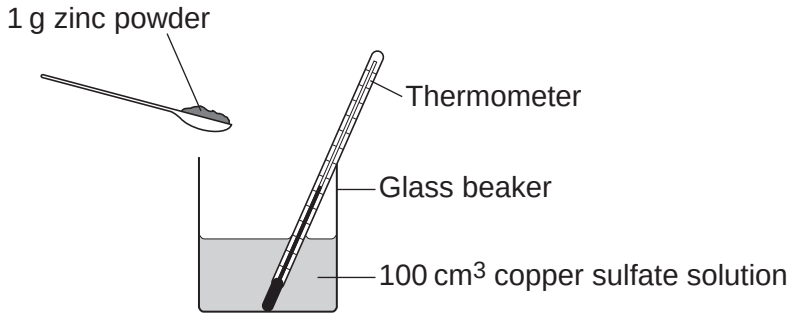
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 35

June 2015 | CH3FP | Original Q3 | Legacy

3 A student investigates the energy released when zinc powder reacts with copper sulfate solution. The student uses the apparatus shown in **Figure 3**.

Figure 3



The student:

- measures 100 cm^3 copper sulfate solution into a beaker
- measures the temperature of the copper sulfate solution
- puts 1 g zinc powder into the beaker
- stirs the mixture with a thermometer
- measures the highest temperature.

The student's results were:

Starting temperature = 21 °C
Highest temperature = 32 °C

3 (a) (i) Calculate the change in temperature.

[1 mark]

.....

Change in temperature = ... °C

3 (a) (ii) Calculate the energy released in the reaction.

Use the equation

$$\text{energy released in J} = \text{volume of solution in } cm^3 \times 4.2 \times \text{temperature change in °C}$$

[2 marks]

.....

.....

Energy released = ... J

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 35 · continued

3 (b) The reaction of zinc with copper sulfate is exothermic.

How can you tell from the student's results that the reaction is exothermic?

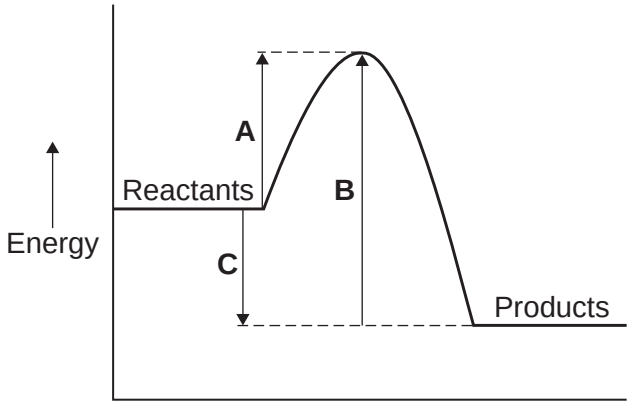
[1 mark]

.....

.....

3 (c) The energy diagram for the reaction is shown in **Figure 4**.

Figure 4



3 (c) (i) How can you tell from the energy diagram that the reaction is exothermic?

[1 mark]

.....

.....

3 (c) (ii) Which arrow shows the activation energy in **Figure 4**?

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

6

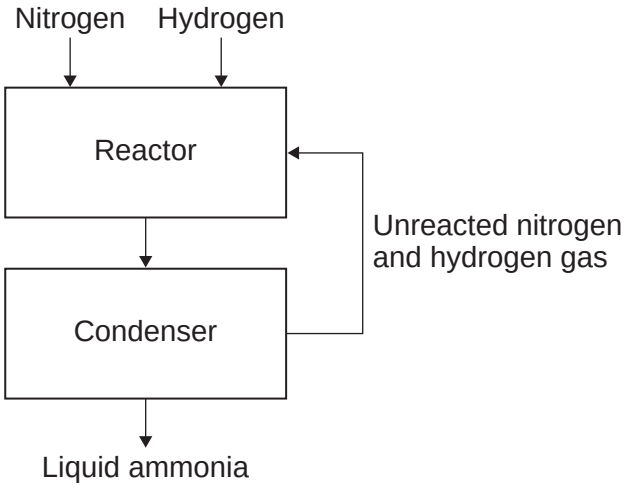
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 36

June 2015 | CH3FP | Original Q4 | Legacy

4 **Figure 5** shows a flow diagram of the Haber process.
The Haber process produces ammonia from nitrogen and hydrogen.

Figure 5



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

[1 mark]

air	limestone	natural gas

Hydrogen is obtained from ..... .

4 (b) In the reactor, nitrogen and hydrogen at a high pressure are heated and passed over a catalyst.

4 (b) (i) Use the correct answer from the box to complete the sentence.

[1 mark]

25	100	450

The temperature in the reactor is ..... °C

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

[1 mark]

copper	iron	nickel

The catalyst used in the reactor is ..... .

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 36 · continued

4 (b) (iii) How does a catalyst speed up a reaction?

[1 mark]

Tick (✓) **one** box.

The catalyst lowers the activation energy. ☐

The catalyst gives the reactants extra energy. ☐

The catalyst increases the pressure in the reactor. ☐

4 (c) A mixture of gases leaves the reactor.

The mixture contains ammonia, nitrogen and hydrogen.

Describe what happens to this mixture of gases in the condenser.

Use **Figure 5** to help you.

[3 marks]

.....

.....

.....

.....

.....

.....

7

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 37

June 2016 | CH1FP | Original Q3 | Legacy

3 Metals are extracted from ores in the Earth's crust.

3 (a) Why is copper used in the manufacture of computers?

[1 mark]

Tick (✓) **one** box.

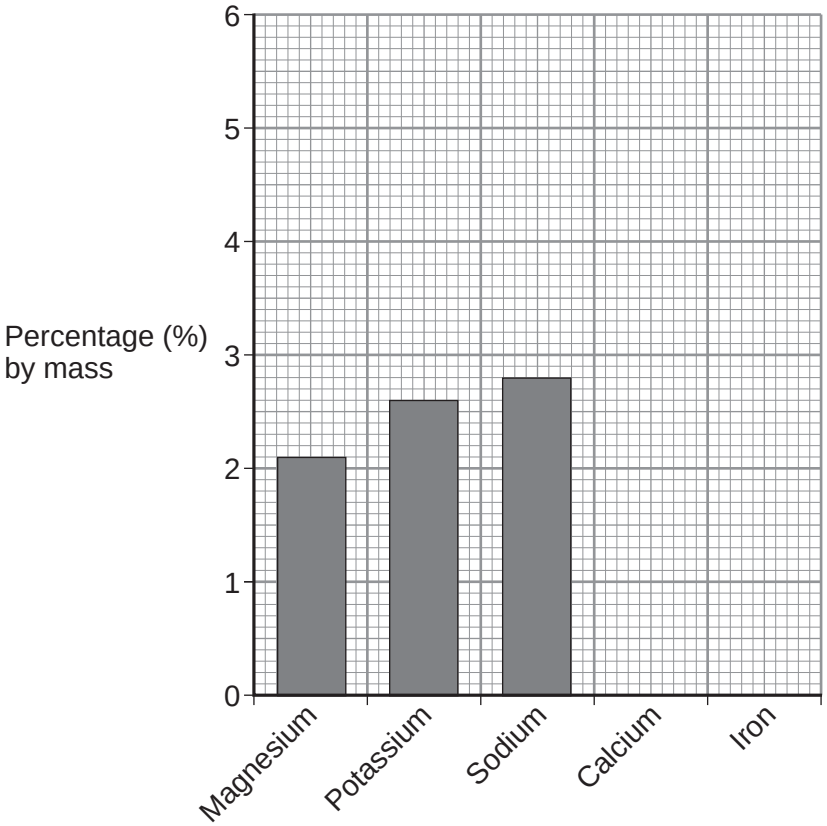
Because it has a high density. ☐

Because it does not react with water. ☐

Because it is a good conductor of electricity. ☐

3 (b) **Figure 6** shows the percentage (%) by mass of some metals in the Earth's crust.

Figure 6



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 37 · continued

3 (b) (i) What is the percentage by mass of magnesium in the Earth's crust?

[1 mark]

_____ %

3 (b) (ii) On **Figure 6** draw the bars for:

- calcium at 3.6% by mass
- iron at 5.0% by mass.

[2 marks]

3 (c) An ore of zinc contains zinc carbonate.

The equation for the reaction when zinc carbonate is heated is:

$$\underset{\text{zinc carbonate}}{ZnCO_3} \longrightarrow \underset{\text{zinc oxide}}{ZnO} + \underset{\text{carbon dioxide}}{CO_2}$$

3 (c) (i) What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

corrosion ☐

decomposition ☐

electrolysis ☐

3 (c) (ii) Which substance in the equation is a gas at room temperature (20 °C)?

[1 mark]

Tick (✓) **one** box.

zinc carbonate ☐

zinc oxide ☐

carbon dioxide ☐

Question 3 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 37 · continued

3 (c) (iii) Complete **Table 1** to show the number of atoms of carbon and oxygen in the formula of zinc carbonate.

[2 marks]

Table 1

Element	Number of atoms in the formula $ZnCO_3$
zinc, Zn	1
carbon, C	
oxygen, O	

3 (c) (iv) When 125 g zinc carbonate is heated, 81 g zinc oxide is produced.

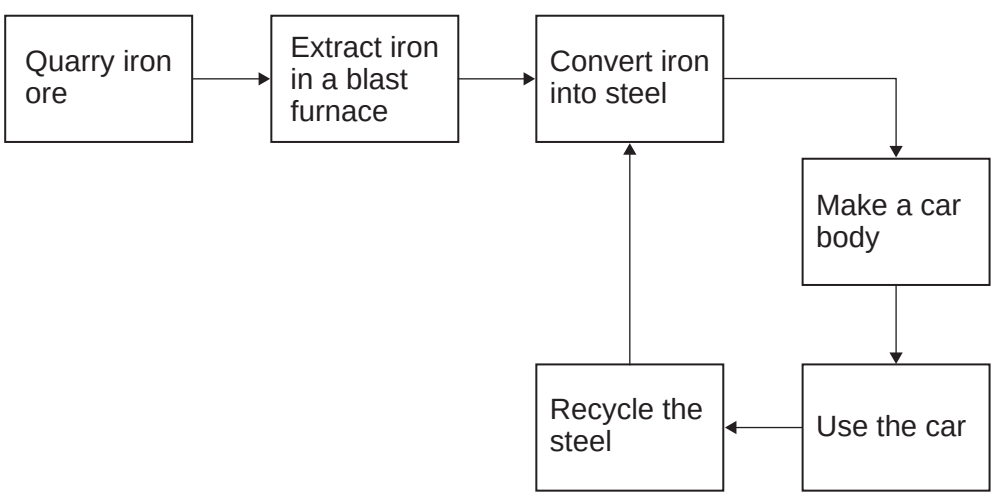
Calculate the mass of carbon dioxide produced.

[1 mark]

Mass of carbon dioxide = _____ g

3 (d) **Figure 7** shows a simple life cycle of a car body.

Figure 7



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 37 · continued

3 (d) (i) What is **one** reason why iron from the blast furnace is converted into steel?

[1 mark]

Tick (✓) **one** box.

To make the iron pure. ☐

To make the iron more brittle. ☐

To make alloys for specific uses. ☐

3 (d) (ii) Apart from cost, give **three different** reasons why steel should be recycled.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

13

4.5.1.1 Energy transfer during exothermic and endothermic reactions

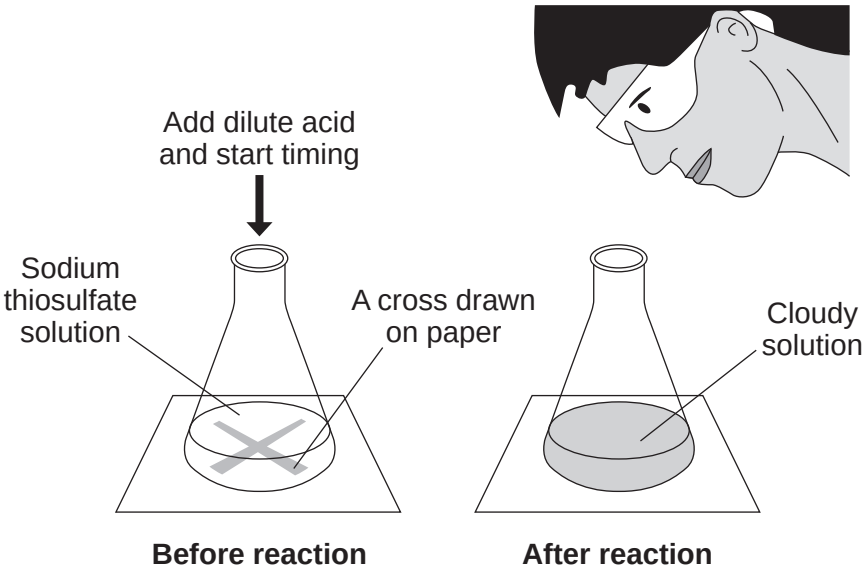
Question 38

June 2016 | CH2FP | Original Q4 | Legacy

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

Figure 9 shows an experiment.

Figure 9



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.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 38 · continued

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

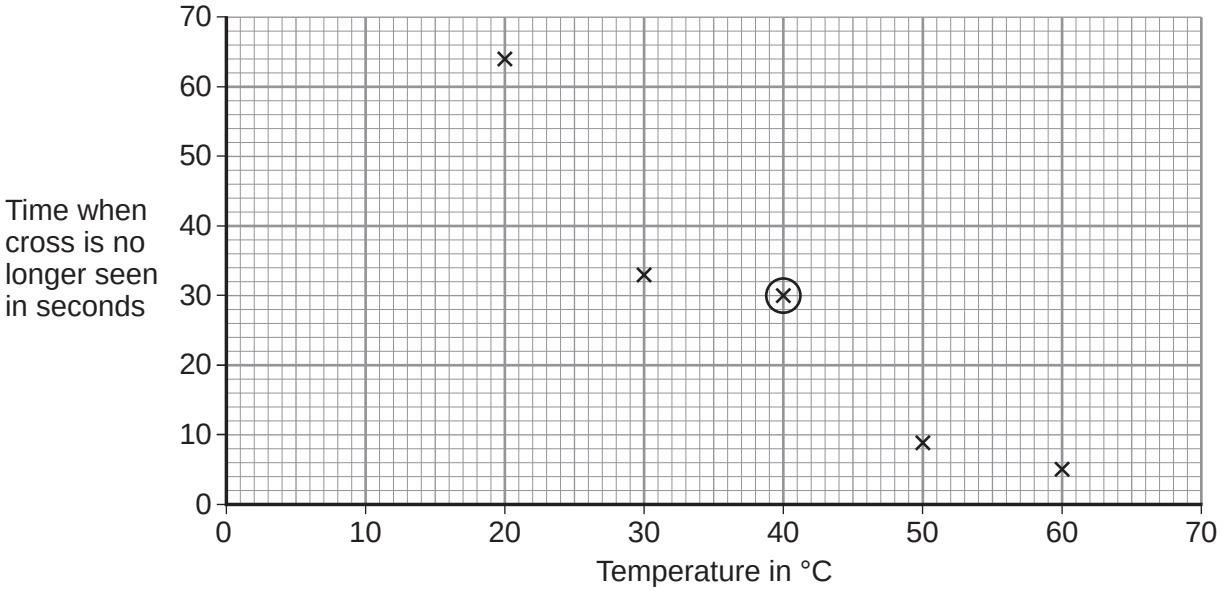
4 (a) Which product is a gas?

[1 mark]

_____

4 (b) **Figure 10** shows the results of this experiment at five different temperatures. The circled result point is anomalous.

Figure 10



4 (b) (i) Draw a line of best fit on **Figure 10** to show how the reaction time varied with reaction temperature.

[1 mark]

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

[1 mark]

_____

_____

Question 4 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 38 · continued

4 (b) (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:

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

[2 marks]

Rate of reaction = _____ grams per second

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

[2 marks]

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. ☐

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

[1 mark]

activation	collision	exothermic

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

the _____ energy.

8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 39

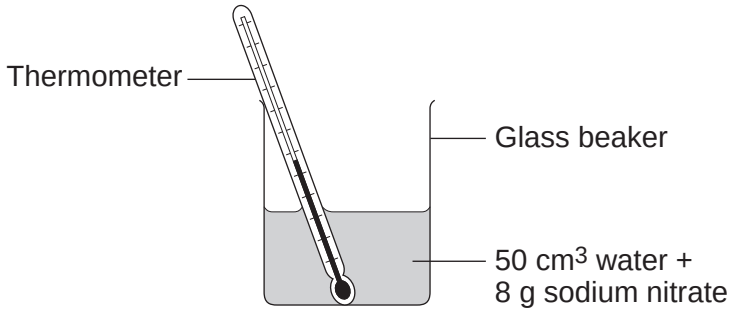
June 2016 | CH2FP | Original Q5 | Legacy

5 This question is about temperature changes.

5 (a) A student investigated the temperature change when 8 g of sodium nitrate dissolves in 50 cm^3 of water.

Figure 11 shows the apparatus the student used.

Figure 11



The student did the experiment five times.
Table 2 shows the results.

Table 2

Experiment	Decrease in temperature of water in °C
1	5.9
2	5.7
3	7.2
4	5.6
5	5.8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 39 · continued

5 (a) (i) Calculate the mean decrease in temperature.
Do not use the anomalous result in your calculation.

[2 marks]

Mean decrease in temperature = _____ °C

5 (a) (ii) Suggest **one** change in the apparatus in **Figure 11** which would improve the accuracy of the results.
Give a reason for your answer.

[2 marks]

Question 5 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 39 · continued

5 (b) The student investigated the temperature change when different masses of sodium carbonate were added to 50 cm^3 of water at 20 °C.

Table 3 shows the results.

Table 3

Mass of sodium carbonate in g	Final temperature of solution in °C
2.0	21.5
4.0	23.0
6.0	24.5
8.0	26.0
10.0	26.6
12.0	26.6
14.0	26.6

Describe the relationship between the mass of sodium carbonate added and the final temperature of the solution.

Use values from **Table 3** in your answer.

[3 marks]

7

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 40

June 2016 | CH2FP | Original Q6 | Legacy

6 This question is about ammonia and fertilisers.

6 (a) Ammonia is produced by a reversible reaction.

The equation for the reaction is:

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

Complete the sentence.

[1 mark]

The forward reaction is exothermic, so the reverse reaction is _____ .

6 (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.

[3 marks]

_____

_____

_____

_____

_____

_____

Percentage by mass of nitrogen = _____%

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 40 · continued

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

6 (c) (i) Give the pH of a neutral solution.

[1 mark]

pH _____

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

[1 mark]

Tick (✓) **one** box.

$H^+ + OH^- \longrightarrow H_2O$ ☐

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

$H^+ + Cl^- \longrightarrow HCl$ ☐

$H^+ + H_2O \longrightarrow H_3O^+$ ☐

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

[1 mark]

_____

Question 6 continues on the next page

Question 40 · continued

6 (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.

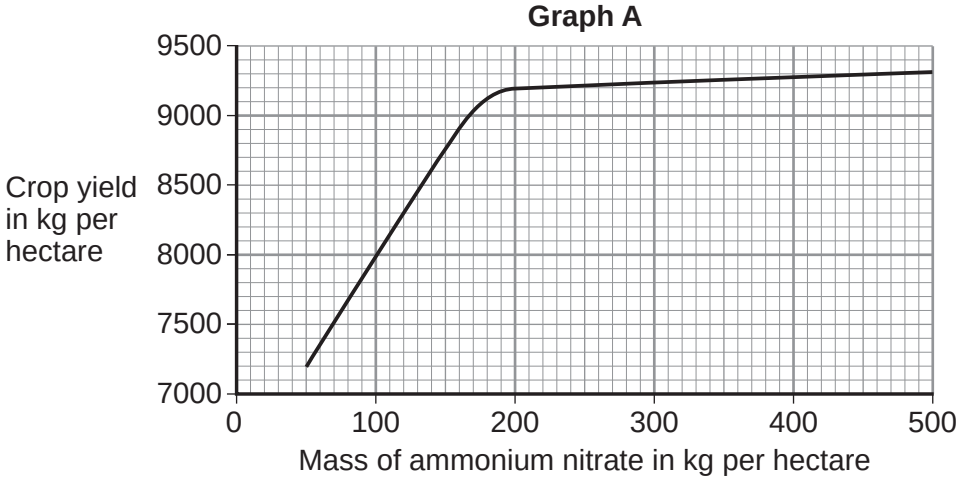
Rainwater dissolves ammonium nitrate in the soil.

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

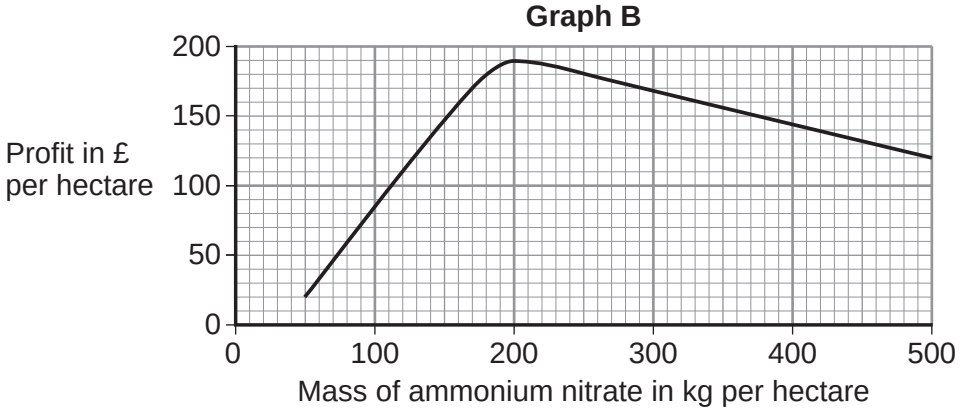
Figure 12 shows three graphs **A**, **B** and **C**. The graphs show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

Figure 12

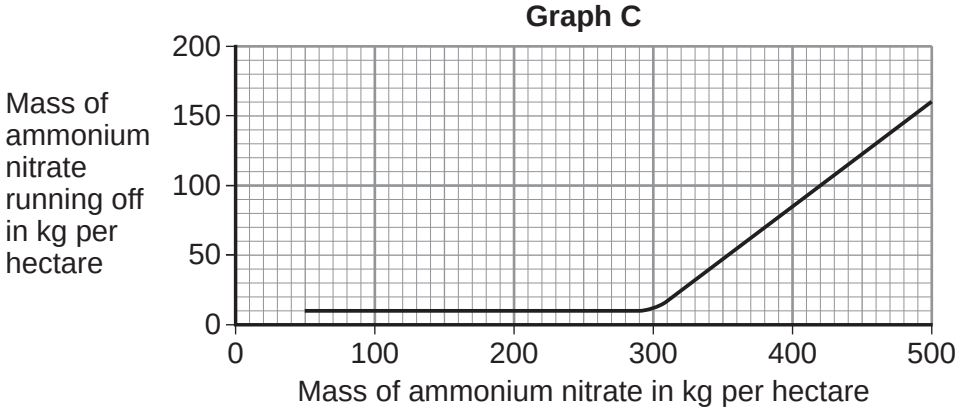
Graph A



Graph B



Graph C



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 40 · continued

Suggest how much ammonium nitrate farmers should use per hectare.
Give reasons for your answer.
Use information from graphs **A**, **B** and **C**.

[6 marks]

Extra space

13

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 41

June 2016 | CH3FP | Original Q3 | Legacy

3 This question is about energy changes in chemical reactions.

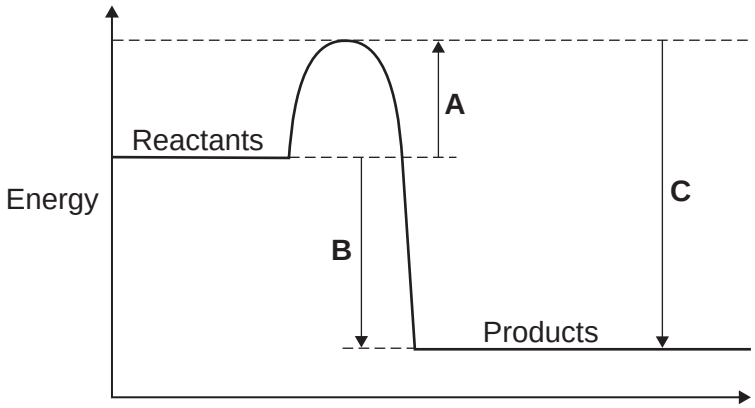
3 (a) Complete the word equation for the combustion of hydrogen.

[1 mark]

hydrogen + oxygen ⟶ _____

3 (b) **Figure 3** shows a simple energy level diagram.

Figure 3



3 (b) (i) Which arrow, **A**, **B** or **C**, shows the activation energy?

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

3 (b) (ii) What type of reaction is shown by the energy level diagram in **Figure 3**?
Give a reason for your answer.

[2 marks]

Type of reaction _____

Reason _____

_____

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 41 · continued

3 (b) (iii) For a reaction, the value of **A** is 1370 kJ and **C** is 3230 kJ.
Calculate the value of **B**.

[1 mark]

_____

_____

B = _____ kJ

Question 3 continues on the next page

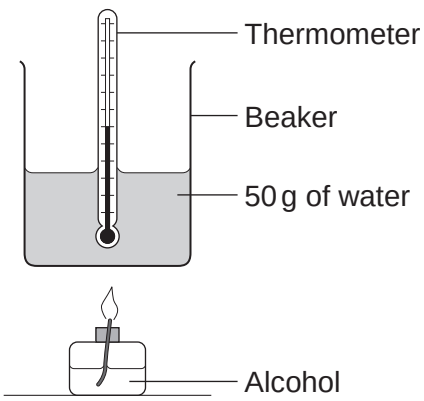
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 41 · continued

3 (c) Alcohols are used as fuels.

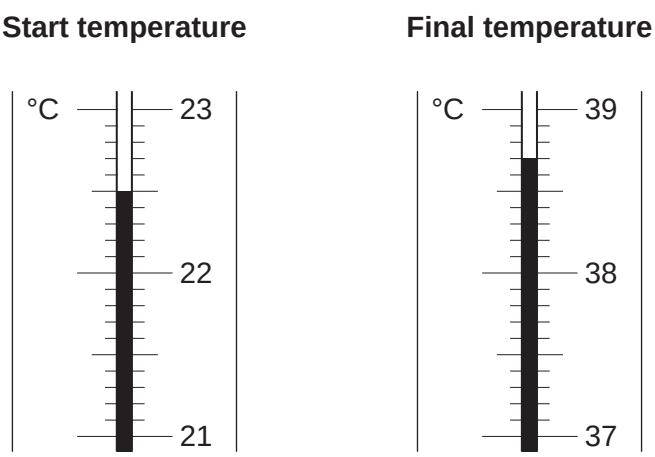
A group of students investigated the amount of energy released when different alcohols are burned.
The students used the apparatus shown in **Figure 4**.

Figure 4



3 (c) (i) **Figure 5** shows the start temperature and the final temperature of the water.

Figure 5



Write the start temperature and the final temperature of the water in **Table 1**.
Work out the increase in temperature to complete **Table 1**.

[3 marks]

Table 1

Start temperature of the water in °C	
Final temperature of the water in °C	
Increase in temperature in °C	

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 41 · continued

3 (c) (ii) The students worked out the heat energy released by burning 1 g of each alcohol. The students used the equation:

Heat energy released = m × 4.2 × increase in temperature

Look at **Figure 4**. What is the value of m?

[1 mark]

m = _____ g

3 (c) (iii) **Table 2** shows the students' results.

Table 2

Name of alcohol	Number of carbon atoms in one molecule of alcohol	Heat energy released when 1 g of alcohol is burned in kJ
Methanol	1	11.4
Ethanol	2	14.5
Propanol	3	20.1
Butanol	4	16.8
Pentanol	5	17.2

Which value of heat energy released is anomalous?

[1 mark]

_____

3 (c) (iv) Look at **Table 2**.
What is the relationship between the number of carbon atoms in one molecule of alcohol and the heat energy released when 1 g of the alcohol is burned?

[1 mark]

_____

_____

Question 3 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 41 · continued

3 (c) (v) The value in a data book for the amount of heat energy released when 1 g of butanol is burned completely is 36.2 kJ.

Suggest **two** reasons why the students' result for butanol is lower than the data book value.

[2 marks]

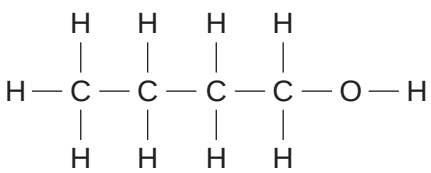
1 _____

_____

2 _____

_____

3 (c) (vi) The displayed structure of butanol is:



What is the functional group of the alcohol?

[1 mark]

Tick (✓) **one** box.

— C — C ☐

— C — H ☐

— O — H ☐

14

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 42

June 2017 | CH2FP | Original Q4 | Legacy

4 This question is about sodium chloride.

4 (a) Calculate the relative formula mass (M_r) of sodium chloride (NaCl).

Relative atomic masses (A_r): Na = 23; Cl = 35.5

[1 mark]

Relative formula mass (M_r) = _____

4 (b) A student reacted hydrochloric acid and sodium hydroxide solution to produce sodium chloride and another product.

Use the correct answer from the box to complete the word equation for the reaction.

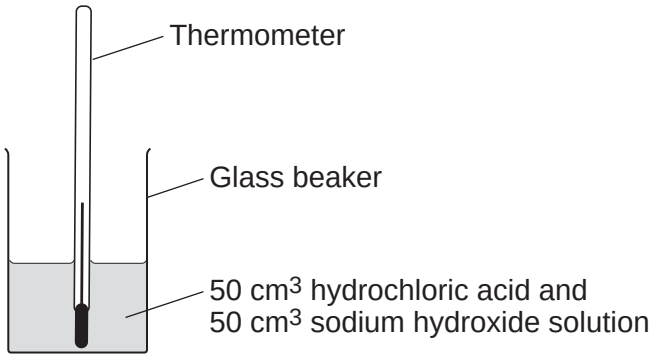
[1 mark]

chlorine	hydrogen	oxygen	water

hydrochloric acid + sodium hydroxide ⟶ sodium chloride + _____

4 (c) **Figure 7** shows the apparatus the student used to measure the temperature change in the reaction between hydrochloric acid and sodium hydroxide solution.

Figure 7



The student:

- measured 50 cm^3 hydrochloric acid into a glass beaker
- measured the temperature of the hydrochloric acid
- added 50 cm^3 of sodium hydroxide solution
- measured the highest temperature of the solution
- repeated the experiment with insulation around the glass beaker.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 42 · continued

4 (c) (i) Suggest **one** reason why the insulation around the glass beaker gives more accurate results.

[1 mark]

_____

_____

4 (c) (ii) The student did the investigation using the insulation three times.

Table 2 shows the results.

Table 2

Experiment number	Temperature of acid before reaction in °C	Highest temperature of solution in °C	Temperature change in °C
1	20	33	13
2	20	34	14
3	19	32	

Calculate the temperature change in **Experiment 3**.

Write your answer in **Table 2**.

[1 mark]

4 (c) (iii) How does **Table 2** show that the results are repeatable?

[1 mark]

_____

_____

4 (c) (iv) Complete the sentence.

[1 mark]

The temperature increase shows that the reaction between hydrochloric acid and sodium hydroxide is _____ .

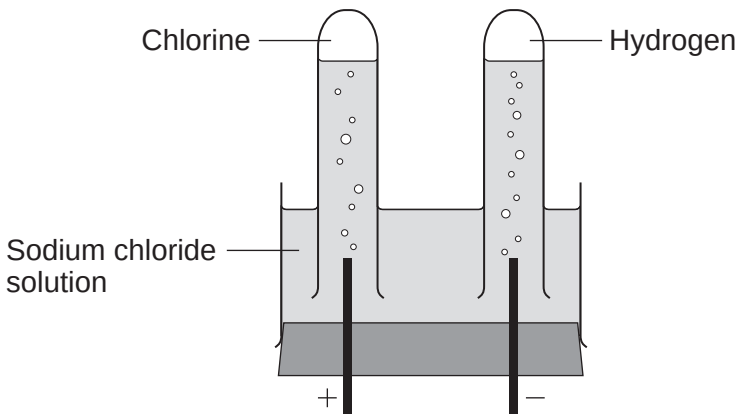
Question 4 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 42 · continued

4 (d) A student investigated the electrolysis of sodium chloride solution, as shown in **Figure 8**.

Figure 8



4 (d) (i) State, in terms of ions, why sodium chloride solution conducts electricity.

[1 mark]

_____

_____

4 (d) (ii) Chlorine is produced at the positive electrode.

Why are chloride ions attracted to the positive electrode?

[1 mark]

_____

_____

4 (d) (iii) When sodium chloride solution is electrolysed, sodium hydroxide is also produced.

What can be manufactured from sodium hydroxide?

[1 mark]

Tick (✓) **one** box.

Alloys ☐

Poly(ethene) ☐

Soap ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 42 · continued

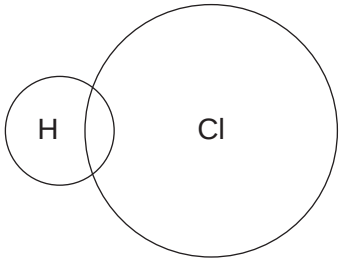
4 (d) (iv) The products chlorine and hydrogen react to form hydrogen chloride.

Hydrogen atoms have one electron in their outer shell. Chlorine atoms have seven electrons in their outer shell.

Complete **Figure 9** to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

[2 marks]

Figure 9



4 (d) (v) Which calculation shows the percentage of hydrogen in hydrogen chloride?

Relative atomic masses (A_r): H = 1; Cl = 35.5

Relative formula mass (M_r): HCl = 36.5

[1 mark]

Tick (✓) **one** box.

$\frac{35.5}{36.5} \times 100$ ☐

$\frac{1}{35.5} \times 100$ ☐

$\frac{1}{36.5} \times 100$ ☐

$\frac{1}{72.0} \times 100$ ☐

12

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 43

June 2017 | CH3FP | Original Q1 | Legacy

1 This question is about elements and compounds.

1 (a) (i) Use the correct answer from the box to complete the sentence.

[1 mark]

densities	numbers	weights

The elements in the modern periodic table are arranged in order of their atomic _____ .

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

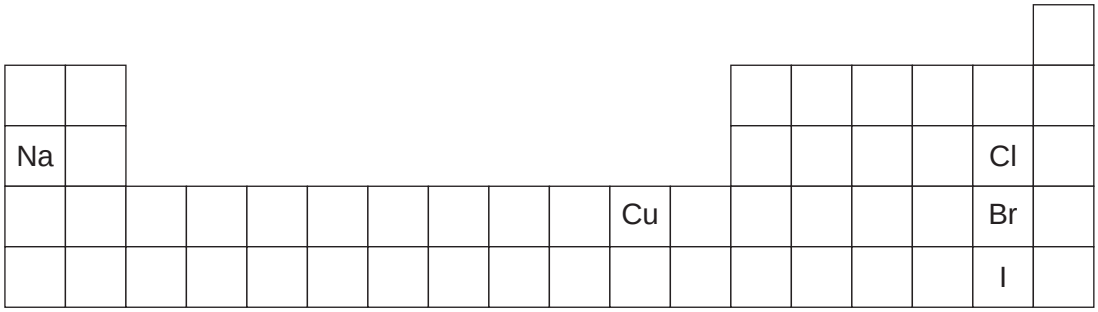
[1 mark]

electrons	neutrons	protons

The outer shells of atoms of elements in the same group have the same number of _____ .

1 (b) **Figure 1** shows the position of five elements in the modern periodic table.

Figure 1



1 (b) (i) Which **one** of the elements in **Figure 1** is a gas at room temperature?

[1 mark]

_____

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 43 · continued

1 (b) (ii) Which **one** of the elements in **Figure 1** is a transition metal?

[1 mark]

_____

1 (b) (iii) Complete the sentence.

[1 mark]

In the modern periodic table, bromine (Br) is in Group _____ .

1 (c) Bromine reacts with sodium iodide to produce iodine.

The word equation for the reaction is:

bromine + sodium iodide ⟶ iodine + sodium bromide

1 (c) (i) What type of reaction is this?

[1 mark]

Tick (✓) **one** box.

Combustion ☐

Displacement ☐

Neutralisation ☐

1 (c) (ii) Use the Chemistry Data Sheet to help you answer this question.

Which halogen would react with sodium chloride solution to produce chlorine?

[1 mark]

Tick (✓) **one** box.

Bromine ☐

Fluorine ☐

Iodine ☐

Question 1 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 43 · continued

1 (d) Silver nitrate in the presence of dilute nitric acid is used to test for iodide ions.

What colour precipitate is produced?

[1 mark]

Tick (✓) **one** box.

Cream ☐

White ☐

Yellow ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 43 · continued

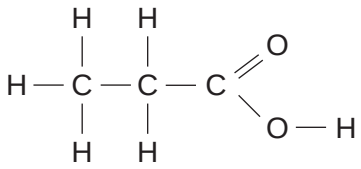
1 (e) Propanoic acid is a compound containing carbon atoms.

1 (e) (i) **Figure 2** shows the displayed structure of propanoic acid.

Draw a ring around the functional group of propanoic acid in **Figure 2**.

[1 mark]

Figure 2



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

[1 mark]

carbon dioxide	hydrogen	oxygen

Propanoic acid reacts with carbonates to produce _____ .

1 (e) (iii) Use the correct answer from the box to complete the sentence.

[1 mark]

alkalis	esters	fuels

Propanoic acid reacts with alcohols to produce pleasant smelling compounds called _____ .

11

4.5.1.1 Energy transfer during exothermic and endothermic reactions

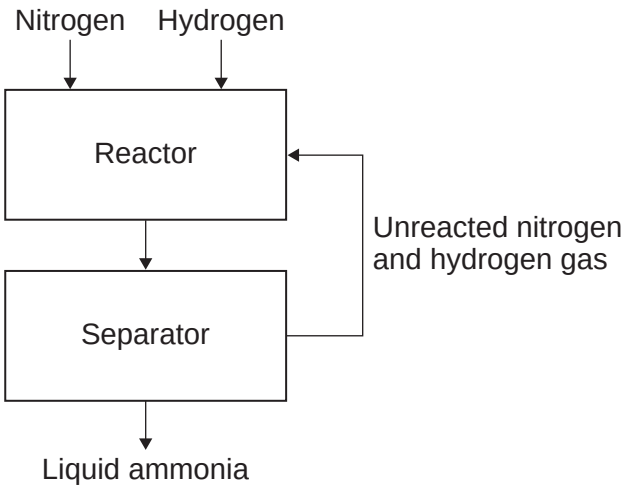
Question 44

June 2017 | CH3FP | Original Q3 | Legacy

3 This question is about the Haber process.

Figure 3 shows a flow diagram of the Haber process.

Figure 3



3 (a) (i) Use the correct answer from the box to complete the sentence.

[1 mark]

air	crude oil	natural gas	water

Nitrogen for the Haber process is obtained from _____ .

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 44 · continued

3 (a) (ii) Iron is used as a catalyst in the reactor.

How does a catalyst speed up a reaction?

[1 mark]

Tick (✓) **one** box.

Changes the pressure in the reactor ☐

Lowers the activation energy ☐

Makes the particles move faster ☐

3 (a) (iii) Describe how the ammonia is separated from the other gases.

[2 marks]

_____

_____

_____

_____

3 (b) Complete the word equation for the reaction in the Haber process.

[1 mark]

nitrogen + _____ ⇌ _____

Question 3 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 44 · continued

3 (c) **Figure 4** shows how, in the Haber process, the rate of reaction changes as the temperature and pressure increase.

Figure 4

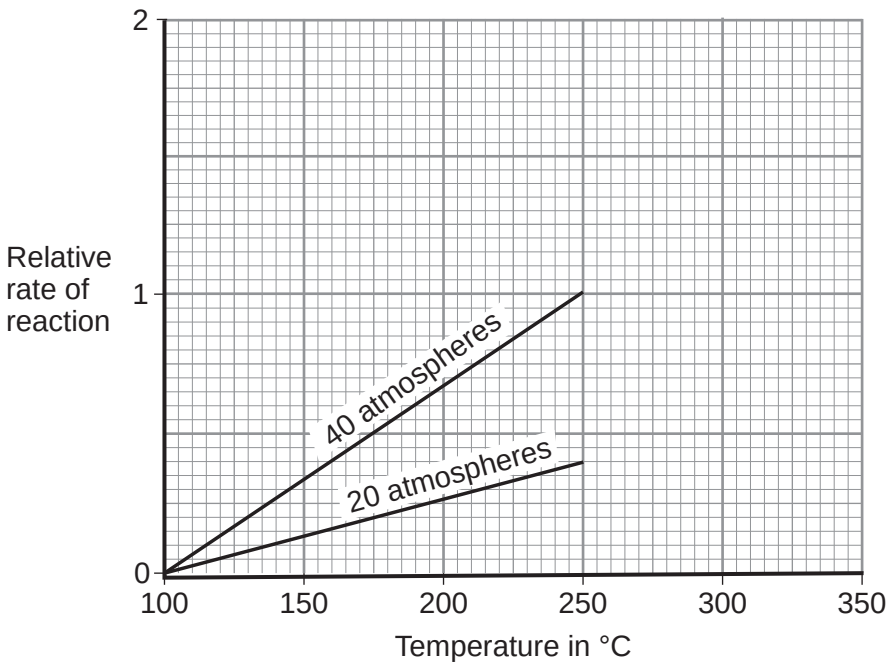


Table 1 shows the relative rate of reaction at 80 atmospheres at different temperatures.

Table 1

Temperature in °C	Relative rate of reaction
100	0.0
150	0.5
200	1.0
250	1.7
300	2.0

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 44 · continued

3 (c) (i) Plot the data in **Table 1** on the graph in **Figure 4**.

[2 marks]

3 (c) (ii) Draw a straight line of best fit for the points you have plotted.

[1 mark]

3 (c) (iii) What is the relative rate of reaction at 20 atmospheres and 300 °C?

Show your working on **Figure 4**.

[2 marks]

Relative rate of reaction = _____

3 (c) (iv) Describe how the rate of reaction changes as the pressure increases.

[1 mark]

_____

_____

11

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 45

June 2018 | 8462/1F | Original Q6

0 6 A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

This is the method used.

1. Measure 50 cm^3 of the copper sulfate solution into a polystyrene cup.
2. Record the starting temperature of the copper sulfate solution.
3. Add the metal and stir the solution.
4. Record the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1-5 with different metals.

0 6 . 1 Draw **one** line from each type of variable to the name of the variable in the investigation.

[2 marks]

Type of variable	Name of variable in the investigation
	Concentration of solution
Dependent variable	Particle size of solid
	Temperature change
Independent variable	Type of metal
	Volume of solution

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 45 · continued

0 6 . 2 The student used a polystyrene cup and **not** a glass beaker.

Why did this make the investigation more accurate?

[1 mark]

Tick **one** box.

- Glass is breakable ☐
- Glass is transparent ☐
- Polystyrene is a better insulator ☐
- Polystyrene is less dense ☐

Question 6 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 45 · continued

Table 5 shows the student's results.

Table 5

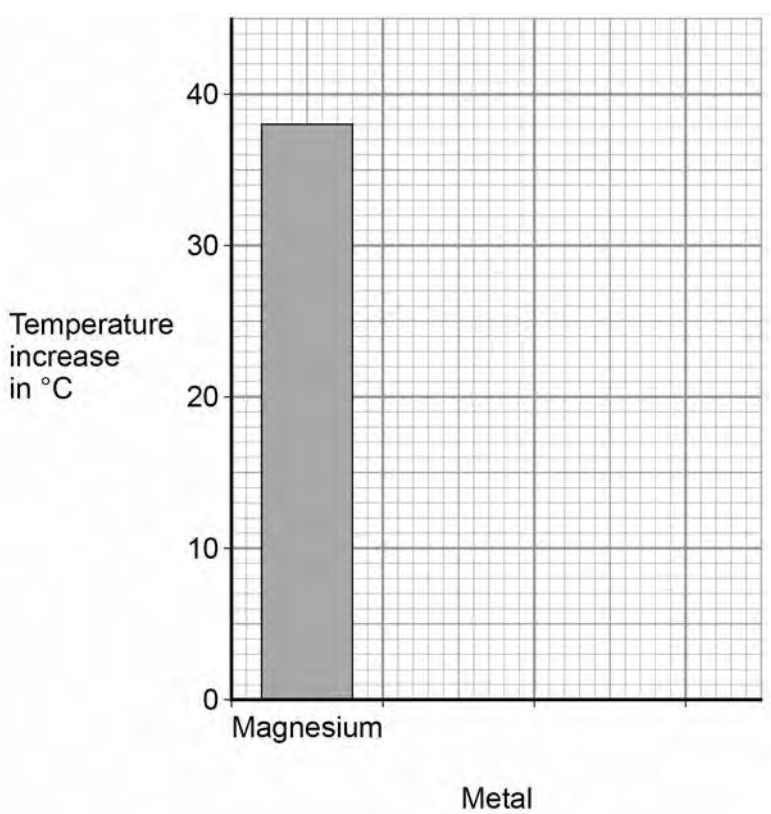
Metal	Temperature increase in °C
Magnesium	38
Nickel	8
Zinc	16

0 6 . 3 Complete **Figure 9**.

Use data from **Table 5**.

[2 marks]

Figure 9



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 45 · continued

0 6 . 4 The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

[1 mark]

0 6 . 5 The temperature increase depends on the reactivity of the metal.

Write the metals magnesium, nickel and zinc in order of reactivity.

Use **Table 5**.

[1 mark]

Most reactive _____

_____

Least reactive _____

0 6 . 6 **Y** is an unknown metal.

Describe a method to find the position of **Y** in the reactivity series in Question **06.5**

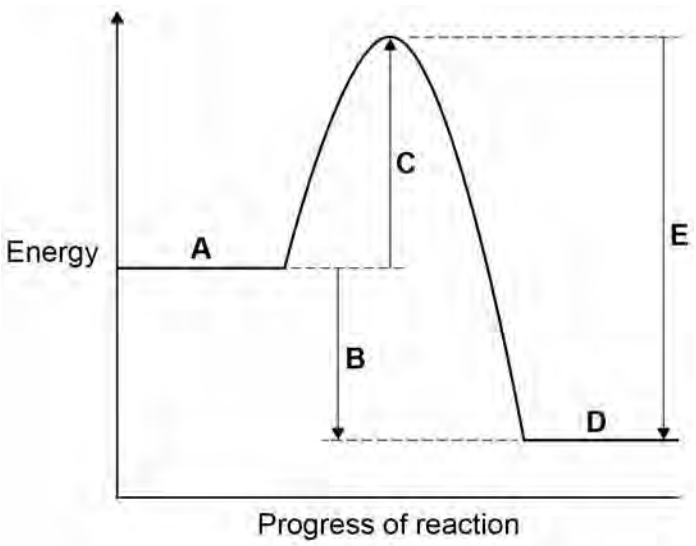
[3 marks]

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 45 · continued

Figure 10 shows the reaction profile for the reaction between zinc and copper sulfate solution.

Figure 10



0 6 . 7 Which letter represents the products of the reaction?

[1 mark]

Tick **one** box.

A		B		C		D		E	

0 6 . 8 Which letter represents the activation energy?

[1 mark]

Tick **one** box.

A		B		C		D		E	

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4.5.1.1 Energy transfer during exothermic and endothermic reactions

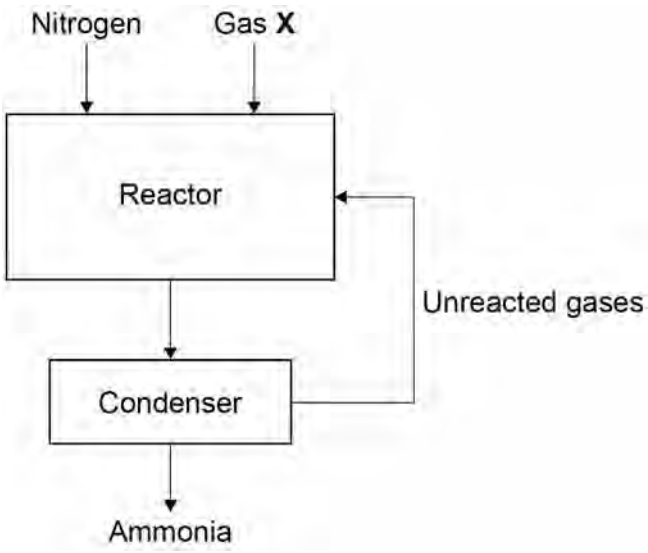
Question 46

June 2018 | 8462/2F | Original Q10

1 0 This question is about gases.

Figure 10 shows how nitrogen is used in the Haber Process to produce ammonia.

Figure 10



1 0 . 1 Gas **X** in **Figure 10** is obtained from methane.

Name gas **X**.

[1 mark]

_____

1 0 . 2 Give the approximate temperature and pressure used in the reactor.

[2 marks]

Temperature _____

Pressure _____

1 0 . 3 The mixture of gases from the reactor cools in the condenser.

Suggest why ammonia condenses but the other gases do not.

[1 mark]

_____

_____

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 46 · continued

June 2018 | 8462/2F | Original Q10

The Earth's early atmosphere was different to Earth's atmosphere today.

Scientists think that the Earth's early atmosphere was like the atmosphere found on Venus today.

Table 7 shows the amounts of carbon dioxide and oxygen in the atmospheres of Venus and Earth today.

Table 7

Gas	Percentage (%) in Venus' atmosphere today	Percentage (%) in Earth's atmosphere today
Carbon dioxide	96.50	0.04
Oxygen	0.00	20.95

10.4 The percentages of carbon dioxide and oxygen have changed from Earth's early atmosphere to Earth's atmosphere today.

Explain the processes that led to these changes.

[6 marks]

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 46 · continued

June 2018 | 8462/2F | Original Q10

1 0 . 5 Why are scientists **not** certain about the percentage of each gas in the Earth's early atmosphere?

[1 mark]

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 47

June 2019 | 8462/1F | Original Q7

0 7 This question is about energy changes in reactions.

0 7 . 1 Ammonium nitrate dissolves in water.

The change is endothermic.

Which piece of equipment uses this change?

[1 mark]

Tick (✓) **one** box.

Hand warmer ☐

Self-heating can ☐

Sports injury pack ☐

A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25 cm^3 of potassium hydroxide solution into a glass beaker.

2. Add 5 cm^3 of dilute sulfuric acid.

3. Stir the solution.

4. Measure the temperature of the solution.

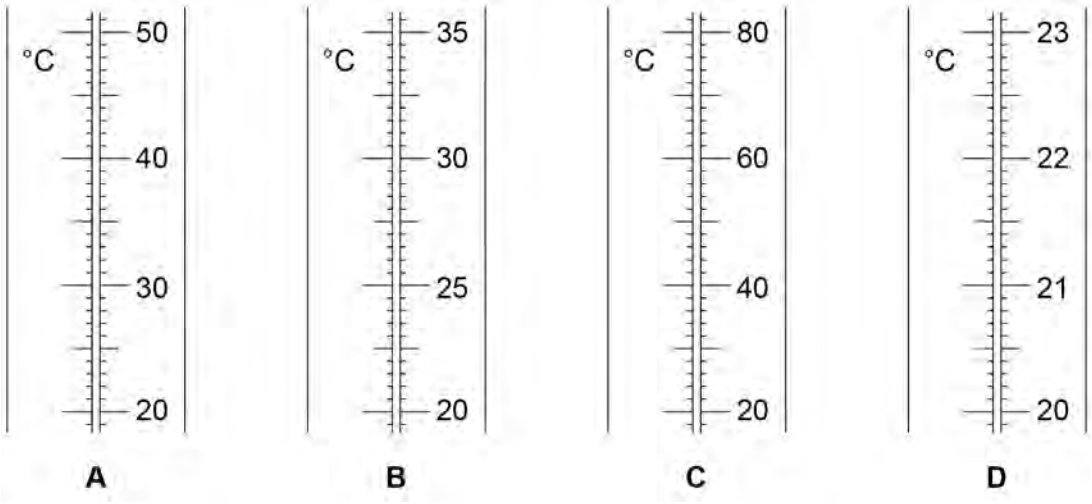
5. Repeat steps 2 to 4 until a total of 30 cm^3 of dilute sulfuric acid has been added.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 47 · continued

0 7 . 2 **Figure 9** shows part of the scales of four thermometers, **A**, **B**, **C** and **D**.

Figure 9



The student wanted to measure the temperature to a resolution of 0.1 °C

Which thermometer should the student use?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 7 . 3 Energy is lost to the surroundings during the reaction.

What type of error does this cause in the results?

[1 mark]

Tick (✓) **one** box.

Human error ☐

Random error ☐

Systematic error ☐

Zero error ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 47 · continued

0 7 . 4 The student used a glass beaker for the reaction.

Name a container the student could use instead of the glass beaker to improve the accuracy of the results.

[1 mark]

0 7 . 5 **Table 3** shows the student's results.

Table 3

Volume of dilute sulfuric acid added in cm^3	Temperature in °C
5	21.2
10	22.0
15	22.8
20	23.6
25	24.4
30	25.2

Plot the data from **Table 3** on **Figure 10**.

You should:

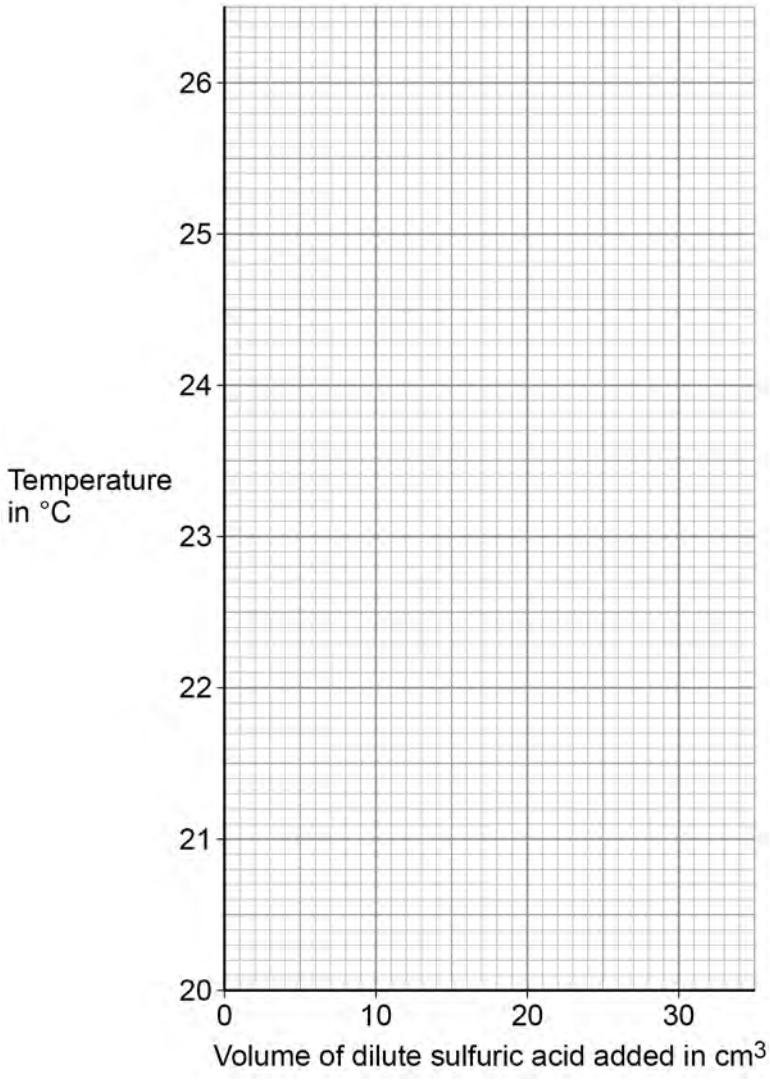
- draw a line of best fit
- extend your line of best fit to the y-axis.

[4 marks]

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 47 · continued

Figure 10



0 7 . 6 The intercept on the y-axis of **Figure 10** shows the starting temperature of the potassium hydroxide solution.

Give the starting temperature of the potassium hydroxide solution.

[1 mark]

Starting temperature = _____ °C

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 47 · continued

0 7 . 7 Another student repeated the investigation and obtained an anomalous result.

This result was lower than expected.

What could have caused the anomalous result?

[2 marks]

Tick (✓) **two** boxes.

- The mixture was not stirred. ☐
- The temperature in the room increased. ☐
- The thermometer was not accurate. ☐
- Too little sulfuric acid was added. ☐
- Too much potassium hydroxide solution was used. ☐

11

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 48

0 8 This question is about the periodic table.

In the 19th century, some scientists tried to classify the elements by arranging them in order of their atomic weights.

Figure 11 shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

Figure 11

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Period 1	H						
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K Cu	Ca Zn	* *	Ti *	V As	Cr Se	Mn Br
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

0 8 . 1 The atomic weight of tellurium (Te) is 128 and that of iodine (I) is 127

Why did Mendeleev reverse the order of these two elements?

[1 mark]

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 48 · continued

0 8 . 2 Mendeleev left spaces marked with an asterisk *

He left these spaces because he thought missing elements belonged there.

Why did Mendeleev's periodic table become more widely accepted than previous versions?

[3 marks]

0 8 . 3 Mendeleev arranged the elements in order of their atomic weight.

What is the modern name for atomic weight?

[1 mark]

Tick (✓) **one** box.

- Atomic number ☐
- Mass number ☐
- Relative atomic mass ☐
- Relative formula mass ☐

0 8 . 4 Complete the sentence.

[1 mark]

In the modern periodic table, the elements are arranged in order of

_____.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 48 · continued

Chlorine, iodine and astatine are in Group 7 of the modern periodic table.

0 8 . 5 Astatine (At) is below iodine in Group 7.

Predict:

- the formula of an astatine molecule
- the state of astatine at room temperature.

[2 marks]

Formula of astatine molecule _____

State at room temperature _____

0 8 . 6 Sodium is in Group 1 of the modern periodic table.

Describe what you would see when sodium reacts with chlorine.

[2 marks]

_____

_____

_____

_____

10

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 49

June 2019 | 8462/2F | Original Q3

0 3 Hydrogen is a raw material in the Haber process.

Hydrogen is produced from methane.

The word equation for the reaction is:

methane + steam ⇌ carbon monoxide + hydrogen

0 3 . 1 How can you tell that the reaction is reversible?

[1 mark]

0 3 . 2 The forward reaction is endothermic.

Name the type of energy change in the reverse reaction.

[1 mark]

0 3 . 3 A nickel catalyst is used in this reaction.

Why is a catalyst used in this reaction?

[2 marks]

Tick (✓) **two** boxes.

- To increase the temperature ☐
- To produce less carbon monoxide ☐
- To reduce costs ☐
- To use less energy ☐
- To use less methane ☐

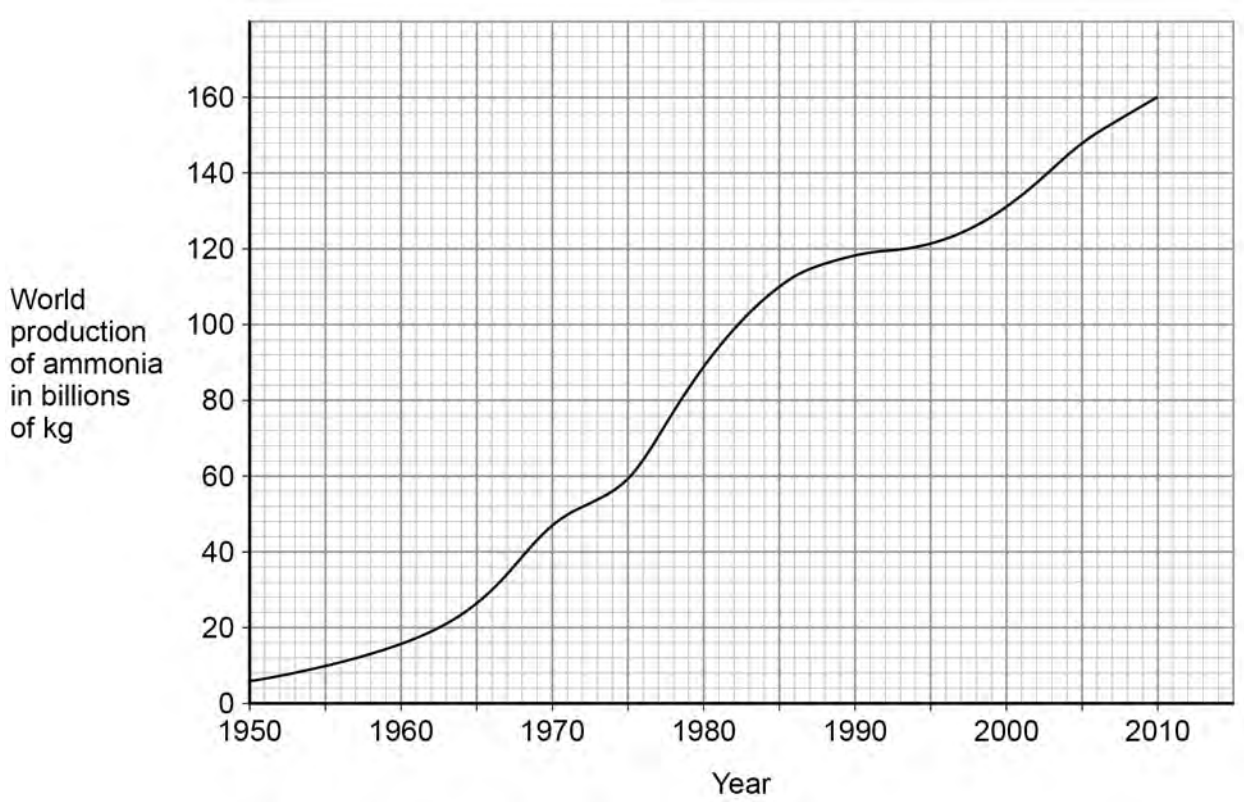
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 49 · continued

0 3 . 4 The Haber process also uses nitrogen to produce ammonia.

Figure 1 shows how the world production of ammonia changed between 1950 and 2010.

Figure 1



Describe how the world production of ammonia changed between 1950 and 2010.

[2 marks]

Question 49 · continued

Most of the ammonia produced is used to make fertilisers.

0 3 . 5 Why did the world production of ammonia change between 1950 and 2010?

[2 marks]

Tick (✓) **two** boxes.

- The demand for food changed. ☐
- The demand for fuels changed. ☐
- The nitrogen percentage in air changed. ☐
- The number of cars changed. ☐
- The world population changed. ☐

Table 1 shows data about four fertilisers, **A**, **B**, **C** and **D**.

Table 1

Fertiliser	Percentage by mass of nitrogen (%)	Percentage by mass of phosphorus (%)	Percentage by mass of potassium (%)
A	35.0	0.0	0.0
B	21.2	0.0	0.0
C	21.2	23.5	0.0
D	0.0	0.0	52.3

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 49 · continued

0 3 . 6 Which combination of fertilisers **A**, **B**, **C** and **D** provides **all** of the elements needed for an NPK fertiliser?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

A and **C** ☐

A and **D** ☐

B and **C** ☐

C and **D** ☐

0 3 . 7 Which fertiliser is **not** made using ammonia?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

10

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 50

June 2019 | 8462/2F | Original Q10

1 0 This question is about rate of reaction.

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

The equation for the reaction is:

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

1 0 . 1 Which state symbol in the equation for the reaction does **not** represent one of the three states of matter?

[1 mark]

The student determined the rate of production of hydrogen gas.

1 0 . 2 What **two** pieces of measuring apparatus could the student use to find the rate of production of hydrogen gas?

[2 marks]

1 _____

2 _____

Question 10 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 50 · continued

Table 6 shows the results of the investigation.

Table 6

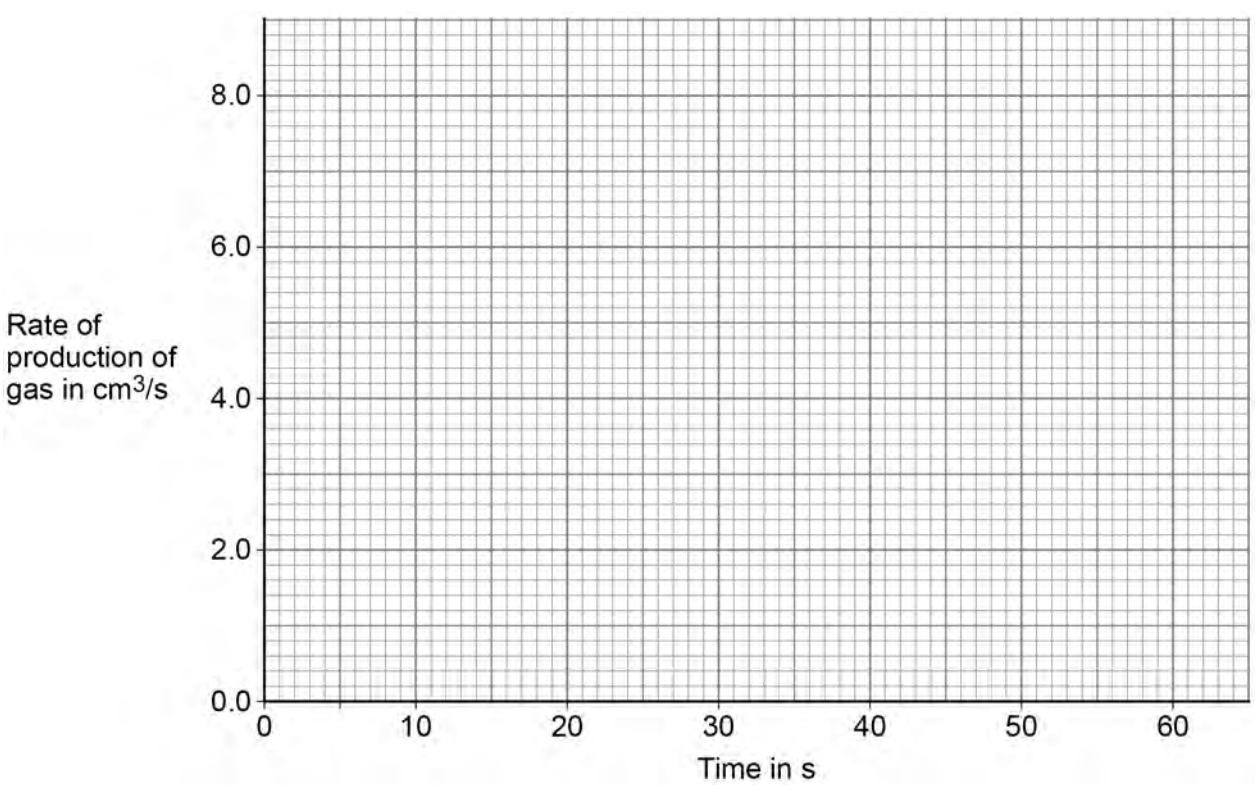
Time in s	Rate of production of gas in cm^3/s
10	6.9
20	3.9
30	2.0
40	0.9
50	0.3
60	0.0

1 0 . 3 Plot the data from **Table 6** on **Figure 8**.

You should draw a line of best fit.

[3 marks]

Figure 8



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 50 · continued

1 0 . 4 Give **three** conclusions that can be drawn about the rate of reaction between magnesium and dilute hydrochloric acid in this investigation.

Use data from **Figure 8** and **Table 6**.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

1 0 . 5 The student repeated the investigation using dilute hydrochloric acid at a higher temperature.

All the other variables were kept the same.

Which **two** statements are correct?

[2 marks]

Tick (✓) **two** boxes.

- More bubbles were produced in the first 10 seconds. ☐
- The activation energy for the reaction was higher. ☐
- The magnesium was used up more quickly. ☐
- The reaction finished at the same time. ☐
- The total volume of gas collected was greater. ☐

11

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 51

November 2020 | 8462/1F | Original Q1

0 1 This question is about the elements in Group 7 of the periodic table.

Table 1 shows the melting points and boiling points of some of the elements.

Table 1

Element	Melting point in °C	Boiling point in °C
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

0 1 . 1 What is the state of bromine at 100 °C?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

Gas ☐

Liquid ☐

Solid ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 51 · continued

0 1 . 2 What temperature does chlorine gas condense at to form a liquid?

Use **Table 1**.

[1 mark]

Temperature = _____ °C

0 1 . 3 Complete the sentences.

[2 marks]

Going down Group 7 the melting points _____.

This is because the size of the molecules increases so the

intermolecular forces _____.

Question 1 continues on the next page

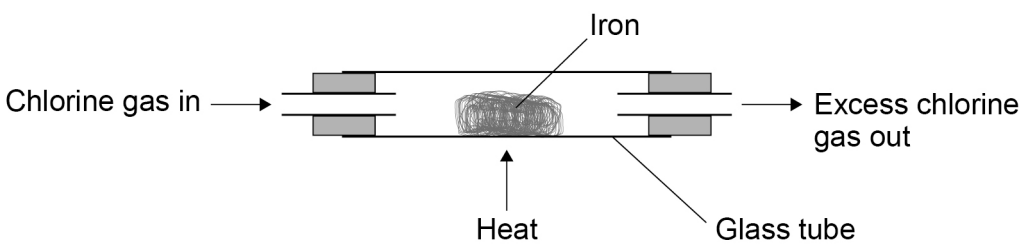
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 51 · continued

A teacher investigated the reaction of iron with chlorine.

Figure 1 shows the apparatus used.

Figure 1



0 1 . 4 Why did the teacher do the investigation in a fume cupboard?

[1 mark]

Tick (✓) **one** box.

Chlorine gas is coloured. ☐

Chlorine gas is flammable. ☐

Chlorine gas is toxic. ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 51 · continued

0 1 . 5 The word equation for the reaction is:

iron + chlorine → iron chloride

Iron chloride is a solid.

The teacher weighed the glass tube and contents:

- before the reaction
- after the reaction.

What happened to the mass of the glass tube and contents during the reaction?

Give **one** reason for your answer.

[2 marks]

The mass of the glass tube and contents _____.

Reason _____

_____

Question 1 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 51 · continued

The teacher repeated the investigation with bromine gas and with iodine gas.

Table 2 shows the results.

Table 2

Element	Observation
Chlorine	Iron burns vigorously with an orange glow
Bromine	Iron burns with an orange glow
Iodine	Iron slowly turns darker

0 1 . 6 Fluorine is above chlorine in Group 7.

Predict what you would observe when fluorine gas reacts with iron.

Use **Table 2**.

[1 mark]

0 1 . 7 Balance the equation for the reaction between iron and bromine.

[1 mark]

$$2Fe + _____ Br_2 \rightarrow 2FeBr_3$$

0 1 . 8 Calculate the relative formula mass (M_r) of $FeBr_3$

Relative atomic masses (A_r): Fe = 56 Br = 80

[2 marks]

Relative formula mass (M_r) = _____

11

4.5.1.1 Energy transfer during exothermic and endothermic reactions

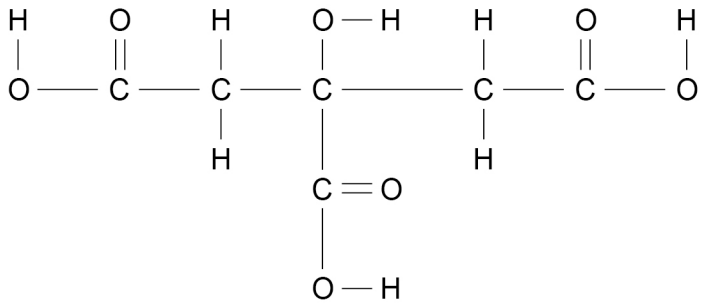
Question 52

November 2020 | 8462/1F | Original Q6

0 6 This question is about citric acid.

Figure 7 represents one molecule of citric acid.

Figure 7



0 6 . 1 Complete the molecular formula of citric acid.

Use **Figure 7**.

[1 mark]

C_6H __ O __

0 6 . 2 What type of bonding is shown in **Figure 7**?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

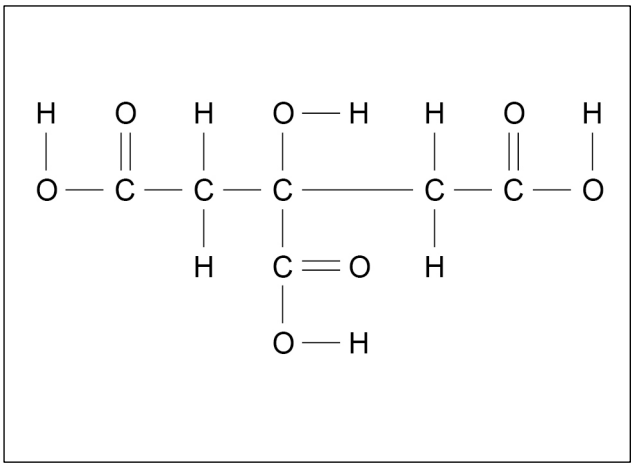
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 52 · continued

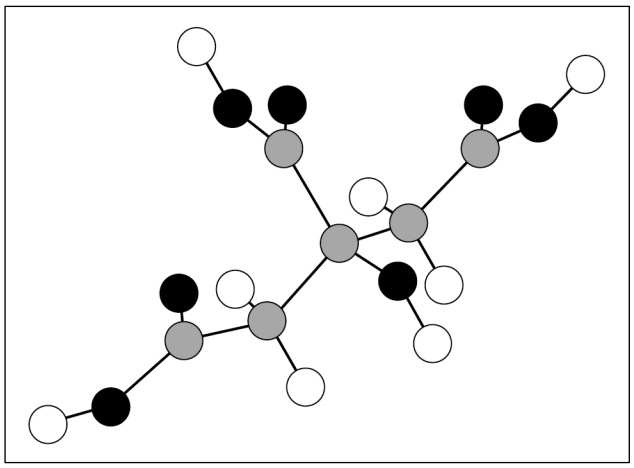
0 6 . 3 **Figure 8** shows two representations of one molecule of citric acid, **A** and **B**.

Figure 8

A



B



Give **two** advantages of representation **A** compared with representation **B**.

[2 marks]

Advantages of **A**:

1 _____

_____

2 _____

_____

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 52 · continued

November 2020 | 8462/1F | Original Q6

A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution.

Citric acid is a solid.

This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.
2. Measure the temperature of the sodium hydrogencarbonate solution.
3. Add 0.25 g of citric acid to the cup.
4. Stir the solution.
5. Measure the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

Table 4 shows some of the student's results.

Table 4

Mass of citric acid added in g	Temperature of solution in °C
0.00	22.6
0.25	22.2
0.50	21.8
0.75	21.4
1.00	21.0
1.25	20.6

0 6 . 4 How do the results in **Table 4** show that the reaction is endothermic?

[1 mark]

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 52 · continued

0 6 . 5 Three of the student's results are plotted on **Figure 9**.

A line of best fit for these points is drawn.

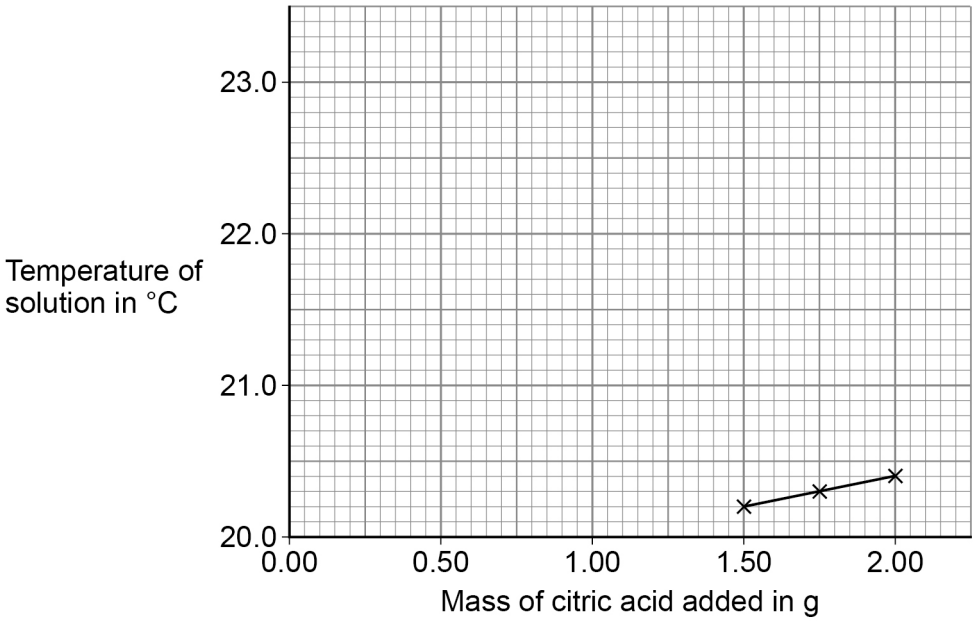
Complete **Figure 9**.

You should:

- plot the data from **Table 4** on **Figure 9**
- draw a line of best fit through the points you have plotted
- extend your line of best fit to meet the line of best fit already drawn on **Figure 9**.

[4 marks]

Figure 9



0 6 . 6 Determine the overall temperature change for the reaction.

Use **Figure 9**.

[2 marks]

Overall temperature change = _____ °C

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 52 · continued

0 6 . 7 What is the dependent variable in this investigation?

[1 mark]

Tick (✓) **one** box.

Mass of citric acid ☐

Temperature of solution ☐

Volume of solution ☐

12

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 53

November 2020 | 8462/2F | Original Q2

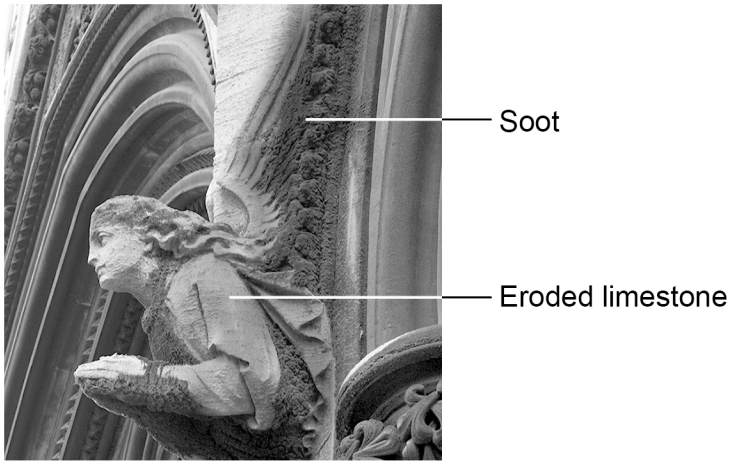
0 2 This question is about atmospheric pollution.

Figure 3 shows a limestone carving which has been damaged by atmospheric pollution.

The carving has been:

- blackened by soot
- eroded where the limestone has reacted with atmospheric pollutants.

Figure 3



0 2 . 1 What reacted with the limestone to cause the erosion?

[1 mark]

Tick (✓) **one** box.

- Acid rain ☐
- Ammonia ☐
- Carbon monoxide ☐
- Oxygen ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 53 · continued

0 2 . 2 Soot is produced by the incomplete combustion of diesel oil.

Complete the sentences.

Choose answers from the box.

[2 marks]

ammonia	**carbon**	**methane**
nitrogen	**oxygen**	

Incomplete combustion happens when there is not enough _____.

Incomplete combustion produces particles of _____.

0 2 . 3 Complete the sentence.

[1 mark]

Particles of soot in the atmosphere cause global _____.

0 2 . 4 Carbon monoxide is produced by the incomplete combustion of methane.

Balance the equation for the reaction.

[1 mark]

$$2\,CH_4 + 3\,O_2 \rightarrow ____\,CO + 4\,H_2O$$

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 53 · continued

0 2 . 5 Car engines work at high temperatures.

Complete the sentences.

Choose answers from the box.

[3 marks]

air	**methane**	**oxides of nitrogen**
oxygen	**petrol**	**sulfur dioxide**

In car engines, nitrogen is present.

The nitrogen in car engines comes from _____.

At high temperatures, the nitrogen reacts with _____.

This reaction produces _____.

8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 54

0 4 A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

1. Measure 50 cm^3 of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

Table 4 shows the student's results.

Table 4

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	**X**
Zinc	18	16	18	20	18

0 4 . 1 Calculate the mean temperature increase **X** for magnesium in **Table 4**.

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

[2 marks]

X = _____ °C

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 54 · continued

0 4 . 2 Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use **Table 4**.

[1 mark]

Most reactive _____

_____

Least reactive _____

0 4 . 3 The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use **Table 4**.

[1 mark]

The mean temperature increase for zinc is 18 ± _____ °C

0 4 . 4 What type of variable is the volume of hydrochloric acid in this investigation?

[1 mark]

Tick (✓) **one** box.

Control ☐

Dependent ☐

Independent ☐

0 4 . 5 Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

[1 mark]

_____

_____

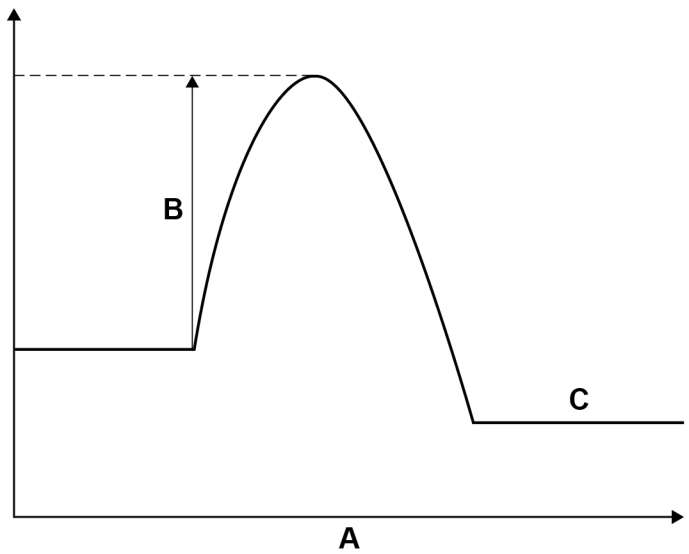
_____

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 54 · continued

0 4 . 6 **Figure 6** shows a reaction profile for the reaction of magnesium with hydrochloric acid.

Figure 6



What do labels **A**, **B** and **C** represent on **Figure 6**?

Choose answers from the box.

[3 marks]

activation energy	**energy**	**overall energy change**
products	**progress of reaction**	**reactants**

A _____

B _____

C _____

9

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 55

June 2022 | 8462/1F | Original Q10

1 0 Sodium carbonate reacts with hydrochloric acid in an exothermic reaction.

The equation for the reaction is:

$$Na_2CO_3(s) + 2\,HCl(aq) \rightarrow 2\,NaCl(aq) + CO_2(g) + H_2O(l)$$

A student investigated the effect of changing the mass of sodium carbonate powder on the highest temperature reached by the reaction mixture.

1 0 . 1 Plan a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached.

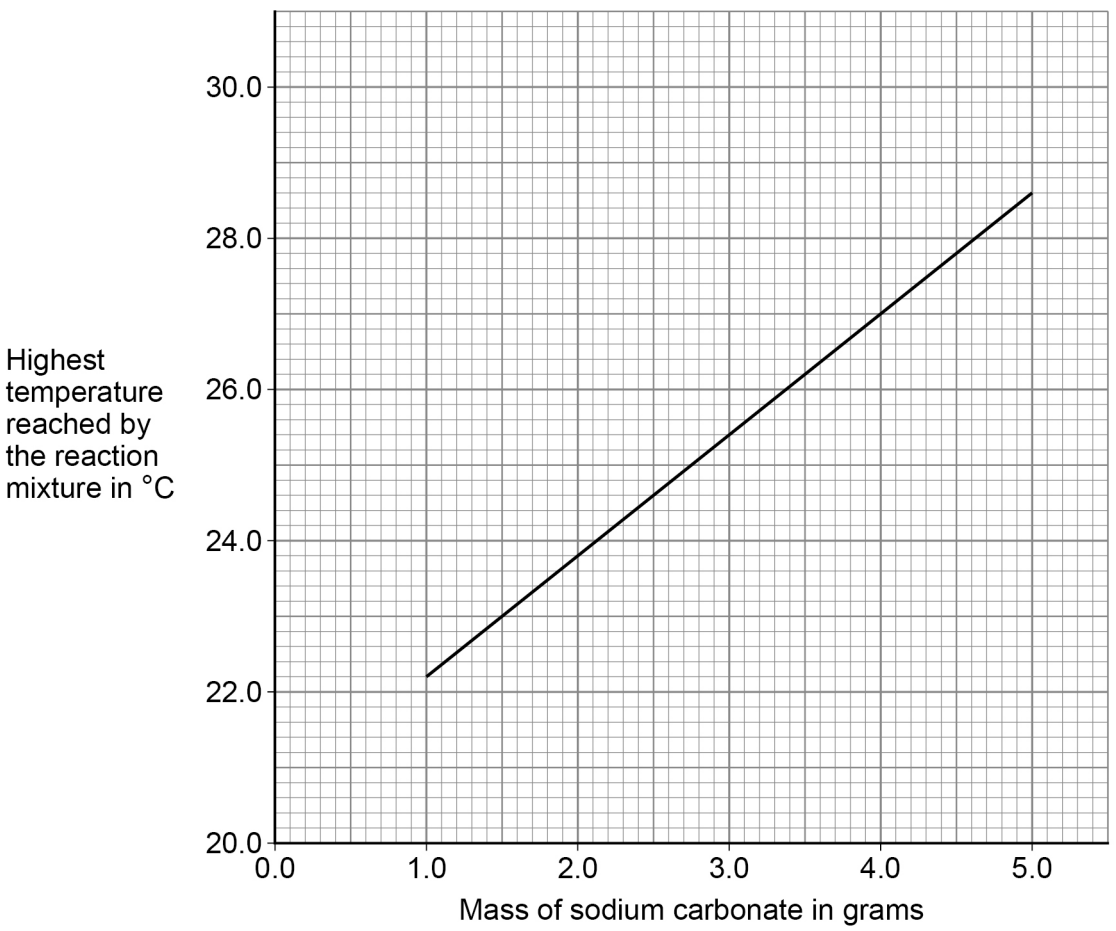
[6 marks]

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 55 · continued

Figure 17 shows a line of best fit drawn through the student's results.

Figure 17



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 55 · continued

1 0 . 2 Determine the gradient of the line of best fit in **Figure 17**.

Use the equation:

$$\text{Gradient} = \frac{\text{Change in highest temperature}}{\text{Change in mass}}$$

Give the unit.

[5 marks]

Gradient = _____ Unit _____

1 0 . 3 The initial temperature of the reaction mixture is where the line of best fit would meet the *y*-axis.

Determine the initial temperature of the reaction mixture.

Show your working on **Figure 17**.

[2 marks]

Initial temperature of the reaction mixture = _____ °C

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 55 · continued

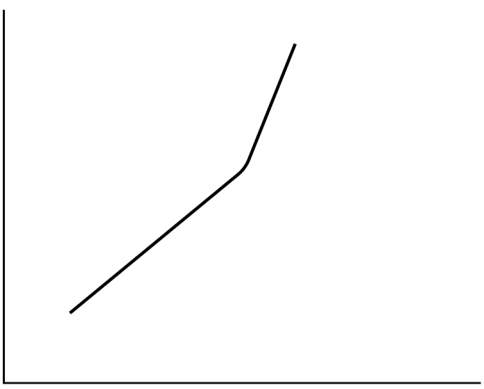
1 0 . 4 Another student repeated the investigation but added sodium carbonate until the sodium carbonate was in excess.

Which sketch graph shows the results obtained when sodium carbonate was added until in excess?

[1 mark]

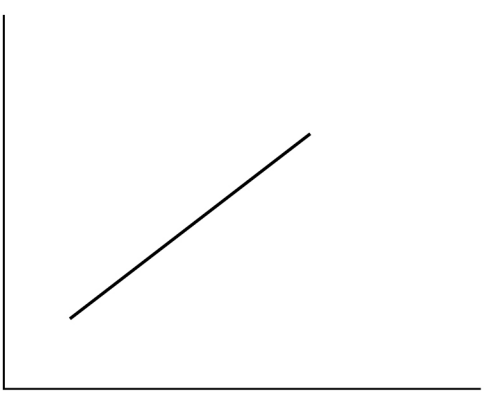
Tick (✓) **one** box.

A



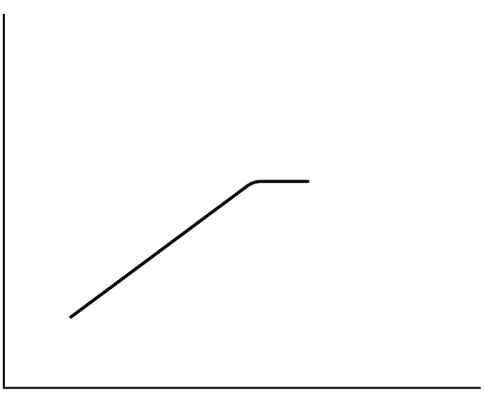
☐

B



☐

C



☐

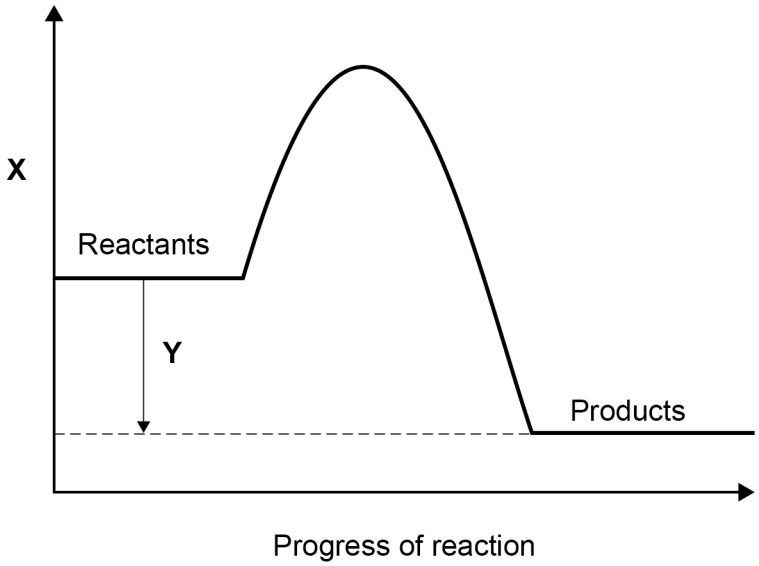
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 55 · continued

June 2022 | 8462/1F | Original Q10

Figure 18 shows a reaction profile for the reaction of sodium carbonate with hydrochloric acid.

Figure 18



1 0 . 5 What do labels **X** and **Y** represent on **Figure 18**?

[2 marks]

X _____

Y _____

1 0 . 6 How does the reaction profile show that the reaction is exothermic?

Use **Figure 18**.

[1 mark]

_____

_____

17

4.5.1.1 Energy transfer during exothermic and endothermic reactions

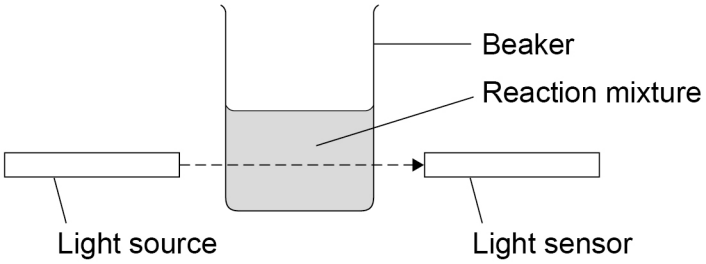
Question 56

June 2022 | 8462/2F | Original Q6

0 6 A student investigated the rate of reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 7 shows the apparatus used.

Figure 7



When hydrochloric acid is added to sodium thiosulfate solution, the mixture gradually becomes cloudy.

A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

This is the method used.

1. Measure 50 cm^3 of sodium thiosulfate solution into the beaker.
2. Add 10 cm^3 of hydrochloric acid to the sodium thiosulfate solution.
3. Immediately start a timer.
4. Record the percentage of light from the light source that reaches the light sensor every 20 seconds for 120 seconds.

0 6 . 1 Balance the equation for this reaction.

[1 mark]

$$Na_2S_2O_3 + 2\,HCl \rightarrow ____\ NaCl + H_2O + SO_2 + S$$

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 56 · continued

0 6 . 2 The mixture becomes cloudy because the sulfur produced is a solid.

What is the state symbol for a solid?

[1 mark]

Tick (✓) **one** box.

(aq) ☐

(g) ☐

(l) ☐

(s) ☐

0 6 . 3 The student monitored the cloudiness of the reaction mixture using a light sensor.

What other piece of equipment could be used to monitor the cloudiness of the reaction mixture?

[1 mark]

Tick (✓) **one** box.

A balance ☐

A cross on a piece of paper ☐

A gas syringe ☐

A thermometer ☐

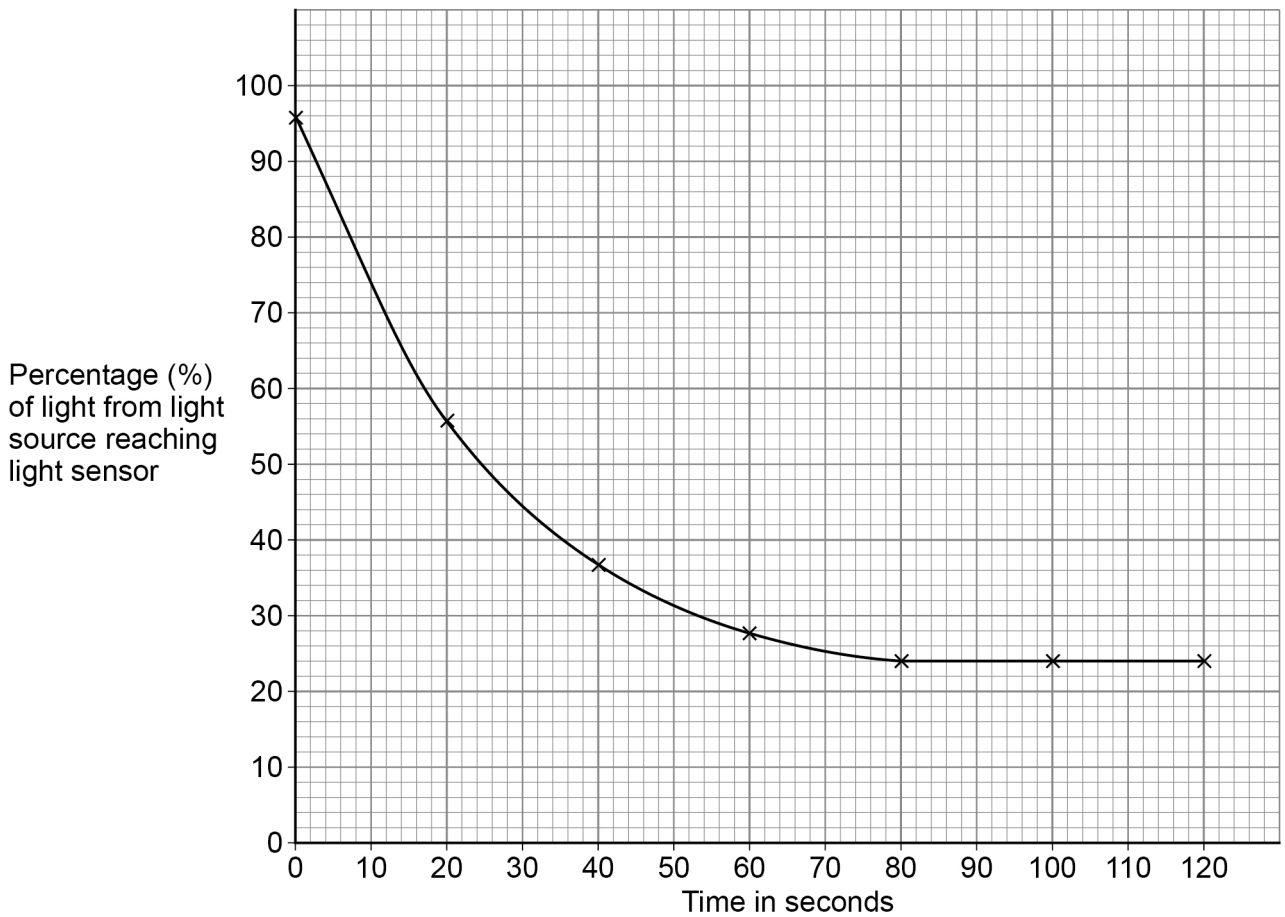
Question 6 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 56 · continued

Figure 8 shows the results.

Figure 8



0 6 . 4 What happened to the rate of reaction between 40 and 60 seconds?

Use **Figure 8**.

[1 mark]

Tick (✓) **one** box.

The rate of reaction decreased. ☐

The rate of reaction stayed at zero. ☐

The rate of reaction increased. ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 56 · continued

0 6 . 5 The student stopped taking measurements after 120 seconds because the percentage of light reaching the sensor stayed constant.

Why did the percentage of light reaching the sensor stay constant?

[1 mark]

Tick (✓) **one** box.

- No light was reaching the sensor. ☐
- One of the reactants was used up. ☐
- The reaction was too vigorous. ☐

0 6 . 6 The student repeated the experiment using sodium thiosulfate solution of a higher concentration.

How would the line of best fit for sodium thiosulfate solution of a higher concentration compare with the line of best fit on **Figure 8**?

[1 mark]

Tick (✓) **one** box.

- Initially the line of best fit would be less steep. ☐
- Initially the line of best fit would be the same steepness. ☐
- Initially the line of best fit would be steeper. ☐

Question 6 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 56 · continued

0 6 . 7 The student then investigated the effect of changing the temperature on the rate of reaction.

The student used sodium thiosulfate solution and hydrochloric acid which had been kept in an ice bath.

Which are **two** effects of using reactants kept in an ice bath rather than at room temperature?

[2 marks]

Tick (✓) **two** boxes.

- Fewer reactant particles have the activation energy. ☐
- The reactant particles collide more frequently. ☐
- The reactant particles have more energy. ☐
- The reactant particles move more slowly. ☐
- There are fewer reactant particles in the same volume. ☐

8

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 57

June 2023 | 8462/1F | Original Q10

1 0 This question is about temperature changes.

A student investigated the change in temperature of a solution when different masses of ammonium nitrate were dissolved in water.

This is the method used.

1. Measure 200 cm^3 of water into a polystyrene cup.

2. Measure the temperature of the water.

3. Add 4.0 g of ammonium nitrate to the water.

4. Stir the solution until all the ammonium nitrate has dissolved.

5. Measure the lowest temperature reached by the solution.

6. Repeat steps 1 to 5 with different masses of ammonium nitrate.

1 0 . 1 Give the independent variable and the dependent variable in the investigation.

[2 marks]

Independent variable _____

Dependent variable _____

Table 6 shows the results.

Table 6

Mass of ammonium nitrate added in grams	Lowest temperature of solution in °C
4.0	18.2
8.0	16.2
12.0	15.2
16.0	13.6
20.0	12.4
24.0	10.6

4.5.1.1 Energy transfer during exothermic and endothermic reactions

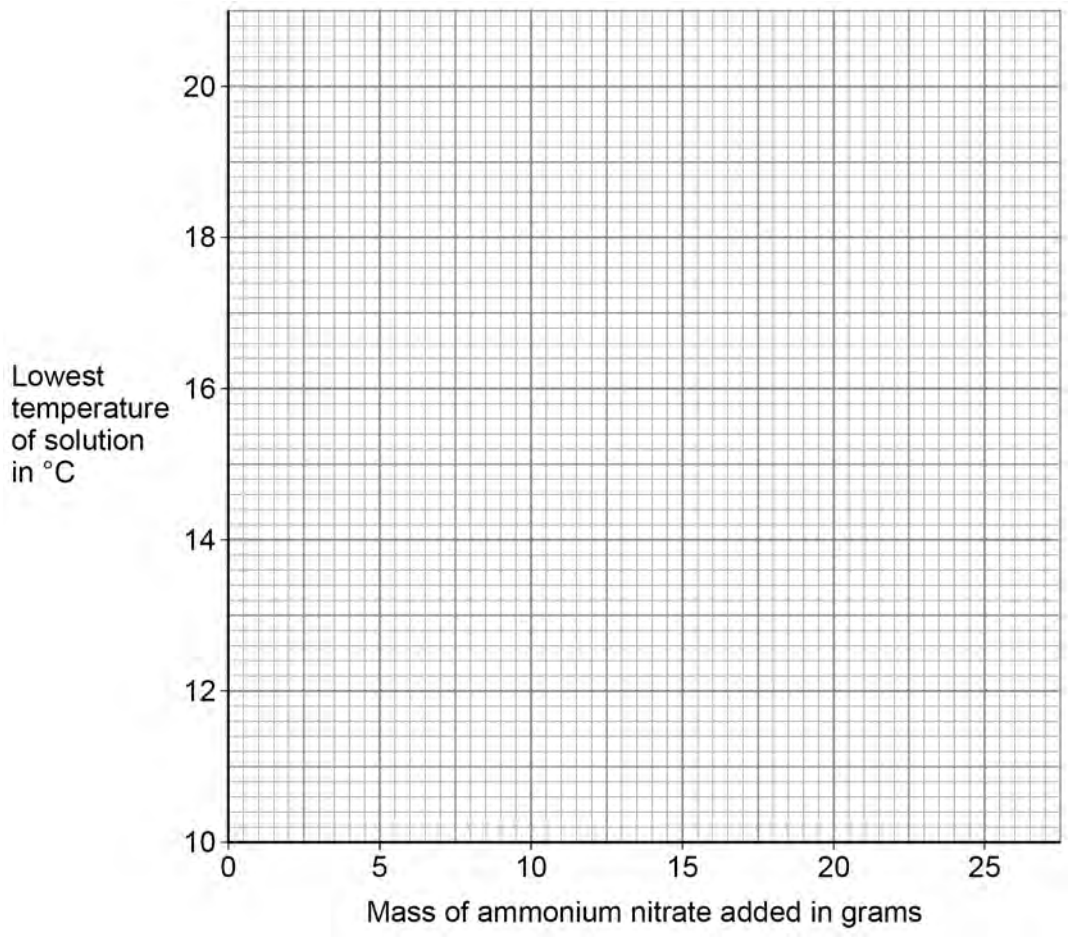
Question 57 · continued

1 0 . 2 Plot the data from **Table 6** on **Figure 11**.

Draw a line of best fit.

[3 marks]

Figure 11



1 0 . 3 Determine the initial temperature of the water.

You should extend your line of best fit on **Figure 11**.

[2 marks]

Initial temperature of the water = _____ °C

1 0 . 4 How do the results show that dissolving ammonium nitrate in water is endothermic?

[1 mark]

_____

_____

Question 57 · continued

The student repeated the experiment three more times.

Table 7 shows the results for 8.0 g of ammonium nitrate.

Table 7

	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Lowest temperature of solution in ºC	16.2	16.6	16.8	16.4	16.5

10.5 The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as 16.5 ± 0.3 ºC.

Explain why the student included ± 0.3 ºC after the mean lowest temperature.

[2 marks]

10.6 What type of error is shown by the results in **Table 7**?

[1 mark]

Tick (✓) **one** box.

Random error ☐

Systematic error ☐

Zero error ☐

11

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 58

June 2023 | 8462/2F | Original Q1

0 1 This question is about oxygen.

Scientists think that there was little or no oxygen in the Earth's early atmosphere.

0 1 . 1 Which planet today has an atmosphere that is similar to the Earth's early atmosphere?

[1 mark]

Tick (✓) **one** box.

- Jupiter ☐
- Mars ☐
- Neptune ☐
- Saturn ☐

0 1 . 2 Which is the approximate percentage of oxygen in the Earth's atmosphere today?

[1 mark]

Tick (✓) **one** box.

- 20% ☐
- 50% ☐
- 80% ☐
- 100% ☐

Question 1 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 58 · continued

0 1 . 3 Which **two** of the following increased the percentage of oxygen in the Earth's atmosphere?

[2 marks]

Tick (✓) **two** boxes.

- Active volcanoes emitted gases ☐
- Algae and plants evolved ☐
- Animals evolved ☐
- Carbonate sediments formed in oceans ☐
- Photosynthesis took place ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 58 · continued

0 1 . 4 Some scientists think that 1100 million years ago the Earth's atmosphere contained:

- 16% oxygen
- 4% carbon dioxide.

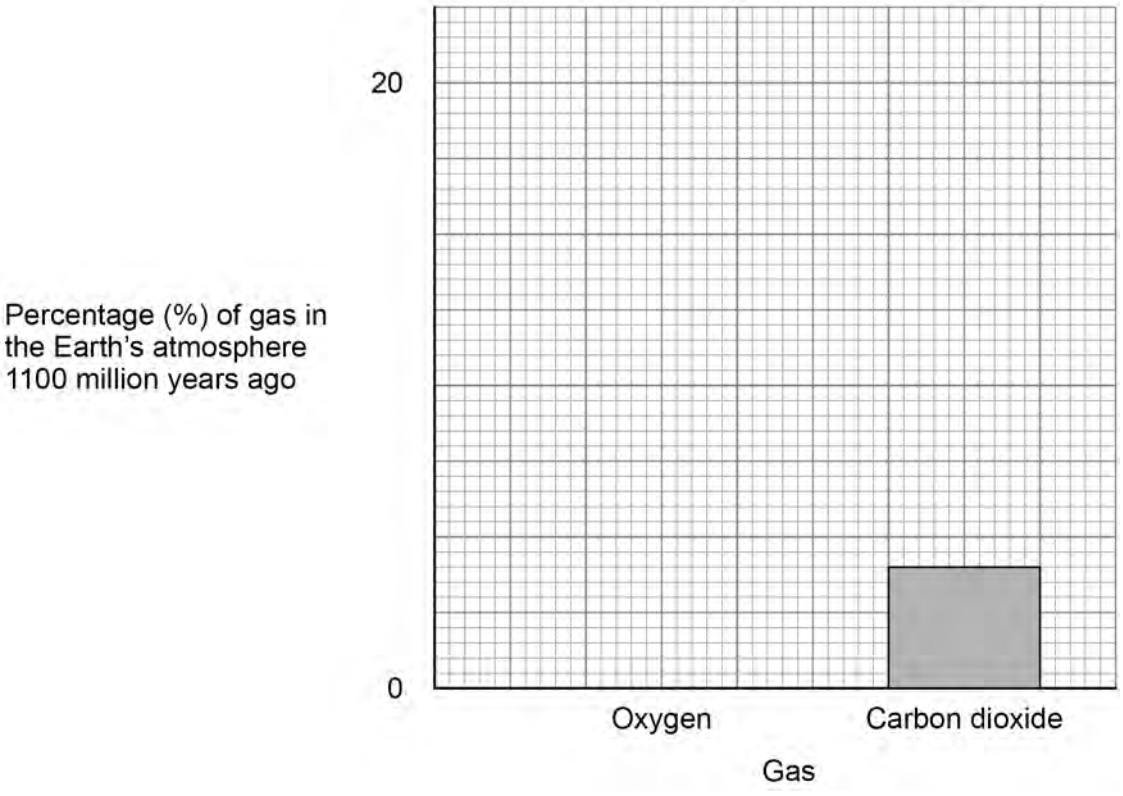
Complete **Figure 1**.

You should:

- complete the *y*-axis scale
- plot the percentage of oxygen in the Earth's atmosphere 1100 million years ago.

[2 marks]

Figure 1



Question 1 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 58 · continued

Oxygen is produced when manganese dioxide is added to hydrogen peroxide solution.

The equation for the reaction is:

hydrogen peroxide → water + oxygen

A student investigated the effect of changing the temperature on the decomposition of hydrogen peroxide.

This is the method used.

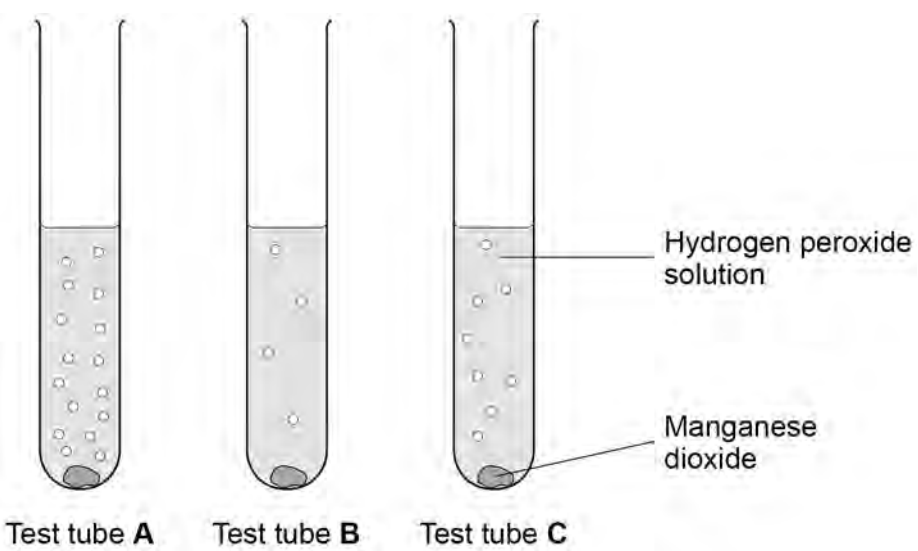
1. Add 5 cm^3 of hydrogen peroxide solution to three test tubes labelled **A**, **B** and **C**.

2. Place each test tube in a water bath at a different temperature.

3. Add 0.2 g of manganese dioxide to each test tube.

Figure 2 shows the results.

Figure 2



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 58 · continued

0 1 . 5 Which test tube contained hydrogen peroxide solution at the highest temperature?

[1 mark]

Tick (✓) **one** box.

Test tube **A** ☐

Test tube **B** ☐

Test tube **C** ☐

0 1 . 6 The student tested the gas produced.

What is used to prove that the gas is oxygen?

[1 mark]

Tick (✓) **one** box.

A glowing splint ☐

Bromine water ☐

Damp litmus paper ☐

0 1 . 7 Manganese dioxide does not appear in the chemical equation for this reaction.

Which is a correct statement about manganese dioxide in this reaction?

[1 mark]

Tick (✓) **one** box.

Manganese dioxide increases the activation energy in this reaction. ☐

Manganese dioxide is a catalyst in this reaction. ☐

Manganese dioxide is used up during this reaction. ☐

Manganese dioxide reduces the rate of this reaction. ☐

9

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 59

June 2023 | 8462/2F | Original Q4

0 4 This question is about a reversible reaction.

A student heated calcium hydroxide to produce calcium oxide and water vapour.

This is the method used.

1. Add 2.00 g of calcium hydroxide into a test tube.

2. Heat the test tube and contents for 1 minute using a Bunsen burner.

3. Allow the test tube and contents to cool.

4. Weigh the test tube and contents.

5. Repeat steps 2 to 4 five more times.

0 4 . 1 **Table 3** gives the appearance of the reactant and of the products.

Table 3

	Compound	Appearance
Reactant	calcium hydroxide	white powder
Products	calcium oxide	white powder
	water vapour	colourless gas

The student looked at the test tube and contents during heating.

The student could **not** tell that a chemical reaction was taking place by looking at the test tube and contents.

Give **two** reasons why.

Use the information in **Table 3**.

[2 marks]

1 _____

_____

2 _____

_____

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 59 · continued

0 4 . 2 Accurate results are **not** produced if solid powders escape from the test tube during heating.

Suggest why sealing the test tube with a stopper is **not** a good way of preventing the solid powders from escaping.

[1 mark]

0 4 . 3 The student wanted to calculate the mass of the contents of the test tube after each minute of heating.

The student weighed the test tube and contents after each minute of heating.

What **other** measurement is also needed to calculate the mass of the contents of the test tube?

[1 mark]

Tick (✓) **one** box.

- The change in mass of the contents of the test tube at the end ☐
- The mass of the contents of the test tube at the start ☐
- The mass of the empty test tube ☐

Question 4 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 59 · continued

The student heated 2.00 g of calcium hydroxide to produce calcium oxide and water vapour.

Table 4 shows the results.

Table 4

Total heating time in minutes	Mass of contents of test tube in grams
0	2.00
1	1.76
2	1.64
3	1.56
4	1.52
5	1.51
6	1.51

0 4 . 4 Complete the sentence.

Choose the answer from the box.

Use **Table 4**.

[1 mark]

3 minutes	**4 minutes**	**5 minutes**	**6 minutes**

The minimum heating time needed for all of the calcium hydroxide to be changed into calcium oxide and water vapour is _____.

0 4 . 5 Calculate the total mass of water vapour produced by heating the calcium hydroxide.

Use **Table 4**.

[2 marks]

_____

_____

Mass = _____ g

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 59 · continued

The word equation for the reaction is:

calcium hydroxide ⇌ calcium oxide + water

The reaction is reversible.

When 4.00 g of calcium hydroxide is completely changed into calcium oxide and water:

- 3.03 g of calcium oxide is produced
- 5.90 kJ of energy is taken in from the surroundings.

0 4 . 6 3.03 g of calcium oxide reacts completely with water to produce 4.00 g of calcium hydroxide.

How much energy is transferred to the surroundings in this reaction?

[1 mark]

Tick (✓) **one** box.

Less than 5.90 kJ ☐

5.90 kJ ☐

More than 5.90 kJ ☐

0 4 . 7 The forward reaction takes in energy from the surroundings.

Complete the sentence.

Choose the answer from the box.

[1 mark]

combustion	**endothermic**	**exothermic**

The forward reaction is _____.

9

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 60

June 2024 | 8462/1F | Original Q3

0 3 This question is about energy changes of reactions.

Zinc reacts with copper sulfate solution.

The word equation for the reaction is:

zinc + copper sulfate → zinc sulfate + copper

0 3 . 1 What type of reaction is the reaction between zinc and copper sulfate solution?

[1 mark]

Tick (✓) **one** box.

Combustion ☐

Decomposition ☐

Displacement ☐

0 3 . 2 Calculate the percentage (%) by mass of copper in copper sulfate ($CuSO_4$).

Give your answer to 3 significant figures.

Relative atomic mass (A_r): Cu = 63.5

Relative formula mass (M_r): $CuSO_4$ = 159.5

[3 marks]

Percentage by mass (3 significant figures) = _____ %

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 60 · continued

A student investigated the energy change in the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm^3 of copper sulfate solution into a polystyrene cup.
2. Weigh 0.20 g of zinc powder.
3. Add the zinc powder to the copper sulfate solution.
4. Measure the highest temperature reached by the mixture.
5. Repeat steps 1 to 4 using different masses of zinc powder.

0 3 . 3 Control variables are used to make an investigation a fair test.

Which is a control variable in the investigation?

[1 mark]

Tick (✓) **one** box.

- Highest temperature reached by the mixture ☐
- Mass of zinc powder ☐
- Volume of copper sulfate solution ☐

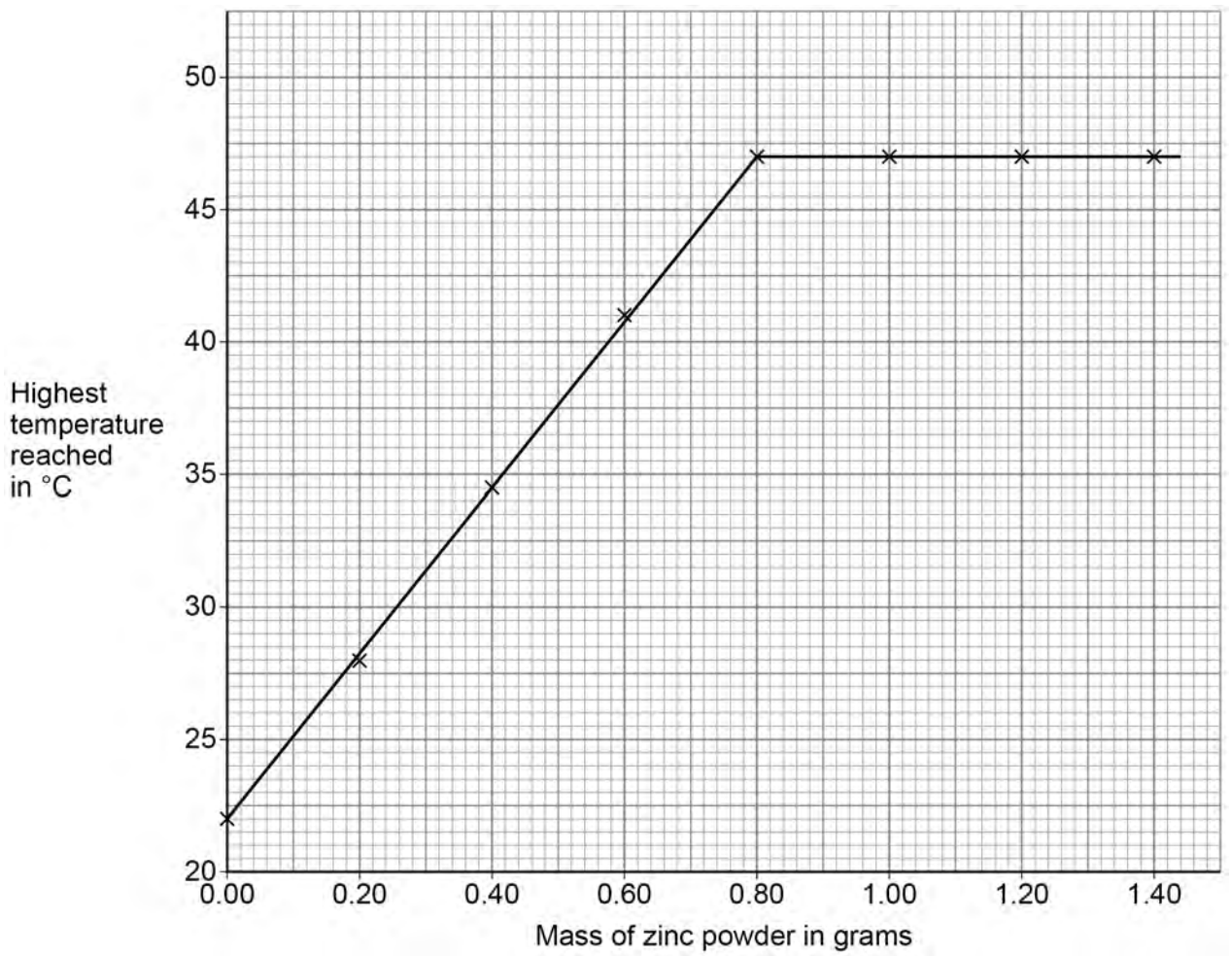
Question 3 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 60 · continued

Figure 6 shows the results.

Figure 6



0 3 . 4 What is the minimum mass of zinc powder needed to react with all the copper sulfate solution?

Use **Figure 6**.

[1 mark]

Minimum mass of zinc powder = _____ g

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 60 · continued

0 3 . 5 What is the maximum temperature change in the reaction between zinc powder and 25 cm^3 of copper sulfate solution?

Use **Figure 6**.

[2 marks]

Maximum temperature change = _____ °C

0 3 . 6 25 cm^3 of copper sulfate solution contained 6.75 g of copper sulfate.

Calculate the concentration of the solution in g/dm^3.

You should:

- calculate the volume of the solution in dm^3 (1000 cm^3 = 1 dm^3)
- use the equation:

$$\text{concentration of solution in g/dm}^3 = \frac{\text{mass of copper sulfate in grams}}{\text{volume of solution in dm}^3}$$

[3 marks]

Volume of solution = _____ dm^3

Concentration of solution = _____ g/dm^3

Question 3 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 60 · continued

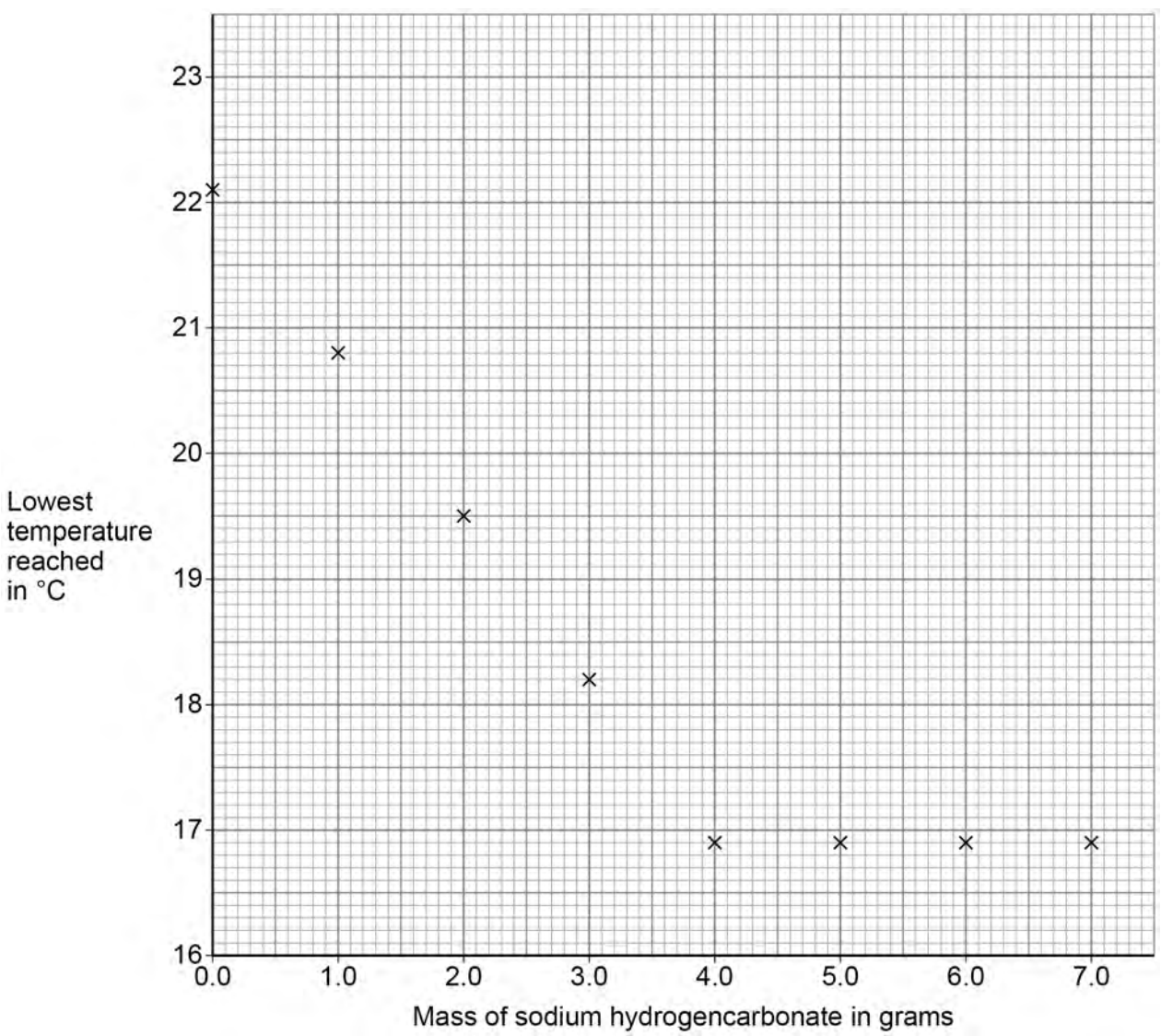
Another student investigated the energy change of the reaction between sodium hydrogencarbonate and hydrochloric acid.

This is the method used.

1. Measure 25 cm^3 of hydrochloric acid.
2. Weigh 1.0 g of sodium hydrogencarbonate.
3. Add the sample of sodium hydrogencarbonate to the hydrochloric acid.
4. Measure the lowest temperature reached by the mixture.
5. Repeat steps 1 to 4 using different masses of sodium hydrogencarbonate.

Figure 7 shows the results.

Figure 7



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 60 · continued

0 3 . 7 Draw **two** straight lines of best fit on **Figure 7**.

The lines should cross.

[2 marks]

0 3 . 8 Which statement describes the energy change in the reaction shown in **Figure 7**?

[1 mark]

Tick (✓) **one** box.

- Energy is **transferred to** the surroundings so the reaction is **endothermic**. ☐
- Energy is **transferred to** the surroundings so the reaction is **exothermic**. ☐
- Energy is **taken in from** the surroundings so the reaction is **endothermic**. ☐
- Energy is **taken in from** the surroundings so the reaction is **exothermic**. ☐

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4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 61

June 2025 | 8462/1F | Original Q2

0 2 Metals react with acids to produce a salt and a gas.

0 2 . 1 Which salt is produced when magnesium reacts with hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Magnesium chloride ☐
- Magnesium nitrate ☐
- Magnesium sulfate ☐

0 2 . 2 Which gas is produced when magnesium reacts with hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Carbon dioxide ☐
- Chlorine ☐
- Hydrogen ☐
- Oxygen ☐

Question 2 continues on the next page

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 61 · continued

A student investigated the temperature change in the reaction between metals and hydrochloric acid.

This is the method used.

1. Measure 25 cm^3 of hydrochloric acid at 20 °C into a container.

2. Add 1 g of a metal.

3. Record the temperature change.

4. Repeat steps 1 to 3 using a different metal.

0 2 . 3 Draw **one** line from the type of variable to the name of the variable in the investigation.

[2 marks]

Type of variable	Name of variable
	Mass of metal
Dependent variable	Temperature change
Independent variable	Type of metal
	Volume of hydrochloric acid

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 61 · continued

0 2 . 4 Which container would be the most suitable to reduce energy transfer with the surroundings?

[1 mark]

Tick (✓) **one** box.

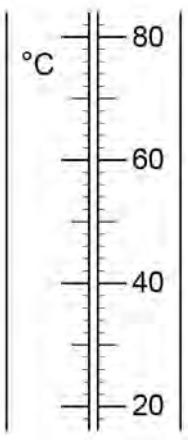
A copper can ☐

A glass beaker ☐

A polystyrene cup ☐

0 2 . 5 **Figure 1** shows part of the scale of the thermometer used in the investigation.

Figure 1



What is the resolution of the thermometer?

[1 mark]

Tick (✓) **one** box.

1 °C ☐ 2 °C ☐ 10 °C ☐ 20 °C ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 61 · continued

0 2 . 6 The reaction between a metal and an acid is exothermic.

What happens to the temperature of the mixture during the reaction?

[1 mark]

Tick (✓) **one** box.

Decreases ☐

Stays the same ☐

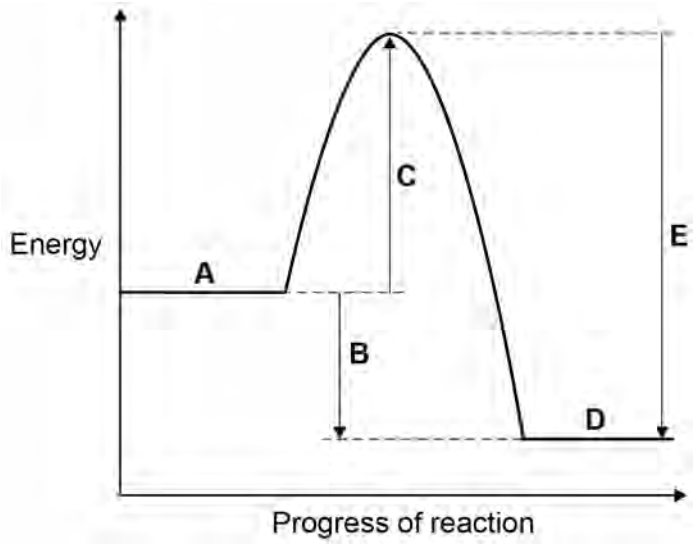
Increases ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 61 · continued

Figure 2 shows the reaction profile for the reaction between a metal and an acid.

Figure 2



0 2 . 7 Which letter in **Figure 2** represents the reactants?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

0 2 . 8 Which letter in **Figure 2** represents the activation energy?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

0 2 . 9 Which letter in **Figure 2** represents the overall energy change?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

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4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 62

June 2025 | 8462/2F | Original Q2

0 2 Alkanes and alkenes are hydrocarbons.

Hydrocarbon molecules are made up of hydrogen and carbon atoms only.

An alkene has the formula C_3H_6

0 2 . 1 Which alkene has the formula C_3H_6?

[1 mark]

Tick (✓) **one** box.

Butene ☐

Ethene ☐

Propene ☐

0 2 . 2 How many atoms are there in a molecule of C_3H_6?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 6 ☐ 9 ☐

0 2 . 3 Which is a use of C_3H_6?

[1 mark]

Tick (✓) **one** box.

Making a polymer ☐

Making ammonia ☐

Making glass ☐

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 62 · continued

0 2 . 4 The percentage (%) by mass of each element in a molecule of C_3H_6 is:

- hydrogen 14%
- carbon 86%.

Figure 1 shows the percentage by mass of hydrogen in a molecule of C_3H_6

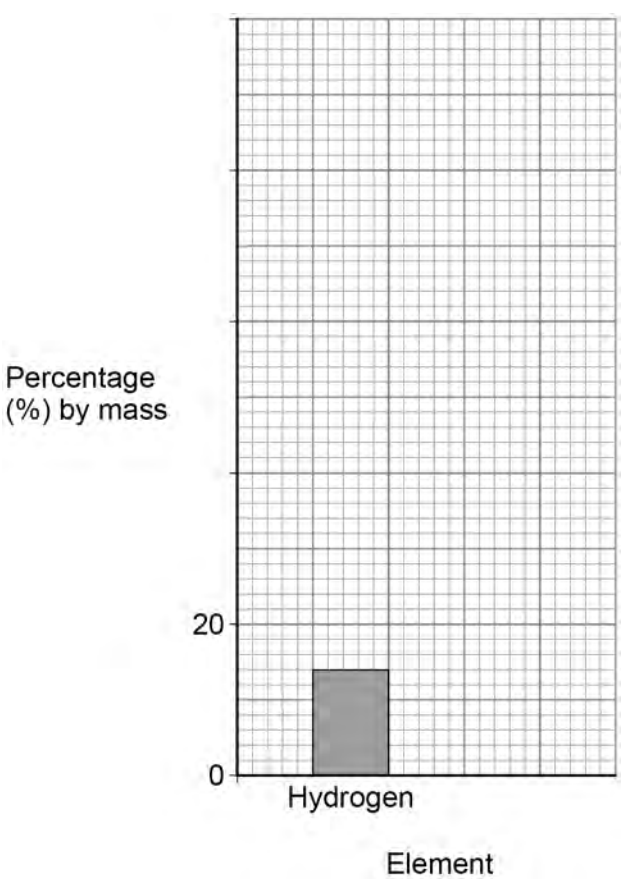
Complete **Figure 1**.

You should:

- complete the *y*-axis scale
- plot the percentage by mass of carbon as a bar
- label the bar plotted for carbon.

[3 marks]

Figure 1



4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 62 · continued

Alkanes can be cracked to produce alkenes and smaller alkane molecules.

0 2 . 5 Describe a test for alkenes.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 2 . 6 $C_{10}H_{22}$ can be cracked to produce C_3H_6 and an alkane.

Complete the equation for the reaction.

[1 mark]

$$C_{10}H_{22} \longrightarrow C_3H_6 + C ___ H_{16}$$

0 2 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

ceramics	**fertilisers**	**fuels**

Smaller alkanes from cracking are useful as _____.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 62 · continued

High temperatures between 450 °C and 750 °C are used in cracking reactions.

0 2 . 8 Which statement describes the molecules at 750 °C compared with the molecules at 450 °C?

[1 mark]

Tick (✓) **one** box.

- The molecules collide more frequently at 750 °C. ☐
- The molecules have less energy at 750 °C. ☐
- The molecules move more slowly at 750 °C. ☐

0 2 . 9 How does the rate of reaction at 750 °C compare with the rate of reaction at 450 °C?

[1 mark]

_____

_____

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4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 63

June 2025 | 8462/2F | Original Q3

0 3 Cement, concrete and steel are building materials.

Cement contains calcium oxide.

Calcium oxide reacts with water to produce calcium hydroxide.

The equation for the reaction is:

calcium oxide + water ⇌ calcium hydroxide

0 3 . 1 How does the equation show that this reaction is reversible?

[1 mark]

0 3 . 2 The forward reaction is exothermic.

What type of reaction is the reverse reaction?

[1 mark]

0 3 . 3 When excess water is added to 20 g of calcium oxide, 23 kJ of energy is released.

Calculate the energy released when excess water is added to 4 g of calcium oxide.

[2 marks]

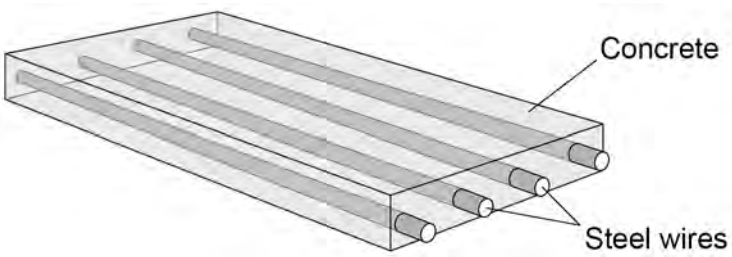
Energy released = _____ kJ

Question 63 · continued

Pre-stressed concrete contains steel wires within the concrete.

Figure 2 shows the structure of a piece of pre-stressed concrete.

Figure 2



0 3 . 4 Pre-stressed concrete is a composite.

Draw **one** line from each component of a composite to a material in pre-stressed concrete.

[2 marks]

Component of composite	Material in pre-stressed concrete
Binder	Concrete
Reinforcement	Pre-stressed concrete
	Steel wires

0 3 . 5 Which metal do **all** steels contain?

[1 mark]

_____

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 63 · continued

0 3 . 6 Bricks are also building materials.

Bricks are ceramics.

Which material is used to make bricks?

[1 mark]

Tick (✓) **one** box.

Aluminium ☐

Clay ☐

Poly(ethene) ☐

8

Turn over for the next question

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 64

June 2025 | 8462/2F | Original Q4

0 4 Ammonia is produced in the Haber process.

The word equation for the reaction to produce ammonia is:

nitrogen + hydrogen ⇌ ammonia

0 4 . 1 Draw **one** line from each element to a source of that element.

[2 marks]

Element	Source of element
Nitrogen	Air
Hydrogen	Clay
	Limestone
	Natural gas
	Sand

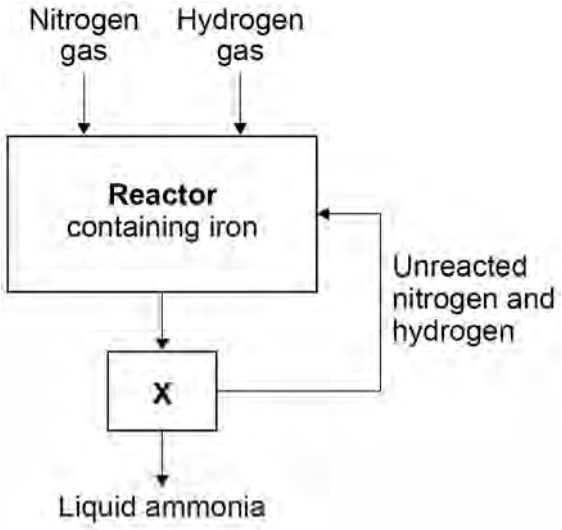
4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 64 · continued

Ammonia is a gas at room temperature.

Figure 3 shows how ammonia is produced from nitrogen and hydrogen.

Figure 3



0 4 . 2 Which process takes place at **X** in **Figure 3**?

[1 mark]

Tick (✓) **one** box.

Cooling ☐

Filtering ☐

Melting ☐

0 4 . 3 Complete the sentence.

Use **Figure 3**.

[1 mark]

The iron in the reactor is used as a _____.

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 64 · continued

Table 1 shows the world production of ammonia between 1990 and 2020.

Table 1

Year	World production of ammonia in arbitrary units
1990	120
2000	130
2010	155
2020	165

0 4 . 4 How did the world production of ammonia change between 1990 and 2020?

Use **Table 1**.

[1 mark]

0 4 . 5 Determine the mean change in mass of ammonia produced per year between 2000 and 2020.

Use **Table 1** and the equation:

$$\text{mean change in mass produced per year} = \frac{\text{change in mass produced between 2000 and 2020}}{\text{number of years}}$$

[4 marks]

Change in mass = _____ arbitrary units

Number of years = _____

Mean change = _____ arbitrary units per year

4.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 64 · continued

Most of the ammonia produced in the Haber process is used to make fertilisers.

0 4 . 6 Which is a reason for the change in the world production of ammonia shown in **Table 1**?

[1 mark]

Tick (✓) **one** box.

- Change in amount of acid rain ☐
- Change in global temperatures ☐
- Change in world population ☐

0 4 . 7 Fertilisers produced using ammonia contain nitrogen.

Which **two** compounds used in fertilisers contain nitrogen?

Use the periodic table.

[2 marks]

Tick (✓) **two** boxes.

- $Ca(NO_3)_2$ ☐
- $Ca_3(PO_4)_2$ ☐
- KCl ☐
- K_2SO_4 ☐
- $(NH_4)_2SO_4$ ☐

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