CHM151 Quiz3 40 Pts Fall 2021 Name: Key

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 J/g·°C.

$$\frac{4.184\ J}{g \cdot {}^\circ C} \times 1.5 \times 10^3\ g \times 47.2\ {}^\circ C = 296000\ J \text{ or } 296\ kJ \text{ or } 3.0 \times 10^2\ kJ$$

$$\Delta T = 85\ {}^\circ F \times \frac{100\ C}{180\ F} =$$

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 J/g·°C.

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

(3.98°C)

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

a. 3.0 M Na_2SO_4 $\quad 2 \times 3.0 = 6.0\ M\ Na^+$

b. 0.150 M Na_3PO_4 $\quad 3 \times 0.150 = 0.450\ M\ Na^+$

4. Glycine, $C_2H_5O_2N$, is important for biological energy. The combustion reaction of glycine is given by the equation

$$4C_2H_5O_2N(s) + 9O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l) + 2N_2(g) \qquad \Delta H^\circ_{rxn} = -3857\ kJ/mol$$

($\Delta H_f^\circ = 0$)

Given that $\Delta H^\circ_f[CO_2(g)] = -393.5$ kJ/mol and $\Delta H^\circ_f[H_2O(l)] = -285.8$ kJ/mol, calculate the enthalpy of formation of glycine.

$$\Delta H_{RXN} = \sum n \Delta H_{products} - \sum n \Delta H_{Reactants}$$

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

$$x = -537.2\ kJ/mol$$

5. Calculate the standard enthalpy of formation of liquid methanol, $CH_3OH(l)$, using the following information:

1	$C(graph) + O_2 \rightarrow CO_2(g)$	$\Delta H^\circ = -393.5$ kJ/mol
2	$H_2(g) + (1/2)O_2 \rightarrow H_2O(l)$	$\Delta H^\circ = -285.8$ kJ/mol
3	$CH_3OH(l) + (3/2)O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	$\Delta H^\circ = -726.4$ kJ/mol

Goal $\quad C(graph) + 2H_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3OH(l) \quad \Delta H_f^\circ = ?$

Hess's law, C(graph): $\quad C(graph) + \cancel{O_2}(g) \rightarrow \cancel{CO_2}(g) \quad -393.5\ kJ/mol$

2LAW ×2 $H_2(g)$: $\quad 2H_2(g) + \cancel{O_2}(g) \rightarrow \cancel{2H_2O(l)} \quad 2 \times -285.8\ kJ/mol$

reverse 3 $CH_3OH(l)$: $\quad \cancel{CO_2}(g) + \cancel{2H_2O(l)} \rightarrow CH_3OH(l) + \frac{3}{2}\cancel{O_2}(g) \quad +726.4\ kJ/mol$

$C(graph) + 2H_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3OH(l) \quad -238.7\ kJ/mol$

Key

6. Given that $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$, $\Delta H^\circ_{rxn} = -64.8$ kJ/mol, how many grams of CaO must react in order to liberate 525 kJ of heat?

$$\frac{525\ \cancel{kJ}}{} \left| \frac{\cancel{mol\ CaO}}{64.8\ \cancel{kJ}} \right| \frac{56.08\ g\ CaO}{\cancel{mol\ CaO}} = 454.4\ g\ CaOH$$

7. Identify the *reducing agent* in the following chemical reaction. reducing agent loses e^-'s

$Cd + NiO_2 + 2H_2O \rightarrow Cd(OH)_2 + Ni(OH)_2$

A) Cd B) NiO_2 C) H_2O D) $Cd(OH)_2$ E) $Ni(OH)_2$

8. What mass of Na_2SO_4 is needed to prepare 350. mL of a solution having a sodium ion concentration of 0.125 M?

$$\frac{350\ \cancel{mL}}{} \left| \frac{0.125\ \cancel{mol\ Na^+}}{1000\ \cancel{mL}} \right| \frac{1\ \cancel{mol}\ Na_2SO_4}{2\ \cancel{mol\ Na^+}} \left| \frac{142.1\ g}{\cancel{mol}} \right. = 3.11\ g\ Na_2SO_4$$

9. 17.5 mL of a 0.1050 M Na_2CO_3 solution is added to 46.0 mL of 0.1250 M NaCl. What is the concentration of sodium ion in the final solution?

$$\frac{17.5\ \cancel{mL}}{} \left| \frac{0.1050\ \cancel{mol\ Na_2CO_3}}{1000\ \cancel{mL}} \right| \frac{2\ mol\ Na^+}{1\ mol\ Na_2CO_3} + \frac{46.0\ \cancel{mL}}{} \left| \frac{0.1250\ mol\ NaCl}{1000\ \cancel{mL}} \right| \frac{1\ mol\ Na^+}{1\ mol\ NaCl} =$$

$$\frac{(0.003675\ mol\ Na^+ + 0.00575\ mol\ Na^+)}{(0.0175\ L + 0.0460\ L)} = 0.148\ M_{Na^+}$$

10.. The concentration of oxalate ion ($C_2O_4^{2-}$) in a sample can be determined by titration with a solution of permanganate ion (MnO_4^-) of known concentration. The net ionic equation for this reaction is

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$

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 MnO_4^-. What is the oxalate ion concentration in the sample?

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$$

MnO_4^-: 21.93 mL, $0.1725\ \frac{mol}{L}$

$C_2O_4^{2-}$: 30.00 mL, $?\ \frac{mol}{L}$

$$\frac{0.02193\ \cancel{L\ MnO_4^-}}{0.03000\ L\ C_2O_4^{2-}} \left| \frac{0.1725\ \cancel{mol}}{\cancel{L\ MnO_4^-}} \right| \frac{5\ mol\ C_2O_4^{2-}}{2\ \cancel{mol\ MnO_4^-}} = 0.3152\ \frac{mol\ C_2O_4^{2-}}{L\ C_2O_4^{2-}}$$