Name _____ **Honors Chemistry** **__/___/___**

Energy Stoichiometry

Energy stoichiometry is a way to relate the amount of energy absorbed or released in a reaction to another factor stoichometrically related. A strong understanding of dimensional analysis helps. In an energy stoichiometry problem you will be given a chemical equation with thermodynamic data included. You will be given a variable in a word problem and be asked to solve for another variable. You will always need to make a relationship between moles of a substance and the heat absorbed or released. Always pay attention to the sign of the thermodynamic date. If a reaction is exothermic, it will always be exothermic, and vise-versa.

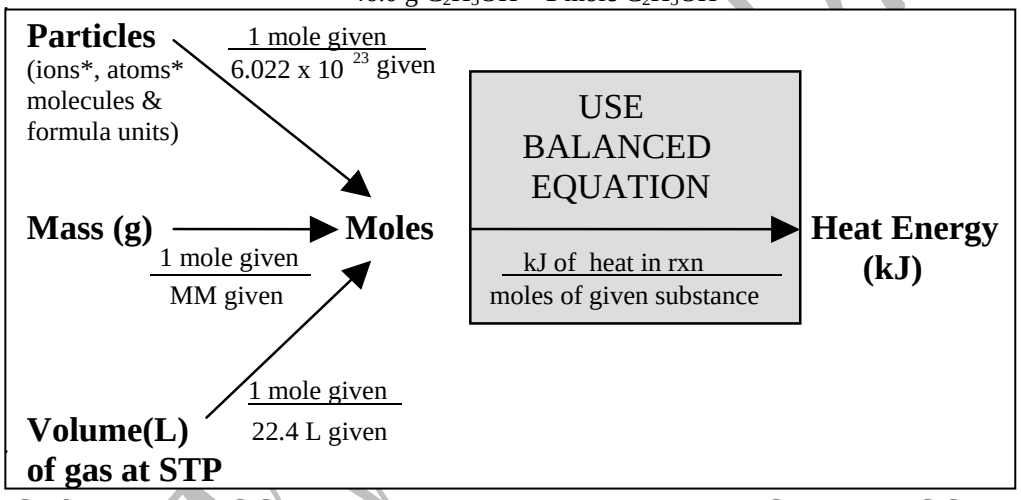
Example 1: When suffering from a fever, your body temperature rises from 37ºC to 40.ºC, using 787 kJ of energy. Assume your body burns only glucose to raise your temperature. How many grams of glucose ($C_6H_{12}O_6$) are consumed? $C_6H_{12}O_6$ (s) + 6 O_2 (g) → 6 H_2O (l) + 6 CO_2 (g) ΔH = -2870 kJ

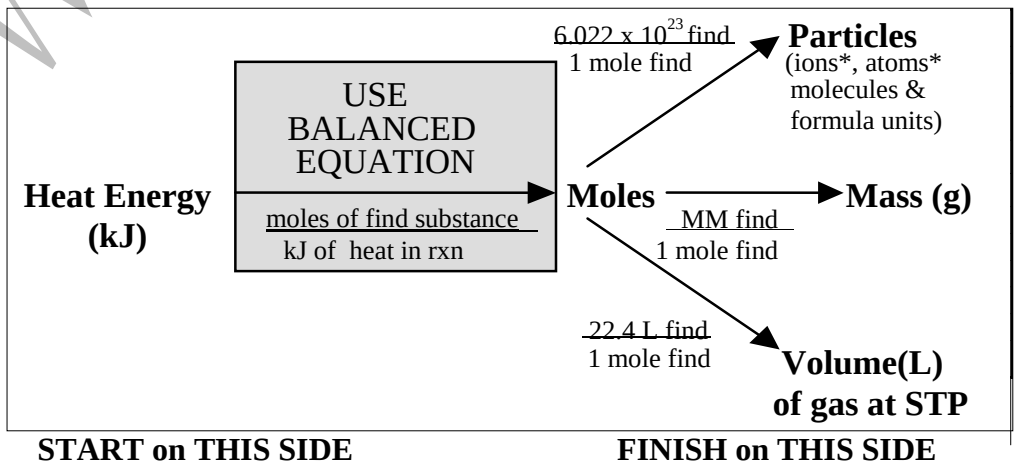
$$\frac{-787\text{ kJ}}{-2870\text{ kJ}} \times \frac{1\text{ mole } C_6H_{12}O_6}{1\text{ mole } C_6H_{12}O_6} \times \frac{180\text{ grams } C_6H_{12}O_6}{1\text{ mole } C_6H_{12}O_6} = \mathbf{49.4\text{ grams } C_6H_{12}O_6}$$

Example 2: Gasohol contains ethanol, C_2H_5OH (l), which reacts with oxygen when burned to produce CO_2 (g) and H_2O (g). Calculate the amount of energy given off as 500.0 grams of ethanol are burned.

C_2H_5OH (l) + 3 O_2 (g) → 2 CO_2 (g) + 3 H_2O (g) ΔH = -1368 kJ

$$500.0\text{ g } C_2H_5OH \times \frac{1\text{ mole } C_2H_5OH}{46.0\text{ g } C_2H_5OH} \times \frac{-1368\text{ kJ}}{1\text{ mole } C_2H_5OH} = \mathbf{-1.49 \times 10^4\text{ kJ}}$$





Homework: Solve each of following energy stoiciometry problems. Show all work.

1. Calculate the amount of heat absorbed when 5.66 grams of carbon disulfide form from the synthesis of C (s) and S (s).

   $C\ (s) + 2\ S\ (s) \rightarrow CS_2\ (l) \quad \Delta H = +89.3\ kJ$

2. How many grams of methane (CH_4) are needed to produce 2100. kJ of energy?

   $CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (l) \quad \Delta H = -890.4\ kJ$

3. How much heat is given off when 1106 grams of phosphorus trichloride are formed?

   $2P + 3Cl_2 \rightarrow 2PCl_3 \qquad \Delta H = -574\ kJ$

4. How many grams of magnesium oxide are produced when 350 kJ of energy is released?

   $2Mg\ (s) + O_2\ (g) \rightarrow 2MgO\ (s) \quad \Delta H = -1204\ kJ$

5. How much energy is required to break down 300.0 grams of phosphorus pentachloride?

   $PCl_5 \rightarrow PCl_3 + Cl_2 \qquad \Delta H = -87.9\ kJ$

6. How many grams of water vapor are released in the production of 3000. kilocalories of energy?

   $2H_2(g) + O_2(g) \rightarrow 2H_2O\ (g) \qquad \Delta H = -484\ kJ$

7. How much energy is released in the break down of 999 grams of iron(III) oxide?

   $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2 \qquad \Delta H = -26.3\ kJ$

8. A mountain climber, wanting a drink of water, must melt the snow from the mountain with a propane burner. How many grams of propane (C_3H_8) would the mountain climber have to use to generate the 55.5 kJ of energy?

   $C_3H_8\ (g) + 5\ O_2\ (g) \rightarrow 4\ H_2O\ (l) + 3\ CO_2\ (g) \qquad \Delta H = -2220\ kJ$

9. How many kJ of energy are needed to produce 2.0 kilograms of glucose?

   $6\ H_2O\ (l) + 6\ CO_2\ (g) \rightarrow C_6H_{12}O_6\ (s) + 6\ O_2\ (g) \qquad \Delta H = 2870\ kJ$

10. How many kJ of energy are released when 560. liters of sulfur dioxide react with excess oxygen at STP?

$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g) \qquad \Delta H = -197.8\ kJ$