

## Enrichment

## Chapter 7

## BLM 7-3

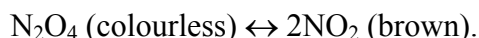
## Chemical Equilibrium of Gases

## Goal

Investigate the relationship between the equilibrium constants for concentration and, for gases, partial pressure

## Procedure

You have learned to determine equilibrium constant ( $K_c$ ) for gaseous systems using concentration data. It is also common to use the pressure of gases to determine the value for the equilibrium constant. Consider the equilibrium between the gases  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$ :



You can write the equilibrium expression as  $K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$  If the pressures of  $\text{NO}_2$

and  $\text{N}_2\text{O}_4$  are used in the equilibrium expression, then  $K_p = \frac{P_{\text{NO}_2}^2}{P_{\text{N}_2\text{O}_4}}$ .

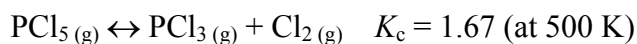
Notice that  $K_p$  is used to represent an equilibrium expression expressed in terms of pressure. The terms in the numerator and the denominator are the equilibrium partial pressures of  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$  respectively, in units of atmospheres. Note that  $K_c \neq K_p$  because the concentrations of gases (in units of mol/L) are not equal to the pressure in atmospheres at equilibrium.

Recall that pressure is related to concentration using the ideal gas law:  $P = (n/v)RT$ . Using this formula, you can obtain a relationship between  $K_c$  and  $K_p$ :  
 $K_p = K_c(0.0821 \text{ T})^{\Delta n}$

In this equation,  $\Delta n = b - a$ , where  $b$  represents the moles of gaseous products, and  $a$  represents the moles of gaseous reactants.

## Questions

1. Write the equilibrium expression,  $K_p$ , for the reaction shown below.



2. If  $K_p$  for the reaction shown above is 1.05 at  $250^\circ\text{C}$ , and the partial pressures for  $\text{PCl}_5$  and  $\text{PCl}_3$  are 0.90 atm, and 0.45 atm respectively, determine the partial pressure of  $\text{Cl}_2$  at equilibrium.
3. If the volume of the vessel is 3 L, determine the amount of  $\text{Cl}_2$  present at equilibrium.
4. Determine the corresponding  $K_c$  for this reaction.