

2009 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS**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 the booklet with the pink cover. Do NOT write your answers on the green insert.

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

1. Answer the following questions that relate to the chemistry of halogen oxoacids.

(a) Use the information in the table below to answer part (a)(i).

Acid	K_a at 298 K
HOCl	2.9×10^{-8}
HOBr	2.4×10^{-9}

- (i) Which of the two acids is stronger, HOCl or HOBr? Justify your answer in terms of K_a .
 - (ii) Draw a complete Lewis electron-dot diagram for the acid that you identified in part (a)(i).
 - (iii) Hypoiodous acid has the formula HOI. Predict whether HOI is a stronger acid or a weaker acid than the acid that you identified in part (a)(i). Justify your prediction in terms of chemical bonding.
- (b) Write the equation for the reaction that occurs between hypochlorous acid and water.
- (c) A 1.2 M NaOCl solution is prepared by dissolving solid NaOCl in distilled water at 298 K. The hydrolysis reaction $\text{OCl}^-(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{HOCl}(aq) + \text{OH}^-(aq)$ occurs.
- (i) Write the equilibrium-constant expression for the hydrolysis reaction that occurs between $\text{OCl}^-(aq)$ and $\text{H}_2\text{O}(l)$.
 - (ii) Calculate the value of the equilibrium constant at 298 K for the hydrolysis reaction.
 - (iii) Calculate the value of $[\text{OH}^-]$ in the 1.2 M NaOCl solution at 298 K.

2009 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS

(d) A buffer solution is prepared by dissolving some solid NaOCl in a solution of HOCl at 298 K. The pH of the buffer solution is determined to be 6.48.

(i) Calculate the value of $[\text{H}_3\text{O}^+]$ in the buffer solution.

(ii) Indicate which of $\text{HOCl}(aq)$ or $\text{OCl}^-(aq)$ is present at the higher concentration in the buffer solution. Support your answer with a calculation.