AP Worksheet 6b (Enthalpy)

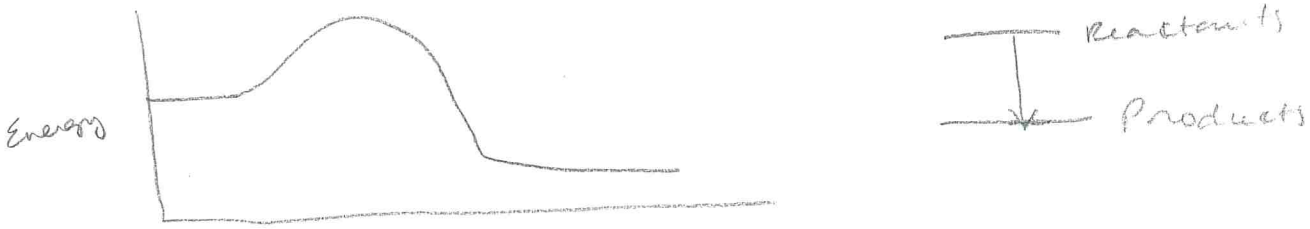
4. Consider the reaction for the formation of ***one mole*** of aluminum oxide.
   a. There are two ways to write a balanced thermochemical equation (including ΔH). Show both ways for the formation of this compound.

$2Al + \frac{3}{2}O_2 \rightarrow 1Al_2O_3 \quad + \Delta H$

$2Al + \frac{3}{2}O_2 \rightarrow Al_2O_3 \quad -\Delta H$

   b. Is this process endothermic or exothermic?

   c. Construct a heat-content diagram (reaction profile) for this reaction.



2. Suppose a 7.40-gram sample of ammonium nitrate salt is dissolved in a calorimeter containing 100. mL of water at 24.2 °C. The dissolving of the salt caused the water temperature to drop to 18.4 °C.
   a. Write the net-ionic dissociation equation for the dissolving of this salt.

$NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$ ✓

   b. Is the dissolving of ammonium nitrate and exothermic or endothermic process?

   c. How many moles of ammonium nitrate dissolved?

$7.40\,g\,NH_4NO_3 \left| \frac{1\,mol}{80.05\,g} \right. = .0924\,mol$

   d. Calculate the ΔH (in kJ/mol) for this process.

$q_{rxn} = -q_{soln}$

$= -(107.\,g)(4.184\,J/g°C)(18.4°C - 24.2°C)$

$= 2.60 \cdot 10^3\,J = 2.60\,kJ$

$\frac{2.60\,kJ}{.0924\,mol} = 28.1\,kJ/mol$ ✓

3. Consider the following reaction:

$2NO(g) \rightarrow N_2(g) + O_2(g) \qquad \Delta H = -180.5\,kJ$

   a. How much energy would be released if 15.0 grams of $N_2(g)$ were formed?

$15.0\,g\,N_2 \left| \frac{1\,mol\,N_2}{28.02\,g\,N_2} \right| \frac{-180.5\,kJ}{1\,mol\,N_2} = -96.6\,kJ$ released ✓

   b. How many molecules of NO(g) were consumed if 250. kJ of energy was released? ✓

$-250.\,kJ \left| \frac{2\,mol\,NO}{-180.5\,kJ} \right| \frac{6.022 \cdot 10^{23}\,molec}{1\,mol\,NO} = 1.67 \cdot 10^{24}\,molec$

over, please

c. How many grams of $O_2(g)$ were ~~consumed~~ produced if 250. kJ were released?

$$-250\text{ kJ} \left| \frac{1\text{ mol } O_2}{-180.5\text{ kJ}} \right| \frac{32.00\text{ g}}{1\text{ mol } O_2} = 44.3\text{ g } O_2$$ ✓

4. How much energy is released when 152 grams of water at a temperature of 85 °C is cooled to 0.°C and subsequently frozen?

$H_2O(\ell)$ 85°C → $H_2O(\ell)$ 0°C $H_2O(\ell)$ 0°C → $H_2O(s)$ 0°C

For water,
heat of fusion = 6.02 kJ/mol
heat of vaporization = 40.7 kJ/mol
specific heat = 4.18 J/g °C

$H_2O(\ell) \rightarrow H_2O(\ell)$

$$q = mc\Delta T$$
$$= (152\text{ g})\left(4.184\ \tfrac{J}{g^\circ C}\right)(0^\circ C - 85^\circ C)$$
$$= -54.1\text{ kJ}$$ ✓

$H_2O(\ell) \rightarrow H_2O(s)$

$$152\text{ g} \left| \frac{1\text{ mol } H_2O}{18.02\text{ g}} \right| \frac{-6.02\text{ kJ}}{1\text{ mol}} = -50.8\text{ kJ}$$

$$\Sigma\Delta H = -54.1\text{ kJ} + -50.8\text{ kJ} = -104.9\text{ kJ}$$ ✓

5. Explain why steam at 100 °C is more dangerous than an equal amount of boiling water at the same temperature (100 °C).

when steam condenses at 100°C it releases energy (exothermic) in addition to the energy from being hot ✓

6. Sketch a ***cooling*** curve for sea-level water. Be sure to do the following:
   - Properly label the axes.
   - Identify the condensation and freezing points on the vertical axis.
   - Identify what state(s) of matter are in existence on the horizontal axis.
   - Identify the areas of changing kinetic and potential energy on the curve.