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Student number

Name _____

Date _____

Attempt/Time taken _____

GCSE
CHEMISTRY

Topic Paper: 5.1 Exothermic and endothermic reactions
Part 2

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

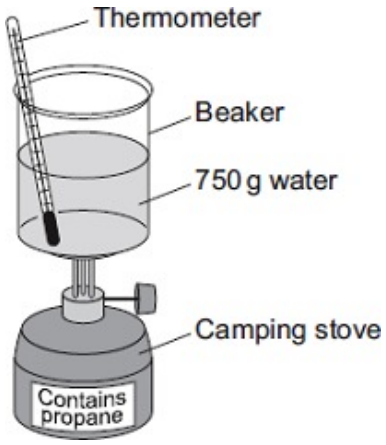
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross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

Q7. A camping stove uses propane gas.



(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 ℃

heated the water by burning propane

measured the temperature of the water again, which was then 64 ℃.

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 (℃)

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

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Energy released = ...

(3)

(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 (a)(i), calculate the energy in kJ released when 1 mole of propane burns.

(If you have no answer for part (a)(i), assume the energy released during the experiment is 144 000 J. This is not the answer to part (a)(i).)

Relative formula mass (M_r) of propane = 44.

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Energy released = ... kJ

(2)

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

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(2)

(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.

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(1)

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

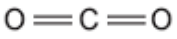
The equation for the combustion of propane is:

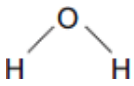
$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

Some bond energies are given in the table

Bond	Bond Energy in kJ per mole
C ═ O	830
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.

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Energy released = ... kJ per mole

(3)

(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.

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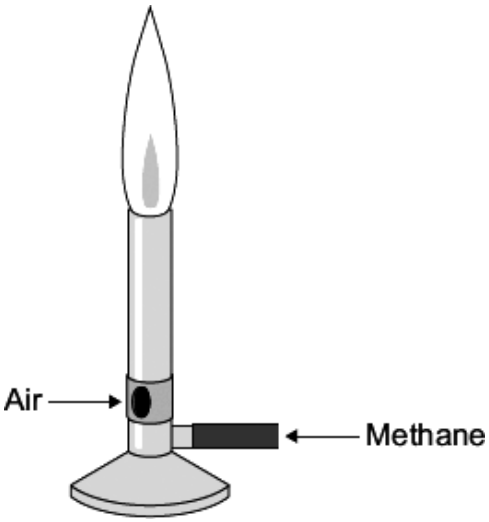
Overall energy change = ... kJ per mole

(1)

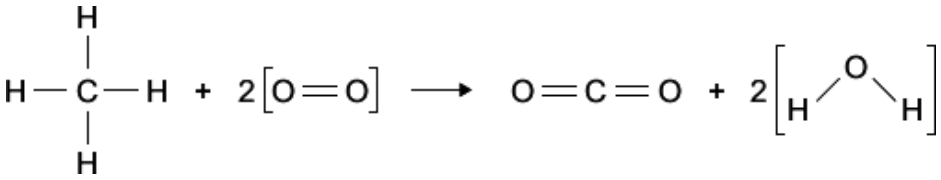
(Total 12 marks)

Q8. A Bunsen burner releases heat energy by burning methane in air.



(a) Methane (CH_4) reacts with oxygen from the air to produce carbon dioxide and water.

(i) Use the equation and the bond energies to calculate a value for the energy change in this reaction.



Bond	Bond energy in kJ per mole
C — H	414
O = O	498
C = O	803
O–H	464

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Energy change = ... kJ per mole

(3)

(ii) This reaction releases heat energy.

Explain why, in terms of bond energies.

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(2)

(b) If the gas tap to the Bunsen burner is turned on, the methane does not start burning until it is lit with a match.

Why is heat from the match needed to start the methane burning?

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(1)
(Total 6 marks)

Q9. 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.

$$2\ H-O-O-H \longrightarrow 2\ H-O-H + O=O$$

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

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Energy change = ... kJ

(3)

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

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(1)

(Total 4 marks)

Q10. When a known mass of a hydrocarbon was completely burned in oxygen, 17.6 g of carbon dioxide and 7.2 g of water were the only products.

Relative formula masses (M_r): CO_2 = 44; H_2O = 18.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answers to calculate the empirical formula of this hydrocarbon.

You must show your working to gain full marks.

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The empirical formula of this hydrocarbon is .....

(3)
(Total 3 marks)

Q11. Some cars are powered by hydrogen fuel cells.

Figure 1

(a) What type of energy is released by hydrogen fuel cells?

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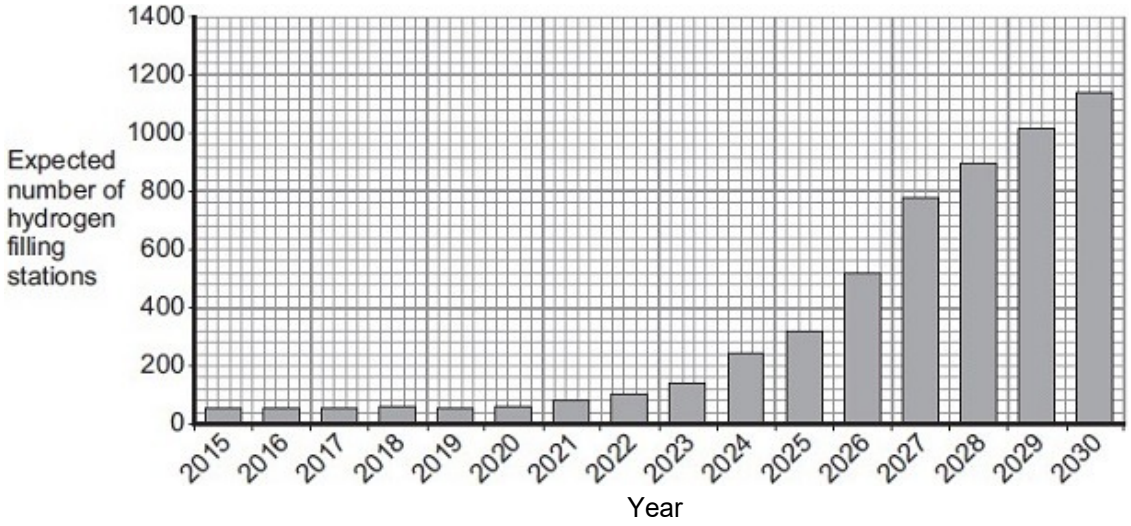
(1)

(b) Owners of cars powered by fuel cells buy hydrogen from hydrogen filling stations.

Figure 2 shows how the number of hydrogen filling stations in the UK is expected to increase up to the year 2030.

Figure 2



Use the information in **Figure 2** and your own knowledge to answer this question.

Suggest **two** reasons why the UK government might encourage the building of more hydrogen filling stations.

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(2)

(c) The equation for the reaction of hydrogen with oxygen is:

$$2\,H_2 + O_2 \longrightarrow 2\,H_2O$$

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

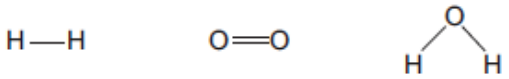
Energy is released when new bonds are made to form the product.

Bond energies for the reaction are given in the table below.

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

The structures of the reactants and product are shown in **Figure 3**.

Figure 3



hydrogen oxygen water

(i) Calculate the energy change for the reaction:

$$2\,H_2 + O_2 \longrightarrow 2\,H_2O$$

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Energy change = ... kJ

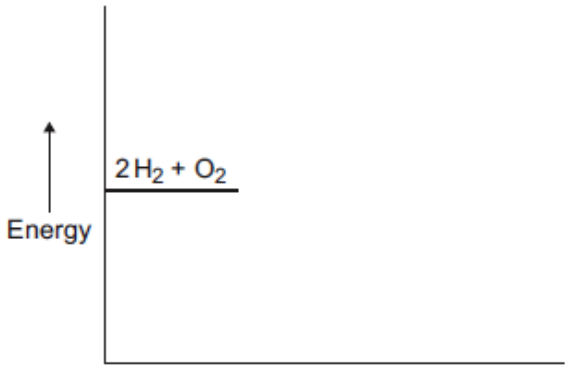
(3)

(ii) The reaction of hydrogen with oxygen is exothermic.

Complete the energy level diagram for this reaction on **Figure 4**.

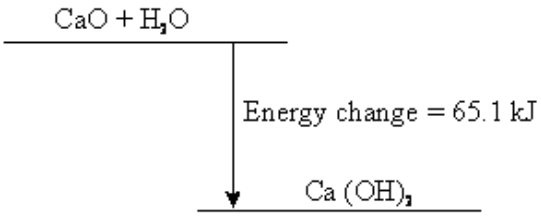
Clearly label the activation energy.

Figure 4



(3)
(Total 9 marks)

Q12. An energy diagram is shown below for the slaking of calcium oxide.



(i) Explain what the diagram tells you about the energy change which takes place in this reaction.

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(2)

(ii) Explain fully what the diagram tells you about the relative amount of energy required to break bonds and form new bonds in this reaction.

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(3)
(Total 5 marks)