Unit 3 and 4 review... Ksp, Ka, Kb

1) Does a precipitate form when 0.050 L of 0.50 M $Ca(NO_3)_2$ is mixed with 0.100 L of 0.12 M NaF?

Moles of Ca^{2+} → $0.50\ M \times 0.050\ L = 0.025$ moles Ca^{2+}

$$[Ca^{2+}] = \frac{0.025 \text{ moles } Ca^{2+}}{0.050\ L + 0.100\ L} = [0.16666]\ M\ Ca^{2+}$$

Moles of F^- → $0.12\ M \times 0.100\ L = 0.012$ moles F^-

$$[F^-] = \frac{0.012 \text{ moles } F^-}{0.050\ L + 0.100\ L} = [0.080]\ M\ F^-$$

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

$= [0.16666][0.080]^2$

$= 0.0011$

$Q >> K_{sp}$

$0.0011 \quad 3.2 \times 10^{-11}$

so CaF_2 will precipitate out until $Q = K_{sp}$

2) Use the Boric acid and its conjugate base to prove that $K_a \times K_b = k_w$.

$H_3BO_3 \rightleftharpoons H_2BO_3^-$

acid base

$H_3BO_3 + H_2O \rightleftharpoons H_2BO_3^- + H_3O^+$

$H_2BO_3^- + H_2O \rightleftharpoons H_3BO_3 + OH^-$

$$K_a = \frac{[H_2BO_3^-][H_3O^+]}{[H_3BO_3]}$$

$$K_b = \frac{[H_3BO_3][OH^-]}{[H_2BO_3^-]}$$

$K_a \times K_b$

$$\frac{[H_2BO_3^-][H_3O^+]}{[H_3BO_3]} \times \frac{[H_3BO_3][OH^-]}{[H_2BO_3^-]}$$

$[H_3O^+][OH^-] = K_w$ ✓