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Winogradsky Column Unit

Chemical and Physical Change

Introductory Lesson

Abstract:
The students will be introduced to two changes, physical and chemical, in order to prepare them to understand what changes take place in a Winogradsky Column. Students will participate in two activities including completion of a worksheet, balloon activity, ice cube activity and a combination of two solutions activity.

Subject: Science – Physical Science

Grade Level: 8th-12th Grades

Utah Core Curriculum Standard:
Topic: Chemical Changes and Physical Changes
Standard 3240-01: Students will observe and describe chemical and physical change.
Objective 3240-0101: Differentiate between common chemical and physical changes.
- Identify and categorize characteristics of chemical and physical change.
- Report examples of chemical and physical change.

Objective 3240-0102: Analyze factors that influence chemical and physical change.
- Hypothesize the effect of variables on chemical reactions.
- Demonstrate the effects of chemical change on physical properties of substances.

In-Class Instructional Time: 10 minutes

Terminology:
Chemical Change – occurs when the chemical makeup of the substance changes, and a new substance or substances are formed.
Physical Change – occurs when the form of a substance changes, but the kind of substance remains the same.

Intended Learning Outcomes:
- Students will compare and contrast chemical and physical change
- Students will understand that a chemical change is a change in which a new chemical is formed.
- Students will understand that a physical change is a change such as breaking, dissolving, boiling, evaporating, or freezing, in which no new chemical is formed.

Goal:
The goal of this activity is to construct student concepts concerning chemical and physical changes.

Materials:
- Worksheet
- Ice cubes
- Matches
- Tongs
- Aluminum pie plate
- Candle, or gas burner
- Balloons (not inflated)

For Alternate Activity:
- Various chemicals: Silver Nitrate, Hydrochloric Acid, Sodium Bicarbonate, and Vinegar (Acetic Acid)
- 50mL beaker
- Dropper

Background
There are two different changes, physical and chemical. Bubbles, heat, light, and color may indicate a chemical change. Chemical changes are not easily reversed. Chemical changes form new substances, but physical changes do not. Physical change is any change in a property of matter that does not result in a change in identity. Change of state is an example of physical change. It is a physical change when water changes from a solid state to a liquid state.

Prior Assessment/Instructional Procedures:
1. Evidence of chemical change or physical change activities:

Balloon Manipulation Activity:
1. Show students the balloons.
2. Ask students what they think will happen to the balloons if they are placed over a gas burner. Ask them if the balloon will go through physical or chemical change. (Note to teacher: the balloon will burn and it is impossible to return to the original state. The conclusion is that a chemical change took place in this activity.)
3. Ask the students what they think will happen to the balloons when air is added into the balloon. Ask them if the balloon will go through a physical or chemical change. (Note to teacher: the balloon will return to original state as air is removed. The conclusion is that a physical change took place in this activity.)
4. Check for understanding and discuss students' conclusions.

Ice Melting Activity:
1. Place the ice on a pie plate and heat it over a gas burner or candle. Use tongs to hold the pie plate.

2. Allow the ice to melt down. Ask the students if the melting of the ice will go through a physical or chemical change. (Note to teacher: this activity is an example of a physical change. The ice changes state, from solid to liquid.)
3. Check for understanding and discuss students' conclusions.

Worksheet Activity:

1. Ask students to complete the worksheet "Challenge Your Thinking: Chemical and Physical Change" which deals with various chemical and physical changes.

Combination of Two Substances Activity (Alternate Activity):

1. Add one dropper full of compound A into a 50mL beaker followed by one dropper full of compound B. Make sure to use different droppers for each solution

   Compounds/Chemicals that are interesting to combine are:

   A. Sodium Bicarbonate and Acetic Acid (Vinegar) – Fizzes when Carbon Dioxide is created.
   B. Silver Nitrate and Hydrochloric Acid – White Silver Chloride precipitate.
2. Ask students if the product is a chemical or physical change.
3. Check for understanding and discuss students' conclusions.

Assessment:

Students will:

Demonstrate their understanding of chemical and physical changes through completion of the worksheet, activities, and discussion.

Winogradsky Column Unit

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Winogradsky Column Lesson

Abstract:
During this lesson students will have the opportunity to explore chemical changes by observing previously assembled Winogradsky Columns made from the sediment and water from the Great Salt Lake southern shore that were previously assembled. Students will create an observation journal and make observations on the Columns. The students will then make their own Winogradsky Columns and be expected to collect detailed observations of any chemical changes taking place. Students will need prior understanding of chemical and physical change.

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- Hypothesize the effect of variables on chemical reactions.
- Demonstrate the effects of chemical change on physical properties of substances.

In-Class Instructional Time: 30 – 55 minutes
Observational Time: several weeks to two months

Terminology:

Chemical Change – occurs when the chemical makeup of the substance changes, and a new substance or substances are formed.

Physical Change – occurs when the form of a substance changes, but the kind of substance remains the same.

Chemical Reaction – process that changes one set of chemicals into another set of chemicals.

Fermentation – process in which organic compounds are degraded incompletely and cells release energy in the absence of oxygen.

Respiration – sequence of events where exchange of gases occurs between cells and the environment; carbon dioxide is released.

Photosynthesis – process by which plants and other organisms like bacteria use light energy to power chemical reactions that convert water and carbon dioxide into oxygen and sugars.

Bacteria – a single-celled organism that does not have a true nucleus; also known as a prokaryote.
Anaerobic – process that does not require oxygen.
Aerobic – process that requires oxygen.

Intended Learning Outcomes:

- Students will compare and contrast chemical and physical change.
- Students will perform detailed observations of a set-up model of a Great Salt Lake Winogradsky Column.
- Students will interpret the chemical transformations that occur in the Column as a result of color changes in the soil.
- Students will set up a Winogradsky Column of their own and collect detailed observations of their Columns concerning any chemical changes taking place.

Background Information:

Sergei Winogradsky discovered in the late 1800s that some bacteria use light energy to make their own food. Before this time, people believed that only plants and algae did this. He developed these columns as a miniature ecosystem to study soil bacteria. He found that if he added the correct substances in the presence of light, the soil bacteria would form a complex world of microbes. The bacteria at the bottom of the column change the environment throughout the column so that new environmental conditions allow other bacteria to thrive.

Microbes thrive on different diets. The variety of diets allows microbes to recycle substances in nature. This is important because it helps eliminate or reduce waste. One building block of natural things is the chemical element sulfur. The rotten egg smell is due to a gas called hydrogen sulfide. It has the element sulfur in it. The gas is made by bacteria in the soil. Other bacteria can use this gas as food. Some of these bacteria are aerobic and grow in the presence of air; others are anaerobic and cannot grow if air is present. Winogradsky Columns allow for the visualization of these different bacteria. Groups of organisms will accumulate into those chemical gradients that they require to live in much the same way they do in nature. A Winogradsky Column is a model of an ecosystem. It is an isolated component of an environment that can be used to study chemical change throughout the soil. The chemicals put into the column cause color changes as microorganisms transform nutrients.

The bacteria, when incubated for several weeks to several months, begin to multiply and occupy distinct layers where the environmental conditions favor their growth. As oxygen diffuses downward from the surface (aerobic zone), fermentation causes the breakdown of cellulose (provided by the shredded newspaper) and hydrogen sulfide diffuses upward from the lower aerobic zone. Nutrient cycling occurs by the following processes: the anaerobic bacteria break down the cellulose and produce fermentation products, the fermentation products plus the sulfate (added from calcium sulfate) are used by sulfate-reducing bacteria to produce hydrogen sulfide, sulfides are then used by anaerobic photosynthetic bacteria (as seen in the purple and green layers), hydrogen sulfide and oxygen are then used by aerobic bacteria found on the top layer of the mud, algae and other photosynthetic organisms are found in the water area producing oxygen for the aerobic bacteria on the surface of the mud.

Whenever a chemical is reduced or combined with another chemical a chemical reaction takes place. Chemicals that are used or made by one bacterium are being transformed chemically. It is going through a chemical change.

Materials:
Demo – already prepared columns that have gone through the incubation period of one-two or more months.

- Mud/soil from the Southern shore of the Great Salt Lake (four samples)
- Water from the Southern shore of the Great Salt Lake
- Clear column – about 5cm in diameter and 17cm in height
- Aluminum foil/petri dishes to cover the column
- Scoop for handling mud or soil
- 5 g $CaCO_3$ (calcium carbonate) per column
- 5 g $CaSO_4$ (calcium sulfate) per column
- 10 g cellulose per column – finely shredded newspaper
- Balance to weigh chemicals and paper
- Gloves
- Bucket to mix chemicals, mud and paper
- Plastic tube/stick to remove air bubbles
- Markers

In-Class experiment

- Mud/soil from stream or lake bed
- Water from the same river or lake
- Clear columns – about 5cm in diameter and 17cm in height (empty water bottles or clear columns from a plastic supply store will do)
- Pre-mixed chemicals: 5 g $CaCO_3$ (calcium carbonate) per column and 5 g $CaSO_4$ (calcium sulfate) per column
- 10 g cellulose (shredded newspaper) per column
- Bucket to mix chemicals, mud and paper
- Plastic graduated cylinder to measure water
- Aluminum foil to cover
- Balance
- Gloves
- Scoop for handling mud or soil
- Plastic tube/stick to remove air bubbles
- Markers

Instructional Procedures:

1. Show the students the Winogradsky Columns that have been made of the Great Salt Lake and incubated for two months prior to this lesson.
2. Hand out worksheet on how to create an observation journal and how to make observations. Have the students write down observations concerning the prepared columns.
3. Discuss information concerning a Winogradsky Column and chemical changes occurring within the column. Discuss terms and how they relate to the column (see background information).

4. Hand out Winogradsky Column Newsletter that includes procedures for making a column.
5. Have students make their own Winogradsky Column.
6. Tell students to make observations of the columns as indicated in the observation journal worksheet to observe any chemical changes that occur in their columns.
7. If there is time, students could use a microscope to look at some of the contents of the columns after they have incubated.

Possible Discussion/Thought-Based Questions:

- Did the columns form layers?
- Why are the chemical changes indicated by a color change?
- Why did the different layers change different colors – what made each layer different?
- Would the columns look the same if you tried to make a column of pond water or lake water from other aquatic ecosystems? Would the layers be the same? Why or why not?
- Could you determine what type of organisms are living in each layer and why? How could you do this?
- What do you think would be the effect of introducing fresh air at the bottom of the column?
- How is the column similar to a real ecosystem and how is it different?
- Why is this a representation of a miniature ecosystem?

Assessment Strategies:

Students will:

Demonstrate their understanding of chemical change by setting up their own Winogradsky Column and collecting detailed observations of any chemical changes taking place in the column. Students will complete an observation journal. The rubric for the observation journal is included.

Resources

Anderson, Delia Castro, & Hairston, Rosalina V. (N.D.) The Winogradsky Column & Biofilms: Models for Teaching Nutrient Cycling & Succession in an Ecosystem. *Biology Labs that Work: The Best of How-to-do-its*, 168-173.

Dashefsky, H. Steven. (1994). *Microbiology: 49 Science Fair Projects*. New York: TAB Books.

Lammet, John M. (1992). *Science Fair How to Do a Successful Project: Microbes*. Vero Beach: Rourke Publications Inc.

Website: http://helios.bto.ed.ac.uk/bto/microbes/winograd.htm

Challenge Your Thinking

Chemical and Physical Change

Initial Activity Worksheet

Take five minutes to classify the changes listed below as either physical or chemical changes and then give a short reason for your decision. The first one has been done for you.

Change	Type	Reason
A newspaper yellowed after a few weeks.	Chemical	Color change indicates a chemical change.
The red meat turned brown as it is cooked.		
The paint on the car turned dull.		
You've got a cavity in a tooth.		
Lightning flashed across the sky.		
The piece of lemon turned the tea cloudy		
Frying an egg		
Breaking glass.		
Souring milk.		
Burning gasoline.		

How to Create an Observation Journal

Follow precise directions when you are making your journal

Step one: Number your pages.

Step two: State the time and date when observation was collected.

Step three: Draw a diagram of your column every time you make an observation. Use colored pencils to show the different colors visible in your column. Be very specific.

Step four: Describe any colors visible in the soil. Describe any smell or odor. Describe water smell and color.

Step five: Describe any other changes that you may see in your column.

Step six: Make your observations daily during the first week and weekly after the first week.

Step seven: Use the last page of your journal to complete any exploration questions.

Time: 9 a.m. Page Number: 1
Date: December 7, 2001
Diagram:

Describe
Soil colors:

Smell or odor:

Water smell:

Water color:

Other observations:

Good Luck!!!

WINOGRADSKY COLUMN

Newsletter

Very Short History

In the late 1800s, two famous biologists, Sergei Winogradsky and Willem Beijerinck, pioneered a process that showed how bacterium keep our biological world turning by using chemicals in the soil and water to turn them into useful elements. In the simple laboratory demonstration, Winogradsky used a column or simple water bottle to illustrate how different microorganisms use energy from light and minerals in the soil to change them into useful products.

A Word from the Principal

How to Make a Winogradsky Column

STEP ONE: Read all the instructions before starting the experiment. Ask your teacher if you have any questions. ***Remember, you are using chemicals that may be dangerous to your health.***

STEP TWO: Collect the necessary materials from your teacher. Those materials are:

- Mud/soil collected from a river or lake
- Water from the river or lake
- Clear water bottle or column
- Pre-mixed chemicals: 5 grams of Calcium Carbonate plus 5 grams of Calcium Sulfate
- Goggles
- Gloves
- Finely shredded newspaper
- Balance (will be used by entire class)

- Scoop for handling the mud or soil
- Markers
- Aluminum foil to cover your column
- Bucket to mix chemicals, mud and paper
- Plastic tube/stick to remove any air bubbles
- Plastic graduated cylinder to measure water

STEP THREE: Mix the mud, chemicals and shredded paper together. Use the plastic bucket to mix your mud, chemicals and paper together in. Wear gloves and goggles to protect your hands and eyes. Mix it well.

STEP FOUR: Fill your plastic bottle with the mud mixture. Only 75% or 2/3rds of your bottle must be filled with mud. Remove any mud or dirt from the remaining 25% of the bottle.

STEP FIVE: Measure 300mL of river/lake water inside of a graduated cylinder (measuring cylinder). Add the 300mL of water to the mud surface. Stir the mixture to remove any air bubbles.

STEP SIX: Mark the water level on the bottle with a marker. Cover the top of the bottle with aluminum foil. Replace water over time, if needed, to original level.

STEP SEVEN: Take a deep breath. One more step to go!!! Place your bottle under florescent light. Keep the light on for 12 hours per day. Make your observations daily during the first week and weekly after the first week.

STEP EIGHT: Good Luck!!

Contest

How to judge your journal

Name: _____ Date: _____

Class: _____

Journal Evaluation

Scoring Key:	5 EXCELLENT 4 GOOD 3 AVERAGE 2 NEEDS IMPROVEMENT 1 POOR

_____ Journal is well organized.

_____ Journal can be read and understood by others including students, parents, and teacher.

_____ Journal is neat.

_____ Journal contains properly labeled diagrams.

_____ Journal contains weekly observations.

_____ Journal follows correct order.

_____ Journal contains additional information relevant to the observation.

Total Grade: _____

Good Luck!!!