Resources available from kickstart tutors

Student number

Name _____

Date _____

Attempt/Time taken _____

GCSE
CHEMISTRY

Topic Paper: 5.1 Exothermic and endothermic reactions
Part 1

Time allowed: 45 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The Periodic Table/Data Sheet is provided as in insert.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

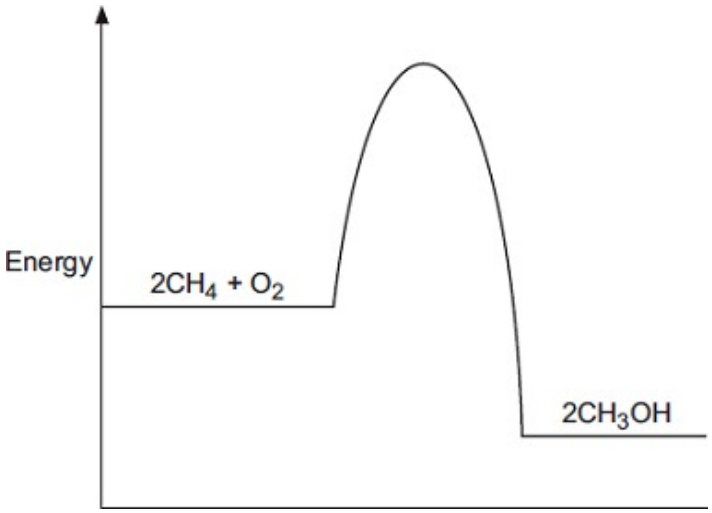
39 Marks

Q1. Methanol (CH_3OH) can be made by reacting methane (CH_4) and oxygen (O_2). The reaction is exothermic.

The equation for the reaction is:

$$2CH_4 + O_2 \longrightarrow 2CH_3OH$$

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



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

.....

.....

.....

(1)

(ii) A platinum catalyst can be used to increase the rate of this reaction.

What effect does adding a catalyst have on the energy level diagram?

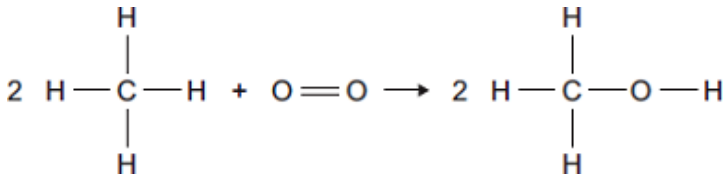
.....

.....

.....

(1)

(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	497
C — O	336
O — H	464

.....

.....

.....

.....

Energy change = ... kJ

(3)

(iii) In terms of the bond energies, why is this an exothermic reaction?

.....

.....

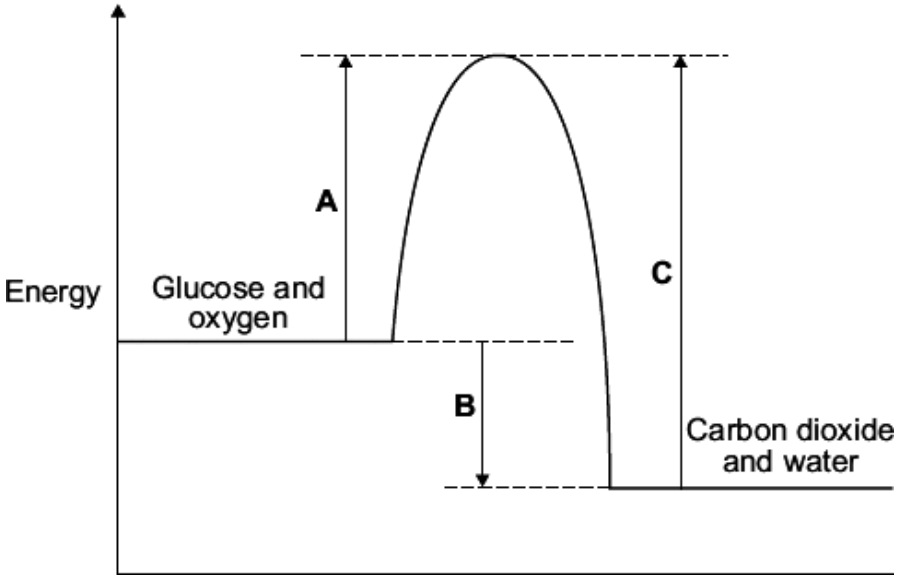
(1)

(Total 6 marks)

Q2. Food provides chemicals and energy to keep your body working. In your body, energy is released by respiration when glucose, $C_6H_{12}O_6$, reacts with oxygen.

$$C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$$

(a) The energy level diagram for the reaction of glucose with oxygen is shown.



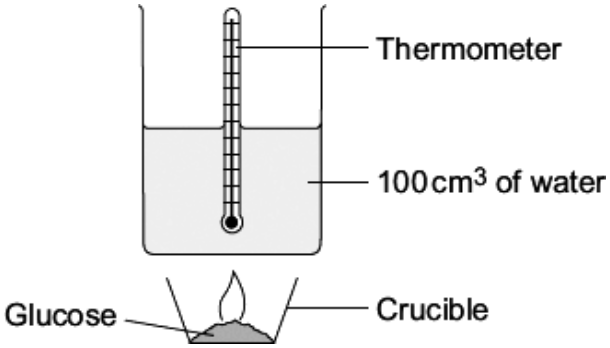
(i) Which energy change, **A**, **B** or **C**, represents the activation energy?

(1)

(ii) Which energy change, **A**, **B** or **C**, shows that the reaction is exothermic?

(1)

(b) A student did an investigation to find the amount of energy released when 1 g of glucose burns in air.



The student:

recorded the room temperature

placed 1 g of glucose into the crucible

set up the equipment as shown in the diagram

lit the glucose

recorded the highest temperature of the water.

(i) One of the main errors in this experiment is energy loss to the surroundings.

Suggest **one** way that the equipment could be changed to reduce this energy loss.

.....

.....

(1)

(ii) The room temperature was 20 ℃ and the highest temperature recorded was 42 ℃.
Use these temperature readings to calculate how much energy is released when 1 g of glucose burns.
The equation that you need to use is:

Energy released in joules = 100 × 4.2 × temperature change

Show clearly how you work out your answer.

.....

.....

.....

Burning 1 g of glucose releases ..... joules

(2)

(iii) The amount of energy released by 1 g of glucose should be 16 000 J.

Apart from energy loss to the surroundings, suggest **two** other reasons why the student's value was less than expected.

1 .....

.....

2 .....

.....

(2)

(c) Suggest **one** reason why food labels provide information about the energy released by the food.

.....

.....

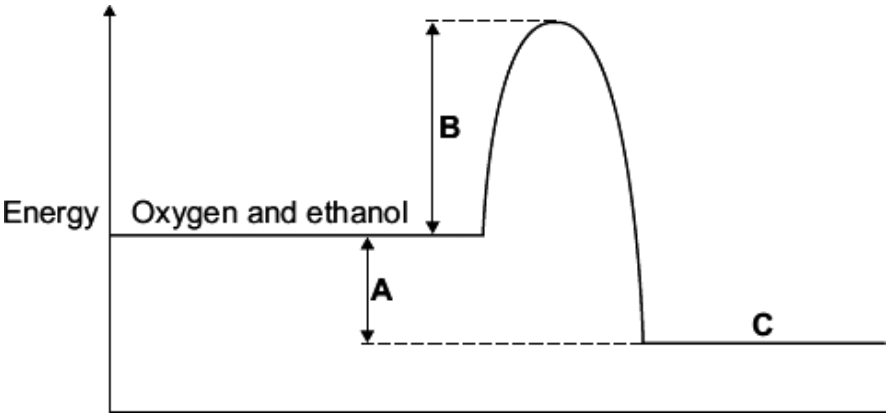
(1)
(Total 8 marks)

Q3. V2 rockets were used during the Second World War.

By aronsson [CC BY-SA 2.0], via Flickr

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)

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

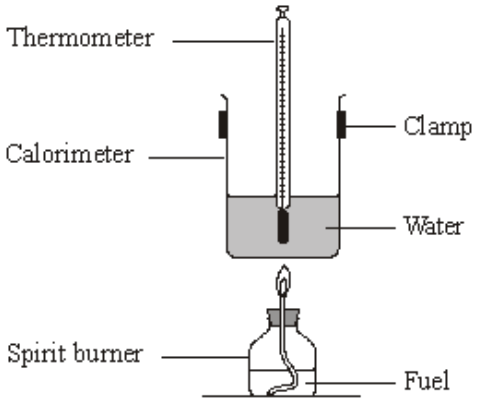
.....

.....

(1)
(Total 4 marks)

Q4. 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)

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

.....

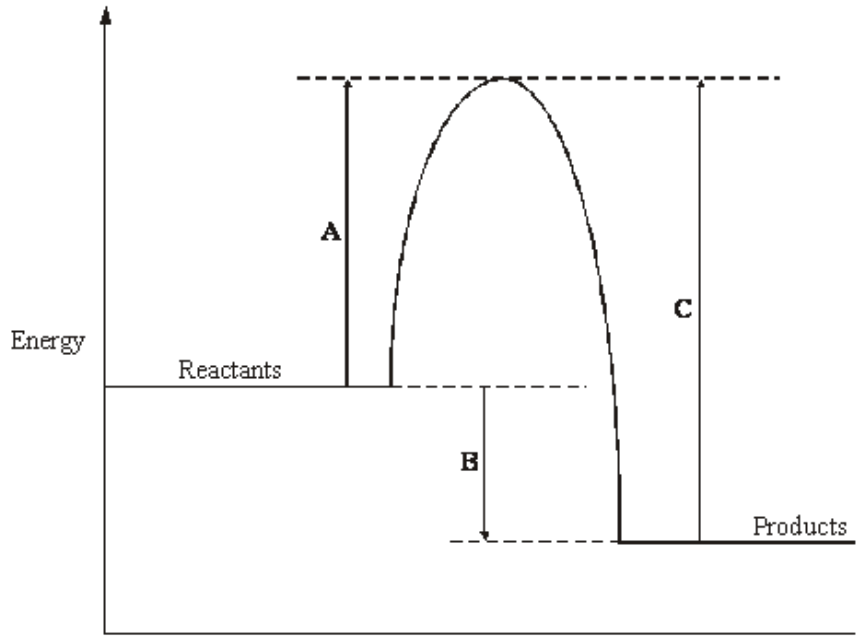
.....

.....

.....

(2)

(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)

(ii) shows the amount of energy given out during the reaction?

.....

(1)
(Total 6 marks)

Q5. HYDROGEN FUEL OF THE FUTURE

It has been suggested that hydrogen could be used as a fuel instead of the fossil fuels that are used at present. The equation below shows how hydrogen burns in air.

$$2H_2 + O_2 \rightarrow 2H_2O + \text{heat}$$

The hydrogen would be made from water using energy obtained from renewable sources such as wind or solar power. The water splitting reaction requires a lot of energy.

(a) Hydrogen was successfully used as a fuel for a Soviet airliner in 1988.
Why would hydrogen be a good fuel for use in an aeroplane?

.....

.....

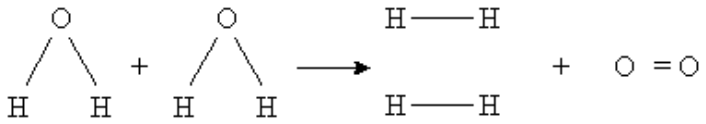
.....

.....

(2)

(b) The water splitting reaction is shown in the equation below.

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



Calculate the energy needed to split the water molecules in the equation into H and O atoms.

$$2H_2O \rightarrow 4H + 2O$$

.....

.....

(2)

(c) On the Periodic Table, hydrogen is placed on its own at the top and in the middle. It is difficult to position it because it has the properties of metals and non-metals.

(i) Where would you expect hydrogen to be placed on the periodic table on the basis of the arrangement of electrons in hydrogen atoms?

.....

.....

(1)

Explain your answer.

.....

.....

(1)

(ii) Give **one** way in which hydrogen behaves like a metal.

.....

.....

(1)

(iii) Give **one** way in which hydrogen behaves like a non-metal.

.....

.....

(1)

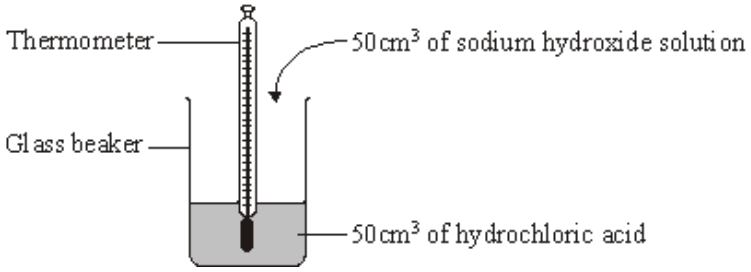
(Total 8 marks)

Q6. 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:

$HCl + NaOH \rightarrow NaCl + H_2O$

The student used the apparatus shown in the diagram.



The student placed 50 cm^3 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)

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

.....

(1)

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

Explain your answer.

.....

.....

(1)

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

.....

.....

(1)

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

.....

Answer = ... ℃

(1)

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

energy change in joules = 100 ×4.2 ×average temperature change

.....

Answer = ... J

(1)

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

Explain why.

Diagram A

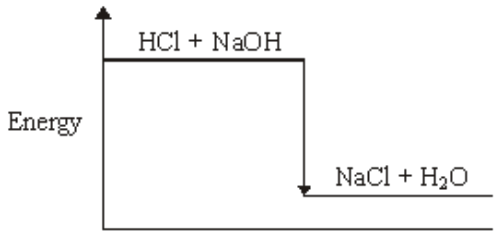
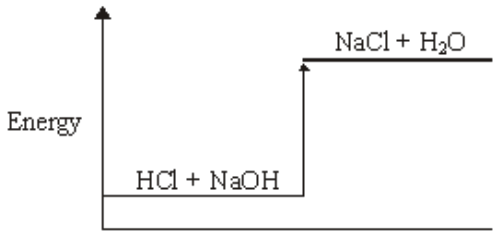


Diagram B



.....

.....

(1)

(Total 7 marks)