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
B. NH_4Cl → WA
C. $KHSO_4$ → WA
D. K_2HPO_4 → WA $K_a = 2.2\times10^{-13}$; WB $K_b = \frac{K_w}{6.2\times10^{-8}} = 1.6\times10^{-7}$

$K_b > K_a$ ∴ 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

8.2 – 10.0 → ~9.0

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

$H_2SO_4 + 2\,NaOH \rightarrow 2\,H_2O + Na_2SO_4$

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

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

__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 Ka values for thymol blue?

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

8.8 transition point
pKa = pH @ equivalence point
$-\log(1.6\times10^{-9}) = 8.8$

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

$NaNO_2 \rightarrow Na^+ + NO_2^-$ (Na^+ spec, NO_2^- WB)

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

$NO_2^- + H_2O \rightleftharpoons HNO_2 + OH^-$

__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?

7.3 transition point

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

Problems:

1. Calculate the pH of 0.60M NH_4F.

$$NH_4F \rightarrow NH_4^+ + F^-$$

NH_4^+: WA, $K_a = 5.6 \times 10^{-10}$ > F^-: WB, ~~$K_b = \frac{K_w}{3.5 \times 10^{-4}} = 2.9 \times 10^{-11}$~~

$$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$$

	NH_4^+	H_2O	NH_3	H_3O^+
I	0.60M		0M	0M
C	$-x$		$+x$	$+x$
E	$0.60-x$		x	x

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

assume $0.60 - x \cong 0.60$

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

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

2. You are given two buffer solutions:
   Buffer #1: 1.0 M NH_3 mixed with 1.0 M NH_4Cl
   Buffer #2: 0.1 M NH_3 mixed with 0.1 M NH_4Cl.

$$[H_3O^+] = K_a\left(\frac{[HA]}{[A^-]}\right)$$

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 Ka

b) Calculate the pH of an undisturbed buffer solution.

$$[H_3O^+] = 5.6 \times 10^{-10}\left(\frac{1.0}{1.0}\right) = 5.6 \times 10^{-10}\left(\frac{0.1}{0.1}\right) = 5.6 \times 10^{-10}$$

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

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 $[H_3O^+]$ or $[OH^-]$

3. 40.0 mL of 0.10 M NH_3 is titrated with 0.20 M $HClO_4$. Calculate the pH of the solution produced in the reaction flask at the following points:

a) At 2.00mL before midpoint.

$$NH_3 + HClO_4 \rightarrow NH_4^+ + ClO_4^-$$

$$0.0400\,L_{NH_3} \times \frac{0.10\,mol_{NH_3}}{1\,L} \times \frac{1\,mol\,HClO_4}{1\,mol\,NH_3} \times \frac{1\,L\,HClO_4}{0.20\,mol} = 0.020\,L\,HClO_4 = 20.\,mL$$

@ equivalence point

$$\frac{20.\,mL}{2} - 2.00\,mL = 8.0\,mL\ HClO_4$$

$[NH_3]$

$C_1V_1 = C_2V_2$

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

$= 0.0833M$

$[HClO_4]$

$C_1V_1 = C_2V_2$

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

$= 0.0333M$

	NH_3	+ $HClO_4$	→ NH_4^+	+ ClO_4^-
I	0.0833M	0.0333M	0 M	
C	-0.0333M	-0.0333M	+0.0333M	
E	0.0500M	0M	0.0333M	

Buffer!

$$[H_3O^+] = Ka\left(\frac{[HA]}{[A^-]}\right)$$

$$= 5.6\times10^{-10}\left(\frac{0.0333}{0.0500}\right)$$

$$= 3.7\times10^{-10}$$

$$pH = -\log(3.7\times10^{-10})$$

$$= \boxed{9.43}$$

b) 5.00 mL past equivalence point. (when 25.0 mL $HClO_4$ is added)

$[NH_3]$

$C_1V_1 = C_2V_2$

$$C_2 = \frac{(0.10M)(40mL)}{(65mL)} = 0.0615M$$

$[HClO_4]$

$C_1V_1 = C_2V_2$

$$C_2 = \frac{(0.20M)(25mL)}{(65mL)} = 0.07691M$$

	NH_3	+ $HClO_4$	$\longrightarrow$ NH_4^+	+ ClO_4^-
I	0.0615M	0.0769M	0M	
C	-0.0615M	-0.0615M	+0.0615M	
E	0M	0.0154M	0.0615M	

SA

$[H_3O^+] = 0.0154M$

$pH = -\log(0.0154M)$

$= \boxed{1.81}$

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

(Calculate pH @ equivalence point)

$[NH_3]$

$C_1V_1 = C_2V_2$

$C_2 = \frac{(0.10M)(40mL)}{(60mL)}$

$= 0.0667M$

$[HClO_4]$

$C_1V_1 = C_2V_2$

$C_2 = \frac{(0.20M)(20mL)}{(60mL)}$

$= 0.0667M$

	NH_3	+ $HClO_4$	$\rightarrow$ NH_4^+	+ ClO_4^-
I	0.0667M	0.0667M	0M	
C	-0.0667M	-0.0667M	+0.0667M	
E	0M	0M	0.0667M	

0.0667M: Hydrolyzes as WA

	NH_4^+	+ H_2O	$\rightleftharpoons$ NH_3	+ H_3O^+
I	0.0667M		0M	0M
C	$-x$		$+x$	$+x$
E	$0.0667M - x$		x	x

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

$x = \sqrt{(0.0667)(5.6 \times 10^{-10})}$

$= 6.11 \times 10^{-6} M = [H_3O^+]$

$pH = -\log(6.11 \times 10^{-6})$

$= 5.21$

$\therefore$ **Methyl Red**