1.0 The **Figure 1** shows magnesium burning in air.

Figure 1

© Charles D Winters/Science Photo Library

1.1 Give **one** observation that you can make from **Figure 1** that shows that a chemical reaction is taking place.

[1 mark]

____

1.2 The Bunsen burner flame provides energy to start the magnesium burning.
Draw a ring around the name given to the energy needed to start a chemical reaction.

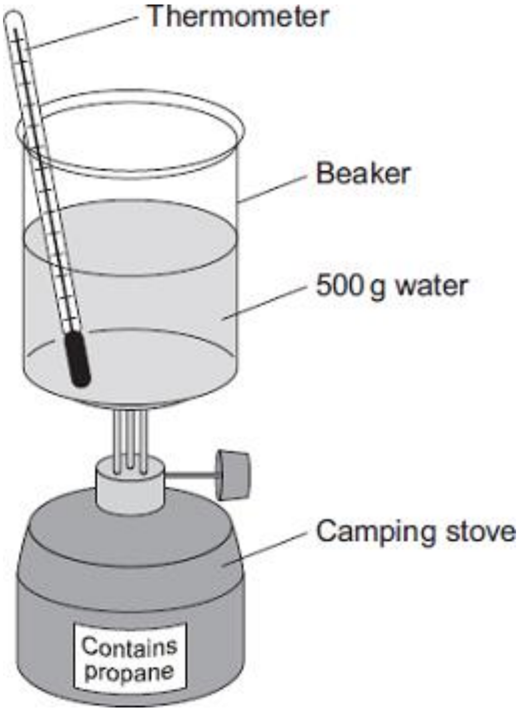
[1 mark]

Activation energy **Potential Energy** **Solar Energy**

This document is licensed to Rodillian Academy - MB28541

2.0 A camping stove uses propane gas.

A student investigated the energy released when propane gas is burnt.



The student:

- put 500 g water into a beaker
- recorded the starting temperature of the water
- heated the water by burning propane for 1 minute
- recorded the temperature of the water after burning the propane.

Table 1 shows the student's results for the investigation.

Table 1

Starting temperature of water in °C	**Temperature of water after burning propane in °C**	**Temperature change of water in °C**
19	34	

2.1 Name the instrument the student should use to measure the temperature.

[1 mark]

____

2.2 Calculate the temperature change of the water.

[1 mark]

Temperature change = __________________ °C

This document is licensed to Rodillian Academy - MB28541

2.3 Calculate the energy released in joules when propane is burned for 1 minute.
Use the equation:

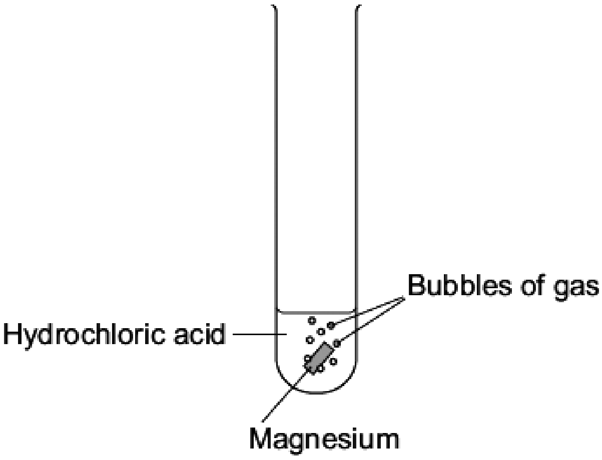
energy released (J) = mass of water (g) × 4.2 × temperature change (°C)

[2 marks]

Energy released = ____________________ J

This document is licensed to Rodillian Academy - MB28541

3.0 A student investigated the reaction of magnesium with hydrochloric acid.



A piece of magnesium was dropped into the hydrochloric acid.

Bubbles of gas were produced and the magnesium disappeared.

3.1 This reaction is **exothermic**.

How could the student prove this?

[2 marks]

____

____

3.2 State **one** safety precaution that the student should take during the experiment.

[1 mark]

____

3.3 How could the student tell if the reaction had finished?

[1 mark]

____

This document is licensed to Rodillian Academy - MB28541

4.0 A student investigated how the temperature of water changed when different masses of ammonium nitrate were added to the same volume of water.

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

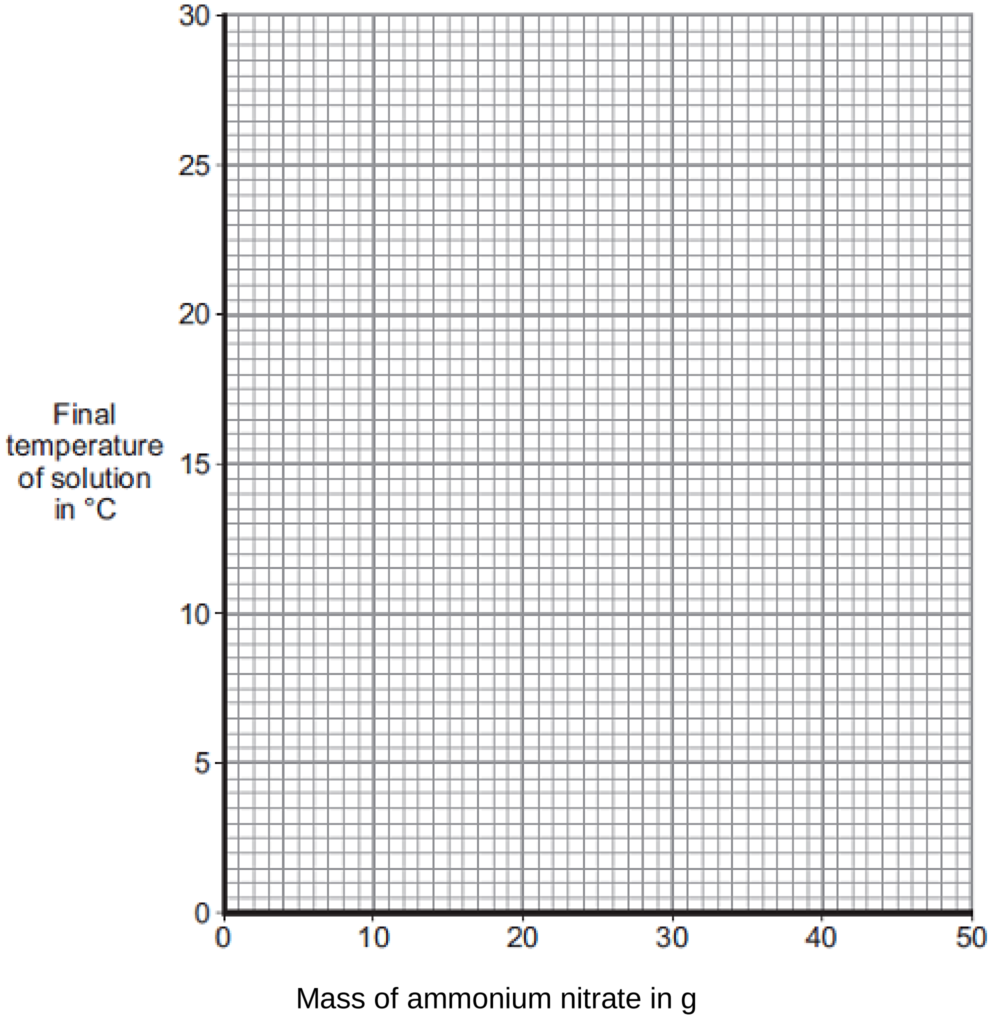
Table 2

Mass of ammonium nitrate in g	Final temperature of solution in °C
10	15.0
15	12.5
20	10.0
25	7.5
30	5.0
35	5.0
40	5.0

4.1 Plot the results on the grid.

Draw two straight lines of best fit through the points.

[4 marks]



This document is licensed to Rodillian Academy - MB28541

4.2 Use your graph to estimate the temperature when no ammonium nitrate has been added to the water.

[1 mark]

Temperature when no ammonium nitrate added = ________________°C

4.3 Suggest what the temperature of the water shows before ammonium nitrate is added.

[1 mark]

Tick **one** box.

Body temperature ☐

Boiling point ☐

Freezing point ☐

Room temperature ☐

This document is licensed to Rodillian Academy - MB28541

5.0 A student investigated the energy released when different metals react with copper sulfate solution.

5.1 What is the independent variable in this investigation?

[1 mark]

____

5.2 What is the dependent variable in this investigation?

[1 mark]

____

5.3 State **two** control variables the student should keep the same.

[2 marks]

____

Table 3 shows the student's results.

Table 3

Metal	**Temperature (°C)**		
	Start	**End**	**Change**
Iron	19	24	5
Magnesium	20	35	15
Zinc	20	28	8

5.4 Which type of graph should the student draw to display these results?

Explain your answer.

[2 marks]

____

____

5.5 What conclusion can you draw from the student's results?

[1 mark]

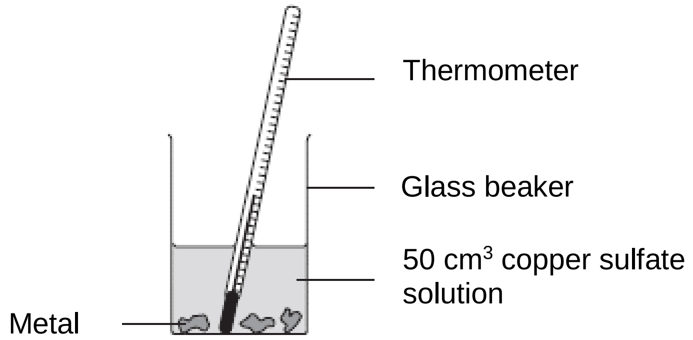
____

____

This document is licensed to Rodillian Academy - MB28541

5.6 **Figure 2** shows the equipment the student used for the investigation.

Figure 2



Explain how the student could have improved the **equipment** used for this investigation.

[4 marks]

____

____

____

____

This document is licensed to Rodillian Academy - MB28541

6.0 Ammonia is used in the manufacture of fertilisers. The equation for the formation of ammonia (NH_3) from nitrogen (N_2) and hydrogen (H_2) is:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

This question refers to the **forward** reaction which is exothermic.

Bond energies for the reaction are given in **Table 4**.

Table 4

Bond	Bond energy in kJ per mole
N ≡ N	945
H – H	436
N – H	390

The structures are shown in **Figure 3.**

Figure 3

```
N ≡ N            H – H     H – N – H
                               I
                               H
```

6.1 Calculate the overall energy change for the **forward** reaction.

[3 marks]

Overall energy change = ___________________ J

6.2 Draw an energy level diagram for the **forward** reaction

Mark on the energy level diagram:

- Nitrogen (N_2)
- Hydrogen (H_2)
- Ammonia (NH_3)
- The activation energy
- The overall energy change.

[5 marks]

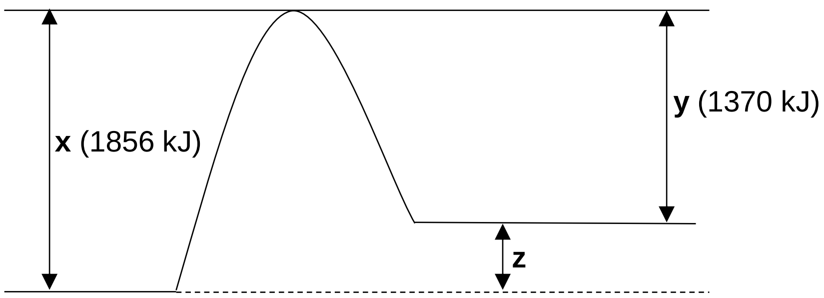
This document is licensed to Rodillian Academy - MB28541

7.0 Water decomposes to form hydrogen and oxygen.

The equation for the reaction is:

$$2H_2O \rightarrow 2H_2 + O_2$$

The reaction profile for this reaction is shown below.



7.1 Explain the significance of **x**, **y** and **z** in the reaction profile in terms of energy transfers that occur in the reaction.

In your answer make reference to:

- the substances involved
- the bonds broken and formed
- the overall energy transfer.

[6 marks]

This document is licensed to Rodillian Academy - MB28541

MARK SCHEME

Qu No.		Extra Information	Marks
1.1	Any **one** from: • there was a flame • (white) smoke was formed • the magnesium turned into a (white) powder		1
1.2	Activation energy		1

Qu No.		Extra Information	Marks
2.1	Thermometer		1
2.2	15 °C		1
2.3	31500 (J)	Allow ecf from 2.1 Allow **1** mark for 500 × 4.2 × 15 or 500 × 4.2 × (ans 2.1)	2

Qu No.		Extra Information	Marks
3.1	Take two measurements of temperature (at beginning and end) temperature would increase		1 1
3.2	Any **one** from: • eye protection • lab coat • (long) hair tied back • secure the test tube		1
3.3	Any **one** from: • magnesium completely disappears • bubbles stop appearing	Do not allow dissolves	1

Qu No.		Extra Information	Marks
4.1	All 7 points plotted correctly Straight line through first 5 points Straight line through last three points	Allow 5/6 points plotted correctly for **1** mark	2 1 1
4.2	20 °C	Allow value read from correct extrapolation of the drawn line of best fit	1
4.3	Room temperature		1

This document is licensed to Rodillian Academy - MB28541

Qu No.		Extra Information	Marks
5.1	Type of metal	Allow metal	1
5.2	Temperature change		1
5.3	Any **two** from: • volume of copper sulfate solution • concentration of copper sulfate solution • mass of metal used • starting temperature.		2
5.4	Bar Chart (Because the independent) variable is categoric/discrete		1 1
5.5	The more reactive the metal the higher the temperature change	Allow a statement along the lines of: "Mg releases more heat than Zn, then Iron" (i.e. refer to all three metals in a sequence)	1
5.6	Used a lid To reduce heat loss or to improve insulation Used a thermometer with a higher resolution. To measure the temperature change more accurately	Allow insulate outside of beaker Allow measure to the nearest 0.5 °C or 0.1 °C	1 1 1 1
Qu No.		**Extra Information**	**Marks**
6.1	(Energy taken in) =945 + (3 × 436) = 2253 (kJ) (Energy given out)= 6 × 390 = 2340 (kJ) (Energy change) 2253 – 2340 = (–) 87 (kJ)	 Allow ecf from step 1/ 2 Correct answer with/without working gains **3** marks.	1 1 1
6.2	Reactant energy higher than the product energy Curve for the reaction correctly drawn Nitrogen and hydrogen shown as reactants and ammonia as a product Activation energy correctly labelled Energy change correctly labelled	 Allow 2253 kJ (or value obtained by student) correctly shown on graph Allow (–) 87 kJ (or value obtained by student) correctly shown on graph	1 1 1 1 1

This document is licensed to Rodillian Academy - MB28541

Qu No.		Extra Information	Marks
7.1			
Level 3:	A detailed and coherent explanation is given, which demonstrates a broad understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.		5-6
Level 2:	An explanation is given which demonstrates a reasonable understanding of the key scientific ideas. Links are made but may not be fully articulated and / or precise.		3-4
Level 1:	Simple statements are made which demonstrate a basic understanding of some of the relevant ideas. The response may fail to make logical links between the points raised.		1-2
Level 0:	No relevant content		0
Indicative content			
Substances • reactant is water • products are oxygen and hydrogen **Significance of x, y and z** • x is energy required to break the bonds in reactant / water • x is activation energy • y is the energy released/given out when bonds form • y is the energy released/given out when hydrogen and oxygen form • z is difference between x and y • z is the overall energy transfer **Overall energy transfer** • z = 1856 – 1370 = (+)486 kJ • overall, energy is absorbed in the reaction • energy required to break existing bonds is greater than the energy released when new bonds form • so reaction is endothermic			

This document is licensed to Rodillian Academy - MB28541