SUCCESS ACADEMY EDUCATION INSTITUTE

Physical Science:
Unit 1

Separating Mixtures: Introduction

Purpose: The Why, What, and How of This Unit

Essential Question: How can scientists make poisonous water safe to drink?

Unit Storyline Synopsis: Scholars are hooked into solving an important real world issue: how can we make water safe to drink? They explore this question as they study the physical properties of matter and how these properties can be used to separate mixtures. They will develop scientific experiments in which they must choose techniques based on their understanding of differences in physical properties of matter. Their ultimate goal by the end of this unit is to design a multistep cleansing process to restore a sample of contaminated water to its original form.

Why This Unit? Lacking access to clean water is a death sentence for millions of people on our planet. As living things, we all need water, but it must be properly sanitized to ensure our safety. How do scientists identify harmful substances, often invisible to the naked eye, that lurk within the world's polluted waterways? And how can they return the water to a safe state for daily use?

Scholars have examined human impact and pollution in previous grades, but now can take a more independent role in scientific design and engineering by applying chemistry principles towards a real world problem. Through this unit, scholars appreciate firsthand and learn from the challenges that scientists encounter when trying to solve problems like water pollution.

What Is the Bottom Line?

Big Idea 1: Substances are made from different types of atoms, which can combine in various ways.

- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
- Understanding the unique properties of substances allows scientists to predict their behaviors and interactions with other substances.
- Mixtures are made by combining multiple substances in a way that allows each substance to retain its chemical properties.

Big Idea 2: Scientists solve real world problems by applying scientific principles to engineer design solutions.

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.
- A solution needs to be tested and then modified on the basis of the test results in order to improve it. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.

How do Next Generation Science Standard practices and crosscutting concepts support mastery of the Big Ideas? Science and Engineering Practices highlighted in this unit:

- **Planning and Carrying Out Investigations**
    - Plan/conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.
- **Constructing Explanations and Designing Solutions**
    - Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process, or system.
    - Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

Crosscutting Concepts highlighted in this unit:

- **Patterns**
    - Graphs, charts, and images can be used to identify patterns in data.
- **Cause and Effect**
    - Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Safety

Plan carefully for safety in all lessons. The top safety risks in this unit include:

- Lesson 7 uses lauric acid. Review all safety information and the Safety Data Sheet for **lauric acid** to ensure proper safety precautions are taken before conducting this lesson. Ensure scholars wear proper personal protective equipment (PPE) as indicated in the lesson.
- Lesson 7 uses ethyl alcohol. Review all safety information and the Safety Data Sheet for **ethyl alcohol** to ensure proper safety precautions are taken before conducting this lesson. Ensure scholars wear proper PPE as indicated in the lesson.
- Lesson 7 uses copper sulfate. Review all safety information and the Safety Data Sheet for **copper sulfate** to ensure proper safety precautions are taken before conducting this lesson. Ensure scholars wear proper PPE as indicated in the lesson.
- Lesson 7 uses cornstarch. Review all safety information and the Safety Data Sheet for **cornstarch** to ensure proper safety precautions are taken before conducting this lesson. Ensure scholars wear proper PPE as indicated in the lesson.
- In Lessons 8 and 10, scholars will use a hot plate. Set up hot plate stations around your room and ensure scholars are aware of how to work with hot materials safely to avoid accidentally burning themselves, as well as what to do should they burn themselves. All materials should be handled with oven mitts at the hot plate station as there is no way to see whether materials are too hot to touch. Ensure scholars wear proper PPE as indicated in the lesson. Ensure hot plates are turned off at the end of each section. Check glassware for chips or cracks before placing on a hot plate as the heat can cause the glass to shatter if already damaged.

Important Note: These lesson plans highlight some of the safety risks you should be aware of while teaching these lessons. These safety suggestions are not meant to take the place of a formal science safety training. Please be sure to follow all safety rules from your district, as well as all local, state, and federal science safety guidelines.

Unit Storyline

Engage: Scholars learn of the scarcity of fresh, clean water on Earth. They are invested in understanding how Earth's water came to be this way and how scientists are fighting a life and death battle to clean it up.

- **Lesson 1: Dirty Water.** What's in the water we drink? Is our tap water really pure water? Is it safe? Scholars explore these questions and more during this introductory lesson.
- **Lesson 2: The Global State of Water.** Scholars study the global state of water to learn why scientists are so invested in maintaining a clean supply of drinking water on Earth. Through their exploration, they will invest in the unit's Essential Question and begin to see scientists and engineers as agents of change.

Explore: Everywhere you look, the Earth's water has a variety of contaminants. Some occur naturally and others are the result of human activity, but they all need to go before the water is safe to use or consume! Scholars tackle a variety of challenges to separate unwanted materials from water samples.

- **Lesson 3: Removing Solid Particles.** Scholars will attempt to separate unwanted sand and pebbles from water. They will discover filtration as an effective method for removing solid particles.
- **Lesson 4: Removing Dissolved Particles.** Scholars tackle a new challenge: How does one remove contaminants from water if they've already dissolved into it?
- **Lesson 5: Removing Other Liquids.** Scholars are challenged to create a procedure to separate multiple liquids to isolate water!

Explain: Separating water with multiple contaminants requires a deeper understanding of physical properties. The properties of a substance such as hardness, material, and polarity can all help scientists determine the best method of separation. Additionally, certain factors such as temperature and agitation can affect the rate of solubility.

- **Lesson 6: Physical Properties.** Scholars are challenged to apply multiple techniques to isolate clean water from a mixture containing three unknown ingredients.
- **Lesson 7: Solubility.** Scholars will study solubility to learn more about how the Earth's water ended up having so many other particles dissolved in it.
- **Lesson 8: Changing Solubility.** Scholars will develop their own procedures to study how rates of solubility can change under specific conditions.
- **Lesson 9: Graphing Solubility.** Scholars will learn how to read a solubility graph. Through careful study of real solubility curves, scholars will identify additional data to support their conclusions from the previous lesson.

Elaborate: Scholars use their knowledge of physical properties and solubility in new ways as they explore two new applications: panning for gold and making refreshing, bubbly soda pop!

- **Lesson 10: Panning for Gold.** Scholars will take a step back from their study of the world's water to study the separation of mixtures in a new context: panning for gold!
- **Lesson 11: Fizz, Fizz, Pop!** Scholars study the separation of mixtures in another new context: the creation of soda pop! Scholars learn why soda is served cold.

Evaluate: Armed with all their knowledge from this unit, scholars are ready for the final challenge: engineer solutions to clean up some very dirty water! Scholars will apply their understanding of how scientists clean up the world's water to separate unwanted particles and solvents from a water sample.

- **Lesson 12: The Dirty Water Design Challengeâ€" Introduction and Planning.** Scholars create a plan to tackle their final challenge; engineer a system for cleaning a sample of very dirty water!
- **Lesson 13: The Dirty Water Design Challengeâ€" Implementation and Reflection.** Scholars will test the efficacy of their designs, make revisions, and reflect on their work. Scholars will revisit the Essential Question for the last time as they issue a final statement.

Extra Resources

In addition to the resources linked throughout the guide, use the following materials to help you prepare to launch this unit with scholars:

- **Printable Exit Tickets**
- **Printable Lab Notebook**