CHEMISTRY

Section II

(Total time—95 minutes)

Part A

Time—55 minutes

YOU MAY USE YOUR CALCULATOR FOR PART A.

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures.

Be sure to write all your answers to the questions on the lined pages following each question in this booklet.

Answer Questions 1, 2, and 3. The Section II score weighting for each question is 20 percent.

1. Answer the following questions about the solubility and reactions of the ionic compounds $M(OH)_2$ and MCO_3, where M represents an unidentified metal.

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

   (b) At 25°C, a saturated solution of $M(OH)_2$ has a pH of 9.15.

      (i) Calculate the molar concentration of $OH^-(aq)$ in the saturated solution.

      (ii) Write the solubility-product constant expression for $M(OH)_2$.

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

   (c) For the metal carbonate, MCO_3, the value of the solubility-product constant, K_{sp}, is 7.4×10^{-14} at 25°C. On the basis of this information and your results in part (b), which compound, $M(OH)_2$ or MCO_3, has the greater molar solubility in water at 25°C ? Justify your answer with a calculation.

   (d) MCO_3 decomposes at high temperatures, as shown by the reaction represented below.

$$MCO_3(s) \rightleftarrows MO(s) + CO_2(g)$$

   A sample of MCO_3 is placed in a previously evacuated container, heated to 423 K, and allowed to come to equilibrium. Some solid MCO_3 remains in the container. The value of K_p for the reaction at 423 K is 0.0012.

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

      (ii) Determine the pressure, in atm, of $CO_2(g)$ in the container at equilibrium at 423 K.

      (iii) Indicate whether the value of $\Delta G°$ for the reaction at 423 K is positive, negative, or zero. Justify your answer.