Energetics – 2021/20 GCSE Gateway Chemistry A

1. Nov/2020/Paper_J248/01/No.19

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

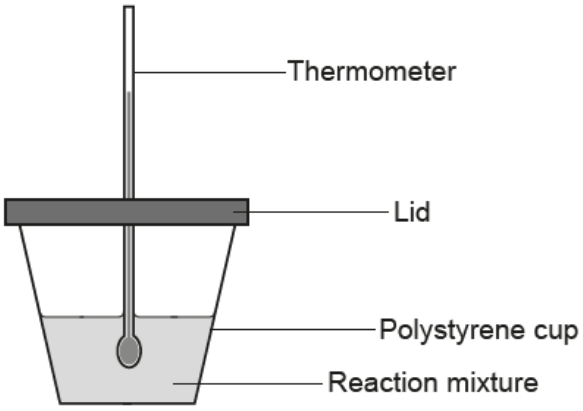


Fig. 19.1

(a) 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 ☐

Explain your answer.

.....

.....

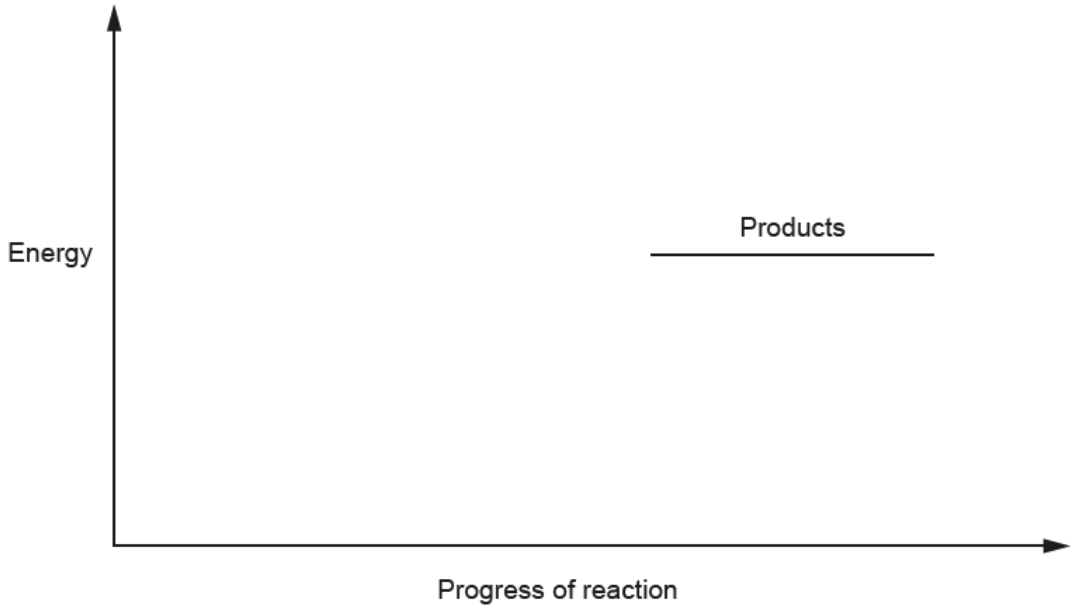
..... **[2]**

(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

(b) The burning of methane gas is an exothermic reaction.

When methane, CH_4, burns in oxygen, O_2, carbon dioxide, CO_2, and water, H_2O, are made.

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

..... **[2]**

(c) A student investigates the combustion of ethanol.

Fig. 19.3 shows the apparatus the student uses.

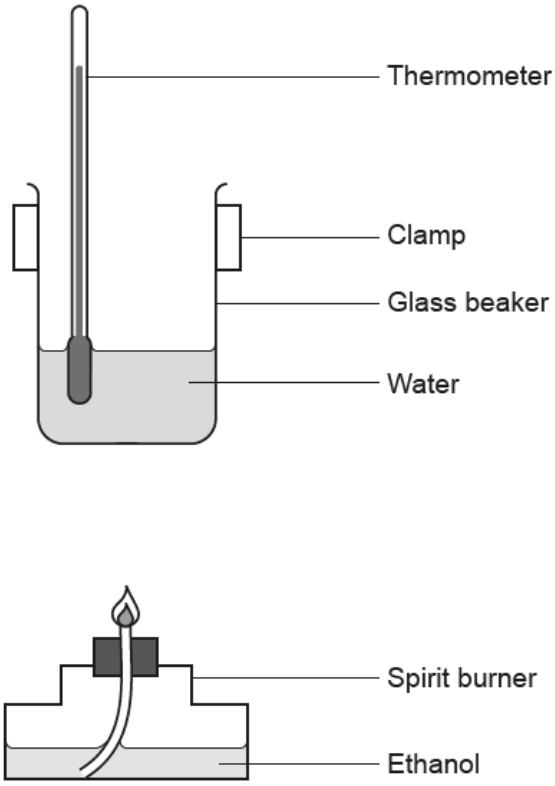


Fig. 19.3

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]

2. Nov/2021/Paper_J248/03/No.5

Which type of reaction occurs when the temperature of the surroundings increases?

A Crystallisation

B Endothermic

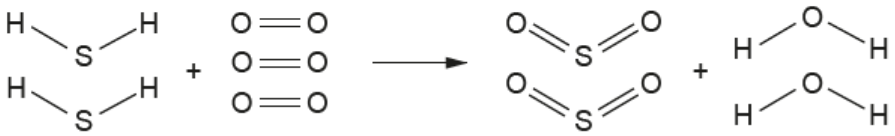
C Exothermic

D Reduction

Your answer ☐ **[1]**

3. Nov/2021/Paper_J248/03/No.22(c, d)

(c) The reaction of hydrogen sulfide with oxygen is shown using displayed formulae.



The table shows the bond energies of the bonds in the reactants and products.

Bond	Bond energy (kJ / mol)
S–H	347
O=O	494
S=O	523
H–O	459

The energy needed to break the bonds in **two** moles of hydrogen sulfide is 1388 kJ.

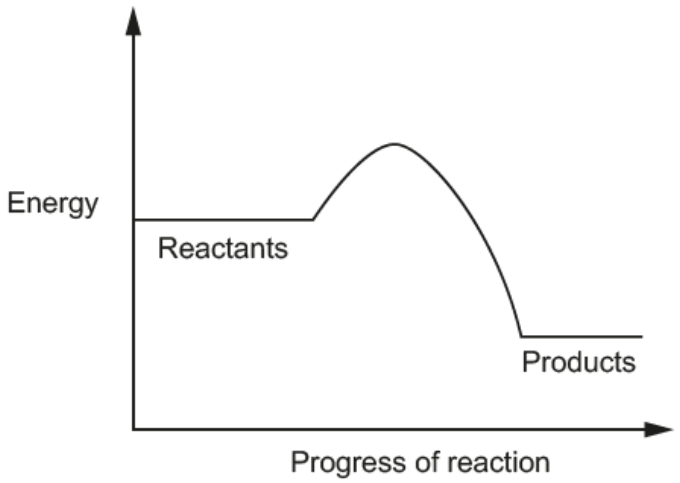
Use the bond energies to calculate the energy change of the reaction when **two** moles of hydrogen sulfide react with oxygen.

Give your answer to **3** significant figures.

Energy change = ... kJ **[4]**

(d) Sulfur dioxide reacts with oxygen to form sulfur trioxide.

The reaction profile is shown.



(i) Which type of reaction happens when sulfur dioxide and oxygen react?

Tick (✓) **one** box.

Endothermic	☐
Exothermic	☐
Reduction	☐
Thermal decomposition	☐

Give a reason for your answer.

.....

..... **[2]**

(ii) Sulfur trioxide reacts with water to form sulfuric acid.

- A scientist measures the pH of some dilute sulfuric acid. The pH is 2.
- The scientist makes a solution by adding 990 cm^3 of water to 10 cm^3 of the dilute sulfuric acid.

Calculate the pH of the solution.

pH of solution = ... **[3]**

4. Nov/2020/Paper_J248/03/No.18

A student is investigating chemical reactions that produce heat.

(a) 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**.

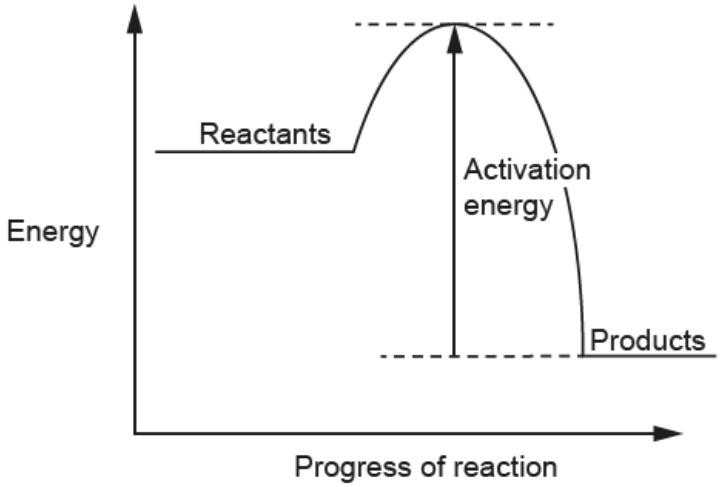


Fig. 18.1

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

.....

..... **[1]**

(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**.

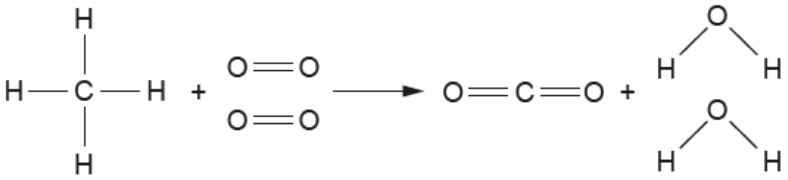


Fig. 18.2

(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**.

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**.

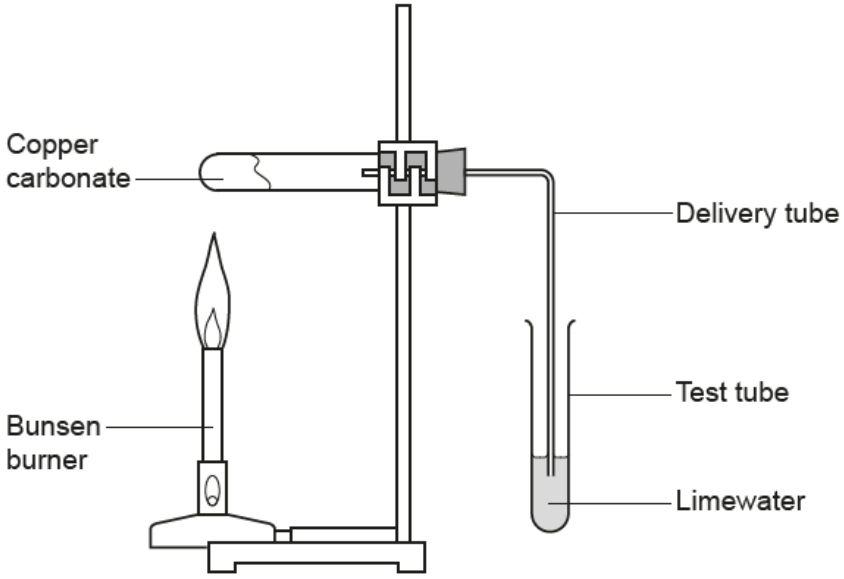
Energy change = ... kJ / mol **[1]**

5. Nov/2020/Paper_J248/03/No.22

A student investigates the thermal decomposition of copper carbonate.

copper carbonate → copper oxide + carbon dioxide

Here is the set-up of the apparatus she uses.



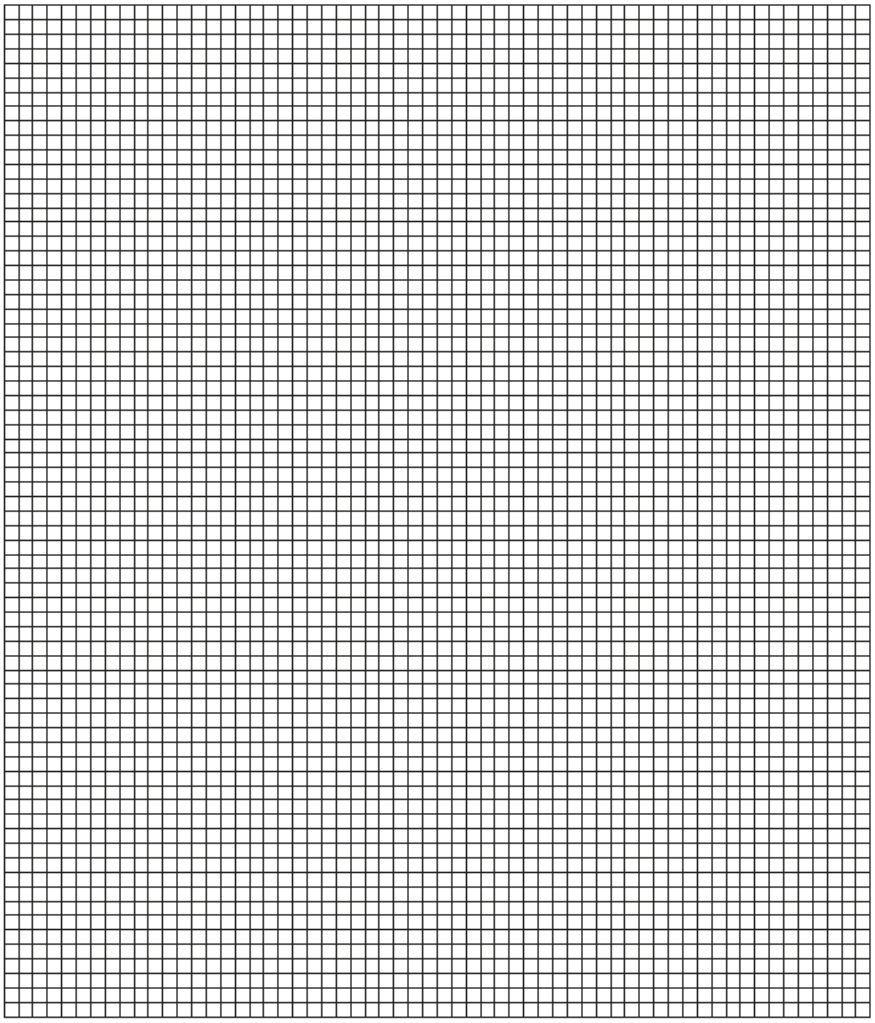
The student measures the mass of copper carbonate at the start of the experiment. She then measures the mass of copper oxide made.

She does the experiment five times using a different mass of copper carbonate each time.

Look at her results.

Mass of copper carbonate (g)	Mass of copper oxide (g)
1.00	0.70
2.00	1.35
3.00	1.95
4.00	2.65
5.00	3.30

(a) (i) Plot a graph of the student's results and draw a line of best fit.



[4]

(ii) What is the mass of copper carbonate that needs to be heated to produce 2.50 g of copper oxide?

Use your graph in your answer.

Mass of copper carbonate = ... g **[1]**

(iii) The mass of copper oxide made in the reaction is less than the mass of the copper carbonate heated.

Suggest why.

.....

.....

..... **[1]**

(b) Calcium carbonate thermally decomposes to make calcium oxide and carbon dioxide.

$CaCO_3 \rightarrow CaO + CO_2$

Calculate the mass of calcium carbonate needed to make 209 g of calcium oxide.
(A_r: Ca = 40.1, C = 12.0, O = 16.0)

Give your answer to **3** significant figures.

Mass of calcium carbonate = ... g **[4]**