CHAPTER 13

HOME WORK SOLUTIONS

1.5

Q. 22. $H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$ $K_p = 3.5 \times 10^4$ at 1495 K. $K_p = ?$ for the following reactions.

$K_p = P^2_{HBr} / (P_{H_2})(P_{Br_2})$

a) $HBr \rightleftharpoons \frac{1}{2} H_2(g) + \frac{1}{2} Br_2(g)$

$$K_p = \frac{(P_{H_2})^{1/2} (P_{Br_2})^{1/2}}{P_{HBr}} = \left(\frac{1}{K_p}\right)^{1/2} = \left[\frac{1}{3.5 \times 10^4}\right]^{1/2} = \boxed{5.3 \times 10^{-3}}$$

b) $2HBr \rightleftharpoons H_2 + Br_2$, $K_p = \frac{(P_{H_2})(P_{Br_2})}{P^2_{HBr}} = \frac{1}{K_p} = \frac{1}{3.5 \times 10^4} = \boxed{2.9 \times 10^{-5}}$

c) $\frac{1}{2} H_2 + \frac{1}{2} Br_2 \rightleftharpoons HBr$, $K_p = \frac{P_{HBr}}{(P_{H_2})^{1/2} (P_{Br_2})^{1/2}} = (K_p)^{1/2} = \boxed{190}$

Q. 30 (1.0) $K_p = 0.25$ for the reaction: $2SO_2(g) + O_2 \rightleftharpoons 2SO_3(g)$ $t = 1100$ K, $K = ?$

$K_p = K(RT)^{\Delta n(g)}$; $K = \frac{K_p}{(RT)^{\Delta n}}$; $\Delta n = 2 - 3 = -1$,

$K = 0.25 \times (0.08206 \times 1100) = \boxed{23}$

1.5

Q. 37/36 (old), $K_p = 2.4 \times 10^3$ at certain temp, $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

Direction of system = ?

(a) $Q = \frac{P_{N_2} \times P_{O_2}}{P^2_{NO}} = \frac{(0.11)(2.0)}{(0.010)^2} = \boxed{2.2 \times 10^3}$ $Q < K_p$, Reaction shift right to reach Equilibrium.

(b) $Q = \frac{(0.36)(0.67)}{(0.0078)^2} = \boxed{4.0 \times 10^3}$ $Q > K_p$ Reaction shift to left to reach equilibrium.

(c) $Q = \frac{(0.51)(0.18)}{(0.0862)^2} = \boxed{2.4 \times 10^3}$ $Q = K_p$, System at equilibrium

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Q. 40/38 (old). $2NO(g) + Br_2(g) \rightleftharpoons 2NOBr(g)$, $K_p = 109$ at 25°C,

1.0 $P_{Br_2} = 0.0159$ atm, $P_{NOBr} = 0.0768$ atm, $P_{NO} = ?$ at equi.

$K_p = \frac{P^2_{NOBr}}{P^2_{NO} \times P_{Br_2}}$, $109 = \frac{(0.0768)^2}{P^2_{NO} \times 0.0159}$ $= P_{NO} = 00583$ atm.

Q.44/46(old) $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$ (1.5)

Initial: 4.0 mol/2.0 L | 0 | 0

Let $2x$ mol/~~L~~ of NH_3 react to reach equilibrium

Change	$-2x$	$+x$	$+3x$
Equil	$2.0-2x$	x	$3x$

$[NH_3]_e$ = 2.0 mol/2.0 L remain, $= 1.0\ M = 2.0-2x$

$x = 0.5\ M$

$[N_2] = x = 0.5\ M$; $[H_2] = 3x = 3(0.5\ M) = \boxed{1.5\ M}$

$$K = \frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{(0.50)(1.5)^3}{(1.0)^2} = \boxed{1.7}$$

Q.50/52(old), $K_p = 0.25$, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ (1.5)

a)

Initial	$P_{4.5\ atm}$	0
change	$-x$	$+2x$
Equil.	$4.5-x$	$2x$

$$K_p = \frac{P^2_{NO_2}}{P_{N_2O_4}} = \frac{(2x)^2}{4.5-x} = 0.25$$

Use quadratic equation ①

$4x^2 + 0.25x - 1.125 = 0$

$a \quad b \quad c$

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$ ①

$x = 0.50$, $P_{NO_2} = 2x = \boxed{1.0\ atm}$ $P_{N_2O_4} = 4.5-x = \boxed{4.0\ atm}$

Q.60/62(old) No. of moles of SO_3 = ? $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ (1.0)

$\Delta H^\circ = 197\ kJ$

a) The moles of SO_3 will increase, Reaction shift to left

b) Increase; Reactant has less molecule than product gas molecule, Reaction shift left with decreasing volume.

c) No effect,

d) Increase; Heat + $2SO_3 \rightleftharpoons 2SO_2 + O_2$, Decreasing T will remove heat, Shifting this endothermic to the left.

e) Decrease.

Q.64/66(old) $N_{2(g)} + 3H_2(g) \rightleftharpoons 2NH_3(g)$ (1.0)

Temperature increase, the value of K decreases. This is Consistant with an exothermic reaction, In an exothermic reaction, heat is a product and increase in temperature shifts the equilibrium to the reactant side.