AP Chemistry
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Ksp Problems Worksheet Solutions

1. a) $CaSO_4 <====> Ca^{+2} + SO_4^{-2}$ If the solubility is 5.0×10^{-3} mol/L then we

x x x will let 'x' be equal to this amount.

$K_{sp} = [Ca^{+2}][SO_4^{-2}] = [x][x] = 5.0 \times 10^{-3}$

Therefore $K_{sp} = (5.0 \times 10^{-3})^2$

$K_{sp} = 2.5 \times 10^{-5}$

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b) $MgF_2 <====> Mg^{+2} + 2\ F^{-1}$ If the solubility is 2.7×10^{-3} mol/L then we

x x 2x will let 'x' be equal to this amount.

$K_{sp} = [Mg^{+2}][F^{-1}]^2 = [x][2x]^2 = 2.7 \times 10^{-3}$

$K_{sp} = 4x^3$

Therefore $x = 4(2.7 \times 10^{-3})^3$

$K_{sp} = 7.8 \times 10^{-8}$

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c) There is 1.02 grams dissolved in 100 mL. this must first be converted to moles/L.

moles = grams/molecular mass

moles = 1.02 g / 166.89 g/moles = 0.006 moles

$[AgC_2H_3O_2]$ = moles/L = 0.006 moles/0.1 L = 0.06 moles/L

$AgC_2H_3O_2 <====> Ag^{+1} + C_2H_3O_2^{-1}$ If the solubility is 0.06 mol/L then we

x x x will let 'x' be equal to this amount.

$K_{sp} = [Ag^{+1}][C_2H_3O_2^{-1}] = [x][x] = 0.06$

Therefore $K_{sp} = (0.06)^2$

$K_{sp} = 3.6 \times 10^{-3}$

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d) Convert 12.2 mg in 100 mL of water into moles/L

12.2 mg / 1000 mg/gram = 0.0122 grams

moles = grams/molecules mass = 0.0122 grams/ 125.62 grams/mole

= 9.7×10^{-5} moles

$[SrF_2]$ = moles/L = 9.7×10^{-5} / 0.1 L = 9.7×10^{-4} moles/L

$SrF_2 <====> Sr^{+2} + 2\ F^{-1}$ If the solubility is 9.7×10^{-4} mol/L then we

x x 2x will let 'x' be equal to this amount.

$K_{sp} = [Mg^{+2}][F^{-1}]^2 = [x][2x]^2 = 9.7 \times 10^{-4}$

$K_{sp} = 4x^3$

Therefore $x = 4(9.7 \times 10^{-4})^3$

$K_{sp} = 3.0 \times 10^{-9}$

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2. **i) AgCN has a K_{sp} of 2.0×10^{-12}**

$AgCN \Longleftrightarrow Ag^{+1} + CN^{-1}$

x x x

$Ksp = [Ag^{+1}][CN^{-1}]$
$2.0 \times 10^{-12} = (x)(x)$
$x = (2.0 \times 10^{-12})^{1/2}$
$x = 1.4 \times 10^{-9}$ moles/L (This is the solubility of the silver cyanide)

molecular mass of Ag^{+1} = 107.87 g/mole
Therefore 107.87 g/mole X 1.4×10^{-9} mole/L = 1.51×10^{-7} g/L
= 1.51×10^{-7} mg/mL

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ii) $BaSO_4$ has a K_{sp} of 1.5×10^{-9}

$AgCN \Longleftrightarrow Ba^{+2} + SO_4^{-2}$

x x x

$Ksp = [Ba^{+2}][SO_4^{-2}]$
$1.5 \times 10^{-9} = (x)(x)$
$x = (1.5 \times 10^{-9})^{1/2}$
$x = 3.9 \times 10^{-5}$ moles/L (This is the solubility of the barium sulphate)

molecular mass of Ba^{+2} = 137.33 g/mole
Therefore 137.33 g/mole X 3.9×10^{-5} mole/L = 5.36×10^{-3} g/L
= 5.36×10^{-3} mg/mL

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iii) FeS has a K_{sp} of 3.7×10^{-19}

$FeS \Longleftrightarrow Fe^{+2} + S^{-2}$

x x x

$Ksp = [Fe^{+2}][S^{-2}]$
$3.7 \times 10^{-19} = (x)(x)$
$x = (3.7 \times 10^{-19})^{1/2}$
$x = 6.1 \times 10^{-10}$ moles/L (This is the solubility of the iron(II) sulphate)

molecular mass of Fe^{+2} = 55.85 g/mole
Therefore 55.85 g/mole X 6.1×10^{-10} mole/L = 3.41×10^{-8} g/L
= 3.41×10^{-8} mg/mL

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iv) $Mg(OH)_2$ has a K_{sp} of 9.0×10^{-12}

$Mg(OH)_2 \Longleftrightarrow Mg^{+2} + 2\ OH^{-1}$

x x 2 x

$Ksp = [Mg^{+2}][OH^{-1}]^2$

$9.0 \times 10^{-12} = (x)(2x)^2$

$x = \left(\frac{9.0 \times 10^{-12}}{(4)}\right)^{1/3}$

x = 1.3×10^{-4} moles/L (This is the solubility of the magnesium hydroxide)

molecular mass of Mg^{+2} = 24.31 g/mole

Therefore 24.31 g/mole X 1.3×10^{-4} mole/L = 3.18×10^{-3} g/L

= 3.18×10^{-3} mg/mL

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v) Ag_2S has a K_{sp} of 1.6×10^{-49}

$Ag_2S \Longleftrightarrow 2\,Ag^{+1} + S^{-2}$

x 2 x x

$Ksp = [Ag^{+1}]^2[S^{-2}]$

$1.6 \times 10^{-49} = (2x)^2(x)$

$x = \left(\frac{1.6 \times 10^{-49}}{(4)}\right)^{1/3}$

x = 3.4×10^{-17} moles/L (This is the solubility of the silver sulphide)

molecular mass of 2 moles of Ag^{+1} = 215.74 g/mole

Therefore 215.74 g/mole X 3.4×10^{-17} mole/L = 7.33×10^{-15} g/L

= 7.33×10^{-15} mg/mL

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vi) CaF_2 has a K_{sp} of 4.9×10^{-11}

$CaF_2 \Longleftrightarrow Ca^{+2} + 2\,F^{-1}$

x x 2 x

$Ksp = [Ca^{+2}][F^{-1}]^2$

$4.9 \times 10^{-11} = (x)(2x)^2$

$x = \left(\frac{4.9 \times 10^{-11}}{(4)}\right)^{1/3}$

x = 2.31×10^{-4} moles/L (This is the solubility of the calcium fluoride)

molecular mass of Ca^{+2} = 40.08 g/mole

Therefore 40.08 g/mole X 2.31×10^{-4} mole/L = 9.26×10^{-3} g/L

= 9.26×10^{-3} mg/mL

3.

	K_{sp}		Solubililty
PbS	8.4×10^{-28}	$K_{sp} = x^2$	2.9×10^{-14} mole/L
$PbSO_4$	1.8×10^{-8}	$K_{sp} = x^2$	1.34×10^{-4} mole/L
$Pb(IO_3)_2$	2.6×10^{-13}	$K_{sp} = 4x^3$	4.02×10^{-5} mole/L

a) The lead(II) sulphate is the most soluble.

b) The solubility of the lead(II) sulphate is 1.34×10^{-4} moles/L

c) Molecular mass of PbSO4 is 303.27 g/mole
m = n X M
= 1.34 X 10^{-4} moles/L X 303.27 grams/mole
= 0.041 grams/L

d) Use the common ion effect and add something with sulphate ion in it that dissociates easily and more readily. i.e., H_2SO_4

e) The PbS concnetration is 2.9 X 10^{-14} moles/L

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4. a) $Cu(OH)_2$ <===> Cu^{+2} + 2 OH^{-1}

Ksp = $[Cu^{+2}][OH^{-1}]^2$

therefore $[Cu^{+2}] = \frac{Ksp}{[OH^{-1}]^2} = \frac{1.6 \text{ X } 10^{-9}}{(1.0 \text{ X } 10^{-4})^2} = \frac{1.6 \text{ X } 10^{-9}}{1.0 \text{ X } 10^{-8}} = 0.16 \text{ mole/L}$

grams = moles * molecular mass
= 0.16 moles / L * 63.55 g/mole
= 10.168 g/L
= 10168 mg/L

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b) $Fe(OH)_3$ <===> Fe^{+1} + 3 OH^{-1}

Ksp = $[Fe^{+1}][OH^{-1}]^3$

therefore $[Fe^{+2}] = \frac{Ksp}{[OH^{-1}]^3} = \frac{6.0 \text{ X } 10^{-38}}{(1.0 \text{ X } 10^{-4})^3} = \frac{6.0 \text{ X } 10^{-38}}{1.0 \text{ X } 10^{-12}}$

$= 6.0 \text{ X } 10^{-26} \text{ mole/L}$

grams = moles * molecular mass
= 6.0 X 10^{-26} mole/L * 55.85 g/mole
= 3.35 X 10^{-24} g/L
= 3.3 X 10^{-21} mg/L

c) $Mg(OH)_2$ <===> Mg^{+2} + 2 OH^{-1}

Ksp = $[Mg^{+2}][OH^{-1}]^2$

therefore $[Mg^{+2}] = \frac{Ksp}{[OH^{-1}]^2} = \frac{6.0 \text{ X } 10^{-12}}{(1.0 \text{ X } 10^{-4})^2} = \frac{6.0 \text{ X } 10^{-12}}{1.0 \text{ X } 10^{-8}}$

$= 6.0 \text{ X } 10^{-4} \text{ mole/L}$

grams = moles * molecular mass
= 6.0 X 10^{-4} mole/L * 24.31 g/mole
= 1.4586 X 10^{-2} g/L = 0.014586 g/L
= 14.586 mg/L