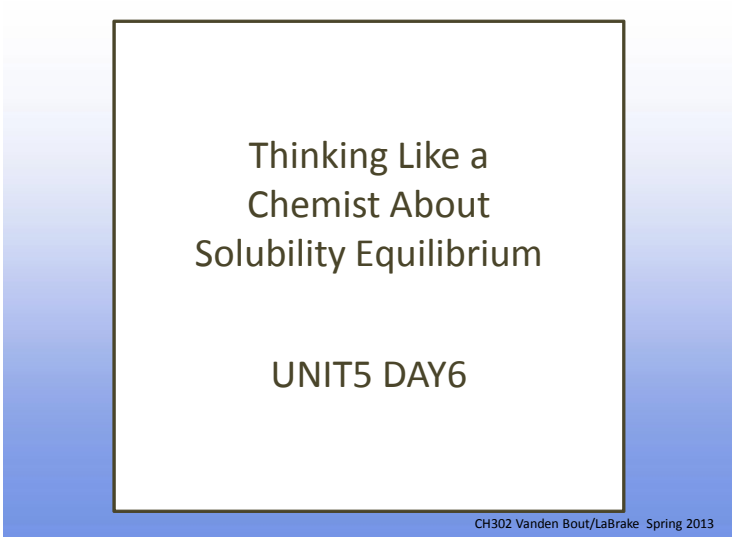
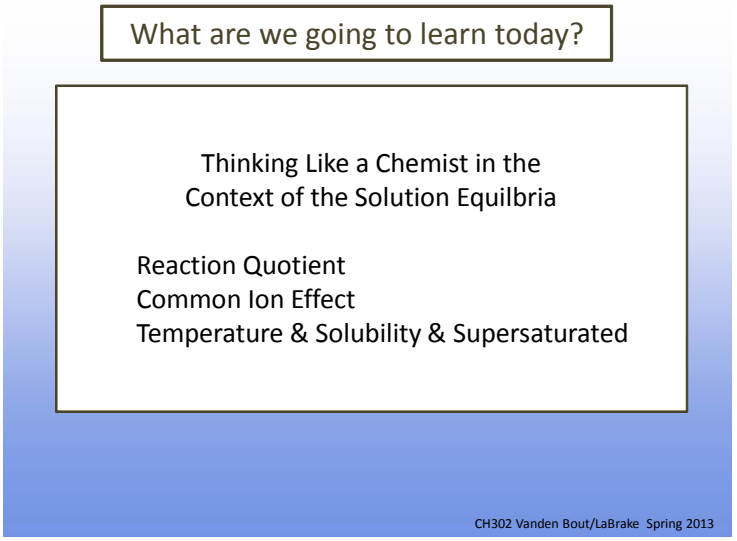
UNIT5-DAY6-LaB1230pm

Thursday, January 31, 2013
8:27 AM





IMPORTANT INFORMATION

LM10 and LM11 due this morning
NG LM 100 – How to succeed on the exam
LM12 and HW3 due Tue 9AM

Looking ahead:
EXAM 1, Feb 6th 7 – 9 PM
Details of room assignments will be posted on website next week

1-3
one-on-one help

Quiz: Clicker Question 1

The K_{sp} expression for the dissolution of $Cd_3(PO_4)_2$ is:

A. $K_{sp} = [Cd^{2+}][PO_4^{3-}]$
B. $K_{sp} = [Cd^{2+}]^2[PO_4^{3-}]^2$
C. $K_{sp} = [x]\,[y]$
D. $K_{sp} = [x]^2\,[x]^3$
E. $K_{sp} = [Cd^{2+}]^3[PO_4^{3-}]^2$

Quiz

Quiz Clicker Question 2

The net ionic equation for the following is:

$(NH_4)_2CO_{3(aq)} + CaCl_{2(aq)} \rightarrow$

A. $(NH_4)_2CO_3(aq) + CaCl_2(aq) \rightarrow 2NH_4Cl(aq) + CaCO_3(aq)$
B. $(NH_4)_2CO_3(aq) + CaCl_2(aq) \rightarrow 2NH_4Cl(aq) + CaCO_3(s)$
C. $2NH_4^+(aq) + CO_3^{2-}(aq) + Ca^{2+}(aq) + 2Cl^- \rightarrow 2NH_4^+(aq) + 2Cl^-(aq) + CaCO_3(s)$
D. $2NH_4^+(aq) + CO_3^{2-}(aq) + Ca^{2+}(aq) + 2Cl^- \rightarrow CaCO_3(s)$
E. $CO_3^{2-}(aq) + Ca^{2+}(aq) \rightarrow CaCO_3(s)$

A few useful definitions and ideas

Precipitation

Insoluble solid that forms and drops out of solution

Spectator Ions

Ions that don't participate in the chemistry

What is soluble?

Many solubility rules

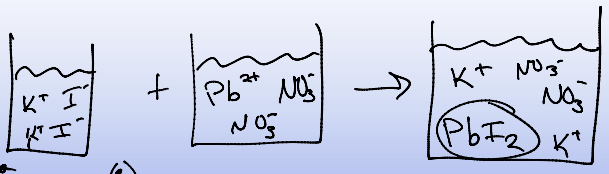
→ Typically K_{sp} is given for insoluble compounds ←

✕ All Na^+, K^+, and NO_3^- salts are soluble NH_4^+ ←

Group 1A

MIX SOME SOLUTIONS TOGETHER AND WRITE THE EQUATIONS

Mix a solution of lead II nitrate with a solution of potassium iodide
Fully describe:



formula $Pb(NO_3)_2^{(aq)} + 2KI_{(aq)} \rightarrow PbI_{2(s)} + 2K^+ + 2NO_3^-$

ionic $Pb^{2+} + 2NO_3^- + 2K^+ + 2I^- \rightarrow PbI_{2(s)} + 2K^+ + 2NO_3^-$

Net $Pb^{2+}_{(aq)} + 2I^-_{(aq)} \rightarrow PbI_{2(s)}$

POLL: Clicker Question 3

The Ksp of PbI_2 is 1.4×10^{-8}. Predict $[Pb^{2+}]$ and $[I^-]$ in the saturated solution.

A. $[Pb^{2+}] = 4.7 \times 10^{-9}$ $[I^-] = 4.7 \times 10^{-9}$
B. $[Pb^{2+}] = 4.7 \times 10^{-9}$ $[I^-] = 9.3 \times 10^{-9}$
C. $[Pb^{2+}] = 1.5 \times 10^{-3}$ $[I^-] = 3.0 \times 10^{-3}$
D. $[Pb^{2+}] = 8.4 \times 10^{-5}$ $[I^-] = 1.7 \times 10^{-4}$

molar solubility → solubility of PbI_2 in a 1:1 ratio w/ Pb^{2+}

$K_{sp} = [Pb^{2+}][I^-]^2$

$PbI_2 \rightarrow Pb^{2+} + 2I^-$

ICE

	0	0
	+x	+2x
	+x	+2x

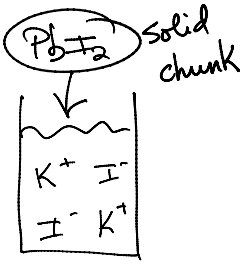
$[Pb^{2+}] = x$

$[I^-] = 2x$

$K_{sp} = x(2x)^2 = 1.4 \times 10^{-8}$

$4x^3 = 1.4 \times 10^{-8}$

$x = 1.5 \times 10^{-3}$



0.5M KI

What happens to the solubility?

$K_{sp} = [Pb^{2+}][I^-]^2 = 1.4 \times 10^{-8}$

must go down — increases from common ion

POLL: Clicker Question 4

The Ksp of PbI_2 is 1.4×10^{-8}. Predict $[Pb^{2+}]$ and $[I^-]$ in the saturated solution after the addition of 0.5 moles of KI.

PbI_2

POLL: Clicker Question 4

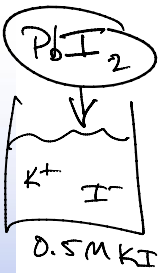
The Ksp of PbI_2 is 1.4×10^{-8}. Predict $[Pb^{2+}]$ and $[I^-]$ in ~~the saturated solution after the addition of 0.5 moles of KI.~~ the solution described

A. $[Pb^{2+}] = 1.5 \times 10^{-3}$ $[I^-] = 3.0 \times 10^{-3}$

B. $[Pb^{2+}] = 1.5 \times 10^{-3}$ $[I^-] = 1.5 \times 10^{-3}$

C. $[Pb^{2+}] = 5.6 \times 10^{-8}$ $[I^-] = 0.5$

D. $[Pb^{2+}] = 5.6 \times 10^{-8}$ $[I^-] = 0.25$



$K_{sp} = [Pb^{2+}][I^-]^2$

R $PbI_2 \rightarrow Pb^{2+} + 2I^-$

I $\quad\quad \varnothing \quad\quad 0.5$

C $\quad\quad +x \quad\quad +2x$

E $\quad\quad +x \quad\quad 0.5+2x$

$K_{sp} = x(0.5+2x)^2 = 1.4 \times 10^{-8}$

in common ion effect

very small $x \ll 0.5$ so we ignore it!

$K_{sp} = x(0.5)^2 = 1.4 \times 10^{-8}$

$x = 5.6 \times 10^{-8}$

Reaction Quotient, Q

Q is the value of the ion product at any point in a process, not necessarily at the equilibrium ion concentrations.

Q is useful, because you can compare it to the value of K to decide if a precipitate will form.

Q = K at equilibrium

Q > K, precipitates

Q < K all ions, no precipitate

at equilibrium $K_{sp} = [Pb^{2+}][I^-]^2$ ideal

$Q_{sp} = [Pb^{2+}][I^-]^2$ reality

whatever you have, right now

POLL: Clicker Question 5

Reaction Quotient, Q

AgCl $K_{sp} = 1.8 \times 10^{-10}$

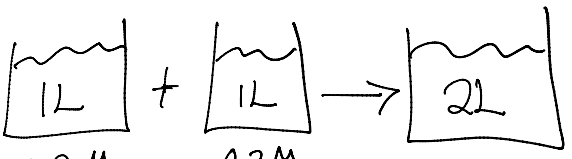
$Q = 1.8 \times 10^{-6}$

Will a precipitate form?

A. Yes

B. No

Q > K



0.2 M $Pb(NO_3)_2$

moles?

0.2 moles Pb^{2+}

0.2M KI

$[Pb^{2+}] = \frac{0.2 \text{ moles}}{2L} = 0.1M$

$[I^-] = \frac{0.2 \text{ moles}}{2L} = 0.1M$

Quiz: Clicker Question 6

Mix 1 liter of 0.2 molar of the lead salt with 1 liter of 0.2 molar of the iodide salt.
What is the value of Q_{sp} and will a precipitate form?

A. $Q_{sp} = 1.4 \times 10^{-8}$; no
B. $Q_{sp} = 1.0 \times 10^{-3}$; no
C. $Q_{sp} = 1.0 \times 10^{-3}$; yes
D. $Q_{sp} = 4.0 \times 10^{-3}$; yes

$Q_{sp} = [Pb^{2+}][I^-]^2$

$K_{sp} = 1.4 \times 10^{-8}$

$Q = (0.1)(0.1)^2$

$Q = 1.0 \times 10^{-3}$

We just have these concentrations

$[Pb^{2+}] = 0.1M$

$[I^-] = 0.1M$

from the problem given

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Quiz: Clicker Question 7

What is the mass of the PbI_2 that was precipitated?

A. 461 g PbI_2
B. 46.1 g PbI_2
C. 92.2 g PbI_2
D. Impossible to tell because equilibrium

Assume 100% complete

$Pb^{2+} + 2I^- \rightarrow PbI_2$

0.2 moles 0.2 moles
(0.1M, 2L) (0.1M, 2L)

Limiting Reactant?
I^- (need 2x as much)

Try it on your own
Have 0.1 moles Pb^{2+} left over
very little I^- will dissolve back

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Quiz: Clicker Question 8

What concentration will the lead ion need to be dropped to to prevent precipitation?

A. 7.0×10^{-9} M
B. 7.0×10^{-8} M
C. 1.4×10^{-10} M
D. 1.4×10^{-6} M

Temperature Dependence of Solubility –

Solubility Increases with ↑ T (increasing) for ENDOTHERMIC solutions

because makes K_{sp} bigger

Solubility Decreases with ↑ T (increasing) for EXOTHERMIC solutions

because makes K_{sp} smaller

K_{sp} changes w/ temperature

DEMONSTRATE

Solubility Increases with T for ENDOTHERMIC solutions

because makes K_{sp} bigger

SUPER SATURATED SOLUTION

METASTABLE SOLUTION

What did we learn today?

Solubility is an equilibrium condition.

Determine the solubility of an insoluble salt in the presence of a common ion.

Q is the reaction quotient and indicates the extent of the reaction.

Learning Outcomes

Calculate solubilities in the presence of a common ion.

Given concentrations of specific ions, predict if a precipitate will form (amount or concentration) using the concept of the reaction quotient, Q.