Bond Energies

GCSE Chemistry · Written to the shared content for AQA, Edexcel and OCR

Name _____ Class _____ Date _____

1. Worked example

Use the bond energies to calculate the overall energy change for $H_2 + Cl_2 \rightarrow 2HCl$. (H–H 436, Cl–Cl 242, H–Cl 431 kJ/mol) (3 marks)

Step 1 · Bonds broken

436 + 242 = 678 kJ/mol

Step 2 · Bonds made

2 × 431 = 862 kJ/mol

Step 3 · Energy change = broken − made

678 − 862 = −184 kJ/mol (exothermic)

Answer: −184 kJ/mol

Check: More energy released than taken in → negative ✓

2. Now try one with the steps

Calculate the energy change for $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$. (C–H 412, O=O 498, C=O 805, O–H 464 kJ/mol) (3 marks)

Step 1 · Broken

Step 2 · Made

Step 3 · Change

Answer:

3. Practice

Show your working. The marks tell you how much is expected.

1. State whether breaking bonds is exothermic or endothermic. [1]

2. $H_2 + Cl_2 \rightarrow 2HCl$. Calculate the total energy, in kJ/mol, needed to break the bonds in the reactants. (H–H 436, Cl–Cl 242) [1]

3. For the same reaction, calculate the energy, in kJ/mol, released when the bonds in the products form. (H–Cl 431) [1]

4. Calculate the overall energy change, in kJ/mol, for $H_2 + Cl_2 \rightarrow 2HCl$. [1]

5. State whether the reaction in question 4 is exothermic or endothermic, and why. [2]

6. Calculate the energy change, in kJ/mol, for $H_2 + Br_2 \rightarrow 2HBr$. (H–H 436, Br–Br 193, H–Br 366) [3]

7. Calculate the energy change, in kJ/mol, for $N_2 + 3H_2 \rightarrow 2NH_3$. (N≡N 945, H–H 436, N–H 391) [3]

8. Calculate the energy change, in kJ/mol, for $2H_2 + O_2 \rightarrow 2H_2O$. (H–H 436, O=O 498, O–H 464) [3]

9. Calculate the energy change, in kJ/mol, for $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$. (C–H 412, O=O 498, C=O 805, O–H 464) [3]

10. Calculate the energy change, in kJ/mol, for $2HCl \rightarrow H_2 + Cl_2$, using the values in question 2 and 3. [2]

11. Calculate the energy change, in kJ/mol, for $C_2H_4 + H_2 \rightarrow C_2H_6$. (C=C 612, C–C 348, C–H 412, H–H 436) [3]

12. For $H_2 + F_2 \rightarrow 2HF$ the energy change is –538 kJ/mol. H–H = 436 and F–F = 158 kJ/mol. Calculate the H–F bond energy in kJ/mol. [3]

13. Suggest why energy changes calculated from bond energies differ slightly from measured values. [1]

14. Explain what a positive overall energy change tells you about a reaction. [2]

4. Before you hand it in

Calculating made – broken
Energy change = bonds broken – bonds made. Negative = exothermic.

Forgetting balancing numbers
Multiply the bonds in each molecule by its balancing number.

Missing double bonds or bonds per molecule
Draw displayed formulae before counting.