OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



EXAM QUESTION PACK

C3.2 ENERGETICS

SCORE	PERCENTAGE
/128	%

STEMUP

These questions belong to OCR, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by OCR. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with OCR and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. OCR has not endorsed, approved or been involved in the production of it. OCR and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

OCR publishes its past papers, mark schemes and examiner reports. Always check the current specification at ocr.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Gateway Chemistry A (9-1)

Energetics

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

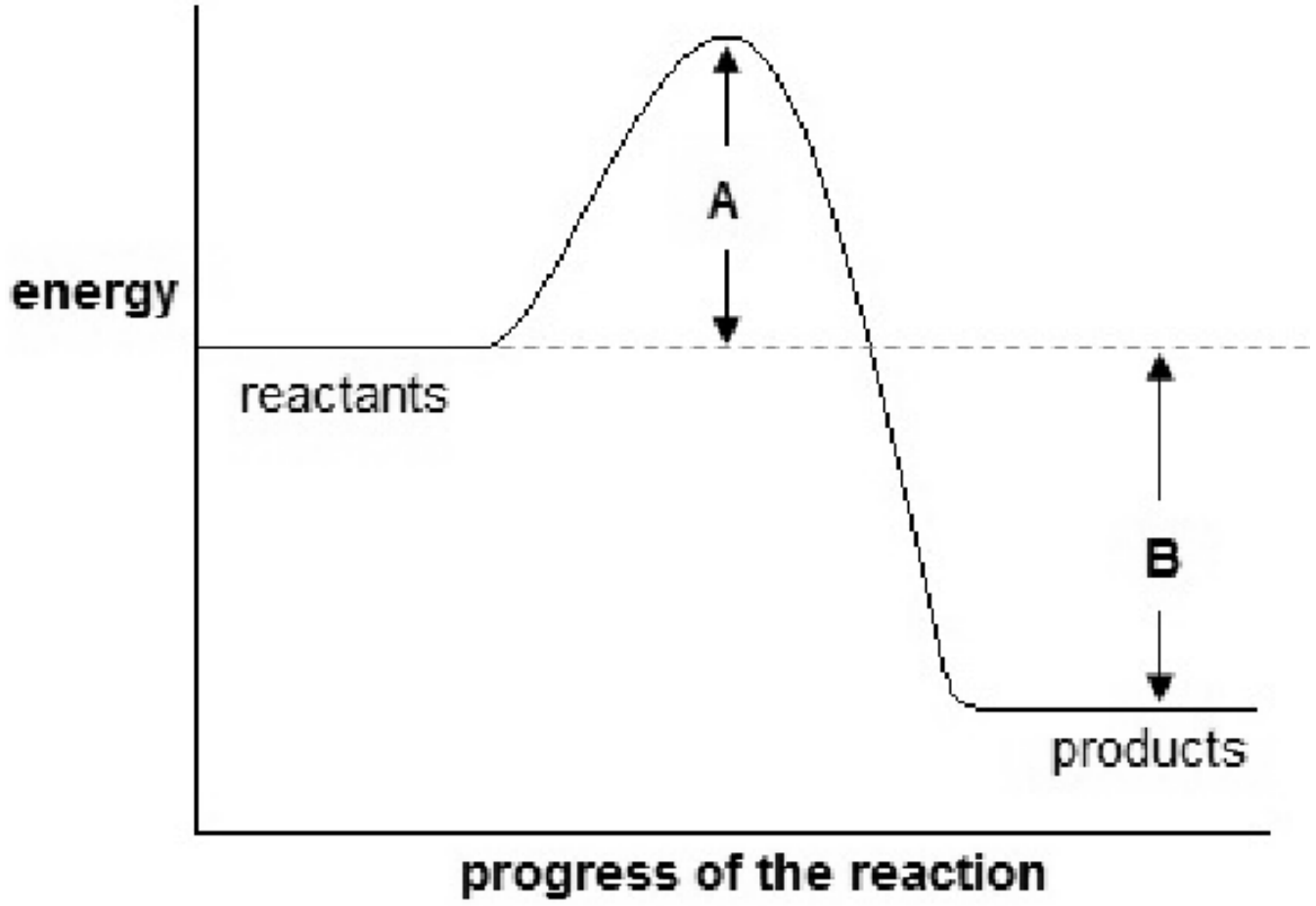
- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **128**.
- The total number of marks may take into account some 'either/or' question choices.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

1(a) Look at the energy profile for a reaction.



What can you deduce about this reaction?

Include the quantities **A** and **B** and a full explanation.

---

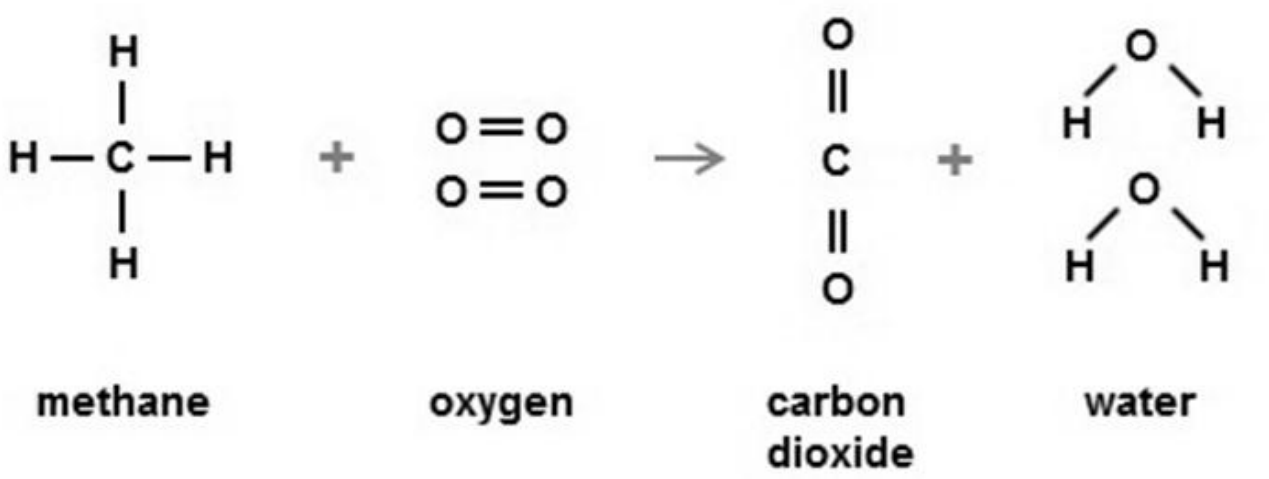
[4]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

(b) Look at the equation.



The table shows the bond energies of the bonds involved.

Bond	Bond energy (kJ/mol)
C-H	435
O=O	498
C=O	805
O-H	464

(i) What type of energy change happens when bonds are broken and when bonds are made?

Bonds broken _____

Bonds made _____ [2]

(ii) Calculate the energy change for this reaction.

STEMUP.CO.UK

Energy change = _____ kJ/mol **[3]**

(c) When propane reacts with oxygen, energy is given out.

Propane gives out 50 kJ/g.

A propane burner is used to boil 200 g of water to make a cup of tea.

The initial temperature of the water is 15°C.

How many grams of propane are needed to heat this water?

Use the following equation:

Energy transferred in J = 4.2 J/g°C × mass of water in g × temperature change in °C

Amount of propane = _____ g **[5]**

2 Hardeep adds magnesium metal to a sample of acid and to a sample of alkali.

He measures the pH of the acid and the alkali.

What results should Hardeep expect?

	Result for acid experiment	Result for alkali experiment
A	pH below 7 no reaction with magnesium	pH above 7 magnesium fizzes
B	pH below 7 magnesium fizzes	pH above 7 no reaction with magnesium
C	pH above 7 magnesium fizzes	pH above 7 no reaction with magnesium
D	pH above 7 no reaction with magnesium	pH below 7 magnesium fizzes

Your answer ☐

[1]

3 When Phil adds water to calcium oxide, a vigorous exothermic reaction takes place forming calcium hydroxide.

Calcium hydroxide has the formula $Ca(OH)_2$.

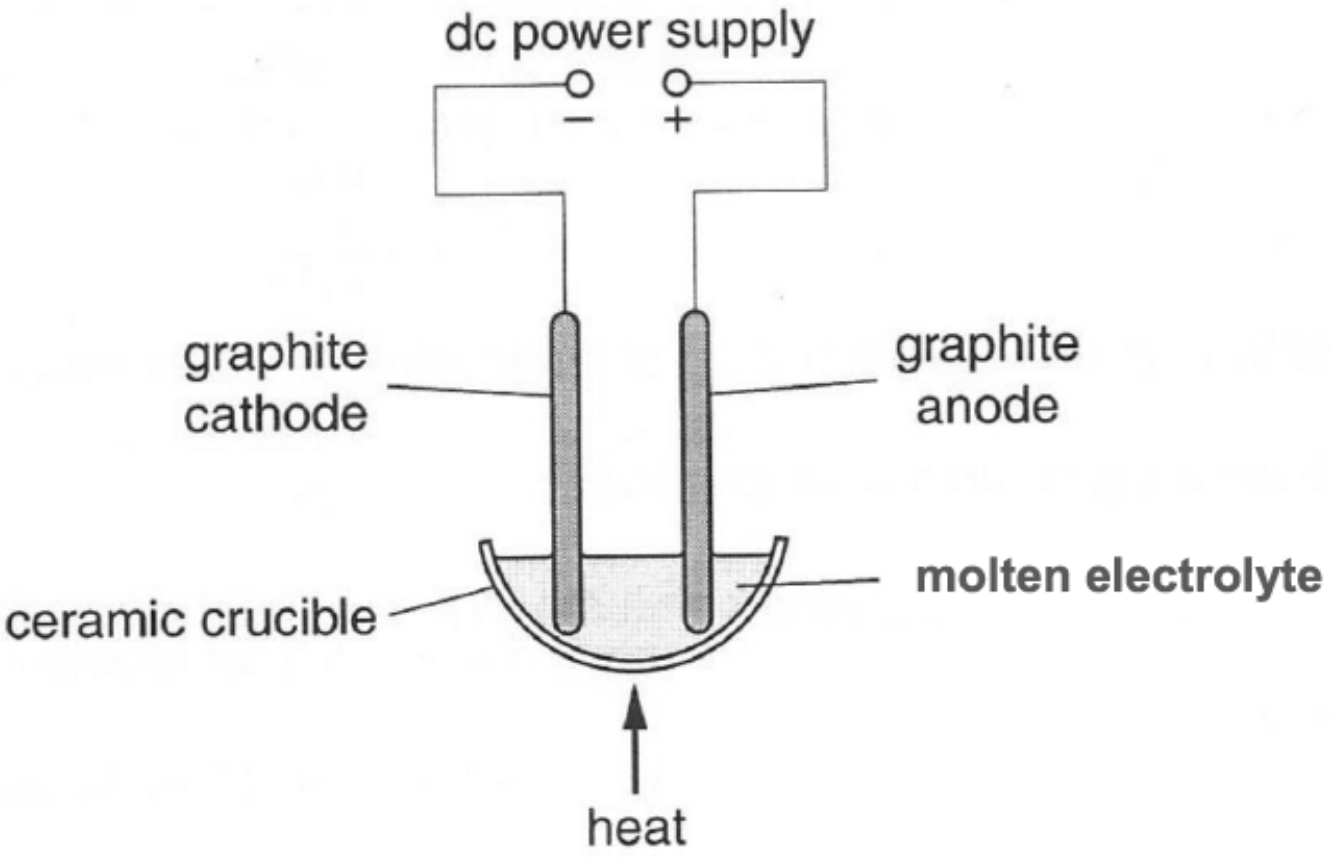
Show that the relative formula mass, M_r, of calcium hydroxide is 74.1.

[2]

STEMUP.CO.UK

4 Look at the diagram.

It shows the apparatus used for the electrolysis of some molten compounds.



The table shows what is made at each electrode during the electrolysis of some molten compounds.

Molten electrolyte	Formula	Product at negative electrode (cathode)	Product at positive electrode (anode)
sodium chloride	Na*Cl*	_____	chlorine
lead bromide	$PbBr_2$	lead	_____

Complete the table.

[2]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

5

(a) Nanoparticles are used as catalysts.

Describe a property of nanoparticles that make them useful as catalysts.

---

[2]

(b) David is synthesising a new titanium dioxide nanoparticle for use as a catalyst.

One TiO_2 nanoparticle has a mass of 5.0×10^{-3} mg.

Calculate how many TiO_2 nanoparticles are in 80.0 mg of TiO_2.

---

[2]

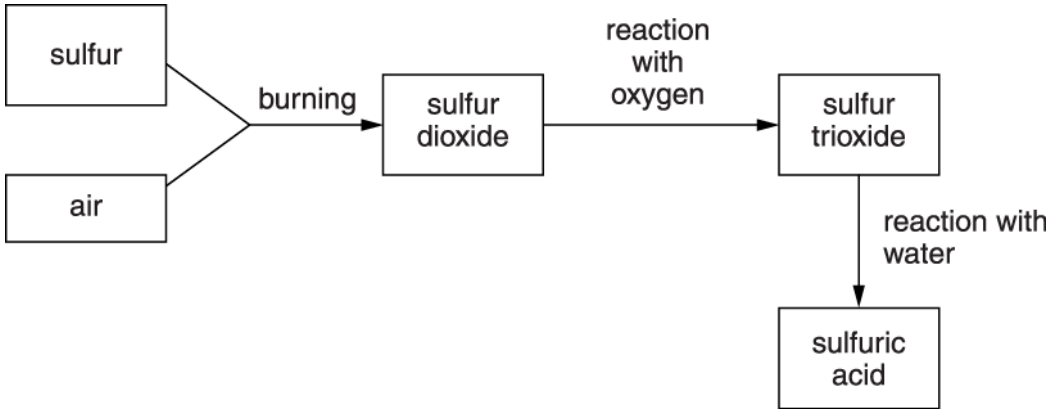
© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

6(a) This question is about the Contact Process used for the manufacture of sulfuric acid.

Look at the flow chart for the process.



In the process, sulfur dioxide reacts with oxygen to make sulfur trioxide.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

The forward reaction is **exothermic**.

Two of the conditions used are:

- a temperature of 450 °C
- a low pressure of 3 atmospheres.

Write down **one other** condition used in the process.

---

[1]

(b) Explain the choice of conditions used in the process.

---

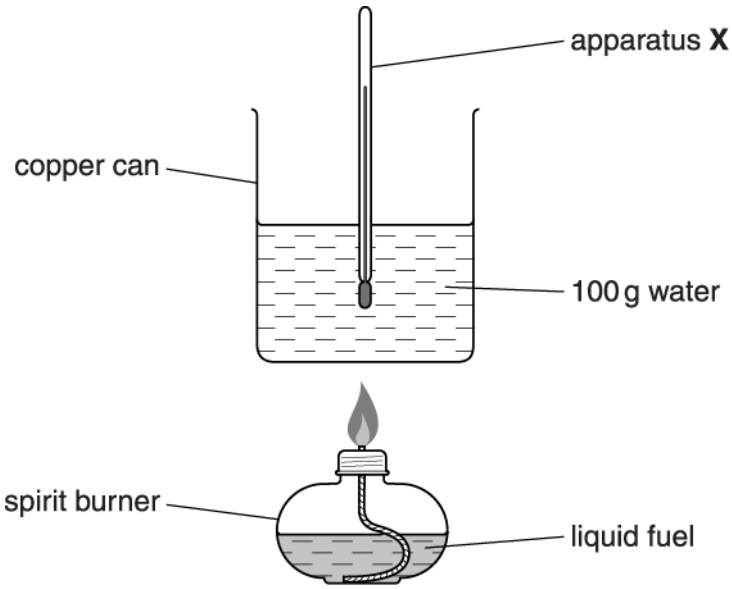
[3]

STEMUP.CO.UK

7 Zak compares different fuels.

He heats 100 g of water each time.

Look at the apparatus he uses.



Look at the diagram.

What is the name of apparatus **X**?

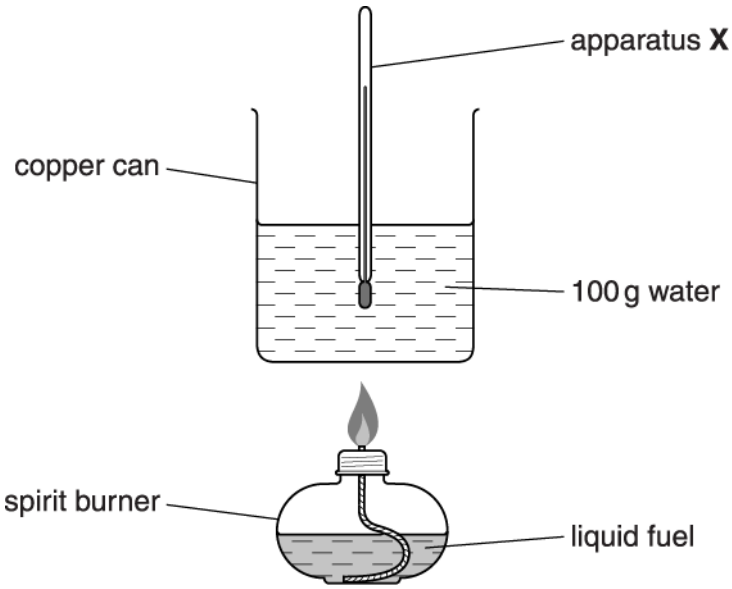
---------- **[1]**

STEMUP.CO.UK

8(a) Zak compares different fuels.

He heats 100 g of water each time.

Look at the apparatus he uses.



Zak uses four fuels.

Zak always burns the same mass of fuel.

Explain why.

---

[1]

STEMUP.CO.UK

(b) Look at Zak's table of results.

Fuel	Fuel Temperature of water at start in °C	Temperature of water after heating in °C	Temperature change of water in °C
A	22	45	23
B	22	48	_____
C	21	48	_____
D	17	47	_____

Calculate the temperature change for each fuel. One has been done for you.

Use these results to decide which fuel releases the most heat energy.

---

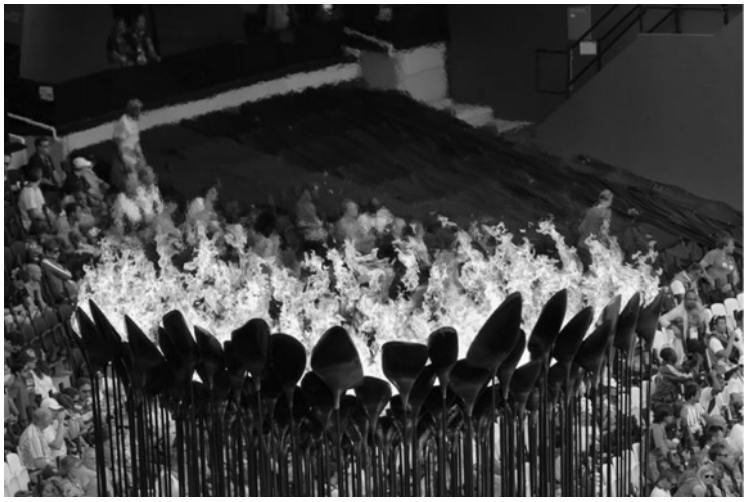
[2]

(c) What is the name of the **type** of chemical reaction that gives out energy into the surroundings?

---

[1]

9 The Olympic flame for the London Olympics burned a fuel. This fuel was a gas.



The designer of the Olympic flame had to decide which fuel to use.

He could not decide whether to use bio gas or natural gas.

One factor he considered was the energy value of the two fuels.

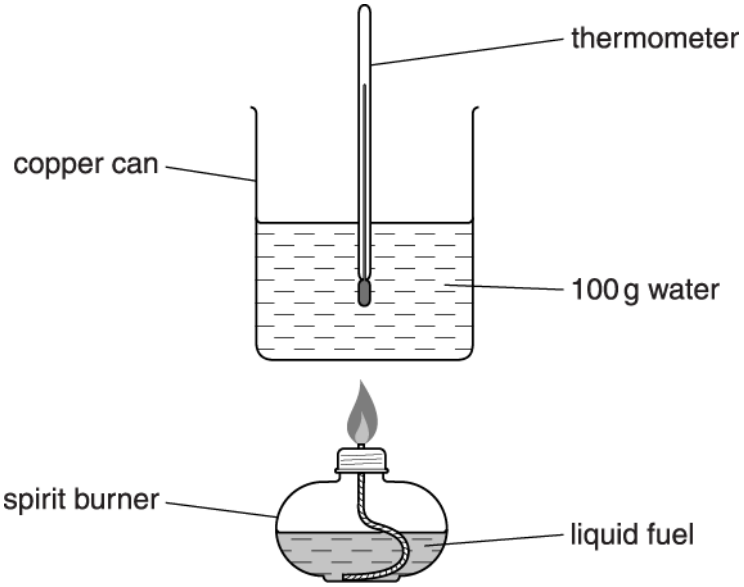
Write about **three** other factors he had to consider.

---

[3]

10(a) Zak heats 100 g of water using a liquid fuel.

Look at the apparatus he uses.



Zak burns 2.0 g of the liquid fuel.

The energy output of the fuel is 16 000 J / g.

Calculate the energy released when 2.0 g of the liquid fuel is burned.

energy released = _ _ _ _ _ _ _ J

[1]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

(b) The energy released by the liquid fuel is related to the rise in temperature of the water, ΔT.

This relationship is shown by the equation

$$\text{energy released} = \text{mass} \times 4.2 \times \Delta T$$

Calculate the rise in temperature of the water in Zak's experiment.

rise in temperature = _____ °C

[3]

(c) The burning of a liquid fuel is an example of an **exothermic** reaction.

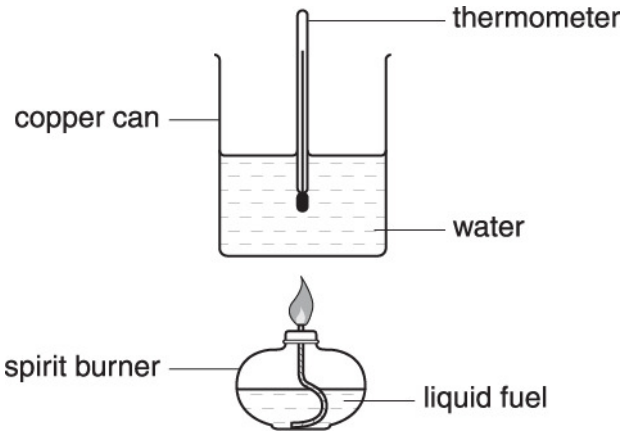
Explain, using ideas about bond breaking and bond making, why this reaction is exothermic.

---

[3]

11(a) Eva is investigating liquid fuels. She wants to find out which liquid fuel gives out the most energy per gram.

Look at the apparatus she uses.

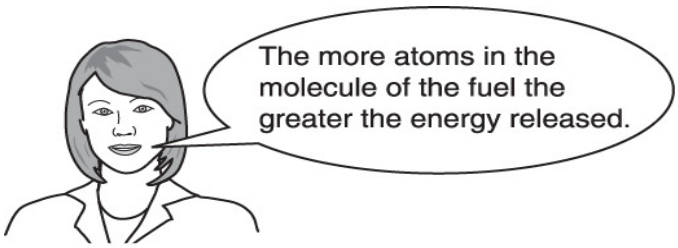


She heats 100 cm^3 of water.

Eva uses five liquid fuels.

Each time she burns 1.0 g of liquid fuel.

She makes a prediction.



Look at Eva's results.

Fuel	Molecular formula	Number of atoms in a molecule	Temperature of water before heating in °C	Temperature of water after heating in °C	Temperature increase in °C
methanol	CH_4O	6	20	29	9
ethanol	C_2H_6O	9	18	30	12
propanol	C_3H_8O	12	18	32	14

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

butanol	$C_4H_{10}O$	15	18	34	16
pentanol	$C_5H_{12}O$	18	20	35	15

The energy released is given by the equation

energy = mass × specific heat capacity × temperature change

where specific heat capacity of water = 4.2 J/g °C.

Calculate the energy released by methanol.

---

energy released = _____ J

[2]

(b) Do Eva's results support her prediction?

Explain your answer.

---

[2]

12 Nitrogen molecules react with oxygen molecules.

Nitrogen monoxide molecules are made.

$$N_2 + O_2 \text{ ? } 2NO$$

The reaction is endothermic.

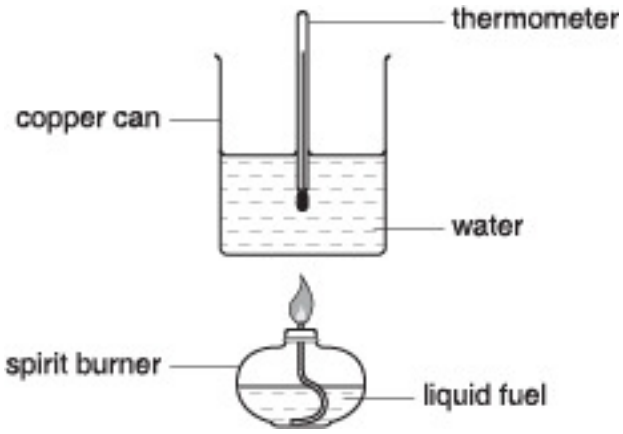
Explain, in terms of bond breaking and bond making, why this reaction is endothermic.

---

[3]

13(a) Eva is investigating liquid fuels. She wants to find out which liquid fuel gives out the most energy per gram.

Look at the apparatus she uses.



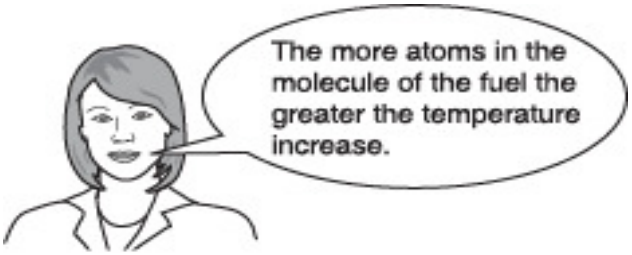
She heats 100 cm^3 of water.

Eva uses five liquid fuels. Each time she burns 1.0 g of liquid fuel. She makes a prediction.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK



Look at Eva's results.

Fuel	Molecular formula	Number of atoms in a molecule	Temperature of water before heating in °C	Temperature of water after heating in °C	Temperature increase in °C
methanol	CH_4O	_____	20	29	9
ethanol	C_2H_6O	9	18	30	_____
propanol	C_3H_8O	12	18	32	_____
butanol	$C_4H_{10}O$	_____	18	34	16
pentanol	$C_5H_{12}O$	18	20	35	15

Complete the table by putting in the missing values for:

- number of atoms in a molecule
- temperature increase.

[2]

(b) Do Eva's results support her prediction?

Explain your answer.

---

[2]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

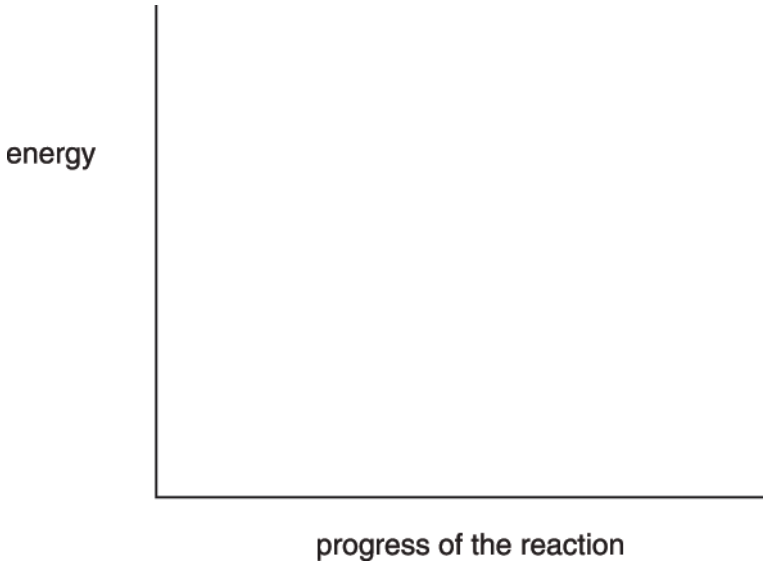
14 What is meant by the words **endothermic reaction**?

---

[1]

15(a) The reaction between hydrogen and oxygen is **exothermic**.

Draw and label an energy level diagram for the reaction between hydrogen and oxygen



[2]

(b) Fuel cells are used to provide electrical energy in spacecraft.

Write down one **other advantage** of using fuel cells in spacecraft.

---

[1]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

16 Paraffin is a liquid fuel.

Paraffin releases heat energy when it burns in air.

Jenna wants to find out how much energy is released when she burns 1 g of paraffin.

She decides to use the paraffin to heat some water.

Write about how she does the experiment. You may wish to include a labelled diagram.

[4]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

17(a) This question is about energy changes during chemical reactions.

Cold packs are used to treat sports injuries.

The cold pack **reduces** the temperature of the injured part of the body.



An endothermic reaction happens when the chemicals in the cold pack react.

Energy is absorbed when bonds break.

Explain, in terms of bonds between atoms, why this reaction is **endothermic**.

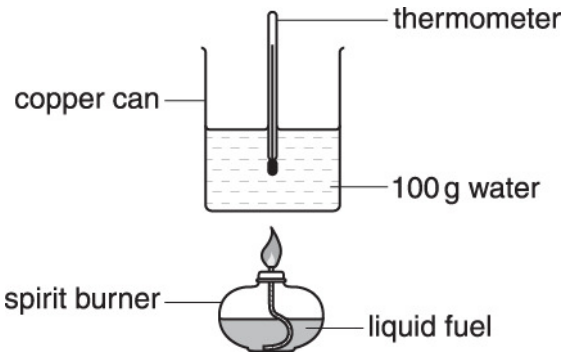
---

[2]

(b) Aimee and Luke investigate four liquid fuels.

They burn an amount of each liquid fuel.

Look at the diagram. It shows the apparatus they use.



Look at the table. It shows their results.

Liquid fuel	Mass of fuel burnt in g	Temperature at start in °C	Temperature at end in °C
ethanol	2.2	20	40
methylated spirits	2.4	21	39
paraffin	1.9	22	45
propanol	2.1	22	44

(i) Calculate the energy transferred by **ethanol**.

energy transferred = mass × specific heat capacity × temperature change

The specific heat capacity of water is 4.2 J/g°C.

---

answer _____ J

[2]

(ii) Aimee thinks **paraffin** gives out the **most** energy per gram.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Use the results to show that she is correct.

---

[2]

18(a) This question is about energy changes during chemical reactions.

Cold packs are used to treat sports injuries.

The cold pack **reduces** the temperature of the injured part of the body.



A chemical reaction happens when the cold pack is squeezed.

Look at the table.

It shows the temperature changes for four different reactions, **A**, **B**, **C** and **D**.

Reaction	Start temperature in °C	Final temperature in °C	Temperature change in °C

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

A	18	12	?6
B	18	18	0
C	18	25	+7
D	18	23	+5

Which reaction would be the best one for use in the cold pack?

Choose from **A**, **B**, **C** or **D**.

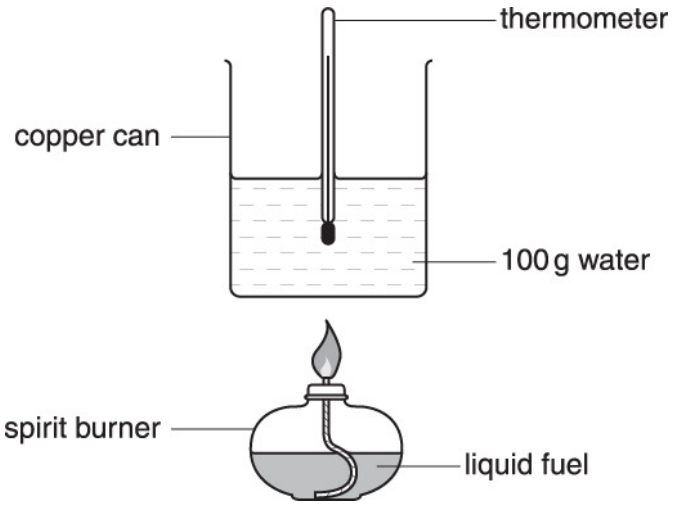
answer _____

[1]

(b) Aimee and Luke investigate four liquid fuels.

They burn 1.0 g of each liquid fuel.

Look at the diagram. It shows the apparatus they use.



Look at the table. It shows their results.

Liquid fuel	Temperature at start in °C	Temperature at end in °C
ethanol	20	40
methylated spirits	21	39
paraffin	22	45
propanol	22	44

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

(i) Which liquid fuel transfers the **least** energy?

answer _____

[1]

(ii) Calculate the energy transferred by **ethanol**.

energy transferred = mass × specific heat capacity × temperature change

The specific heat capacity of water is 4.2 J/g°C

_____

_____

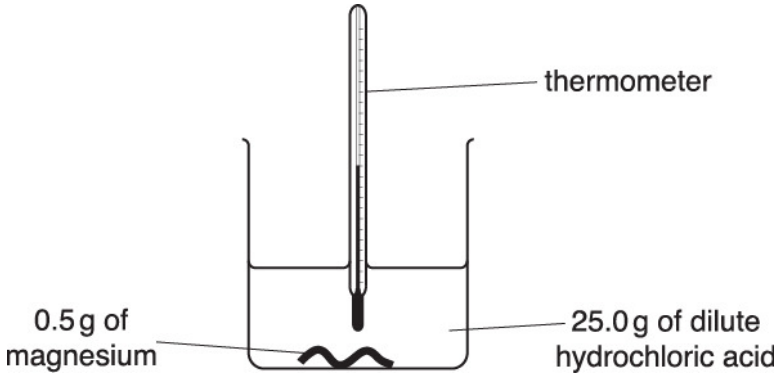
_____

answer _____ J

[2]

19(a) Sue investigates the reaction between magnesium ribbon and dilute hydrochloric acid.

Look at the apparatus she uses.



The temperature of the acid before the magnesium is added is 22.0°C.

The energy released by the reaction can be calculated using the equation

energy released = mass of acid heated × specific heat capacity × temperature change

The specific heat capacity of the acid = 4.2 J / g°C

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

The energy released in Sue's experiment was 1600 J.

Calculate the **final** temperature of the acid.

Quote your answer to **one** decimal place.

Final temperature of the acid is _____ °C

[3]

(b) Energy is released in this reaction.

Explain why. Use ideas about bond breaking and bond making.

---

[2]

20(a) Paraffin is a liquid fuel obtained from crude oil.

Heat energy is released when paraffin burns.

What is the name of a reaction that releases heat energy?

Put a ring around the correct answer.

catalysis **endothermic** **evaporation**

exothermic **filtration**

[1]

(b) Jenna investigates the amount of energy released when paraffin is burnt.

She does five experiments.

She uses the same mass of water in each experiment.

She uses a different mass of paraffin for each experiment.

Look at her results.

Mass of paraffin burnt in grams	Temperature increase of water in °C
1.0	12
2.0	24
3.0	36
4.0	48
5.0	60

(i) Jenna uses a spirit burner with paraffin in the investigation.

Draw a fully **labelled** diagram of the apparatus she must use to collect these results.

© OCR 2022. You may photocopy this page.

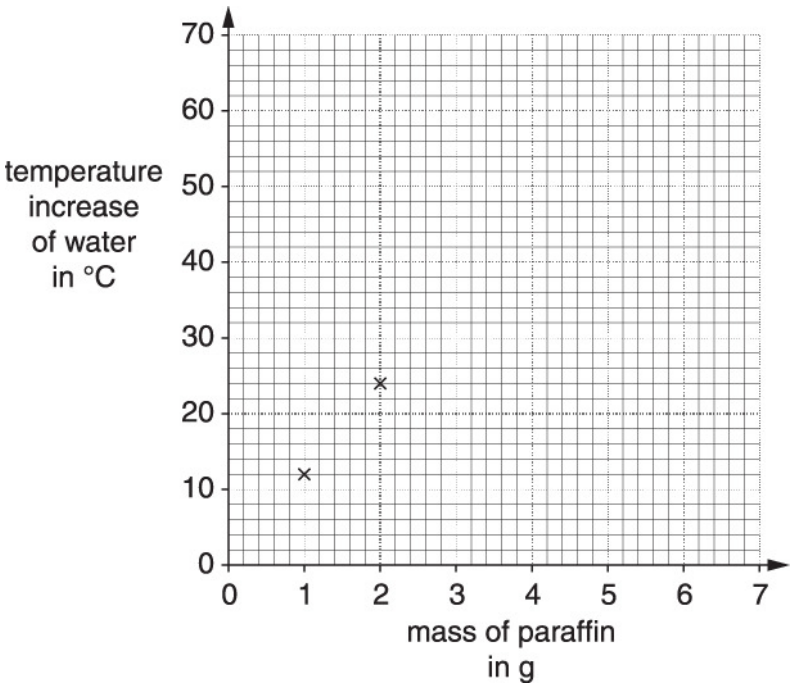
Created in ExamBuilder

STEMUP.CO.UK

[3]

(ii) Plot Jenna's results on the graph below. Two points have been done for you.

Use the graph to predict what mass of paraffin would give a temperature rise of 30 °C.



mass of paraffin = _____ g

[2]

21(a) Ethanol can be used as a biofuel. The combustion of ethanol is an **exothermic** reaction.

Explain why combustion is an exothermic reaction.

Use ideas about bond breaking and bond making in your answer.

---

[1]

STEMUP.CO.UK

(b)

(i) Methanol is another biofuel that can be used in combustion reactions.

$CH_3OH + 2O_2 \rightarrow CO_2 + 2H_2O$

Look at the table. It shows some bond energies.

Bond	Bond energy (kJ / mol)
C-H	413
O=O	498
C-O	358
C=O	805
O-H	464

Calculate the energy transferred to break all the bonds in the reactants.

Energy transferred = ... kJ / mol **[2]**

(ii) Calculate the energy transferred when all the bonds form in the products.

Energy transferred = ... kJ / mol **[2]**

(iii) Use your answers to parts **(i)** and **(ii)** to calculate the energy change for this reaction.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Energy change = ... kJ / mol **[1]**

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

22 Lead is most commonly extracted from an ore called galena, PbS.

Extracting lead from the galena ore involves two steps.

Step 1: The galena ore is roasted in air to produce lead oxide, PbO.

Step 2: The lead oxide is heated in a blast furnace with carbon.

(i) The reaction in step 1 is an **exothermic** reaction.

Draw a labelled reaction profile diagram for an exothermic reaction.

Label the **activation energy** and the **energy change** on your diagram.



[4]

(ii) In step 2 the lead oxide is reduced by carbon.

$PbO + C \rightarrow Pb + CO$

Explain, in terms of electron transfer, why carbon is called a **reducing agent** in this reaction.

[1]

23 What is meant by the **activation energy** in a chemical reaction?

A The total energy used up when a reaction has stopped.

B The energy absorbed during a reaction.

C The energy released during a reaction.

D The minimum energy needed for a reaction to occur.

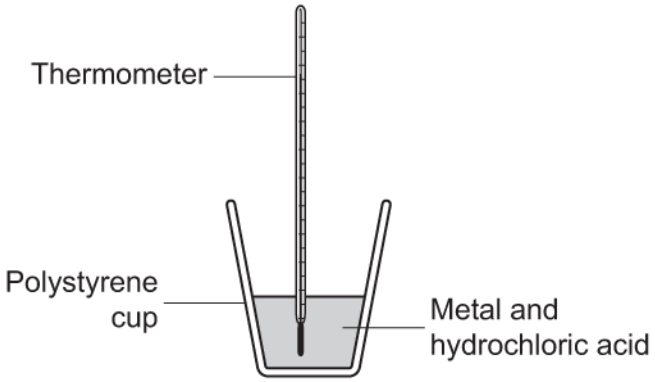
Your answer [ ] [1]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

24(a) A student investigates the reaction of different metals with hydrochloric acid.



(i) The student notices that the **temperature rises** when a metal is added to the acid.

What name is given to this type of reaction when the temperature rises?

[1]

(ii) The metal magnesium reacts with hydrochloric acid, HC*l*, to form magnesium chloride, MgCl_2, and hydrogen.

Write a **balanced symbol** equation for this reaction.

[2]

(iii) The experiment is repeated with aluminium and hydrochloric acid.

Write down the **name** of the **salt** produced in this reaction.

[1]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

(b) The student repeats the experiment with different metals.

She repeats the experiment three times for each metal.

She measures the temperature change in each experiment.

Look at her results.

Metal	Temperature change (°C)		
	Test 1	Test 2	Test 3
Magnesium	10.3	10.5	10.2
Zinc	8.6	8.7	7.6
Iron	5.2	4.9	5.1

(i) One of the student's results is anomalous.

Put a ring around the anomalous result in the table. [1]

(ii) Suggest a reason why the result could be anomalous.

---

[1]

(iii) Calculate the **mean** temperature change for **magnesium**.

Give your answer to **1** decimal place.

Mean temperature change = ... °C **[2]**

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

(c)

(i) The student wants to improve her experiment to get more **accurate** results.

Suggest an improvement to her experiment, which will give more accurate results.

Give a reason for the improvement.

Improvement _____

Reason _____

[2]

(ii) The student concludes that the more reactive the metal is, the higher the temperature rise.

Describe further tests the student can do to confirm her conclusion.

_____

_____

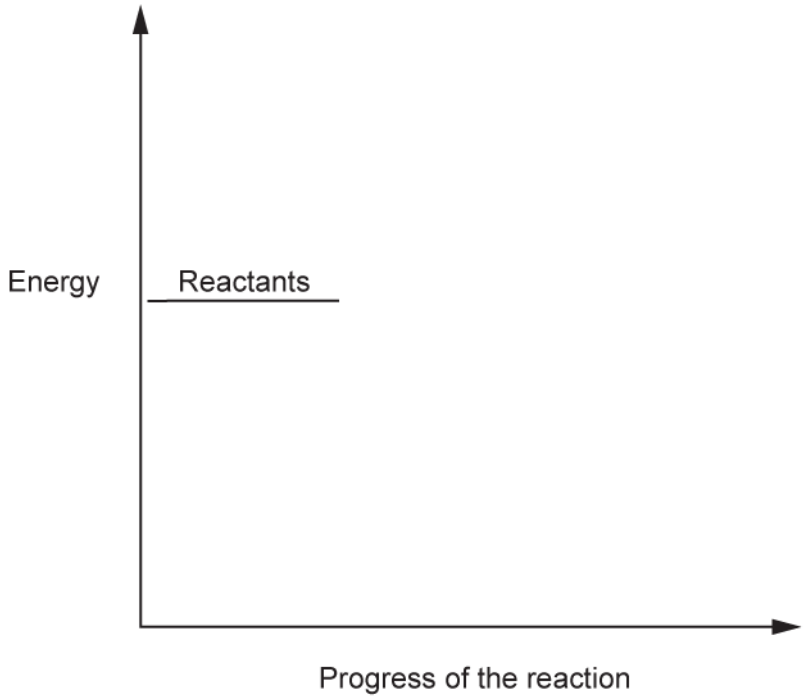
_____ **[2]**

(d) A reaction profile shows the energy involved in a reaction.

Draw the reaction profile for the reaction between magnesium and hydrochloric acid.

Label the:

- products
- energy change
- activation energy.



[3]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

25(a) A student investigates the energy changes in different reaction mixtures, **X**, **Y** and **Z**. **Fig. 19.1** shows the apparatus she uses.

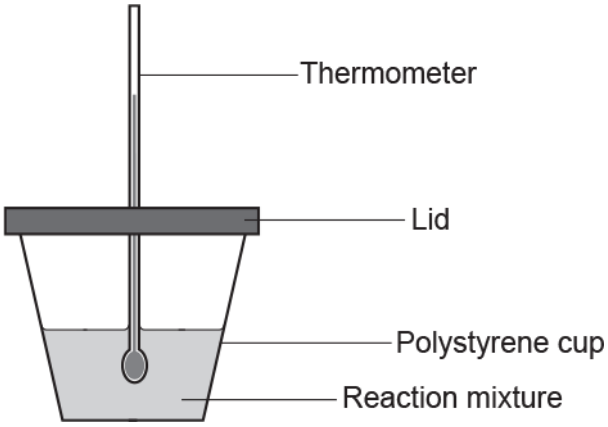


Fig. 19.1

Look at the table of the student's results.

(i) Add the temperature change for each reaction mixture.
Include a + or – sign where relevant.

Reaction mixture	Temperature at start (°C)	Temperature at end (°C)	Temperature change (°C)
X	20.0	25.5	.....
Y	19.0	8.0	.....
Z	20.0	20.0	.....

[1]

(ii) Which reaction mixture has an **endothermic** reaction?

Tick (✓) **one** box.

X ☐

Y ☐

Z ☐

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Explain your answer.

---

[2]

(iii) Complete the reaction profile for an **endothermic** reaction in **Fig. 19.2**.

The products have already been added.

Label the:

- reactants
- energy change
- activation energy.



[3]

Fig. 19.2

STEMUP.CO.UK

(b) A student investigates the combustion of ethanol.

Fig. 19.3 shows the apparatus the student uses.

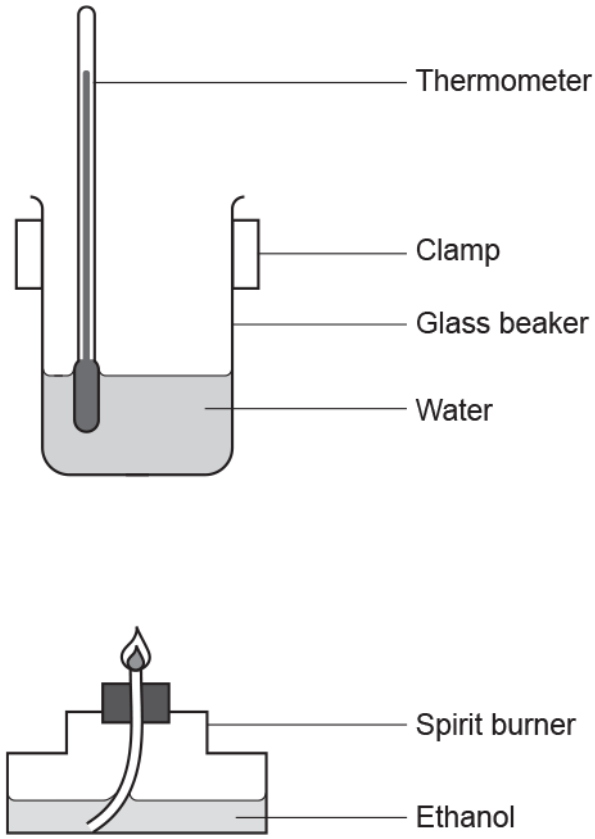


Fig. 19.3

The temperature change is much lower than the textbook value.

Suggest **two** ways that the student could improve the set-up of the apparatus in **Fig. 19.3**, so the temperature change is closer to the textbook value.

1 _____

_____

2 _____

_____

[2]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

26(a) A student is investigating chemical reactions that produce heat.

She adds zinc to hydrochloric acid, HCl.

Zinc chloride, $ZnCl_2$, and hydrogen gas are made.

(i) Write the **balanced symbol** equation for this reaction.

[2]

(ii) What term is used to describe a reaction that produces heat?

[1]

(b) The student draws the reaction profile for this reaction, as shown in **Fig. 18.1**.

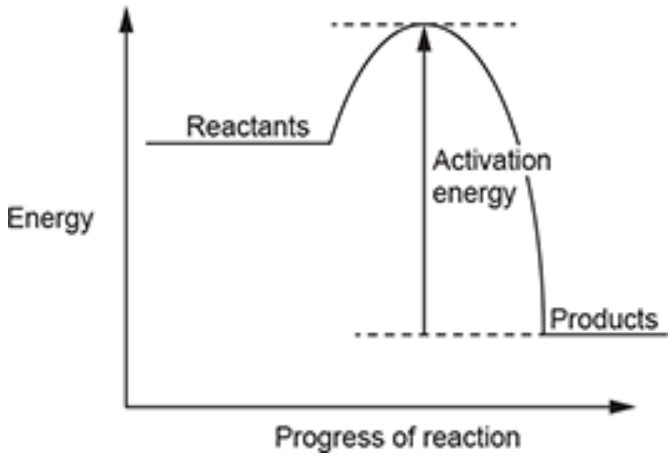


Fig. 18.1

Explain what is meant by the term **activation energy**.

[1]

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

(c) Combustion reactions produce a lot of heat energy.

Bond energies can be used to calculate the energy change in combustion reactions.

Bond	Bond energy (kJ / mol)
C–H	413
O=O	498
C=O	805
O–H	464

Methane is a common fuel used in combustion reactions.

Methane reacts with oxygen. Carbon dioxide and water are made, as shown in **Fig. 18.2**.

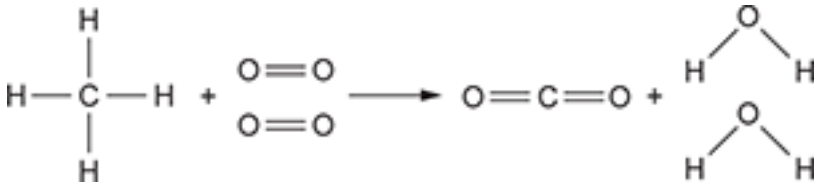


Fig. 18.2

(i) The reaction of methane with oxygen produces heat.

Explain why.

Use ideas about bond breaking and bond making in your answer.

---

[3]

(ii) Calculate the total energy transferred to break the bonds in the reactants in **Fig. 18.2**.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Total energy transferred = ... kJ / mol **[1]**

(iii) Calculate the total energy transferred to make the bonds in the products in **Fig. 18.2**.

Total energy transferred = ... kJ / mol **[1]**

(iv) Use your answers to parts **(ii)** and **(iii)** to calculate the energy change for the reaction in **Fig. 18.2**.

Energy change = ... kJ / mol **[1]**

END OF QUESTION PAPER

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK