## Chemical Equilibrium

**#4**

Homogeneous gaseous equilibrium

$$N_2O_4(g) \rightleftharpoons 2\ NO_2(g)$$

At equilibrium, at a certain temperature, the partial pressure of $N_2O_4(g)$ is 0.50 bar and the partial pressure of $NO_2(g)$ also is 0.50 bar. On increasing the total pressure to 2.00 bar at that constant temperature, calculate the partial pressures of both components.

### Solution

We calculate $K_p$ from the given data at equilibrium:

$$K_p = \frac{P^2_{NO_2\,eq}}{P_{N_2O_4\,eq}} = \frac{(0.50)^2}{0.50} = 0.50$$

Increasing the pressure on a homogeneous equilibrium in the gaseous phase, and thus decreasing the volume of the gas mixture, will result in a shift of the equilibrium position toward the side of the reaction involving the smaller number of gaseous molecules: in this case to the **left**.

Suppose that, in the new equilibrium that is formed:

$P_{N_2O_4\,new\ eq} = x$ and $P_{NO_2\,new\ eq} = y$

From the following equations we can calculatie x and y:

The total pressure is increased up to 2.00 bar → $x + y = 2.00$ bar

The equilibrium constant does not change → $K_p = \frac{P^2_{NO_2\,new\ eq}}{P_{N_2O_4\,new\ eq}} = \frac{y^2}{x} = 0.50$

$$\frac{y^2}{x} = 0.50$$

$$\Leftrightarrow x = \frac{y^2}{0.50}$$

$$x + y = 2.00$$

$$\Rightarrow \frac{y^2}{0.50} + y = 2.00$$

$$\Rightarrow y^2 + 0.50\,y - 1.00 = 0$$

$$\Rightarrow \quad y = 0.78$$

$$x = 1.22$$

Thus:

$P_{N_2O_4\,new\ eq} = 1.22$ bar and $P_{NO_2\,new\ eq} = 0.78$ bar