Worksheet 1.1: Bond Energy Calculations

ChemistrySheets

Specification: GCSE Chemistry (AQA 5.5.1.2 / Edexcel SC13 / OCR Gateway)

Core Concepts: Bond energy is energy to break 1 mole of a bond (endothermic). Energy is released when bonds form (exothermic).

Key Formula:

$\Delta H = \sum$ bonds broken $- \sum$ bonds formed

Where:

- ΔH: Overall energy change (kJ/mol)
- $\sum$ bonds broken: Total energy absorbed to break bonds in reactants (kJ/mol)
- $\sum$ bonds formed: Total energy released to form bonds in products (kJ/mol)

Rearranged Forms:

$\sum$ bonds broken $= \Delta H + \sum$ bonds formed

$\sum$ bonds formed $= \sum$ bonds broken $- \Delta H$

Section A: Understanding the Formula & Units

1. State the SI unit for each variable in the bond energy calculation formula.
   - ΔH: _____
   - $\sum$ bonds broken: _____
   - $\sum$ bonds formed: _____
2. Rearrange the formula for:
   - $\sum$ bonds broken:

     _____
   - $\sum$ bonds formed:

     _____
3. Perform the following unit conversions:
   a) Convert 3500 J to kJ: _____
   b) Convert 0.8 kJ to J: _____
   c) Convert 1.5 MJ to kJ: _____
   d) Convert 450000 J to MJ: _____

Section B: Practice Calculations

Use Table 1 for bond energies. Show working.

Bond	Bond Energy (kJ/mol)
C-H	413
C-C	348
C=C	614
C-O	358
C=O	799
O-H	463
O=O	498
H-H	436
Cl-Cl	242
H-Cl	431
N≡N	945
N-H	391

Table 1: Average bond energies

4. Calculate ΔH for: $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$

   _____

   _____
5. Calculate ΔH for the complete combustion of methane: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

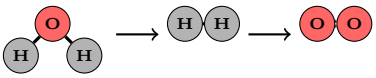
   _____

6. The Haber process: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$. If ΔH = -92 kJ/mol, calculate the total energy released when bonds are formed in the products.

7. Ethene hydrogenation: $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$. ΔH = -136 kJ/mol. Using Table 1, calculate the C-C bond energy in ethane.

Section C: Challenge Context

8. Water decomposition: $H_2O(g) \rightarrow H_2(g) + \frac{1}{2}O_2(g)$.



Using Table 1, calculate ΔH for the decomposition of 1 mole of gaseous water.

9. Ethanol combustion: $C_2H_5OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$. Calculate the total energy released when 23 g of ethanol undergoes complete combustion (M_r C_2H_5OH = 46 g/mol).