

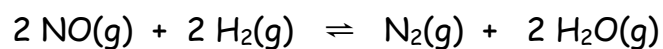
NAME:

CHM 2046

Practice Quiz 1

Answer all questions. Give your final answer with the correct units, if any, and to the correct sig. figs. **Useful Information:** $0\text{ }^\circ\text{C} \approx 273\text{ K}$, $R = 0.0820\text{ L}\cdot\text{atm/mol}\cdot\text{K}$

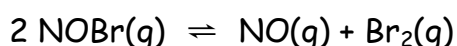
1. a) (3 points each) Balance the following reactions, if necessary, and write down their mass-action expression, Q_c



$$Q_c = \frac{[\text{N}_2][\text{H}_2\text{O}]^2}{[\text{NO}]^2[\text{H}_2]^2}$$

$$Q_c = [\text{K}]^2[\text{Cl}_2]$$

- b) (5 points) At $100\text{ }^\circ\text{C}$, $K_p = 60.6$ for the reaction



In a particular experiment, 0.35 atm (atmospheres) of NOBr , 4.0 atm of NO , and 2.0 atm of Br_2 are placed in a vessel. Is the reaction at equilibrium? Explain.

Balance first! $2\text{NOBr(g)} \rightleftharpoons 2\text{NO(g)} + \text{Br}_2\text{(g)}$

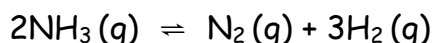
$$Q_p = \frac{P_{\text{NO}}^2 P_{\text{Br}_2}}{P_{\text{NOBr}}^2} = \frac{(4.0)^2 (2.0)}{(0.35)^2} = 2.6 \times 10^2$$

NOT at equilibrium because $Q_p \neq K_p$

If not, in which direction will it proceed? Explain.

reaction proceeds right \rightarrow left
because $Q_p > K_p$ (and Q_p must become smaller).

2. a) (4 points) Gaseous ammonia (NH_3) was introduced into a sealed container and heated to a certain temperature



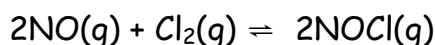
At equilibrium, $[\text{NH}_3] = 0.0250\text{ M}$, $[\text{N}_2] = 0.124\text{ M}$, and $[\text{H}_2] = 0.322\text{ M}$. Calculate K_c for this reaction at this temperature.

$$K_c = \frac{[\text{N}_2][\text{H}_2]^3}{[\text{NH}_3]^2} = \frac{(0.124)(0.322)^3}{(0.0250)^2} = 6.62$$

- b) (1 point) What will happen to the $[\text{NH}_3]$ if more N_2 is now added to the container?

Reaction shifts $\text{R} \rightarrow \text{L}$ $\therefore [\text{NH}_3] \uparrow$

- c) (4 points) For the following reaction, $K_p = 8.5 \times 10^4$ at a particular temperature.



At equilibrium, $p_{\text{NO}} = 0.35\text{ atm}$ and $p_{\text{Cl}_2} = 0.10\text{ atm}$. What is the partial pressure of NOCl(g) (p_{NOCl}) at equilibrium?

$$K_p = 8.5 \times 10^4 = \frac{P_{\text{NOCl}}^2}{P_{\text{NO}}^2 P_{\text{Cl}_2}} = \frac{P_{\text{NOCl}}^2}{(0.35)^2 (0.10)} \therefore P_{\text{NOCl}}^2 = 1041.2$$

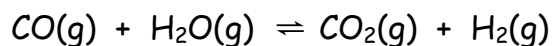
$\therefore P_{\text{NOCl}} = 32\text{ atm}$

- d) (1 point) What will happen to the p_{NO} if N_2 is now added to the container?

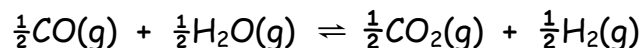
N_2 does not appear in the equation \therefore no change to P_{NO} .

3 (3 points each)

The reaction below has $K_c = 4.4$ at 300 K. Use this to answer a) and b).



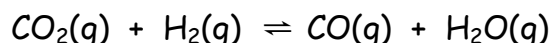
a) What is K_c for the reaction below. Explain your answer.



$$\text{New } K_c = \sqrt{\text{old } K_c}$$

$$K_c = 2.1$$

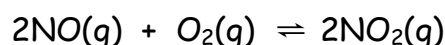
b) What is K_c for the reaction below? Explain your answer.



$$\text{New } K_c = \frac{1}{\text{old } K_c}$$

$$K_c = 0.23$$

c) $K_c = 122$ for the reaction below at 300 K? What is K_p ?



$$\text{Change in moles of gas } (\Delta n) = -1 \therefore K_p = K_c(\text{RT})^{-1} = K_c/\text{RT} = 4.96$$

$$K_p = 4.96$$

4 (10 points) Consider the following reaction at a particular temperature:



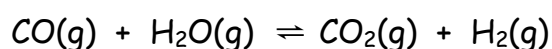
A 2.00 L flask is filled with 0.320 mol of HI and allowed to reach equilibrium. At equilibrium, $[\text{HI}] = 0.098 \text{ M}$. Calculate K_c .

	2HI (g)	=	H ₂ (g)	+	I ₂ (g)
n(init)	0.320 mol		0		0
[init]	0.160 M		0		0
[change]	-2x		+x		+x
[equil]	(0.160-2x)		x		x

$$\text{Since } [\text{HI}] = (0.160-2x) = 0.098\text{M}, x = \left(\frac{0.160 - 0.098}{2} \right) = 0.031\text{M}$$

$$\therefore K_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} = \frac{(0.031)^2}{(0.098)^2} = 0.10$$

5 (10 points) At a particular temperature, the reaction below has $K_c = 0.680$



In a 20.0 L vessel, 1.00 mol of CO and 1.00 mol of H₂O are allowed to reach equilibrium. Calculate the concentrations of all four species at equilibrium.

	CO (g)	+	H ₂ O (g)	≡	CO ₂ (g)	+	H ₂ (g)
n(init)	1.00 mol		1.00 mol		0		0
[init]	0.0500		0.0500		0		0
[change]	-x		-x		+x		+x
[equil]	(0.0500-x)		(0.0500-x)		x		x

$$K_c = 0.680 = \frac{x^2}{(0.0500-x)^2} \text{ square-rooting: } \pm 0.8246 = \frac{x}{(0.0500-x)}$$

$$\therefore x = 0.0226 \text{ (or } -0.235) \therefore x = 0.0226\text{M}$$

$$\therefore [\text{CO}_2] = [\text{H}_2] = 0.0226\text{M}$$

$$[\text{CO}] = [\text{H}_2\text{O}] = 0.0274\text{M}$$