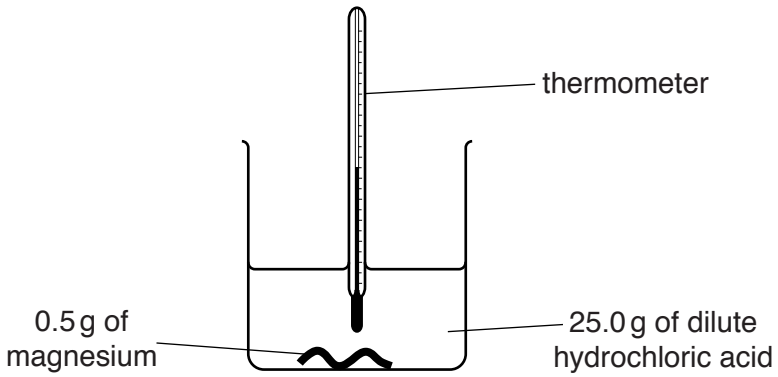
1 Sue investigates the reaction between magnesium ribbon and dilute hydrochloric acid.

Look at the apparatus she uses.



The temperature of the acid before the magnesium is added is 22.0 °C.

The energy released by the reaction can be calculated using the equation

energy released = mass of acid heated × specific heat capacity × temperature change

The specific heat capacity of the acid = 4.2 J / g °C

The energy released in Sue's experiment was 1600 J.

(a) Calculate the **final** temperature of the acid.

Quote your answer to **one** decimal place.

Final temperature of the acid is ..... °C **[3]**

(b) Energy is released in this reaction.

Explain why. Use ideas about bond breaking and bond making.

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

2 Paraffin is a liquid fuel.

Paraffin releases heat energy when it burns in air.

Jenna wants to find out how much energy is released when she burns 1 g of paraffin.

She decides to use the paraffin to heat some water.

Write about how she does the experiment. You may wish to include a labelled diagram.

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..... **[4]**

[Total: 4]

3 This question is about energy changes during chemical reactions.

(a) Cold packs are used to treat sports injuries.

The cold pack **reduces** the temperature of the injured part of the body.

An endothermic reaction happens when the chemicals in the cold pack react.

Energy is absorbed when bonds break.

Explain, in terms of bonds between atoms, why this reaction is **endothermic**.

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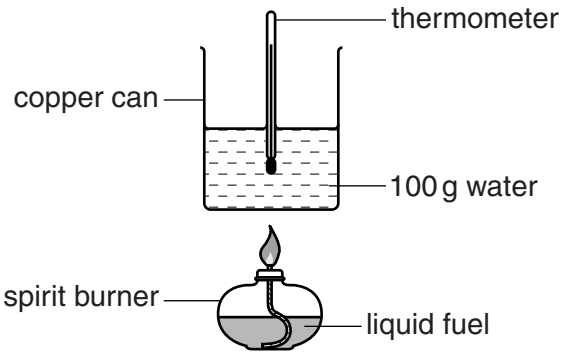
..... **[2]**

(b) Aimee and Luke investigate four liquid fuels.

They burn an amount of each liquid fuel.

Look at the diagram. It shows the apparatus they use.



Look at the table. It shows their results.

Liquid fuel	Mass of fuel burnt in g	Temperature at start in °C	Temperature at end in °C
ethanol	2.2	20	40
methylated spirits	2.4	21	39
paraffin	1.9	22	45
propanol	2.1	22	44

(i) Calculate the energy transferred by **ethanol**.

energy transferred = mass × specific heat capacity × temperature change

The specific heat capacity of water is 4.2 J/g°C.

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answer ..... J **[2]**

(ii) Aimee thinks **paraffin** gives out the **most** energy per gram.

Use the results to show that she is correct.

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

[Total: 6]

4 Nitrogen molecules react with oxygen molecules.

Nitrogen monoxide molecules are made.

$$N_2 + O_2 \rightarrow 2NO$$

The reaction is endothermic.

(a) Explain, in terms of bond breaking and bond making, why this reaction is endothermic.

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

(b) Nitrogen molecules and oxygen molecules react extremely slowly, even at 200 °C.

The reaction between nitrogen and oxygen becomes faster as both the temperature and the pressure increase.

Explain why, using the reacting particle model.

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

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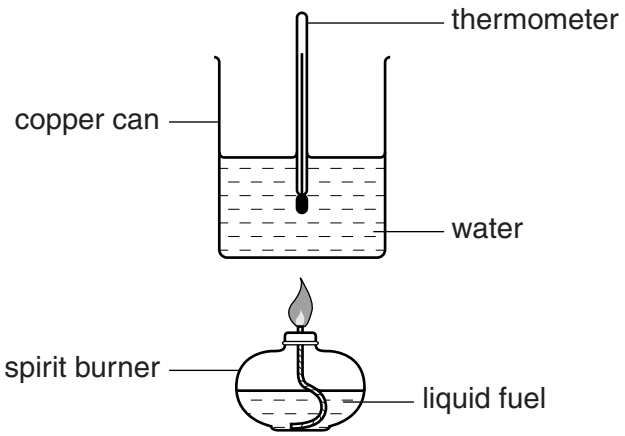
..... **[6]**

[Total: 9]

5 Eva is investigating liquid fuels. She wants to find out which liquid fuel gives out the most energy per gram.

Look at the apparatus she uses.

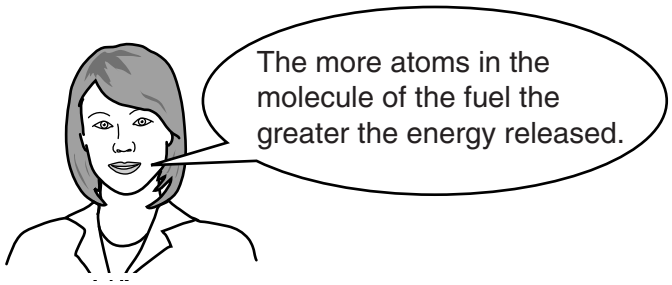


She heats 100 cm^3 of water.

Eva uses five liquid fuels.

Each time she burns 1.0 g of liquid fuel.

She makes a prediction.



Look at Eva's results.

Fuel	Molecular formula	Number of atoms in a molecule	Temperature of water before heating in °C	Temperature of water after heating in °C	Temperature increase in °C
methanol	CH_4O	6	20	29	9
ethanol	C_2H_6O	9	18	30	12
propanol	C_3H_8O	12	18	32	14
butanol	$C_4H_{10}O$	15	18	34	16
pentanol	$C_5H_{12}O$	18	20	35	15

The energy released is given by the equation

energy = mass × specific heat capacity × temperature change

where specific heat capacity of water = 4.2 J/g °C.

(a) Calculate the energy released by methanol.

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energy released = ... J **[2]**

(b) Do Eva's results support her prediction?

Explain your answer.

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

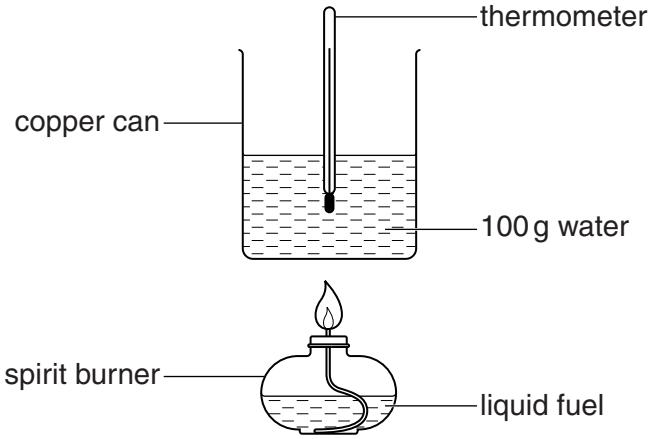
[Total: 4]

6 Stephanie is investigating some liquid fuels.

Stephanie investigates the energy given out by three different fuels.

Look at the diagram.

It shows the apparatus Stephanie uses.



Look at the table. It shows her results.

fuel	starting temperature of water in °C	final temperature of water in °C	temperature change in °C	mass of fuel burned in grams
paraffin	20	45	25	0.6
petrol	20	40	20	1.2
ethanol	18	48	30	1.8

(a) (i) Write down how Stephanie made her experiment a **fair test**.

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

(ii) Write down how Stephanie could **increase confidence** in her results.

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

(b) Look at the results for **paraffin**.

0.6 g of paraffin was used to heat 100 g of water.

Calculate the energy transferred **per gram** of paraffin.

Use the equation

energy = mass × specific heat capacity × temperature change

The specific heat capacity of water is 4.2 J/g °C.

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

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answer ..... J/g **[2]**

(c) Stephanie decides to use paraffin in a camping stove, even though it is slightly more expensive per gram than ethanol or petrol.

Is this is a sensible choice? Use only the data in the table to explain your answer.

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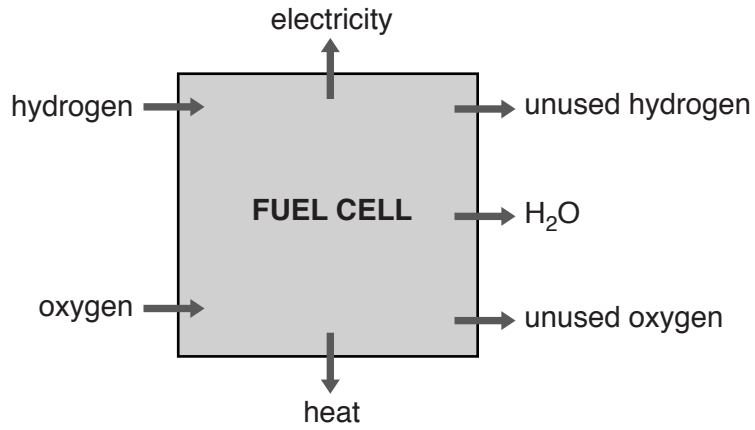
[Total: 6]

7 Fuel cells are used to make electricity.

Look at the diagram. It shows what happens in a fuel cell.



(a) In this fuel cell, hydrogen, H_2, reacts with oxygen, O_2.

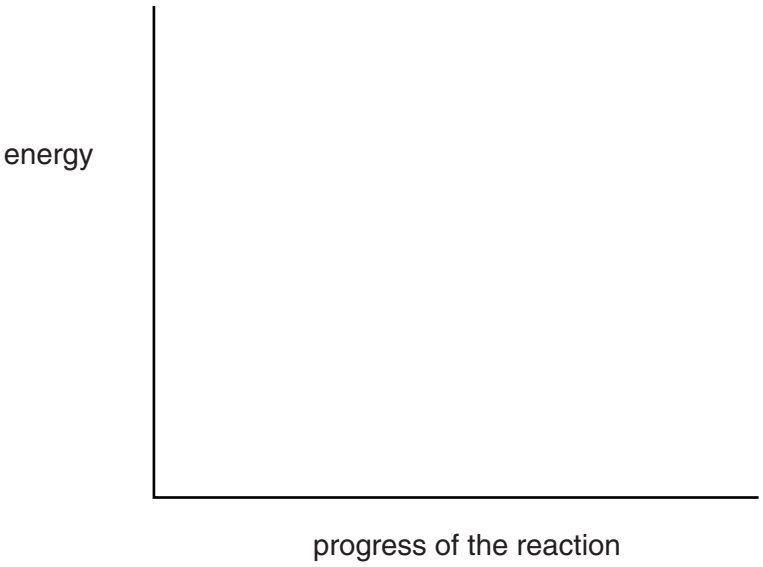
Water, H_2O, is made.

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

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

(b) The reaction between hydrogen and oxygen is **exothermic**.

Draw and label an energy level diagram for the reaction between hydrogen and oxygen



[2]

(c) Fuel cells are used to provide electrical energy in spacecraft.

Write down one **other advantage** of using fuel cells in spacecraft.

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

(d) Hydrogen-oxygen fuel cells produce water.

Water is not a pollutant.

Fuel cells still cause pollution.

Write down two ways that fuel cells can cause pollution.

1 .....

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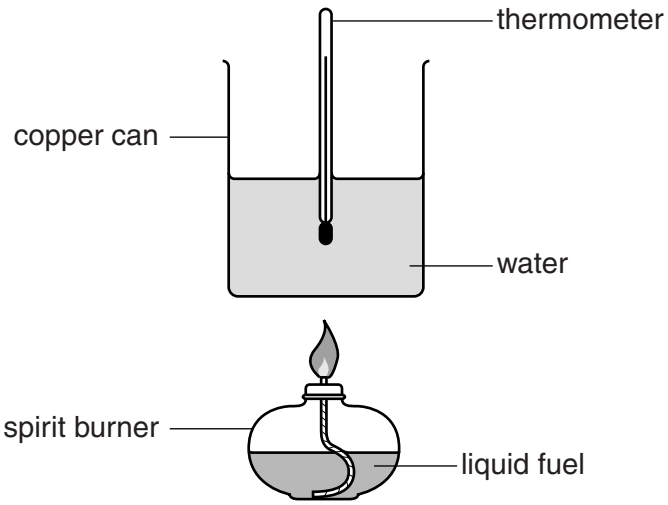
2 .....

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

8 Petrol is a mixture of hydrocarbons.

David investigates the energy released when five of these hydrocarbons are burned.

Look at the apparatus he uses.



Each time, he burns 0.5 g of hydrocarbon and heats 100 g of water.

David measures the temperature of the water before heating.

He measures the temperature again when the hydrocarbon has finished burning.

These are his results.

hydrocarbon	**molecular formula**	**temperature of water in °C**	
		at start	**at end**
hexane	C_6H_{14}	20	40
heptane	C_7H_{16}	19	41
octane	C_8H_{18}	15	39
nonane	C_9H_{20}	18	45
decane	$C_{10}H_{22}$	20	46

(a) Calculate the energy released per gram by **hexane**.

Use the equation

energy = mass × specific heat capacity × temperature change

The specific heat capacity of water is 4.2 J/g °C.

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energy released per gram = ... J/g **[2]**

(b) David knows that the bigger the hydrocarbon molecule, the more carbon atoms it has.

David concludes that the bigger the hydrocarbon molecule, the more energy per gram is released.

Explain whether David's results fully support this conclusion.

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

[Total: 4]