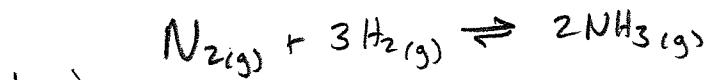


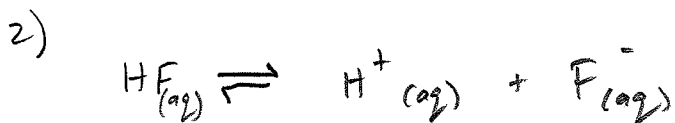
## Chemical Equilibria I



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

b) concentration of reactants are much greater than products. Therefore  $K_{\text{eq}}$  will be  $\ll 1$  reactants are favored

c) 
$$K_{\text{c}} = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{(0.01)^2}{(1.5)(2.00)^3} = 1.67 \times 10^{-5}$$



a) 
$$K_{\text{eq}} = K_{\text{c}} = \frac{[\text{H}^+][\text{F}^-]}{[\text{HF}]}$$

b) In this case, the equil concentration of HF is very large compared to  $\text{H}^+$  and  $\text{F}^-$ . Therefore  $K_{\text{eq}}$  will be  $\ll 1$  Reactants are favored.

c) 
$$K_{\text{c}} = \frac{[\text{H}^+][\text{F}^-]}{[\text{HF}]} = \frac{(0.001)(0.001)}{(0.55)} = 1.82 \times 10^{-6}$$

3) a) 
$$K_{eq} = K_c = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^{-}]}$$

b) at equilibrium, The products are roughly equal to the reactants  $[FeSCN^{2+}] \approx [SCN^{-}]$  therefore the equilibrium is fairly even.

c) 
$$K_c = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^{-}]} = \frac{[0.001]}{[0.001][0.55]} = 1.82$$

Note, this is fairly close to 1 is the equil favors an even amount of prod + reactants as stated in (b)

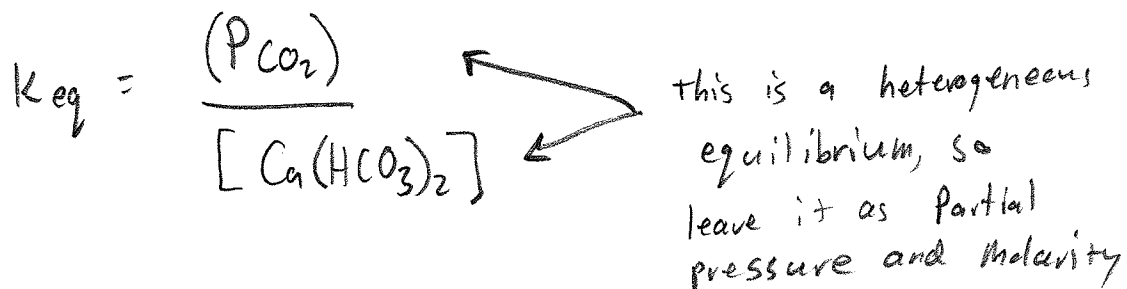
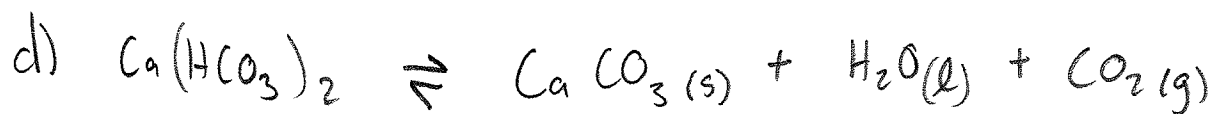
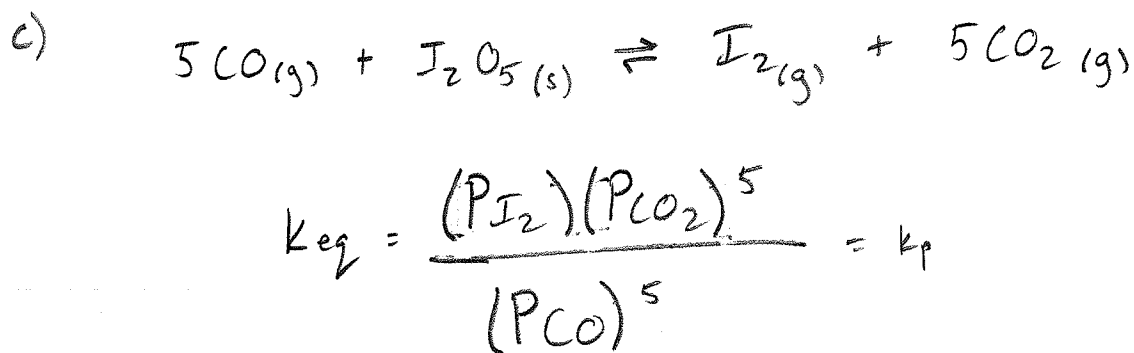
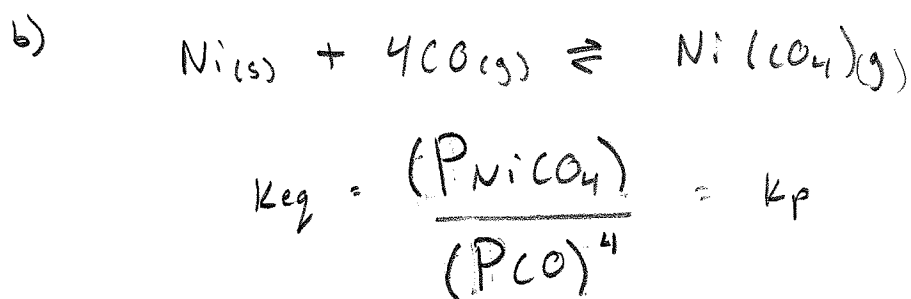
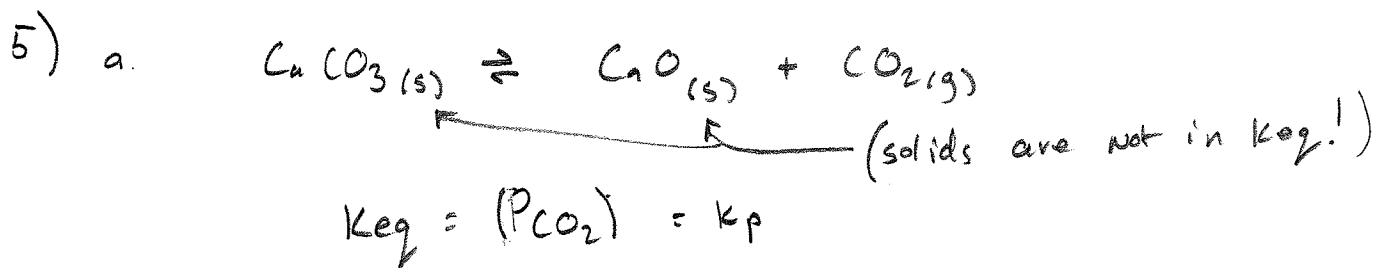
4 a) 
$$\frac{1g}{1mL} \times \frac{1000mL}{1L} = \frac{1000g}{L} \text{ or } \frac{1kg}{L}$$

$$\frac{1000g H_2O}{18.01528g H_2O} = 55.508 \text{ mol } H_2O$$

$$\frac{55.508 \text{ mol}}{1L} = \boxed{55.508 \text{ M } H_2O}$$

- At this temp you can NOT get any more moles of  $H_2O$  into this liter, because you can not dissolve (autoionize) water any more. (If you change the temp  $\uparrow$ , volume  $\uparrow$  and molarity  $\downarrow$ )

- The  $[H_2O]$  is NOT constant.  $\uparrow$  temp  $\uparrow$  volume  $\downarrow$  Molarity.  
or  $\downarrow$  Temp  $\downarrow$  volume  $\uparrow$  Molarity.





$$K_{eq} = [\text{Ag}^+][\text{Cl}^-] = K_{sp}$$

$$6 \ a) \quad K_p = \frac{(P_{\text{N}_2})^2 (P_{\text{H}_2\text{O}})^6}{(P_{\text{NH}_3})^4 (P_{\text{O}_2})^3} = 1 \times 10^{228} \text{ atm}$$

$K_{eq} \gg 1$   
products favored!

$$b) \quad K_p = \frac{(P_{\text{NO}})^2}{(P_{\text{N}_2})(P_{\text{O}_2})} = 5 \times 10^{-31}$$

$K_{eq} \ll 1$   
reactants favored

$$c) \quad K_p = \frac{(P_{\text{H}_2})(P_{\text{F}_2})}{(P_{\text{HF}})^2} = 1 \times 10^{-13}$$

$K_{eq} \ll 1$   
reactants favored

$$d) \quad K_p = \frac{(P_{\text{NO}})^2 (P_{\text{Cl}_2})}{(P_{\text{NOCl}})^2} = 4.7 \times 10^{-4} \text{ atm}$$

$K_{eq} < 1$   
reactants favored

Rank of reactions in order of increasing tendency to completion:

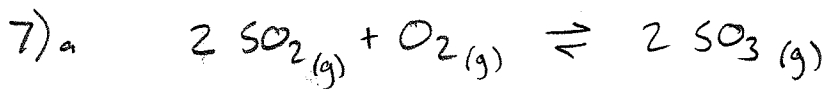
Least complete  
(react favored)

Most complete  
(prod favored)

B    C    D    A

Question You should be able to answer:

$K_p$  don't have units because they cancelled in part (b) and (c) units were raised to same power top and bottom.



$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]} = \frac{(3.50)^2}{(1.5)^2 (1.25)} = 4.356 \text{ M}^{-1}$$

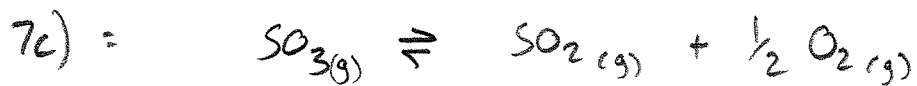


$$K_c = \frac{[\text{SO}_2]^2 [\text{O}_2]}{[\text{SO}_3]^2} = \frac{(1.5)^2 (1.25)}{(3.50)^2} = 0.230 \text{ M}$$

Comparing 7a to 7b we see that

$K_c$  is inverted for the reverse reaction

$$K_c \text{ forward} = \frac{1}{K_c} \text{ for reverse.}$$



$$K_c = \frac{[\text{SO}_2][\text{O}_2]^{1/2}}{[\text{SO}_3]}$$

comparing  $K_c$  to  $K_c$  in part b, we see that by multiplying coefficients by  $\frac{1}{2}$ , you actually raise  $K_c$  to the  $\frac{1}{2}$  power (square root it)

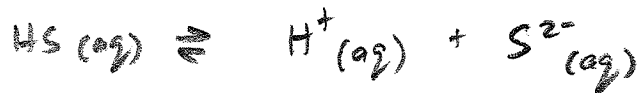
7d) since multiplying any coefficients raises  $K_c$  to that power, multiplying the coefficients by 2 would result in  $(K_c)^2$

Summarize.

Equation	$K_c$ expression + Value
doubled	$(K_c)^2$
reversed	$\frac{1}{K_c}$
halved	$(K_c)^{1/2}$

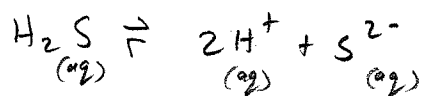


$$K_{c1} = \frac{[\text{H}^+][\text{HS}^-]}{[\text{H}_2\text{S}]}$$



$$K_{c2} = \frac{[\text{H}^+][\text{S}^{2-}]}{[\text{HS}]}$$

a) Overall reaction



$$K_c = \frac{[\text{H}^+]^2 [\text{S}^{2-}]}{[\text{H}_2\text{S}]}$$

$$K_1 \cdot K_2 = K_c$$

$$\frac{[\text{H}^+][\text{HS}]}{[\text{H}_2\text{S}]} \cdot \frac{[\text{H}^+][\text{S}^{2-}]}{[\text{HS}]} = K_c$$

$$\frac{[\text{H}^+][\text{H}^+][\text{S}^{2-}]}{[\text{H}_2\text{S}]} = K_c = \frac{[\text{H}^+]^2 [\text{S}^{2-}]}{[\text{H}_2\text{S}]}$$

