

Chemistry 12

Acid-Base Part II Practice Test

Name: Key  
 Date:  
 Block:

Multiple Choice.

C 1. Which term does the following statement best describe? A mixture of a weak acid and its conjugate base, each with distinguishing colours.

- A. Buffer
- B. Titration
- C. Indicator
- D. Primary standard

A 2. Which of the following properties is true for a solution of  $KNO_3$ ?

- A. It is neutral
- B. It is basic
- C. It is slightly basic
- D. It is slightly acidic

-both spectators

D 3. Which of the following salts will be basic?

- A.  $KCl$  → WA
- B.  $NH_4Cl$
- C.  $KHSO_4$  → WA
- D.  $K_2HPO_4$  → WA

$K_a = 2.2 \times 10^{-3}$   
 $K_b = \frac{K_w}{K_a} = 1.6 \times 10^{-7}$

$K_b > K_a$  ∴ WB

C 4. A weak acid is titrated with a strong base using the indicator phenolphthalein to detect the end point. What is the approximate pH at the transition point?

- A. 7.0
- B. 8.0
- C. 9.0
- D. 10.0

$pH = \frac{pK_a + pK_b}{2}$   
 $pH = \frac{2.7 + 6.8}{2} = 9.75 \approx 9.0$

B 5. What volume of 0.100M  $H_2SO_4$  is needed to titrate 25.0 mL of 0.200M NaOH?

- A. 12.5 mL
- B. 25.0 mL
- C. 50.0 mL
- D. 100.0 mL



$0.025L_{NaOH} \times \frac{0.200 \text{ mol NaOH}}{1L} \times \frac{1 \text{ mol } H_2SO_4}{2 \text{ mol NaOH}} \times \frac{1L_{H_2SO_4}}{0.100 \text{ mol}}$

D 6. Which of the following titrations always results in pH = 7.0 at the equivalence point?

- A. A weak acid is titrated with a weak base
- B. A weak acid is titrated with a strong base
- C. A strong acid is titrated with a weak base
- D. A strong acid is titrated with a strong base

C 7. Which of the following pairs of chemicals could be used to make a buffer solution?

WA & CB

- A.  $NH_3$  and  $H_2O$
- B.  $HCl$  and  $NaCl$
- C.  $NH_3$  and  $NH_4Cl$
- D.  $CH_3COOH$  and  $HCl$

C 8. When performing a titration experiment, the indicator must always have

- A. A distinct colour change at pH = 7.0
- B. The ability to change from colourless to pink
- C. A transition point that is close to the equivalence point
- D. An equivalence point that is close to the stoichiometric point

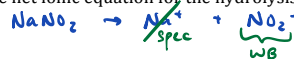
A 9. What is one of the  $K_a$  values for thymol blue?

- A.  $1.6 \times 10^{-9}$
- B.  $2.0 \times 10^{-7}$
- C.  $1.0 \times 10^{-7}$
- D.  $6.0 \times 10^{-2}$

$pK_a = pH @ \text{equivalence point}$   
 $-\log(1.6 \times 10^{-9}) = 8.8$

B 11. Which of the following describes the net ionic equation for the hydrolysis of a  $NaNO_2$  solution?

- A.  $NaNO_2 \rightleftharpoons Na^+ + NO_2^-$
- B.  $NO_2^- + H_2O \rightleftharpoons HNO_2 + OH^-$
- C.  $Na^+ + 2H_2O \rightleftharpoons H_3O^+ + NaOH$
- D.  $NaNO_2 + H_2O \rightleftharpoons NaOH + HNO_2$



D 12. What do a chemical indicator and a buffer solution typically both contain?

- A. A strong acid and its conjugate acid
- B. A strong acid and its conjugate base
- C. A weak acid and its conjugate acid
- D. A weak acid and its conjugate base

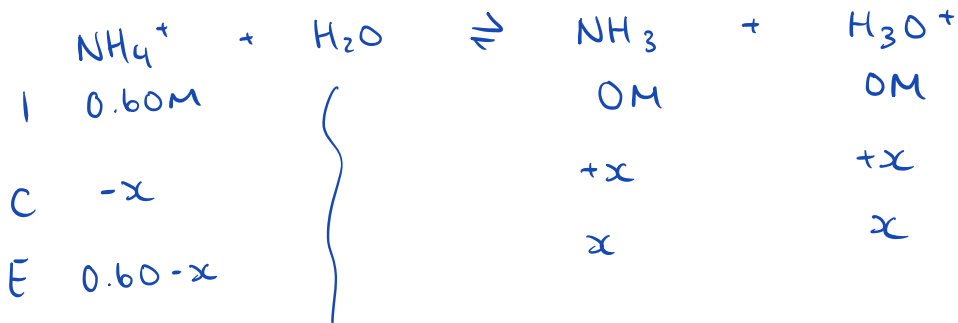
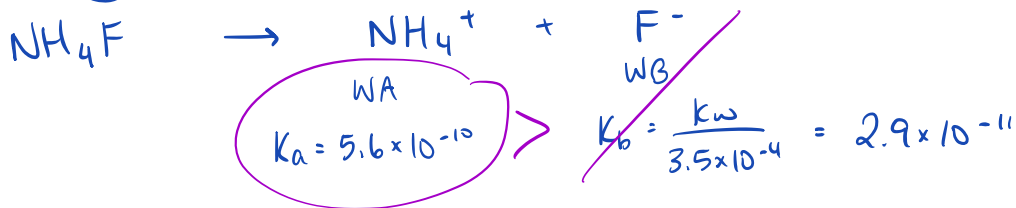
C 13. What is the approximate pH and  $K_a$  at the transition point for phenol red?

A.	pH = 6.6	$K_a = 3.0 \times 10^{-7}$
B.	pH = 7.3	$K_a = 1.0 \times 10^{-14}$
<u>C.</u>	pH = 7.3	$K_a = 5.0 \times 10^{-8}$
D.	pH = 8.0	$K_a = 1.0 \times 10^{-8}$

7.3 transition point

**Problems:**

1. Calculate the pH of 0.60M  $\text{NH}_4\text{F}$ .



$$K_a = 5.6 \times 10^{-10} = \frac{x^2}{0.60-x}$$

assume  $0.60-x \approx 0.60$

$$x = \sqrt{(0.60)(5.6 \times 10^{-10})}$$
$$= 1.8 \times 10^{-5}$$

$$\text{pH} = -\log(1.8 \times 10^{-5})$$
$$= \boxed{4.74}$$

2. You are given two buffer solutions:

Buffer #1: 1.0 M  $\text{NH}_3$  mixed with 1.0 M  $\text{NH}_4\text{Cl}$

Buffer #2: 0.1 M  $\text{NH}_3$  mixed with 0.1 M  $\text{NH}_4\text{Cl}$ .

$$[\text{H}_3\text{O}^+] = K_a \left( \frac{[\text{HA}]}{[\text{A}^-]} \right)$$

a) Will the pH of the buffers differ from each other? Why?

They will have the same pH b/c the ratio of [acid] to [base] is the same and it is the same  $K_a$

b) Calculate the pH of an undisturbed buffer solution.

$$[\text{H}_3\text{O}^+] = 5.6 \times 10^{-10} \left( \frac{1.0}{1.0} \right) = 5.6 \times 10^{-10} \left( \frac{0.1}{0.1} \right) = 5.6 \times 10^{-10}$$

$$\text{pH} = -\log(5.6 \times 10^{-10}) = \boxed{9.25}$$

c) Which buffer solution would be more effective? Explain your answer.

Buffer #1 will be more effective b/c there is a higher [acid] and [base] to neutralize the incoming  $[\text{H}_3\text{O}^+]$  or  $[\text{OH}^-]$

3. 40.0 mL of 0.10 M  $\text{NH}_3$  is titrated with 0.20 M  $\text{HClO}_4$ . Calculate the pH of the solution produced in the reaction flask at the following points:

a) At 2.00 mL before midpoint.



$$0.0400 \text{ L NH}_3 \times \frac{0.10 \text{ mol NH}_3}{1 \text{ L}} \times \frac{1 \text{ mol HClO}_4}{1 \text{ mol NH}_3} \times \frac{1 \text{ L HClO}_4}{0.20 \text{ mol}} = 0.020 \text{ L HClO}_4 = 20. \text{ mL @ equivalence point}$$

$$\frac{20. \text{ mL}}{2} - 2.00 \text{ mL} = 8.0 \text{ mL HClO}_4$$

[ $\text{NH}_3$ ]

$$C_1 V_1 = C_2 V_2$$

$$C_2 = \frac{(0.10 \text{ M})(40 \text{ mL})}{(48 \text{ mL})}$$

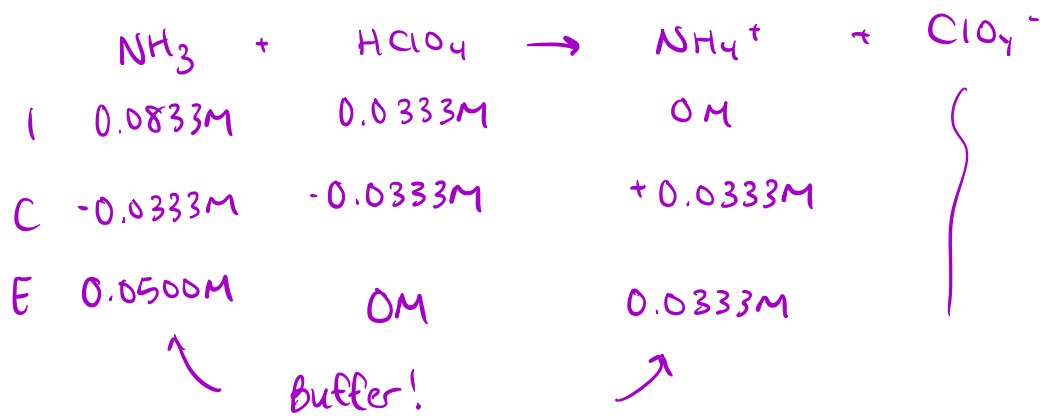
$$= 0.0833 \text{ M}$$

[ $\text{HClO}_4$ ]

$$C_1 V_1 = C_2 V_2$$

$$C_2 = \frac{(0.20 \text{ M})(8.0 \text{ mL})}{(48 \text{ mL})}$$

$$= 0.0333 \text{ M}$$



$$[\text{H}_3\text{O}^+] = K_a \left( \frac{[\text{HA}]}{[\text{A}^-]} \right)$$

$$= 5.6 \times 10^{-10} \left( \frac{0.0333}{0.0500} \right)$$

$$= 3.7 \times 10^{-10}$$

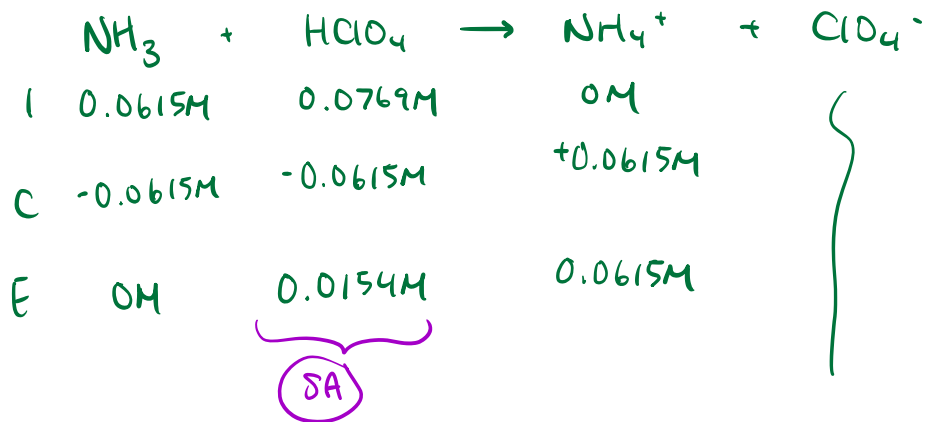
$$\text{pH} = -\log(3.7 \times 10^{-10})$$

$$= \boxed{9.43}$$

b) 5.00 mL past equivalence point. (When 25.0 mL  $\text{HClO}_4$  is added)

$$\begin{aligned} & [\text{NH}_3] \\ C_1 V_1 &= C_2 V_2 \\ C_2 &= \frac{(0.10\text{M})(40\text{mL})}{(65\text{mL})} \\ &= 0.0615\text{M} \end{aligned}$$

$$\begin{aligned} & [\text{HClO}_4] \\ C_1 V_1 &= C_2 V_2 \\ C_2 &= \frac{(0.20\text{M})(25\text{mL})}{(65\text{mL})} \\ &= 0.07691\text{M} \end{aligned}$$



$$[\text{H}_3\text{O}^+] = 0.0154\text{M}$$

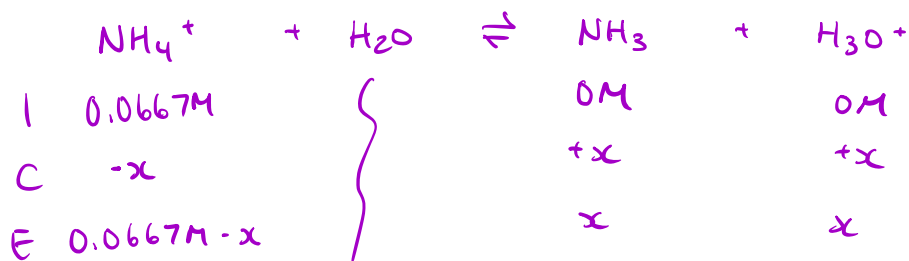
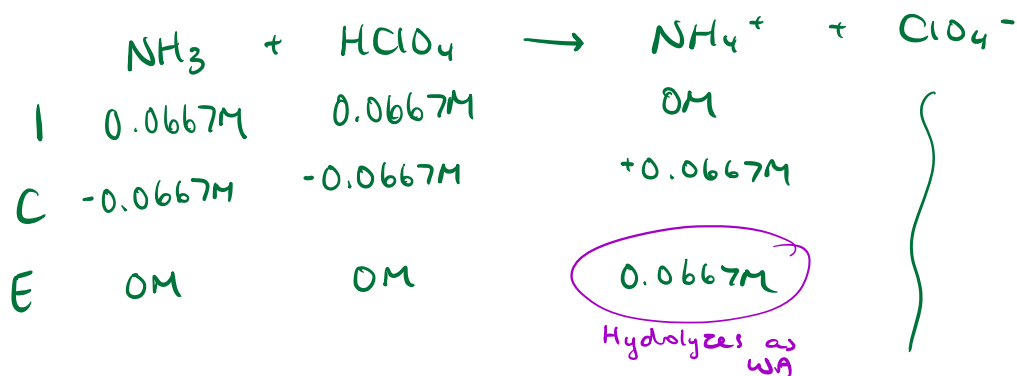
$$\begin{aligned} \text{pH} &= -\log(0.0154\text{M}) \\ &= 1.81 \end{aligned}$$

c) What indicator would be most appropriate for this titration? Explain your answer.

(Calculate pH @ equivalence point)

$$\begin{aligned}
 &[\text{NH}_3] \\
 &C_1V_1 = C_2V_2 \\
 &C_2 = \frac{(0.10\text{M})(40\text{mL})}{(60\text{mL})} \\
 &= 0.0667\text{M}
 \end{aligned}$$

$$\begin{aligned}
 &[\text{HClO}_4] \\
 &C_1V_1 = C_2V_2 \\
 &C_2 = \frac{(0.20\text{M})(20\text{mL})}{(60\text{mL})} \\
 &= 0.0667\text{M}
 \end{aligned}$$



$$K_a = 5.6 \times 10^{-10} = \frac{x^2}{0.0667 - x}$$

Assume  $0.0667 - x \approx 0.0667$

$$\begin{aligned}
 x &= \sqrt{(0.0667)(5.6 \times 10^{-10})} \\
 &= 6.11 \times 10^{-6}\text{M} = [\text{H}_3\text{O}^+]
 \end{aligned}$$

$$\begin{aligned}
 \text{pH} &= -\log(6.11 \times 10^{-6}) \\
 &= 5.21
 \end{aligned}$$

∴ Methyl Red