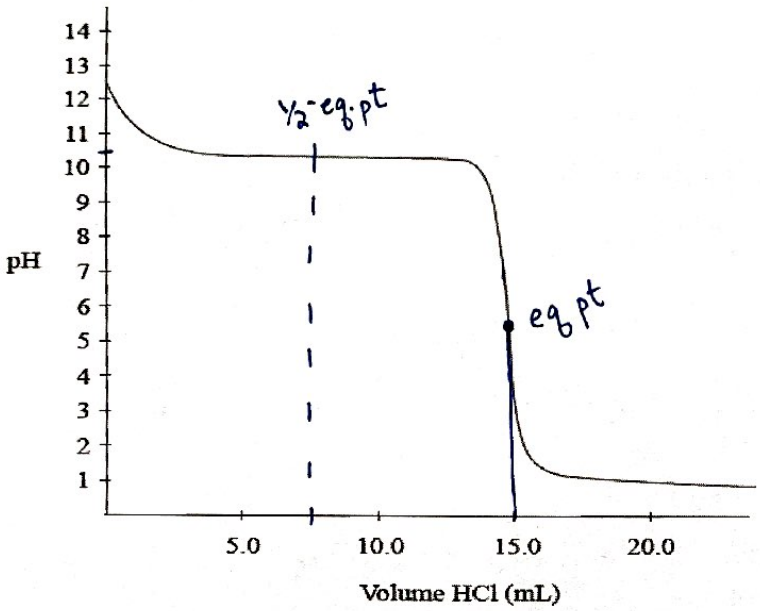
Unit 8 Multiple Choice Practice

Use the following information to answer questions 1–4.

A student titrates some 1.0 M HCl into 20.0 mL of methylamine (CH_3NH_2), a weak base which only accepts a single proton. The following titration curve results:



$M_a V_a = M_b V_b$

$(1.0\ M)(15\ mL) = M_b(20\ mL)$

$M_b = \frac{15}{20} = 0.75\ M$

1. What is the concentration of the methylamine?

   a. 0.50 M (b.) 0.75 M c. 1.0 M d. 1.25 M

2. What is the approximate pK_b for methylamine? $pK_a(\text{conj. acid}) \approx 10.5 \Rightarrow pK_b = 14 - 10.5 = 3.5$

   (a.) 3.5 b. 5.5 c. 10.5 d. 12.5

3. What buffer region of this titration is located:

   a. Below 3.0 mL
   (b.) Between 3.0 mL and 14.0 mL
   c. Between 14.0 mL and 16.0 mL
   d. Above 16.0 mL

4. The methylamine is replaced by 20.0 mL of sodium hydroxide of an identical concentration. If the sodium hydroxide is titrated with the 1.0 M HCl, which of the following options accurately describes the pH levels at various points during the titration when compared to the pH levels at the same point in the HCl/methylamine titration?

	Initial pH	**Equivalence pH**	**Ending pH**
a.	lower	same	higher
(b.)	higher	higher	same
c.	same	higher	same
d.	higher	lower	lower

5. What volume of 0.300 M KOH would be needed to completely neutralize 60.0 mL of 0.200 M H_2SO_4?

   a. 40.0 mL b. 60.0 mL (c.) 80.0 mL d. 100. mL

$[H^+] = 0.2\ M\ H_2SO_4 \times \frac{2\ H^+}{1\ H_2SO_4} = 0.4\ M$

$M_{H^+} V_a = M_b V_b$

$(0.4\ M)(60\ mL) = (0.3\ M) V_b$

$V_b = \frac{0.4 \times 60}{0.3} = \frac{4 \times 60}{3} = 4 \times 20 = 80$

6. Which of the following indicators would be most suitable for the titration of 0.10 M lactic acid (pK_a = 3.08) with 0.10 M KOH(aq)?

   (a.) phenol red (pK_a = 6.9) c. thymol blue (pK_a = 1.7)

   b. alizarin red (pK_a = 4.5) d. methyl orange (pK_a = 3.4)

WA + SB ⇒ basic @ eq. pt

⇒ choose indicator closest to basic pH when 1:1 buffer

7. What is the pH of the solution formed when 0.040 moles of NaOH(s) is added to 1.00 L of 0.050 M HCl?

   a. 1.00 (b.) 2.00 c. 7.00 d. 12.00

H^+	+	OH^-
0.050		0.040
−0.040		−0.040
0.010		∅

H^+ excess! $[H^+]_{new} = \frac{0.010\ mol}{1.00\ L} = 0.010 = 1 \times 10^{-2}\ M$

⇒ pH = 2

8. What volume of 0.25 M $HClO_4$ would be needed to completely neutralize 30.0 mL of 0.20 M $Ca(OH)_2$?

   a. 12 mL b. 24 mL c. 36 mL (d.) 48 mL

$[OH^-] = 0.2\ M\ Ca(OH)_2 \times \frac{2\ OH^-}{1\ Ca(OH)_2} = 0.4\ M$

$M_a V_a = M_{OH^-} V_b$

$(0.25\ M) V_a = (0.40\ M)(30\ mL)$

$V_a = \frac{0.4 \times 30}{0.25} = \frac{12}{1/4} = 4 \times 12 = 48$

9. Equal volumes of 0.50 M $Mg(OH)_2$(aq) and 1.0 M H_3PO_4(aq) are mixed. Which of the following ions is found in the highest concentration?

   (a.) $H_2PO_4^-$ b. HPO_4^{2-} c. PO_4^{3-} d. OH^-

$[H^+] = 0.1\ M\ H_3PO_4 \times \frac{3\ H^+}{1\ H_3PO_4} = 0.3\ M$

10. What volume of 0.100 M NaOH is required to completely neutralize 15.00 mL of 0.100 M H_3PO_4?

    a. 5.00 mL b. 15.00 mL c. 30.00 mL (d.) 45.00 mL

$M_{H^+} V_a = M_b V_b$

$(0.3\ M)(15\ mL) = (0.1\ M) V_b$

$V_b = \frac{0.3 \times 15}{0.1} = 3 \times 15 = 45$

11. The complete neutralization of 15.0 mL of KOH requires 0.025 mol H_2SO_4. The [KOH] was:

a. 1.50 M b. 1.67 M (c.) 3.33 M d. 6.67 M

$\text{mol } H^+ = M_b V_b$

$0.050 \text{ mol} = M_b (0.015 \text{ L}) \Rightarrow M_b = \frac{0.050}{0.015} = \frac{50}{15} = 3.3$

12. During a titration, what volume of 0.500 M KOH is necessary to completely neutralize 10.0 mL of 2.00 M $HC_2H_3O_2$?

a. 10.0 mL b. 20.0 mL c. 25.0 mL (d.) 40.0 mL

$M_a V_a = M_b V_b$

$(2 \text{ M})(10 \text{ mL}) = (0.5 \text{ M}) V_b \Rightarrow V_b = \frac{2 \times 10}{0.5} = \frac{20}{1/2} = 2 \times 20 = 40$

13. What is the pH of the solution formed when 0.060 moles of NaOH is added to 1.00 L of 0.050 M HCl?

0.050 mol H^+

a. 2.00 b. 7.00 (c.) 12.00 d. 12.78

H^+	OH^-
0.050	0.060
-0.050	-0.050
ϕ	(0.010)

OH^- excess! $[OH^-]_{new} = \frac{0.010 \text{ mol}}{1.00 \text{ L}} = 0.010 \text{ M} = 10^{-2} \text{ M}$

$\Rightarrow pOH = 2 \Rightarrow pH = 14 - 2 = 12$

14. Which of the following titrations will always have an equivalence point at a pH > 7.00?

a. weak acid with a weak base (c.) weak acid with a strong base

b. strong acid with a weak base d. strong acid with a strong base