Lesson: Solutions: Solubility & Concentration

Objectives: The students will be able to:
1. Identify and describe three types of solutions.
2. Define solubility and apply the concept of solubility to a solubility of curve of various solutes dissolved in water.
3. Calculate the molarity and molality of solutions given appropriate quantities.

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.

Content: Mixtures (homogeneous, heterogeneous), suspensions, colloids, solutions (unsaturated, saturated, supersaturated), solvent, solute, concentrations, dilute, concentrated, solubility, factors affecting solubility, solubility curves, molarity, molality.


Activity:
1. Introduction to New Unit
   - distribute objective list to students and review the material that will be studied in this unit.
2. Matter Worksheet
   - place matter worksheet transparency on overhead;
   - most of this diagram is a review from an earlier unit, the parts that are not review will be discussed in class to complete the graphic organizer of information pertaining to solutions.
3. Solubility Notes
   - discuss factors affecting solubility (temperature and pressure);
   - relate these concepts to bottling soda; how soda manufacturers employ chemical concepts to process and bottle soda;
   - solubility curves worksheet p. 67 – go through the first example as a class. Students will work together to complete the remaining questions.
4. Molarity & Molality Notes
   - define terms;
   - perform a sample calculation;
   - guided practice on the first problem from each worksheet;
   - partner work to complete the remaining worksheet items;
   - review the answers as a class.

Assessment:
1. Teacher observation via in-class participation.
2. How well the students complete the worksheet; appropriateness of results
3. Quiz on Friday.
Lesson: Characteristics of Acids and Bases

Objectives: The students will be able to:
1. Calculate the molarity and molality of solutions given appropriate quantities.
2. Identify the characteristics of acids and bases.
3. Define the three conceptions of acids and bases – Arrhenius, Bronsted-Lowry, and Lewis.

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: acids, bases, electrolyte (strong, weak, non), indicators, acid/base definitions (Arrhenius, Bronsted-Lowry, Lewis), monoprotic, diprotic, triprotic, hydronium ion, hydroxide ion, amphoteric.

Materials and Equipment: 15-2 Practice problems, overhead slides, projector.

Activity:
1. Review
   - finish solubility curve worksheet individually – review answers and concepts from yesterday’s class;
   - review molarity and molality problems on the board.
2. Notes
   - characteristics of acids and bases;
   - electrolytes;
   - indicators;
   - definitions of acids and bases (Arrhenius, Bronsted-Lowry, Lewis)
3. Homework
   - 15-2 Practice Problems #s1-4, 9-12.

Assessment:
1. Teacher observation via in-class participation.
2. Homework
3. Quiz on Friday.
Lesson: Solutions, Suspensions, Colloids & Colligative Properties

Objectives: The students will be able to:
1. Differentiate between solutions, suspensions and colloids.
2. Analyze and interpret a solubility chart.
3. Calculate freezing point depression and boiling point elevations given appropriate quantities for various solutions.

Academic Standards:

3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: solutions, suspensions, colloids, solubility curve, freezing point depression, boiling point elevation.

Materials and Equipment: p. 37 Solutions, Colloids, and Suspensions; Solubility Questions, p.73 Effect of a Solute on Freezing and Boiling Points, 15-4 Practice Problems.

Activity:
1. Introduction
   - the students will be provided with the following introductory question to answer when coming into class: Why does orange juice, or iced tea have to be shaken up before drinking, whereas a soda does not? This introduces the students to the concept of solutions via a practical dimension of their lives. It also allows me to see if anyone understands the connection to homogeneous and heterogeneous mixtures from this simple example of common drinks that students likely consume.
2. Demonstration
   - I will have previously prepared/displayed the following substances: 1) sugar in water (unsaturated), 2) food coloring in water, 3) cooking oil in water, 4) sand in water, 5) clay in water, and 6) cornstarch in water;
   - I will ask for six student volunteers to assist me with this demonstration. These volunteers will be instructed (one at a time) to stir the given solution and to tell the class what observations they notice after the mixtures have been stirred. After the class is made aware of the observations, I will transfer the mixture to an individual test tube and then instruct the student to shine a flashlight on the mixture (the lights will be shut off for this part of the demonstration). The students should make note of the mixtures in which the path of the light beam is visible. Continue for each of the remaining solutions;
   - If the students are unable to classify the mixtures into appropriate categories, we will hold off on the designations until after I have taught the students the properties of solutions, suspensions, and colloids.
3. Notes
   - solutions, suspensions and colloids;
   - worksheet p. 37;
   - return to results from demonstrations to classify mixtures by type;
   - solubility questions practice with partners.
4. Notes – Colligative Properties
   - Freezing point depression, boiling point elevations
   - practice problems
5. Homework
   - solubility question packet to finish
   - 15-4 practice problems #s1-3 and 11-13.

Assessment:
1. Teacher observation via in-class participation; Questions weaved throughout the lecture, as well as teacher observation.
2. Homework.
3. Quiz on Friday.
Lesson: Neutralization Reactions & Titrations

Objectives: The students will be able to:
1. Calculate the molarity and molality of solutions given appropriate quantities.
2. Describe a neutralization reaction.
3. Define what is meant by a salt and identify the parent acids and bases which it comes from.
4. Understand the importance of titrations in acid-base chemistry and determine concentrations or volumes used to neutralize given solutions.

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: Acid/base definitions (Arrhenius, Bronsted-Lowry, Lewis), neutralization reactions, salts, titrations, equilivalence point, saturation point.

Materials and Equipment: Worksheets (p. 84 Bronsted-Lowry Acids and Bases, p. 66 Acids, Bases or Salts), overhead slide of connecting to your world via neutralization reaction of stomach acid and antacid tablets.

Activity:
1. Quiz
   - students will be given 20 minutes to complete their quiz;
2. Review
   - characteristics and definitions of acids and bases;
   - introduce conjugate acid and base with Bronsted-Lowry definition;
   - worksheet p. 84, Bronsted-Lowry Acids and Bases.
3. Neutralization Reactions
   - connecting to your world activity to introduce neutralization
   - definition of a salt
   - worksheet p. 66, Acid, Base or Salt
4. Notes - Titrations
   - define important terms - standard solution, equivalence point, end point and indicator
   - show equipment that will be used with titrations
   - titration calculations
   - practice problems from Modern Chem.
5. Homework
   - 15-2 practice problems
   - 15-4 practice problems
   - titration calculations from Heath textbook, p. 652 #s 16, 17, 23, 24

Assessment:
1. Teacher observation via in-class participation.
2. Homework.
3. Individual titration practical.
Quiz 8-1
Solutions, Acids & Bases

Part I. Provide a definition for the following terms.

1. Saturated solution

2. Solubility

3. Unsaturated solution

4. Strong electrolyte

5. Bronsted-Lowry acid

6. Arrhenius base

Part II. Molarity & Molality calculations: determine the indicated quantity.

7. What is the molarity of the solution produced when 14.1 g of ammonia is dissolved in sufficient water to prepare 100 mL of solution.

8. What is the molality of a solution made by dissolving 8.11 g of potassium sulfide in 47.6 g of ethanol.

9. How many grams of potassium chloride are needed to prepare 0.75 L of 2.25 M solution of potassium chloride in water?
Lesson: Neutralization Reactions & Titrations

Objectives: The students will be able to:
1. Calculate the molarity and molality of solutions given appropriate quantities.
2. Describe a neutralization reaction.
3. Define what is meant by a salt and identify the parent acids and bases which it comes from.
4. Understand the importance of titrations in acid-base chemistry and determine concentrations or volumes used to neutralize given solutions.
5. Describe the ways to differentiate a strong acid from a weak acid.

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: Acid/base definitions (Arrhenius, Bronsted-Lowry, Lewis), neutralization reactions, salts, titrations, equivalence point, saturation point.

Materials and Equipment: Worksheet, p. 66 Acids, Bases or Salt, Modern Chemistry textbook

Activity:
1. Review
   - solubility curve homework;
   - 15-4 practice problems;
   - overall review of material covered so far.
2. Notes – strengths of acids and bases
   - define the methods used to determine the strength of acids.
3. Titration Practice
   - review concept of titration;
   - example problem together as a class;
   - Modern Chemistry Problems to work on in groups at lab benches
     * p. 514, #2
     * p. 516, # 3
     * p. 518, #s 17, 18, 19
     * p. 519, # 8
4. Homework
   - lab write-up due Wednesday
   - Heath book problems
     * p. 523, #s 32, 33, 34
     * p. 652, #s 16, 17, 23, 24

Assessment:
1. Teacher observation via in-class participation.
2. Homework.
3. Individual titration practical.
Lesson: Neutralization Reactions & Titrations

Objectives: The students will be able to:
1. Calculate the molarity and molality of solutions given appropriate quantities.
2. Describe a neutralization reaction.
3. Define what is meant by a salt and identify the parent acids and bases which it comes from.
4. Understand the importance of titrations in acid-base chemistry and determine concentrations or volumes used to neutralize given solutions.
5. Describe the ways to differentiate a strong acid from a weak acid.

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: Acid/base definitions (Arrhenius, Bronsted-Lowry, Lewis), neutralization reactions, salts, titrations, equivalence point, saturation point.

Materials and Equipment: Worksheet, p. 66 Acids, Bases or Salt, Modern Chemistry textbook

Activity:
1. Review
   - solubility curve homework;
   - 15-4 practice problems;
   - overall review of material covered so far.
4. Notes – strengths of acids and bases
   - define the methods used to determine the strength of acids.
5. Titration Practice
   - review concept of titration;
   - example problem together as a class;
   - Modern Chemistry Problems to work on in groups at lab benches
     * p. 514, #2
     * p. 516, # 3
     * p. 518, #s 17, 18, 19
     * p. 519, # 8
4. Homework
   - lab write-up due Wednesday
   - Heath book problems
     * p. 523, #s 32, 33, 34
     * p. 652, #s 16, 17, 23, 24

Assessment:
1. Teacher observation via in-class participation.
2. Homework.
3. Individual titration practical.
Lesson: Titration Practice, pH and pOH

Objectives: The students will be able to:
1. Describe a neutralization reaction.
2. Define what is meant by a salt and identify the parent acids and bases which it comes from.
3. Understand the importance of titrations in acid-base chemistry and determine concentrations or volumes used to neutralize given solutions.
4. Set up and perform a simple titration given quantities of acid and base.
5. Calculate any of the following quantities given one value, pH, [H₃O⁺], pOH, [OH⁻].

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: Neutralization reactions, salts, titrations, equivalence point, saturation point, pH and pOH.

Materials and Equipment: Worksheet, p. 66 Acids, Bases or Salt, dilute solution of HCl, dilute solution of NaOH, buret, erhlenmeyer flask, ring stand, clamp.

Activity:
1. Opening
   - p. 66 Acids, Bases or Salts;
2. Review
   - neutralization reactions;
   - titrations with calculations.
3. Titration Practice Experiment
   - describe set-up;
   - description of apparatus with chemicals involved;
   - experiment – partners to determine concentration of unknown acid solution, concentration of base solution provided.
4. Homework
   - pre-lab write-up due Thursday (block 2 & 5)
   - lab write-up due Thursday (block 4)
   - signed gradesheet due Thursday
   - Unit 3 & 4 Review Questions due Wednesday
   - Practice problems 2 & 3

Assessment:
1. Teacher observation via in-class participation.
2. Homework.
3. Lab write-up
4. Individual titration practical.
Lesson: Titration Experiment

Objectives: The students will be able to:

1. Describe a neutralization reaction.
2. Define what is meant by a salt and identify the parent acids and bases which it comes from.
3. Understand the importance of titrations in acid-base chemistry and determine concentrations or volumes used to neutralize given solutions.
4. Set up and perform a simple titration given quantities of acid and base.

Academic Standards:

3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: Neutralization reactions, salts, titrations, equivalence point, saturation point, pH and pOH.

Materials and Equipment: Dilute solution of HCl, dilute solution of NaOH, buret, erlenmeyer flask, ring stand, clamp.

Activity:

1. Opening
   - collect unit 3 & 4 review sheets.
2. Pre-lab quiz
   - students will have 10 minutes to complete this quiz.
3. Titration Experiment
   - describe set-up;
   - description of apparatus with chemicals involved;
   - experiment – partners to determine concentration of unknown acid solution, concentration of base solution provided.
4. Homework
   - lab write-up due Friday
   - Unit 5 Review Questions due Friday

Assessment:

1. Teacher observation via in-class participation.
3. Homework.
3. Lab write-up
4. Individual titration practical.
Lesson: Partner Quiz & Review

Objectives: The students will be able to:
1. Apply knowledge of acids, bases and solution to complete a three part partner quiz aimed at assessing the students mastery of the content knowledge.

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: Solutions (saturated, unsaturated, supersaturated), suspensions, colloids, solubility, factors affecting solubility, solubility curves, colligative properties, molarity, molality, acids & bases (characteristics, definitions), strong vs. weak acids, acid-base pairs, indicators, pH & pOH, neutralization reactions, salts, titration.

Materials and Equipment: Dilute solution of HCl, dilute solution of NaOH, buret, erlenmeyer flask, ring stand, clamp.

Activity:
1. Opening
   - collect unit 5 review sheets.
2. Partner Quiz
   - students will have 45 minutes to complete this quiz with their partners.
3. Review Answers
4. Take Home Experiment
   - review directions for take home experiment;
   - distribute litmus paper (red and blue)
   - due May 31\textsuperscript{st}.
5. Homework
   - Unit 6 Review sheets due Tuesday.

Assessment:
1. Teacher observation via in-class participation.
2. Performance on partner quiz.
3. Homework.
Lesson: Titration Practical and Unit 8 Review

Objectives: The students will be able to:
1. Apply knowledge of acids, bases and solution to complete the test review sheet part partner quiz aimed at assessing the students mastery of the content knowledge.
2. Apply knowledge of titrations and past lab experiments to set-up, perform and calculate the appropriate values for the neutralization reaction of HCl and NaOH.

Academic Standards:
3.4.12.A – Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.
3.4.12.A - Characterize and identify important classes of compounds (e.g., acids, bases, salts).

Content: Solutions (saturated, unsaturated, supersaturated), suspensions, colloids, solubility, factors affecting solubility, solubility curves, colligative properties, molarity, molality, acids & bases (characteristics, definitions), strong vs. weak acids, acid-base pairs, indicators, pH & pOH, neutralization reactions, salts, titration.

Materials and Equipment: Dilute solution of HCl, dilute solution of NaOH, buret, erhlenmeyer flask, ring stand, clamp.

Activity:
1. Opening
   - collect unit 6 review sheets;
   - review format of class (unit 8 review and 20 minute intervals for titration practical).
2. Class
   - groups of 10 students at a time will be directed to perform their individual lab practical;
   - those students not performing their practical will work on unit 8 review sheets;
   - any questions on the review sheet will be answered by the teacher;
   - with 20 minutes remaining in class, a review of material covered on the test will be addressed; additionally, answers from the review packet will be given and students can ask any remaining questions at this point.
3. Homework
   - take home experiment due tomorrow.
   - unit 7 review questions due Thursday.
   - study for unit 8 test, last test of the year!

Assessment:
1. Teacher observation via in-class participation.
2. Performance on unit 8 test.
3. Individual titration practical.
Pre-lab Quiz
Acid/Base Titrations

1. What is the purpose of this experiment?

2. What base will be used to perform the titration?

3. How many grams of base will you mass out to prepare your standard base solution?

4. Once you prepare the base solution, what apparatus do you fill with the base?

5. What is the acid being used in this experiment?

6. What piece of glassware will contain the acid for the titration?

7. What is the name of the indicator?

8. How many drops of indicator should you add to your acid?

9. How do you know when you are finished titrating?

10. What does it mean if your final solution turns dark pink.
**pH and pOH Practice**

\[ \text{pH} = -\log [\text{H}_3\text{O}^+] \]
\[ \text{pOH} = -\log [\text{OH}^-] \]

Together, \( \text{pH} + \text{pOH} = 14 \)

Complete the missing components in the chart below.

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<th>[\text{H}_3\text{O}^+]</th>
<th>pH</th>
<th>[OH(^-)]</th>
<th>pOH</th>
<th>Red Litmus</th>
<th>Blue Litmus</th>
<th>Phenolphthalein</th>
<th>Acid, Base or Neutral?</th>
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<tr>
<td>1.</td>
<td>(10^{-5})</td>
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<td>Red</td>
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**Indicators**

Red Litmus – Red in Acids, Blue in Bases
Blue Litmus – Blue in Bases, Red in Acids
Phenolphthalein – Colorless in Acids, Pink in Bases
Unit 8 Test
Solution, Acids & Bases

** Answer all questions **

** Show all work and units **

Points Earned ________

100
Part I – Multiple Choice. Write the letter of the best possible answer. (30 points)

1. ______ A solution containing the maximum amount of solute is said to be . . .
   a. supersaturated
   b. saturated
   c. unsaturated
   d. concentrated

2. ______ What quantity represents the number of moles of solute dissolved in 1 kg of solvent?
   a. normality
   b. molarity
   c. molality
   d. mass percent

3. ______ Which of the following is a diprotic acid?
   a. H₂SO₄
   b. CH₃COOH
   c. HCl
   d. H₃PO₄

4. ______ How many hydrogens does a triprotic acid have?
   a. 0
   b. 1
   c. 2
   d. 3

5. ______ What color does the indicator phenolphthalein appear in basic solutions?
   a. yellow
   b. pink
   c. blue
   d. colorless

6. ______ What is the maximum amount of KCl that can dissolve in 200 g of water?
   (The solubility of KCl is 34g/100g H₂O at 20°C)
   a. 17 g
   b. 34 g
   c. 68 g
   d. 6800 g

7. ______ In a concentrated solution there is ______?
   a. no solvent
   b. a large amount of solute
   c. a small amount of solute
   d. no solute
8. ______ What is the molarity of a solution that contains 6 moles of solute in 2 L of solution?
   a. 6 M
   b. 12 M
   c. 7 M
   d. 3 M

9. ______ Colligative properties depend upon the _____.
   a. nature of the solute
   b. nature of the solvent
   c. number of solute particles in a solution
   d. freezing point depression

10. ______ What is the molality of a solution containing 8.1 moles of solute in 4847 g of solvent?
    a. 0.67 m
    b. 4 m
    c. 1.67 m
    d. 0.017 m

11. ______ When an acid reacts with a base, what compounds are formed?
    a. a salt only
    b. water only
    c. metal oxides only
    d. a salt and water

12. ______ What is the formula for phosphoric acid?
    a. $\text{H}_2\text{PO}_3$
    b. $\text{H}_3\text{PO}_4$
    c. $\text{HPO}_2$
    d. $\text{HPO}_4$

13. ______ Which of the following is a property of an acid?
    a. sour taste
    b. nonelectrolyte
    c. strong color
    d. unreactive with metals

14. ______ Which of the following is NOT a property of a base?
    a. electrolyte
    b. burns in a cut
    c. bitter taste
    d. feels slippery

15. ______ What is the formula for a hydronium ion?
    a. $\text{H}_2\text{O}^+$
    b. $\text{H}^+$
    c. $\text{H}_4\text{O}^+$
    d. $\text{H}_3\text{O}^+$
16. ______ What type of acid is nitric acid?
   a. diprotic
   b. monoprotic
   c. amphoteric
   d. triprotic

17. ______ Which compound can act as both an acid and as a base?
   a. ammonia
   b. sodium hydroxide
   c. water
   d. hydrochloric acid

18. ______ What is the pH range?
   a. 0 to 1
   b. -1 to 1
   c. 0 to 7
   d. 0 to 14

19. ______ Which of the following is an example of a suspension?
   a. mayonnaise
   b. sand in water
   c. fog
   d. lemonade

20. ______ Which type of solution is one with a pH of 8?
   a. acid
   b. basic
   c. neutral
   d. the type varies, depending on solution

21. ______ What process measures the amount of solution of known concentration required to react with a measured amount of unknown concentration?
   a. neutralization
   b. hydrolysis
   c. titration
   d. buffer capacity

22. ______ An amphoteric species is one that reacts as which of the following?
   a. acid only
   b. base only
   c. acid or base
   d. none of the above

23. ______ What is the pH of a neutral solution at 25°C?
   a. 0
   b. 1
   c. 7
   d. 14
24. ______ Which of the following is not an important factor that influences solubility?
   a. temperature
   b. “like dissolves like”
   c. pressure
   d. none of the above

25. ______ Dyes with pH-sensitive colors are used as which of the following?
   a. primary standards
   b. indicators
   c. titrants
   d. none of the above

26. ______ An acid-base titration is carried out by monitoring what quantity?
   a. temperature
   b. pH
   c. pressure
   d. density

27. ______ What is the molarity of an HCl solution if 50.0mL is neutralized in a titration by 40.0mL of 0.400 M NaOH?
   a. 0.200 M
   b. 0.280 M
   c. 0.320 M
   d. 0.500 M

28. ______ Which of the following is a thoroughly mixed homogeneous mixture of substances in a single phase?
   a. solution
   b. compound
   c. colloid
   d. suspension

29. ______ A substance whose water solution conducts a current is a(n)?
   a. nonelectrolyte
   b. electrolyte
   c. nonpolar substance
   d. solute

30. ______ Which of the following is NOT a property of a colloid?
   a. does not separate on standing
   b. has intermediate size particles between a solution and a suspension
   c. is a homogeneous mixture
   d. scatters light
Part II – Short Answer. Be sure to answer each question completely. (50 points)

Use the following figure to answer questions 1-5.

1. According to the solubility curve, how many grams of potassium nitrate can be dissolved at 50°C?

2. Determine if the following solution is supersaturated, saturated or unsaturated: 30 grams of potassium chloride at 60°C.

3. If 30 grams of ammonium chloride is dissolved in 100 g of water at 90°C, how many more grams must be added to produce a saturated solution of ammonium chloride?

4. If sodium nitrate is cooled from 50°C to 30°C, how much solid sodium nitrate will come out of solution?

5. How many grams of sodium chloride can be dissolved at 100°C?
6. What is the molarity of a solution prepared by dissolving 5.68 g of sodium hydroxide in 400 mL of water?

7. How many grams of hydrochloric acid are required to prepare 250 mL of a 0.158 M solution?

8. How many grams of C₂H₆O₂ are required to make a 4.50 m solution using 2.50 kg of water?

9. What will be the freezing point depression if 42.0 g of ibuprofen, C₁₃H₁₈O₂, is dissolved in 975 g of naphthalene? Kᵥ for naphthalene is 7.00 Cº/m. The dissociation factor is 1.
   \[ \Delta T_f = m \times d.f. \times K_f \]

10. In the following reaction, label the acid (A) and base (B) for both the reactants and the products.
    \[ \text{H}_2\text{SO}_4 + \text{H}_2\text{O} \leftrightarrow \text{H}_5\text{O}_4^- + \text{H}_2\text{O} \]
    \[ \text{NH}_3 + \text{H}_2\text{O} \leftrightarrow \text{NH}_4^+ + \text{OH}^- \]
    \[ \text{HF} + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+ + \text{F}^- \]

11. What is the difference between a strong acid and a weak acid. Include a description of 1 of the 2 methods discussed in class for the way to differentiate between the two.
12. A titration of an unknown hydrochloric acid solution requires 43.25 mL of 0.213 M sodium hydroxide to neutralize 50.0 mL of hydrochloric acid. What is the molarity of hydrochloric acid?

13. A volume of 34.0 mL of 0.10 M HNO₃ neutralizes 25.0 mL of LiOH solution. What is the molarity of this LiOH solution?

Using your knowledge of pH and pOH, complete the following table. (20 points)

<table>
<thead>
<tr>
<th>[H₃O⁺]</th>
<th>pH</th>
<th>[OH⁻]</th>
<th>pOH</th>
<th>Type of solution (acid/base/neutral)</th>
<th>Color of Phenolphthalein</th>
</tr>
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<tbody>
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<td>10⁻⁷</td>
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<td>12</td>
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</tbody>
</table>
Acid-Base Indicators

At home lab experiment

In this unit we have learned about different definitions, characteristics and reactions for acids and bases. We have also seen that indicators can be used to determine the acidity or basicity of chemical substances. For this experiment, you will have the opportunity to test common household substances using both red and blue litmus paper to determine which products are acids and which are bases.

Procedure:
1. Choose five common household products from the list below to test.
   - liquid soap
   - window cleaner
   - salt solution
   - sugar solution
   - vinegar
   - baking soda solution
   - ammonia cleaner
   - cooking oil
   - clear carbonated soft drink (sprite, clear cream soda)
   - lemon juice
   - sauerkraut juice
   - any additional clear products you would like to test

2. Put the item in a small glass.
3. Before testing the product with the red and blue litmus paper make a hypothesis as to the nature of the substance. Include a reason why (i.e. an ingredient or component of the substance makes me think it is an acid/base).
4. Dip the end of the red litmus paper into the glass with your first substance. Let the paper dry and tape it to your data table. Record the resulting color in your data table. Identify if you think this substance is an acid, base or neutral.
5. Dip the end of the blue litmus paper into the glass with the same substance. Let the paper dry and tape it to your data table. Record the resulting color in your data table. Identify if you think this substance is an acid, base or neutral.
6. Repeat steps 2-5 with the remaining 4 substances you have chosen to test.

** For extra credit, bring in a picture of yourself performing the lab at home. The picture must be turned in on May 30th along with this lab report **
## Data Table – Indicator Lab Report

<table>
<thead>
<tr>
<th>Name of the product tested</th>
<th>Hypothesis and reason why</th>
<th>Red Litmus</th>
<th>Blue Litmus</th>
<th>Acid, Base or Neutral and reason why</th>
</tr>
</thead>
<tbody>
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<td>1.</td>
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</table>
Conclusion Questions

1. Make a list of those substances that were found to be acids. What are the common characteristics of acids?

2. Make a list of those substances that were found to be bases. What are the common characteristics of bases?

3. Did you test any solutions that were neutral? If so, how could you tell they were neutral?

4. What did you learn about common household products by performing this experiment?
Unit 8 Test Review

Colligative Properties

1. What is the definition of colligative properties and what are the two that we talked about in this unit?

2. What is the boiling point elevation when 43.5 g of the dye magenta (C₂₀H₂₀ClN₃) is dissolved in 1650 g of ethanol. Kᵇ for ethanol is 1.20 °C/m.

3. If 13.4 g of the medication scopolamine (C₁₇H₂₁NO₄) is dissolved in 50.3 g of water, how much will the freezing point be lowered. Kᶠ for water is 1.86 °C/m.

Molarity and Molality

4. Provide a definition in the form of an equation for both molarity and molality.

5. To produce 3.00 L of 1.90 M solution of sodium hydroxide, how many grams of sodium hydroxide must be dissolved?

6. What is the molarity of the solution produced when 145 g of sodium chloride is dissolved in sufficient water to prepare 2.75 L of solution?

7. What is the molality of a solution containing 1330 g of methanol, (CH₃OH) and 16.6 g of sodium bromide?

8. In order to prepare a 0.523 m aqueous solution of potassium iodide, how many grams of potassium iodide must be added to 2.00 kg of water?
Solubility & Solubility Curves

9. What is the definition of solubility and what are the main factors that affect solubility?

Use the following diagram to answer questions 10-13.

10. According to the solubility curve, how many grams of potassium chloride can be dissolved at 30°C?

11. Determine if the following solution is supersaturated, saturated or unsaturated: 80 grams of sodium nitrate at 40°C.

12. If 60 grams of potassium nitrate is dissolved in 100 g of water at 50°C, how many more grams must be added to produce a saturated solution of potassium nitrate?

13. If potassium iodide is cooled from 15°C to 0°C, how much solid sodium nitrate will come out of solution?
Acids & Bases

14. What characteristics are associated with acids? With bases?

Identify the acids and bases in problems 15-17.

15. $\text{H}_2\text{SO}_4 + \text{OH}^- \rightarrow \text{HSO}_4^- + \text{H}_2\text{O}$

16. $\text{HCN} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{CN}^-$

17. $\text{OH}^- + \text{H}_3\text{O}^+ \rightarrow \text{H}_2\text{O} + \text{H}_2\text{O}$

18. What are the two methods used to differentiate between strong and weak acids?

pH & pOH

19. What is the formula commonly taken to be the definition of pH?

20. What is the range of pH values? What values are associated with acids, bases and neutral solutions?

21. What number does $\text{pH} + \text{pOH}$ equal?
Complete the following table.

<table>
<thead>
<tr>
<th>[H₃O⁺]</th>
<th>pH</th>
<th>[OH⁻]</th>
<th>pOH</th>
<th>Type of solution (acid/base/neutral)</th>
<th>Color of Phenolphthalein</th>
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<td>10⁻⁷</td>
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</table>

**Titrations**

22. What products are produced in a neutralization reaction?

23. What is the molarity of HCl if it takes 25.5 mL of 0.50M NaOH to neutralize 15.1 mL of acid?

24. 14.2 mL of 0.10M LiOH is required to neutralize 30.0 mL of H₂SO₄. What is the molarity of sulfuric acid?

25. What type of acid (monoprotic, diprotic, or triprotic) is sulfuric acid?
Take Home Essay

SOLUTIONS, ACIDS AND BASES

Write an essay discussing the material we covered in this unit. You will need to write a sentence corresponding to each letter of the phrase listed above (22 sentences total). A word starting with S will be your first sentence, O will be the letter of a word for your second sentence, L your third. Continuing in this pattern, your essay must be arranged in order to make coherent sense of the material. Sentences before and after must go together. Additionally, jumping from topic to topic is not permitted; once you have written all you want on a particular topic (i.e. solutions) move on to another topic. This assignment will be graded on overall composition, grammar, and creativity. You can either type or hand-write this assignment. After you have finished your Unit 8 test begin working on this assignment. Your essay will be due June 1\textsuperscript{st} in class and will be worth 31 points.
Grading Rubric – Solutions, Acids and Bases Essay

Appropriate length ______ (22)
One point will be deducted for each letter of the phrase that is missing

All letters must be bolded within the essay

Convections (Spelling & Grammar)

3  Few errors, sentence structure varied

2  Errors in grammar, but common words are spelled correctly

1  Frequent errors in basic convections; commonly used words may be misspelled

Appropriateness & Understanding

3  All sentences are related to the current unit of study; the author shows superior understanding of the material

2  Some sentences are unrelated to solutions, acids and bases; the author shows partial understanding of the material

1  A majority of the sentences are unrelated; the author shows an obvious misunderstanding of the material

Organization

3  Logical progression of ideas is present; no jumping back and forth between topics is evident

2  Lacks logical progression of ideas; topics are started and finished out of order

1  No organization of sentences is observable
SOLUBILITY CURVES

1. Which salt is least soluble in water at 20°C? ________________

2. How many grams of potassium chloride can be dissolved in 200 g of water at 80°C? __________________

3. At 40°C, how much potassium nitrate can be dissolved in 300 g of water? ________________

4. Which salt shows the least change in solubility from 0°C – 100°C? ________________

5. At 30°C, 90 g of sodium nitrate is dissolved in 100 g of water. Is this solution saturated, unsaturated or supersaturated? ________________

6. A saturated solution of potassium chlorate is formed from one hundred grams of water. If the saturated solution is cooled from 80°C to 50°C, how many grams of precipitate are formed? ________________

7. What compound shows a decrease in solubility from 0°C to 100°C? ________________

8. Which salt is most soluble at 10°C? ________________

9. Which salt is least soluble at 50°C? ________________

10. Which salt is least soluble at 90°C? ________________
Solubility Questions

1) How many grams of each of the following can be dissolved in 100 mL of water at the given temperature?
   a) Sodium chloride at 30°C
   b) Potassium chloride at 40°C
   c) Potassium nitrate at 40°C
   d) Ammonium chloride at 16°C
   e) Sodium nitrate at 80°C

2) Decide whether each of the following solutions is unsaturated or saturated.
   a) 50 grams of sodium chloride dissolved in 100 mL of water at 35°C
   b) 45 grams of potassium chloride dissolved in 100 mL of water at 70°C
   c) 10 grams of potassium nitrate dissolved in 100 mL of water at 10°C
   d) 41 grams of ammonium chloride dissolved in 100 mL of water at 70°C
   e) 140 grams dissolved in 100 mL of water at 15°C

3) In each of the following cases, how many more grams of solute have to be added to 100 mL of water to have a saturated solution?
   a) 80 grams of sodium nitrate dissolved at 10°C
   b) 25 grams of ammonium chloride dissolved at 20°C
   c) 80 grams of potassium nitrate dissolved at 55°C
   d) 25 grams of potassium chloride dissolved at 80°C
   e) 12 grams of potassium chloride dissolved at 80°C

4) Suppose you have a saturated solution containing a certain amount of solute in 100 mL of water, which is then cooled. For each of the following cases, decide how much solid will come out of solution (precipitate).
   a) Potassium chloride is cooled from 50 to 30°C
   b) Potassium chlorate is cooled from 40 to 0°C
   c) Potassium nitrate is cooled from 55 to 30°C
   d) Sodium chloride is cooled from 100 to 50°C
15–2 Practice Problems

1. What is the molarity of the solution produced when 145 g of sodium chloride (NaCl) is dissolved in sufficient water to prepare 2.75 L of solution?

2. How many grams of potassium chloride (KCl) are needed to prepare 0.750 L of a 1.50 M solution of potassium chloride in water?

3. What is the molarity of the solution produced when 85.6 g of hydrochloric acid (HCl) is dissolved in sufficient water to prepare 0.385 L of solution?

4. To produce 3.00 L of a 1.90 M solution of sodium hydroxide (NaOH), how many grams of sodium hydroxide must be dissolved?

5. If 8.77 g of potassium iodide (KI) are dissolved in sufficient water to make 4.75 L of solution, what is the molarity of the solution?

6. In order to prepare 2.00 L of a 3.00 M solution of ferric chloride (FeCl₃), how many grams of ferric chloride must be used?

7. What is the molarity of the solution produced when 14.1 g of ammonia (NH₃) is dissolved in sufficient water to prepare 0.100 L of solution?

8. To prepare 10.5 L of a 2.50 M solution of potassium hydroxide (KOH), how many grams of potassium hydroxide must be used?

9. What is the molality of a solution containing 75.2 g of silver perchlorate (AgClO₄) dissolved in 885 g of benzene?

10. What is the molality of a solid solution containing 0.125 g of chromium and 81.3 g of iron?

11. If 18.6 g of methanol is used to dissolve 2.68 g of Hg(CN)₂, what is the molality of the solution?

12. What is the molality of solid solder wire if it is made from 68.7 g of lead dissolved in 117 g of tin?
EFFECT OF A SOLUTE ON FREEZING AND BOILING POINTS

We use the following formulas to calculate changes in freezing and boiling point due to the presence of a nonvolatile solute. Freezing point is always lowered, boiling point is always raised.

\[ \Delta T_f = m \times d.f. \times k_f \]
\[ \Delta T_b = m \times d.f. \times k_b \]

- \( k_f \) \( H_2O = 0.52^\circ C/m \)
- \( k_b \) \( H_2O = 1.86^\circ C/m \)

\( m \) = molality of solution
\( k_f \) and \( k_b \) = constants for particular solvent
\( d.f. \) = dissociation factor (how many particles solute breaks up into:
for a nonelectrolyte, \( d.f. = 1 \))
(Theoretical Dissociation Factor is always greater than observed effect.)

Solve the problems below.

1. What is the new boiling point if 25 g of NaCl is dissolved in 1.0 Kg of water?

2. What is the freezing point of the solution in Problem 1?

3. What are the new freezing and boiling points of water if 50. g of ethylene glycol (molecular mass = 62 g/mol) is added to 50. g of water?

4. When 5.0 g of a nonelectrolyte is added to 25 g of water, the new freezing point is -2.5\(^\circ\) C. What is the molecular mass of the unknown compound?
SOLUTIONS, COLLOIDS AND SUSPENSIONS

Label the following mixtures as a solution, colloid or suspension. Give an example of each.

1. large particles,
   settles out on standing

   Kind of mixture:_____________________
   Example:__________________________

2. medium size particles,
   settles out on standing
   scatters light

   Kind of mixture:_____________________
   Example:__________________________

3. very small particles
   does not settle out on standing

   Kind of mixture:_____________________
   Example:__________________________
pH and pOH Practice

\[
pH = -\log [H_3O^+]
\]
\[
pOH = -\log [OH^-]
\]

Solution, \(pH + pOH = 14\)

Complete the missing components in the chart below.

<table>
<thead>
<tr>
<th></th>
<th>([H_3O^+])</th>
<th>(pH)</th>
<th>([OH^-])</th>
<th>(pOH)</th>
<th>Red Litmus</th>
<th>Blue Litmus</th>
<th>Phenolphthalein</th>
<th>Acid, Base or Neutral?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10^{-5}</td>
<td>5</td>
<td>10^{-9}</td>
<td>9</td>
<td>Red</td>
<td>Red</td>
<td>Colorless</td>
<td>Acid</td>
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</tbody>
</table>

Indicators

Red Litmus – Red in Acids, Blue in Bases
Blue Litmus – Blue in Bases, Red in Acids
Phenolphthalein – Colorless in Acids, Pink in Bases
18–1 Review and Reinforcement

Defining Acids and Bases

Complete each of the following sentences by filling in the appropriate word or phrase from the list below:

electrolyte
acid-base indicator
neutralization reaction
salt

hydronium ion
amphoteric
conjugate

1. An ionic compound that forms from an acid-base neutralization reaction is a(n) _____________.

2. A(n) ____________ is a substance that conducts electricity.

3. The chloride ion (Cl\(^-\)) is the ____________ base of hydrochloric acid (HCl).

4. The formula H\(_2\)O\(^+\) represents a(n) ____________.

5. A(n) ____________ turns one color in an acidic solution and another color in a basic solution.

6. The reaction between an acid and a base is called a(n) ____________.

On the line at the left, write “A” if the statement is a property of an acidic solution. Write “B” if it is a property of a basic solution, and write “X” if it is a property of both acidic and basic solutions.

7. ____________ often feels smooth and slippery

8. ____________ has a sour taste

9. ____________ stings in open wounds

10. ____________ typically reacts vigorously with metals

11. ____________ has a bitter taste

12. ____________ turns litmus paper from blue to red

13. ____________ is an electrolyte

14. ____________ often looks like pure water

15. ____________ turns litmus paper from red to blue

16. ____________ typically does not react with metals

Answer the following questions in the space provided.

17. What is the Arrhenius definition of an acid? What is the Arrhenius definition of a base?
19–3 Review and Reinforcement

Acid-Base Titration

Complete the following statements by filling in the appropriate word or phrase from the list below.

- acid-base titration
- standard solution
- equivalence point
- indicator
- phenolphthalein
- titration curve
- end point

1. The point at which exactly enough standard solution is added to neutralize the unknown solution is the ____________.
2. A(n) ____________ is used to represent pH data.
3. A(n) ____________ is a carefully controlled neutralization reaction.
4. A(n) ____________ changes color at certain pH values.
5. A(n) ____________ contains an acid or a base in known concentration.
6. A common indicator used in titrations is ____________.
7. The point at which the indicator changes color is the ____________ of the reaction.

Answer the following questions as directed.

8. Why is it difficult to directly measure the concentration of a weak acid such as acetic acid?

9. How is an indicator useful in a titration?

10. Why should the end point of a titration be close to the equivalence point?

11. Should phenolphthalein be chosen for a titration reaction between HCl and NaOH? Why or why not?