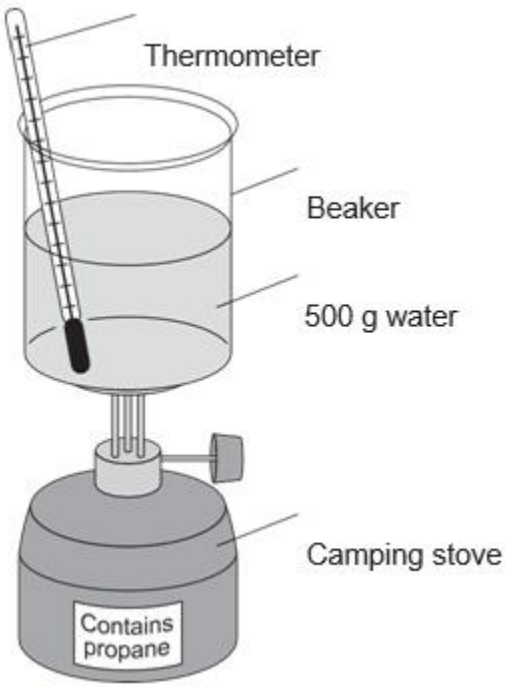
EXOTHERMIC REACTIONS, ENDOTHERMIC REACTIONS & BOND ENERGIES 1

Q1. A camping stove uses propane gas.



(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)

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

_____

_____

Energy released =_____ J

(2 marks)

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

_____

_____

_____

_____

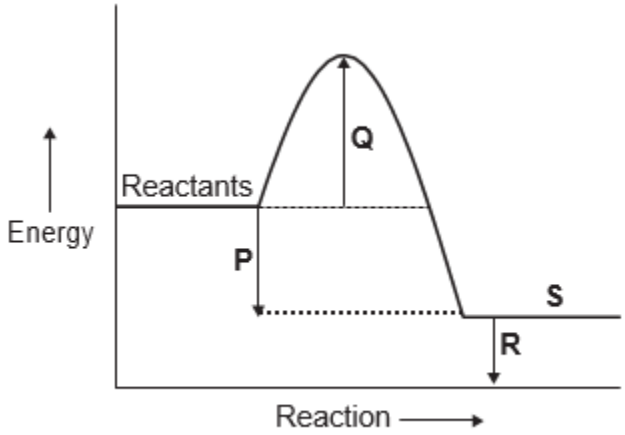
(2 marks)

(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)

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



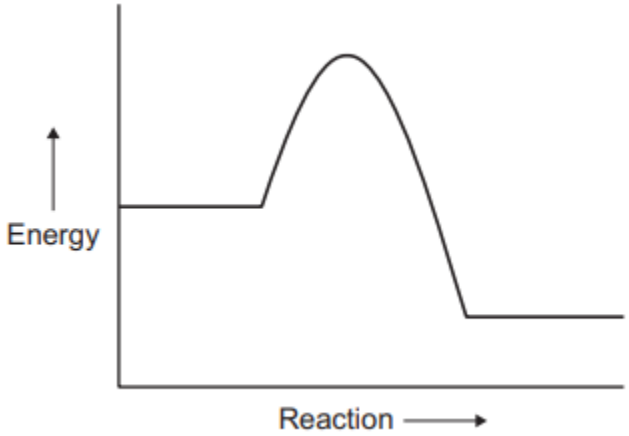
Draw **one** line from each description to the correct letter.

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

(3 marks)

Q2. A temperature of 450 °C is used in the reactor of the Haber process for ammonia production. The reaction of nitrogen with hydrogen is reversible.
The forward reaction is exothermic.

An energy level diagram for the reaction between nitrogen and hydrogen is shown below.



(i) How does the energy level diagram show this reaction is exothermic?

_____

_____

(1 mark)

(ii) In the Haber process iron is used as a catalyst.

Draw a line on the energy level diagram to show the effect of adding a catalyst.

(1 mark)

Q3. Propane is used as a fuel in stoves.

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

The student:

- put 750 g water into a beaker
- measured the temperature of the water, which was 17 °C
- heated the water by burning propane
- measured the temperature of the water again, which was then 64 °C.

The student calculated the energy released using the equation

$$Q = m \times 4.2 \times \Delta T$$

Where:
Q = energy released (J)
m = mass of water (g)
ΔT = temperature change (°C)

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

_____

_____

_____

_____

_____

_____

(3 marks)

(ii) To find how much propane had been used the student weighed the camping stove before and after the experiment. The mass of the camping stove decreased by 6.0 g.
Using this information and your answer to part **(i)**, calculate the energy in kJ released when 1 mole of propane burns.
(If you have no answer for part (i), assume the energy released during the experiment is 144000 J. This is not the answer to part (i).)

Relative formula mass (M_r) of propane = 44.

_____

_____

_____

_____

(2 marks)

(iii) Suggest two things the student could do to make his results more accurate.

_____

_____

_____

_____

(2 marks)

(iv) The student's method does not give accurate results.

However, this method is suitable for comparing the energy released by different fuels.
Suggest why.

_____

_____

(1 mark)

(b) The student used bond energies to calculate the energy released when propane is burned.

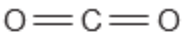
The equation for the combustion of propane is

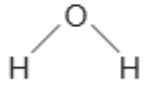
$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

Some bond energies are given in the table.

Bond	Bond Energy in kJ per mole
C ═ O	803
O — H	464

The displayed structures of the products are:

carbon dioxide 

water 

(i) Calculate the energy released by bond making when the products are formed.

_____

_____

_____

_____

_____

_____

(3 marks)

(ii) The energy used for bond breaking of the reactants in the equation is 6481 kJ per mole. Calculate the overall energy change of this reaction.

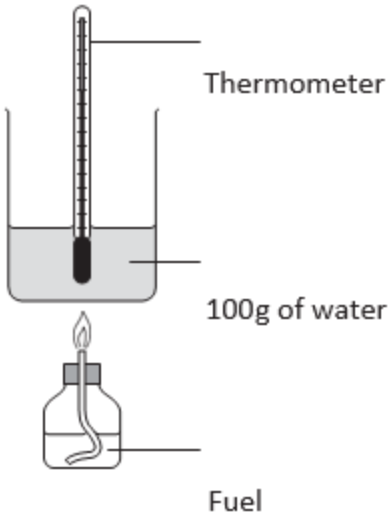
_____

_____

(1 mark)

Q4. A student burned three liquid fuels and compared the amounts of energy they produced.

(a) The diagram shows the apparatus the student used.



The heat produced when each fuel was burned increased the temperature of 100g of water.

The table shows the student's results.

Fuel	Mass of fuel burned in g	Temperature increase in °C	Type of flame
A	1	5	smoky
B	1	4	not smoky
C	1	5	not smoky

(i) The student suggested that fuel **C** was the best fuel. Give **two** reasons why.

_____

_____

_____

_____

_____

_____

(2 marks)

(ii) Use the following equation to calculate the energy change for burning 1 g of fuel A.

energy change in joules = 100 × 4.2 × temperature increase for 1 g of fuel

_____

(1 mark)

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

(i) Energy is usually measured in joules.

Some food labels give energy measured in

calories.
degrees.
minutes.

(1 mark)

(ii) Suggest why knowing about the energy in food can help towards a healthier lifestyle.

_____

_____

(1 mark)

Total marks (28)