

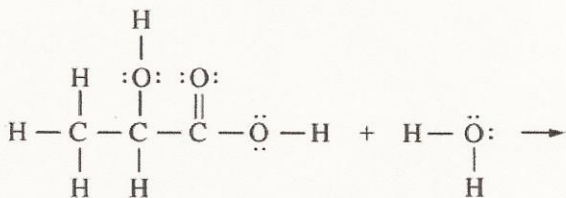
**CHEMISTRY FREE-RESPONSE QUESTIONS (Form B)**

Answer Question 5 and Question 6. The Section II score weighting for these questions is 15 percent each.

Your responses to these questions will be graded on the basis of the accuracy and relevance of the information cited. Explanations should be clear and well organized. Examples and equations may be included in your responses where appropriate. Specific answers are preferable to broad, diffuse responses.

5. Answer the following questions about laboratory situations involving acids, bases, and buffer solutions.

- (a) Lactic acid,  $\text{HC}_3\text{H}_5\text{O}_3$ , reacts with water to produce an acidic solution. Shown below are the complete Lewis structures of the reactants.



In the space provided above, complete the equation by drawing the complete Lewis structures of the reaction products.

- (b) Choosing from the chemicals and equipment listed below, describe how to prepare 100.00 mL of a 1.00 M aqueous solution of  $\text{NH}_4\text{Cl}$  (molar mass  $53.5 \text{ g mol}^{-1}$ ). Include specific amounts and equipment where appropriate.

$\text{NH}_4\text{Cl}(s)$	50 mL buret	100 mL graduated cylinder	100 mL pipet
Distilled water	100 mL beaker	100 mL volumetric flask	Balance

- (c) Two buffer solutions, each containing acetic acid and sodium acetate, are prepared. A student adds 0.10 mol of  $\text{HCl}$  to 1.0 L of each of these buffer solutions and to 1.0 L of distilled water. The table below shows the pH measurements made before and after the 0.10 mol of  $\text{HCl}$  is added.

	pH Before $\text{HCl}$ Added	pH After $\text{HCl}$ Added
Distilled water	7.0	1.0
Buffer 1	4.7	2.7
Buffer 2	4.7	4.3

- Write the balanced net-ionic equation for the reaction that takes place when the  $\text{HCl}$  is added to buffer 1 or buffer 2.
- Explain why the pH of buffer 1 is different from the pH of buffer 2 after 0.10 mol of  $\text{HCl}$  is added.
- Explain why the pH of buffer 1 is the same as the pH of buffer 2 before 0.10 mol of  $\text{HCl}$  is added.

# EMISTRY FREE-RESPONSE QUESTIONS

## CHEMISTRY

### Section II

(Total time—95 minutes)

#### Part A

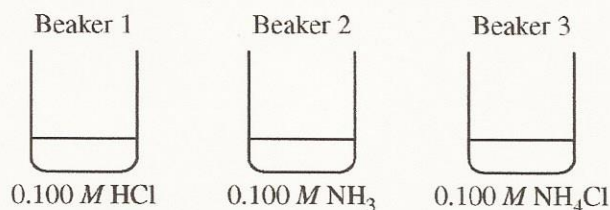
Time—55 minutes

**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. Each of three beakers contains 25.0 mL of a 0.100 M solution of HCl, NH<sub>3</sub>, or NH<sub>4</sub>Cl, as shown above. Each solution is at 25°C.
- (a) Determine the pH of the solution in beaker 1. Justify your answer.
- (b) In beaker 2, the reaction  $\text{NH}_3(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{NH}_4^+(aq) + \text{OH}^-(aq)$  occurs. The value of  $K_b$  for  $\text{NH}_3(aq)$  is  $1.8 \times 10^{-5}$  at 25°C.
- (i) Write the  $K_b$  expression for the reaction of  $\text{NH}_3(aq)$  with  $\text{H}_2\text{O}(l)$ .
- (ii) Calculate the  $[\text{OH}^-]$  in the solution in beaker 2.
- (c) In beaker 3, the reaction  $\text{NH}_4^+(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{NH}_3(aq) + \text{H}_3\text{O}^+(aq)$  occurs.
- (i) Calculate the value of  $K_a$  for  $\text{NH}_4^+(aq)$  at 25°C.
- (ii) The contents of beaker 2 are poured into beaker 3 and the resulting solution is stirred. Assume that volumes are additive. Calculate the pH of the resulting solution.
- (d) The contents of beaker 1 are poured into the solution made in part (c)(ii). The resulting solution is stirred. Assume that volumes are additive.
- (i) Is the resulting solution an effective buffer? Justify your answer.
- (ii) Calculate the final  $[\text{NH}_4^+]$  in the resulting solution at 25°C.

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