Chemical Reactions

Students use the scientific method to explore a set of chemical reactions and discover how organisms use chemistry to survive.

Grade Level: 6th

Phenomena:
By conducting experiments, we can observe different types of reactions and how they relate to nature.

Objectives:
- Students will list three ways that living things use chemical reactions
- Students will explain how to tell whether a chemical reaction has occurred.

Materials:
- A glow stick for each group
- Paper cups, popsicle sticks, plastic spoon, glue, borax
- Clear cups or beakers, pH strips, baking soda, vinegar
- Steel wool, vinegar, glass jar, thermometer
- Laminated instruction sheets for each station
- Worksheets - if the students don't keep notebooks

Appendixes:
- Station instructions: Page 5
- Reaction action worksheet: Page 6
- Station and reaction key: Page 7

Time Considerations:
Preparations: 45 minutes
Lesson Time: 50-55 minutes
Introduction: 5 minutes
Activity 1: 40 minutes
Conclusion: 5-10 minutes

Related Lesson Plans:

Nevada Outdoor School . org

Next Generation Science Standards

MS-PS1-2.
Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Science and Engineering Practices (SEP):
Analyzing and Interpreting Data

Disciplinary Core Ideas:
Structure and Properties of Matter

Crosscutting Concepts
Patterns

Excellence in Environmental Education Guidelines

Strand 1— Questioning, Analysis and Interpretation

A) Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.

B) Learners are able to design environmental investigations to answer particular questions—often their own questions.

C) Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.

G) Learners are able to synthesize their observations and findings into coherent explanations.

Background

Chemistry is an extremely versatile science that can be used to make everything from pharmaceuticals to athletic shoes. Without chemistry we'd have no gasoline, plastics or preservatives.

While it is essential to today's society, chemistry is the basis for nearly all biological processes. Chemical interactions are responsible for photosynthesis, digestion and basic cellular functions. In addition to these primary functions, some living things also use chemistry for survival. Organisms like fireflies and angler fish use a reaction known as bioluminescence to attract mates or prey. This reaction occurs when a chemical in the organism called luciferin combines with oxygen and gives off energy in the form of light. Other organisms including jellyfish and some algae and fungi are also bioluminescent, but for unknown reasons.

These organisms give off light like an activated glow stick as the result of a chemical reaction. Some insects and plants will glow under UV radiation or blacklight. This is

This fish uses bioluminescence to lure prey toward its mouth.

not the same process as bioluminescence and it is not caused by a chemical reaction. Instead, the energy emitted by the UV light is absorbed by electrons in some molecules and re-emitted as light. Depending on how long light is emitted, this process is called either fluorescence or phosphorescence (*Haddock, S.H.D.*).

Spiders and silkworms use chemistry to make their webs and cocoons through polymerization reactions. A single silk molecule is called a monomer. When the polymerization reaction occurs, these monomers link up like paperclips to form large strings or blobs called polymers. The properties of the polymer depend on the molecules involved and how they are connected. Manmade polymers include rubber, nylon and polyester (*Ontario Educational Communications Authority*).

Other natural chemicals make stink bugs smell bad and certain plants taste bitter. Some organisms make poisonous chemicals for protection or to kill their prey. Others animals borrow chemicals from other organisms. Reindeer keep their cells healthy by eating mosses that have a chemical that acts as a natural antifreeze.

Humans often impact the chemistry of the environment by adding more chemicals to the mix. Sometimes this is helpful like when we use fertilizer or pesticides to grow healthy crops. However too much of these chemicals can be bad for the ecosystem and make the animals sick. Extra fertilizer can cause something called algae bloom where algae populations grow out of control and suffocate other aquatic organisms.

Another way humans affect Earth's chemistry is by adding carbon to the atmosphere. When gasses like carbon dioxide mix with water in the atmosphere they form acids that can hurt plants and animals or even erode buildings! Biologists use special tools called pH meters or chemicals called pH indicators to track the acidity of lakes and streams.

Spiders make their webs from proteins linked together by a polymerization reaction.

In many biological processes, molecules must be taken apart to form new molecules. When the bonds holding atoms in the molecule are broken, energy is often released in the form of heat. When more heat is released than it takes to break up the molecules, the processes is called exothermic. When chemical reactions take in heat instead, they are called endothermic. Exothermic reactions feel warm while endothermic reactions feel cold.

Preparation

Prepare a borax solution by adding powdered borax to water until it will no longer dissolve. Prepare the baking soda solution by combining two tablespoons of baking soda and four cups of water. Gather all lesson materials and set up the stations prior to the lesson.

Introduction:
Ask the class what a chemical reaction is. Explain that a chemical reaction is an interaction between substances that makes or destroys molecules.

Doing the Activity

In physical reactions, the molecules and chemical properties of the substance

don't change. Cutting your grass or smashing a vase are physical changes. So are melting, boiling and freezing.

Ask the students if they know any of the signs that a chemical reaction has happened. (light emitted, temperature, color or odor change, bubbles, new "stuff" is made) List these indicators on the board for student reference.

Tell the students that they will be examining some chemical reactions today that relate to reactions found in nature.

Activity 1: Reaction Stations
Explain each station to the students and remind them of important safety procedures: do not put anything in your mouth, try not to get anything on your skin or clothes, no horseplay.

Split the class into groups of no more than three students and send them to a station. If a group's first station is a writing station, they should be working on the physical or chemical worksheet.

Half of the stations will give students the chance to write on their worksheets or in their science notebooks. The experiments will be completed at the other stations. Stations last five minutes.

Note that materials listed are per group.

Station 1: Bioluminescence
Materials: 1 glow stick

Students should examine the glow stick before activating it.

Write any observations or questions and draw and label a picture of the glow stick. Activate the glow stick and write down any observations or questions.

Answer these questions:
How do glow sticks work? (They are made of two tubes each containing different chemicals. When the inner tube is broken and the chemicals mix, a reaction occurs that gives off energy in the form of light.)

Are there similar reactions in nature? If so, where? (Yes. Fireflies, fish, plants, bacteria and fungi all perform similar chemical reactions called bioluminescence.)

Station 2: Polymers
*Place two groups at this station instead of having a corresponding writing station

Materials: paper cup, popsicle stick, glue, borax solution, plastic spoons

Put two spoonfuls of glue into the empty cup. Using the clean spoon add two spoons of borax solution to the glue.

Count to three and stir the mixture with a popsicle stick (*The Science House*).

Compare the glue to the ending material and write down any other observations.

What kind of natural reactions could this be related to? (This reaction sticks long molecule chains called polymers together. Spiders, silkworms and caterpillars all make polymers to build their webs or cocoons.)

Station 3: Color Change
Materials: clear cup or beaker, pipette, baking soda solution, pH strips, vinegar

Pour about 1/2 inch of baking soda solution into the cup. Measure the pH by dipping a pH strip in the liquid and noting what color the strip is.

Using the pipette, slowly add vinegar to the solution and write your observations.

Why do bubbles form? Why does the solution change color? Vinegar is an acid and baking soda is a base; how do you think the pH changes when you mix them together? (The reaction between baking soda and vinegar produces carbon dioxide. The color change comes from an indicator solution when the acid and base are neutralized.)

Why is pH important to life on Earth? (Organisms need a specific pH to survive because it

impacts the chemistry of their bodies.)

Station 4: Temperature Change
Materials: glass container, steel wool, vinegar, thermometer

Measure the temperature inside the jar and write it down.
Soak a piece of steel wool in vinegar for 1 minute. Squeeze out the extra vinegar, wrap the steel wool around the base of the thermometer and place in jar. Make sure to cover the jar (with tin foil, shrink wrap, etc…)
Measure the temperature again after a few minutes
(*Helmenstein and Science Kids*)

Conclusion

Ask the students to return to their desks and discuss the results of each experiment. Briefly discuss some ways similar reactions show up in nature. (fireflies, spider webs, acid rain etc...)

Ask the students to list some signs that a chemical reaction has happened.

Assessment

Use the students' journals or worksheets and discussion responses to assess their learning.

Extensions

Make a list of every day objects or activities that require chemistry
Choose an endothermic reaction to demonstrate another type of temperature change. Perform a series of chemic demonstrations for the students.

Vocabulary

Acid: sour substance which reacts with bases to form a salt and has a pH less than seven

Base: bitter substance which reacts with acids to form a salt and has a pH greater than seven

Bioluminescence: the emission of light from living organisms caused by a biochemical reaction

Endothermic: taking in heat

Exothermic: giving off heat

Hypothesis: a temporary prediction that can be tested about how a scientific investigation or experiment will turn out

Indicator: substance that changes color to show whether a solution is acidic or basic

Observation: information gained by careful examination using the senses

pH: a measure of how acidic or alkaline a substance is

Polymer: a natural or synthetic compound made up of small, simple molecules linked together in long chains of repeating units

Sources

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Station 1: Light Emitted

- Do not activate the glow stick.
- Record careful observations and draw a diagram of the glow stick in your notebook
- Activate the glow stick by bending it until you hear it snap. Do not shake the glow stick.
- Record your observations.

Science Journal Questions:

1. How do glow sticks work?

2. Can similar chemical reactions be found in nature? If so, where?

Station 2: New "Stuff"

- Put two spoonfuls of glue into the empty cup.
- Using the clean spoon add two spoonfuls of borax solution to the glue.
- Count to three and stir the mixture with a popsicle stick.
- Compare the glue to the ending material and write down any other observations.

Science Journal Questions:

1. What kind of natural reactions could this be related to?

Station 3: Color Change

- Pour about 1/2 inch of the baking soda solution into the cup.
- Dip half a pH strip into the solution. What color does it turn?
- Slowly add vinegar using the pipette.
- Record your observations. Dip another half pH strip in the cup.

Science Journal Questions:

1. Vinegar is an acid and baking soda is a base; how do you think the pH changes when you mix them together?

2. Why is pH important to life on Earth?

Station 4: Temperature Change

- Measure the temperature inside the empty jar and write it down.
- Soak a piece of steel wool in vinegar for one minute.
- Squeeze out the extra vinegar, wrap the steel wool around the base of the thermometer and put in the empty jar.
- Cover the top of the jar with tinfoil.
- Measure the temperature of the steel wool in the jar after a few minutes and record the result.

Science Journal Questions:

1. Why might the temperature increase as the result of a chemical reaction?

2. Could the temperature decrease? Why or why not?

Reaction Action!
For each process, determine whether the reaction is chemical, physical or both.

1. Cutting the lawn

2. Fireworks

3. Making Kool-Aid

4. Rusting metal

5. Baking cookies

6. Water evaporating

7. Digestion

8. Burning wood

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Station and Reaction Key

Station 1: Light Emitted

- Answer the following questions in your notebook:

1. How do glow sticks work?

Glow sticks have the outer plastic tube and a small inner tube made of glass. Each tube contains a different set of chemicals and sometimes a dye. When the glass tube is broken, the chemicals react and give off energy in the form of light.

2. Can similar chemical reactions be found in nature? If so, where?

Yes. Fire flies, lantern fish, and some algae, jellyfish, bacteria and mushrooms.

Station 2: New "Stuff"

- Compare the glue to the ending material and write down any other observations.

The ending material is less runny, and sticks to the popsicle stick. It's rubbery.

- Answer the following question in your note-book:

1. What kind of natural reactions could this be related to?

Rubber tree sap, spider webs, silk worm silk

Station 3: Color Change

- Answer the following questions in your notebook:

1. Vinegar is an acid and baking soda is a base; how do you think the pH changes when you mix them together?

The acid and base essentially cancel each other out in a neutralization reaction that makes water and salts. So the pH gets closer to seven.

2. Why is pH important to life on Earth?

All organisms need a specific pH to survive. For many things it's between six and eight but some live in very acidic or basic environments

Station 4: Temperature Change

- Answer the following questions in your notebook:

1. Why might the temperature increase as the result of a chemical reaction?

When the molecules or atoms react the breaking up or connecting can release energy.

2. Could the temperature decrease? Why or why not?

Yes. The reaction might need energy from the surroundings to happen.

Reaction Action!

For each process, determine whether the reaction is chemical, physical, or both.

1. Cutting the lawn *Physical, the grass is just cut in little pieces*

2. Fireworks *Chemical, there is combustion involved. Both if you count the shells exploding*

3. Making Kool-Aid *Physical, the powder and sugar dissolve but no new "stuff" is made*

4. Rusting metal *Chemical, oxygen combines with iron to make ferric oxide, or rust.*

5. Baking cookies *Both, ingredients like baking soda react alone or with other ingredients during*

baking. The heat evaporates water in the eggs and melts chocolate chips

6. Water evaporating *Physical, phase changes are never chemical*

7. Digestion *Both, chewing and mixing are physical while acids and enzymes cause chemical reactions*

8. Burning wood *Chemical, new carbon compounds are made*

Name: _____

CHEMICAL REACTIONS

Station 1: Light Emitted

Science Journal Questions:

1. Draw and label a glow stick

2. How do glow sticks work?

3. Can similar chemical reactions be found in nature? If so, where?

Station 2: New "Stuff"

Science Journal Questions:

1. Compare the glue to the ending material and write down any observations

2. What kind of natural reactions could this be related to?

Station 3: Color Change

Science Journal Questions:

1. What was the pH reading of the first strip?

2. What was the pH reading of the second strip?

3. Vinegar is an acid and baking soda is a base; how do you think the pH changes when you mix them together?

4. Why is pH important to life on Earth?

Station 4: Temperature Change

Science Journal Questions:

Temperature inside beaker

Temperature of steel wool in beaker

1. Why might the temperature increase as the result of a chemical reaction?

2. Could the temperature decrease? Why or why not?

Reaction Action!

For each process, determine whether the reaction is chemical, physical or both.

1. Cutting the lawn
2. Fireworks
3. Making Kool-Aid
4. Rusting metal
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