Salts and Solubility

Clicker questions for 5 actvitites

Each set of clicker questions and the activity can be downloaded from the Teaching Ideas database at PhET

by Trish Loeblein updated July 2008

Salts and Solubility Activity1

Learning Goals Students will be able to:

- Determine the chemical formula by observation of ionic ratios in solutions
- Relate the simulation scale to real lab equipment through illustration and calculations
- Predict the chemical formula of compounds with a variety of ion charge combinations

Trish Loeblein July 2008 Questions 1-3 are a pretest. 4-8 are reflective

1. Which is the formula for the compound made from M^{+1} and N^{-2}

A. MN_2

B. M_2N

C. MN

D. M_2N_2

2. Which is the formula for the compound made from M^{+3} and N^{-1}

A. MN_3

B. $M_3\ N$

C. MN

D. $M_3\ N_3$

3. Which is the formula for the compound made from M^{+3} and N^{-2}

A. MN

B. $M_3 N_2$

C. $M_2 N_3$

D. $M_6 N_6$

4. I thought this lab was _____ USEFUL for learning about ionic formulas.

A. very

B. mostly

C. barely

D. not

5. I thought this lab was _____ ENJOYABLE for learning about ionic formulas.

A. very

B. mostly

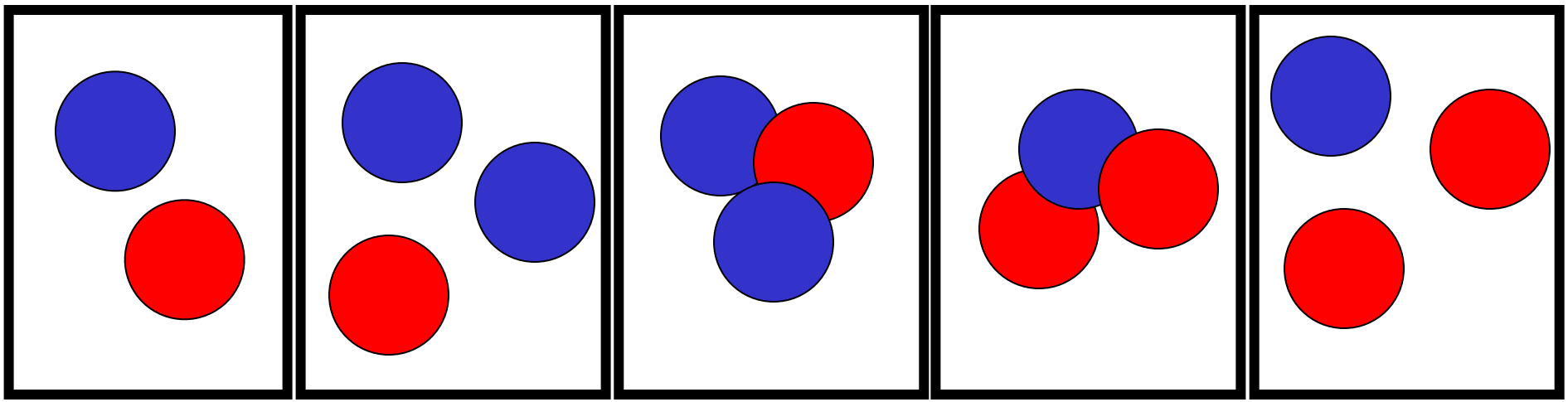
C. barely

D. not

6. Which is the best drawing for Magnesium chloride in a water solution?

Mg

Cl

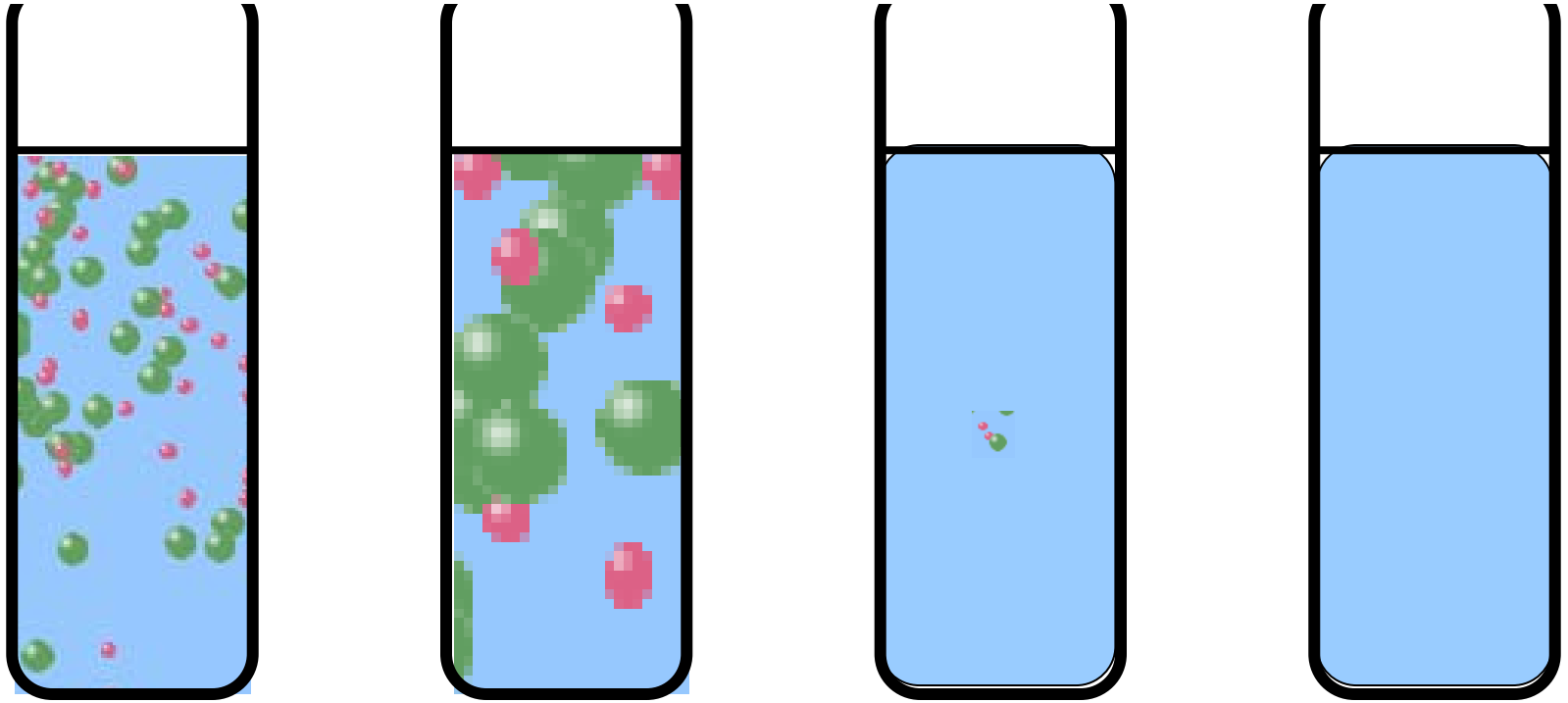


A B C D E

7. How would the drawing change if Magnesium chloride were changed to Magnesium oxide?

A. The ratio of the ions would be the same
B. The ratio would change to 1 magnesium for every oxide
C. The ratio would change to 2 magnesium for every oxide
D. You would have to use different colors

8. Which drawing best represents how large ions should be drawn in a 5 ml test tube of water?



A B C D

Salts and Solubility Activity 2

Learning Goals: Students will be able to:

- Write the dissolving reaction for salts
- Describe a saturated solution microscopically and macroscopically with supporting illustrations
- Calculate solubility in grams/100ml
- Distinguish between soluble salts and slightly soluble salts macroscopically.

Trish Loeblein July 2008

1. Which is correct for dissolving barium iodide in water ?

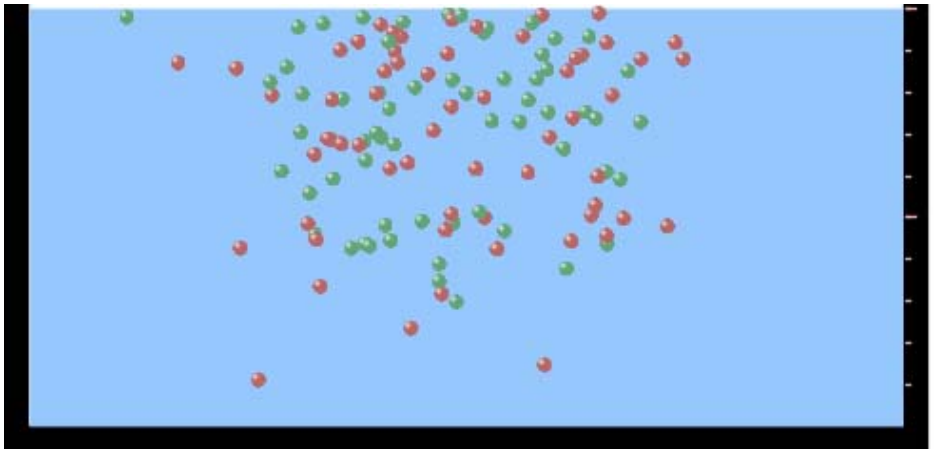
A. $BaI_{2(s)} \rightarrow Ba_{(aq)} + 2I_{(aq)}$

B. $BaI_{(s)} \rightarrow Ba_{(aq)} + I_{(aq)}$

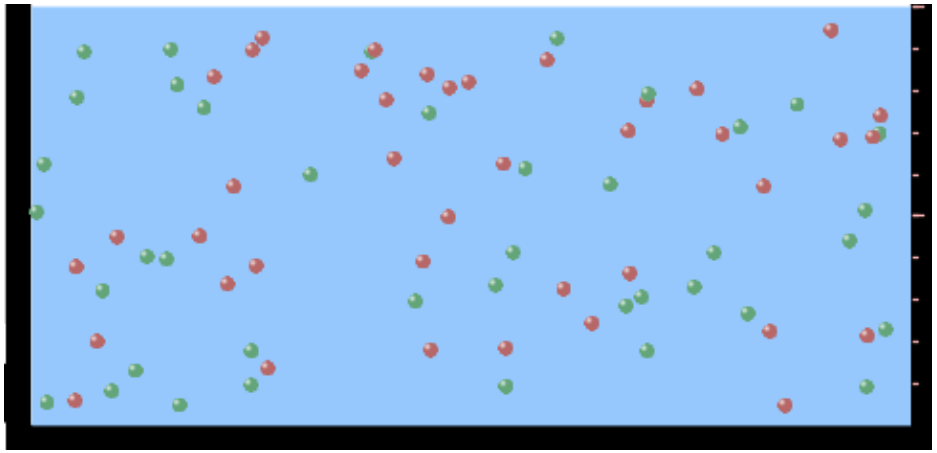
C. $BaI_{2(s)} \rightarrow Ba^{+2}_{(aq)} + 2I^{-}_{(aq)}$

D. $BaI_2 \rightarrow Ba^{+2} + 2I^{-}$

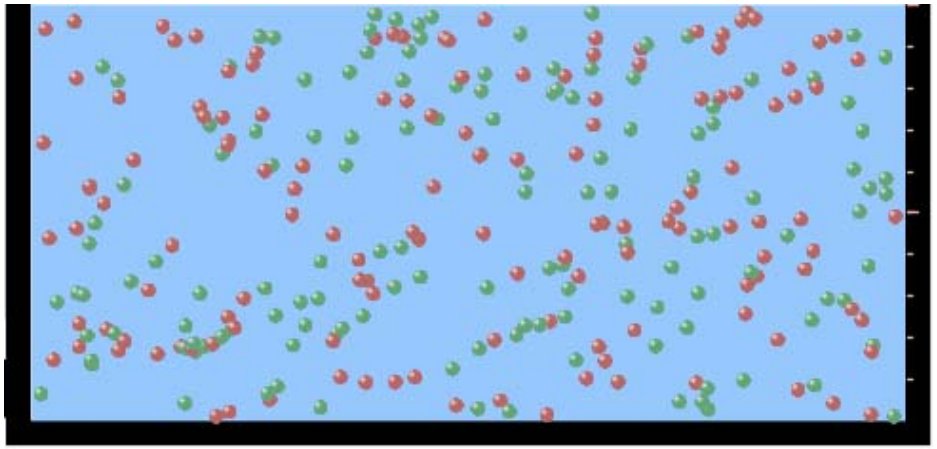
2. Sue used *Salts* to learn about “saturated solution”. Which image best shows a saturated solution?



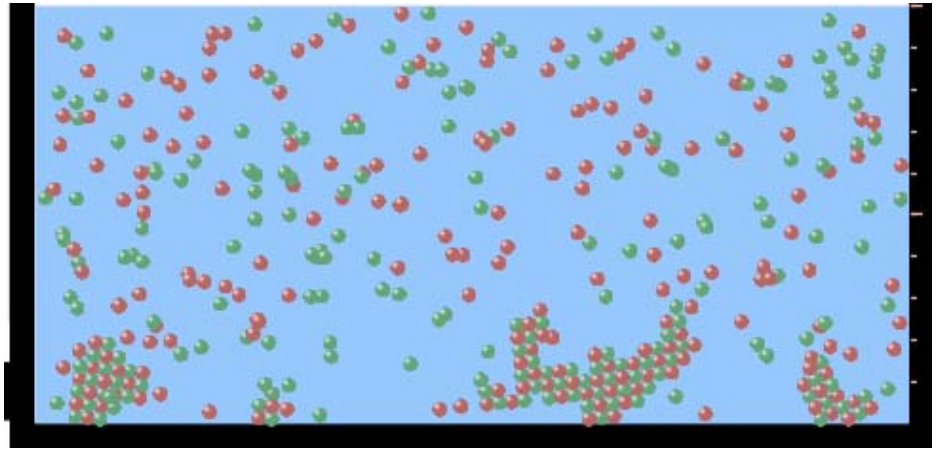
A



B

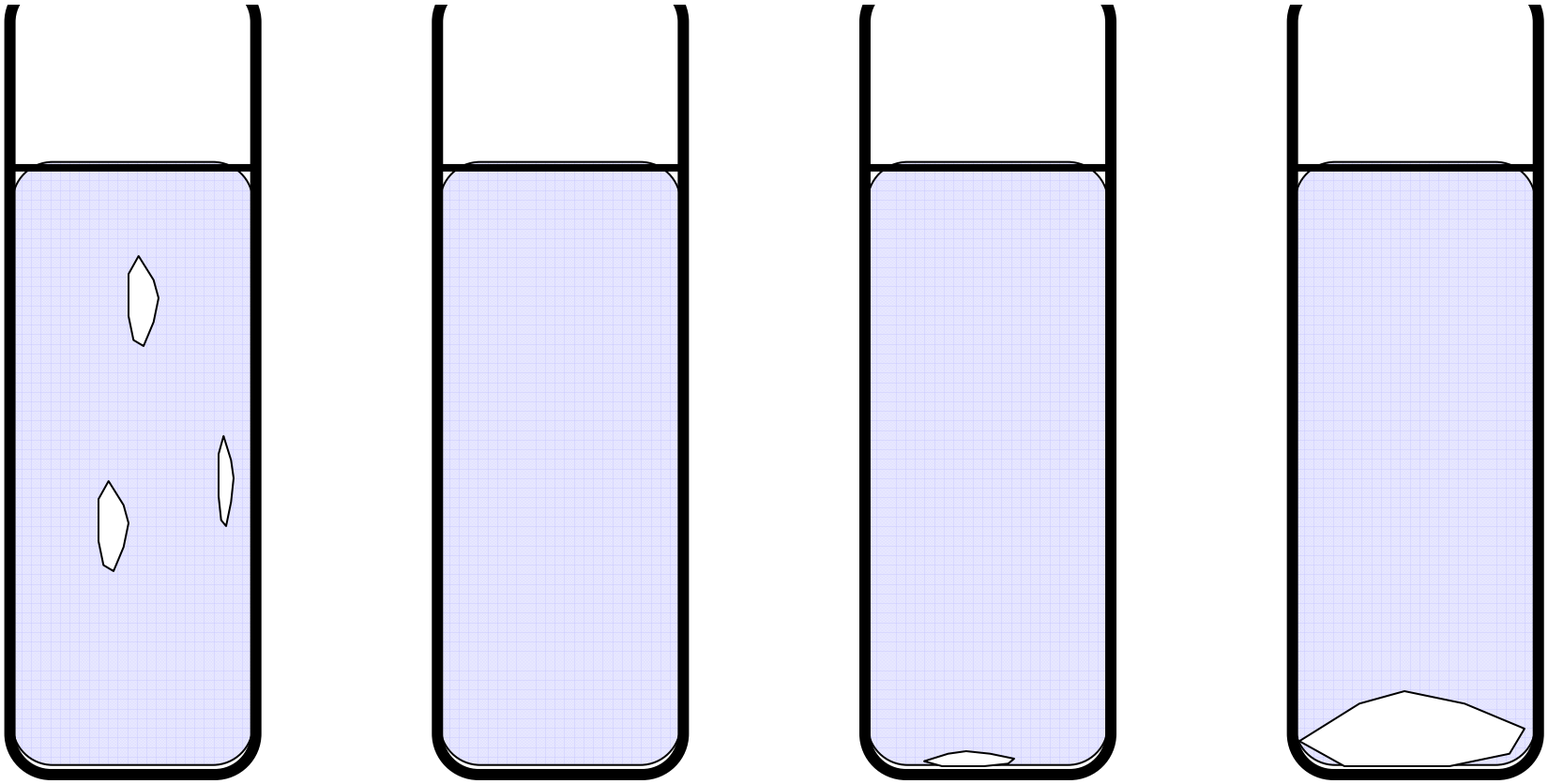


C



D

3. Waldo added salt to a test tube of water to learn about “saturated solution”. Which image best shows a saturated solution?



A B C D

4. If you used the sim to test silver chloride, you would see 80 Ag^+ ions dissolved in 1E-17 liters. What is the solubility in 100 ml of water?

A. .0019 grams/100 ml water

B. .00019 grams/100 ml water

C. .0014 grams/100 ml water

D. .00014 grams/100 ml water

The calculation for AgCl example:

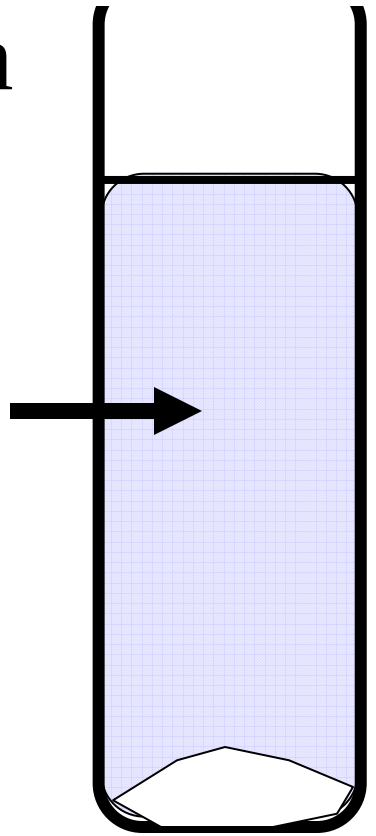
80 AgCl /6.02E23 AgCl/mole) *(143.5grams/mole)
= 2.4E –20 grams

1.9E –20 grams/(1E-17L) = .0019 grams/L

.0019 grams/L* .1L/100ml=.00019 g/100ml

B

5. You knew a salt was either sodium chloride or silver chloride.
If you put **1** gram in 10 ml of water in a test tube, and it looked like this



Which is it?

A. Sodium chloride

B. Silver Chloride

C. This is not an identifying test

Salts and Solubility Activity 3

Solution Equilibrium and K_{sp}

Learning Goals: Students will be able to:

- Describe the equilibrium of a saturated solution macroscopically and microscopically with supporting illustrations. (not covered in these questions)
- Write equilibrium expressions for salts dissolving
- Calculate K_{sp} from molecular modeling.

Trish Loeblein updated July 2008

I simplified the reactions by omitting (aq), my students have found this helpful and they know that they must put it on tests.

1. Table salt dissolves in water:

$NaCl(s) \rightleftharpoons Na^+ + Cl^-$

What is the correct K_{sp} expression if s is the molar solubility Sodium chloride?

a. $K_{sp} = s^2$

b. $K_{sp} = 2s^2$

c. $K_{sp} = s^5$

d. $K_{sp} = 4s^4$

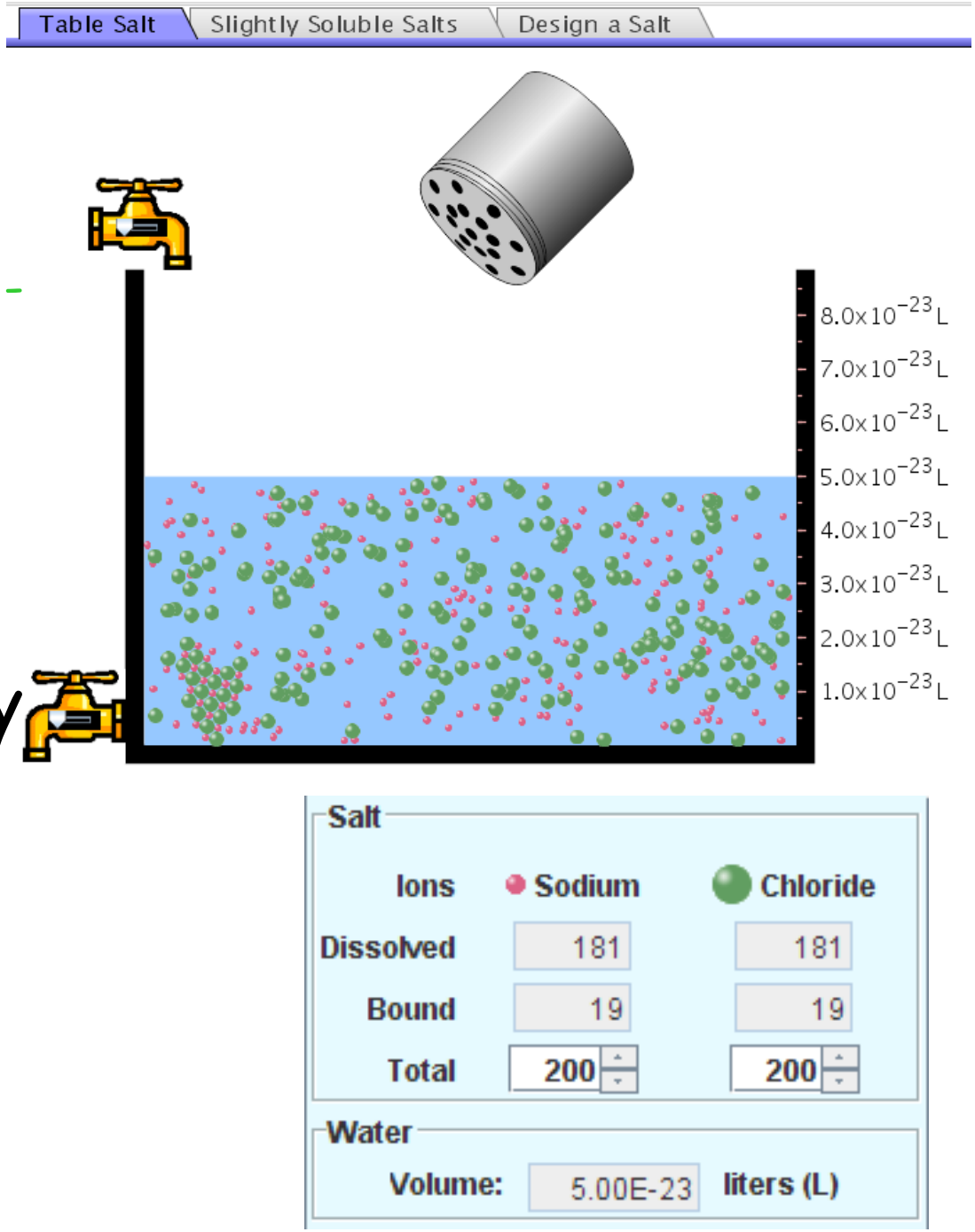


Table salt dissolves in water:

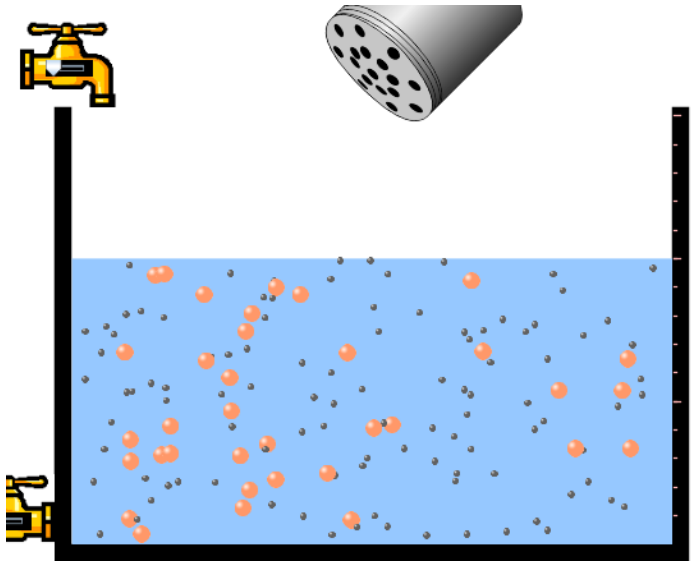
$NaCl(s) \rightleftharpoons Na^+ + Cl^-$

$K_{sp} = [Na^+]\,[Cl^-]$

For every NaCl molecule that dissolves there was one Na^+ and one Cl^- put into solution, so if we let **s** equal the amount of NaCl that dissolved then the expression substitutes to be $K_{sp} = s^2$

2. Silver arsenate dissolves in water:

$Ag_3AsO_4(s) \rightleftharpoons 3\ Ag^+ + AsO_4^{3-}$



What is the correct K_{sp} expression if s is the molar solubility Silver arsenate?

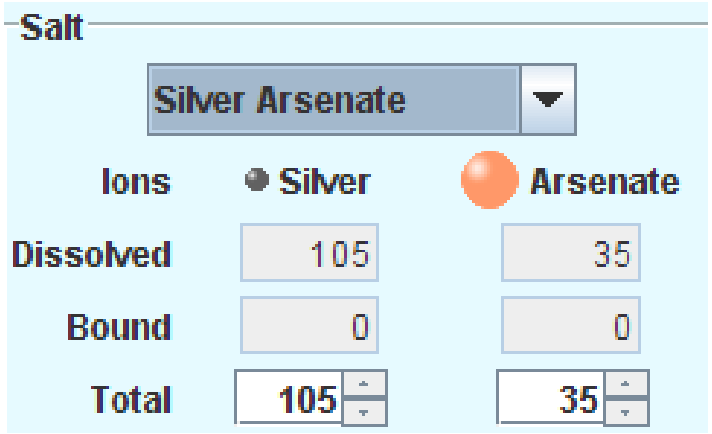
a. $K_{sp} = s^2$

b. $K_{sp} = 3s^2$

c. $K_{sp} = s^4$

d. $K_{sp} = 3s^4$

e. $K_{sp} = 27s^4$



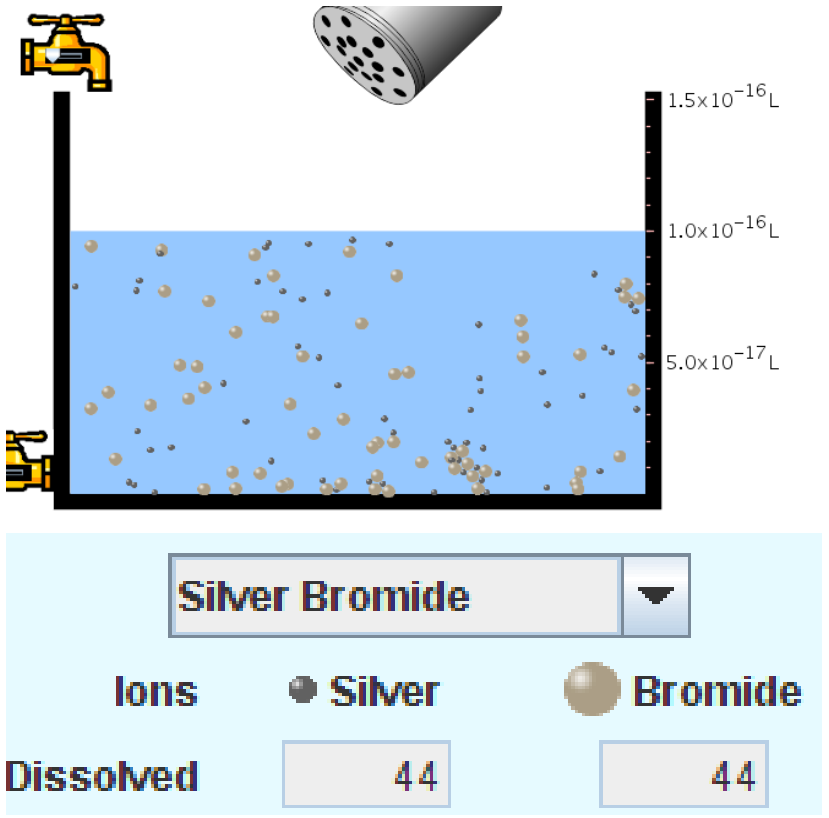
3. What is the proper expression for the molar solubility **s** of **AgCl** in terms of K_{sp}?

a. $s = K_{sp}$

b. $s = (K_{sp})^2$

c. $s = (K_{sp})^{1/2}$

d. $s = K_{sp}/2$



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

$[Ag^+]=[Br^-]$ (44 of each are dissolved)

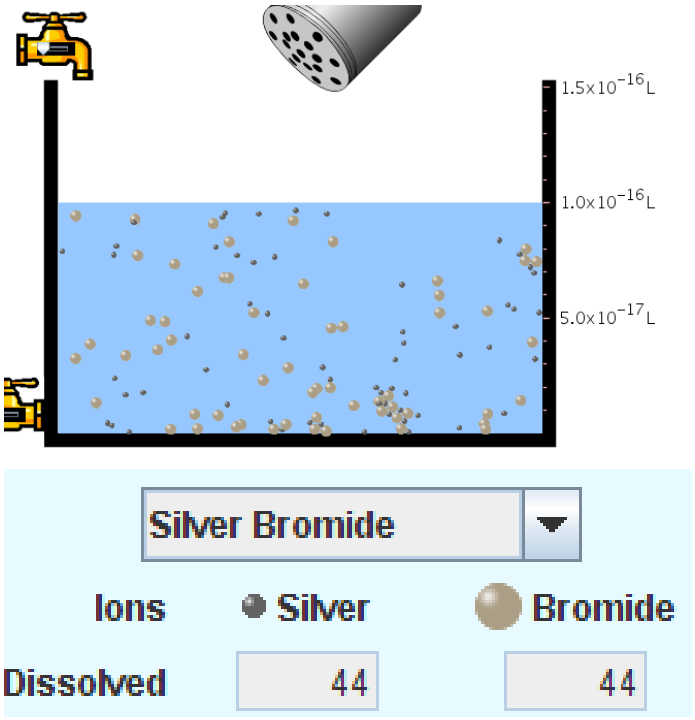
$K_{sp} = s^2$

$s = (K_{sp})^{1/2}$

Answer to previous slide

$AgBr \leftrightarrow Ag^+ + Br^-$ $K_{sp} = 5.0 \times 10^{-13}$

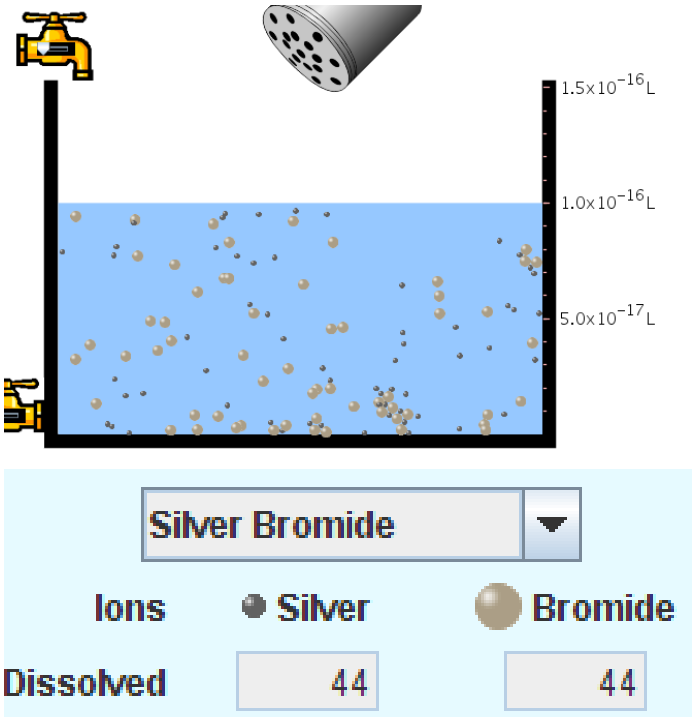
4. A saturated solution of AgBr in 1×10^{-16} liters of water contains about 44 Ag^+ and 44 Br^- ions as shown.
Suppose that K_{sp} were reduced to 2.5×10^{-13}. How many Ag^+ ions would you expect to see at equilibrium ?



a. 11 b. 22 c. 31 d. 44 e. 88

$AgBr \leftrightarrow Ag^+ + Br^-$ $K_{sp} = 5.0x10^{-13}$

Suppose that K_{sp} were reduced to $2.5x10^{-13}$. How many Ag^+ ions would you expect to see at equilibrium ?



$$s = \sqrt{Ksp}$$

$$= \sqrt{2.5x10^{-13}}$$

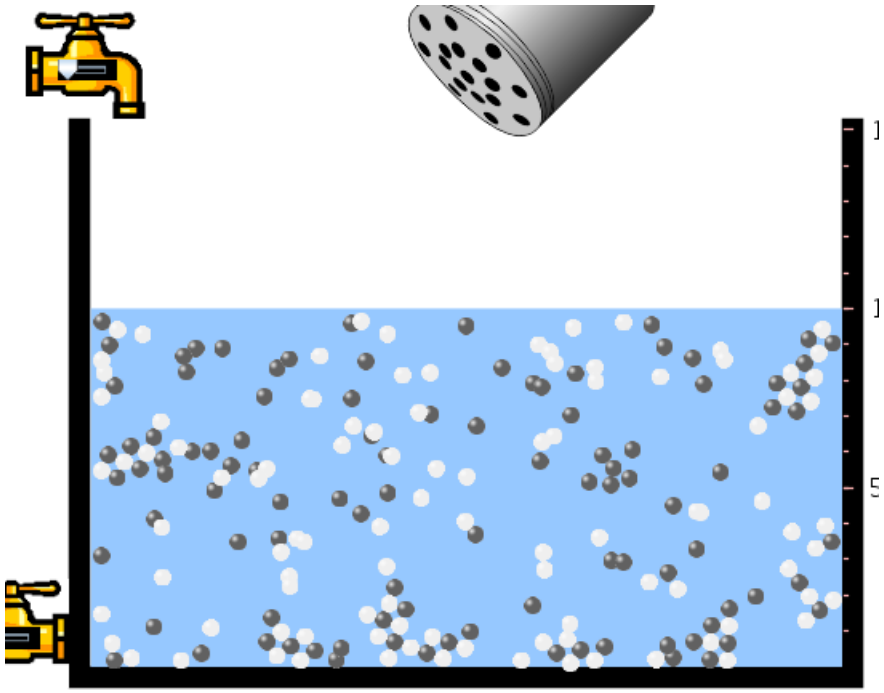
$$\approx 31$$

Answer to previous slide

5. Two salts have similar formulas XY and AB, but they have different solubility product constants.

XY: $K_{sp} = 1x10^{-12}$

AB: $K_{sp} = 1x10^{-8}$



Which one would be more soluble?

A. AB

B. XY

C. The amount that dissolves would be the same.

D. Not enough information

6. Two salts have similar formulas XY and AB, but they have different solubility product constants.

XY: $K_{sp} = 1x10^{-12}$

AB: $K_{sp} = 1x10^{-8}$

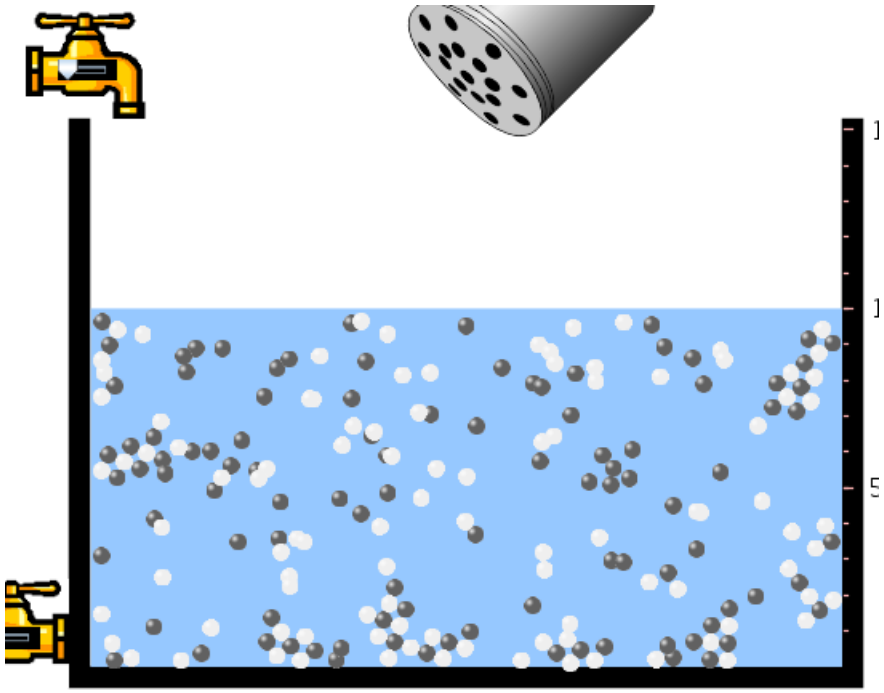
Which one would be more likely to precipitate?

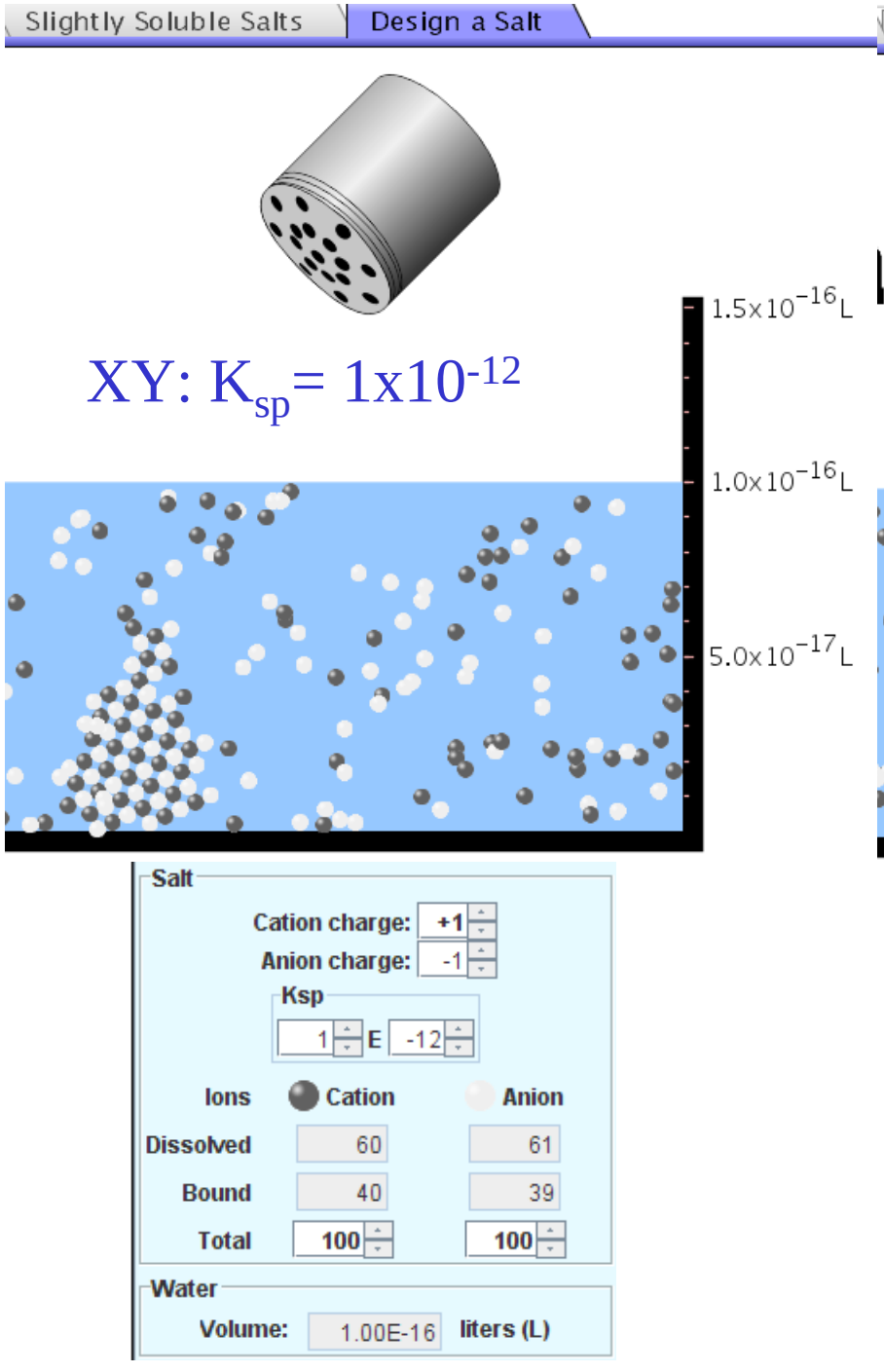
A. AB

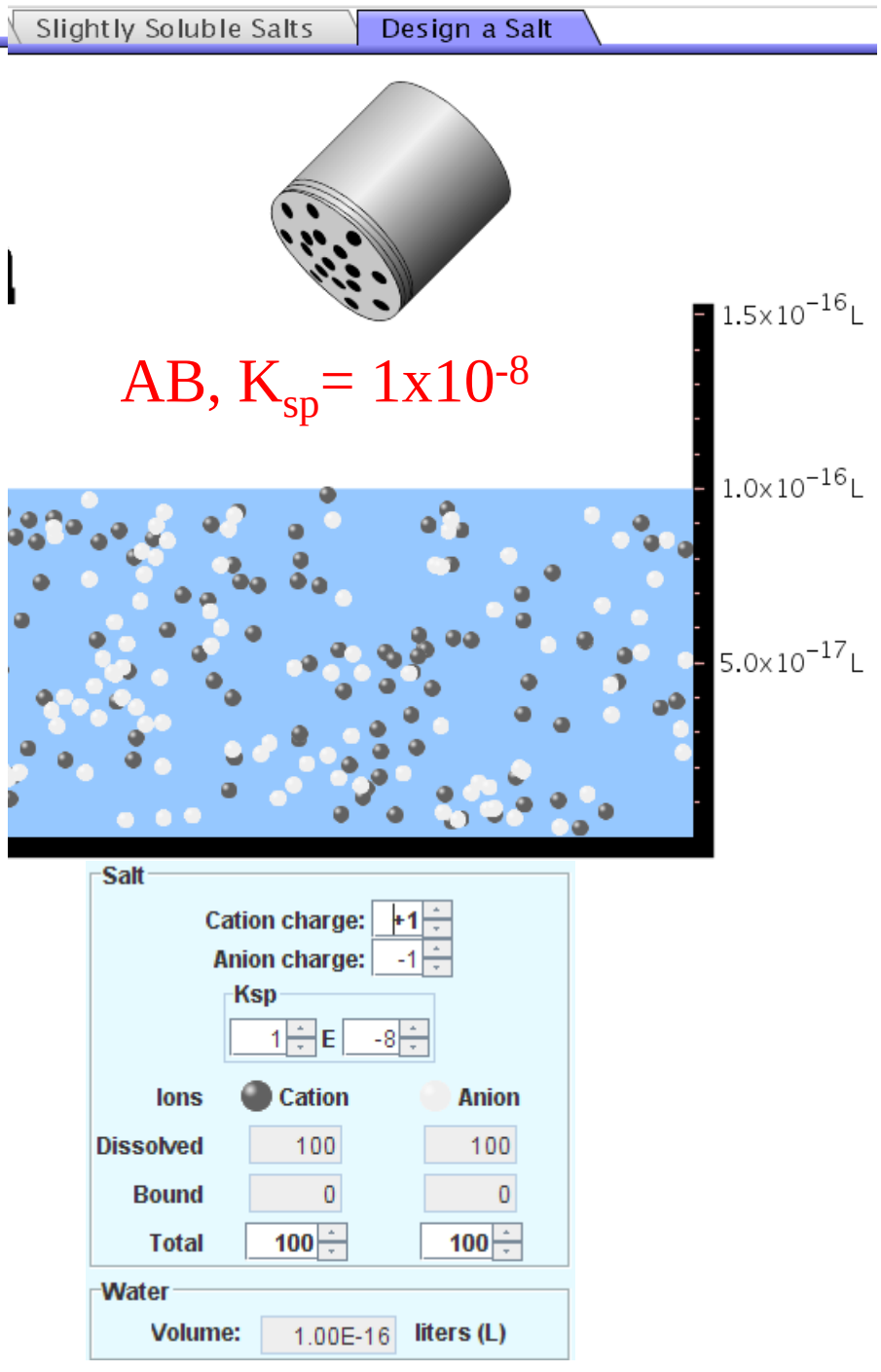
B. XY

C. They behave the same

D. Not enough information




Slightly Soluble Salts
Design a Salt
XY: K_{sp}= 1x10^{-12}
1.5x10^{-16}L
1.0x10^{-16}L
5.0x10^{-17}L
Salt
Cation charge: +1
Anion charge: -1
Ksp
1 E -12
Ions Cation Anion
Dissolved 60 61
Bound 40 39
Total 100 100
Water
Volume: 1.00E-16 liters (L)


Slightly Soluble Salts
Design a Salt
AB, K_{sp}= 1x10^{-8}
1.5x10^{-16}L
1.0x10^{-16}L
5.0x10^{-17}L
Salt
Cation charge: +1
Anion charge: -1
Ksp
1 E -8
Ions Cation Anion
Dissolved 100 100
Bound 0 0
Total 100 100
Water
Volume: 1.00E-16 liters (L)

Salts and Solubility Activity 4

The clicker questions do not directly address the goals because the are quantitative or have been well discussed by the group during the activities.

Learning Goals for 4: Students will be able to:

•Calculate Q.

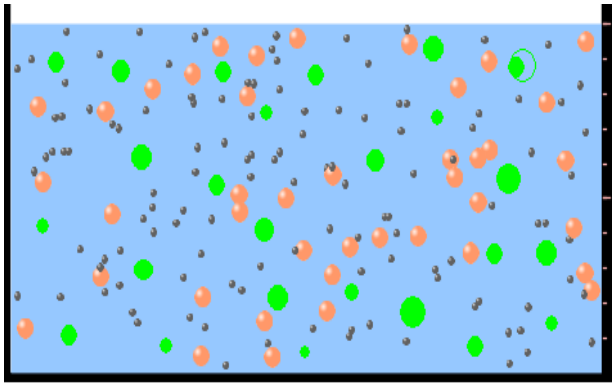
•Predict what would be observed on a macroscopic level to a solution by comparing Q to K_{sp}.

•Use microscopic illustrations, to help explain the predictions.

•Use LeChatelier's Principle to predict how changing the amount of water will affect the solution.

Trish Loeblein updated July 2008

Two salts, **XB** and **AB**, are dissolved in a beaker of water. There are equal number of moles. They have different solubility product constants.



XB: K_{sp}= 1x10^{-12} **AB: K_{sp}= 1x10^{-8}**

1. If you added B^- ions which would precipitate first?

A. AB

B. XB

C. They behave the same

D. Not enough information

2. 0.010 moles of $MgCl_2$ and 0.020 moles of $CuCl_2$ are dissolved in 0.10 liters of water. A solution of NaOH is slowly stirred in. Which precipitate forms first ?

$Cu(OH)_2$ $K_{sp} = 2.2 \times 10^{-20}$

$Mg(OH)_2$ $K_{sp} = 6.3 \times 10^{-10}$

a. $MgCl_2$ b. $CuCl_2$ c. $Mg(OH)_2$ d. $Cu(OH)_2$

Salts and Solubility Activity 5

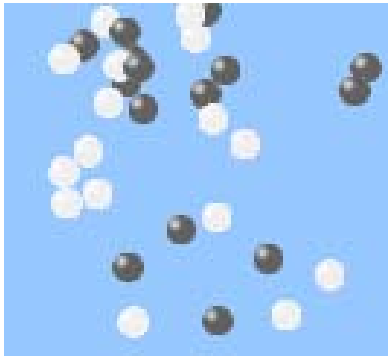
Learning Goal for 5: Students will be able to predict what would be observed on a macroscopic and microscopic level for salts with varying ionic charge given the K_{sp}.

Trish Loeblein July 2008

.

1. Which will have more dissolve particles in a saturated solution?
   K_{sp}=3 E –13
   A compound made from

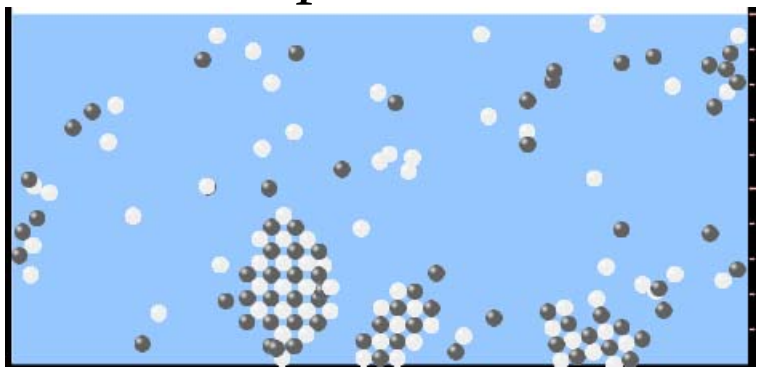
A. XY **B. XY_2** **C. no difference**



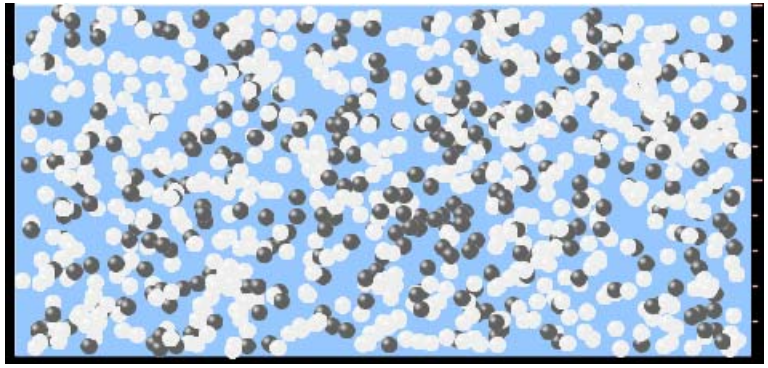
Answer to 1

$$A.K_{sp} = x^2; x = 5E-7$$

$$B.K_{sp} = (x)(2x)^2; x = 4E-5$$



XY



XY_2

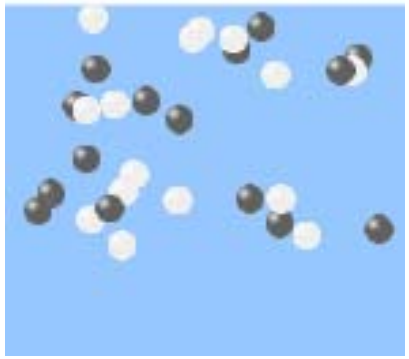
Why doesn’t the mass of the particle matter?

2. Which will have more dissolve particles in a saturated solution?

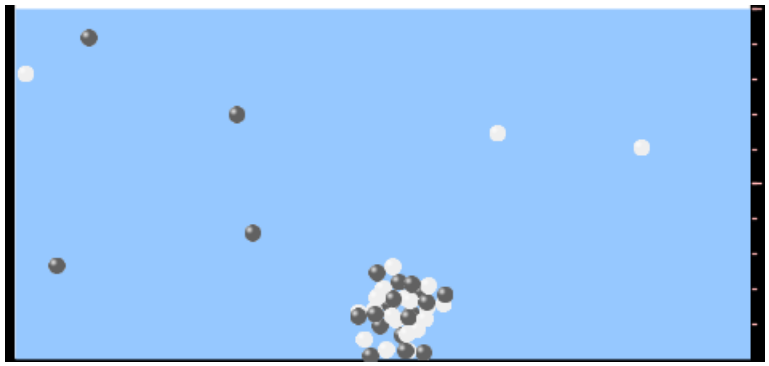
K_{sp}=2 E –15

A compound made from

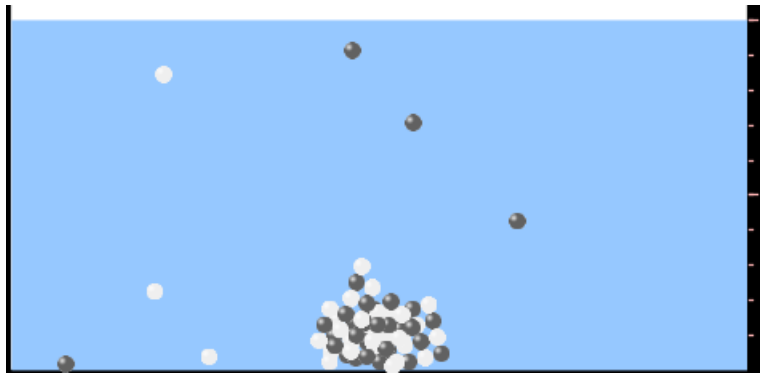
A. X^{+1} and Y^{-1} B. X^{+2} and Y^{-2} C. no difference



Answer to 2



XY



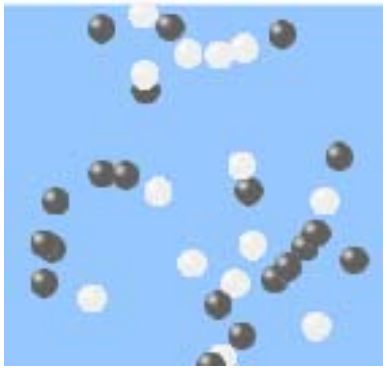
XY

3. Which will have more dissolve particles in a saturated solution?

K_{sp}=2 E –15

A compound made from

A. X^{+2} and Y^{-2} B. X^{+2} and Y^{-3} C. no difference

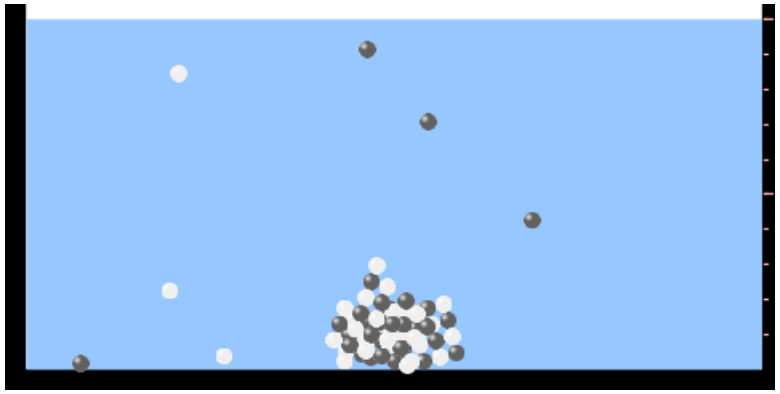


Answer to 3

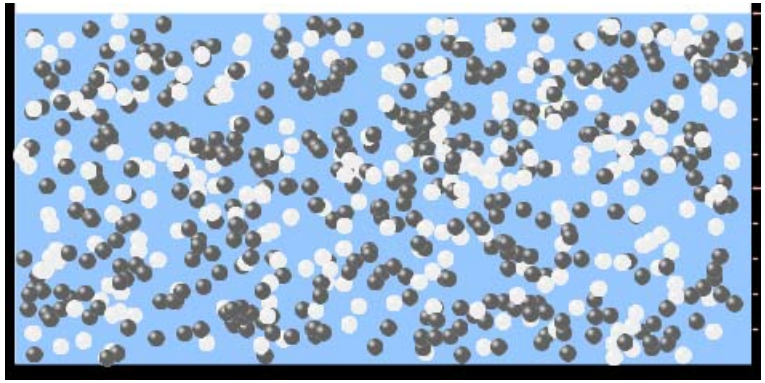
$$A.K_{sp} = x^2; x = 4E-8$$

$$B.K_{sp} = (3x)^3(2x)^2; x = 5E-4$$

If you run the sim at the default volume, you cannot get the second compound to ppt, but only 4 dissolve of the first.



XY



X_3Y_2