Energetics (H)

1 (a). 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**.

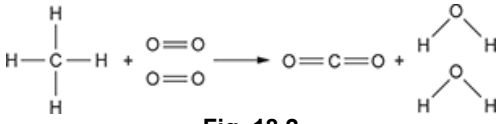

Fig. 18.2

i. The reaction of methane with oxygen produces heat.

Explain why.

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

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[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]**

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

She adds zinc to hydrochloric acid, HC*l* .

Zinc chloride, ZnC*l* $_2$, 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]

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

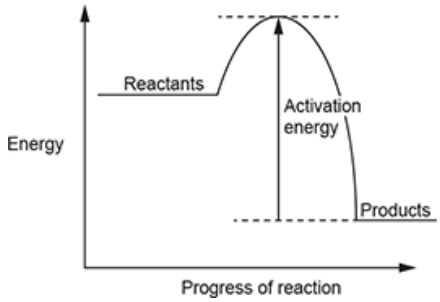


Fig. 18.1

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

[1]

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

Extracting lead from the galena ore involves two steps.

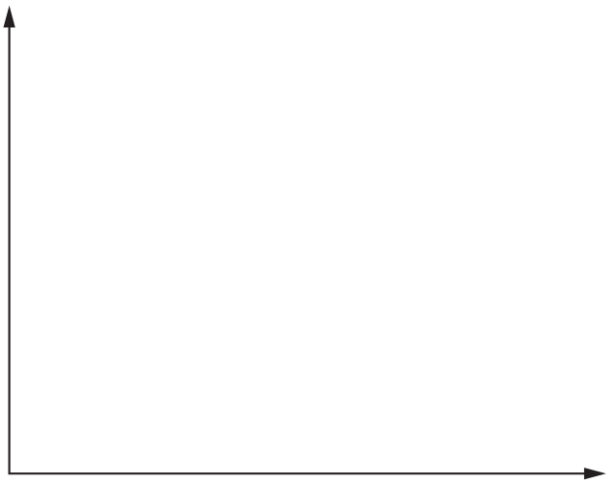
Step **1**: The galena ore is roasted in air to produce lead oxide, PbO.

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.

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[1]

3 (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.

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[1]

(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]**

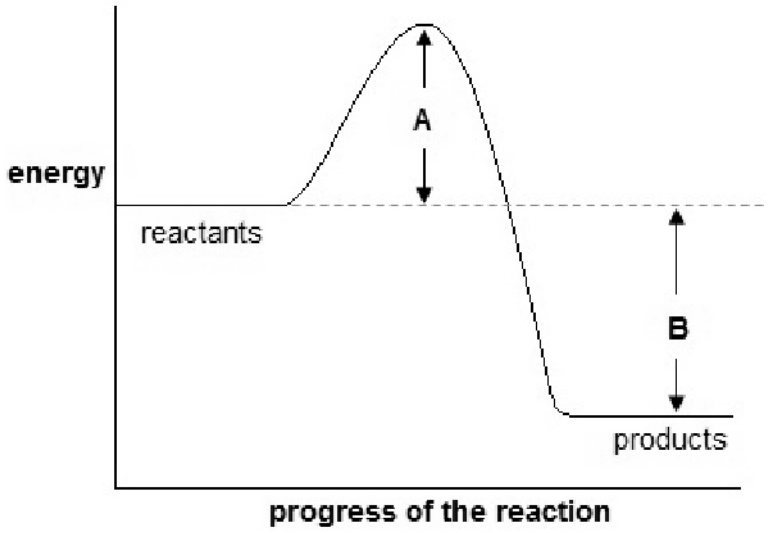
ii. Calculate the energy transferred when all the bonds form in the products.

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

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

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

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

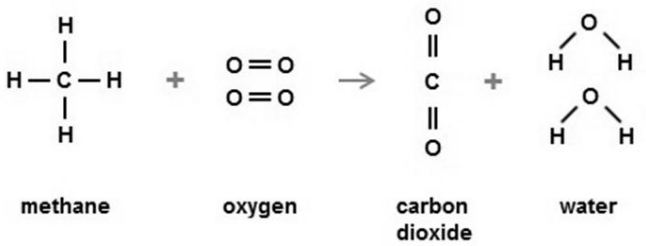


What can you deduce about this reaction?

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

---**[4]**

(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.

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]**

END OF QUESTION PAPER