**Using bond energy data practice answers**

A chemical bond has a **bond energy**. This is the average amount of energy required to break **one mole** of that type of bond.

The table below shows the values of some bond energies. We can see that to break one mole of C-H bonds 413 kJ of energy must be supplied. When one mole of C-H bonds is formed 413 kJ of energy will be released.

|  |  |
| --- | --- |
| **Bond** | **Bond energy (kJ/mol)** |
| C-H | + 415 |
| O=O | + 498 |
| O-H | + 464 |
| C=O | + 805 |
| C ≡ C | +837 |

Ethyne has the formula C2H2. It contains a carbon carbon triple bond (C ≡ C). Ethyne is commonly called acetylene. Ethyne completely combusts as shown in the equation below.

C2H2 + 2 ½ O2 🡪 H2O + 2 CO2

1. **Draw** each of the **molecules** in the balanced equation, **showing their bonds**.
2. **Use** the **bond energy data** to calculate the amount of **energy required to break all of the bonds** in reactants.

No. of C ≡ C bonds = 1. Energy needed to break these bonds = .1 x +837 = +837. kJ/mol

No. of C-H bonds = 2 Energy needed to break these bonds = 2 x +415 = +830 kJ/mol

No. of O=O bonds = 2.5 Energy needed to break these bonds = 2.5 x +498 = +1245 kJ/mol

**Total energy needed to break bonds = +2912 kJ/mol**

1. **Use** the **bond energy data** to calculate the amount of **energy released** when the products are formed.

No. of C=O bonds = 4 Energy released when these bonds form = 4x -805 = -3220 kJ/mol

No. of O-H bonds = 2 Energy released when these bonds form = 2 X -464 = -928 kJ/mol

**Total energy released when bonds form = -4148 kJ/mol**

1. Now **calculate** the **overall energy change (∆H),** for the reaction.

**∆H = total energy needed to break bonds –total energy released when bonds form**

……………+2912 – (-4148) = - 1236 kJ mol-1………………………….

I**f, ∆H is negative is the reaction is exothermic**

If, **∆H is positive is the reaction is endothermic**

1. Is the combustion of ethyne **exothermic** or **endothermic**? …exothermic…………………..

**Extension**

Produce a fully labelled energy level diagram naming

the reactants

the products

energy needed to break all bonds in the reactants

energy released when all bonds formed

overall energy change ((∆H).

**More practice questions**

(Question 1 and 2a, b, c are from page 197 in OCR text book)

1) How can endothermic and exothermic reactions be explained in terms of breaking and making of chemical bonds?

**Follow the steps above and in the example to answer the questions below.**

2) The bond enthalpies for some common bonds are shown below.

C-H: +413 kJ mol-1, C-C: +347 kJ mol-1, C-O: +358 kJ mol-1, O=O: +497 kJ mol-1, C=O: +805 kJ mol-1,

O-H: +463 kJ mol-1, C=C: +612 kJ mol-1, H-H: +436 kJ mol-1, NΞN: +945 kJ mol-1, N-H: +391 kJ mol-1

Calculate the enthalpy changes of reaction for each of the following reactions.

a. C­2­H4(g) + H­2(g) → C­2­H6(g)

b. C­3­H8(g) + 5O2(g) → 3CO2(g) + 4H2O(g)

c. N2(g) + 3H2(g) → 2 NH3(g)

d. C­H2C­H2(g) + H­2O(g) → C­­H3C­­H2O­H(g)

e. (C­H3)3C­OH(g) + 6O2(g) → 4CO2(g) + 5H2O(g)