Announcements – Lecture XX I– Monday, June 24th

FINAL LAB : TUE, JUN 25th, 1:30-4:30

EXAM III : FRI, JUN 28th, IN CLASS

3 OR 4 questions taken from:

LAB ONLS, 3.4, 4.2, 4.5, 5.5, 5.6

Quiz 17 **Last Name:** ______________________

A chunk of silver weighing 19.7 grams and originally at 97.48°C is dropped into an insulated cup containing 76.6 grams of water at 23.38°C. Assuming that all of the heat is transferred to the water, the final temperature of the water is

24.44 °C

Heat Capacity : H_2O = 4.184 J/g°C **Ag = 0.237 J/g°C**

$q_{H_2O} = m \times C \times \Delta T$

$= 76.6 (4.184) \Delta T$

$= 320.49 (T_f - 23.38)$

$= 320.49 T_f - 7493.16$

$q_{Ag} = m \times C \times \Delta T$

$19.7 (0.237) \Delta T$

$4.6689 (T_f - 97.48)$

$4.6689 T_f - 455.12$

$\Sigma q\text{'s} = 0$

$q_{H_2O} + q_{Ag} = 0$

$320.49 T_f - 7493.16 + 4.6689 T_f - 455.12 = 0$

$325.16 T_f - 7948.28 = 0$

$325.16 T_f = 7948.28$

$T_f = \frac{7948.28}{325.16} = 24.44°C$

5.4 Enthalpy Changes and Chemical Reactions

C: Determining Enthalpy Change – Calorimetry

A **0.242g** sample of napthalene ($C_{10}H_8$) is burned in a bomb calorimeter containing **1025g** of water. How much will the temperature rise

Heat capacity of the calorimeter = 802 J/°C
Heat of combustion $C_{10}H_8$ = -5.15×10^3 kJ/mol
Heat capacity of water = 4.184 J/g.°C

$C_{10}H_8$: $10(12.01) + 8(1.01) = 128.18\,g.mol^{-1}$

$$\frac{0.242\,g}{} \left| \frac{1\,mol}{128.18\,g} \right. = 1.89\times10^{-3}\,mol$$

$q_{RXN} = -5.15\times10^6\,J.mol^{-1}\,(1.89\times10^{-3}\,mol)$
$= -9.72\times10^3\,J$

$q_{RXN} + q_{H_2O} + q_{cal} = 0$

$q_{H_2O} + q_{cal} = -q_{RXN} = 9.72\times10^3\,J$

$q_{H_2O} = m \times C \times \Delta T$
$= 1025 \times 4.184 \times \Delta T = 4.29\times10^3\,\Delta T$

$q_{cal} = 802\,\Delta T$

$q_{H_2O} + q_{cal} = 9.72\times10^3$

$4.29\times10^3\,\Delta T + 802\,\Delta T = 9.72\times10^3$
$5.09\times10^3\,\Delta T = 9.72\times10^3$

$$\Delta T = \frac{9.72\times10^3}{5.09\times10^3} = 1.91\,°C$$

5.5 Hess's Law

A: Hess's Law

Given the standard enthalpy changes for the following two reactions:

(1) $2\,Pb(s) + O_2(g) \longrightarrow 2\,PbO(s)$ $\Delta H° = -434.6$ kJ

(2) $Pb(s) + Cl_2(g) \longrightarrow PbCl_2(s)$ $\Delta H° = -359.4$ kJ

what is the standard enthalpy change for the reaction:

(3) $2\,PbCl_2(s) + O_2(g) \longrightarrow 2\,PbO(s) + 2\,Cl_2(g)$ $\Delta H° = ?$

2... x2 + Reversed $2\,PbCl_2(s) = 2\,Pb(s) + 2\,Cl_2(g)$ $\Delta H° = -2(-359.4)$

1... as is $2\,Pb(s) + O_2(g) = 2\,PbO(s)$ $\Delta H° = -434.6$

$2\,PbCl_2(s) + O_2(g) = 2\,PbO(s) + 2\,Cl_2(g)$ $\Delta H° = 284.2$ kJ

Hess's Law:

Reverse a reaction ... Reverse the sign of $\Delta H°$.

Multiply reaction by an integer ... Multiply $\Delta H°$ by the integer.

Add two or more reactions ... Add up the $\Delta H°$'s of each.

5.5 Hess's Law

A: Hess's Law

Given the standard enthalpy changes for the following two reactions:

(1) $Ni(s) + Cl_2(g) \longrightarrow NiCl_2(s)$ $\Delta H° = -305.3$ kJ

(2) $Pb(s) + Cl_2(g) \longrightarrow PbCl_2(s)$ $\Delta H° = -359.4$ kJ

what is the standard enthalpy change for the reaction:

(3) $Ni(s) + PbCl_2(s) \longrightarrow NiCl_2(s) + Pb(s)$ $\Delta H° = ?$

1. as is
2. Reversed

$Ni(s) + Cl_2(g) = NiCl_2(s)$ $\Delta H° = -305.3$

$PbCl_2(s) = Pb(s) + Cl_2(g)$ $\Delta H° = 359.4$

$Ni(s) + PbCl_2(s) = NiCl_2(s) + Pb(s)$ $\Delta H° = 54.1$ kJ

$\Delta H°_{RXN} = \Delta H°_1 - \Delta H°_2$

5.6 Standard Heats of Reaction

A: Standard Heat of Formation

ΔH_f^o : The standard molar enthalpy of formation is the enthalpy change for the formation of 1 mole of a compound from its elements in their standard states.

$\Delta H_f^o\ CH_4(g) = -74.9\ kJ.mol^{-1}$ $\quad C(gr) + 2H_2(g) = CH_4(g)$

$\Delta H_f^o\ NiCl_2(s) = -305\ kJ.mol^{-1}$ $\quad Ni(s) + Cl_2(g) = NiCl_2(s)$

$\Delta H_f^o\ PbCl_2(s) = -359\ kJ.mol^{-1}$ $\quad Pb(s) + Cl_2(g) = PbCl_2(s)$

$\Delta H_f^o\ Cl_2(g) = 0$ $\quad Cl_2(g) = Cl_2(g)$

→ The ΔH_f^o for the formation of any element in its standard state is zero

5.6 Standard Heats of Reaction

A: Standard Heat of Formation and Hess's Law

Given the standard enthalpy changes for the following two reactions:

(1) $Ni(s) + Cl_2(g) \longrightarrow NiCl_2(s)$ $\Delta H° = -305.3$ kJ $\Delta H_f^o\ NiCl_2(s)$

(2) $Pb(s) + Cl_2(g) \longrightarrow PbCl_2(s)$ $\Delta H° = -359.4$ kJ $\Delta H_f^o\ PbCl_2(s)$

what is the standard enthalpy change for the reaction:

(3) $Ni(s) + PbCl_2(s) \longrightarrow NiCl_2(s) + Pb(s)$ $\Delta H° = ?$

$\Delta H_f^o = 0$ (Ni(s)) $\Delta H_f^o = 0$ (Pb(s))

1. As is $Ni(s) + Cl_2(g) = NiCl_2(s)$ $\Delta H° = -305.3$
2. Reversed $PbCl_2(s) = Pb(s) + Cl_2(g)$ $\Delta H° = 359.4$

$Ni(s) + PbCl_2(s) = NiCl_2(s) + Pb(s)$ $\Delta H° = 54.1$ kJ

$\Delta H^o_{RXN} = \Delta H^o_1 - \Delta H^o_2$

$\Delta H^o_{RXN} = \sum \Delta H_f^o$ Products $- \sum \Delta H_f^o$ Reactants ?

$\Delta H^o_{RXN} = \Delta H_f^o\ NiCl_2(s) + \Delta H_f^o\ Pb(s) - \Delta H_f^o\ Ni(s) - \Delta H_f^o\ PbCl_2(s)$

$\Delta H^o_{RXN} = \Delta H^o_1 + 0 - 0 - \Delta H^o_2$

$\Delta H^o_{RXN} = \Delta H^o_1 - \Delta H^o_2$

$$\Delta H^o_{RXN} = \sum \Delta H_f^o \text{ Products} - \sum \Delta H_f^o \text{ Reactants}$$

5.6 Standard Heats of Reaction

A: Standard Heat of Formation and Hess's Law

Using standard heats of formation, calculate the standard enthalpy change for the following reaction.

$$2CO_2(g) + 5H_2(g) \longrightarrow C_2H_2(g) + 4H_2O(g)$$

$$\Delta H^\circ_{RXN} = \Sigma \Delta H^\circ_f \text{ Products} - \Sigma \Delta H^\circ_f \text{ Reactants}$$

$$= \Delta H^\circ_f C_2H_2(g) + 4\Delta H^\circ_f H_2O(g) - 2\Delta H^\circ_f CO_2(g) - 5\Delta H^\circ_f H_2(g)$$

$$\Delta H^\circ_f H_2(g) = 0$$

$$= \Delta H^\circ_f C_2H_2(g) + 4\Delta H^\circ_f H_2O(g) - 2\Delta H^\circ_f CO_2(g)$$

Simply look these values up!