



AP[®] Chemistry 2002 Sample Student Responses Form B

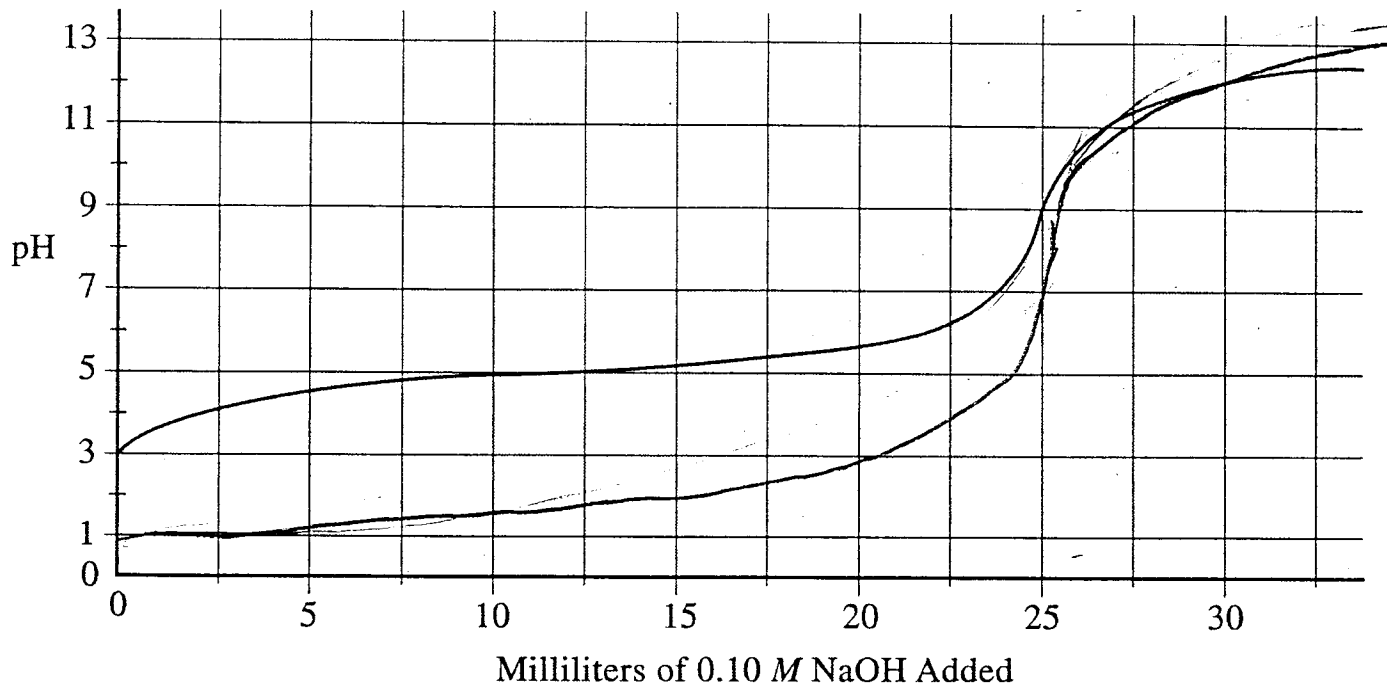
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8. The graph below shows the result of the titration of a 25 mL sample of a 0.10 M solution of a weak acid, HA, with a strong base, 0.10 M NaOH.



- (a) Describe two features of the graph above that identify HA as a weak acid.
- (b) Describe one method by which the value of the acid-dissociation constant for HA can be determined using the graph above.
- (c) On the graph above, sketch the titration curve that would result if 25 mL of 0.10 M HCl were used instead of 0.10 M HA.
- (d) A 25 mL sample of 0.10 M HA is titrated with 0.20 M NaOH.
 - (i) What volume of base must be added to reach the equivalence point?
 - (ii) The pH at the equivalence point for this titration is slightly higher than the pH at the equivalence point in the titration using 0.10 M NaOH. Explain.

a) ① The graph remains horizontal for a long period, meaning that it is a good buffer. \Rightarrow weak acid and conjugate base
 ② The pH of the equivalence pt is above 7

b) $K_a = \frac{[H^+][A^-]}{[HA]}$ At the half equivalence point, $[A^-] = [HA]$, so $K_a = [H^+]$
 using the pH, we can find the $[H^+]$, and thus the K_a

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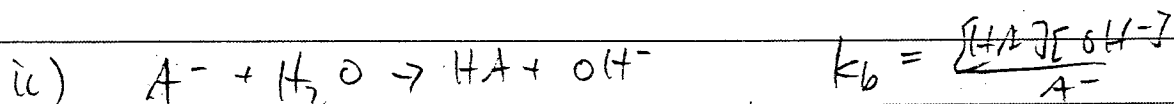
ADDITIONAL PAGE FOR ANSWERING QUESTION 8.

c) $pH = -\log 0.1 = 1$
 eg pt $pH = 7$

d) i) $0.025 L \times 0.1 M HA = 0.0025 \text{ mol } HA = 0.0025 \text{ eq } H^+$

$0.2 M NaOH = 0.2 \text{ eq/L}$

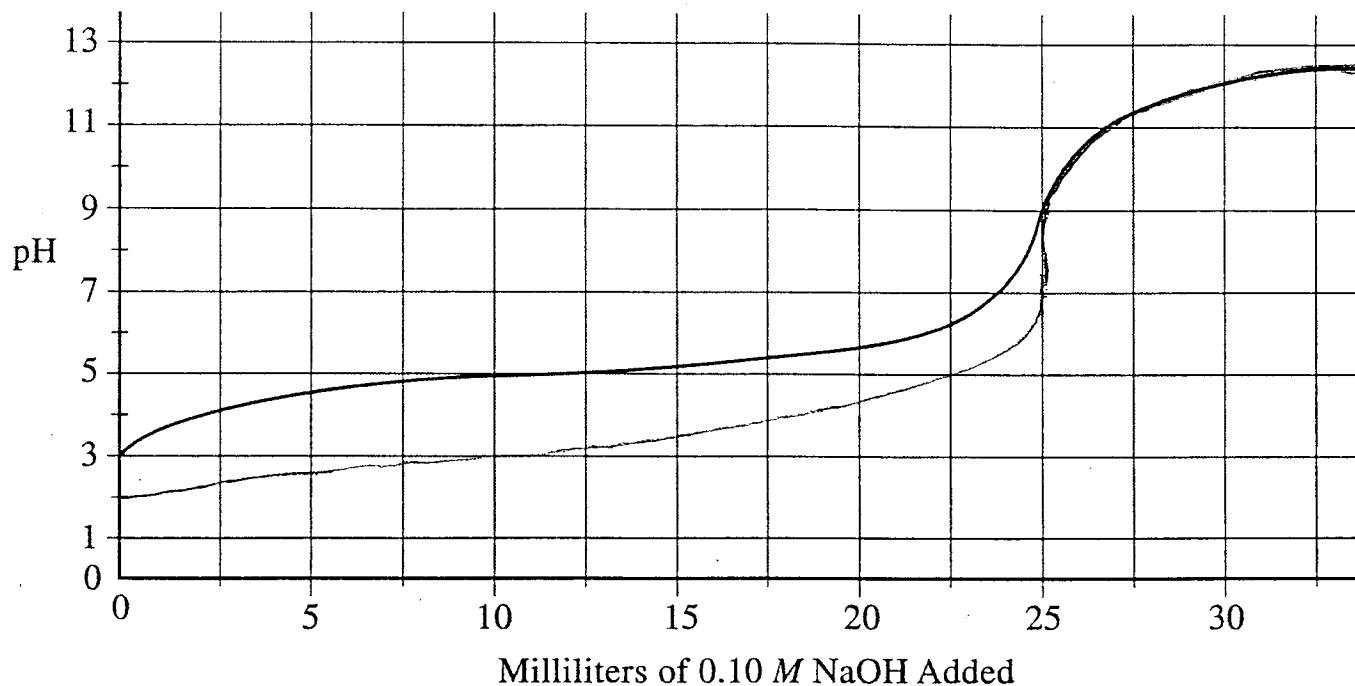
$$\frac{0.0025 \text{ eq}}{0.2 \text{ eq/L}} \times \frac{0.025}{2} = \boxed{0.0125 L}$$



This reaction occurs at the eq pt because HA is a weak acid.

Because less base is added to reach the eq pt, the concentration of A^- is higher, which means $[OH^-] \approx K_b \times [A^-]$, thus $[OH^-]$ is higher, meaning that pH is higher.

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- (a) Describe two features of the graph above that identify HA as a weak acid.
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a) The graph shows that the equivalence point is at a pH of 9. If it were a strong acid the pH would be at 7. The graph starts at a pH of 3, if it were a strong acid the graph would start ~~at~~ closer to ~~zero~~ a pH of zero.

b). From the halfway point on the graph we can calculate the K_a because at the halfway point.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 8.

$$pH = pK_a$$

when we have the pka we can apply the negative antilog function and get the ka.

$$d) \cdot i) \cdot \text{moles of HA} = 0.10 \times 25$$

$$\text{Volume of NaOH needed to be added} = \frac{0.10 \times 25}{0.202}$$

$$= 12.5 \text{ mL}$$

ii) This is because a more concentrated base is being added which increase the concentration of OH^- in solution giving a higher pH.