

CONCEPT: BOND ENERGY

- Bond Energy (Bond Enthalpy; $\Delta H_{B.E.}$): the amount of energy stored in a bond between atoms in a molecule.
 - Bond Energy values can be used to calculate the _____ of reaction (ΔH_{Rxn}).
 - Endothermic Process: Energy is _____ to break a bond and a has a _____ sign.
 - Exothermic Process: Energy is _____ to form a bond and a has a _____ sign.

Enthalpy of Reaction Formulas

When given individual bond enthalpies (bond energies).

Enthalpy of Reaction Formula ($\Delta H_{B.E.}^{\circ}$)

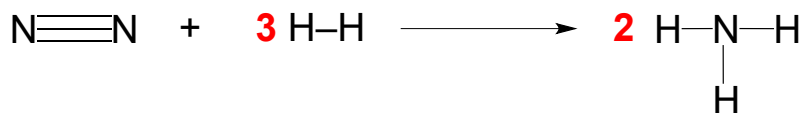
$$\Delta H_{Rxn}^{\circ} = \text{Reactants} - \text{Products}$$

When given the enthalpy of formation for a compound.

Enthalpy of Reaction Formula (ΔH_f°)

$$\Delta H_{Rxn}^{\circ} = \text{Products} - \text{Reactants}$$

EXAMPLE: The formation of ammonia is accomplished by the reaction between hydrogen and nitrogen gas.



Calculate the ΔH_{rxn}° if the bond enthalpies of $\text{N} \equiv \text{N}$, $\text{H}-\text{H}$ and $\text{N}-\text{H}$ are 945 kJ/mol, 432 kJ/mol and 391 kJ/mol respectively.

STEP 0: CHECK to see if the chemical equation is balanced and if not then do the necessary steps to balance it.

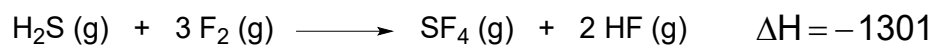
- If the Lewis Dot Structures is not given, then you will have to draw them as well.

STEP 1: For the reactants and products, multiply the **coefficients** of each bond-type with its bond enthalpy value, $\Delta H_{B.E.}$.

$$\text{Reactants} - \text{Products} = \left[\left(\text{---} \text{N} \equiv \text{N} \times \text{---} \frac{\text{kJ}}{\text{mol}} \right) + \left(\text{---} \text{H}-\text{H} \times \text{---} \frac{\text{kJ}}{\text{mol}} \right) \right] - \left[\left(\text{---} \text{N}-\text{H} \times \text{---} \frac{\text{kJ}}{\text{mol}} \right) \right]$$

STEP 2: Take both totals and place them into the enthalpy of reaction formula to determine ΔH_{Rxn}° .

$$\Delta H_{Rxn}^{\circ} = \text{Reactants} - \text{Products} = \left[\text{---} \right] - \left[\text{---} \right] =$$

CONCEPT: BOND ENERGY**PRACTICE:** Consider the following equation:

Determine the bond enthalpy value for the F–S bond.

Standard Bond Energies	
Bonds	ΔH kJ / mol
S–H	347
F–H	565
F–F	159

PRACTICE: Use the bond energies to estimate the enthalpy of reaction for the combustion of 5 moles of acetylene:

Standard Bond Energies			
Bonds	ΔH kJ / mol	Bonds	ΔH kJ / mol
C–C	347	C=O	745
C=C	614	C≡O	1070
C≡C	839	O–O	204
C–H	413	O=O	498
C–O	358	O–H	467

