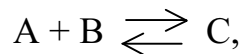


CHEM131 HOMEWORK #9 KEY

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:



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

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  $K$ ,  $\text{atm}^{-1}$  for  $K_P$ , and  $\text{cm}^3/\text{molecules}$  for  $K^*$ . So you have to convert from  $\text{cm}^3/\text{molecules}$  to  $\text{atm}^{-1}$  and L/mol.

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

See page 198 for conversions between  $K$  and  $K_P$ , and the role of  $\Delta n$ .

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

6-18.b. Part *b* follows in exactly the same fashion.

$$2.09 \times 10^{-12} (\text{cm}^3/\text{molecules}) \cdot (1\text{L}/1000 \text{ cm}^3) \cdot 6.02 \times 10^{23} (\text{molecules}/\text{mol}) = 1.26 \times 10^9 \text{ L}/\text{mol}$$

$$1.26 \times 10^9 (\text{L}/\text{mol}) / [RT (\text{L} \cdot \text{atm}/\text{mol})] = 1.26 \times 10^9 / (.08206 \cdot 300) = 5.11 \times 10^7 \text{ atm}^{-1}$$

6-18.c  $1.26 \times 10^{-11} = [\text{HO}_2\text{NO}_2] / (1.65 \times 10^{10} \cdot 6.00 \times 10^{12})$  and  $[\text{HO}_2\text{NO}_2] = 1.25 \times 10^{12}$  molecules/ $\text{cm}^3$ .

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

6-21  $K = [\text{Cl}_2][\text{NO}]^2 / [\text{NOCl}]^2 = (2.4/3.00)(0.0045/3.00)^2 / (1/3.00) = 1.6 \times 10^{-5}$ . 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  $\text{H}_2\text{O}$  and  $\text{H}_2$ , but are given  $P_{\text{H}_2\text{O}} = 15 \text{ Torr}$  and  $P_{\text{total}} = 36.3 \text{ Torr}$ . We know from the ideal gas chapter,  $P_{\text{H}_2} = 36.3 - 15 = 21.3 \text{ Torr}$ . 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.)

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

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