

# 2005 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS

## CHEMISTRY

### Section II

(Total time—90 minutes)

#### Part A

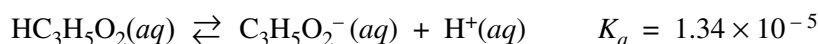
Time—40 minutes

**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 the booklet with the pink cover. Do NOT write your answers on the green insert.

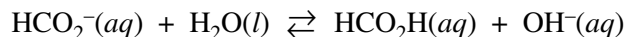
Answer Question 1 below. The Section II score weighting for this question is 20 percent.



1. Propanoic acid,  $\text{HC}_3\text{H}_5\text{O}_2$ , ionizes in water according to the equation above.

- (a) Write the equilibrium-constant expression for the reaction.
- (b) Calculate the pH of a 0.265 *M* solution of propanoic acid.
- (c) A 0.496 g sample of sodium propanoate,  $\text{NaC}_3\text{H}_5\text{O}_2$ , is added to a 50.0 mL sample of a 0.265 *M* solution of propanoic acid. Assuming that no change in the volume of the solution occurs, calculate each of the following.
  - (i) The concentration of the propanoate ion,  $\text{C}_3\text{H}_5\text{O}_2^-(aq)$ , in the solution
  - (ii) The concentration of the  $\text{H}^+(aq)$  ion in the solution

The methanoate ion,  $\text{HCO}_2^-(aq)$ , reacts with water to form methanoic acid and hydroxide ion, as shown in the following equation.



- (d) Given that  $[\text{OH}^-]$  is  $4.18 \times 10^{-6}$  *M* in a 0.309 *M* solution of sodium methanoate, calculate each of the following.
  - (i) The value of  $K_b$  for the methanoate ion,  $\text{HCO}_2^-(aq)$
  - (ii) The value of  $K_a$  for methanoic acid,  $\text{HCO}_2\text{H}$
- (e) Which acid is stronger, propanoic acid or methanoic acid? Justify your answer.