Problem Session #4

1) The oxidation of glucose, $C_6H_{12}O_6$, is a basic metabolic process in all life. In cells, it is performed by a complex series of enzyme-catalyzed reactions. The overall reaction is

   $C_6H_{12}O_6$ (s) + $6O_2$ (g) → $6CO_2$ (g) + $6H_2O$ (l)

   If the standard enthalpy of formation of glucose is -1277 kJ/mole, what is the ΔH_r^0 for this process? The ΔH_f values for CO_2 (g) and H_2O (l) are -393.51 and -285.83 kJ/mole, respectively.

2) Combustion of ethanol in a constant- volume calorimeter produces 1364.34 $kJ.mol^{-1}$ at 25 °C. What is the value of ΔH_r^0 for the following combustion reaction?

   $$C_2H_5OH\ (l) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 3\ H_2O\ (l)$$

3) What are the standard enthalpy changes at 298.15 K and 2000 K for the following reaction?

   $$CO_2\ (g) + C\ (\text{graphite}) \rightarrow 2\ CO\ (g)$$

	$\Delta_f H^0(CO)(kJ.mol^{-1})$	$\Delta_f H^0(CO_2)(kJ.mol^{-1})$
298.15 K	-110.527	-393.522
2000 K	-118.896	-396.784

4) Calculate ΔH_r^0 for the hydrolysis of urea to give carbon dioxide and ammonia in aqueous solution:

   $$H_2NCONH_2\ (aq) + H_2O\ (l) \rightarrow\ CO_2\ (aq) + 2\ NH_3\ (aq)$$

   $$1)\ C\ (\text{graphite}) + 2H_2\ (g) + \frac{1}{2}\ O_2\ (g) + N_2\ (g) \rightarrow\ H_2NCONH_2\ (aq) \qquad \Delta_f H^0 = -317.77\ kJ.mol^{-1}$$

2) $H_2\ (g) + \frac{1}{2} O_2\ (g) \rightarrow\ H_2O\ (l)$ $\Delta_f H^0 = -285.85\ kJ.mol^{-1}$

3) $C\ (graphite) + O_2\ (g) \rightarrow\ CO_2\ (aq)$ $\Delta_f H^0 = -413.80\ kJ.mol^{-1}$

4) $\frac{1}{2} N_2\ (g) + \frac{3}{2} H_2\ (g)\ \rightarrow NH_3\ (aq)$ $\Delta_f H^0 = -80.71\ kJ.mol^{-1}$

5) The enthalpy changes in complete combustion of crytalline α-D-glucose and maltose at 298 K, with the formation of gaseous CO_2 and liquid H_2O, are:

	$\Delta_c H^0 (kJ.mol^{-1})$
$\alpha - D - Glucose,\ C_6H_{12}O_6\ (c)$	-2809.1
$Maltose,\ C_{12}H_{22}O_{11}\ (c)$	-5645.5

Calculate the enthalpy change accompanying the conversion of 1 mol of cystalline glucose into crystalline maltose.

1) $C_6H_{12}O_6\ (c) + 6O_2\ (g) \rightarrow 6CO_2\ (g) + 6H_2O\ (l)$ $\Delta_c H^0 = -2809.1\ kJ.mol^{-1}$

2) $C_{12}H_{22}O_{11}\ (c) + 12O_2\ (g) \rightarrow 12CO_2\ (g) + 11H_2O\ (l)$ $\Delta_c H^0 = -5645.5\ kJ.mol^{-1}$

6) Calculate the ΔH^0 at 85°C for the reaction

$Fe_2O_3\ (s) + 3H_2\ (g)\ \rightarrow 2Fe\ (s) + 3H_2O\ (l)$

The data are: $\Delta H_{298}{}^0 = -33.29\ kJ.mol^{-1}$ and

Substance	Fe_2O_3 (s)	Fe (s)	H_2O (l)	H_2 (g)
$\bar{C}_p{}^0 (J.K^{-1}.mol^{-1})$	103.8	25.1	75.3	28.8