UNIVERSITY OF
ROCHESTER

COLLEGE OF ARTS AND SCIENCE

DEPARTMENT OF CHEMISTRY

CHEM131 HOMEWORK #9 KEY

6-18.a. Parts *a.* and *b.* are essentially the same, somewhat complicated ***units*** problem. The first step is to write out the units for K^*, K_P, and K. Both reactions have two reactants going to one product, so the generic situation is:

$$A + B \rightleftharpoons C,$$

$$K = [C]/[A][B].$$

So the ***units*** for each of the three different equilibrium constants are 1/(the appropriate concentration), *i.e.* $\Delta n = -1$ and the units are L/mol for K, atm^{-1} for K_P, and cm^3/molecules for K^*. So you have to convert from cm^3/molecules to atm^{-1} and L/mol.

$1.26*10^{-11}(cm^3/molecules)*(1L/1000\ cm^3)*6.02*10^{23}(molecules/mol) = 7.59*10^9$ L/mol

See page 198 for conversions between K and K_P, and the role of Δn.

$7.59*10^9(L/mol)/[RT(L*atm/mol)] = 7.59*10^9/(.08206*300) = 3.08*10^8\ atm^{-1}$

6-18.b. Part *b* follows in exactly the same fashion.
$2.09*10^{-12}(cm^3/molecules)*(1L/1000\ cm^3)*6.02*10^{23}(molecules/mol) = 1.26*10^9$ L/mol
$1.26*10^9(L/mol)/[RT(L*atm/mol)] = 1.26*10^9/(.08206*300) = 5.11*10^7\ atm^{-1}$

6-18.c $1.26*10^{-11} = [HO_2NO_2]/(1.65*10^{10}*6.00*10^{12})$ and $[HO_2NO_2] = 1.25*10^{12}$ molecules/cm^3.

6-19. $K_P = K(RT)^{\Delta n}$ and $\Delta n = -1$. $K_P = 3.7*10^9/(0.08206*298) = 1.5*10^8\ atm^{-1}$.

6-21 $K = [Cl_2][NO]^2/[NOCl]^2 = (2.4/3.00)(0.0045/3.00)^2/(1/3.00) = 1.6 * 10^{-5}$. Note that since $\Delta n = 1$, the volumes do not cancel, so the units of K are mol/L.

6-23. You need the pressure of H_2O and H_2, but are given $P_{H2O} = 15$ Torr and $P_{total} = 36.3$ Torr. We know from the ideal gas chapter, $P_{H2} = 36.3 - 15 = 21.3$ Torr. You could convert the pressures in Torr to atm, but it is simpler to recognize that $\Delta n = 0$ and units will cancel. (If you were to do this on an exam, make sure to write the $\Delta n = 0$ and that's why you are not converting units. Otherwise the grader would assume you forgot to convert.)

$K_P = (21.3)^4/(15)^4 = 4.07$ (Make sure you know how to raise numbers to arbitrary powers with you calculator for exams.)

Next H.W.: Ch6: 25, 28, 29, 31, 33, 39, 41, 46, 49, 60

University of Rochester
Rochester, New York 14627-0216