Test # 2 – Winter 2010

____ 2. Which of the following statements is incorrect with regards to a titration of a weak base with a strong acid?

a. At the equivalence point, moles of acid added will be equal to the initial moles of base

b. At the equivalence point, the resulting solution is acidic

c. The titration becomes buffered at some point between the start of the titration and the equivalence point.

d. After the equivalence point, the pH of the solution will continue to decrease.

e. At the half equivalence point, pH = pK_b of the weak base

____10. You wish to prepare a buffer solution with pH = 5.2. In the lab you have solutions of HCl (aq) and NaOH (aq) available. Choose one other solution you will use to make your buffer.

a. CH_3COONa (aq) $K_b = 5.6 \times 10^{-10}$

b. HOCl (aq) $K_a = 2.9 \times 10^{-8}$

c. NaOCl (aq) $K_b = 3.4 \times 10^{-7}$

d. HCOOH (aq) $K_a = 1.8 \times 10^{-4}$

e. CH_3NH_2 (aq) $K_b = 4.4 \times 10^{-4}$

____11. Which of the following solutions (all at 1.0 M) will create an effective buffer?

i. 50.0 mL of HCl with 50.0 mL of KBr
ii. 50.0 mL of NH_3 with 50.0 mL of NH_4Cl
iii. 50.0 mL of HF with 2.5 mL of NaOH
iv. 50.0 mL of HCN with 25.0 mL of KOH

a. iii

b. iii, iv

c. ii, iv

d. i, ii

e. ii, iii

____12. Which of the following statements is true about adding a strong acid to a buffer composed of acetic acid and sodium acetate?

a. The pH of the solution will rise

b. The pH of the solution will not change

c. The percent ionization of acetic acid will decrease

d. The concentration of acetic acid will decrease

e. The concentration of acetate ion will increase

____13. How many grams of ammonium chloride (NH_4Cl) would you have to add to 500. mL solution of 0.250 M NH_3 to get a pH of 8.90? (K_b (NH_3) = 1.8 x 10^{-5})

a. 15.2 g
b. 5.43 g
c. 10.1 g
d. 2.95 g
e. 3.31 g

____14. Predict the correct changes in the pH values in three flasks, each containing a 1.0M HCN solution. Assume no volume change upon addition.
(K_a (HCN) = 6.2 x 10^{-10})

Flask 1: Addition of KCN (s)
Flask 2: Addition of KCl (s)
Flask 3: Addition of HCl (g)

	Flask 1	Flask 2	Flask 3
a.	decrease	no change	decrease
b.	no change	increase	increase
c.	increase	no change	decrease
d.	decrease	no change	increase
e.	increase	decrease	increase

____26. What is the pH of a solution after 50.0 mL of 0.350 M pyridine is titrated with 20.0 mL of 0.875M HCl? (K_b = 1.5 x 10^{-9})

a. 1.27
b. 5.38
c. 2.89
d. 3.61
e. 4.41

____28. Titration of 15.0 mL of 0.125M unknown base with 0.103M HCl required 18.2 mL to reach the equivalence point. The pH at the equivalence point was 2.74. What is the K_b of the weak base?

a. 4.21 x 10^{-9}
b. 1.70 x 10^{-10}
c. 2.41 x 10^{-11}
d. 3.26 x 10^{-11}
e. 6.56 x 10^{-10}

Test # 2 – 2009

1.What is the **percent ionization** of a 0.200 M solution of formic acid, HCOOH?

(K_a = 1.8 × 10^{-4}).

(A) 0.017 %

(B) 0.25 %

(C) 0.58 %

(D) 3.0 %

(E) 4.8 %

2. A buffer made from equal volumes of 0.100 M NH_3(aq) and 0.100 M NH_4Cl(aq) (K_b (NH_3) = 1.8 × 10^{-5}) will have **a pH** that is:

(A) very acidic (*e.g.*, pH < 3)

(B) slightly acidic

(C) neutral

(D) slightly basic

(E) very basic (*e.g.*, pH > 12)

3. Which of the following mixtures will result in the **formation of a buffer solution**, when dissolved in 1.00 L of water?

(i) 0.30 mol KCN and 0.15 mol NaOH (2 bases, *no acid*)

(ii) 0.15 mol HCN and 0.15 mol NaOH →

0.15 mol NaCN + 0.15 mol H_2O, *no weak acid remains*

(iii) **0.15 mol KCN and 0.10 mol HCN** (*conjugate acid-base pair*)

(iv) **0.30 mol KCN and 0.15 mol HCl** →

0.15 mol KCN + *0.15 mol HCN* + 0.15 mol KCl

(A) i, ii

(B) i, iv

(C) ii, iii

(D) **iii, iv**

(E) ii, iv

4. Which of the following statements about acid/base systems is **FALSE**?

(A) Dilution of a buffer by addition of water will not cause a pH change.

(B) Percent ionization of a weak acid solution will increase upon dilution with water.

(C) Optimal buffering capacity occurs when concentrations of weak acid and conjugate base are equal.

(D) Addition of A^- to a solution of HA causes suppression of HA ionization.

(E) A buffer solution can be prepared by using weak acid and conjugate base species with concentrations approximately equal to K_a for the acid.

Test # 2 – 2008

5. What is the **pH** of a 1.00 L solution that contains 0.35 M formic acid (HCO_2H) and 0.18 M sodium formate (HCO_2Na)? K_b (formate ion) = 5.56×10^{-11}

(A) **3.45**

(B) 4.22

(C) 5.13

(D) 10.49

(E) 9.37

6. What is the **pH of the solution** resulting from the addition of 7.80 grams of solid KOH to 750 mL of 0.350 M HCOOH? Assume no volume change occurs on addition of KOH solid. The K_a for HCOOH is 1.8×10^{-4}.

(A) 3.80

(B) 4.25

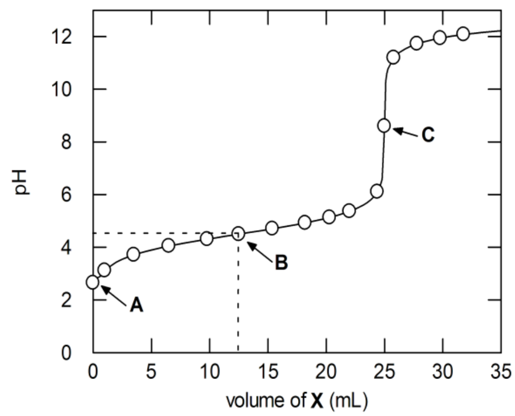
(C) 5.60

(D) 9.12

(E) 10.11

Exam 2010

____ 3. Both the acid and base used to generate the titration plot below are monoprotic. The concentration of the solution being added, **X**, is 0.500 M. You start with a solution of **Y** at point A. Determine which of the following statements is/are **true**:



i. The K_a of the acid is approximately 4.5.
ii. The effective buffer region can be described when 2.5 mL to 22.5 mL of **X** has been added.
iii. An appropriate indicator would be Thymol blue (K_{In} = 1.26 x 10^{-9}).
iv. Approximately 0.250 moles of acid were present at the beginning of this titration.
v. This graph represents the titration of a weak acid with a strong base.

a. i, ii, iii, v
b. i, iii
c. ii, iii, v
d. v
e. ii, iv v

____ 4. Which of the following indicators could you use to distinguish between a beaker containing 1.50 M acetic acid (K_a = 1.8 x 10^{-5}) and a beaker containing 0.0025 M phenol (K_a = 1.1 x 10^{-10})?

i. Methyl red K_{In} = 1.12 x 10^{-5}

ii. Methyl orange K_{In} = 3.98 x 10^{-4}

iii. Crystal violet K_{In} = 1.3 x 10^{-1}

iv. Cresol red K_{In} = 8.7 x 10^{-9}

a. i, iv
b. iv
c. ii
d. i, ii
e. ii, iii

____ 5. Benzoic acid (8.50 g, K_a = 6.5 x 10^{-5}) and 9.50g of sodium benzoate are dissolved in water to a final volume of 250.0 mL. The pH of this solution is:

a. 9.21
b. 3.18
c. 5.73
d. 4.05
e. 4.16

____ 6. A 100. mL solution of diethylamine (K_b = 1.3 x 10^{-3}) was titrated with 0.0150 M HCl. The equivalence point was reached when 180. mL of acid had been added. What was the concentration of the base in the original solution, and what is the pH at the equivalence point?

a. 0.270 M; pH = 8.21

b. 0.0270 M; pH = 6.12

c. 0.0400 M; pH = 4.31

d. 0.0400 M; pH = 5.24

e. 0.0270 M; pH = 6.56

____ 7. Which statement is <u>incorrect</u> about the titration in which 0.10 M HCl is added to 25.0 mL of 0.10 M NH_3 (K_b = 1.8 x 10^{-5})?

a. An indicator with pK_{HIn} = 5.3 could be used for this titration.

b. The initial pH is greater than 7.0.

c. The equivalence point is when 25.0 mL of HCl has been added.

d. The pH at the equivalence point is greater than 7.0.

e. A buffer is created before reaching the equivalence point.

____ 33. A 500.0 mL solution of a formic acid/sodium formate buffer is created, with a pH of 4.00. What is the minimum concentration of formate ion required in the buffer such that the addition of 100.0mL of 0.7853M HCl only changes the pH by 0.4 units? ($K_a(HCOOH) = 1.8 \times 10^{-4}$)

a. 0.140 M
b. 0.300 M
c. 0.125 M
d. 0.450 M
e. 0.350 M

Exam 2009

1. A solution is created by adding 40. mL of 0.60 M NaOH to 1.0 L of 0.50 M $EtNH_2$ (pK_b = 3.40). What is the percent ionization of ethylamine in the solution?

(A) 1.7 %

(B) 7.8 %

(C) 12 %

(D) 0.031 %

(E) 3.5 %

2. If 100 mL of water is added to a 0.500 L solution containing 0.200 M ammonium nitrate and 0.200 M ammonia, what is the effect of dilution on the pH?

(A) The acidity decreases by a factor of 2.
(B) The pH of the solution will become neutral.
(C) There is no change in pH.
(D) The pOH will change but not the pH.
(E) None of the above is correct.

3. Which of the following mixtures is a buffer with pH close to 9?
(K_a NH_4^+ = 5.6×10^{-10})

(A)	50 mL of 0.1 M NH_4Cl	and 25 mL of 0.15 M NaOH
(B)	50 mL of 0.1 M NH_3	and 25 mL of 0.1M NaOH
(C)	50 mL of 0.1 M NH_4Cl	and 5 mL of 1.0M HCl
(D)	50 mL of 0.1 M NH_4Cl	and 25 mL of 0.1M HCl
(E)	25 mL of 0.1 M NH_4Cl	and 5 mL of 1M NaOH

4. A 25 mL solution of methylamine is titrated with 0.1009 M HCl and the equivalence point is reached at 25.57 mL of acid. (i) What is the **concentration of the methylamine stock solution**, and (ii) what is the **pH at the equivalence point**? The K_a for the conjugate acid of methylamine is 2.4×10^{-11}.

(A) (i) 0.050 M (ii) 5.96

(B) (i) 0.10 M (ii) 5.96

(C) (i) 0.050 M (ii) 8.01

(D) (i) 0.025 M (ii) 8.01

(E) None of the above is correct

5. What is the **pH of the solution** that results when 0.300 mole of CH_3COOH, 0.250 mole of CH_3COONa and 0.110 mole of NaOH are dissolved in sufficient water to produce 1.00 L of solution? (K_a $CH_3COOH = 1.8 \times 10^{-5}$)

(A) 4.27
(B) 5.02
(C) 6.18
(D) 7.26
(E) 8.73

6. In the titration of 25.00 mL of 0.0940 M NaOH(aq) with HCl(aq) of unknown concentration, it was found that 16.30 mL of HCl were required to reach pH = 11.67. What is the **concentration (M) of the HCl(aq)** being titrated?

(A) 0.132 M
(B) 0.136 M
(C) 0.118 M
(D) 0.105 M
(E) 0.0968 M

Exam 2008

5. You wish to make a buffer solution with pH = 10.8. In the lab you have solutions of HCl(aq) and NaOH(aq) available. Choose **one other** solution you will **use to make your buffer**.

(A) CH_3COONa(aq), $K_b = 5.6 \times 10^{-10}$

(B) NaOCl(aq), $K_b = 3.4 \times 10^{-7}$

(C) HOCl(aq), $K_a = 2.9 \times 10^{-8}$

(D) HCOOH(aq), $K_a = 1.8 \times 10^{-4}$

(E) CH_3NH_2(aq), $K_b = 4.4 \times 10^{-4}$

6. Regarding the titration of a weak base (A^-) with a strong acid, choose the **TRUE** statements:

   (i) The pH at the equivalence point depends on the concentrations used.

   (ii) The solution will have neutral pH at the equivalence point.

   (iii) The pH at the half-equivalence point equals the pK_a of HA.

   (iv) The best indicator for this titration will have a pK_a similar to the pH of the half-equivalence point.

(A) all are true

(B) i, iv

(C) ii, iii

(D) i, iii

(E) iii, iv

7. Alazarin yellow R is an acid-base indicator with a pK_a of 11.0. The acidic form is yellow and the basic form is violet. A few drops of this indicator are added to the titration of methylamine (pK_b = 3.36) with HCl. Find the **FALSE** statement(s) about this titration experiment.

(i) The alazarin yellow R indicator is an appropriate choice for locating the equivalence point of this titration.

(ii) The indicator starts to change from violet to yellow at about pH = 12 and completes the change at about pH = 10.

(iii) The indicator will be yellow over the entire buffer region of the titration curve.

(A) i

(B) ii

(C) iii

(D) i, iii

(E) ii, iii

8. Carbon dioxide dissolves in water and reacts to give H_2CO_3, which then ionizes to produce HCO_3^- in the equilibria shown below. These equilibria are critical for maintaining an optimal blood pH = 7.4. Assuming this is the only system controlling blood pH, what is the <u>**ratio**</u> **of [HCO_3^-] to [H_2CO_3]** in the blood of a patient with severe acidosis (blood pH = 7.0)?

$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$
$$H_2CO_3 + H_2O \rightleftharpoons HCO_3^- + H_3O^+ \quad K_a = 4.3 \times 10^{-7}$$

(A) 0.096

(B) 2.6

(C) 4.3

(D) 6.4

(E) 10.7

9. What is the **approximate pH of the endpoint** of the titration of 100.0 mL of 0.050M HNO_3 by 0.050 M KOH if phenolphthalein is used as an indicator? Phenolphthalein is colourless in acid solution and pink in basic solution. The pK_a for phenolphthalein is 9.5.

(A) 13
(B) 10
(C) 8.3
(D) 7.0
(E) 4.74

10. **What will the effect be on the pH** of a 1.0 M HCN solution upon addition of the following reagents in each of the following flasks? (Assume no volume change upon addition). (K_a(HCN) = 6.2×10^{-10})

Flask 1:	Addition of KCN(s) to 1.0 L of 1.0 M HCN (aq)
Flask 2:	Addition of KCl(s) to 1.0 L of 1.0 M HCN (aq)
Flask 3:	Addition of HCl(g) to 1.0 L of 1.0 M HCN (aq)

	Flask 1	Flask 2	Flask 3
(A)	no change	increase	increase
(B)	increase	decrease	decrease
(C)	increase	no change	decrease
(D)	decrease	no change	increase
(E)	increase	no change	increase

11. What is the **pH of the solution that results** after 50.0 mL of 0.010 M CH_3CH_2COOK have been titrated with 25.0 mL 0.010 M HBr? ($K_a(CH_3CH_2COOH) = 1.3 \times 10^{-5}$).

(A) 2.88
(B) 3.79
(C) 4.89
(D) 8.67
(E) 9.11

12. Which of the following mixtures is/are **buffers**?

(i) 10 mL of 0.1 M HNO_3 + 5 mL of 0.1 M $NaNO_2$

(ii) 5 mL of 0.1 M HNO_3 + 10 mL of 0.1 M NH_3

(iii) 10 mL of 0.1 M HNO_3 + 5 mL of 0.1 M $NaNO_3$

(iv) 5 mL of 0.1 M HNO_2 + 5 mL of 0.1 M NaOH

(v) 10 mL of 0.1 M HNO_3 + 5 mL of 0.1 M HNO_2

(A) i
(B) ii, iii
(C) iii, v
(D) iv
(E) ii

13. Arrange the following 3 solutions **in order of increasing pH** (from lowest to highest pH): (K_a (C_6H_5COOH) = 6.3×10^{-5})

(i) 0.1 M C_6H_5COOH + 0.1 M C_6H_5COONa

(ii) 0.1 M C_6H_5COONa

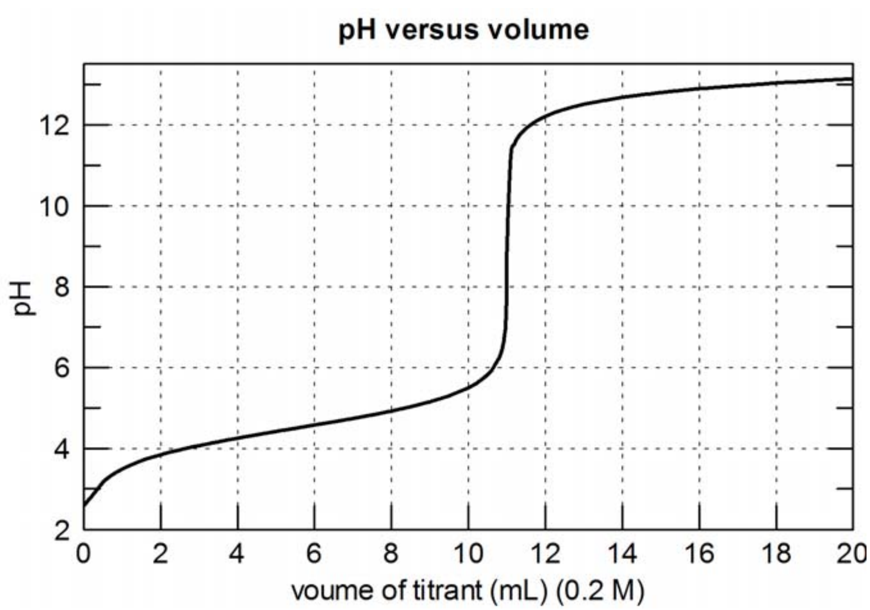
(iii) 0.1 M C_6H_5COOH

(A) iii < ii < i
(B) iii < i < ii
(C) ii < iii < i
(D) ii < i < iii
(E) i < ii < iii

14. Titration of 15.0 ml of an unknown weak base with a strong acid (0.103 M) required 18.2 mL to reach the equivalence point. The pH at the equivalence point was 2.74 and the K_a of the conjugate acid is 5.9×10^{-5}. What was the **original concentration of the weak base**?

(A) 0.125 M
(B) 0.219 M
(C) 1.16 M
(D) 6.54×10^{-3} M
(E) 0.713 M

15. Given the following graph, what is the **approximate K_a of the weak acid** being titrated?



(A) 3.2×10^{-5}

(B) 4.5

(C) 8.5

(D) 3.1×10^{-9}

(E) 7.9×10^{-3}