← my 4 year old decided my paper needed decorating!

Unit 7 Study guide

① a

② c

③ b

$NaOH(s) \Longleftrightarrow Na^+(aq) + OH^-(aq) + 10.6$ kcal

④

Stress	Equilibrium Shift	Amount NaOH(s)	$[Na^+]$	$[OH^-]$	K
Add NaOH(s)	→	-------	↑	↓	same
Add NaCl (adds Na^+)	←	↑	-------	↓	same
Add KOH (Adds OH^-)	←	↑	↓	-------	same
Add H^+ (Removes OH^-)	→	↓	↑	-------	same
Increase Temperature	←	↑	↓	↓	changes decreases
Decrease Temperature	→	↓	↑	↑	changes increases
Increase Pressure	NO effect - no gases				same
Decrease Pressure					same

⑤ a) $K_c = \frac{[NH_4^+][OH^-]}{[NH_3]}$ (leave out $H_2O(l)$)

b) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

	NH_3	NH_4^+	OH^-
i	.75M	0	0
c	$-x$	$+x$	$+x$
e	$.75-x$	x	x

plug into K_c: $1.8 \cdot 10^{-5} = \frac{(x)(x)}{.75-x} = \frac{x^2}{.75}$ $x = .0037$

↑ negligible due to small k

$[NH_3] = .75M$
$[NH_4^+] = [OH^-] = .0037\ M$

c) $Q = \frac{[NH_4^+][OH^-]}{[NH_3]} = \frac{(.0025M)(.0025M)}{(.50M)} = 1.3 \cdot 10^{-5}$

$Q < K_c$, so Rxn will shift left + produce more reactants

d) Acid/base - an H^+ is transferred from H_2O to NH_3

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
base, acid, c.acid, c.base

← from my 4-year-old

(16) a) $t = 100$ min

b) $2\,SO_2 + O_2 \rightleftharpoons 2\,SO_3$

$[SO_2] = \frac{3.0\text{ mol}}{5.0\text{ L}} = .60\text{ M}$

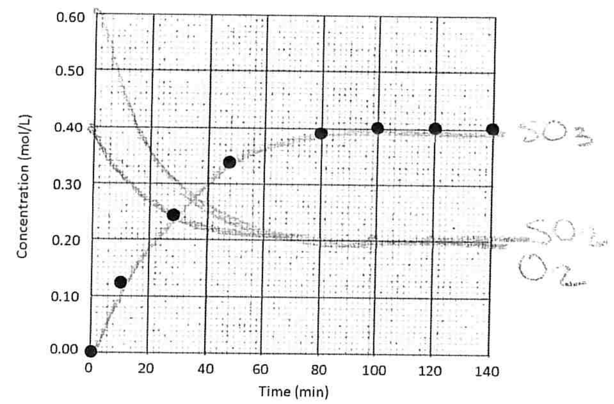
$[O_2] = \frac{2.0\text{ mol}}{5.0\text{ L}} = .40\text{ M}$

	$2\,SO_2$	O_2	$2\,SO_3$
I	.60	.40	0
C	$-2x$	$-x$	$+2x$
E	$.60-2x = .20$	$.40-x = .20$	$2x = .40$

$x = .20$

$[SO_2] = .20\text{ M}$
$[O_2] = .20\text{ M}$

c)



d) $K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$

e) $K_c = \frac{(.40\text{ M})^2}{(.20\text{ M})^2(.20\text{ M})} = \boxed{20.}$

f) i) original equation is reversed. $K_{new_1} = \frac{1}{K_c} = .050$

ii) original equation x2 $K_{new_2} = (K_c)^2 = 4.0 \cdot 10^2$

iii) Reversed, $\times \frac{1}{2}$ $K_{new_3} = \left(\frac{1}{K_c}\right)^{1/2} = .22$

g) homogeneous - all species are same phase (g)

h) adding a catalyst does not change K (only T does)
a catalyst just makes equilibrium get reached faster

i) no effect - same T means same K

(7) a) $2CO_2 + \cancel{H_2O} \rightleftharpoons \cancel{2O_2} + CH_2CO$ $\quad K_{p1} = \frac{1}{1.6\cdot10^{-9}} = 6.3\cdot10^{8}$

$CH_4 + \cancel{2O_2} \rightleftharpoons \cancel{CO_2} + \cancel{2}H_2O$ $\quad K_{p2} = 1.2\cdot10^{14}$

$CO_2 + CH_4 \rightleftharpoons CH_2CO + H_2O$ $\quad K_p = K_{p1}\cdot K_{p2}$

$= (6.3\cdot10^{8})(1.2\cdot10^{14})$

$= \boxed{7.6\cdot10^{22}}$

b) $CO_2 + CH_4 \rightleftharpoons CH_2CO + H_2O$

	CO_2	CH_4	CH_2CO	H_2O
I	.50 atm	.30 atm	0	0
C	$-x$	$-x$	$+x$	$+x$
E	$.50-x$	$.30-x \approx 0$	x	x
	.20	0	.30	.30

K_p is very large, so $P_{CH_4} \approx 0$ (but not $= 0$)

$P_{CH_2CO} = P_{H_2O} = .30$ atm

$P_{CO_2} = .20$ atm

$P_{CH_4} \approx 0$ atm

(8) a) $BaCO_{3(s)} \rightleftharpoons Ba^{2+}(aq) + CO_3^{2-}(aq)$

b) $\qquad x \qquad x$

$K_{sp} = [Ba^{2+}][CO_3^{2-}]$

$5.0\cdot10^{-9} = x\cdot x$ $\quad \boxed{x = 7.1\cdot10^{-5}\ M}$

(9) a) $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$

b) $\qquad x \qquad 2x$

$K_{sp} = [Ca^{2+}][F^-]^2$

$3.9\cdot10^{-11} = (x)(2x)^2 = 4x^3$ $\quad \boxed{x = 2.1\cdot10^{-4}\ M}$

$\frac{2.1\cdot10^{-4}\ mol}{L} \cdot \frac{70.08\ g}{1\ mol\ CaF_2} = \boxed{.017\ g/L}$

c) $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$ $\quad 3.9\cdot10^{-11} = (x)(.025)^2$

	Ca^{2+}	$2F^-$
I	0	.025
C	$+x$	$+2x$
E	x	$.025+2x$

$\boxed{x = 6.2\cdot10^{-8}\ M}$

$2x$: assume negligible b/c K_{sp} is so small

(9) d) CaF_2 is much less soluble in .025M NaF because F^- ions are already present. Using the same Ksp value (same T), a larger $[F^-]$ will mean smaller $[Ca^{2+}]$ from dissolving CaF_2.

e) Calcium fluoride $K_{sp} = [Ca^{2+}][F^-]^2$

barium carbonate $K_{sp} = [Ba^{2+}][CO_3^{2-}]$

$[F^-]^{(2)}$ in CaF_2 Ksp is squared, which impacts Ksp values

AP Problems

(1) $Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$

a) $K_{sp} = [Ag^+]^2[CrO_4^-]$

b) $Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

2x   x

$2.6 \cdot 10^{-12} = (2x)^2(x) = 4x^3$

$x = 8.7 \cdot 10^{-5} M$

$[Ag^+] = 2x = 1.7 \cdot 10^{-4} M$

c) molar solubility $= 8.7 \cdot 10^{-5} M$

$\frac{8.7 \cdot 10^{-5} \text{ mol}}{L} \cdot \frac{331.74 g}{1 \text{ mol}} = \frac{.029 g}{L} \cdot .100 L = .0029 g$

d) $\frac{.100 \text{ mol } AgNO_3}{1.00 L} = .100M\ AgNO_3$

$Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

	$2Ag^+$	CrO_4^{2-}
I	.100	0
C	+2x	x
E	.100 +2x	x

(2x) negligible b/c of small Ksp

$K_{sp} = [Ag^+]^2[Cr^-]$

$2.6 \cdot 10^{-12} = (.100)^2(x)$

$x = 2.6 \cdot 10^{-10} M$

$[CrO_4^{2-}]$ decreases when compared to part c.

e) $Ag_3PO_4(s) \rightleftharpoons 3Ag^+(aq) + PO_4^{3-}(aq)$

f) $3x \qquad x$

$5.3 \cdot 10^{-5} M \qquad \frac{5.3 \cdot 10^{-5} M}{x} = 1.8 \cdot 10^{-5} M$

$K_{sp} = [Ag^+]^3 [PO_4^{3-}]$

$= (5.3 \cdot 10^{-5} M)^3 (1.8 \cdot 10^{-5} M) = \boxed{2.6 \cdot 10^{-18}}$

g) $[Ag^+]$ stays the same. K_{sp} doesn't change. As H_2O evaporates more Ag_3PO_4 will precipitate

$131 kJ + C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

a) # moles CO will decrease as H_2 is added. The reaction will shift towards reactants to consume additional H_2. CO will react w/ H_2 until equilibrium is reached again.

b) # moles CO will increase. Rxn will produce more products to relieve the extra heat

c) # moles CO will decrease. Rxn will produce more reactants to alleviate extra pressure

d) no change in CO. C is not involved in equilibrium expression.

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① a) $K_c = \frac{[H_2]^2[S_2]}{[H_2S]^2}$

b) $2H_2S \rightleftharpoons 2H_2 + S_2$

	$2H_2S$	$2H_2$	S_2
i	.0798M	0	0
c	-2x	2x	x
e	.0798M-2x	2x	x = $\boxed{[S_2]\ .0298M}$
	.0203M	2x = $\boxed{[H_2]\ .0595M}$	

$\frac{3.40 g\ H_2S}{} \Big| \frac{1 mol}{34.08 g} = .0998\ mol\ H_2S$

$\frac{.0998\ mol\ H_2S}{1.25 L} = .0798 M$

$\frac{3.72 \cdot 10^{-2} mol\ S_2}{1.25 L} = .0298 M$

c) $K_c = \frac{(.0595M)^2(.0298M)}{(.0203M)^2} = \boxed{.256}$

d) $3.72 \cdot 10^{-2}$ mol S_2

$P_{S_2} = ?$

$V = 1.25\,L$

$R = .08206\ L\,atm/mol\,K$

$T = 483\,K$

$PV = nRT$

$P = \frac{nRT}{V} =$

$= \frac{(3.72 \cdot 10^{-2}\ mol)(.08206\ \frac{L\,atm}{mol\,K})(483\,K)}{1.25\,L}$

$= \boxed{1.18\ atm}$

e) $H_2 + \frac{1}{2} S_2 \rightleftharpoons H_2S$

$2H_2S \rightleftharpoons 2H_2 + S_2$

Reverse $2H_2 + S_2 \rightleftharpoons 2H_2S$

$\frac{1}{K_c}$

$\frac{1}{2}(2H_2 + S_2 \rightleftharpoons 2H_2S)$

$\left(\frac{1}{K_c}\right)^{1/2}$

$\left(\frac{1}{.256}\right)^{1/2} = \boxed{1.98}$