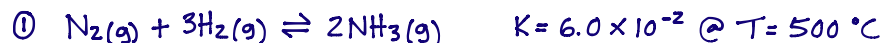


Equilibrium and Le Chatelier's Principle Practice Problems



To determine which way the rxn shifts to establish equilibrium, you must calculate "Q" for the given concentrations, then compare Q to K. (you are trying to see if the given conc. are equilibrium conc. If not the value of Q in comparison to K will tell you in which direction the rxn will shift to reach \rightleftharpoons)

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

Ⓐ $Q = \frac{(1.0 \times 10^{-3})^2}{(1.0 \times 10^{-5})(2.0 \times 10^{-3})^3} = 12500000$

$Q > K \quad \therefore \text{Shift left (reverse)}$

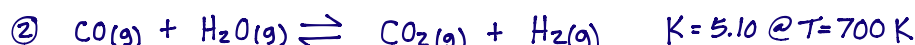
Since Q & K are $\frac{P}{R}$, to make Q = K (i.e. reach \rightleftharpoons) Q must get smaller, thus [P] must decr & [R] must incr \therefore rxn shifts in reverse direction

Ⓑ $Q = \frac{(2.00 \times 10^{-4})^2}{(1.50 \times 10^{-5})(3.54 \times 10^{-1})^3} = .0601 = 6.01 \times 10^{-2}$

$Q = K \quad \therefore \text{Rxn is at equilibrium, NO SHIFT}$

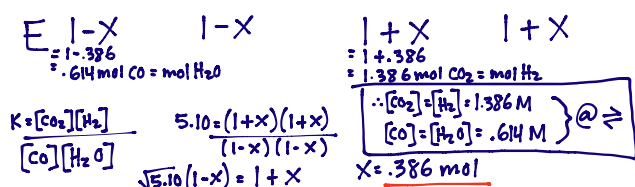
Ⓒ $Q = \frac{(1.0 \times 10^{-4})^2}{(5.0)(1.0 \times 10^{-2})^3} = .0020$

$Q < K \quad \therefore \text{SHIFT RIGHT (FORWARD)}$



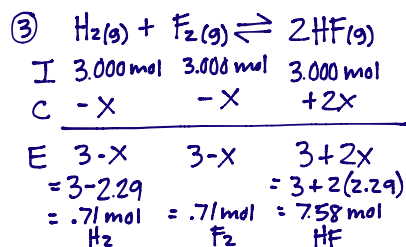
* since you determined the system shifts \rightarrow subtract from Reactants & Add to Products

* Start w/ amounts of all reactants & products so ask yourself, "is the system @ \rightleftharpoons under these conditions? If not, in which direction will the system shift to reach \rightleftharpoons ?"



How do you answer this? Calculate Q!

$Q = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]} = \frac{(1)(1)}{(1)(1)} = 1 \quad Q < K \quad \therefore \text{SHIFT } \rightarrow$



$$[\text{H}_2] = [\text{F}_2] = \frac{.71 \text{ mol}}{1.5 \text{ L}} = .473 \text{ M}$$

$$[\text{HF}] = \frac{7.58 \text{ mol}}{1.5 \text{ L}} = 5.05 \text{ M}$$

$$\therefore @ \rightleftharpoons [\text{H}_2] = [\text{F}_2] = .473 \text{ M}$$

$$[\text{HF}] = 5.05 \text{ M}$$

$$K = 1.15 \times 10^2 @ T = ?$$

$$V = 1.500 \text{ L}$$

$$Q = \frac{[\text{HF}]^2}{[\text{H}_2][\text{F}_2]} = \frac{(3 \text{ mol}/1.5 \text{ L})^2}{(3 \text{ mol}/1.5 \text{ L})(3 \text{ mol}/1.5 \text{ L})} = \frac{(3 \text{ mol}/1.5 \text{ L})^2}{(3 \text{ mol}/1.5 \text{ L})^2} = 1$$

$$Q < K \therefore \text{SHIFT} \rightarrow$$

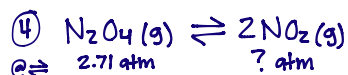
$$K = \frac{[\text{HF}]^2}{[\text{H}_2][\text{F}_2]}$$

$$1.15 \times 10^2 = \frac{(3+2x)^2}{(3-x)^2}$$

$$10.7 = \frac{3+2x}{3-x}$$

$$32.1 - 10.7x = 3 + 2x$$

$$x = 2.29 \text{ mol}$$



$$K_p = \frac{(P_{\text{NO}_2})^2}{P_{\text{N}_2\text{O}_4}}$$

$$0.133 = \frac{(P_{\text{NO}_2})^2}{2.71}$$

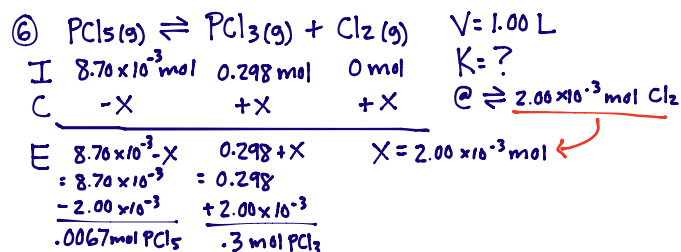
$$P_{\text{NO}_2} = .600 \text{ atm}$$

$$K_p = 0.133$$

* Since given equilibrium value
& K_p (can only plug in \rightleftharpoons values into K_p),
use K_p expression to solve for the
unknown equilibrium pressure.

⑤ OMIT

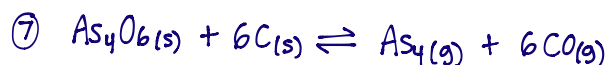




$\frac{.0067 \text{ mol PCl}_5}{1.00 \text{ L}} = 6.70 \times 10^{-3} \text{ M PCl}_5$
 $\frac{.3 \text{ mol PCl}_3}{1.00 \text{ L}} = .300 \text{ M PCl}_3$
 $\frac{2.00 \times 10^{-3} \text{ mol Cl}_2}{1.00 \text{ L}} = 2.00 \times 10^{-3} \text{ M Cl}_2$

* Plug in \Rightarrow values into K_c

$K_c = \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]}$
 $K_c = \frac{(.300)(2.00 \times 10^{-3})}{6.70 \times 10^{-3}}$
 $K_c = .0896$

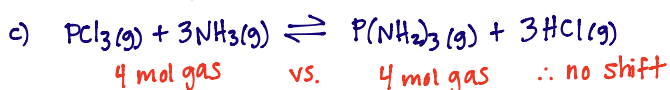
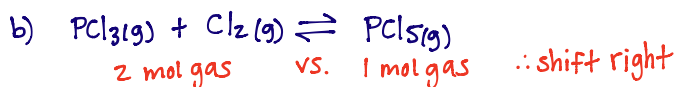
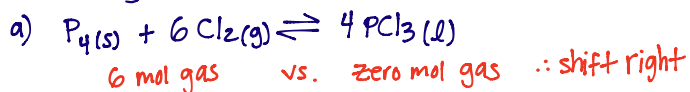


a) shift left. Adding CO will cause Q to be greater than K . Thus, more reactants must be made to reestablish equilibrium.

b) No shift. As_4O_6 is a solid, thus it does not affect Q .

c) shift right. Removing As_4 will cause Q to be less than K . Thus, more products must be made to reestablish equilibrium.

⑧ Decreasing volume = shift to side w/ less moles of gas



⑨ Increase T = favor side without heat

