

Show all work in detail to receive full credit. Due Monday October 4th at the beginning of class.

1. How much heat is required to raise the temperature of 1.5×10^3 g of water from 45°F to 130°F ? The specific heat of water is $4.184 \text{ J/g}\cdot^\circ\text{C}$.

$$\frac{4.184 \text{ J}}{\text{g}\cdot^\circ\text{C}} \times \frac{1.5 \times 10^3 \text{ g}}{1} \times \frac{47.2^\circ\text{C}}{1} = 296000 \text{ J} \text{ or } 296 \text{ kJ}$$

$$\Delta T = \frac{85^\circ\text{F}}{1.8} = 47.2^\circ\text{C}$$

or $3.0 \times 10^2 \text{ kJ}$

2. A beaker contains 115 g of ethanol at 18.2°C . If the ethanol absorbs 1125 J of heat without losing heat to the surroundings, what will be the final temperature of the ethanol? The specific heat of ethanol is $2.46 \text{ J/g}\cdot^\circ\text{C}$.

$$\frac{1125 \text{ J}}{2.46 \text{ J/g}\cdot^\circ\text{C}} \times \frac{1}{115 \text{ g}} + 18.2^\circ\text{C} = 22.17^\circ\text{C}$$

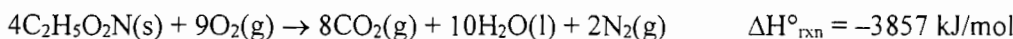
(3.98°C)

3. What is the sodium ion concentration in each of the following solutions?

a. $3.0 \text{ M Na}_2\text{SO}_4$ $2 \times 3.0 = 6.0 \text{ M Na}^+$

b. $0.150 \text{ M Na}_3\text{PO}_4$ $3 \times 0.150 = 0.450 \text{ M Na}^+$

4. Glycine, $\text{C}_2\text{H}_5\text{O}_2\text{N}$, is important for biological energy. The combustion reaction of glycine is given by the equation



Given that $\Delta H^\circ_f[\text{CO}_2(g)] = -393.5 \text{ kJ/mol}$ and $\Delta H^\circ_f[\text{H}_2\text{O}(l)] = -285.8 \text{ kJ/mol}$, calculate the enthalpy of formation of glycine.

$$\Delta H_{\text{rxn}} = \sum n \Delta H_{\text{products}} - \sum n \Delta H_{\text{reactants}}$$

$$-3857 \text{ kJ} = [8(-393.5) + 10(-285.8)] - [4x] \quad (x = \Delta H_f^\circ \text{ of Glycine})$$

$$x = -537.2 \text{ kJ/mol}$$

5. Calculate the standard enthalpy of formation of liquid methanol, $\text{CH}_3\text{OH}(l)$, using the following information:

- 1 $\text{C}(\text{graph}) + \text{O}_2 \rightarrow \text{CO}_2(g) \quad \Delta H^\circ = -393.5 \text{ kJ/mol}$
- 2 $\text{H}_2(g) + (1/2)\text{O}_2 \rightarrow \text{H}_2\text{O}(l) \quad \Delta H^\circ = -285.8 \text{ kJ/mol}$
- 3 $\text{CH}_3\text{OH}(l) + (3/2)\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(l) \quad \Delta H^\circ = -726.4 \text{ kJ/mol}$

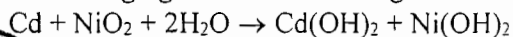
Goal $\text{C}(\text{graph}) + 2\text{H}_2(g) + \frac{1}{2}\text{O}_2(g) \rightarrow \text{CH}_3\text{OH}(l) \quad \Delta H_f^\circ = ?$

$\text{C}(\text{graph}) + \text{O}_2 \rightarrow \text{CO}_2(g)$	-393.5 kJ/mol
$2 \times [\text{H}_2(g) + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}(l)]$	$2 \times -285.8 \text{ kJ/mol}$
$-\text{CH}_3\text{OH}(l) + \frac{3}{2}\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(l)$	$+ 726.4 \text{ kJ/mol}$
$\text{C}(\text{graph}) + 2\text{H}_2(g) + \frac{1}{2}\text{O}_2(g) \rightarrow \text{CH}_3\text{OH}(l)$	-238.7 kJ/mol

6. Given that $\text{CaO}(s) + \text{H}_2\text{O}(l) \rightarrow \text{Ca}(\text{OH})_2(s)$, $\Delta H^\circ_{\text{rxn}} = -64.8 \text{ kJ/mol}$, how many grams of CaO must react in order to liberate 525 kJ of heat?

$$\frac{525 \cancel{\text{kJ}}}{64.8 \cancel{\text{kJ}}} \times \frac{\cancel{\text{mol CaO}}}{\cancel{\text{mol CaO}}} \times 56.08 \text{ g CaO} = 454.4 \text{ g CaO}$$

7. Identify the *reducing agent* in the following chemical reaction. *reducing agent loses e⁻s*



- A) Cd B) NiO₂ C) H₂O D) Cd(OH)₂ E) Ni(OH)₂

8. What mass of Na₂SO₄ is needed to prepare 350. mL of a solution having a sodium ion concentration of 0.125 M?

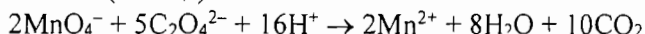
$$\frac{350 \cancel{\text{mL}}}{1000 \cancel{\text{mL}}} \times \frac{0.125 \cancel{\text{mol Na}^+}}{2 \cancel{\text{mol Na}^+}} \times \frac{1 \cancel{\text{mol Na}_2\text{SO}_4}}{1 \cancel{\text{mol}}} \times 142.1 \text{ g} = 3.11 \text{ g Na}_2\text{SO}_4$$

9. 17.5 mL of a 0.1050 M Na₂CO₃ solution is added to 46.0 mL of 0.1250 M NaCl. What is the concentration of sodium ion in the final solution?

$$\frac{17.5 \cancel{\text{mL}}}{1000 \cancel{\text{mL}}} \times \frac{0.1050 \cancel{\text{mol Na}_2\text{CO}_3}}{1 \cancel{\text{mol Na}_2\text{CO}_3}} \times \frac{2 \text{ mol Na}^+}{1 \text{ mol Na}_2\text{CO}_3} + \frac{46.0 \cancel{\text{mL}}}{1000 \cancel{\text{mL}}} \times \frac{0.1250 \cancel{\text{mol NaCl}}}{1 \cancel{\text{mol NaCl}}} \times \frac{1 \text{ mol Na}^+}{1 \text{ mol NaCl}} = 0.003675 \text{ mol Na}^+ + 0.00575 \text{ mol Na}^+ = 0.009425 \text{ mol Na}^+$$

$$\frac{0.009425 \text{ mol Na}^+}{(0.0175 \text{ L} + 0.0460 \text{ L})} = 0.148 \text{ M Na}^+$$

10. The concentration of oxalate ion (C₂O₄²⁻) in a sample can be determined by titration with a solution of permanganate ion (MnO₄⁻) of known concentration. The net ionic equation for this reaction is



- A 30.00 mL sample of an oxalate solution is found to react completely with 21.93 mL of a 0.1725 M solution of MnO₄⁻. What is the oxalate ion concentration in the sample?

$$\begin{array}{l} 2 \text{MnO}_4^- \\ 21.93 \text{ mL} \\ 0.1725 \text{ mol/L} \end{array} + \begin{array}{l} 5 \text{C}_2\text{O}_4^{2-} \\ 30.00 \text{ mL} \\ ? \text{ mol/L} \end{array} \rightarrow 2 \text{Mn}^{2+} + 8 \text{H}_2\text{O} + 10 \text{CO}_2$$

$$\frac{0.02193 \text{ L MnO}_4^-}{0.1725 \text{ mol MnO}_4^-} \times \frac{5 \text{ mol C}_2\text{O}_4^{2-}}{2 \text{ mol MnO}_4^-} = 0.3152 \frac{\text{mol C}_2\text{O}_4^{2-}}{\text{L C}_2\text{O}_4^{2-}}$$