Name Mr. Shank Class AP1, 2, 3

Equilibrium IV

1. Hydrogen iodide can be produced from hydrogen gas and iodine gas at 430 C according the following reaction

$$H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)} \quad K_c = 54.3$$

If a chemist initially fills a2.4 L reaction vessel with 0.714 moles of H2, 0.984 moles of I2, and 0.886 moles of HI, what will be the equilibrium concentrations of each of the gases in the vessel?

R	H_2	+	I_2	⇌	2HI
I	.714		.984		.886
C	+x		+x		-2x
E	.714+x		.984+x		.886-2x

$$K_c = \frac{\left(\frac{.886-2x}{2.4}\right)^2}{\left(\frac{.714+x}{2.4}\right)\left(\frac{.984+x}{2.4}\right)} = 54.3$$

$x = -1.855$ or $x = -0.548$

$[H_2]_{eq}$ 0.069 M = $\frac{0.166\ M}{2.4}$ $[I_2]_{eq}$ 0.182 M = $\frac{0.436\ M}{2.4}$ $[HI]_{eq}$ 0.826 M = $\frac{1.982\ M}{2.4}$

2. The equilibrium constant for the decomposition of phosgene, $COCl_2$, is 0.304 at 527 C.

$$COCl_{2(g)} \rightarrow CO_{(g)} + Cl_{2(g)} \quad K_p = 0.304$$

If the initial reaction vessel contains 0.760 atm of pure phosgene, calculate the equilibrium partial pressures of all three gases.

R	$COCl_2$	⇌	CO	+	Cl_2
I	.76		0		0
C	-x		+x		+x
E	.76-x		x		x

$$K_p = \frac{x^2}{.76-x} = 0.304$$

$x = -0.656$ or $x = 0.352$

$p_{COCl2,eq}$ 0.408 atm $p_{CO,\ eq}$ 0.352 atm $p_{Cl2,\ eq}$ 0.352 atm

3. The following equilibrium constants were determined at 1123 K:

$C_{(s)} + CO_{2(g)} \rightarrow 2CO_{(g)}$ $^1K_p = 1.3 \times 10^{14}$

$CO_{(g)} + Cl_{2(g)} \rightarrow COCl_{2(g)}$ $^2K_p = 6.0 \times 10^{-3}$

$C_{(s)} + CO_{2(g)} \rightarrow 2CO_{(g)}$ ^1K_p

$+ 2(CO_{(g)} + Cl_{2(g)} \rightarrow COCl_{2(g)})$ $^2K_p^2$

$C_{(s)} + CO_{2(g)} + 2Cl_{2(g)} \rightarrow 2COCl_{2(g)}$ $^1K_p \times {}^2K_p^2$

Write K_p and calculate its value at 1123 K for the following reaction

$$C_{(s)} + CO_{2(g)} + 2Cl_{2(g)} \rightarrow 2COCl_{2(g)}$$

$K_p = (1.3 \times 10^{14})(6.0 \times 10^{-3})^2 = 4.68 \times 10^9$

K_p 4.68×10^9