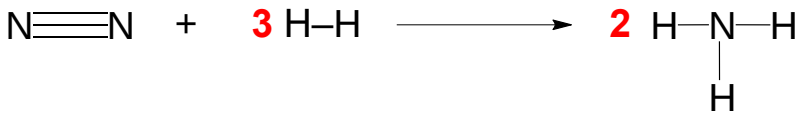
CONCEPT: BOND ENERGY

- **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).	When given the enthalpy of formation for a compound.
Enthalpy of Reaction Formula ($DH^{o}_{B.E.}$)	**Enthalpy of Reaction Formula (DH^{o}_{f})**
$\triangle H^{o}_{Rxn}$ = Reactants – Products	$\triangle H^{o}_{Rxn}$ = Products – Reactants

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



Calculate the ΔH^{o}_{rxn} if the bond enthalpies of N≡N, H–H and N–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, $DH_{B.E.}$.

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

STEP 2: Take both totals and place them into the enthalpy of reaction formula to determine DH^{o}_{Rxn}.

$$DH^{o}_{Rxn} = \text{Reactants - Products} = [\_\_\_\_\_] - [\_\_\_\_\_] =$$

CONCEPT: BOND ENERGY

PRACTICE: Consider the following equation:

$$H_2S\ (g) + 3\ F_2\ (g) \longrightarrow SF_4\ (g) + 2\ HF\ (g) \qquad DH = -1301$$

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

Standard Bond Energies

Bonds	DH 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:

$$2\ C_2H_2\ (g) + 5\ O_2\ (g) \longrightarrow 4\ CO_2\ (g) + H_2O\ (g)$$

Standard Bond Energies

Bonds	DH kJ / mol	Bonds	DH 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