Chemistry 2740 Spring 2008 Practice Test 1

Time: 50 min	**Questions:** 8	**Marks:** 50

Aids permitted: calculator, one 8.5×11-inch formula sheet
Useful data is given on the reverse of this page.

1. Would you expect the entropy to increase or decrease in the gas-phase reaction A+B $\rightarrow$ C? Explain briefly. [2 marks]

2. What is wrong with the following statement? [2 marks]

   > ΔG gives the maximum work which a system can perform at constant temperature and pressure.

3. Using a diagram, explain why a reversible isothermal expansion produces more work than any real isothermal expansion of the same substance. [6 marks]

4. Consider the following argument:

   > For an endothermic process, $dq > 0$. According to the Clausius inequality, $dS \geq dq/T > 0$, so the entropy change for an endothermic process is always positive. Therefore endothermic processes are always spontaneous.

   Do you agree with argument? If so, can we use similar reasoning to say something about the spontaneity of exothermic processes? If not, explain where the argument goes wrong. [4 marks]

5. When we adsorb gas onto a surface, we often express the amount adsorbed as a percentage of the surface sites occupied, which we call the percent coverage. Suppose that we have 10% coverage in one experiment, and 90% coverage in another. How would the entropy of the gas compare in the two experiments? In other words, in which case, if any, is the entropy higher? [4 marks]

6. (a) What is the enthalpy of combustion of α-D-glucose at 10°C? [6 marks]
   (b) If you burned 1.00 g of glucose in a bomb calorimeter near 25°C, how much heat would be released? The molar mass of glucose is 180.156 g/mol. [6 marks]

7. The entropy of liquid water at 25°C is $69.95\,\mathrm{J\,K^{-1}mol^{-1}}$. The heat capacity of liquid water is $75.40\,\mathrm{J\,K^{-1}mol^{-1}}$. The enthalpy of fusion (melting) of ice at 0°C is 6007 J/mol. What is the entropy of ice at 0°C? [6 marks]

8. (a) Assuming that ΔH° and ΔS° are constant, calculate the standard Gibbs energy change for the reaction of calcium oxide with carbon dioxide to form calcium carbonate at 5°C. [10 marks]
   (b) The partial pressure of carbon dioxide in air is about 4×10^{-4} bar. If we keep a sample of calcium oxide in air at 5°C, will it spontaneously convert to calcium carbonate? [4 marks]

Useful data

$R = 8.314\,472\,\mathrm{J\,K^{-1}mol^{-1}}$

To convert degrees Celsius to Kelvin, add 273.15.

Standard thermodynamic data at 1 bar and 25°C

Species	$\Delta_f H^\circ$ / kJ mol^{-1}	$\Delta_f G^\circ$ / kJ mol^{-1}	C_p / J K^{-1}mol^{-1}
$C_6H_{12}O_{6(s)}$ (α-D-glucose)	−1274.4	−910.23	218.16
$CO_{2(g)}$	−393.51	−394.37	37.1
$CaCO_{3(s)}$	−1206.9	−1128.8	81.9
$CaO_{(s)}$	−634.92	−603.30	42.8
$H_2O_{(l)}$	−285.830	−237.140	75.40
$O_{2(g)}$	0	0	29.35