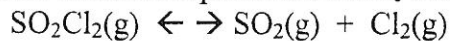


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1. Set up the equilibrium constant expressions for K_c and K_p for the following equation:



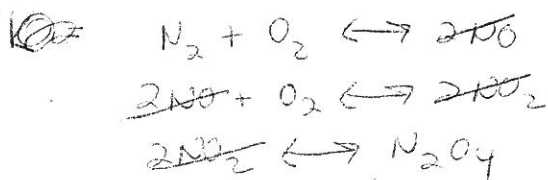
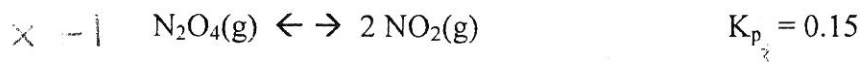
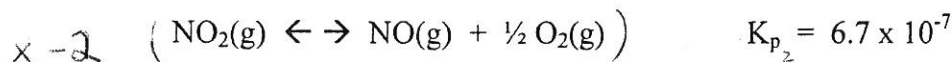
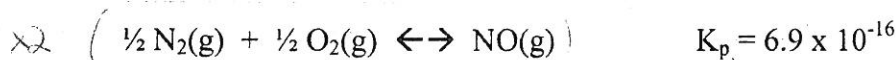
$$K_c = \frac{[\text{SO}_2][\text{Cl}_2]}{[\text{SO}_2\text{Cl}_2]}$$

$$K_p = \frac{P_{\text{SO}_2} P_{\text{Cl}_2}}{P_{\text{SO}_2\text{Cl}_2}}$$

If the $K_p = 2.9 \times 10^{-2}$ at 303 K, what is the K_c ?

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{2.9 \times 10^{-2}}{((0.0821)(303))^1} = \boxed{1.2 \times 10^{-3}}$$

2. What is the value of K_p at 298 K for the reaction: $\text{N}_2(\text{g}) + 2 \text{O}_2(\text{g}) \leftrightarrow \text{N}_2\text{O}_4(\text{g})$ given the following data?



$$K = (K_{p1})^2 \left(\frac{1}{K_{p2}}\right)^2 \left(\frac{1}{K_{p3}}\right)$$

$$= (6.9 \times 10^{-16})^2 \left(\frac{1}{6.7 \times 10^{-7}}\right)^2 \left(\frac{1}{0.15}\right)$$

$$= \cancel{6.9 \times 10^{-16}} \times \cancel{6.9 \times 10^{-16}}$$

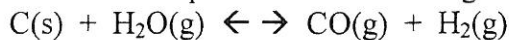
$$(4.76 \times 10^{-31}) \times (2.23 \times 10^{12}) \times (6.67)$$

$$= 7.08 \sim \boxed{7.1 \times 10^{-18}}$$

3. If the equilibrium concentrations found in the reaction $2 \text{A}(\text{g}) + \text{B}(\text{g}) \leftrightarrow \text{C}(\text{g})$ are $[\text{A}] = 2.4 \times 10^{-2} \text{ M}$, $[\text{B}] = 4.6 \times 10^{-3} \text{ M}$, and $[\text{C}] = 6.2 \times 10^{-3} \text{ M}$, calculate the value of K_c .

$$K_c = \frac{[\text{C}]}{[\text{A}]^2[\text{B}]} = \frac{6.2 \times 10^{-3}}{(2.4 \times 10^{-2})^2 (4.6 \times 10^{-3})} = \boxed{2.3 \times 10^3}$$

4. The water-gas reaction is used to produce combustible gases from carbon (coal) and steam.



$$K_p = 9.7 \times 10^{-17} \text{ at } 298 \text{ K}$$

$$\Delta H^\circ = 131 \text{ kJ}$$

What will be the effect on the final equilibrium amount of $\text{H}_2\text{(g)}$ if a gaseous mixture originally at equilibrium with a large excess of C(s) at 298 K is subjected to the following changes:

a) more H_2O is added \rightarrow , $[\text{H}_2] \uparrow$

b) a catalyst is added no shift, no change \leftarrow $[\text{H}_2]$

c) the mixture is transferred to a reaction vessel of greater volume

~~No Δ b/c
no Δ gas mol~~

d) more CO(g) is added \leftarrow , $[\text{H}_2] \downarrow$

e) an inert gas is added to the reaction vessel to increase the total pressure

of each gas do not change, no change \leftarrow $[\text{H}_2]$

f) the temperature is raised to 1000 K

endothermic \rightarrow $[\text{H}_2] \uparrow$

g) a small amount of C(s) is removed

Solids are not part of equil. expression
no change \leftarrow $[\text{H}_2]$

5. A mixture of 5.25 g I_2 and 2.15 g Br_2 is brought to equilibrium in a 3.15 L reaction vessel at 115°C . At equilibrium, 1.98 g of I_2 is present. What is K_c at 115°C for the reaction $\text{I}_2\text{(g)} + \text{Br}_2\text{(g)} \rightleftharpoons 2 \text{IBr(g)}$?

$$\frac{5.25 \text{ g I}_2}{253.82 \text{ g/mol}} = 0.0207 \text{ mol} = \frac{0.0207 \text{ mol}}{3.15 \text{ L}} = 6.57 \times 10^{-3} \text{ M I}_2$$

$$\frac{2.15 \text{ g}}{159.8 \text{ g/mol}} = 4.27 \times 10^{-3} \text{ M Br}_2$$

$$\frac{1.98 \text{ g I}_2}{253.82 \text{ g/mol}} = 2.48 \times 10^{-3} \text{ M I}_2$$

	I_2	$+$	Br_2	\rightleftharpoons	2IBr
I (M)	6.57×10^{-3}		4.27×10^{-3}		—
C	-4.09×10^{-3}		-4.09×10^{-3}		$2(4.09 \times 10^{-3})$
E	2.48×10^{-3}		1.80×10^{-4}		8.18×10^{-3}

$$K_c = \frac{[\text{IBr}]^2}{[\text{I}_2][\text{Br}_2]} = \frac{(8.18 \times 10^{-3})^2}{(2.48 \times 10^{-3})(1.80 \times 10^{-4})} = 149.9 \sim \boxed{150}$$

6. If a reaction mixture at 588 K contains 20.0 g each of CO and H₂O and 25.0 g each of CO₂ and H₂, in what direction will a net reaction occur to reach equilibrium? Explain. $\text{CO(g)} + \text{H}_2\text{O(g)} \leftrightarrow \text{CO}_2\text{(g)} + \text{H}_2\text{(g)}$ $K_c = 31.4$ at 588 K

$$\frac{20.0 \text{ g CO}}{28 \text{ g/mol}} = 0.714 \text{ mol}$$

$$\frac{20.0 \text{ g H}_2\text{O}}{18 \text{ g/mol}} = 1.11 \text{ mol}$$

$$\frac{25.0 \text{ g CO}_2}{44.0 \text{ g/mol}} = 0.568 \text{ mol}$$

$$\frac{25.0 \text{ g H}_2}{2.0 \text{ g/mol}} = 12.5 \text{ mol}$$

Volumes cancel

$$Q_c = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]}$$

$$= \frac{(0.568)(12.5)}{(0.714)(1.11)} = 8.96$$

$$Q_c < K_c$$

rxn proceeds right
to ↑ [P]

7. In the reaction $\text{Sb}_2\text{S}_3\text{(s)} + 3 \text{H}_2\text{(g)} \leftrightarrow 2 \text{Sb(s)} + 3 \text{H}_2\text{S(g)}$, $K_p = 0.429$ at 713 K. If, at equilibrium, $P_{\text{H}_2\text{S}} = 0.200 \text{ atm}$, what must be P_{H_2} and the total gas pressure, P_{Total} ?

$$P_T = P_{\text{H}_2\text{S}} + P_{\text{H}_2}$$

$$[P_{\text{H}_2\text{S}}]_{\text{eq}} = 0.200 \text{ atm}$$

$$K_p = \frac{(P_{\text{H}_2\text{S}})^3}{(P_{\text{H}_2})^3} = 0.429 = \frac{(0.200)^3}{x^3}$$

$$P_{\text{H}_2} = 0.265 \text{ atm}$$

$$P_T = 0.200 \text{ atm} + 0.265 \text{ atm}$$

$$= 0.465 \text{ atm}$$