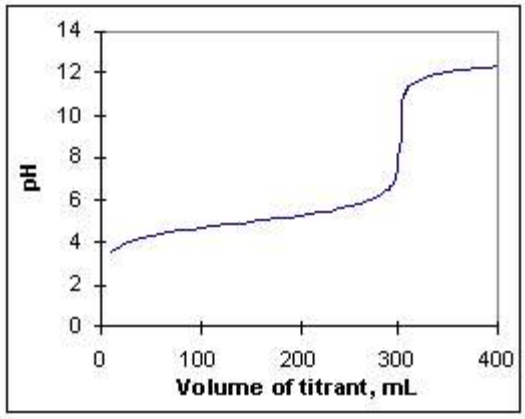
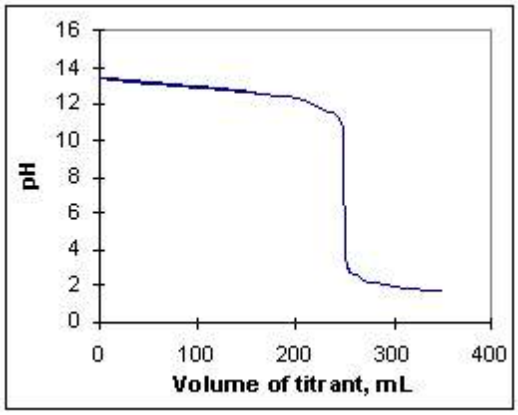
You will need to use the Tables of Ka and Kb values given with the "Buffers" exam study questions to answer some of these questions.

Examine the following titration curves for the next 3 questions: [spr 00, ex 2p]

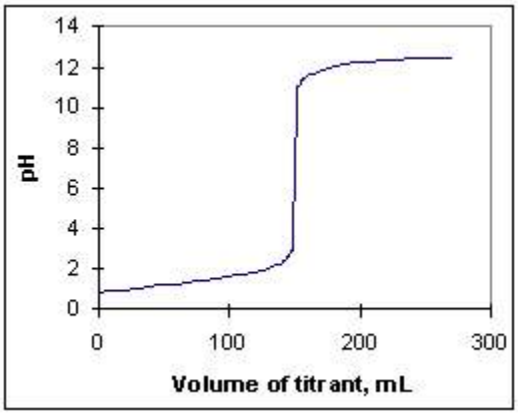
Titration (a)



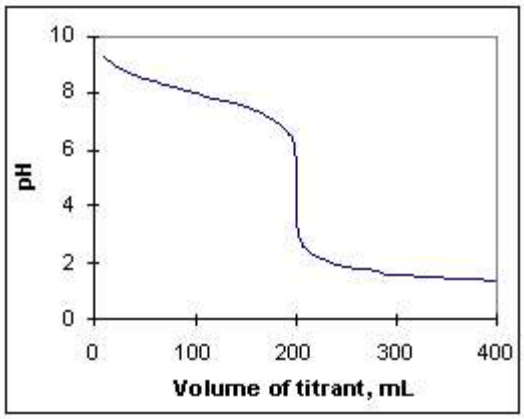
Titration (b)



Titration (c)



Titration (d)



1. Which one of the titration curves correspondsto the titration of a weak acid (in flask) with a strong base (in buret)?

2. Consider titration (b). What was the original concentration of the acid or base in the flask if the original volume was 100 mL and it was titrated with a standard solution (in buret) that had a concentration of 0.100 M?

   a. 0.100 M b. 0.150 M c. 0.200 M d. 0.250 M e. 0.300 M

3. Consider the titration curve that corresponds to the titration of a weak base with a strong acid. From the data shown, what is the approximate $\mathbf{K_b}$ of the weak base?

   a. 1×10^{-4} b. 1×10^{-5} c. 1×10^{-6} d. 1×10^{-7} e. 1×10^{-8}

Consider the following titration for the next 5 questions. [fall 02, ex2]

20.0 mL of 0.060 M **$HClO_4$** (in the flask) is titrated with 0.040 M **NaOH** (in buret).

4. What is the <u>overall</u> reaction occurring in the titration?

(a) $HClO_4(aq) + H_2O \rightarrow H_3O^+(aq) + ClO_4^-(aq)$
(b) $HClO_4(aq) + NaOH(aq) \rightarrow H_2O + NaCl(aq) + 2\ O_2(g)$
(c) $HClO_4(aq) + NaOH(aq) \rightarrow NaClO_4(aq) + H_2O$
(d) $NaOH(aq) + H_2O \rightarrow H_2O + OH^-(aq) + Na^+(aq)$
(e) $HClO_4(aq) + NaOH(aq) \rightarrow H_2O_2(aq) + NaClO_3(aq)$

5. How many mL of the NaOH solution need to be added to reach the equivalence point of the titration?

(a) 10.0 mL (b) 20.0 mL (c) 30.0 mL (d) 40.0 mL (e) 50.0 mL

6. Which of the following is present in the flask after some NaOH has been added, but before the equivalence point has been reached? **Mark all correct answers.**

(a) $HClO_4(aq)$ (b) $NaOH(aq)$ (c) $NaClO_4(aq)$ (d) $NaClO_3(aq)$

7. Which of the following is present in the flask at the equivalence point of the titration? **Mark all correct answers.**

(a) $HClO_4(aq)$ (b) $NaOH(aq)$ (c) $NaClO_4(aq)$ (d) $NaClO_3(aq)$

8. What is the pH of the solution in the flask at the equivalence point of the titration?

(a)10.84 (b) 5.86 (c) 8.22 (d) 7.00 (e) 5.43

Consider the following titration for the next 5 questions. [fall 02, ex2]

20.0 mL of 0.060 M piperidine,**$C_5H_{11}N$**, (in the flask) is titrated with 0.040 M **$HClO_4$** (in buret).

9. What is the <u>overall</u> reaction occurring in the titration?

(a) $C_5H_{11}N(aq) + HClO_4(aq) \rightarrow [C_5H_{10}N]ClO_3(aq) + H_2O(l)$
(b) $C_5H_{11}N(aq) + HClO_4(aq) \rightarrow C_5H_{11}NH(aq) + ClO_4(aq)$
(c) $H_3O^+(aq) + OH^-(aq) \rightarrow 2\ H_2O(l)$
(d) $C_5H_{11}N(aq) + H_2O(l) \rightarrow [C_5H_{11}NH]OH(aq)$
(e) $C_5H_{11}N(aq) + HClO_4(aq) \rightarrow [C_5H_{11}NH]ClO_4(aq)$

10. How is the solution in the flask best characterized after 5.00 mL of the $HClO_4$ solution have been added? This is before the equivalence point of the titration.

(a) solution of a strong acid (b) solution of a strong base
(c) solution of a weak acid (d) solution of a weak base
(e) buffer solution (ab) neutral solution

11. What is the pH of the solution in the flask after 5.00 mL of the $HClO_4$ solution have been added? (Note the equivalence point is the same as for the previous titration problem because the volume and concentrations are the same.)

(a)6.29 (b) 11.81 (c) 11.11 (d) 3.59 (e) 12.60

12. How is the solution in the flask best characterized at the equivalence point of the titration?

(a) solution of a strong acid (b) solution of a strong base
(c) solution of a weak acid (d) solution of a weak base
(e) buffer solution (ab) neutral solution

13. What is the pH of the solution in the flask at the equivalence point of the titration? The equivalence point is the same as for the previous titration problem, question 5.)

(a)7.75 (b) 7.00 (c) 5.53 (d) 6.37 (e) 8.92

Consider the following titration for the next 3 questions. [spr 02, ex 2]

30.0 mL of 0.200 M **KOH** (in the flask) is titrated with 0.300 M **HCl** (in buret).

14. How many mL of the NaOH solution need to be added to reach the equivalence point of the titration?

(a)10.0 mL (b) 20.0 mL (c) 30.0 mL (d) 40.0 mL (e) 50.0 mL

15. Fill in the blanks with the following choices:

(1) solution of a strong acid (2) solution of a strong base
(3) solution of a weak acid (4) solution of a weak base
(5) buffer solution (6) neutral solution

Initially, before any HCl is added, the solution in the flask is best characterized as a _____.
After HCl is added, but before reaching the equivalence point, the solution in the flask is best characterized as a_____.
At the equivalence point the solution in the flask is best characterized as a_____.
Beyond the equivalence point the solution in the flask is best characterized as a _____.

The answers in order (top to bottom) are

(a) 1,1,6,2 (b) 3,5,4,2 (c) 2,2,6,1 (d) 3,5,6,2 (e) 4,5,3,1

16. What is the pH of the solution in the flask after 5.00 mL of the HCl solution have been added? (This is before the equivalence point.)

(a)12.50 (b) 13.30 (c) 0.89 (d) 0.70 (e) 13.11

Consider the following titration for the next 6 questions: [spr 01, ex2]

30.0 mL of a 0.100 M HF solution (in flask) is titrated with a 0.200 M NaOH solution (in the buret).

17. How many mL of the NaOH solution needs to be added to reach the equivalence point of the titration?

(a) 10.0 mL (b) 15.0 mL (c) 30.0 mL (d) 50.0 mL (e) 60.0 mL

18. Which one of the following <u>best</u> characterizes the solution in the flask after 5.00 mL of the NaOH solution has been added?

(a) a solution of a strong acid (b) a solution of a strong base
(c) a solution of a weak acid (d) a solution of a weak base
(e) a buffer solution (ab) a neutral solution

19. What will be the pH of the solution in the flask after 5.00 mL of the NaOH solution has been added?

(a) 3.16 (b)12.45 (c) 2.20 (d) 5.82 (e) 3.45

20. Which one of the following best characterizes the solution in the flask at the equivalence point of the titration?

(a) a solution of a strong acid (b) a solution of a strong base
(c) a solution of a weak acid (d) a solution of a weak base
(e) a buffer solution (ab) a neutral solution

21. What is the pH of the solution at the equivalence point of the titration?

(a)12.55 (b) 7.00 (c) 6.27 (d) 8.14 (e) 9.11

22. Which one of the following best characterizes the solution in the flask past the equivalence point of the titration?

(a) a solution of a strong acid (b) a solution of a strong base
(c) a solution of a weak acid (d) a solution of a weak base
(e) a buffer solution (ab) a neutral solution

Answers: 1 a, 2 d, 3 c, 4 c, 5 c, 6 ac, 7 c, 8 d, 9 e, 10 e, 11 b, 12 c, 13 d, 14 b, 15 c, 16 e, 17 b, 18 e, 19 a, 20 d, 21 d, 22 b.