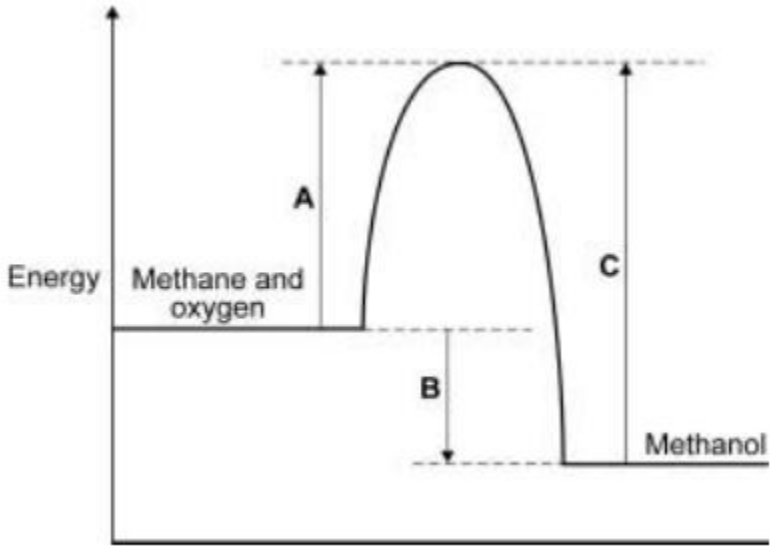
EXOTHERMIC REACTIONS,ENDOTHERMIC REACTIONS & BOND ENERGY 3

Q1. Methanol can be made when methane reacts with oxygen.

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



(i) What is the energy change represented by A?

_____

(1 mark)

(ii) Use the energy level diagram to explain how it shows that this reaction is exothermic.

_____

_____

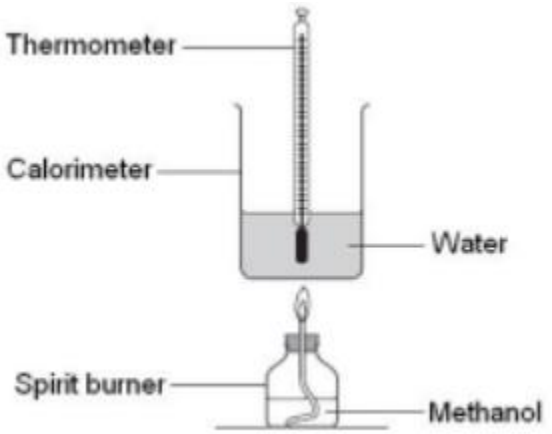
_____

(2 marks)

(b) A student did an experiment to find the energy released when methanol burns in air.

The student:

- weighed a spirit burner containing methanol
- set up the equipment as shown in the diagram
- recorded the initial temperature



- lit the spirit burner
- put out the flame when the temperature of the water had risen by about 20°C
- stirred the water and recorded the highest temperature of the water
- reweighed the spirit burner containing the methanol.
- The student repeated the experiment and recorded his results.

	Experiment 1	Experiment 2	Experiment 3
Initial mass of spirit burner and methanol in g	299.3	298.3	296.9
Final mass of spirit burner and methanol in g	298.3	297.1	295.9
Initial temperature in °C	23	22	23
Highest temperature in °C	45	50	43
Temperature change in °C	22	28	20

Use the diagram and the information in the table to answer the questions.

(i) The main error in this experiment is energy loss. Suggest one way that the equipment could be changed to reduce energy loss.

_____

(1 mark)

(ii) The temperature change in Experiment 2 is greater than the temperature change in Experiment 1 and Experiment 3. Explain why.

_____

_____

_____

_____

(2 marks)

(iii) Suggest one reason why the student repeated the experiment.

_____

(1 mark)

(iv) Use the temperature change in Experiments 1 and 3 to calculate how much energy is released when 1g of methanol burns. The equation that you need to use is:

Energy released in joules = 100 x 4.2 x mean temperature change

Show clearly how you work out your answer.

_____

_____

_____

_____

(2 marks)

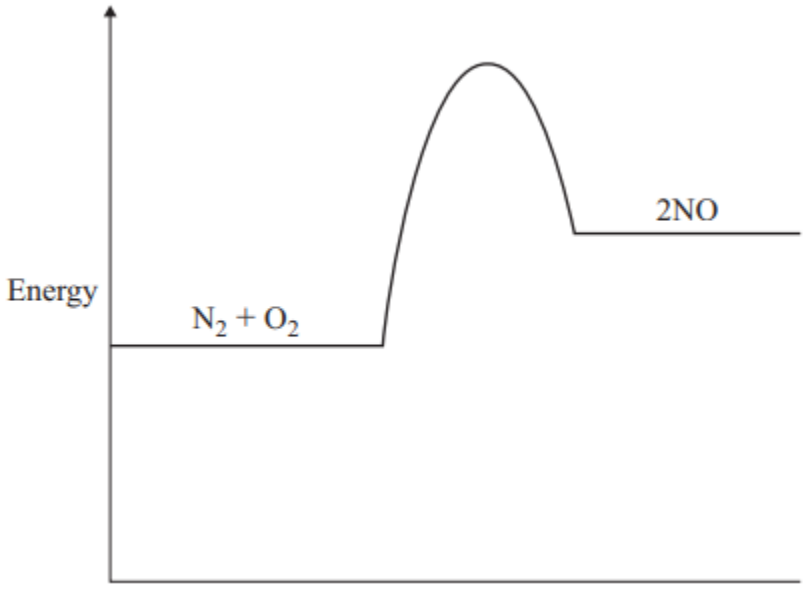
Q2. During a thunderstorm lightning strikes the Eiffel Tower.

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.

An equation that represents this endothermic reaction is:

$$N_2 + O_2 \rightarrow 2NO$$

The energy level diagram for this reaction is given below.



(a) The energy level diagram shows that this reaction is endothermic. Explain how.

_____

_____

(1 mark)

(b) What is meant by the term activation energy?

_____

_____

(1 mark)

(c) The equation showing the structural formulae of the reactants and products is

$$N \equiv N + O = O \rightarrow 2\ N = O$$

Bond	Bond energy in kJ
$N \equiv N$	945
$O = O$	498
$N = O$	630

(i) Use the bond energies in the table to calculate the energy change for this reaction.

_____

_____

_____

_____

_____

(3 marks)

(ii) In terms of bond energies, explain why this reaction is endothermic.

_____

_____

(1 mark)

Q3. The equation for the reaction of hydrogen with oxygen is:

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

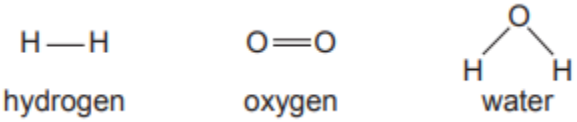
During the reaction, energy is used to break the bonds of the reactants.

Energy is released when new bonds are made to form the product.

Bond energies for the reaction are given in the table.

Bond	Bond energy in kJ
H H	436
O O	498
O H	464

The structures of the reactants and product are given below.



(i) Calculate the energy change for the reaction:

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

_____

_____

_____

_____

_____

_____

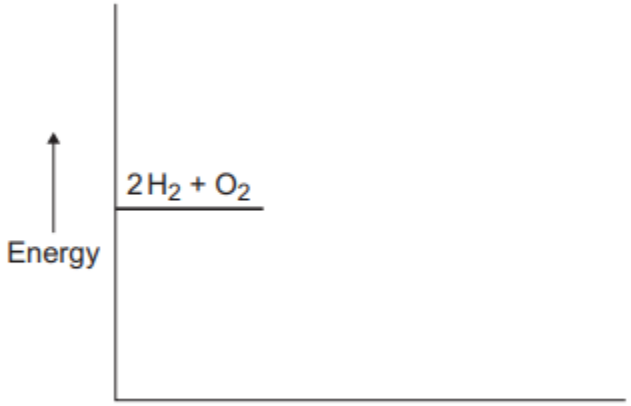
_____

_____

(3 marks)

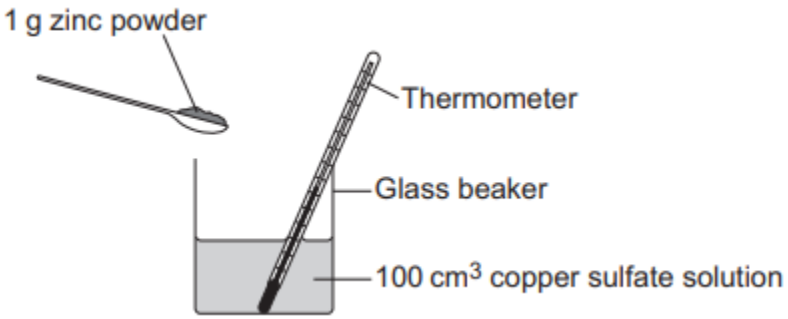
(ii) The reaction of hydrogen with oxygen is exothermic. Complete the energy level diagram for this reaction on the figure.

Clearly label the activation energy.



(3 marks)

Q4. A student investigates the energy released when zinc powder reacts with copper sulfate solution. The student uses the apparatus shown in the figure.



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

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

_____

_____

(1 mark)

(ii) Calculate the energy released in the reaction.

Use the equation

energy released in J = volume of solution in cm^3 × 4.2 × temperature change in °C

_____

_____

_____

_____

(2 marks)

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

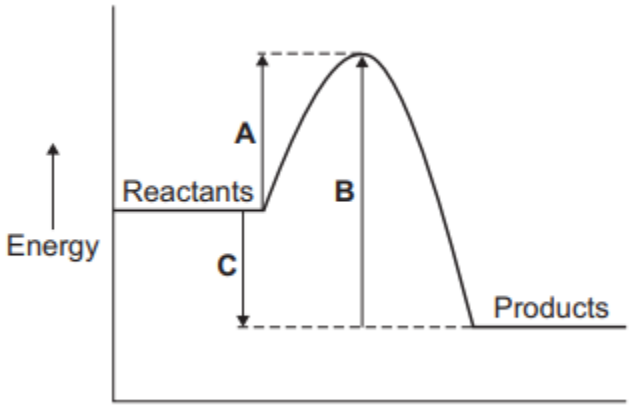
How can you tell from the student's results that the reaction is exothermic?

_____

_____

(1 mark)

(c) The energy diagram for the reaction is shown in the figure.



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

_____

_____

(1 mark)

(ii) Which arrow shows the activation energy in the figure?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

(1 mark)

Total marks (27)