Common Ion Effect

① $NaCl(s) \rightleftharpoons Na^+(aq) + Cl^-(aq)$

$[Cl^-] = [NaCl] = 0.10 \text{ mol/L}$

$AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$

I	–	0	0.1
C	–	$+x$	$+x$
E	–	x	$0.1 + x$

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

$1.8 \times 10^{-10} = (x)(0.1 + x)$

$1.8 \times 10^{-10} = (x)(0.1)$

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

Solubility of $AgCl(s)$ is 1.8×10^{-9} mol/L

② $Ca(NO_3)_2(s) \rightleftharpoons Ca^{2+}(aq) + 2NO_3^-(aq)$

$[Ca^{2+}] = [Ca(NO_3)_2] = 0.01 \text{ mol/L}$

$CaSO_4(s) \rightleftharpoons Ca^{2+}(aq) + SO_4^{2-}(aq)$

	–	Ca^{2+}	SO_4^{2-}
I	–	0.01	0
C	–	+x	+x
E	–	0.01 + x	x

$K_{sp} = [Ca^{2+}][SO_4^{2-}]$

$7.1 \times 10^{-5} = (0.01 + x)(x)$

$7.1 \times 10^{-5} = 0.01x + x^2$

$x^2 + 0.01x - 7.1 \times 10^{-5} = 0$

$$x = \frac{-0.01 \pm \sqrt{0.01^2 - 4(1)(-7.1 \times 10^{-5})}}{2(1)}$$

$x = 4.8 \times 10^{-3}$ or -1.4×10^{-2} (not possible)

∴ Solubility of $CaSO_4$ is 4.8×10^{-3} mol/L

(3) a) $Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$

	—		
I	—	0	0
C	—	$+2x$	$+x$
E	—	$2x$	x

$K_{sp} = [Ag^+]^2 [CrO_4^{2-}]$

$1.1 \times 10^{-12} = (2x)^2 (x)$

$= 4x^3$

$x = \sqrt[3]{\frac{1.1 \times 10^{-12}}{4}}$

$x = 6.5 \times 10^{-5}$

Solubility is 6.5×10^{-5} mol/L

③ b) $Na_2CrO_4(s) \rightleftharpoons 2Na^+(aq) + CrO_4^{2-}(aq)$

$[CrO_4^{2-}] = [Na_2CrO_4] = 0.1 \text{ mol/L}$

$Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$

	—		
I	—	0	0.1
C	—	$+2x$	$+x$
E	—	$2x$	$0.1+x$

$K_{sp} = [Ag^+]^2 [CrO_4^{2-}]$

$1.1 \times 10^{-12} = (2x)^2 (0.1+x)$

$= 4x^2 (0.1)$

$= 0.4x^2$

$x = \sqrt{\frac{1.1 \times 10^{-12}}{0.4}}$

$x = 1.66 \times 10^{-6}$

Solubility is 1.66×10^{-6} mol/L

④ Anything with either Ba^{2+} or SO_4^{2-} in it.

e.g. $BaCl_2$ Na_2SO_4

⑤ Anything with Cu^{2+} or CO_3^{2-} in it.

e.g. $CuCl_2$ Na_2CO_3