DENSITY SEPARATION OF LOCAL SEDIMENTS
(MODIFIED FOR ADEED)

Science Concept:

One of the factors governing the settling rate of sediment particles is the density of the sediments.

Objectives:

The student will:

- determine the identity of substances based on their density;
- perform research on density and evaluate scientific sources; and
- use diagrams, charts, or illustrations to explain research conclusions.

GLEs Addressed:

Science

[7] SB1.1 The student demonstrates understanding of the structure and properties of matter by using physical properties (i.e., density, boiling point, freezing point, conductivity) to differentiate among and/or separate materials (i.e., elements, compounds, and mixtures).

[7] SA2.1 The student demonstrates an understanding of the attitudes and approaches to scientific inquiry by identifying and evaluating the sources used to support scientific statements.

Writing

[7] W3.2.4 The student writes for a variety of purposes and audiences by using diagrams, charts, or illustrations with captions or labels in research projects and extended reports.

Vocabulary:

density - the quantity of something per unit volume, unit area, or unit length
settling rate - the rate at which something sinks in a liquid (sediment settles to the bottom)
sediment - the material from a liquid that settles to the bottom; also, material (as stones and sand) deposited by water, wind, or glaciers
particle - a very small quantity or piece
shape - something having a certain form
grain size - physical extent or bulk of a grain (or particle)
relative - existing in comparison to something else (the relative value of two houses)

Materials:

- Stopwatch (one per group)
- Spoon (one per group)
- 100-milliliter graduated cylinder (one per group)
- Samples of local sediments*
- 5-8 known-density mineral samples (one set per group)
- Water
- Transparent container with lid
- STUDENT WORKSHEET: "Density Separation of Local Sediments"

*NOTE: Be cautious when using non-commercial soil samples, as they may be contaminated.

Activity Procedure:

Please refer to the assessment task and scoring rubric located at the end of these instructions. Discuss the assessment descriptors with the class before teaching this lesson.

Gear Up

Process Skills: questioning, observing, communicating, and predicting

1. Explain a demonstration will be conducted; students should complete Question 2 of their worksheets during and immediately after the demonstration. Display a transparent container partially filled with

water. Place a sample of local sediments into the water. Place a lid on the container and shake to mix. Place the container to rest on a flat surface where all students can see. Ask students the following questions:

a. What is going on?
b. Why is the soil settling?
c. Why doesn't everything in the container settle exactly the same?

Explore

Process Skill: observing

2. Distribute the STUDENT WORKSHEET: "Density Separation of Local Sediments." Explain that students will be conducting an experiment and completing a lab report regarding relative density. Ask students to complete Question 1 of their worksheets. Discuss student answers.
3. Divide the class into groups and distribute soil samples and a 100-milliliter graduated cylinder to each group. Ask groups to fill the graduated cylinder halfway with water, add samples of local sediments, shake carefully and allow settling. Instruct groups to try to empty their container and repeat with combinations of sediments collected from different locations. Students should complete Questions 3 and 4 of their worksheets during this section of the lesson.

Generalize

Process Skills: questioning, communicating, and classifying

4. As a class, discuss the following questions, answered in Question 4 of the student worksheets.
   a. What do you see happening?
   b. What types of sediments are on the bottom of the cylinder?
   c. What is happening to the water?
   d. How can you tell which particles are the most dense? Explain.
   e. How might you tell what is contained in these sediment samples?
   f. If we could think of a method to compare the density of a known material to the sediments, would we be able to determine what the sediments are? How?

Experiment

Process Skills: observing, measuring, collecting data, classifying, developing models, analyzing data, investigating, and making generalizations

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Teacher's Note: Density is a physical property of matter. It is the mass per unit volume of a substance. Pure water has a density of 1. If an object floats, the density of the object is < 1; if it sinks, it is > 1. The settling rate is the time it takes a particle to traverse from the top of the water column to the bottom, thus to settle on the bottom. How fast an object moves through the water column is a function of water's density and the object's density. Gravity provides the force to the particle and the water. Differences in settling rates of objects can be used to determine relative density. Relative density is the density of an object compared to another.

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5. Explain that groups will perform an investigation to test the following testable questions:
   a. Given the density of known objects, can an observer determine the relative densities of unknown particles based upon settling rates?
   b. If an observer knows the density of five mineral samples, can unknown objects be identified based upon their individual settling rates?
6. Distribute a set of known-density mineral samples, a spoon, and a stopwatch to each group. Explain that groups should fill out the Experiment section of their worksheets as they complete the experiment. Guide groups through the following experimental procedure:
   STEP 1. Fill a graduated cylinder to 90 milliliters.
   STEP 2. Release each known object into the water column and measure the time it takes to settle to the bottom. Pay particular attention to first contact with the water at the top and when it first touches the bottom. Make a data table and record data.

STEP 3. Repeat STEP 1 and 2 three times for each object.
STEP 4. Calculate the mean time for each object and record in the data table.
STEP 5. Create a table of settling rates based upon the known densities. For example: Known A settles in _____ seconds and has a density of _____.
STEP 6. Create a second data chart for the unknown samples.
STEP 7. Separate out three grains of sand that seem similar in color, size, shape, and texture. Do this again with three other types of sand so that there are three grains each of four types of sand.
STEP 8. Repeat Step 7 with gravel instead of sand.
STEP 9. Test the settling rate of each type of sand/gravel in the same manner as Steps 1-4. Record all data.
STEP 10. Compare the settling rate for the unknowns to the settling rates of the known density samples.
STEP 11. Use your data to rank the unknown and known samples together in order from lowest to highest density.
STEP 12. Estimate the density of each unknown sample in grams per milliliter.
STEP 13. Create a third data table that shows the data from Step 9 and name each unknown sample. Record any additional observations that helped your group to name each sample.

Apply
Process Skills: communication, analyzing data, describing, making generalizations

7. After students have evaluated the literature, discuss with the class how the process could be improved to more accurately determine how local sediments separate?

Answers to Student Worksheet:

1. A. density - the quantity of something per unit volume, unit area, or unit length
   B. settling rate – the rate at which something sinks in a liquid <sediment settles to the bottom>
   C. sediment – the material from a liquid that settles to the bottom; also, material (as stones and sand) deposited by water, wind, or glaciers
   D. particle - a very small quantity or piece
   E. shape - something having a certain form
   F. grain size - physical extent or bulk of a grain (or particle)
   G. relative density – the density of an object compared to another
2. A. The soil is settling.
   B. Answers will vary (NOTE: The soil settles at different rates due to the varying density of its particles.)
   C. Answers will vary (NOTE: The soil settles at different rates due to the varying density of its particles.)
3. Answers will vary
4. Answers will vary
5. Answers will vary
6. Answers will vary
7. I was able to rank unknown and known density samples by comparing the settling rates of the unknown samples to the known samples.
8. I was able to determine the approximate densities of the unknown samples by comparing their settling rates to the settling rates of the known samples.
9. I was able to identify each sample by comparing the settling rates of the unknown samples to the settling rates of the known samples.
10. Saltwater has a greater density than fresh water. Using saltwater would change the settling rates of each sample.
11. Yes. The settling rates of each individual sample would be different, but they would all be the same relative to each other.
12. Answers will vary
13. Answers will vary, but should indicate that density and settling rate can be used to identify particles.
14. Answers will vary

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RUBRIC

Assessment Task

Instruct students to research and evaluate three scientific sources as they relate to properties of density for identification. Organize all pertinent accumulated data sets and reproduce, or otherwise acquire and use, two diagrams, charts and/or illustrations to explain research results.

Rubric

Objective	GLE	Below Proficient	Proficient	Above Proficient
The student identifies substances based on density.	[7] SB1.1	The student correctly identifies zero to two substances based upon density.	The student correctly identifies three substances based upon density.	The student correctly identifies four or more substances based upon density.
The student researches and evaluates scientific sources.	[7] SA2.1	The student researches or evaluates zero to three scientific sources related to density identification.	The student researches and evaluates three scientific sources related to density identification.	The student researches and evaluates three or more scientific sources related to density identification.
The student uses diagrams, charts, or illustrations to explain research conclusions.	[7] W3.2.4	The student uses zero to two diagrams, charts or illustrations to explain research conclusions.	The student uses two diagrams, charts or illustrations to explain research conclusions.	The student uses three or more diagrams, charts or illustrations to explain research conclusions.

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Directions: Read everything in this template before beginning. When you are finished with this lab, read everything (including what you wrote) again, before turning in your lab report.

Where appropriate, use complete sentences for all answers, including the vocabulary.

Use a different color to type your answers to that it is easy to tell the difference between the question and the answer.

1. Use a reliable source to locate the definitions of the following terms and write them below. Many words have multiple meanings, so be sure to pick the meaning that fits with this lab activity. Use each of these terms at least once in the remainder of your lab report. When you use each of these terms for the first time, make them bold or a different color than everything else.

   A. density_____

   _____

   B. settling rate_____

   _____

   C. sediment_____

   _____

   D. particle_____

   _____

   E. shape_____

   _____

   F. grain size_____

   _____

   G. relative density_____

   _____

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2. Answer these questions during and immediately after the demonstration.

   A. What is occurring? _____

   _____

   B. Why is it settling? _____

   _____

   C. Why do you think the different particles do not all settle at the same time?

   _____

   _____

3. Fill a 100-milliliter graduated cylinder halfway with water, add samples of local sediments, shake, and allow settling. Repeat with different combinations of sediments. Keep a log of observations below.

   _____

   _____

   _____

   _____

   _____

   _____

4. Answer the following questions about your observations from the previous activity. Answers should be written in your own words but may be discussed with your group.

   A. What do you see happening?_____

   _____

   B. What types of sediments are on the bottom?_____

   _____

C. What is happening to the water?_____

_____

D. How can you tell which particles are the most dense? Explain.

_____

_____

E. How might you tell what is contained in these sediment samples?

_____

_____

F. If we could think of a method to compare the density of a known material to the sediments, would we be able to determine what the sediments are? How?

_____

_____

Experiment
Testable Question:
Can the density and identity of unknown minerals be calculated by comparing their settling rates to the settling rates of minerals that have known densities and names?

Hypothesis
5. Write a hypothesis or prediction to answer the testable question.

_____

_____

Background Information
6. What have you already learned this year that applies to this experiment?

_____

_____

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Materials

- 100-milliliter graduated cylinder
- Spoon
- Water
- Stopwatch
- Samples of known-density minerals
- Soil samples

Procedure

STEP 1. Fill a graduated cylinder to 90 milliliters.

STEP 2. Release each known object into the water column and measure the time it takes to settle to the bottom. Pay particular attention to first contact with the water at the top and when it first touches the bottom. Make a data table and record data.

STEP 3. Repeat STEP 1 and 2 three times for each object.

STEP 4. Calculate the mean time for each object and record in the data table.

STEP 5. Create a table of settling rates based upon the known densities. For example: Known A settles in _____ seconds and has a density of _____.

STEP 6. Create a second data chart for the unknown samples.

STEP 7. Separate out three grains of sand that seem similar in color, size, shape, and texture. Do this again with three other types of sand so that there are three grains each of four types of sand.

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STEP 9. Test the settling rate of each type of sand/gravel in the same manner as Steps 1-4. Record all data.

STEP 10. Compare the settling rate for the unknowns to the settling rates of the known density samples.

STEP 11. Use your data to rank the unknown and known samples together in order from lowest to highest density.

STEP 12. Estimate the density of each unknown sample in grams per milliliter.

STEP 13. Create a third data table that shows the data from Step 9 and name each unknown sample. Record any additional observations that helped your group to name each sample.

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Conclusion

7. How was it possible to rank the unknown samples (mineral, gravel, and sand) according to density?

_____

_____

8. How was it possible to figure out the approximate densities of the unknown samples?

_____

_____

9. How was it possible to identify each sample?_____

_____

_____

10. How would using saltwater instead of fresh water change the data for this experiment?

_____

_____

11. Would the process used to find the density of the samples work using any liquid (alcohol, mercury, gasoline, etc.)? Explain.

_____

_____

12. After evaluating at least three sources of literature on this topic, describe how the accuracy of this experiment could be improved. In other words, how would it be possible to make this process more fair? List each source and the information gathered.

_____

_____

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13. How the information learned during this experiment be applied to particles in the atmosphere and/or ocean?

14. List anything else observed or thought of during this lab. Include tables, graphs, explanations, etc., where appropriate. Note: The information provided here can make the difference between a good lab and an outstanding lab.

Remember to read everything through again before turning in this lab report.