

Chemistry 2720 Fall 2001 Test 2

Name: _____

Student number: _____

Answer the questions in the spaces provided. If you run out of space, use the back of the page, making sure to label your answer properly so that it can easily be identified with the question.

Aids allowed: calculator. Periodic tables and other printed aids are strictly forbidden.

Questions: 5. Total marks: 50. Time: 75 min.

Formulas and data

$$G = H - TS$$

$$P^\circ = 1 \text{ bar}$$

$$\Delta \bar{G} = \Delta \bar{G}^\circ + RT \ln Q$$

$$\ln \left(\frac{K_1}{K_2} \right) = \frac{\Delta \bar{H}^\circ}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$R = 8.314472 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$2d \sin \theta = n\lambda$$

$$p = mv$$

$$p = h/\lambda$$

$$h = 6.6260688 \times 10^{-34} \text{ J/Hz}$$

$$K = \frac{1}{2}mv^2$$

$$1 \text{ bar} = 100 \text{ kPa} = 750.062 \text{ Torr}$$

$$1 \text{ \AA} = 10^{-10} \text{ m}$$

To convert degrees Celsius to Kelvin, add 273.15.

Standard Thermodynamic Properties at 298 K and 1 bar			
Species	$\Delta \bar{H}_f^\circ$ (kJ/mol)	$\Delta \bar{G}_f^\circ$ (kJ/mol)	\bar{C}_P (J K ⁻¹ mol ⁻¹)
Cl _(aq) ⁻	-167.080	-131.218	71.7
Ni _(aq) ²⁺	-54	-46	
NiCl _{2(s)}	-305.3	-259.03	
UF _{6(g)}	-2112.9	-2029.1	
U ₃ O _{8(s)}	-3574.8	-3369.5	

1. Suppose that you want to use neutron diffraction to study a crystal in which the planes of atoms are about 1.8 \AA apart. You would like for the first reflection to occur at about 10° . What kinetic energy should the neutrons have? The mass of a neutron is $1.67492716 \times 10^{-27} \text{ kg}$. [8 marks]

2. (a) Most fission reactors use enriched uranium as their fuel. The enrichment process uses uranium hexafluoride. The fuel pellets are actually U_3O_8 so the hexafluoride must be converted to this oxide prior to use. Show that the conversion of uranium hexafluoride to U_3O_8 is nonspontaneous at 25°C if the pressures of uranium hexafluoride, fluorine and oxygen are, respectively, 1, 10^{-4} and 0.2 bar. [8 marks]

- (b) Suppose that you wanted to use a coupled reaction to make the conversion spontaneous. Give a concrete example of a reaction which you might investigate to achieve this goal. It is understood that this will be an educated guess since you don't have a detailed set of thermodynamic tables at your disposal. [4 marks]

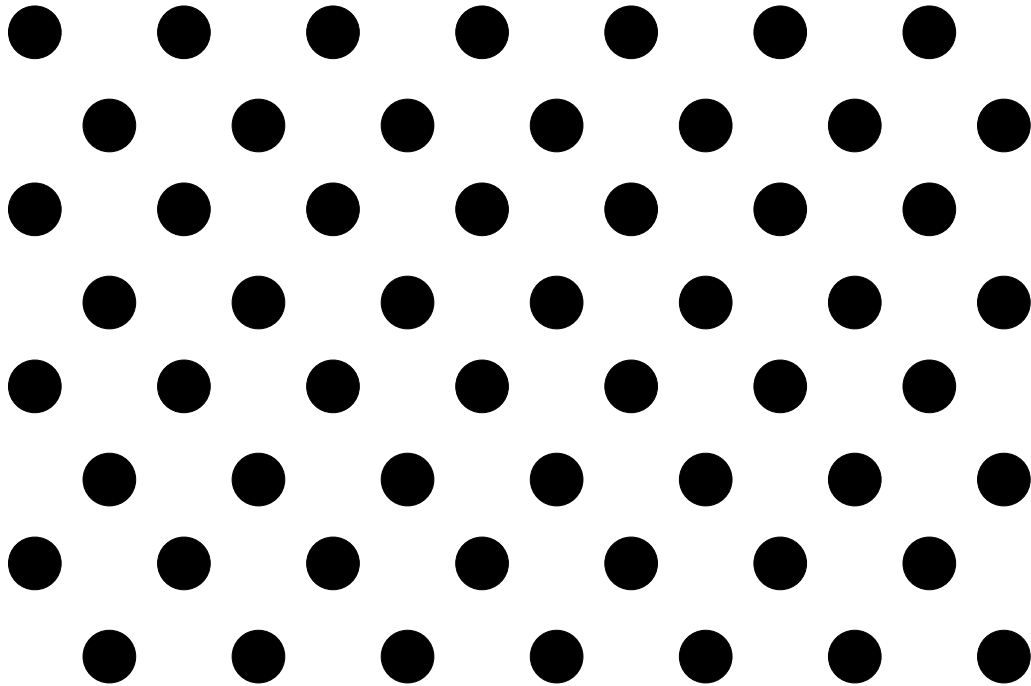
- Predict the solubility of nickel (II) chloride in water at 25°C. Comment on the magnitude of the value computed. [10 marks]

4. The following data were obtained for the equilibrium of $\text{NO}_{2(g)}$ with $\text{N}_2\text{O}_{4(g)}$:

T (K)	P_{NO_2} (Torr)	$P_{\text{N}_2\text{O}_4}$ (Torr)
298	46	23
305	68	30

Calculate the standard enthalpy and standard free energy of reaction at 298 K. [10 marks]

5. (a) Draw, on the two-dimensional crystal lattice illustrated below, the primitive unit cell and another (different) unit cell:



Make sure to indicate which unit cell is primitive. [4 marks]

- (b) Find a set of Miller indices for the plane shown on the next page: [6 marks]

