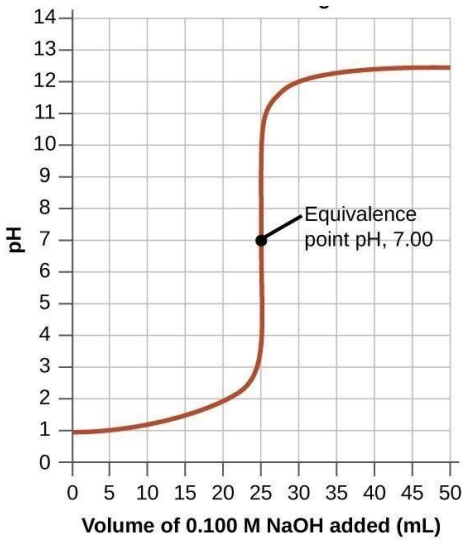
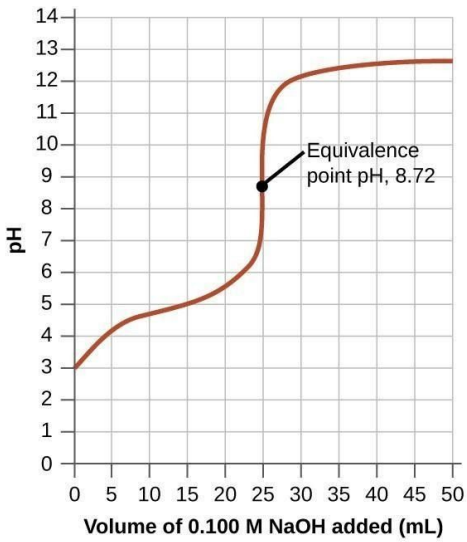
Topic 8.5 Worksheet

1. Explain the process of the titration of an acid with a base.



Titration Curve A



Titration Curve B

2. Consider the two titration curves given above.
   a. Which titration curve above is of a strong acid/strong base titration? Explain how you know.

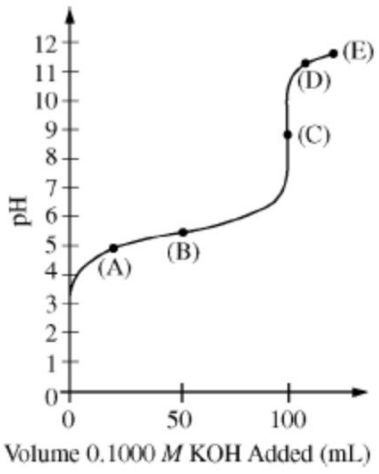
   b. Explain why the other titration curve is of a weak acid/strong base titration.

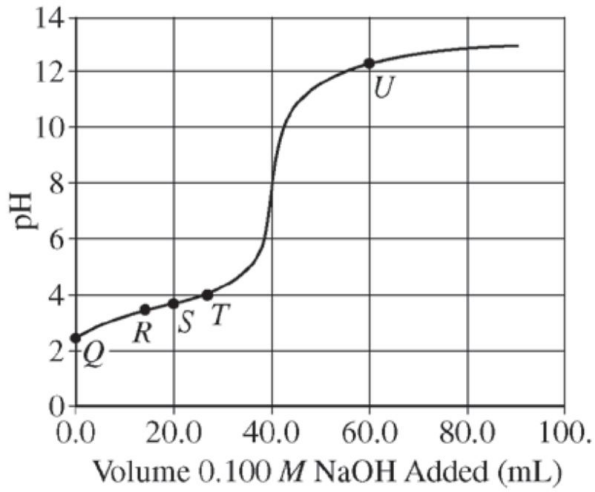
   c. What is the pK_a and K_a of the weak acid?

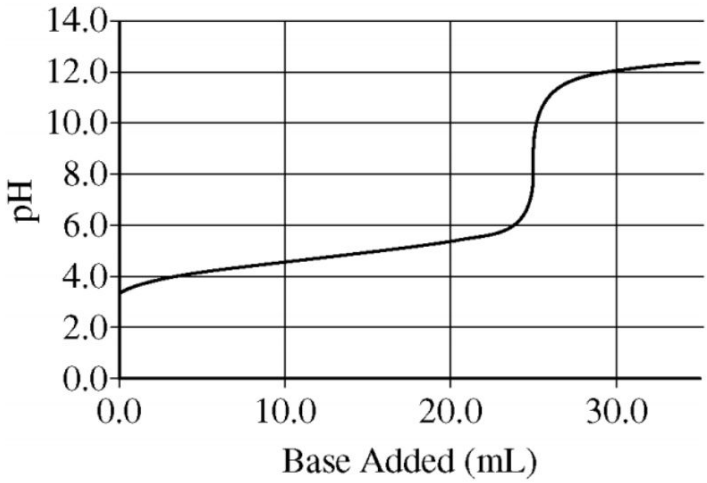
3. For the following titrations, determine the molarity of the monoprotic acid.
    a. In a titration, 15.0 mL of acid reaches equivalence with 23.8 mL of 0.100 M base.

    b. 13.4 mL of 0.125 M base reaches equivalence with 25.0 mL of a weak acid.

4. Determine the pK_a and K_a of the following acids based on the titration curve.







For a weak acid/strong base titration, explain why the pH = pK_a at half-way to the equivalence point.

5. Draw a general titration curve for …
    a. H_3PO_4

    b. H_2SO_4

6. Explain the method to …
    a. determine equivalence via titration.

    b. determine equivalence via pH electrodes.

7. Define:
    a. Titrant

    b. Analyte

    c. Equivalence point

    d. End point

8. At which point in a titration are the concentrations of the weak acid and its conjugate base approximately equal?

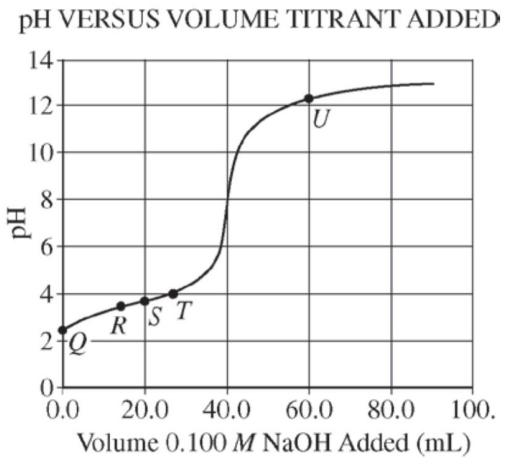
9. A titration is carried out to determine the molarity of an unknown acid. Determine if the following would increase, decrease, or have no effect on the calculated molarity. Explain your reasoning for each.
    a. You use an indicator with an endpoint slightly past the equivalence point.

    b. You use an indicator with an endpoint slightly before the equivalence point.

    c. You choose the wrong indicator. The indicator you chose should be used for a strong acid/strong base titration but you are carrying out a weak acid/strong base titration.

    d. You choose the wrong indicator. The indicator you chose should be used for a weak acid/strong base titration but you are carrying out a strong acid/strong base titration.

10. For the titration curve given below, determine which species are present by placing an "X" in the box and which species has the highest concentration by placing also placing an "O" in the box.



Point	HA	A^-	H_3O^+	OH^-
Q				
R				
S				
T				
U				

$$HCOOH(aq) \rightleftharpoons HCOO^-(aq) + H^+(aq) \qquad K_a = 1.8 \times 10^{-4}$$

11. Formic acid, HCOOH, dissociates in water as shown in the equation above. A 25.0 mL sample of an aqueous solution of pure formic acid is titrated using standardized 0.150 M NaOH.
    a. After addition of 15.0 mL of the 0.150 M NaOH, the pH of the resulting solution is 4.37. Calculate each of the following.
        i. $[H^+]$ in the solution

        ii. $[OH^-]$ in the solution

        iii. The number of moles of NaOH added

        iv. The number of moles of $HCOO^-$ (aq) in the solution.

        v. The number of moles of HCOOH in the solution.

    b. At equivalence, will the pH be greater than 7, less than 7, or equal to 7. Explain your reasoning.

12. Determine the volume of each solution needed to reach equivalence. Do not use a calculator.
    a. What volume of 0.15 M HCl is needed to reach equivalence with 23.0 mL of 0.15 M NaOH?

    b. What volume of 0.23 M Benzoic acid ($K_a = 6.3 \times 10^{-5}$) is needed to reach equivalence with 32.92 mL of 0.23 M NaOH?

    c. What volume of 0.10 M HCl is needed to reach equivalence with 20 mL of 0.20 M NaOH?

13. What is the pH at equivalence of a …
    a. strong acid/strong base titration. Explain why.

    b. weak acid/strong base titration. Explain why.

    c. weak base/strong acid titration. Explain why.

14. NEED PARTICLE PICTURE PROBLEMS