

What is the molar solubility of $\text{Ca}_3(\text{PO}_4)_2$ in distilled H_2O at 25°C ?



$$K_{sp} = [\text{Ca}^{2+}]^3 [\text{PO}_4^{3-}]^2$$

	$[\text{Ca}^{2+}]$	$[\text{PO}_4^{3-}]$
I	0	0
C	+3X	+2X
E	3X	2X



$$K_{sp} = [\text{Ca}^{2+}]^3 [\text{PO}_4^{3-}]^2$$

$$= (3x)^3 (2x)^2$$

$$= (27x^3)(4x^2)$$

$$= 108x^5$$

$$108x^5 = 2.0 \times 10^{-29}$$

$$x^5 = \frac{2.0 \times 10^{-29}}{108} = 1.85 \times 10^{-31}$$

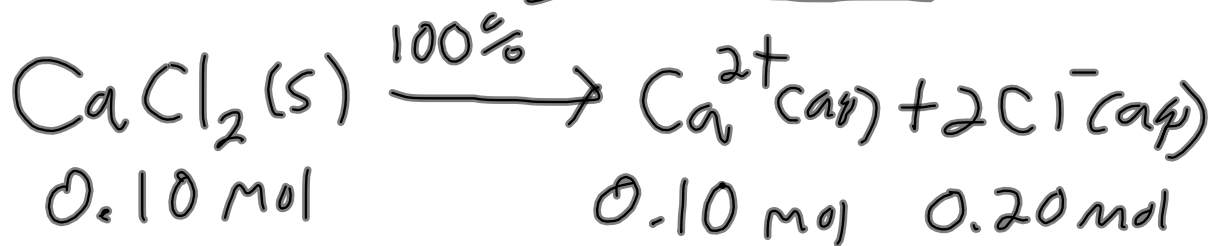
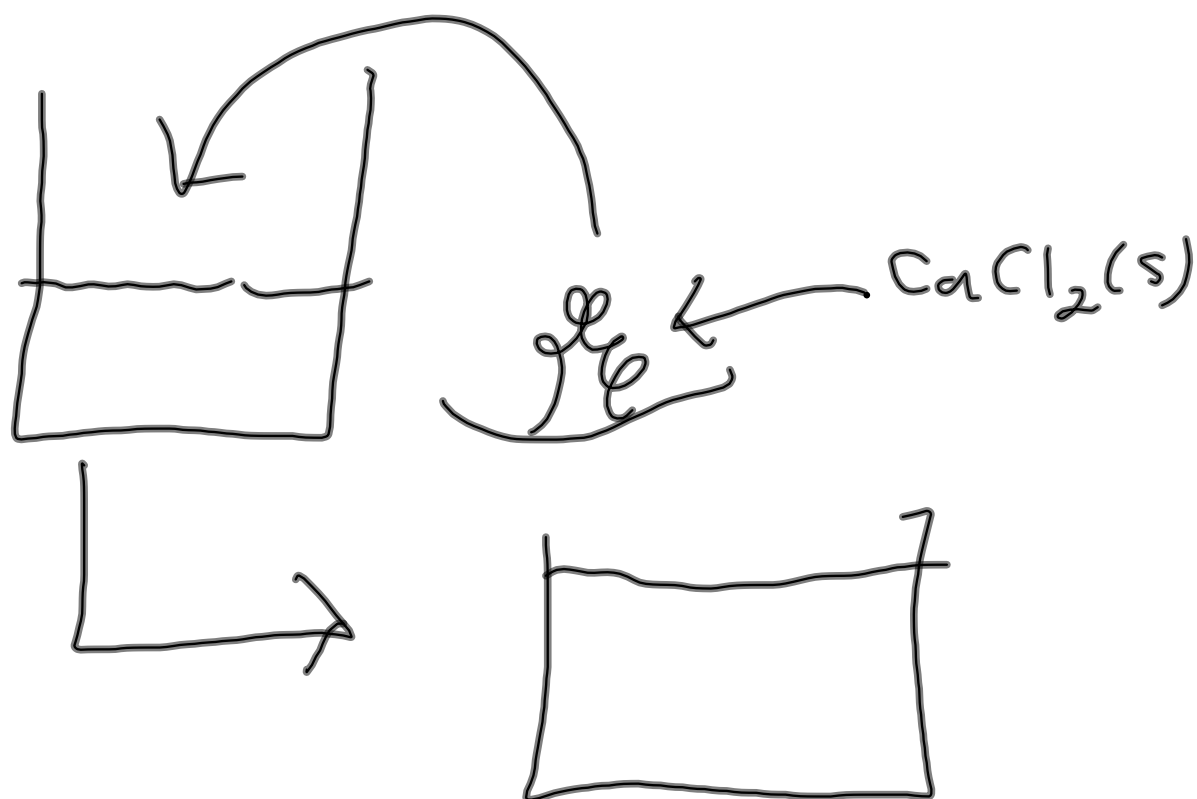
$$x = \sqrt[5]{1.85 \times 10^{-31}}$$

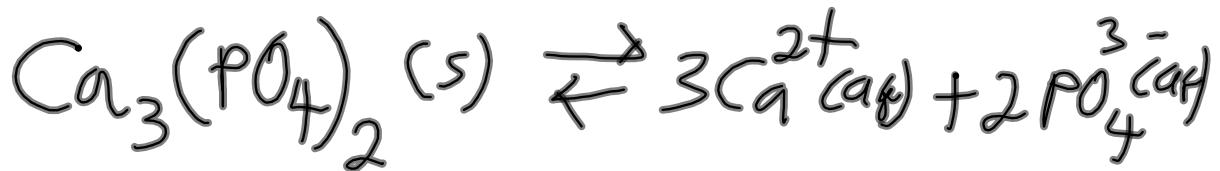
$$= 7.14 \times 10^{-7}$$

$$7.14 \times 10^{-7} \frac{\text{mol}}{\text{L}} \left(\frac{310.18 \text{ g}}{1 \text{ mol}} \right) \left(\frac{1000 \text{ mg}}{1 \text{ g}} \right)$$

$$= 0.221 \frac{\text{mg}}{\text{L}} = 0.221 \text{ ppm}$$

Common ion effect





	$[\text{Ca}^{2+}]$	$[\text{PO}_4^{3-}]$
I	0.10	0
C	+3X	+2X
E	0.10+3X	2X

$$K_{sp} = [\text{Ca}^{2+}]^3 [\text{PO}_4^{3-}]^2$$

$$\approx (0.10 + 3X)^3 \cdot (2X)^2$$

$$3X \ll 0.10$$

$$0.10 + 3X \approx 0.10$$

$$(0.10)^3 (2x)^2 = 2.0 \times 10^{-29}$$

$$(0.0010)(4x^2) = 2.0 \times 10^{-29}$$

$$x^2 = \frac{2.0 \times 10^{-29}}{0.0040} = 5.0 \times 10^{-27}$$

$$x = \sqrt{5.0 \times 10^{-27}}$$

$$x = 7.07 \times 10^{-14}$$



	$[\text{Ag}^+]$	$[\text{Cl}^-]$
H	0	0
C	+X	+X
E	X	X

$$K_{sp} = [\text{Ag}^+]_e [\text{Cl}^-]_e$$

$$= (X)(X)$$

$$= X^2 = 1.8 \times 10^{-10}$$

$$X = 1.34 \times 10^{-5}$$

	$[Ag^+]$	$[Cl^-]$
I	0	0.100
C	+X	+X
E	X	0.100 + X

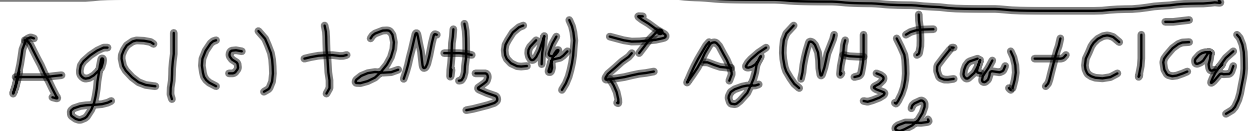
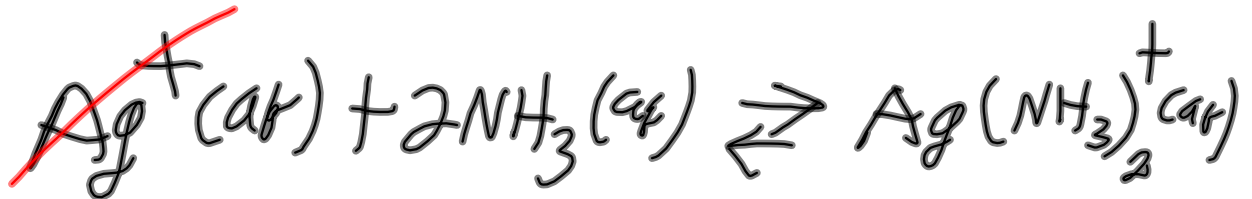
$$K_{sp} = [Ag^+]_e [Cl^-]_e = (X)(0.100 + X) \\ = 1.8 \times 10^{-10}$$

$$X \ll 0.100$$

$$0.100 + X \approx 0.100$$

$$0.100 X = 1.8 \times 10^{-10}$$

$$X = 1.8 \times 10^{-9}$$



$$K = \frac{[\text{Ag}(\text{NH}_3)_2^+]_a [\text{Cl}^-]_a}{[\text{NH}_3]_a^2}$$

↓

$$K = (1.8 \times 10^{-10})(1.6 \times 10^7)$$

$$= 2.88 \times 10^{-3}$$

	$[NH_3]$	$[Ag(NH_3)_2^+]$	$[Cl^-]$
I	0.100	0	0
C	$-2x$	$+x$	$+x$
E	$0.100 - 2x$	x	x

$$K = \frac{[Ag(NH_3)_2^+][Cl^-]}{[NH_3]^2} = \frac{(x)(x)}{(0.100 - 2x)^2}$$

$$\frac{x^2}{(0.100 - 2x)^2} = 2.88 \times 10^{-3}$$