

IB2 HL Chemistry

2. Equilibrium

Solution to Further problems:

- Concentrations of chemical species in a system at equilibrium are constant while those in a system not at equilibrium change over time.
 - In both systems reactions will be taking place.
 - In a system at equilibrium, the rate of opposing reactions will be equal, while in a system not at equilibrium they would be different.
- Three properties that can be measured to determine equilibrium state are: color intensity, pH and concentration of a chemical species involved,
- The percentage conversion to ammonia will be greater. The production of ammonia, forward reaction, is followed by a reduction in the number of moles of gases, and therefore increasing the pressure shifts the equilibrium to the right.
 - The equilibrium amount of ammonia will be less. Since the forward reaction is exothermic, increasing the temperature shifts the equilibrium to the left, the direction in which energy is consumed.
 - Adding a catalyst will not affect the equilibrium percentage of ammonia in the mixture; it will remain at 5%.
- The value of equilibrium constant is considerably less than 1, and therefore the concentration of reactants are present in greater concentration at equilibrium.
 - The equilibrium constant is considerable higher than 1 and therefore the concentration of the products are present in greater concentration at equilibrium.
- Increasing the temperature reduces the value of equilibrium constant.
 - Increasing the concentration of NO does not affect the value of the equilibrium constant.
- Substance X would be expected to have a higher boiling point. Substance X is more likely to exhibit hydrogen bonding. As X has a bigger enthalpy of vaporization, it would have a stronger intermolecular force, and since hydrogen bonding is the strongest of the three intermolecular force, the one with the stronger force is likely to have a hydrogen bonding.
- There would be greater number of moles of tetrachloromethane in the vapor phase. A lower boiling point of tetrachloromethane indicates a weaker intermolecular force which means it evaporates more readily than benzene.
- Since the initial and equilibrium concentration of the product is 0 M and 4.00 M respectively, and the ratio of product to each reactant is 1:1, the concentration of each reactant decreases by 4.00 M.

	$\text{Fe}^{3+}(\text{aq})$	+	$\text{SCN}^{-}(\text{aq})$	\rightleftharpoons	$\text{FeSCN}^{2+}(\text{aq})$
Initial []	6.00 M		10.0 M		0 M
Δ in []	-4.00 M		-4.00 M		+ 4.00 M
Eqm []	2.00 M		6.00 M		4.00 M

$$K_c = \frac{[\text{FeSCN}^{2+}]}{[\text{Fe}^{3+}][\text{SCN}^-]}$$

$$K_c = \frac{4.00 \text{ M}}{(2.00 \text{ M})(6.00 \text{ M})}$$

$$K_c = 0.333 \text{ M}^{-1}$$

9. Since the volume is 1.00- dm^3 , the concentration of 2.00 moles of ammonia = 2.00 M .

Since the initial and equilibrium concentration of the reactant is 2.0 M and 1.0 M respectively, the concentration of the product decreases by 1.0 M .

Nitrogen increases by

$$1.0 \text{ mol NH}_3 \left(\frac{1 \text{ mol N}_2}{2 \text{ mol NH}_3} \right) = 0.50 \text{ mol N}_2$$

Hydrogen increases by

$$1.0 \text{ mol NH}_3 \left(\frac{3 \text{ mol H}_2}{2 \text{ mol NH}_3} \right) = 1.5 \text{ mol H}_2$$

	$2\text{NH}_3(\text{g})$	\rightleftharpoons	$\text{N}_2(\text{g})$	+	$3\text{H}_2(\text{g})$
Initial []	2.00 M		0 M		0 M
Δ in []	-1.00 M		$+0.500 \text{ M}$		$+1.50 \text{ M}$
Eqm []	1.00 M		$+0.500 \text{ M}$		$+1.50 \text{ M}$

$$K_c = \frac{[\text{N}_2][\text{H}_2]^3}{[\text{NH}_3]^2}$$

$$K_c = \frac{(0.500 \text{ M})(1.50 \text{ M})^3}{(1.00 \text{ M})^2}$$

$$K_c = 1.687 = 1.69 \text{ M}^2$$

10.

$$K_c = \frac{[\text{HF}]^2}{[\text{H}_2][\text{F}_2]}$$

$$2.1 \times 10^3 = \frac{[\text{HF}]^2}{(0.0021)(0.0021)}$$

$$[\text{HF}]^2 = 9.26 \times 10^{-3}$$

$$[\text{HF}] = 9.62 \times 10^{-2} = 0.096 \text{ M}$$