Chemistry 2290, Winter 2012, G. Schreckenbach
Practice problems –1–

Unit Conversions, Moles and Other Background Knowledge

(Problem ideas courtesy J. van Wijngaarden)

1.1 Write out the following in SI units:
1 N =?
1 J =?
1 Pa =?

1.2 Convert the following distances into meters: 1.47×10^2 Å; 200 nm, 25 km

1.3 Convert the following pressures into Pa:
5.0 atm
35 psi
30 mmHg
4.0×10^{-5} bar

1.4 Convert the following into m^3 (the SI unit of volume): 32 L; 402 cm^3; 120 mL

1.5 Convert the following energies into J: 1200 kcal; 100 mJ; 2.2eV

1.6 How many moles of NaOH are in 10.0 mL of a 0.1 M solution?

1.7 How many moles are in 20.0 g of CO_2?

1.8 What is the mass of one SiO_2 molecule? Of one mole of SiO_2?

1.9 If you pipette 10.0 mL of 0.50 M KOH into a volumetric flask and top it up with distilled water to 25 mL, what is the final concentration of the base?

1.10 You need to prepare 1.5 L of 0.30 M H_2SO_4 by diluting a concentrated, 1.8 M solution of the acid. What volume of concentrated H_2SO_4 do you need?

1.11 If the density of blood is 1.06 g cm^{-3}, what is the mass of 2.5 μL of blood?

1.12 A sample of molten iron weighing 1.35 kg occupies a volume of 175 cm^3. What is the density of the iron in g L^{-1}?

Integrals and differential calculus

1.13 Solve the following definite integrals:

(a) $\int_{x=-1}^{1} \frac{x^2}{3} dx$ **(b)** $\int_{T=1}^{b} \frac{2}{T} dT$ (where b>1) **(c)** $\int_{y=1}^{L} \left((y^3 + Ay + \frac{1}{y^2} \right) dy$

(d) $\int_{V_1}^{V_2} pV^\gamma dV$ (where $\gamma > 1$) **(e)** $\int_{T_a}^{T_b} \frac{\Delta H_m}{RT^2} dT$ **(f)** $\int_0^\pi \sin(2x) dx$ **(g)** $\int_{p_\alpha}^{p_\beta} \frac{nRT}{p} dp$

1.14 Calculate the two partial derivatives $\left(\frac{\partial f}{\partial x}\right)_y$ and $\left(\frac{\partial f}{\partial y}\right)_x$ (with respect to the variables *x* and *y*) for the following functions $f = f(x,y)$.

(a) $f(x,y) = x^3 y + qx$ **(b)** $f(x,y) = \ln(tx) + \ln(uy)$

(c) $f(x,y) = Ay^{-1/2}e^{-2x}$

(d) $f(x,y) = \frac{1}{3x+1} + \frac{x}{y^2} + Z$

(e) $f(x,y) = y^2\cos(xy)$

Equations of state; ideal and real gases

Engel and Reid, 2nd ed.:
P1.1, P1.2, P1.3, P1.4, P1.5, P1.6, P1.11, P. 1.12, P. 1.18, P7.5, P. 7.8, P7.13 (van der Waals only), P7.14

Some practice problems from Laidler/ Meiser
(Problems adapted from Laidler Meiser Sanctuary, Physical Chemistry, 4th ed., Houghton Mifflin)

LM1. The unit torr, defined as 1/760 atm, is commonly used in the measurement of low pressures, for instance in vacuum technology.
Calculate at 298.15K the number of molecules present in 1.00 m^3 at 1.00 x 10^{-6} Torr and at 1.00 x 10^{-15} Torr (approximately the best vacuum available).

LM2. An ideal gas occupies a volume 0.300 dm^3 at a pressure of 1.80 x 10^5 Pa.
(i) What is the new volume of the gas (maintained at the same temperature) if the pressure is reduced to 1.15 x 10^5 Pa?
(ii) If the gas were initially at 330.K, what will be the final volume if the temperature were raised to 550.K at constant pressure?

LM3. A gas that behaves ideally has a density of 1.92 g dm^{-3} at 150 kPa and 298 K. What is the molar mass of the sample?

LM4. What are the mole fractions and partial pressures of each gas in a 2.50L container into which 100.00g of nitrogen and 100.00g of carbon dioxide are added at 25.0ºC? What is the total pressure?

LM5. Compare the pressures for 0.800 L of Cl_2 weighing 17.5 g at 273.15 K using (a) the ideal gas equation and (b) the van der Waals equation (a = 0.6579 Pa m^6 mol^{-2}; b = 0.0562 x 10^{-3} m^3 mol^{-1}).

Other practice problems
(courtesy J. van Wijngaarden)

1.14 Calculate the density of HBr at STP. Assume ideal behavior.

1.15 The mass % composition of dry air at seal level is: 75.5% nitrogen, 23.2% oxygen, 1.3% argon. What is the partial pressure of each component, assuming a total atmospheric pressure of 1.00atm?

1.16 To synthesize NH_3, the Haber process is used. It requires high temperatures and pressures. Calculate the pressure of 2000. moles of N_2 in a container of a volume of 800. L at 625ºC. Use the van der Waals equation of state.

More to come …