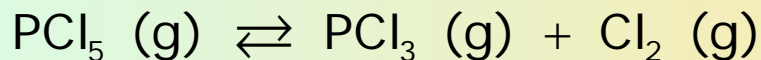
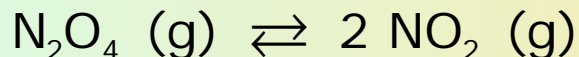


Kp equilibrium constant: exercises

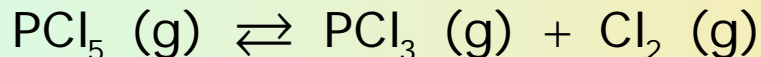
1. The equilibrium constant K_p for the following reaction is 1.05 atm (at 250 °C). If the partial pressures at equilibrium of PCl_5 is 0.875 atm and of PCl_3 is 0.463 atm, determine the partial pressure of chlorine at equilibrium.



2. The equilibrium constant K_p for the following reaction is 0.143 atm (at 25 °C). A 1 L-flask is charged with N_2O_4 and the initial pressure is 0.05 atm. Determine the partial and total pressures at equilibrium



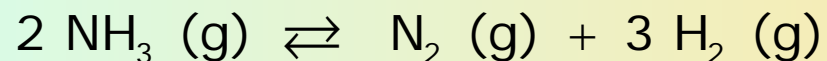
3. A 2 L-flask is charged with 0.1 mol of PCl_5 at 250 °C and the following equilibrium is reached



If K_p is 1.80, determine K_c at the same temperature and the percentage of dissociation of PCl_5

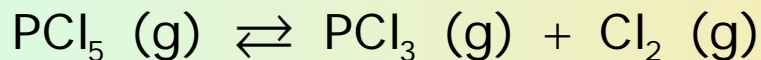
Kp equilibrium constant: exercises

4. The percentage of dissociation of ammonia, at 423 K and 200 atm, is 30 %. Determine the constants Kp and Kc for the dissociation reaction expressed below



Kp equilibrium constant: exercises

1. The equilibrium constant K_p for the following reaction is 1.05 atm (at 250 °C). If the partial pressures at equilibrium of PCl_5 is 0.875 atm and of PCl_3 is 0.463 atm, determine the partial pressure of chlorine at equilibrium.



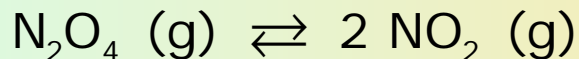
Substituting the values in the expression of equilibrium constant:

$$K_p = 1.05 \text{ atm} = \frac{P_{\text{PCl}_3} P_{\text{Cl}_2}}{P_{\text{PCl}_5}} = \frac{0.463 \text{ atm} * P_{\text{Cl}_2}}{0.875 \text{ atm}}$$

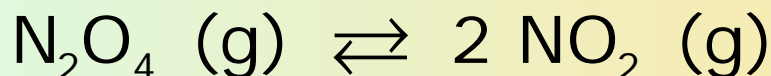
$$P_{\text{Cl}_2} = \frac{1.05 \text{ atm} * 0.875 \text{ atm}}{0.463 \text{ atm}} = 1.98 \text{ atm}$$

Kp equilibrium constant: exercises

2. The equilibrium constant K_p for the following reaction is 0.143 atm (at 25 °C). A 1 L-flask is charged with N_2O_4 and the initial pressure is 0.05 atm. Determine the partial and total pressures at equilibrium



We can express the changes in partial and total pressures as follows:



p initial	0.05	0
p changes	-x	2x
p equilibrium	0.05 - x	2x

total pressure
0.05
x
0.05 + x

From the expression of K_p , we can calculate x:

$$K_p = \frac{P_{NO_2}^2}{P_{N_2O_4}} = \frac{4x^2}{0.05 - x} = 0.143$$

$$4x^2 + 0.143x - 0.00715 = 0$$

$$\text{Condition: } 0 < x < 0.05$$

$$x = 0.028$$

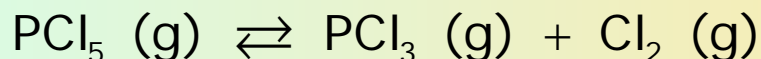
$$P_{\text{tot}} = 0.05 + x = 0.078 \text{ atm}$$

$$P_{NO_2} = 2x = 0.056 \text{ atm}$$

$$P_{N_2O_4} = 0.05 - x = 0.022 \text{ atm}$$

Kp equilibrium constant: exercises

3. A 2 L-flask is charged with 0.1 mol of PCl_5 at 250 °C and the following equilibrium is reached



If K_p is 1.80, determine K_c at the same temperature and the percentage of dissociation of PCl_5

From the relationship between both constants we get:

$$K_p = K_c (RT)^{\Delta n} \rightarrow K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{1.80}{(0.082 * 523)} = 0.042$$

The # of moles at equilibrium: $\text{PCl}_5 (\text{g}) \rightleftharpoons \text{PCl}_3 (\text{g}) + \text{Cl}_2 (\text{g})$

n initial	0.1	0	0
n changes	-x	x	x
n equilibrium	0.1 - x	x	x
[] equilibrium	(0.1 - x)/2	x/2	x/2

The value of x is:

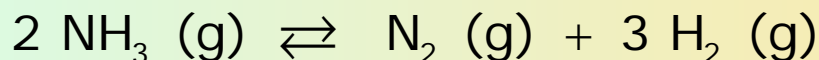
$$K_c = 0.042 = \frac{x^2}{0.2 - 2x} \rightarrow x^2 + 0.084x - 0.0084 = 0$$

$$\text{Condition: } 0 < x < 0.1 \rightarrow x = 0.059$$

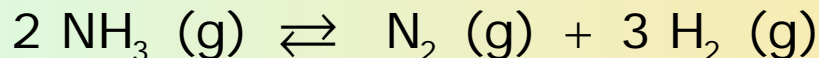
$$\text{dissociation } (\alpha) \dots \alpha = \frac{0.059}{0.1} = 0.59 \text{ or } 59 \%$$

Kp equilibrium constant: exercises

4. The percentage of dissociation of ammonia, at 423 K and 200 atm, is 30 %. Determine the constants Kp and Kc for the dissociation reaction expressed below



At equilibrium:



p initial	p_0	0	0
p changes	$- p_0 \alpha$	$p_0 \alpha / 2$	$3 p_0 \alpha / 2$
p equilibrium	$p_0 (1 - \alpha)$	$p_0 \alpha / 2$	$3 p_0 \alpha / 2$

total pressure

$$p_0$$

$$p_0 \alpha$$

$$p_0 (1 + \alpha) = 200 \text{ atm}$$

Determination of values:

$$p_0 (1 + \alpha) = 200 \text{ atm} \rightarrow 1.3 p_0 = 200 \text{ atm}$$

$$p_0 = \frac{200 \text{ atm}}{1.3} = 153.8 \text{ atm}$$

$$p(\text{NH}_3) = p_0 (1 - \alpha) = 107.7 \text{ atm}$$

$$p(\text{N}_2) = p_0 \alpha / 2 = 23.07 \text{ atm}$$

$$p(\text{H}_2) = 3 p_0 \alpha / 2 = 69.21 \text{ atm}$$

$$K_p = \frac{P_{\text{N}_2} * P_{\text{H}_2}^3}{P_{\text{NH}_3}^2} = \frac{23.07 * (69.21)^3}{(107.7)^2} = 659$$

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{659}{(0.082 * 423)^2} = 0.548$$