TEACHER GUIDE
Chemical Science

LEARNING UNDEFEATED
Educate | Elevate | Empower

Mixing Things Up

Topic(s): Chemistry

Grade level(s): 6th-8th grades

Time: One class period, 50-60 minutes

NGSS Alignment: MS-PS1-2

TEKS Alignment: 6.5C, 6.6B, 7.6

ACTIVITY OVERVIEW

This activity dives into physical and chemical changes by having students learn and investigate the clues of each. Physical and chemical changes can be difficult concepts to teach students due to differences happening at the molecular level. This lab activity will allow students to see the differences between physical and chemical changes that challenge their observations and understandings.

This lab is part of the chemical science unit which is broken up into three lab activities. The activity, What's in A Change?, works well as an introduction to chemical and physical changes by allowing students to observe physical and chemical properties before and after two reactions: dry ice with water and acetic acid with calcium carbonate. To follow up on these ideas and concepts, we recommend trying our second and third activity of the unit. The second lab activity, Mixing Things Up, centers around solubility and mixtures and will challenge students to determine whether creation of a powdered drink mix is a physical or chemical change. The third activity, Wait, Weight?, will challenge students' understanding of the law of conservation of mass and have them collect data to support its viability for both physical and chemical changes.

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ALIGNMENT TO STANDARDS

NGSS:

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.

TEKS:

6.5C. Identify the formation of a new substance by using the evidence of a possible chemical change such as production of a gas, change in temperature, production of a precipitate, or color change.

6.6B. Calculate density to identify an unknown substance

7.6. Distinguish between physical and chemical changes in matter.

LEARNING OUTCOMES

Students will know:

- The common examples of physical change: color, shape, change of state, density.
- The common examples of chemical change: change in temperature, change in color, noticeable odor after reaction, formation of a solid, formation of a gas.
- Solutions are the result of a physical change.

Students will understand:

- Appearance or form of matter changes in a physical change, but not the kind of matter in a substance, e.g. ice to water.
- Kind of matter changes in a chemical change and at least one new product or substance with NEW properties is formed.
- Matter of different types will have different physical and/or chemical properties.
- What they do in this lab are the same skills needed in STEM careers.

Students will be able to:

- Collect and analyze density data about products and reactants.
- Use data as evidence to construct an argument that a change is chemical.
- Identify the formation of a new substance by interpreting data on the properties of substances before and after a change.
- Distinguish between physical and chemical changes in matter.

CAREER CONNECTIONS

Chemical Technician

Chemical technicians use special instruments, equipment, and techniques in research labs to assist chemists and chemical engineers.

Work Environment: Chemical technicians can usually be found in laboratories or manufacturing facilities.

Duties: Professionals in these jobs have the following duties and more: monitor chemical processes, test quality of products, setup and maintain lab equipment, troubleshoot problems, prepare chemical solutions, run experiments, analyze and interpret data results, prepare reports, and give presentations.

Median Salary: $49,820 (US Bureau of Labor Statistics, 2020)

Source: https://www.bls.gov/ooh/life-physical-and-social-science/chemical-technicians.htm

Food Chemist

A food chemist researches foods and their ingredients for improvements. This research could range from examining the balance of ingredients in different foods to improve the taste, to testing the quality of foods to ensure safety for human consumption before production, and sales.

Work Environment: Many food chemists work in laboratories and offices. Many food chemists work for the United States Food and Drug Administration, a federal agency.

Duties: Professionals in these jobs have a number of duties, such as testing food or drink samples to ensure they follow federal guidelines, observing quality of processing of food, and analyzing ingredients to offer accurate nutritional information.

Median US Salary: $68,830 (US Bureau of Labor Statistics, 2020)

Source: https://www.bls.gov/ooh/life-physical-and-social-science/agricultural-and-food-scientists.htm

Geochemist

A geochemist specializes in research that improves the quality of essential things for natural life, such as oil, minerals, and water. Geochemists often explore the history of the earth and its changing conditions.

Work Environment: Many geochemists work mainly outdoors. They are typically employed by oil companies, universities, and research institutes.
Duties: Professionals in these jobs have a number of duties, such as collecting environmental samples for quality testing, analyzing data for quality improvement, and writing reports and presenting them to other scientists or elected officials in a community.

Median US Salary: $93,580 (US Bureau of Labor Statistics, 2020)

Source: https://www.bls.gov/ooh/life-physical-and-social-science/geoscientists.htm

Materials Scientist

A materials scientist examines natural and man-made substances to document their composition, properties, and how the quality can be the most efficient.

Work Environment: Many materials scientists work in manufacturing facilities and laboratories. Many of these professionals are employed by technology manufacturing facilities.

Duties: Professionals in these jobs have a number of duties, such as examining chemical properties of different materials, testing the quality of materials, and creating materials to improve a specific model.

Median Salary: $80,680 (US Bureau of Labor Statistics, 2020)

Source: https://www.bls.gov/ooh/life-physical-and-social-science/chemists-and-materials-scientists.htm

Chemical Engineer

Chemical engineers apply chemistry, biology, physics, and math to solve problems involving the use of chemicals. This includes areas like fuel (biodiesel), drugs (vaccines), and food (GMOs).

Work Environment: You can find chemical engineers working in the office or in laboratories. You may also find them directly at work sites like an industrial plant or refinery to monitor and ensure operations run smoothly.

Duties: Chemical engineers are involved in a wide range of duties. These include conducting research, designing and planning the layout of instruments and equipment, conducting tests and monitoring performance, developing processes for step-by-step use, and much more. They can be responsible for overseeing entire projects or very specific processes within a project.

Median Salary: $108,540 (US Bureau of Labor Statistics, 2020)

Source: https://www.bls.gov/ooh/architecture-and-engineering/chemical-engineers.htm

Mixing Things Up (1 class period)

BACKGROUND INFORMATION

In this activity, students will investigate a combination to determine if it produces a chemical reaction or a mixture. Students will analyze powdered drink mix (e.g. powdered Gatorade, KoolAid) to see if when mixed with water it creates a new substance or a mixture.

Students should be introduced to chemical and physical changes prior to this experiment. Students should know that chemical changes produce new substances and that those new substances will have different properties from the reactants.

This investigation will introduce mixtures. A mixture is made when two or more substances are combined to blend physically, but not chemically. The components of a mixture maintain their original properties and can be separated easily by physical methods.

There are two types of mixtures, heterogenous and homogenous. In a homogeneous mixture, all the substances are evenly distributed throughout the mixture. We see examples of homogeneous mixtures in saltwater, steel, and the air we breathe. They are especially common in liquid mixtures because of a property called solubility. Solubility is the property that refers to the ability of a substance to dissolve into another. For example, salt is soluble in water but is insoluble in rubbing alcohol. This means the salt seems to disappear in water while it remains in crystals in alcohol. If you drink that water you can still taste the salt because, instead of staying in its solid form, it has broken down into small pieces that are now suspended in the water. Homogeneous mixtures, specifically solutions, are often separated using distillation. This heats the mixture to the lowest of the boiling points to allow one substance to boil and condense into a second vessel. The other material with the higher boiling point remains in the original vessel unchanged, as it hasn't reached its boiling point.

Opposite from homogeneous mixtures are heterogeneous mixtures. In a heterogeneous mixture the substances are not evenly distributed. Often times we are able to see the components separately in heterogeneous mixtures. Heterogeneous mixtures include things like chocolate chip cookies, oil and water, and salads. Heterogeneous mixtures can often be separated through techniques like sifting and filtration. In sifting, larger substances can be separated from smaller substances by using a grate with holes. The size of the hole determines how much of the mixture can fall through. In filtration, we use substances like filter paper to catch solid parts of a liquid mixture. The liquid can drip through the paper but the solids will remain in the filter paper.

Physical and chemical change

- https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Fundamentals/Chemical_Change_vs._Physical_Change

Video of powdered drink mix and water. The written lab activity runs a similar experiment to the one seen in this video.

- https://www.youtube.com/watch?v=0vgvgKW8UHQ

REAGENT PREPARATIONS

Powdered Drink Mix

- Fill 50mL conicals with powdered drink mix (store brand lemonade, Gatorade, etc)
- Keep for use with multiple classes and refill as necessary

Water

- Fill 50ml conicals with distilled water
- Keep for use with multiple classes and refill as necessary

Filter Paper

- Cut the paper to fit the provided funnels.

STUDENT STATION SET UP

Each station accommodates 2 students who will work on the activity as a pair:

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1. Paper towel (optional)
2. Weigh boats
3. Scale
4. 2 125mL Erlenmeyer flasks
5. Lab tape
6. 50mL conical of powdered drink mix
7. 50mL conical of water
8. Funnel
9. Filter paper
10. Small flask or bottle
11. Rubber stopper with vinyl tubing
12. Ice bath with ice
13. 10mL graduated cylinder
14. 50mL graduated cylinder
15. Permanent marker
16. Hot plate
17. Metal stand with clamp
18. ¼ Teaspoon Measure

LESSON PLAN

Slide 1: Do Now: Think, Pair, Share

- Distribute the *Mixing Things Up* worksheet and have students read the activity introduction while the class settles in. After reading, have students pair up to discuss the question from the first page.
    - The main ingredients in most powdered drink mixes are sugar, citric acid, salt, and natural/artificial flavors. With this information, make a hypothesis: do you think the powdered Gatorade forms a mixture or chemically reacts to create Gatorade?
        - Answers will vary, but their reasoning should indicate whether the new substance has new properties or the same properties as the reactants.

Slide 2: Mixing Things Up

- Introduce today's activity about types of mixtures.

Slide 3: Learning Objectives

- Explain to students that at the end of today's activity, they will have done the following:
    - Calculated density of known and unknown substances
    - Analyzed collected data to determine if a new substance was created
    - Separated a mixture

Slide 4: What is a mixture?

- Explain to students that a mixture is created when two or more different substances are combined and can be separated back into its original substances.
- Ask students if they can think of any examples of mixtures.
    - Examples may include: can of rainbow sprinkles, soup, salad, water and oil, salad dressing, sugar and water, etc.

Slide 5: How do mixtures compare to substances?

- Explain to students that mixtures are still composed of matter, but they are physical combinations of pure substances.

Slide 6: Types of Mixtures

- Explain to students that there are two types of mixtures: homogeneous and heterogeneous. In a homogeneous mixture, all the substances are evenly distributed throughout the mixture. Ask students if they can think of any examples of homogeneous mixtures.
    - Examples may include, saltwater, air, steel, well mixed cake batter, solutions, etc.
    - *Teacher's Note: Advance slide to have examples appear on slide.*
- Explain to students that in a heterogeneous mixture the substances are not evenly distributed. Ask students if they can think of any examples of heterogeneous mixtures.
    - Examples may include, chocolate chip cookies, salad, oil and water, rainbow sprinkles.
    - Emphasize that if you were to take a sample of the mixture, you would come out with different amounts of substances in each sample.
    - *Teacher's Note: Advance slide to have examples appear on slide.*

Slide 7: Solubility

- Explain to students that in liquid mixtures, the property of solubility will determine if the mixture will be homogeneous or heterogeneous. Solubility is the ability of a substance to dissolve in a solvent. If a substance is soluble it will become surrounded by the solvent and seem to disappear. Advance the slide to show a short video of how sugar dissolves in water.

  - *Teacher's Note: Advance the slide again to show an additional video showing sugar in water and ethanol. Ask students to make a hypothesis before the video starts as to which substance dissolves sugar best.*

Slide 8: Separating Mixtures

- Explain to students that because mixtures are created in physical changes, we can separate them by using their differences in properties. For example, we can separate mixtures of solids by their size using a sieve.
- Advance the slide before the next process. Explain to students that we can also use a process called filtration to help separate a solid and liquid mixture. This process is especially usefully when the solid is too small for a sieve. In this process we often use filter paper to catch the small solids while letting the liquid flow through.
- Advance the slide before explaining the next process. Explain to students that we can also utilize differences in boiling points to separate liquids or solid/liquid mixtures by distillation/evaporation. By heating the mixture to the lower boiling point, we can have the rising vapors collected and then condensed in a separate vessel while the substance with the higher boiling point remains in the original vessel.

Slide 9: Today's Investigation

- Introduce students to the main question of today's activity: is powdered Gatorade forming a mixture or chemically changing to make the Gatorade we know?
- Break students into groups of two to three and assign each group a station in the laboratory/classroom.
  - *Teacher's Note: Students will work on their worksheets, but have their responses recorded collectively through the slides.*

Slide 10: Part 1 Preparing the Powdered Drink

- Review the procedure for Part 1 "Preparing the Powdered Drink." Allow all student groups to prepare their solutions before moving on.

Slide 11: Part 2 Separating by Filtration

- Review the procedure for Part 2 "Separating by Filtration."
- If time allows, review the "Quick Check" questions with students. This can also be a student's exit ticket or homework.
  - Did the filter allow us to separate any of the components? Why or not?
    - *The filter did not separate any of the components because all of the components are all soluble in water. Filtration can only separate solids (insoluble molecules) from liquids.*

Slide 12: Part 3 Separating by Distillation

- Review the procedure for Part 3 "Separating by Distillation." Review how to set up the equipment for the distillation and how to use the metal stand and clamp.
- Explain to students that we are trying to boil out some of the product and that as the liquid boils, the students will move on to part 4.

Slide 13: Density (optional)

- Explain to students that we will be measuring the density of our reactants and products to help us determine if the powdered drink was in fact a mixture or a chemical reaction. Explain to students that density is a physical property of a substance that describes the amount of matter (mass) that occupies a defined space (volume). Explain that we measure density in grams/mL.
- Advance the slide and explain that density is temperature dependent. Density for the same substance will vary depending on the temperature. The provided images are

meant to represent isopropyl alcohol (rubbing alcohol). Ask students why rubbing alcohol at 0 °C will have a different density than rubbing alcohol at 90 °C.
    - At 0 °C, rubbing alcohol is a liquid. This means that the molecules are close together but are moving around. At 90 °C, rubbing alcohol is a gas. This means that the molecules are very far apart and moving around much faster. For the same volumes, there would be fewer molecules present at 90 °C than at 0 °C which means the density would be lower.
    - *Teacher's Note: Emphasize that this means all densities must be measured at the same temperature if we want this data to inform our decision if a new substance was created.*

Slide 14: Part 4 Calculating Density

- Review the procedure for Part 4 "Calculating Density." Explain to students that we will be measuring the densities of our starting reactants while our product is boiling.
- Review and record collected data in the table on the slide.
- If time allows, review the "Quick Check" questions with students.
    - *Teacher's Note: These questions must be completed while in class as they will need to make observations of their distillation set up while it is in use.*
    - What do you notice happening in flask 1? What physical change is occurring?
        - *The liquid is going down over time. The liquid is evaporating.*
    - What do you notice happening in the vinyl tubing? What physical change is occurring?
        - *There are droplets forming. The vapor is condensing.*

Slide 15: Lab Clean Up I

- If students finish the questions but are still waiting for their distillation to reach 30 minutes, have students start cleaning up their stations.
- This slide can be skipped if students are short on time.

Slide 16: Part 5 Analyzing Products

- Review the procedure for Part 5 "Analyzing Products." Explain to students that we will be measuring the density of distilled product. Emphasize the importance of measuring density at the same temperature and the importance of waiting for flask 2 to return to room temperature.
- Review and record collected data in the table on the slide.
- If time allows, review the "Quick Check" questions with students. This can also be a student's exit ticket or homework.
    - Does the density of the substance in flask 2 match either of our initial components? Does that mean the drink was a mixture or a new substance? Was it a physical or chemical change to make the drink?
        - *The density of the substance in flask 2 is the same as the water we started with. This means that the drink was a mixture that was made through a physical change.*

Slide 17: Lab Clean Up II

- Before students leave, ask them to tidy and clean their station.