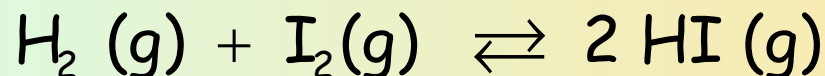


# Chemical Equilibrium: Exercises

1. At 670 °C, a 1 L-flask contains a mixture of gases at equilibrium: 0.003 mol hydrogen, 0.003 mol iodine and 0.024 mol of hydrogen iodide. The reaction is:

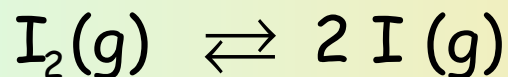


Determine:

- The values of  $K_c$  and  $K_p$
- The total pressure and the partial pressures at equilibrium in the previous conditions

$$R = 0.082 \text{ atm.L/K.mol}$$

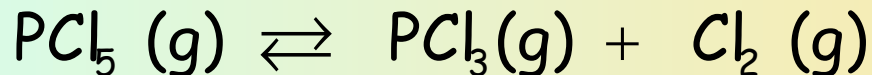
2. The equilibrium constant for this process



At 1000 K is  $K_c=3.76 \cdot 10^{-5}$ . If a 2 L-flask that contains  $5 \cdot 10^{-3}$  moles of I is charged with 1 mol of  $\text{I}_2$ , determine the concentrations of both components at equilibrium

## Chemical Equilibrium: Exercises

3. A 5 L-container is charged with 2 moles of  $\text{PCl}_5$  (g) and 1 mole of  $\text{PCl}_3$  (g). The mixture is heated at  $250^\circ\text{C}$  and this equilibrium is reached:

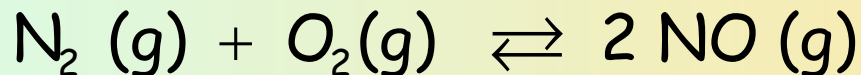


The equilibrium constant at that temperature is  $K_c = 0.042$ . Determine:

- The concentration of  $\text{Cl}_2$  at equilibrium.
- The value of  $K_p$  at that temperature
- The dissociation percent of  $\text{PCl}_5$

$$R = 0.082 \text{ atm}\cdot\text{L}/\text{K}\cdot\text{mol}$$

4. A 5 L-container is charged with 0.92 moles of  $\text{N}_2$  and 0.51 moles of  $\text{O}_2$ . The mixture is heated at 2200 K and the following equilibrium is reached:



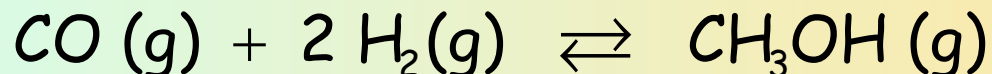
If 1.09 % of the initial nitrogen reacts, determine:

- The concentrations of all components at equilibrium
- The values of  $K_c$  and  $K_p$

$$R = 0.082 \text{ atm}\cdot\text{L}/\text{K}\cdot\text{mol}$$

## Chemical Equilibrium: Exercises

5. The synthesis of methanol is based on this equilibrium

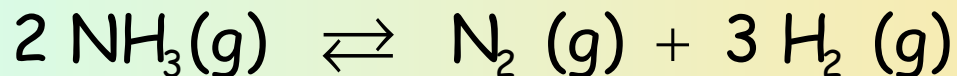


In a 1 L-flask we have initially 2 moles of CO and 2 moles of hydrogen and the mixture is heated to 600 K. At equilibrium 0.8 moles of methanol are formed. Determine:

- The number of moles of each component at equilibrium
- The value of  $K_p$  at 600 K
- The effect produced when the equilibrium is disturbed by increasing the volume of the container

$$R = 8.134 \text{ J/K.mol} = 0.082 \text{ atm.L/K.mol}$$

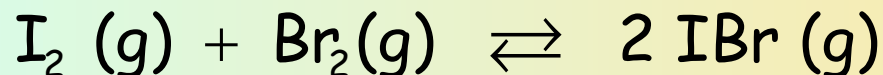
6. At 400 °C ammonia is 40 % dissociated in nitrogen and hydrogen when the pressure of the mixture is 710 mm Hg. Determine:



- The partial pressures of each component when we start with 4 moles of ammonia
- The value of  $K_p$

## Chemical Equilibrium: Exercises

7. A 400 mL-flask is charged with 2.032 g of iodine and 1.28 g of bromine. The mixture is heated at 150 °C and the following equilibrium is reached:

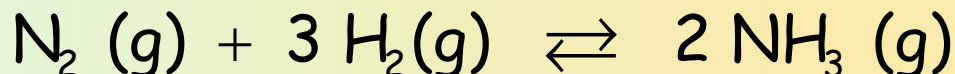


Determine:

- The molar concentrations of each component and the total pressure
- The value of  $K_p$  at this temperature

$K_c$  (at 150 °C) = 280;  $R = 0.082 \text{ atm}\cdot\text{L}/\text{K}\cdot\text{mol}$ ; Atomic weights: Br=79.9 I=126.9

8. A 0.4 L-flask is charged with 1 mole of  $\text{N}_2$  and 3 moles of  $\text{H}_2$  at 780 K. When the following equilibrium is reached



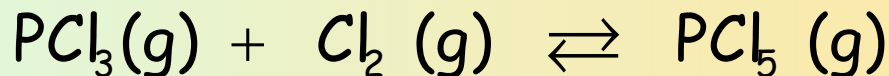
the mixture has a 28 % of ammonia (in moles). Determine:

- The number of moles of each component in equilibrium
- The total pressure at equilibrium
- The value of  $K_p$

$R = 0.082 \text{ atm}\cdot\text{L}/\text{K}\cdot\text{mol}$

## Chemical Equilibrium: Exercises

9. Chlorine reacts with phosphorus trichloride to yield phosphorus pentachloride, according to this equation:

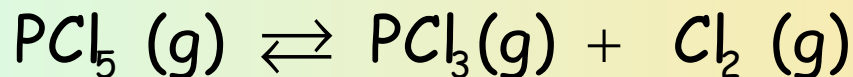


In a 2 L-vessel, at a given temperature, there is a gas mixture in equilibrium that contains 132 g of  $\text{PCl}_3$ , 56.8 g of  $\text{Cl}_2$  and 10.4 g of  $\text{PCl}_5$ .

- Determine  $K_c$  at that temperature
- Explain if  $K_p$  can be calculated with the data available in this exercise
- Determine the composition at equilibrium (concentrations) if the volume is halved.

10. A 10 L-vessel is charged with 2 moles of  $\text{PCl}_5$  at 162 °C. Determine

- The concentrations of all components when the following equilibrium is reached:



- The total pressure at equilibrium

$K_c = 0.0454$  (at 162 °C);  $R = 0.082 \text{ atm}\cdot\text{L}/\text{K}\cdot\text{mol}$