

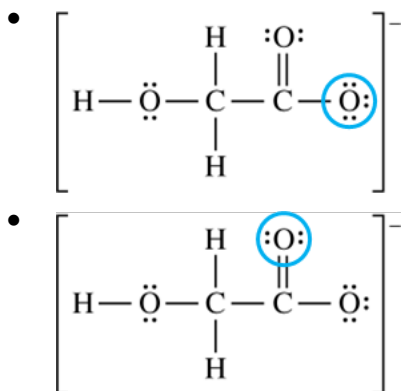
Question 7: Short Answer

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

$$K_b = \frac{[\text{HC}_2\text{H}_3\text{O}_3][\text{OH}^-]}{[\text{C}_2\text{H}_3\text{O}_3^-]} = \frac{(1.3 \times 10^{-5})(1.3 \times 10^{-5})}{(2.5 - 1.3 \times 10^{-5})} \approx \frac{(1.3 \times 10^{-5})^2}{(2.5)} = 6.8 \times 10^{-11}$$

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

Point 03

$$K_a = \frac{K_w}{K_b} = \frac{1.0 \times 10^{-14}}{6.8 \times 10^{-11}} = 1.5 \times 10^{-4}$$

C For the correct answer and a valid justification:

Point 04

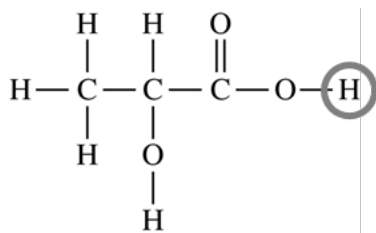
Agree. H_3O^+ is consumed in step 1 and regenerated in step 2, which is consistent with the behavior of a catalyst.

Question 1: Long Answer

10 points

- (a) For the correct circled atom: 1 point

The rightmost hydrogen atom should be circled.



- (b) For the correct calculated value: 1 point

$$\frac{(10.22 \text{ g})\left(\frac{1 \text{ mol}}{40.00 \text{ g}}\right)}{0.500 \text{ L}} = 0.511 \text{ M}$$

- (c) For the correct $\text{p}K_a$: 1 point

3.9 (acceptable range: 3.7 – 4.0)

- (d) (i) For the X at the correct point: 1 point

The X should be at a point greater than or equal to 3 mL and less than 8 mL.

- (ii) For a correct justification: 1 point

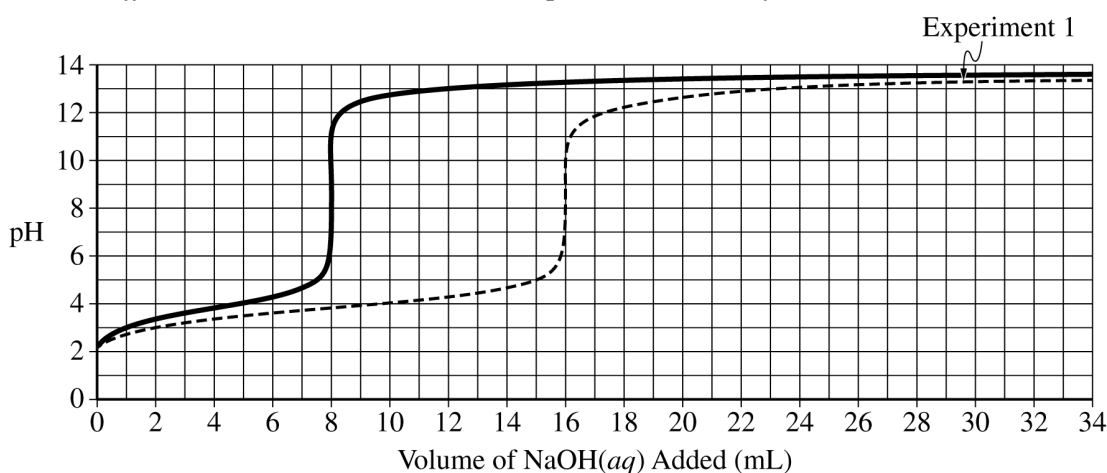
More acid particles are present than conjugate base particles, meaning that the titration is before the half-equivalence point.

- (iii) For a curve showing the correct equivalence point: 1 point

The equivalence point should be at 8 mL. See example response below.

For a curve with appropriate initial and final pH with a correct shape: 1 point

The drawn curve should begin at the same pH, gradually increase, rise sharply at a volume different than 16 mL, and end at a pH similar to the first curve.



Total for part (d) 4 points

(e) (i)	For the correct calculated value:	1 point
(ii)	For the correct calculated value:	1 point
(iii)	For the correct answer and a valid justification:	1 point
		Total for part (e) 3 points
		Total for question 1 10 points