

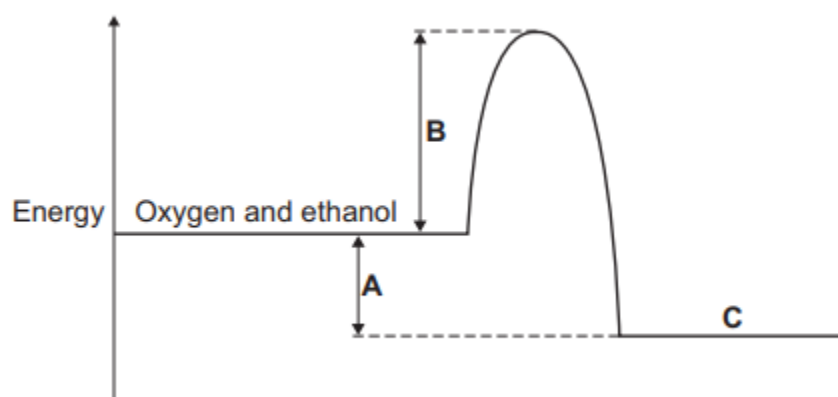
EXOTHERMIC REACTIONS, ENDOTHERMIC REACTIONS & BOND ENERGIES 2

Q1. V2 rockets were used during the Second World War.



V2 rockets were powered by liquid oxygen and ethanol. Oxygen and ethanol react to produce carbon dioxide and water.

The energy level diagram represents the energy changes during this reaction.



(a) On the energy level diagram what is represented by the letter:

A _____

B _____

C

(3 marks)

(b) What type of reaction is represented by this energy level diagram?

(1 mark)

Q2. Hydrogen peroxide is often used to bleach or lighten hair.

Hydrogen peroxide slowly decomposes to produce water and oxygen.

(a) The equation for the reaction can be represented using structural formulae.



Use the bond energies in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy in kJ per mole
H - O	464
O - O	146
O = O	498

(3 marks)

(b) Explain, in terms of bond making and bond breaking, why the reaction is exothermic.

(1 mark)

Q3. 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.

(a) Nitrogen and oxygen in the air do not react easily. What makes nitrogen and oxygen react during thunderstorms?

(1 mark)

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

nitrogen + →

(1 mark)

(c) In an endothermic reaction, energy is taken in from the surroundings. Draw a ring around the correct answer to complete the sentence.

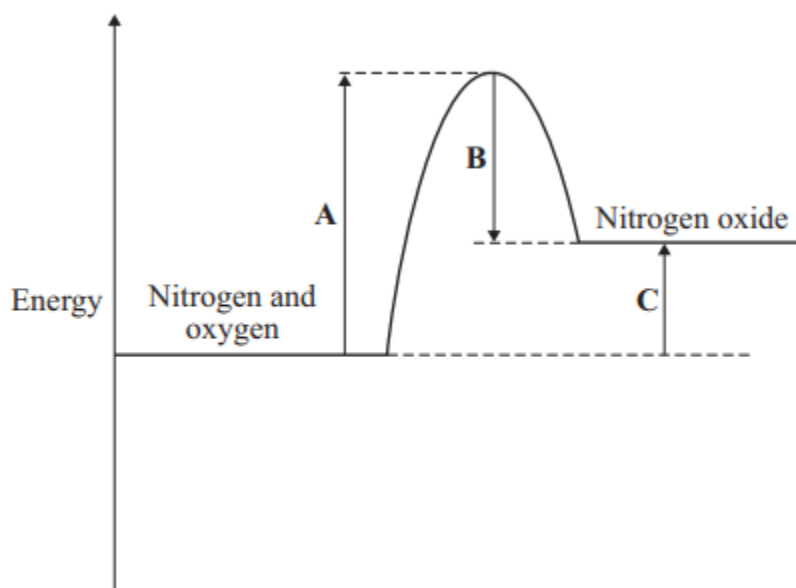
In an endothermic reaction, the energy needed to break existing bonds is

less than
more than
the same

the energy released from forming new bonds.

(1 mark)

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



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

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

(1 mark)

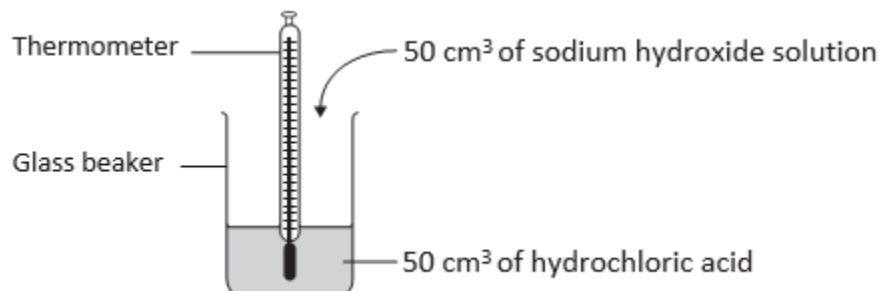
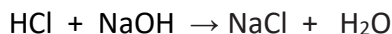
(ii) Which energy change, A, B or C, shows that this reaction is endothermic?

(1 mark)

Q4. Read the information about energy changes and then answer the questions.

A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide.

The equation which represents the reaction is:



The student placed 50 cm³ of hydrochloric acid in a glass beaker and measured the temperature. The student then quickly added 50 cm³ of sodium hydroxide solution and stirred the mixture with the thermometer. The highest temperature was recorded.

The student repeated the experiment, and calculated the temperature change each time.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Initial temperature in °C	19.0	22.0	19.2	19.0
Highest temperature in °C	26.2	29.0	26.0	23.5
Temperature change in °C	7.2	7.0	6.8	4.5

(a) The biggest error in this experiment is heat loss.
Suggest how the apparatus could be modified to reduce heat loss.

(1 mark)

(b) Suggest why it is important to stir the chemicals thoroughly.

(1 mark)

(c) Which one of these experiments was probably carried out on a different day to the others? Explain your answer.

(1 mark)

(d) Suggest why experiment 4 should not be used to calculate the average temperature change.

(1 mark)

(e) Calculate the average temperature change from the first three experiments.

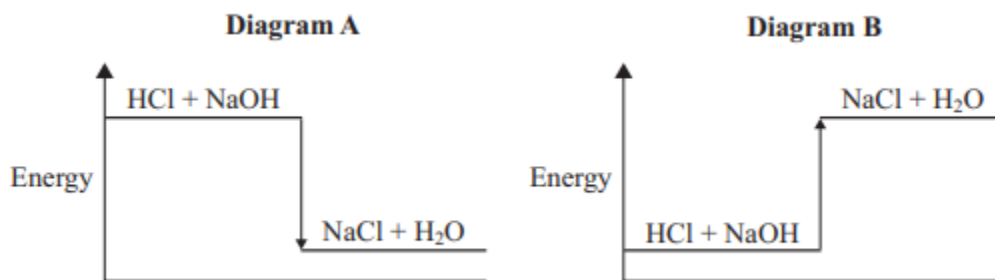
(1 mark)

(f) Use the following equation to calculate the energy change for this reaction.

$$\text{energy change in joules} = 100 \times 4.2 \times \text{average temperature change}$$

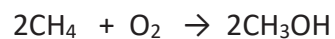
(1 mark)

(g) Which one of these energy level diagrams, A or B, represents the energy change for this reaction?
Explain why.

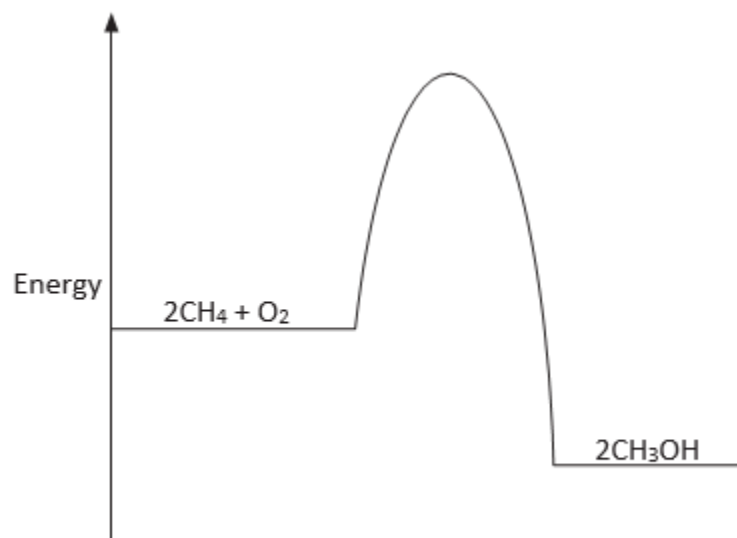


(1 mark)

Q5. Methanol (CH₃OH) can be made by reacting methane (CH₄) and oxygen (O₂) in the presence of a platinum catalyst. The reaction is exothermic.
An equation that represents the reaction is:



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



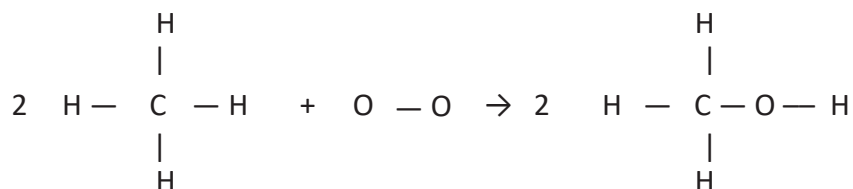
(a)(i) Use the diagram to explain how you know that this reaction is exothermic.

(1 mark)

(ii) Explain, in terms of the energy level diagram, how the platinum catalyst increases the rate of this reaction.

(1 mark)

(b) The equation can also be written showing the structural formulae of the reactants and the product.



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

Bond	Bond energy in kJ
C—H	435
O—O	498
C—O	805
O—H	464

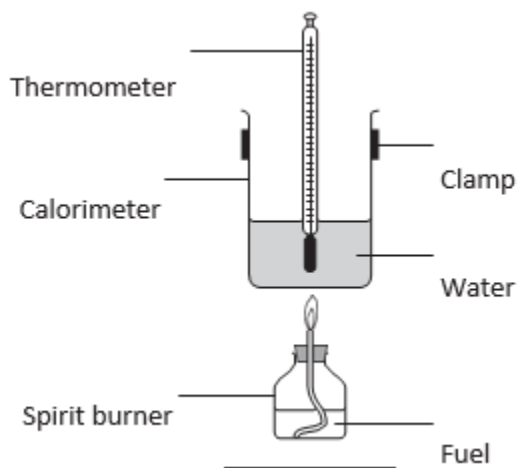
(3 marks)

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

(1 mark)

Q6. A student burned four fuels and compared the amounts of energy they produced.

The student set up the apparatus as shown in the diagram.



The heat produced when each fuel was burned was used to raise the temperature of 100 g of water. The student noted the mass of fuel burned, the increase in temperature and whether the flame was smoky.

The results are shown in the table.

Fuel	Mass of fuel burned (g)	Temperature increase (°C)	Type of flame
Ethanol	4	24	Not smoky
Methanol	3	9	Not smoky
Peanut oil	2	20	Smoky
Vegetable oil	1	15	Smoky

(a) The student suggested that the vegetable oil was the best fuel for producing heat.

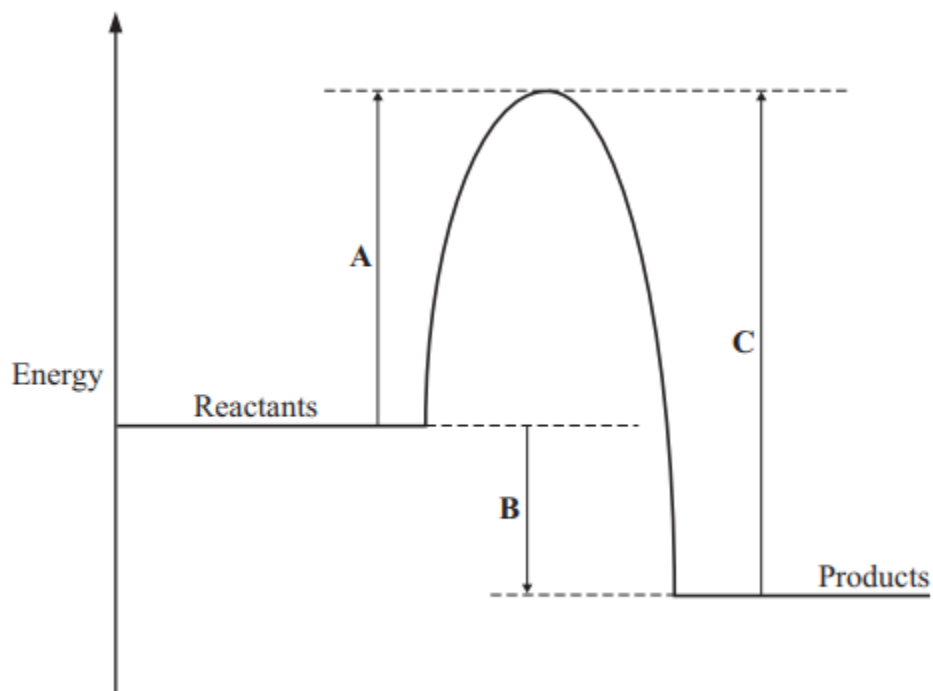
Explain why.

(2 marks)

(b) Suggest an environmental problem that could be caused when large amounts of vegetable oil are burned. Suggest how the problem could be overcome.

(2 marks)

(c) An energy level diagram for the burning of vegetable oil is shown below.



Which of the energy changes A, B or C:

(i) Represents the activation energy

(1 mark)

(ii) Shows the amount of energy given out during the reaction.

(1 mark)

Total marks (32)