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

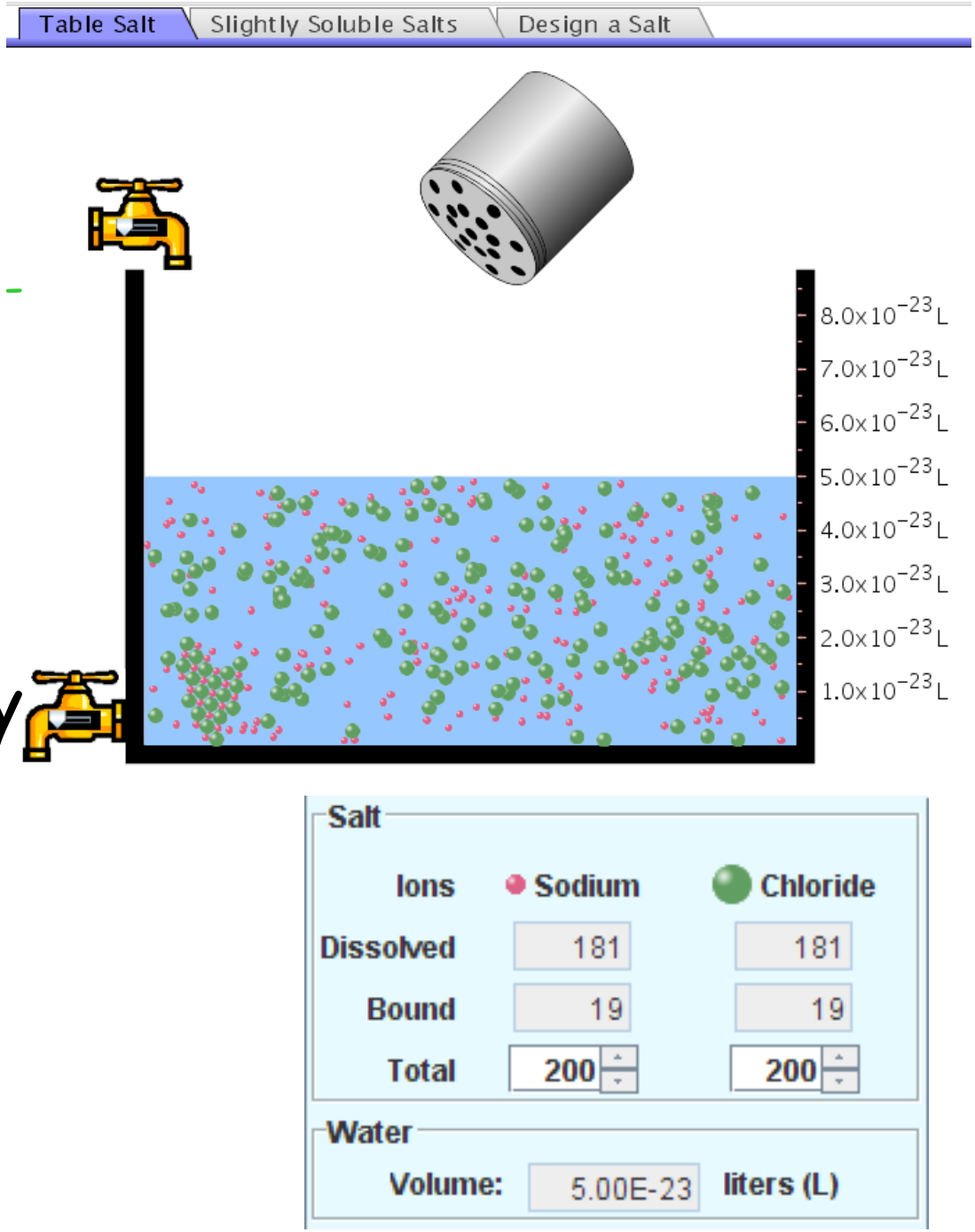


Table salt dissolves in water:

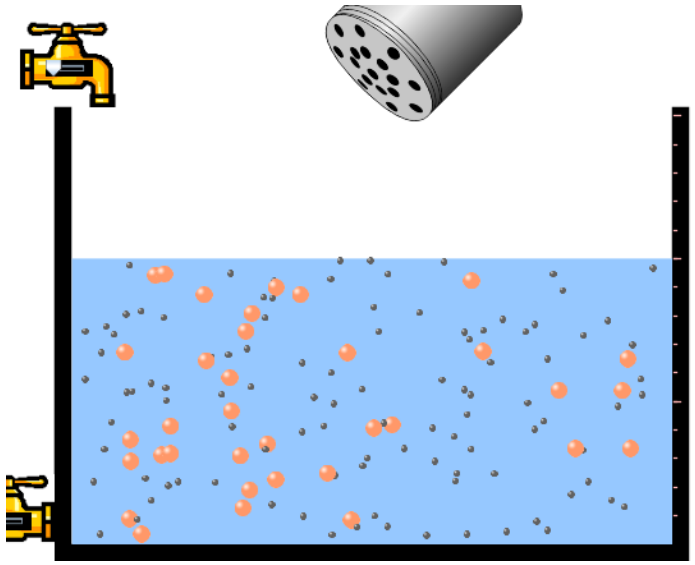
$NaCl(s) \rightleftharpoons Na^+ + Cl^-$

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

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?

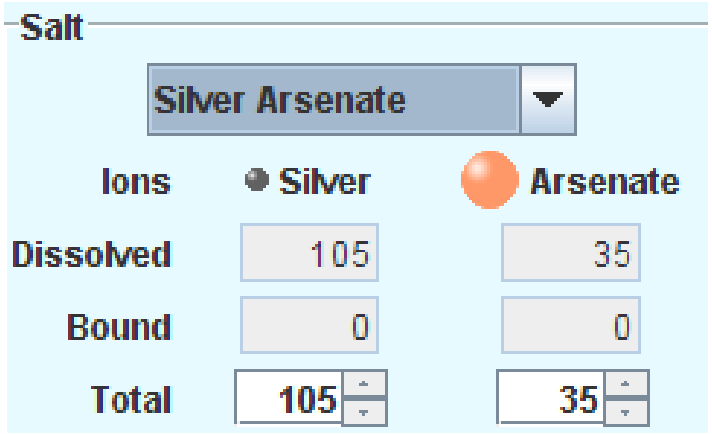
a. $K_{sp} = s^2$

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

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

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

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



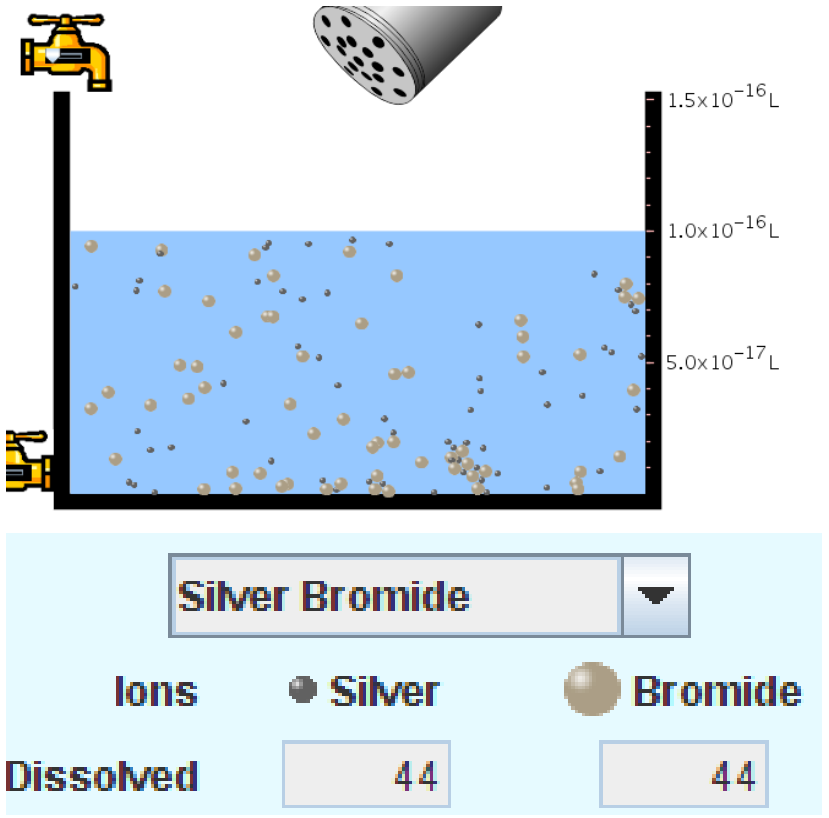
3. What is the proper expression for the molar solubility **s** of **AgCl** in terms of K_{sp}?

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)

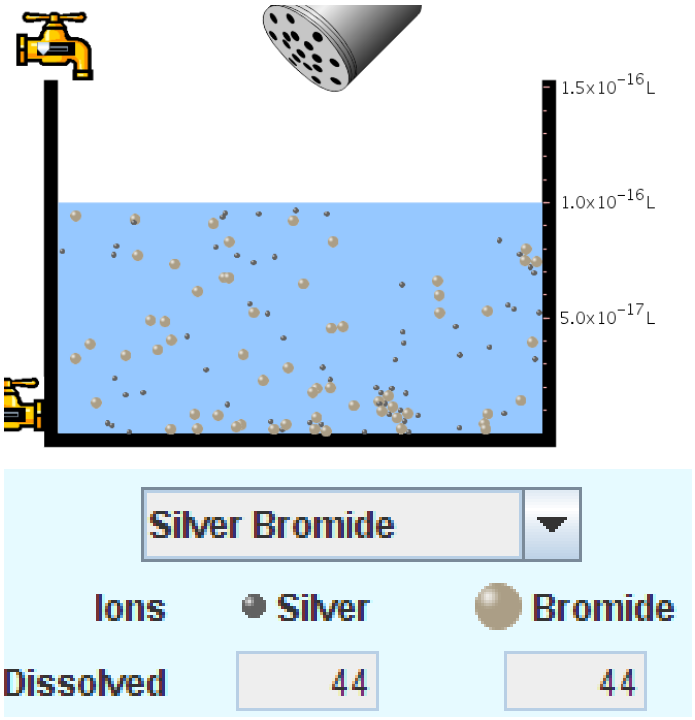
$K_{sp} = s^2$

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

Answer to previous slide

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

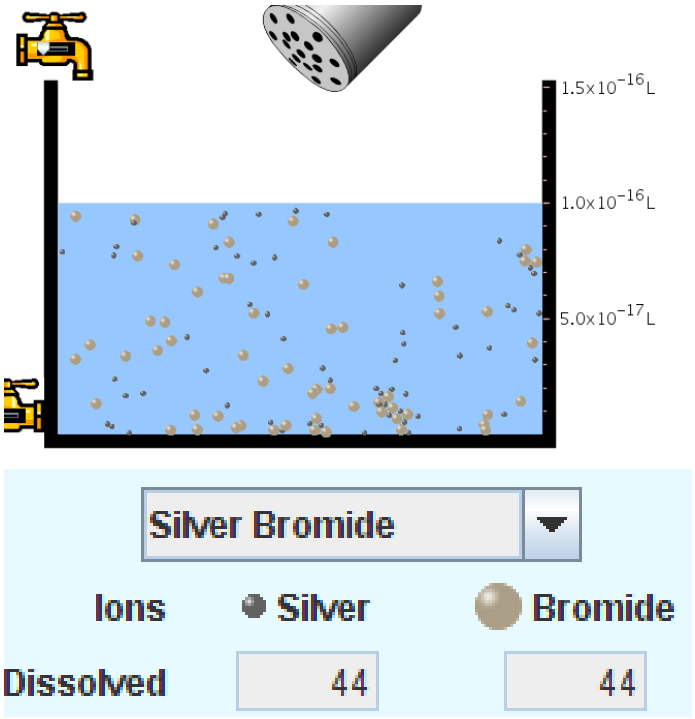
4. A saturated solution of AgBr in 1×10^{-16} liters of water contains about 44 Ag^+ and 44 Br^- ions as shown.
Suppose that K_{sp} were reduced to 2.5×10^{-13}. How many Ag^+ ions would you expect to see at equilibrium ?



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 ?



$$s = \sqrt{Ksp}$$

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

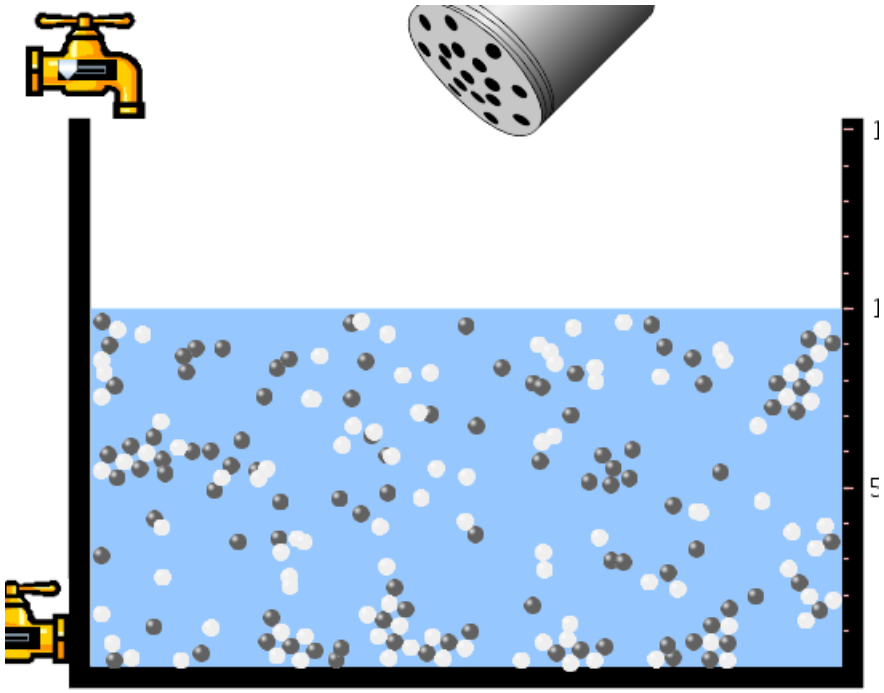
$$\approx 31$$

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

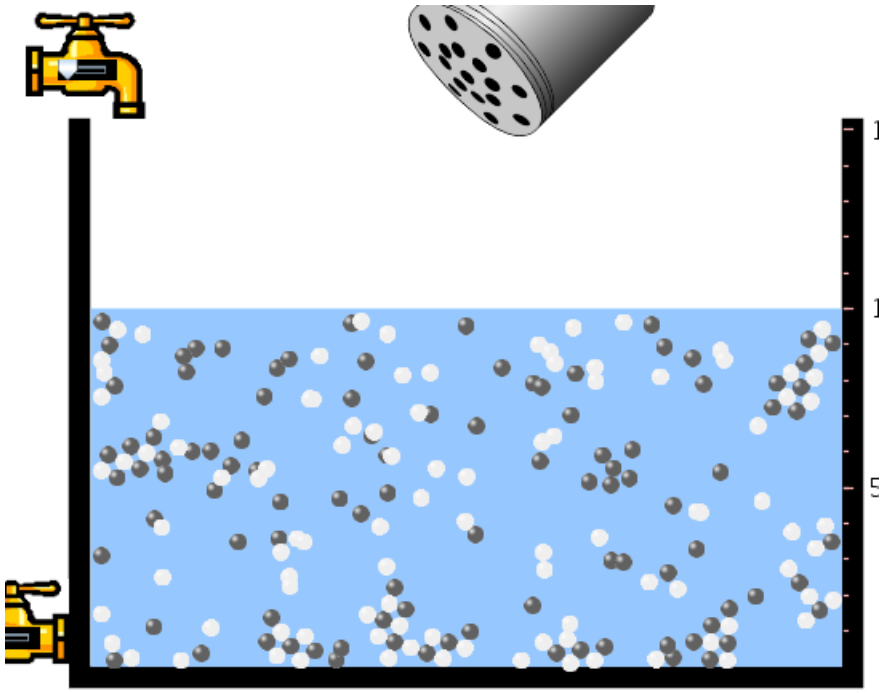
Which one would be more likely to precipitate?

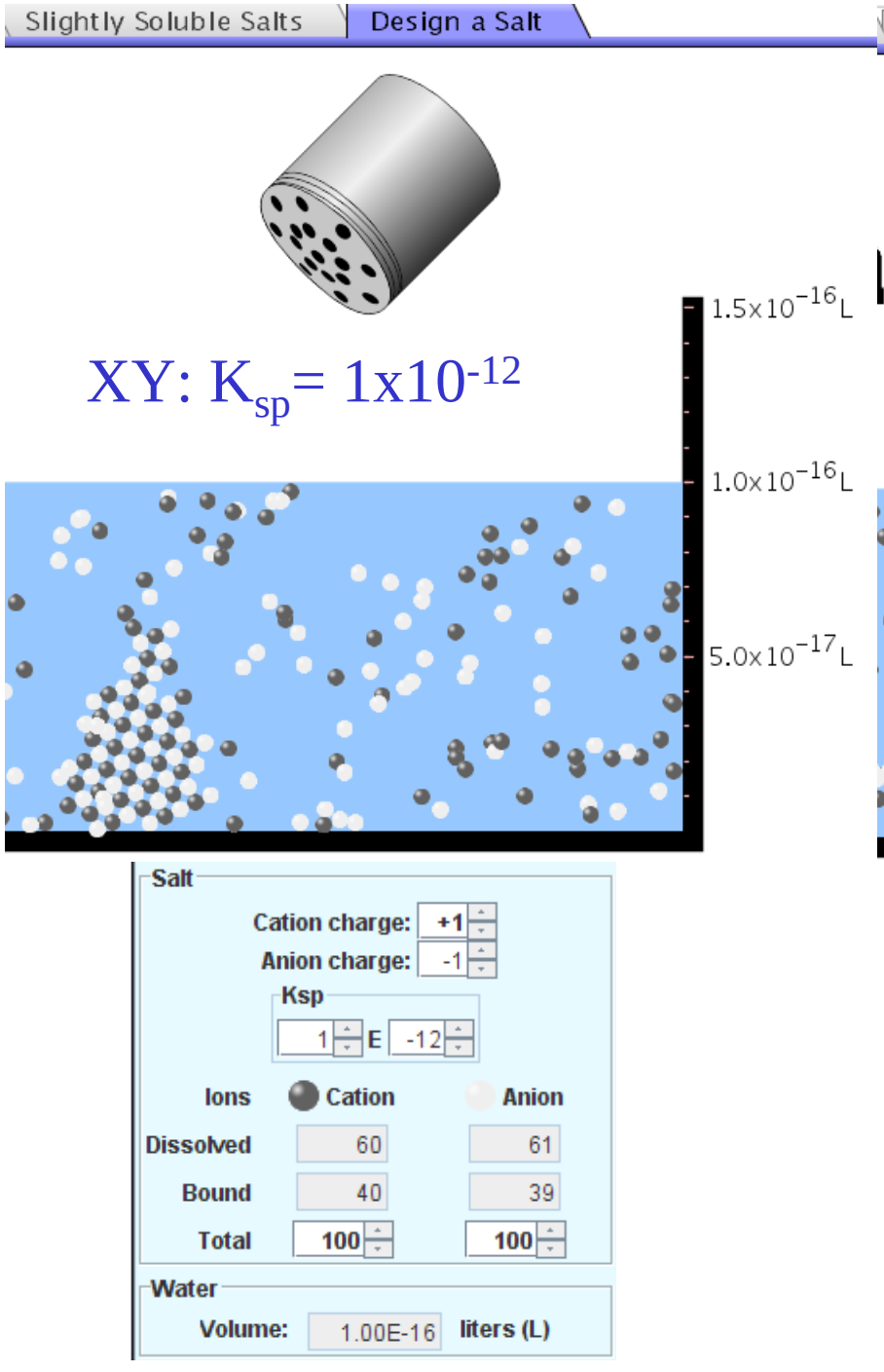
A. AB

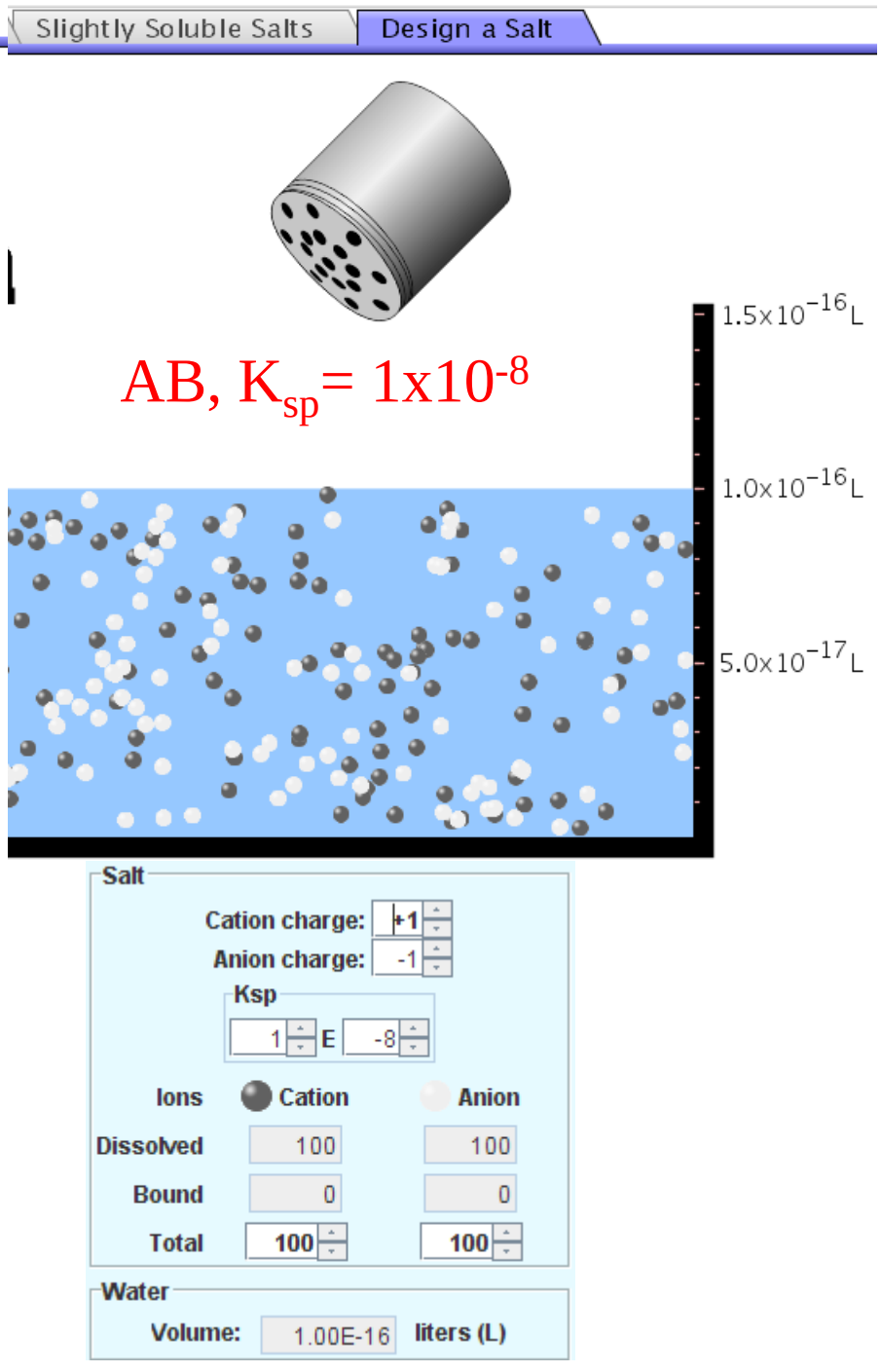
B. XY

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)