

Bond properties

Covalent bond: a bond formed by shared electrons. (remember, unequal electronegativity means unequal sharing of the electrons)

Bond length: the most stable distance between two nuclei that are bonded together. (bonded atoms stretch back and forth like balls on a spring)

Bond enthalpy: a measure of the stability of a bond, specifically, the change in enthalpy when a bond is broken. Always a positive number because breaking a bond requires an energy input. Also called bond energy, bond strength. Symbolized by BE, DE, D (dissociation energy).

Example: Calculate the enthalpy of reaction when propane (C_3H_8) is burned.



Given in a table of data:

$$\text{BE}(\text{H} - \text{C}) = 416 \text{ kJ/mol}$$

$$\text{BE}(\text{C} - \text{C}) = 356 \text{ kJ/mol}$$

$$\text{BE}(\text{O} = \text{O}, \text{ in } \text{O}_2) = 498 \text{ kJ/mol}$$

$$\text{BE}(\text{C} = \text{O}, \text{ in } \text{CO}_2) = 803 \text{ kJ/mol}$$

$$\text{BE}(\text{H} - \text{O}) = 467 \text{ kJ/mol}$$

You need to draw Lewis structures to see bonds:

$\Delta H^\circ = \text{cost to break bonds} - \text{cost to make bonds}$

$\Delta H^\circ = \text{enthalpies of bonds broken in the reactants} - \text{enthalpies of bonds made in the products}$

Practice: Using bond enthalpies, calculate the enthalpy change for the reaction



Given in a table of data:

$$\text{BE (H - H)} = 436 \text{ kJ/mol}$$

$$\text{BE (Cl - Cl)} = 242 \text{ kJ/mol}$$

$$\text{BE (H - Cl)} = 431 \text{ kJ/mol}$$

Bond Energy (BE) calculations vs. ΔH_f° calculations

BE

- => average energy value from many different substances with that type of bond,
- => the calculation is for substances in the gas state,
- => initial – final. (reactants – products)

ΔH_f°

- => exact enthalpy value for that substance at standard conditions
- => the calculation can be for substances in different physical states (gas, liquid, solid, etc.).
- => final – initial. (products – reactants)

Bond strength and bond length

Stronger bonds mean shorter bonds
(more electrons pulling the atoms closer together
and holding them more strongly together)

<u>bond energy</u>	<u>bond length</u>
BE(C – C) = 356 kJ/mol	154 pm (10^{-12} m)
BE(C = C) = 598 kJ/mol	134 pm
BE(C ≡ C) = 813 kJ/mol	121 pm

But be careful!

Bigger atoms mean longer bonds

BE(H – F) = 566 kJ/mol	92 pm
BE(F – F) = 158 kJ/mol	128 pm