Answer all the questions below then check your answers

1. What is an exothermic reaction?

a. Is bond breaking an exothermic or endothermic process? What about bond formation? Is that exothermic or endothermic?

2. The table below contains some bond energy data, use the values given to answer the following questions.

bond	Bond energy kJ/mol
C-C	347
C-H	413
O=O	498
C=O	805
O-H	464
C-O	358

a. Methane burns in air to form carbon dioxide and water. Calculate the enthalpy change (amount of heat energy released) for this reaction. It may help you to draw up a table to show the bonds broken and bonds formed to help you get the correct answer.

Methane + oxygen ⟶ carbon dioxide + hydrogen oxide

$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$

3. Calculate the energy change when 4.6g of ethanol is burned in air. Ethanol burns according to the equation below:

Ethanol + oxygen ⟶ carbon dioxide + hydrogen oxide

$C_2H_5OH_{(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

Bond energies

Answers

1. What is an exothermic reaction? Reaction which releases heat energy to the surrounding

a. Is bond breaking an exothermic or endothermic process? What about bond formation? Is that exothermic or endothermic? Bond breaking requires an input of energy, it is an endothermic reaction. Bond formation releases energy, it is an exothermic process.

2. The table below contains some bond energy data, use the values given to answer the following questions.

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a. Methane burns in air to form carbon dioxide and water. Calculate the enthalpy change (amount of heat energy released) for this reaction. It may help you to draw up a table to show the bonds broken and bonds formed to help you get the correct answer.

Methane + oxygen ⟶ carbon dioxide + hydrogen oxide

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Bonds broken	Energy required/kJ/mol	Bonds formed	Energy released
C-H x4	413 x4 = 1652	C=O x2	805 x2=1660
O=O x2	498 x2= 996	O-H x4	464 x4= 1856
Total energy required to break all bonds in the reactants = 1652 + 996 = 2648 kJ/mol		Total energy released by bond formation in the products = 1660 + 1856 = 3516kJ/mol	

Energy change for the combustion of methane =energy in - energy out

= 2648-3516

=-868kJ/mol

The - sign indicates the reaction is exothermic.

3. Calculate the energy change when 4.6g of ethanol is burned. Ethanol burns according to the equation below:

Ethanol + oxygen ⟶ carbon dioxide + hydrogen oxide

$C_2H_5OH_{(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

Bonds broken	Energy required/kJ/mol	Bonds formed	Energy released
C-C	347	C=O x4	805 x4 = 3220
C-H x5	413 x5 = 2065	O-H x6	464 x6 = 2784
C-O	358		
O-H	464		
O=O x3	498 x3= 1494		
Total energy required to break all bonds in the reactants = 4728 kJ/mol		Total energy released by bond formation in the products = 3220 + 2784 = 6004kJ/mol	

Energy change for the combustion of ethanol =energy in - energy out

= 4728 -6004

= -1276kJ/mol

The - sign indicates the reaction is exothermic.

This would be the enthalpy change for the combustion of 1 mole of ethanol. 1 mole of ethanol has a mass of 46g. So 4.6g is 0.1 moles. So enthalpy change for the combustion of 4.6g (0.1moles) is 126.6 kJ.