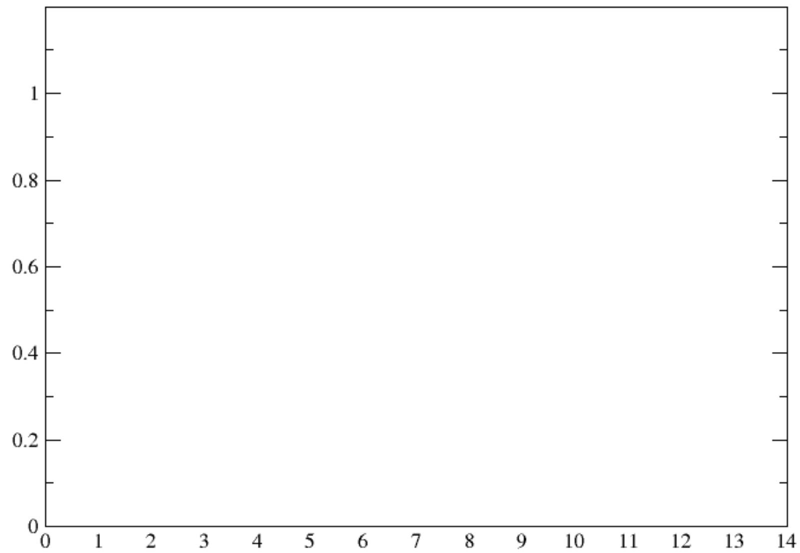
Exam 3 Review

1. Sketch an acid-base distribution plot for the 1.0 M *diprotic* acid H_2CO_3, and label the principal species at each stage, as well as the intermediate form, given the $K_{a1} = 4.3 \times 10^{-7}$ and $K_{a2} = 5.6 \times 10^{-11}$.



2. How does the concentration of a weak acid change with respect to that of its conjugate base as the pH increases?

3. How does an acid-base titration indicator work?

4. K_a___ $K_b = K_w$
   (a) +
   (b) -
   (c) *
   (d) /

5. What is the value of K_w?

6. Define a hydrolysis reaction and provide an example using an acid and an example using a base.

7. All ____________ are potential bases.
8. All ____________ are potential acids.
9. For the following salts, determine if the solution will be acidic, basic, or neutral:
   (a) $LiNO_3$
   (b) NH_4ClO_4
   (c) NH_4Br
   (d) $NaCl$
   (e) KCN
10. For each of the salts above, write an equation of an acid and a base that could be used to produce it.
11. For the following equilibrium constants, calculate the equilibrium constant of the conjugate:
   (a) $C_9H_8O_4$, $K_a = 3.0 \times 10^{-4}$
   (b) NH_3, $K_b = 1.8 \times 10^{-5}$
   (c) Co^{2+}, $K_a = 1.3 \times 10^{-9}$
12. Calculate the pH of a 0.10M NH_4Cl solution.
13. Starting from an equilibrium constant expression, derive the Henderson-Hasselbalch equation.
14. Starting from the other equilibrium constant expression, derive a similar equation.

15. Over what range of concentrations can these equations be used?

16. What is the significance of the first equation with respect to an acid-base distribution plot?

17. How many mL of 1M HCl would be necessary to destroy a buffer solution formed by 5 mmol each of NH_3 and NH_4Cl?

18. What would happen to the pH of the above solution if instead of acid, 50 mL of water were added?

19. Which of the following conjugate pairs would be the best choice to create a buffer with pH = 3.42?

    (a) Acetic acid/Acetate, $K_a = 1.8 \times 10^{-5}$

    (b) Formic acid/Formate, $K_a = 1.8 \times 10^{-4}$

    (c) Hydrocyanic acid/Cyanide, $K_a = 4.9 \times 10^{-10}$

    (d) Phenol/Phenolate, $K_a = 1.3 \times 10^{-10}$

20. Which of the above acids is used by some ants to deliver painful stings?

21. What ratio of acid:base would be necessary to create the buffer above?

22. How could you create a buffer with pH = 6.2 using 25 mL of 0.10 M citric acid and a 0.10 M strong base? $K_{a1} = 7.1 \times 10^{-4}$, $K_{a2} = 1.7 \times 10^{-5}$, $K_{a3} = 4.1 \times 10^{-7}$?

23. What is the difference between the equivalence point and the end point of a colorimetric titration?

24. Sketch a titration curve corresponding to the titration of 20 mL of the acid from Question 1 with 1 M NaOH by:

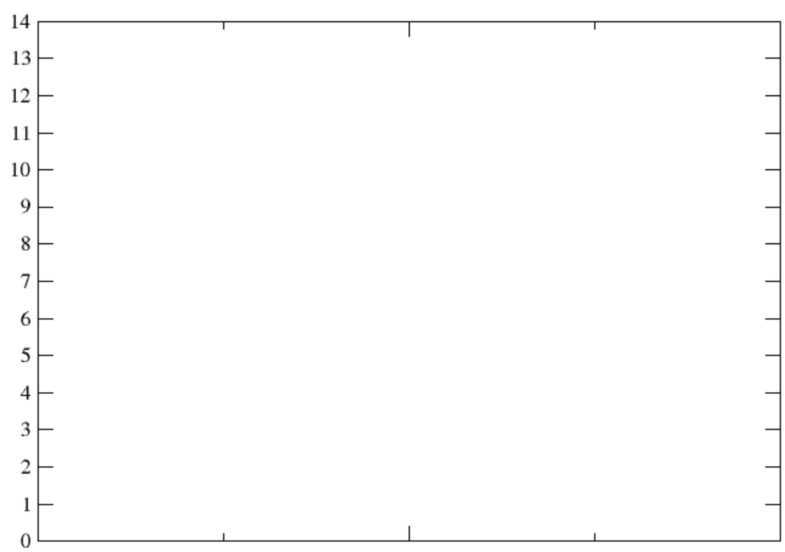
   (a) Finding the initial pH before titration

   (b) Finding the pH at the half equivalence points

   (c) Finding the pH at the equivalence points

   (d) Finding the pH after twice the volume to reach the last equivalence point has been added.

   (e) Identifying the buffer region(s) present

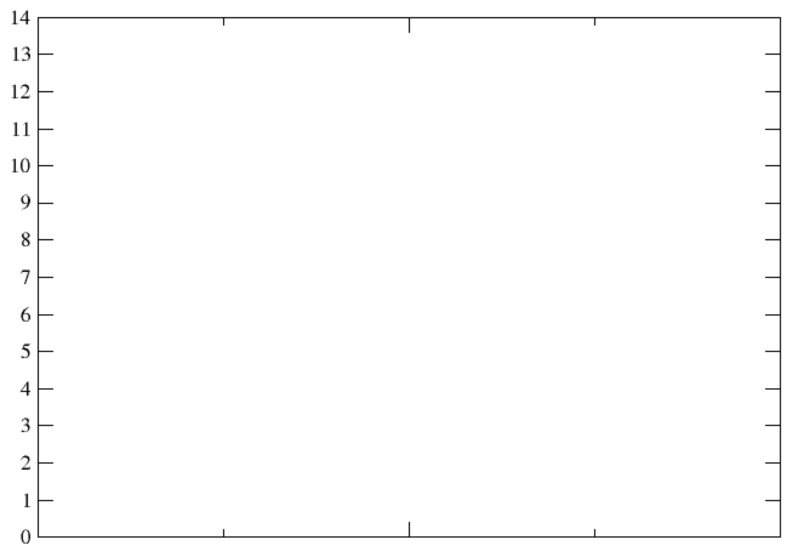


25. Sketch the following titration curves below and label each appropriately:

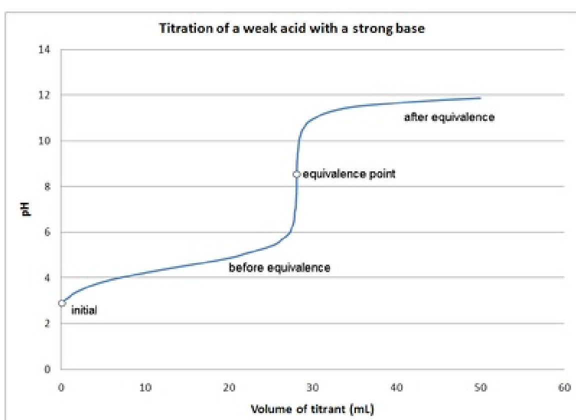
(a) Strong acid/strong base

(b) Weak acid/strong base

(c) Weak base/strong acid



26. Based on the following figure, approximate the K_a value for the acid.



27. Explain how you would identify the equivalence point of a titration using a first derivative titration curve.

28. Relate the terms oxidation and reduction to a naturally occurring, yellow-to-black liquid found in geological formations beneath the Earth's surface.

29. Relate the terms anode and cathode to felines of a rosy disposition.

30. Oxidizing agents get ____________ while reducing agents get ____________.

31. Sketch the cell diagram corresponding to $Zn(s)|Zn^{2+}(1M)||Cu^{2+}(1M)|Cu(s)$ and label the anode, cathode, direction of electron flow, and direction of anion flow.

32. What constitutes standard conditions for electrochemistry?

33. How are absolute values for reduction potentials defined? (Hint: What are they in reference to?)

34. Write the Nernst equation. Define all the terms.

35. For the galvanic cell composed of cadmium and mercury:

(a) Write the overall cell equation, as well as the two half reactions and identify which species is being reduced and which is being oxidized

(b) Calculate the emf of the cell under standard conditions

(c) Calculate the emf of the cell if the $[Cd^{2+}] = 2.4$ M and $[Hg^{2+}] = 1.3 \times 10^{-2}$ M

36. For the galvanic cell composed of lithium and silver:

(a) Write the overall cell equation, as well as the two half reactions and identify which species is being reduced and which is being oxidized

(b) Calculate the emf of the cell under standard conditions

(c) Calculate the emf of the cell if the $[Li^{+}] = 3.3$ M and $[Ag^{+}] = 2.5$ M