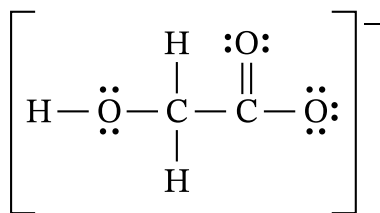
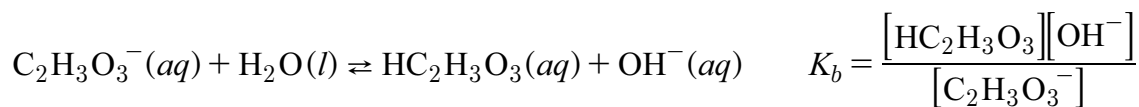


7. Answer the following questions about the glycolate ion, $\text{C}_2\text{H}_3\text{O}_3^-$, which acts as a base in aqueous solution. A Lewis diagram for the ion is provided.



A. On the Lewis diagram in part A, circle the atom that accepts the proton when the glycolate ion reacts with water.

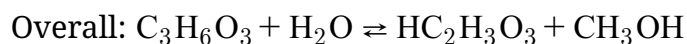
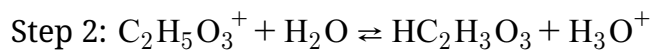
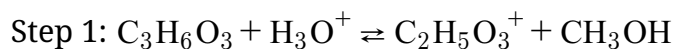
When the glycolate ion reacts with water, it forms glycolic acid, $\text{HC}_2\text{H}_3\text{O}_3$, according to the following equation. The K_b expression for the reaction is provided.



B. At 25°C , a 2.5 M solution of glycolate is found to have $[\text{OH}^-] = 1.3 \times 10^{-5}\text{ M}$.

- Calculate the value of K_b for the glycolate ion.
- Using your answer to part B (i), calculate the value of K_a for glycolic acid at 25°C .

Glycolic acid can be produced from the hydrolysis of methyl glycolate, $\text{C}_3\text{H}_6\text{O}_3$. A proposed mechanism for the reaction is given.



C. A student claims that H_3O^+ is a catalyst for the reaction. Do you agree or disagree? Justify your answer based on the mechanism given.

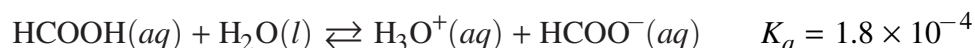
STOP

END OF EXAM

CHEMISTRY**SECTION II****Time—1 hour and 45 minutes****7 Questions****YOU MAY USE YOUR CALCULATOR FOR THIS SECTION.**

Directions: Questions 1–3 are long free-response questions that require about 23 minutes each to answer and are worth 10 points each. Questions 4–7 are short free-response questions that require about 9 minutes each to answer and are worth 4 points each.

For each question, show your work for each part in the space provided after that part. Examples and equations may be included in your responses where appropriate. For calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Pay attention to significant figures.



1. Methanoic acid, HCOOH , ionizes according to the equation above.

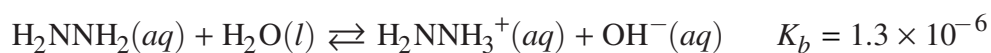
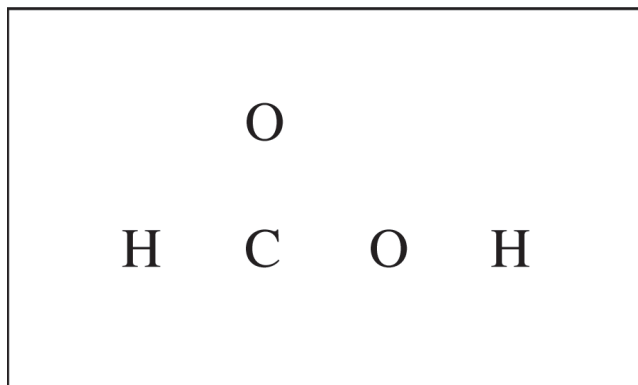
(a) Write the expression for the equilibrium constant, K_a , for the reaction.

(b) Calculate the pH of a 0.25 M solution of HCOOH .

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Use a pencil or pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

(c) In the box below, complete the Lewis electron-dot diagram for HCOOH . Show all bonding and nonbonding valence electrons.



(d) In aqueous solution, the compound H_2NNH_2 reacts according to the equation above. A 50.0 mL sample of 0.25 M $\text{H}_2\text{NNH}_2(aq)$ is combined with a 50.0 mL sample of 0.25 M $\text{HCOOH}(aq)$.

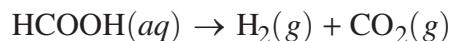
(i) Write the balanced net ionic equation for the reaction that occurs when H_2NNH_2 is combined with HCOOH .

(ii) Is the resulting solution acidic, basic, or neutral? Justify your answer.

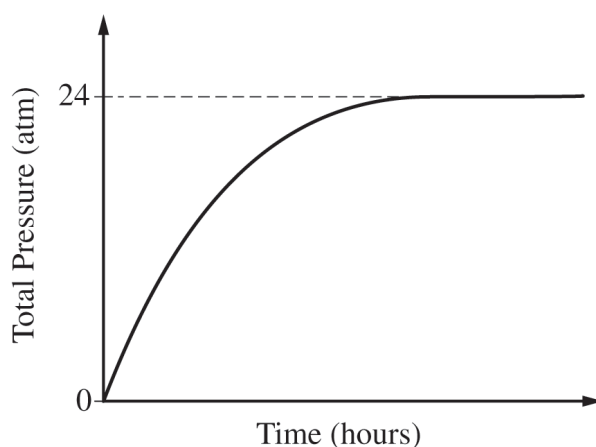
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When a catalyst is added to a solution of $\text{HCOOH}(aq)$, the reaction represented by the following equation occurs.



(e) Is the reaction a redox reaction? Justify your answer.



(f) The reaction occurs in a rigid 4.3 L vessel at 25°C , and the total pressure is monitored, as shown in the graph above. The vessel originally did not contain any gas. Calculate the number of moles of $\text{CO}_2(g)$ produced in the reaction. (Assume that the amount of $\text{CO}_2(g)$ dissolved in the solution is negligible.)

(g) After the reaction has proceeded for several minutes, does the amount of catalyst increase, decrease, or remain the same? Justify your answer.

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