This print-out should have 49 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 10.0 points

What is the pH at the point during a titration when 30 mL of 0.200 M HCl has been added to 31 mL of 0.0500 M NH_3 solution? HCl is strong acid, $K_b = 1.8 \times 10^{-5}$ for NH_3.

1. 1.25964
2. 1.10914
3. 0.979797
4. 0.938343
5. 1.07542
6. 1.20713
7. 1.24304
8. 1.00352
9. 1.13697
10. 1.33882

Answer in units of pH.

002 10.0 points

The acid form of an indicator is yellow and its anion is blue. The K_a of this indicator is 1×10^{-5}. What will be the approximate pH range over which this indicator changes color?

1. $3 < \text{pH} < 5$

2. $8 < \text{pH} < 10$

3. $4 < \text{pH} < 6$

4. $9 < \text{pH} < 11$

5. $5 < \text{pH} < 7$

003 10.0 points

50.0 mL of 0.0018 M aniline (a weak base) is titrated with 0.0048 M HNO_3. How many mL of the acid are required to reach the equivalence point?

1. Need to know the K_b of aniline.

2. 4.21 mL

3. 18.8 mL

4. Bad titration since HNO_3 is not a strong acid.

5. 133 mL

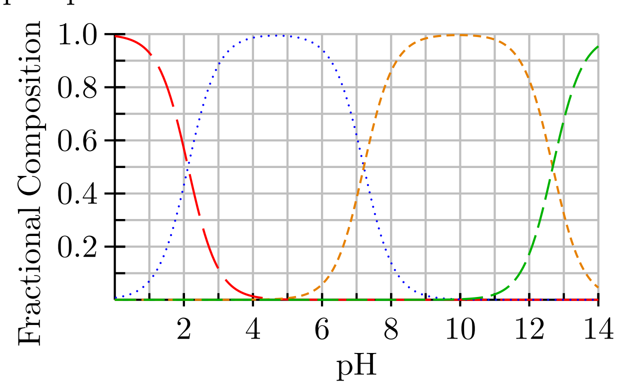
004 10.0 points

A buffer was prepared by mixing 0.50 mole of HX acid and 0.50 mole of NaX to form an aqueous solution with a total volume of 1.00 liter. The pH of this buffer was 5.525. Then, to 400 mL of this buffer solution was added 25.0 mL of 2.0 M HCl. What is the pH of this new solution?

1. 4.00315
2. 4.70315
3. 5.30315
4. 5.20315
5. 3.80315
6. 5.00315
7. 4.90315
8. 4.80315
9. 4.40315
10. 4.20315

005 10.0 points

Consider the fraction of species diagram for phosphoric acid.



What is the dominant species at pH = 0.83?

1. $H_2PO_4^-$

2. PO_4^{3-}

3. HPO_4^{2-}

4. None of these is correct

5. H_3PO_4

006 10.0 points

What is the equilibrium pH of a solution which is initially mixed at 0.200 M in formic acid and 0.00500 M in formate ion? $K_a = 1.8 \times 10^{-4}$ for formic acid.

1. 4.35

2. None of the other answers is correct

3. 2.14

4. 5.34

5. 11.86

6. 2.40

007 10.0 points

Calculate the ratio of the molarities of HPO_4^{2-} and $H_2PO_4^-$ ions required to achieve buffering at pH = 7.00. For H_3PO_4, $pK_{a1} = 2.12$, $pK_{a2} = 7.21$, and $pK_{a3} = 12.68$.

1. 1.23

2. 0.81

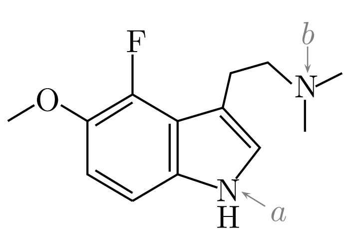
3. 1.62

4. 0.21

5. 0.62

008 10.0 points

Consider a large organic molecule seen on Exam 3 of CH301. This molecule has two functional groups that can participate in acid base chemistry. The amine group marked with arrow a has a $pK_a = 6.5$. The amine group marked with arrow b has a $pK_a = 10.6$.



As shown above, the molecular formula for this molecule is $C_{13}H_{17}FN_2O$. What is the molecular formula at pH = 3.4?

1. $C_{13}H_{17}FN_2O$

2. $[C_{13}H_{16}FN_2O]^-$

3. $[C_{13}H_{15}FN_2O]^{2-}$

4. $[C_{13}H_{18}FN_2O]^+$

5. $[C_{13}H_{19}FN_2O]^{2+}$

009 10.0 points

The un-ionized form of an acid indicator is yellow and its anion is blue. The K_a of this indicator is 10^{-5}. What will be the color of the indicator in a solution of pH 3?

1. green

2. blue

3. yellow

4. red

5. orange

010 10.0 points

Mixing the contents of which two solutions will result in an ideal buffer at pH = 4.63?

1. 50 mL 0.3 M HCl and 150 mL 0.1 M $C_6H_5NH_2$

2. 40 mL 0.2 M HCl and 160 mL 0.1 M $C_6H_5NH_2$

3. 180 mL 0.3 M HCl and 60 mL 0.1 M C_5H_5N

4. 60 mL 0.3 M HCl and 180 mL 0.1 M C_5H_5N

5. 30 mL 0.3 M HCl and 180 mL 0.1 M C_5H_5N

011 10.0 points

A solution is 0.30 M in NH_3. What concentration of NH_4Cl would be required to achieve a buffer solution with a final pH of 9.0? $K_b = 1.8 \times 10^{-5}$ for NH_3.

1. 0.45 M

2. 0.54 M

3. 0.10 M

4. 0.30 M

5. 0.20 M

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012 10.0 points

A 100 mL portion of 0.300 M acetic acid is being titrated with 0.200 M NaOH solution. What is the $[H^+]$ of the solution after 50.0 mL of the NaOH solution has been added? The ionization constant of acetic acid is 1.8×10^{-5}.

1. 9.94×10^{-6}

2. 8.95×10^{-6}

3. 6.01×10^{-4}

4. 3.63×10^{-5}

5. 1.21×10^{-5}

---

013 10.0 points

When we titrate a weak base with a strong acid, the pH at the equivalence point will be

1. pH $<$ 7.

2. pH $=$ 7.

3. pH $>$ 7.

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014 10.0 points

Explain why the salt of a weak acid, as well as the acid itself, must be present to form a buffer solution.

1. The anion from the salt is needed to partially neutralize added base.

2. The anion from the salt is needed to partially neutralize added acid.

3. The cation from the salt is needed to partially neutralize added acid.

4. Actually, a weak acid by itself is a buffer; no salt is needed.

5. The cation from the salt is needed to partially neutralize added base.

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015 10.0 points

Which one of the following combinations is NOT a buffer solution?

1. NH_3 and $(NH_4)_2SO_4$

2. HBr and KBr

3. NH_3 and NH_4Br

4. CH_3COOH and $NaCH_3COO$

5. HCN and NaCN

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016 10.0 points

What is the pH of a solution which is 0.600 M in dimethylamine ($(CH_3)_2NH$) and 0.400 M in dimethylamine hydrochloride $\left((CH_3)_2NH_2^+Cl^-\right)$? K_b for dimethylamine $= 7.4 \times 10^{-4}$.

1. 10.87

2. 10.78

3. 2.95

4. 11.05

5. 10.69

6. 3.31

7. 11.21

---

017 10.0 points

A buffer solution is made by dissolving 0.45 moles of a weak acid (HA) and 0.23 moles of KOH into 840 mL of solution. What is the pH of this buffer? $K_a = 5 \times 10^{-6}$ for HA.

1. 4.73956
2. 4.94604
3. 5.06473
4. 4.96534
5. 6.16058
6. 5.46267
7. 5.26343
8. 5.32034
9. 5.51505
10. 5.69897

Answer in units of pH.

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018 10.0 points

You have a solution that is buffered at pH = 2.0 using H_3PO_4 and $H_2PO_4^-$ ($pK_{a1} = 2.12$; $pK_{a2} = 7.21$; $pK_{a3} = 12.68$). You decide to titrate this buffer with a strong base. 15.0 mL are needed to reach the first equivalence point. What is the total volume of base that will have been added when the second equivalence point is reached?

1. $>$ 30 mL

2. A second equivalence point in the titration will never be observed.

3. $<$ 30 mL

4. 30 mL

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019 10.0 points

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

1. phenol red ($pK_{In} = 7.9$)

2. methyl orange ($pK_{In} = 3.4$)

3. alizarin yellow ($pK_{In} = 11.2$)

4. bromophenol blue ($pK_{In} = 3.9$)

5. thymol blue ($pK_{In} = 1.7$)

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020 10.0 points

The equivalence point for the neutralization of 10^{-3} M NH_3 by HCl occurs at pH = 6.1. The equivalence point is accurately detected using the indicator DYNAMO RED when the solution turns from clear to red. Which of the following statements about DYNAMO RED is FALSE?

1. The concentration of of DYNAMO RED in the titrated solution must be much less than 10^{-3} M.

2. The acid form of DYNAMO RED is colored.

3. DYNAMO RED could be a diprotic acid.

4. The pK_a of DYNAMO RED must be much less than 4.0.

5. DYNAMO RED is an acid or a base in its nonionized state.

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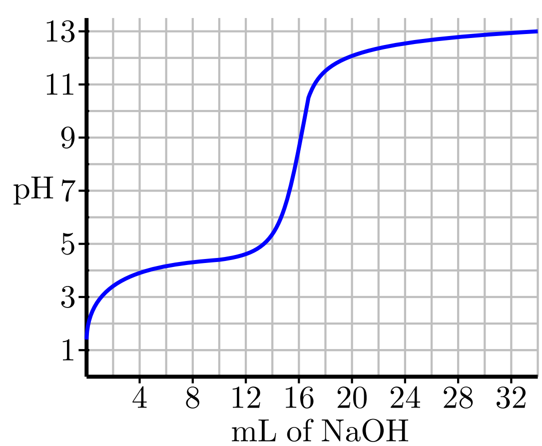
021 (part 1 of 3) 10.0 points

A sample of 100 mL of a weak acid (HA) solution was titrated with 0.040 M NaOH. The pH curve for this titration is shown.



What is the concentration of the original weak acid solution (the 100 mL) ?

1. 0.016 M

2. 0.0013 M

3. 0.0126 M

4. 0.0064 M

5. 0.0032 M

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022 (part 2 of 3) 10.0 points

Which of these acids and bases could be the solution that was titrated?

1. Acrylic acid

2. Acetic acid

3. Hypoiodous acid

4. Nitric acid

5. Hydrofluoric acid

6. Trimethlyamine

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023 (part 3 of 3) 10.0 points

Which of the following chemicals would be a suitable indicator for this titration experiment?

1. Methyl orange

2. Bromocresol green

3. Methyl red

4. Phenolphthalein

5. Bromothymol blue

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024 10.0 points

Lithium acetate is a common component of the buffer system used in gel electrophoresis of DNA and RNA. How many moles of lithium hydroxide do you need to add to a 650 mL 0.590 M CH_3COOH solution to make a buffer with a pH = 5.000?

1. 0.180 mol

2. 0.590 mol

3. 0.384 mol

4. 0.214 mol

5. 0.151 mol

6. 3.97 mol

7. 0.247 mol

8. 0.192 mol

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025 10.0 points

What molar ratio of sodium acetate to acetic acid (NaAc/HAc) should be used in preparing a buffer having a pH of 4.35? ($K_a = 1.8 \times 10^{-5}$ for acetic acid.)

1. 0.40 : 1.0

2. 1.0 : 1.0

3. 1.0 : 0.40

4. 0.59 : 1.0

5. 2.0 : 1.0

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026 10.0 points

A buffer (pH 4.74) was prepared by mixing 1.00 mole of acetic acid and 1.00 mole of sodium acetate to form a 1.0 liter aqueous solution. To 100 mL of this solution, 10.0 mL of 2.00 molar NaOH was added. What is the new pH?

1. 5.20

2. 5.31

3. 4.47

4. 4.92

5. 4.72

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027 10.0 points

A buffer was prepared by mixing 0.200 mole of ammonia ($K_b = 1.8 \times 10^{-5}$) and 0.200 mole of ammonium chloride to form an aqueous solution with a total volume of 500 mL. To 250 mL of this solution was added 50.0 mL of 1.00 M HCl. What is the pH of this solution?

1. 8.38

2. 9.35

3. 7.87

4. 8.78

5. 9.73

6. 8.53

7. 8.18

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028 10.0 points

The diprotic acid, H_2A has two pK_a values equal to 3.90 and 7.10. You mix 0.3 moles NaHA into 334 mL pure water. What is the pH of this solution?

1. 7.10

2. 5.50

3. 3.57

4. 4.85

5. 1.97

6. 3.90

7. 5.85

8. 4.05

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029 10.0 points

A solution of an unknown weak acid (HA) has a ratio $\dfrac{[A^-]}{[HA]} = \dfrac{1}{2000}$ at a pH of 3. What would be this ratio at a pH of 5?

1. 2000

2. $\dfrac{10^{-3}}{2}$

3. $\dfrac{1}{20}$

4. $\dfrac{20}{1}$

5. $\dfrac{3}{5}$

---

030 10.0 points

To simulate blood conditions, a phosphate buffer system with a pH = 7.4 is desired. What mass of Na_2HPO_4 must be added to 1 L of 0.15 M NaH_2PO_4(aq) to prepare such a buffer?

1. 28.5829
2. 395.763
3. 122.027
4. 311.663
5. 62.6624
6. 151.709
7. 32.9802
8. 137.418
9. 270.438
10. 211.073

Answer in units of g.

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031 10.0 points

Which of the following mixtures will be a buffer when dissolved in a liter of water?

1. 0.3 mol NaCl and 0.3 mol HCl

2. 0.2 mol HBr and 0.1 mol NaOH

3. 0.2 mol HF and 0.1 mol NaOH

4. 0.4 mol NH_3 and 0.4 mol HCl

5. 0.1 mol $Ca(OH)_2$ and 0.3 mol HI

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032 10.0 points

For the titration of 50.0 mL of 0.020 M aqueous salicylic acid with 0.020 M KOH(aq), calculate the pH after the addition of 55.0 mL of KOH(aq). For salycylic acid, pK_a = 2.97.

1. 11.26

2. 10.98

3. 12.02

4. 12.30

5. 7.00

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033 10.0 points

Which solution is most basic?

1. 0.10 M HClO and 0.10 M NaClO

2. 0.10 M CH_3COOH and 0.20 M $NaCH_3COO$

3. 0.10 M aq NH_3 and 0.10 M NH_4Cl

4. 0.10 M CH_3COOH and 0.10 M $NaCH_3COO$

5. 0.10 M aq NH_3 and 0.20 M NH_4Cl

---

034 10.0 points

A few drops of methyl red are added to an unknown solution. Which of the following represents the best conclusion that can be made if the unknown solution turns yellow?

1. The solution has a pH greater than 6.0

2. The solution has a pH less than 4.8

3. The solution has a pH value approximately between 4.8 and 6.0

4. The solution is extremely acidic

5. The solution is extremely basic

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035 10.0 points

What is the pH of an aqueous solution that is 0.018 M $C_6H_5NH_2$ ($K_b = 4.3 \times 10^{-10}$) and 0.12 M $C_6H_5NH_3Cl$?

1. 10.19

2. 9.37

3. 4.02

4. 4.63

5. 8.54

6. 2.87

7. 5.46

8. 3.81

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036 10.0 points

What would be the final pH if 0.0100 moles of solid NaOH were added to 100 mL of a buffer solution containing 0.600 molar formic acid (ionization constant $= 1.8 \times 10^{-4}$) and 0.300 molar sodium formate?

1. 3.65

2. None of these

3. 4.05

4. 3.84

5. 3.44

---

037 10.0 points

Consider the titration of 50.0 mL of 0.0200 M HClO(aq) with 0.100 M NaOH(aq). What is the formula of the main species in the solution after the addition of 10.0 mL of base?

1. ClO_2

2. ClOH

3. $HClO_2$

4. ClO^-

5. NaOH

---

038 (part 1 of 2) 10.0 points

For the next two questions, choose if the statement is true or false.

An acceptable weak acid buffer has a minimum 1:10 ratio of A^-:HA.

1. True

2. False

039 (part 2 of 2) 10.0 points

The end point of a titration curve has a similar pH value to the equivalence point, but not necessarily equal.

1. True

2. False

040 10.0 points

How much NH_4Cl must be added to 2.0 liters of 0.200 M aqueous ammonia to give a solution with pH = 8.2? Assume no volume change due to the addition of NH_4Cl. K_b for NH_3 is 1.8×10^{-5}.

1. 146 g

2. 225 g

3. 243 g

4. 166 g

5. 123 g

041 10.0 points

Calculate the ratio of $\frac{[NH_3]}{[NH_4^+]}$ that gives a solution of pH = 10.60.

1. $\frac{[NH_3]}{[NH_4^+]} = 22$

2. $\frac{[NH_3]}{[NH_4^+]} = 0.045$

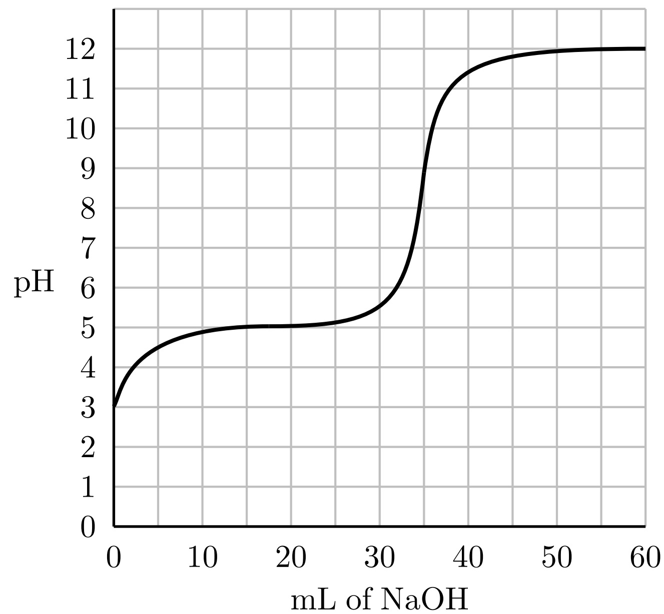
3. $\frac{[NH_3]}{[NH_4^+]} = 5.6 \times 10^{-6}$

4. $\frac{[NH_3]}{[NH_4^+]} = 5.6 \times 10^{-5}$

5. $\frac{[NH_3]}{[NH_4^+]} = 1.8 \times 10^{-5}$

042 (part 1 of 2) 10.0 points

Titration Curve



What is the pH at the equivalence point of this titration?

1. 6.96

2. 10.45

3. 8.89

4. 3.02

5. 5.03

6. 4.03

7. 5.8

043 (part 2 of 2) 10.0 points

What is the pK_a of this acid?

1. 3.02

2. 5.8

3. 8.89

4. 5.03

5. 10.45

6. 6.96

7. 4.03

---

044 10.0 points

A buffer is prepared by combining 300 mL 0.850 M butanoic acid (C_3H_7COOH) to 300 mL 0.640 M sodium hydroxide (NaOH). What is the pH of this solution?

1. 4.82

2. 5.22

3. 5.16

4. 4.34

5. 5.05

6. 4.70

7. 9.18

8. 5.30

---

045 10.0 points

What is the pH at the half-stoichiometric point for the titration of 0.22 M HNO_2(aq) with 0.01 M KOH(aq)? For HNO_2, $K_a = 4.3 \times 10^{-4}$.

1. 7.00

2. 3.37

3. 2.01

4. 2.31

5. 2.16

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046 10.0 points

Consider a buffer made of 0.10 M HF and 0.15 M KF with a volume of 450 mL. Which of the following statements is/are true?

I) If 10 mL 0.1 M NaOH is added, the potassium from KF and hydroxide from NaOH will react to form potassium hydroxide

II) If a small amount of NaOH is added, the solution will increase in pH a very small amount

III) If HI is added, the fluoride anions will react with hydrogen ions

IV) The pK_a for HF represents the neutralization reaction that forms KF

1. III only

2. II and III

3. II only

4. I, II, and III

5. II, III, and IV

6. I, II, and IV

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047 10.0 points

At the stoichiometric point in the titration of 0.130 M HCOOH(aq) with 0.130 M KOH(aq),

1. the pH is greater than 7.

2. the pH is 7.0.

3. the pH is less than 7.

4. [HCOOH] = 0.0650 M.

5. $[HCO_2^-] = 0.130$ M.

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048 10.0 points

Methyl orange is an indicator with a K_a of 3.4×10^{-4}. Its non-ionized form is red, while its ionized form is yellow. At a pH of exactly 4.00, this indicator's color would best be described as which of the following colors?

1. red-orange

2. orange

3. green

4. blue

5. yellow

6. cyan

7. red

8. purple

9. yellow-orange

---

049 10.0 points

A solution has an initial concentration of 0.0100 M HClO ($K_a = 3.5 \times 10^{-8}$) and 0.0300 M NaClO. What is the pH after the addition of 0.0030 mol of solid NaOH to 1.00 L of this solution? Assume no volume change.

1. 8.02

2. 5.33

3. 8.13

4. 9.06

5. 5.34