2025

AP® Chemistry

Sample Student Responses and Scoring Commentary

Inside:

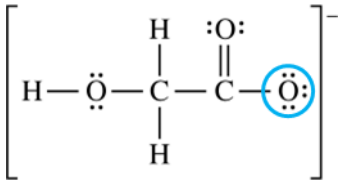
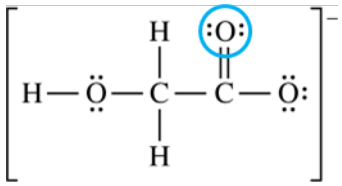
Free-Response Question 7

- ☑ **Scoring Guidelines**
- ☑ **Student Samples**
- ☑ **Scoring Commentary**

Question 7: Short Answer — 4 points

A For a correct circled atom. **Point 01**

Accept one of the following:

- 
- 

(Because of resonance, the two $C-O$ *bonds on the right are equivalent.)*

B (i) For the correct calculated value: **Point 02**

$$K_b = \frac{[HC_2H_3O_3][OH^-]}{[C_2H_3O_3^-]} = \frac{(1.3\times10^{-5})(1.3\times10^{-5})}{(2.5-1.3\times10^{-5})} \approx \frac{(1.3\times10^{-5})^2}{(2.5)} = 6.8\times10^{-11}$$

(ii) For the correct calculated value, consistent with part B (i): **Point 03**

$$K_a = \frac{K_w}{K_b} = \frac{1.0\times10^{-14}}{6.8\times10^{-11}} = 1.5\times10^{-4}$$

C For the correct answer and a valid justification: **Point 04**

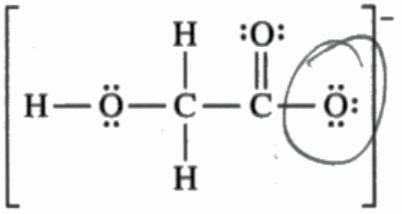
Agree. H_3O^+ *is consumed in step 1 and regenerated in step 2, which is consistent with the behavior of a catalyst.*

Sample 7A

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

Question 7

Part A



Part B

$C_2H_3O_3^-(aq) + H_2O(l) \rightleftharpoons HC_2H_3O_3(aq) + OH^-(aq)$ $K_b = \frac{[HC_2H_3O_3](aq)}{[C_2H_3O_3^-]}$

2.5M

$2.5 - 1.3\times10^{-5}M$ $1.3\times10^{-5}M$ $1.3\times10^{-5}M$

i) $K_b = \frac{[1.3\times10^{-5}]^2}{[2.5-1.3\times10^{-5}]} = 6.8\times10^{-11}$

ii) $K_w = K_a K_b$ (for conj pairs $C_2H_3O_3^-$ & $HC_2H_3O_3$)

$1.0\times10^{-14} = K_a * 6.8\times10^{-11}$

$K_a = 1.5\times10^{-4}$

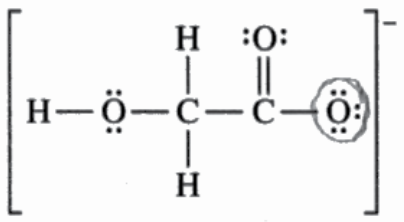
Part C

I agree. H_3O^+ is a reactant of the first step, beginning the reaction, and a product of the 2nd. It is not in the overall reaction and therefore doesn't bond with or react as the other molecules do. However, it is a part of the mechanism which starts off the reaction, therefore it is a catalyst.

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

Question 7

Part A



Part B

1. $[OH^-] = [HC_2H_3O_3]$

$[C_2H_3O_3^-] = 2.5$

$K_b = \frac{(1.3 \cdot 10^{-5})^2}{2.5} \approx \boxed{6.8 \cdot 10^{-11}}$

2. $K_a = \frac{[C_2H_3O_3^-]}{[HC_2H_3O_2][OH^-]} = \frac{1}{K_b} = \boxed{1.5 \cdot 10^{10}}$

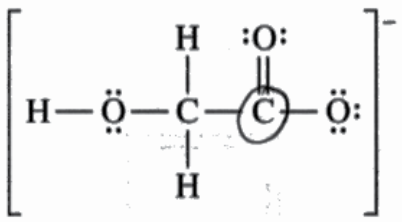
Part C

I agree. Adding H_3O increases the forward and reverse rates of reaction.

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

Question 7

Part A



Part B

1. $K_b = \frac{[OH^-][HB^+]}{[B]} = \frac{(1.3 \cdot 10^{-5})(3)}{2.5} = 1.04e^{-5}$

$K_b = 1.04e^{-5}$

ii. $K_a = \frac{[H_3O^+][A^-]}{[HA]}$

$K_a = 5.6e^{-3}$

Part C

I agree that H_3O^+ is a catalyst in the reaction. It is an ion that is in the reactants for step 1, and then shows back up in the products of step 2, but is not in the overall reaction. This qualifies it as a catalyst.

Question 7

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

NEW for 2025: The question overviews can be found in the *Chief Reader Report on Student Responses* on AP Central.

Sample: 7A
Score: 4

Point 01: 1
Part A: The point was earned for circling a correct oxygen atom.

Point 02: 1
Part B (i): The point was earned for correctly calculating the value of K_b by substituting the correct concentrations into the K_b expression.

Point 03: 1
Part B (ii): The point was earned for correctly calculating K_a using $K_w = K_a K_b$.

Point 04: 1
Part C: The point was earned for correctly agreeing and stating that "H_3O^+ is a reactant of the first step, beginning the reaction, and a product of the 2nd" and indicating "it is not in the overall reaction."

Sample: 7B
Score: 2

Point 01: 1
Part A: The point was earned for circling a correct oxygen atom.

Point 02: 1
Part B (i): The point was earned for correctly calculating the value of K_b by substituting the correct concentrations into the K_b expression.

Point 03: 0
Part B (ii): The point was not earned because the response incorrectly determines that $K_a = 1 / K_b$.

Point 04: 0
Part C: The point was not earned. While the response correctly agrees with the claim, it does not provide a justification based on the mechanism provided.

Question 7 (continued)

Sample: 7C
Score: 1

Point 01: 0
Part A: The point was not earned because the response circles a carbon atom.

Point 02: 0

Part B (i): The point was not earned because the response incorrectly calculates the value of K_b using an incorrect concentration of glycolic acid. Additionally, correct scientific notation is not used.

Point 03: 0

Part B (ii): The point was not earned because the response sets up a K_a expression, but it neither substitutes appropriate concentrations nor calculates a value of K_a using K_w / K_b.

Point 04: 1

Part C: The point was earned for correctly agreeing with the claim and stating that it (H_3O^+) is consumed in step 1 and "shows back up in the products" in step 2.