Calculating Enthalpy from Bond Energies

$\Delta_r H = \Delta_r H$ (bonds broken) – $\Delta_r H$ (bonds made)

Bond energies are a measure of the energy needed to break an intramolecular covalent bond in a molecule.

"Bond energy is the average energy required to break 1 mole of covalent bonds between 2 atoms in the gaseous state"

e.g. $AB_{(g)} \rightarrow A_{(g)} + B_{(g)}$ $\quad \Delta_r H = +ve$

A chemical reaction is a series of bond breaking processes (ΔH = +ve) and bond making processes (ΔH = -ve).

We can estimate the enthalpy of a chemical reaction by adding the bond energies for bonds that break and subtracting energies for those bonds which are made.

Example

Bond energies (kJ mol^{-1})	
C - H	413
C - Cl	339
Cl – Cl	242
H - Cl	431

Calculate the heat of reaction for the following reaction given the bond energies above

$C_2H_{6\,(g)} + Cl_{2\,(g)} \rightarrow C_2H_5Cl_{\,(g)} + HCl_{\,(g)}$ $\quad \Delta_r H^o = ?$

Answer

Bonds Broken (ΔH = +ve)		Bonds Made (ΔH = -ve)	
Cl – Cl	413	C – Cl	339
C – H	242	H – Cl	431
	655		**770**

$\Delta_r H = \Delta_r H$ (bonds broken) – $\Delta_r H$ (bonds made)

= 655 – 770

= -115 kJ mol^{-1}

Hint: Draw structural formula to really see how many bonds break / form