Unit Plan

Acids and Bases

Ms. Li

Chem 12

**Prior skills and knowledge:** Students have completed the unit on chemical equilibrium, which are the basics for the acid/base section. They also know how to Keq to find the concentrations of reactants/products at equilibrium and work backwards to solve for Keq. They may or may not have learned how to use logs, which is needed for calculating pH and pOH. Students have experience with neutralization reactions and know the strong acid to strong base reaction only.

**Prescribed learning outcomes:**

**D1** identify acids and bases through experimentation

**D2** identify various models for representing acids and bases

**D3** analyse balanced equations representing the reaction of acids or bases with water

**D4** classify an acid or base in solution as either weak or strong, with reference to its electrical conductivity

**D5** analyse the equilibria that exist in weak acid or weak base systems

**D6** identify chemical species that are amphiprotic

**E1** analyse the equilibrium that exists in water

**E2** perform calculations relating pH, pOH, [H3O+], and [OH-]

**E3** explain the significance of the Ka and Kb equilibrium expressions

**E4** perform calculations involving Ka and Kb

**Big Ideas and Skills learned at end of unit**

1. Not all acids and bases dissociate completely in water, the more they dissociate in water, the stronger they are
2. The stronger the acid/base, the more they "don't want"/"want" their proton
3. Acid or base alone is different when they're mixed in water. Water acting as a weak acid/base sets pH/pOH limit even when strong acid/base is added.
4. Safety and application of acid/base reactions in real life situations.

**Vocabulary:** acid, amphiprotic, Arrhenius, base, Brönsted-Lowry, conjugate acid-base pair, electrical conductivity, strong acid, strong base, weak acid, weak base, acid ionization constant (Ka ), base ionization constant (Kb ), ion product constant, pH, pKw, pOH, water ionization constant (Kw)

**Assessment**

1. Hand-ins (classroom activities, class handouts) - 15%
2. Labs and projects - 25%
3. Quizzes - 20%
4. Unit Test - 40%

**Materials:** laptop, projector, and quiz/pre-quiz/unit test/problems handouts, household acids/bases

**Total lessons:**  12 lessons **Total time: 16hrs**

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| Lesson | Activities | Materials and Extensions | Learning Objectives | Assessment |
| 1 | **1) Class intro, social norms/expectations, introduce unit project with instructions and rubric to follow later**  **2) Introduction to Acids and Bases**  **Students do:**  - Pre-lab preparation:  Read procedure in class, answer pre-lab questions, short discussion to probe prior knowledge about acids and bases  - Perform Lab 20A  - Make data tables  - Record data and observations  - Answer questions to be handed in.  Article on mixing household cleaners  HMK - identify the chemical formulae and chemical names of the household cleaners used in the article and classify them as acids/bases. Brief description on the chemical reaction that happened between those chemicals.  Give 3 examples of acid/bases you use and write their chemical names and formulae. These must be different than the ones we worked with today. | -NaOH  -HCl  -KOH  -Ca(OH)2  -H2SO4  -HNO3  -Oven cleaner  -Lemon Juice  -7-up  -Ammonia  -Easy Off  -Milk of Magnesia  -White vinegar  -Copies of article  Lab 20A  P156 Heath Chemistry Lab Experiments – Teacher’s Ed. | - D1  - Identify acids and bases through experimentation  - Test and classify various laboratory solutions and household chemicals as acids or bases.  - List general properties of acids and bases  - Write names and formulae of some common household acids and bases  - Outline some of the uses and commercial names of common household acids and bases.  Big Ideas  4) Safety and application of acid/base reactions in real life situations. | Questions to hand in for the lab  Page description on article + 3 examples |
| 2 | **1) unDemonstration - Dissolving pop can in acid/base Students:**  - Complete undemo worksheets and hand in  **2) Arrhenius acids/bases and neutralization**-  **Students**: use definition of Arrhenius acids/bases in neutralization reactions. Can write a practice question on the white board and switch with their partner  **HMK:** Colgur Acid and Base worksheet 4-1 to hand in next class | -pre-disintegrated pop can  -4-5 cut out empty, pop cans  -Strong base/strong acid  -demo handout  -Colgor worksheets | - D1  - Write balanced equations representing the neutralization of acids by bases in solution  D2  - Define Arrhenius acids and bases  Big Ideas  1) Not all acids and bases dissociate completely in water, the more they dissociate in water, the stronger they are  2) The stronger the acid/base, the more they "don't want"/"want" their proton  3) Acid or base alone is different when they're mixed in water. Water acting as a weak acid/base sets pH/pOH limit even when strong acid/base is added.  4) Safety and application of acid/base reactions in real life situations. | unDemo worksheets |
| 3 | **1) Notes and Venn diagram on Arrhenius/Bronsted-Lowry acids/bases -** students form pairs or groups and work on a Venn-diagram on Arrhenius/Bronsted Lowry definitions on their white boards. Teacher discusses this afterwards with the class  **2) Conjugate pairs** - Students  - Take notes  - Learn how to identify conjugate acid-base pairs  - Independently work on worksheet  - After completing the problems, discuss with a partner  - Mark worksheet together as a class, clear doubts and misconceptions  **3) Kahoot it -** formative assessment  HMK-complete rest of Colgur worksheets | White boards  Colgur worksheets with selected problems to do as class  Kahoot game room | D2  - Define Arrhenius acids and bases  - Define Brönsted-Lowry acids and bases  D3  - Identify Brönsted-Lowry acids and bases in an equation  - Define conjugate acid-base pairs  - Identify the conjugate of a given acid or base  - Show that in any Brönsted-Lowry acid-base equation there are two conjugate pairs present.  - Identify an H3O+ ion as a protonated H2O molecule rep. as H+  Big Ideas  1) Not all acids and bases dissociate completely in water, the more they dissociate in water, the stronger they are | Discussion and checking white boards  Kahoot it |
| 4 | **1) Show PhET simulation with acid/base strengths**  **2) Test yourself -** students rotate stations to test conductivity of acids and bases  Alternative:  **Computer lab - PhET simulation + handout**  **Next class: Quiz on D1-D3** | http://phet.colorado.edu/en/simulation/acid-base-solutions  - Alternating voltage (preferred)  -Ammeters  -Electrodes  -Strong/weak acids and bases at different concentrations  -Conductivity meter? | D4  - Relate electrical conductivity in a solution to the total concentration of ions in the solution  - Define and give several examples for the following terms:  – Strong acid  – Strong base  – Weak acid  – Weak base  - Write equations to show what happens when strong and weak acids and bases are dissolved in water.  Big Ideas  1) Not all acids and bases dissociate completely in water, the more they dissociate in water, the stronger they are  2) The stronger the acid/base, the more they "don't want"/"want" their proton  4) Safety and application of acid/base reactions in real life situations. | Lab/simulation handout |
| 5 | **1) Quiz**  **2) Notes on electrical conductivity and acid/base strengths**  - Use of conductivity experiments to determine whether or not the forward reaction is favored.  - Examples of reactions and data for students to determine which reaction is favored based on the strength of the acid and base.  **HMK: Distribute instructions and rubric for unit project** | Quiz  Unit project rubric and instructions | D5  - Compare the relative strengths of acids or bases by using a table of relative acid strengths  - Predict whether products or reactants are favored in an acid-base equilibrium by comparing the strength of the two acids (or two bases)  - Compare the relative conc. of H3O+ (or OH-) between two acids (or between two bases) using their relative positions on an acid strength table.  Big Ideas  1) Not all acids and bases dissociate completely in water, the more they dissociate in water, the stronger they are  2) The stronger the acid/base, the more they "don't want"/"want" their proton | Quiz |
| 6 | **Amphiprotic Species and Analysis of the Equilibrium in Water**  **1) Notes**  -Explain the amphiprotic property of ions, i.e. their ability to act as either acids or bases  - Explain how water can be amphiprotic in given situations  - Connect to Al can demo  - Show equilibrium equations to represent the ionization of water using hydrogen ions as well as hydronium ions  - Introduce the concept of pH and pOH as the concentration of these ions  **2) Kahoot it -** formative assessment | Kahoot game room | D6  - Define amphiprotic  - Describe situations in which H2O would act as an acid or base  E1  - Write equations representing the ionization of water using either H3O+ and OH- or H+ and OH-  - Predict the effect of the addition of an acid or base to the equilibrium system: 2H2O ⇆ H3O+ + OH-  - State the relative concentrations of H3O+ and OH- in acid, base, and neutral solutions  Big Ideas  3) Acid or base alone is different when they're mixed in water. Water acting as a weak acid/base sets pH/pOH limit even when strong acid/base is added. | Kahoot responses |
| 7 | **Equilibrium in Water**  **1) Notes** - Explain the relationship between the hydronium ion concentration, hydroxide ion concentration and Kw using Keq  - Explain that the value for Kw has been determined at standard conditions and can be used to calculate the concentration of hydronium or hydroxide ions, given the concentration of one.  **2) Problems on white board -** students work on problems using the white board  **3) Go over the white board questions with students** | White boards | E1  - Write the equilibrium expression for the ion product constant of water (water ionization constant: Kw)  - State the value of Kw at 25°C  - Describe and explain the variation in the value of Kw with temperature  - Calculate the concentration of H3O+ (or OH-) given the other, using Kw  Big Ideas  3) Acid or base alone is different when they're mixed in water. Water acting as a weak acid/base sets pH/pOH limit even when strong acid/base is added. |  |
| 8 | **pH and pOH**  **1) Quiz**  **2) Notes** - Explain pH and pOH, how to find one from the other, how they are related  **3) Red cabbage juice activity** - Conduct the red cabbage juice activity to produce pH scale with everyday solutions and chemicals.  Activity and worksheet: https://www.teachengineering.org/view\_activity.php?url=collection/wst\_/activities/wst\_environmental/wst\_environmental\_lesson02\_activity3.xml | - Prepare red cabbage juice and gather and label the following:  lemon/lime juice, white vinegar, dilute household ammonia, rubbing alcohol, dissolved baking soda, dissolved baking powder, liquid laundry detergent, liquid soap, hydrogen peroxide, window cleaner, dissolved aspirin, distilled water, dissolved corn starch, all-purpose cleaner, Pepto-Bismol, Alka-Seltzer. | - E2  - Define pH and pOH  - Describe the pH scale with reference to everyday solutions.  Big Ideas  3) Acid or base alone is different when they're mixed in water. Water acting as a weak acid/base sets pH/pOH limit even when strong acid/base is added.  4) Safety and application of acid/base reactions in real life situations. | Worksheet to hand in  Quiz |
| 9 | **Calculations**  **1**) **Notes** - Show examples and allow students time to perform calculations.  **2) Jigsaw** - In groups, assign students with problems to solve to make them accountable for researching and solving one part and being responsible to communicate and teach that to the rest of the group.  - They can help each other after each one has tried working on their part.  **3) Exit slip question** - hand in before leaving | Prepared questions  Exit slip questions | E2  - Define pKw , give its value at 25°C, and its relation to pH and pOH  - Calculate [H3O+] or [OH-] from pH and pOH.  Big Ideas  1) Not all acids and bases dissociate completely in water, the more they dissociate in water, the stronger they are  3) Acid or base alone is different when they're mixed in water. Water acting as a weak acid/base sets pH/pOH limit even when strong acid/base is added.  4) Safety and application of acid/base reactions in real life situations. | Exit slip |
| 10 | **Introduction to Titrations**  **1) Start with “Wine UnDemo”** as a hook  - Prepare required solutions for Lab 20C  - Practice run a titration and record volumes to calculate the concentration for self  - Provide white vinegar as unknown for part 2  - As conclusion: ask students to calculate % value of acetic acid by mass, and determine whether it complies with the law.  (Extra – Not on the unit test)  Lab 20C – p161 Teacher’s Ed | Burets  White vinegar  Strong base  Indicator  Ring stands | F1  - Perform and identify a neutralization reaction  - Understand the use of titrations to determine the concentration of an unknown acid or base, given the concentration of one  - Learn how to use a burette and how to determine the equivalence point. | Handout that students:  - Determine the concentration of HCl  - Determine the amount of acetic acid present in vinegar  - Determine % acetic acid by mass and evaluate whether it complies with the law of being not less than 4% in vinegar. |
| 11 | **Review session**  **1) Review package**  **2)** **Jeopardy -** divide students into 2 groups, announce rules clearly  **2) Go over­ -** what students can bring to test, what they're provided with | Jeopardy game  Review package | - PLO’s D1 – D6, E1, E2 | Jeopardy response  Review package |
| 12 | **Unit Test** |  |  | Unit Test |

\*\*Unit Plan has no coverage on E3 and E4\*\*