Chemistry 2740 Spring 2018 Test 2

Time: 50 minutes
Marks: 29
Aids allowed: calculator, 8.5×11-inch formula sheet
Useful data is given on the reverse of this page.
Instructions: You can answer the questions in any order, but make sure that you clearly label each of your answers with the question number in your exam booklet(s).
Briefly note any procedures you carried out on your calculator (e.g. solving equations, linear regression, etc.). You need not give me a key-by-key account of what you did, but do keep in mind that I need to have something to mark, especially if your final answer is incorrect.
If you use a graph to answer a question, make sure to provide a reasonable sketch of the graph, including properly labeled axes. This is important even if you only use regression data from the graph.

1. Gold is known as a noble metal because it does not oxidize in air under normal conditions.
   (a) We could attempt to make gold oxide (Au_2O_3) by using a large pressure of oxygen. Could we make gold oxide from gold and oxygen at a pressure of 300 bar at 25 °C? [6 marks]
   (b) Would it help to change the temperature? In which direction? Explain using the results of a *small* calculation. [3 marks]
2. The solubility of thallium(I) bromide (TlBr, molar mass $284.287\,\mathrm{g\,mol^{-1}}$) at 25 °C is $0.54\,\mathrm{g\,L^{-1}}$. Using Debye-Hückel theory, calculate the solubility product, i.e. the equilibrium constant for dissolving this ionic compound in water. The permittivity of water at this temperature is $6.939 \times 10^{-10}\,\mathrm{C^2J^{-1}m^{-1}}$. [11 marks]
3. Adenosine (Fig. 1) has a number of potential basic sites, but only nitrogen-1 is significantly basic. The following table gives the equilibrium constant for the protonation of adenosine ($A + H^+ \rightleftharpoons AH^+$) in aqueous solution as a function of temperature:[1]

T/K	293.15	298.15	303.15	308.15
$K/10^3$	3.0	2.2	1.5	1.1

   Determine the enthalpy change for the protonation of adenosine. [9 marks]

[1] F. Soleimani et al., *J. Chem. Thermodynamics* **83**, 6 (2015).

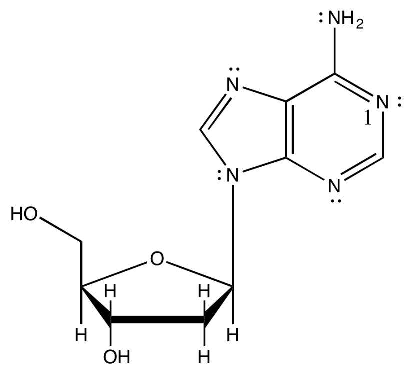

Figure 1: Structure of adenosine. Lone pairs are shown on potential basic sites. Only nitrogen-1 (labeled) is significantly basic.

Useful data

Constants and conversion factors

$0\,\text{K} = -273.15\,°\text{C}$
$R = 8.314\,472\,\text{J}\,\text{K}^{-1}\text{mol}^{-1}$

$$\left.\begin{array}{l}\ln\gamma_i = -Az_i^2(\varepsilon T)^{-3/2}\sqrt{I_c}\\ \ln\gamma_\pm = -A|z_+z_-|(\varepsilon T)^{-3/2}\sqrt{I_c}\end{array}\right\}\text{ with } A = 1.107\times10^{-10}$$

Standard thermodynamic data at 298.15 K

Species	$\frac{\Delta_f H°}{\text{kJ mol}^{-1}}$	$\frac{\Delta_f G°}{\text{kJ mol}^{-1}}$
$Au_2O_{3(s)}$	80.75	163.2