Clark Fork Trunk Extension Lesson

Duration: 2 class sessions

Grade Level: 7- 8, with adaptations for elementary and High School

Lesson Topic: What is the difference between an acid and a base? How do they mine the Berkley Pit water for Copper?

Correlation to Montana Science Standards and Benchmarks:

Objectives:

- Students will be able to describe the differences between acids and bases and will be able to give examples of common household acids and bases.
- Students will be able to describe how copper can be removed from solution.
- Students will be able to draw a model of the Copper and Solution Discovery experiment.
- Students will be able to relate historic information about the discovery of copper removal from solution to the classroom experiment and confirm that the observations by William Ledford, Fred Miller, and Morgan about iron and "copper water" were correct.

Materials/Equipment/Resources:

Part I: Copper Solution Discovery

-Story and background information about William Ledford and others who discovered "Copper water".
-Pit Watch information and background regarding mining Berkley Pit water
-Glass jars with lids such as old baby food jars (enough to pair students)
-Lemon Juice
-Table Salt
-5 pennies per jar
-Galvanized nails – 2 per group (1 for jar and one for comparison)
-Graduated cylinders

Part II: What is the difference between acids and bases?

-Common household items such as detergent, lemon juice, salt water, baking soda water, vinegar, tomato juice, cola, milk, etc.
-De-ionized water
-Tap water
-pH meter or strips if no meter available

Prior Knowledge Assessment: (Engage)

Prior to conducting this experiment, students should have done the "What Happened to the Clark Fork River Case Study" lesson.

-Leading questions part I:

Middle school/High School Level

(For Elementary school level, please see lesson adaptation for elementary kids)

- Who can tell me what minerals are dissolved in the water of the Berkeley Pit?
- Throughout history, people have "mined" water for Copper. How is that possible?
- Does anyone know how much money Montana Resources makes mining the pit water?
- How can we prove that there are minerals in the pit water?

- How can we get minerals out of water?

Leading Questions part II:
Middle school/High School Level
- What is the difference between an acid and a base?
- What are some common acids and bases in our homes?
- Are all acids bad or toxic?
- How about bases… are there any harmful bases?
- Without running a chemical test, is there any way to tell if a substance is an acid or a base?

Procedure Part I: (Explore)
Students will complete a replication of the copper plating process utilizing pennies and common household items.

Working in pairs, students will need:
-5 to 10 pennies
-Galvanized nail
-Dime
-Graduated cylinder or other measuring tool
-Glass jar with lid
-Salt Shaker
-Lemon Juice

Add 110 ml of lemon juice to glass jar, with a dash of salt. (Students could measure out the salt using a balance if available, otherwise estimate ~1/4 teaspoon). Add five pennies, the dime, and a galvanized nail to the jar. With the lid on, shake that jar and allow the jar to sit. Students will not be able to see what is happening inside the jar due to the lemon juice color, therefore tweezers should be provided so that students may remove the nail, dime, and pennies to record observations throughout the experiment.

Note: The reaction will take place slowly. The nail will begin to show a color change in ~ 15 minutes, but it will take several days to actually see the copper plating. A "control" nail and dime should be placed near the jars for students to compare the nail and dime in the solution to a nail and a dime not in the solution.

Procedure Part II: (Explore)
Students will explore common household acid and bases and will be able to relate how acids affect metals in solutions.

Working in pairs, students will need:

-Several common acids and bases from home such as vinegar, lemon juice, tomato juice, baking soda water, detergent, dish soap, cola, and milk. Depending on lab availability and ability level, teachers could have students test the pH of distilled water versus tap water. Teachers could use common items such as ammonia cleaner or bleach to demonstrate how to use pH meters and or strips if there is an available lab area.(*Teachers should demonstrate how to conduct the pH experiment with ammonia or bleach due to the potentially toxic nature of both cleaners).*

-Graduated cylinders
-Glass jars or beakers
-pH strips or pH meters if available

Have students predict the pH of each household item and place on the pH scale according to their prediction. Once the students have made their predictions, have students measure out their household solutions into the jars provided. Students will measure pH using either the pH strips or pH meter.

Students should record qualitative observations about each household product along with the pH reading. Some examples of observations would be color, texture, and smell. *Students should not be asked to record taste of any items, but could record previous experience of taste (for example, lemon juice tastes sour).*

Students should make predictions about what will happen to common solids in each of their solutions. What would happen if you added a penny to each solution? Will the penny dissolve, change color, do nothing?

What would happen if you added table salt to each solution?

Explain: Part I

Homework: What are students expected to do on their own outside of the classroom to reinforce the objectives of the lesson?

Assessment: How will you determine if you have accomplished your objectives? Assessment strategies might include a traditional test, a project, or a portfolio of work. Include the assessment instrument.

Resources: List references providing additional background information (books, journals, websites).

Extensions (Elaborate):
Part I:
Students can practice identifying and eliminating variables in their copper solution discovery experiment.

Notes: Tips or advice

Vocabulary:
pH: a measure of acidity and alkalinity of a solution that is a number on a scale on which a value of 7 represents neutrality, lower numbers indicate increasing acidity, higher numbers indicate increasing alkalinity. On the pH scale, each unit of change represents a tenfold change in acidity or alkalinity and is the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity in gram equivalents per liter of the solution. *Relate definition to how pH affects living organisms in general. Please refer to reference section regarding pH for aquatic organisms.*

Acid: any of various typically water-soluble and sour compounds that in solution have **a pH less than 7,** that are hydrogen-containing molecules or ions able to give up a proton to a base, or that are substances able to accept an unshared pair of electrons from a base.

Ion: an atom or group of atoms that carries a positive or negative electric charge as a result of having lost or gained one or more electrons

Base: any of various typically water-soluble and bitter tasting compounds that in solution have a **pH greater than 7**, and are molecules or ions able to take up a proton from an acid or able to give up an unshared pair of electrons to an acid.

Correlation to Montana Science Standards and Benchmarks:

Homework: What are students expected to do on their own outside of the classroom to reinforce the objectives of the lesson?

Resources: List references providing additional background information (books, journals, websites).

Extensions: Can you think of other activities for continued investigation?

Science Process Skills** ***Correlation to Bloom's Taxonomy in Italics

1. **Gathering information** ***Knowledge***
   Reading, observing, listening, collecting, researching, interviewing, measuring, computing, calculating, recording

2. **Interpreting information** ***Comprehension***
   Generalizing, summarizing, translating, relating, inferring, making models, drawing conclusions, defining problems, identifying cause and effect, confirming

3. a. **Applying learned information** ***Application***
   Planning, designing, building, composing, experimenting, predicting, hypothesizing, problem solving, decision making, developing and implementing investigations and action plans

   b. **Organizing information** ***Application***
   Matching, plotting data, graphing, sorting, arranging, listing, classifying, categorizing, estimating, mapping, drawing, charting, manipulating materials

4. a. **Analyzing information** ***Analysis***
   Identifying components, relationships and patterns, comparing, formulating questions, contrasting, discussing

   b. **Presenting evidence of learning** ***Analysis and Synthesis***
   Demonstrating, writing, drawing, describing, public speaking, reporting, persuading, debating

5. **Evaluating application of learned information** ***Evaluation and Synthesis***
   Establishing criteria, verifying, testing, assessing, critiquing results