AP® Chemistry
2002 Sample Student Responses
Form B

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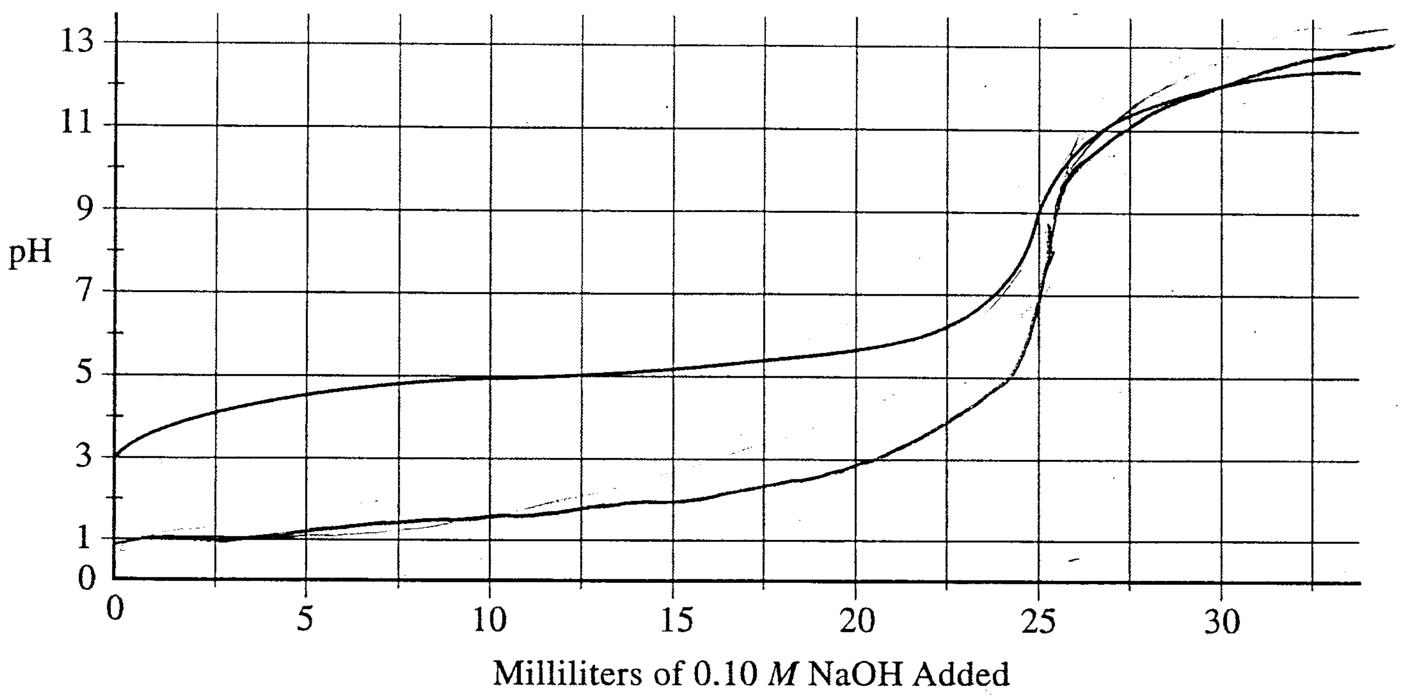
8. The graph below shows the result of the titration of a 25 mL sample of a 0.10 M solution of a weak acid, HA, with a strong base, 0.10 M NaOH.



(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. => weak acid and conjugate base

② The pH of the equivalence pt is above 7

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

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ADDITIONAL PAGE FOR ANSWERING QUESTION 8.

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

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

0.2 M NaOH = 0.2 eq/L

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

ii) $A^- + H_2O \rightarrow HA + OH^-$ $\quad k_b = \frac{[HA][OH^-]}{A^-}$
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.
$[OH^-] \approx kb \times [A^-]$, thus $[OH^-]$ is higher, meaning that pH is higher.

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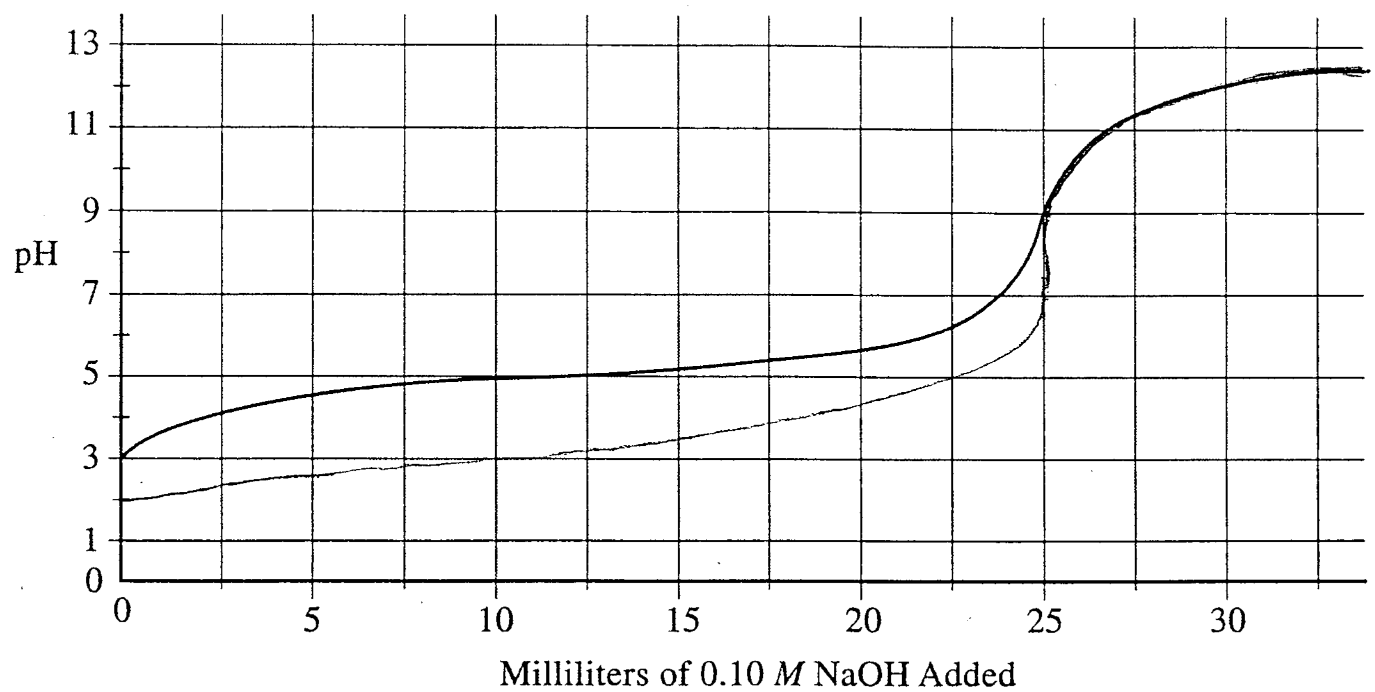

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(i) What volume of base must be added to reach the equivalence point?

(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) The graph shows that the equivalance 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 halway point on the graph we can calculate the Ka because at the halfway point.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 8.

pH = pKa
when we have the pka we can apply the negative antilog function and get the Ka.

d).i). moles of HA = 0.10 x 25
volume of NaOH needed to be added = ~~0.10~~ 1 x 25 / ~~0.20~~ 2
= 12.5 mL

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