1. Answer the following questions about the solubility and reactions of the ionic compounds \( \text{M(OH)}_2 \) and \( \text{MCO}_3 \), where M represents an unidentified metal.

(a) Identify the charge of the M ion in the ionic compounds above.

(b) At \( 25^\circ \text{C} \), a saturated solution of \( \text{M(OH)}_2 \) has a pH of 9.15.

   (i) Calculate the molar concentration of \( \text{OH}^- \) in the saturated solution.

   (ii) Write the solubility-product constant expression for \( \text{M(OH)}_2 \).

   (iii) Calculate the value of the solubility-product constant, \( K_{sp} \), for \( \text{M(OH)}_2 \) at \( 25^\circ \text{C} \).

(c) For the metal carbonate, \( \text{MCO}_3 \), the value of the solubility-product constant, \( K_{sp} \), is \( 7.4 \times 10^{-14} \) at \( 25^\circ \text{C} \).

   On the basis of this information and your results in part (b), which compound, \( \text{M(OH)}_2 \) or \( \text{MCO}_3 \), has the greater molar solubility in water at \( 25^\circ \text{C} \)? Justify your answer with a calculation.

(d) \( \text{MCO}_3 \) decomposes at high temperatures, as shown by the reaction represented below.

   \[
   \text{MCO}_3(s) \leftrightharpoons \text{MO}(s) + \text{CO}_2(g)
   \]

   A sample of \( \text{MCO}_3 \) is placed in a previously evacuated container, heated to \( 423 \text{ K} \), and allowed to come to equilibrium. Some solid \( \text{MCO}_3 \) remains in the container. The value of \( K_p \) for the reaction at \( 423 \text{ K} \) is 0.0012.

   (i) Write the equilibrium-constant expression for \( K_p \) of the reaction.

   (ii) Determine the pressure, in atm, of \( \text{CO}_2(g) \) in the container at equilibrium at \( 423 \text{ K} \).

   (iii) Indicate whether the value of \( \Delta G^\circ \) for the reaction at \( 423 \text{ K} \) is positive, negative, or zero. Justify your answer.