Chemistry 3.6 **Worksheet 1** Name _____

Question One

Calcium carbonate ($CaCO_3$) and calcium sulfate ($CaSO_4$) are sparingly soluble in water.

(a) (i) Write the equation for the equilibrium present in a saturated solution of calcium carbonate.

$CaCO_{3(s)} \rightleftharpoons Ca^{2+}{}_{(aq)} + CO_3{}^{2-}{}_{(aq)}$

(ii) Write the expression for $Ks(CaCO_3)$.

$$Ks = [Ca^{2+}][CO_3{}^{2-}]$$

(iii) Calculate the solubility of $CaCO_3$ in mol L^{-1}.

$$K_s(CaCO_3) = 1.70 \times 10^{-8}$$

$$\sqrt{1.70 \times 10^{-8}} = solubility$$

solubility = 1.30×10^{-4} $molL^{-1}$

(b) A solution contains $CO_3{}^{2-}$ and $SO_4{}^{2-}$ ions both at a concentration of 1.18×10^{-2} mol L^{-1}. A solution of calcium chloride ($CaCl_2$) is added to this mixture until a precipitate forms. (Assume any change in volume is insignificant)

$$K_s(CaCO_3) = 1.70 \times 10^{-8} \qquad K_s(CaSO_4) = 2.30 \times 10^{-4}$$

(i) State the salt which will precipitate first.
Give a reason for your answer.

Since both $CaCO_3$ and $CaSO_4$ is type AB salt, $CaCO_3$ will precipitate first as it has a smaller K_s value.

(ii) Calculate the concentration of calcium ions required for calcium sulfate to precipitate.

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

$2.30 \times 10^{-4} = [Ca^{2+}] \times 1.18 \times 10^{-2}$

$[Ca^{2+}] = 1.95 \times 10^{-2}$ $molL^{-1}$

(iii) Account for the fact that the solubility of calcium carbonate increases in dilute nitric acid but the solubility of calcium sulfate is not changed. Include equations in your answer. (Assume any change in volume is insignificant).

$CO_3{}^{2-}$ reacts with H^+ in dilute nitric acid

$CO_3{}^{2-} + 2H^+ \rightarrow H_2O + CO_2$

Since $CO_3{}^{2-}$ is removed from the equilibrium equation

$CaCO_{3(s)} \rightleftharpoons Ca^{2+}{}_{(aq)} + CO_3{}^{2-}{}_{(aq)}$

The equilibrium will move to the right, hence more $CaCO_{3(s)}$ dissolves. Solubility increases.

However, $CaSO_4$ does not react with dilute acid, so the solubility does not change.