SeaHawk Tutors

AQA Chemistry GCSE Topic 4.5 - Energy Changes

Topic 4.5 only

1. The combustion reaction of Pentane has the equation:

   $C_5H_{12} + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$

   The bond in Carbon Dioxide is a double bond. The relevant bond energies are as follow:

Bond	C - C	C - H	C = O	O - H	O = O
Bond Energy (kJ/mol)	346	413	740	463	497

   Calculate the overall energy change for this reaction. [4]

Total marks [4]

2. The combustion reaction of Propane has the equation:

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

   The bond in Carbon Dioxide is a double bond. The relevant bond energies are as follow:

Bond	C - C	C - H	C = O	O - H	O = O
Bond Energy (kJ/mol)	346	413	740	463	

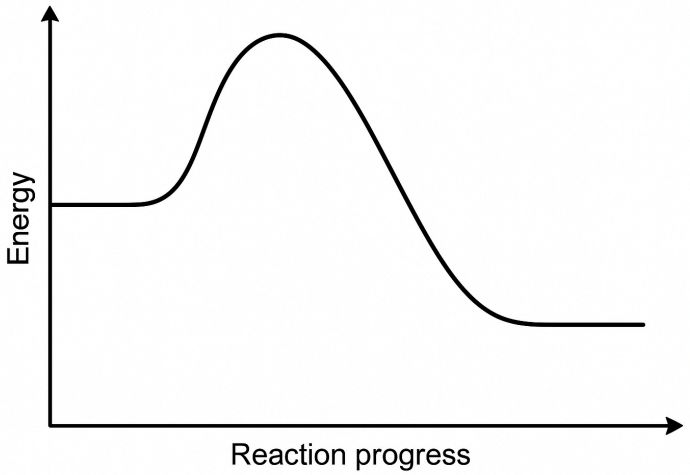
   The overall energy change for this reaction is -1,663 kJ/mol.

   a. Explain why Propane is useful as a fuel for camping stoves. [2]

   b. Calculate the bond energy of the O = O bond. [4]

   Total marks [6]

3. The diagram shows the energy changes in a reaction.
   a. Mark on the diagram:
      i. Reactants and Products
      ii. Activation energy
      iii. Overall energy change [3]



b. Explain whether the reaction is exothermic or endothermic. [2]

Total marks [5]

4. This question is about energy changes in chemical reactions.

A chemist conducts a neutralisation reaction between Sodium Hydroxide and Nitric Acid in a beaker. They observe that the contents of the beaker in which the reaction took place became warmer.

a. Ring the correct word. We can deduce that this reaction is exothermic / endothermic. [1]

b. Complete the following sentence using words from the table below. You may use each word once, more than once or not at all. [3]

In chemical reactions the bonds of the reactants are _____ and new bonds are _____ that create the products. When bonds are _____ energy is _____ and when bonds are _____ energy is _____. If more energy is _____ than is _____ then the reaction is exothermic and thermal energy will be _____ to the surroundings.

released	used	broken	made

The reaction between Carbon monoxide and Oxygen has the equation:

$2\ CO + O_2 \rightarrow 2\ CO_2$

The bond in Carbon Monoxide is a triple bond, in Carbon Dioxide it is a double bond. The relevant bond energies are as follow:

Bond	C = O	C ≡ O	O = O
Bond Energy (kJ/mol)	799	1072	495

c. Calculate the energy change for this reaction. You must include a sign with your answer. [4]

d. State whether this reaction is exothermic or endothermic. [1]

Total marks [9]

Synoptic questions involving 4.5

5. Alkanes are a homologous series of Hydrocarbons.
   a. Define the term 'Hydrocarbon.' [1]

   b. Tick the correct general formula for the Alkanes. [1]

   ☐ C_nH_2

   ☐ C_nH_{2n}

   ☐ C_nH_{2n+2}

   ☐ C_nH_{2n-2}

Alkanes are widely used as fuels.

   c. Explain the property of alkanes that makes them suitable for use as fuels. [2]

All Hydrocarbons burn in air to form carbon dioxide and water.

   d. Write the balanced chemical equation for the combustion of Methane. [2]

   e. Calculate the energy change for this reaction. The bond in Carbon Dioxide is a double bond. The relevant bond energies are as follows:

Bond	C - C	C - H	C = O	O - H	O = O
Bond Energy (kJ/mol)	346	413	740	463	497

[3]

f. Calculate the energy released when 240cm^3 of Methane is burned. [3]

Total marks [12]

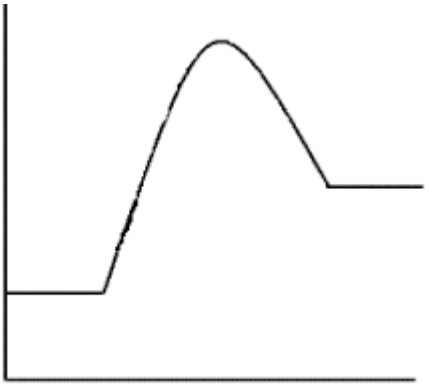
Synoptic topics: 4.3, 4.7

6. The diagram shows the energy changes in a reaction.

   a. Label the axes. [2]

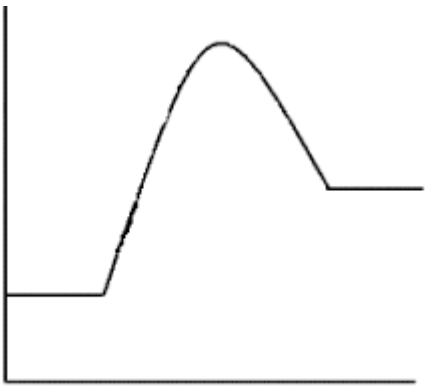
   b. Mark on the diagram:

      i. Reactants and Products
      ii. Activation energy
      iii. Overall energy change [3]



c. Explain whether the reaction is exothermic or endothermic. [2]

d. The original reaction can be speeded up by using a catalyst. Draw on the diagram below the energy profile diagram for the reaction with a catalyst. [2]



Total marks [9]

Synoptic topics: 4.6

Answers

1.

Bonds Broken	Number	Energy	Total
C - C	4	346	1,384
C - H	12	413	4,956
O = O	8	497	3,976
Bonds Made			10,316
C = O	10	740	7,400
O = H	12	463	5,556
			12,956

Overall energy change = 10,316 - 12,956 = -2,640 kJ/mol

2.

a. Combustion reaction is EXOTHERMIC => releases energy to the surroundings

b.

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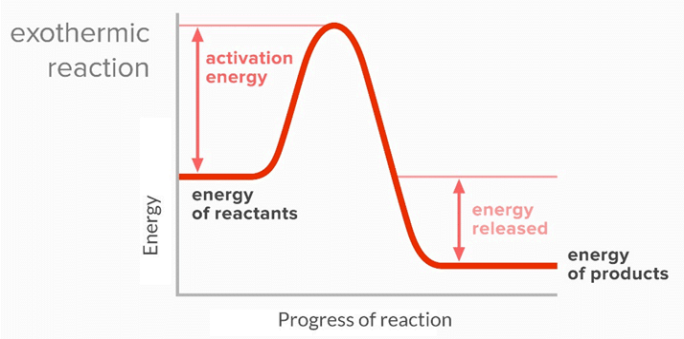
Bonds Broken	Number	Energy	Total
C - C	2	346	692
C - H	8	413	3,304
O = O	5	n	5n
Bonds Made			3,996 + 5n
C = O	6	740	4,440
O = H	8	463	3,704
			8,144

3,996 + 5n - 8,144 = - 1663
5n = 2,485
n = 497 kJ/mol

3.

a. 

b. Exothermic because energy of products is less than energy of reactants

4.

a. Exothermic
b. Broken, made, broken, used, made, released
c.

Bonds Broken	Number	Energy	Total
C ≡ O	2	1,072	2,144
O = O	1	495	495
Bonds Made			2,639
C = O	2	799	1,598
			1,998

Energy change = 2639 - 1998 = +641 kJ/mol
M1 for any correct total for a given bond
M1 for subtracting product energy from reactant energy
A1 for correct answer with + sign

d. Endothermic

5.

a. A substance made up of **only** (A1) (atoms of) **Hydrogen and Carbon** (A1)
b. C_nH_{2n+2}
c. They have **exothermic combustion** reactions so they **release energy (to the surroundings)** when burned
d. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
e.

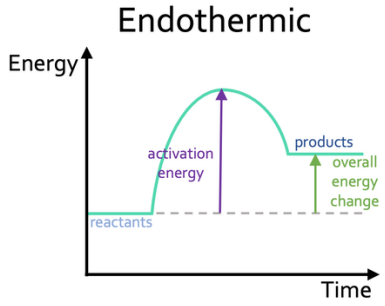
Bonds Broken	Number	Energy	Total
C - H	4	413	1,652
O = O	2	497	994
Bonds Made			2,646
C = O	2	740	1,480

O = H	4	463	1,852
			3,332

Energy change = 2646 - 3332 = -686 lJ/mol
M1 for any one correct total energy for one bond
M1 for subtracting product energy from reactant energy
A1 for correct figure with correct -ve sign

f. $240cm^3 = 0.24\ dm^3 = 1/100$ mole (M1)
686 kJ / mol x 0.01 mol (M1) = 6.86 kJ (A1)

6.

a. 

Allow Progress of Reaction for Time

b. As above

c. Endothermic, because energy of products is greater than energy of reactants / energy is taken out of the surroundings