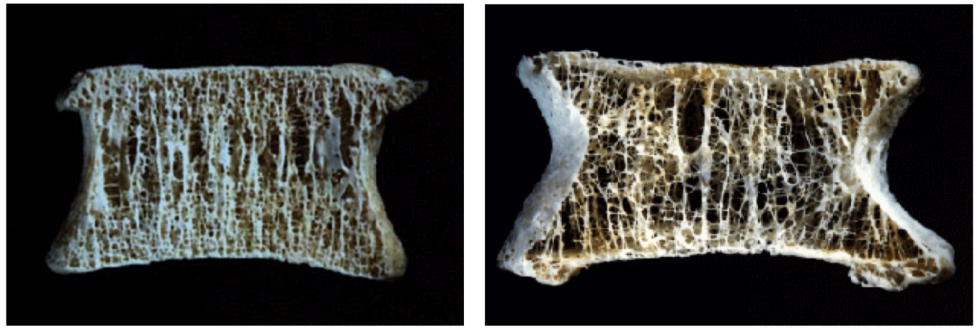
NASA Spotlite
Interactive Lesson

Density
Grades 5-8



Source: Mosekilde, L. Z rheumatol 2000;59:Suppl 1:1-9

Figure 1: Normal bone on left compared to osteoporotic bone.

Teacher Packet

NASA Spotlite Interactive Lesson Guide

This NASA eClips™ Spotlite Interactive Lesson supports existing curriculum and should be used as one of many strategies to build students' understandings of science content. The goal of this 5E lesson is to address a science misconception. Through watching a student-produced video (Engage), completing activities (Explore), explaining relevant concepts while applying new vocabulary collectively using a Frayer Model (Explain), and applying new information (Extend/Elaborate), students will develop an understanding of the science content and how to correct the science misconception.

This PDF document should be downloaded to use the interactive features. The hyperlinks included in this document open PDFs or webpages and may perform differently based on the device being used. Links may have to be cut and pasted into a web browser to open.

Try using Adobe Acrobat Reader and Flash Player for optimal performance of all interactive features included in this guide.

An accompanying student packet is located on the NASA eClips™ Website.

What are NASA Spotlites?

NASA Spotlites are 90-120 second student-produced video segments that address common science misconceptions as determined by reputable assessment sources such as the National Assessment of Educational Progress (NAEP), National Science Foundation (NSF) Factual Knowledge Questions, and the Misconceptions-Oriented Standards-based Assessment Resources for Teachers (MOSART). NASA Spotlites are designed to increase scientific literacy in a standards-based classroom. By producing Spotlite videos, students gain production experience, as well as deepen their understanding of science content. Approved NASA Spotlites can be found at the NASA eClips™ website. https://nasaeclips.arc.nasa.gov/

Animated 5E Instructional Model

NASA eClips™ Guides use the 5E constructivist model developed by Biological Sciences Curriculum Study. Constructivism is an educational philosophy that promotes student-centered learning where, students build their own understanding of new ideas. The 5E instructional model consists of five stages for teaching and learning: Engage, Explore, Explain, Extend (or Elaborate), and Evaluate.

Lesson Information

Science Misconception

Student Misconception: The density of a sample material is dependent on the amount of the material present.

Standards

Next Generation Science Standards

5-PS1-3: Make observations and measurements to identify materials based on their properties.

Disciplinary Core Ideas:

PS1.A: Structure and Properties of Matter

Measurements of a variety of properties can be used to identify materials.

PS1.A: Structure and Properties of Matter

Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

Crosscutting Concepts:

Scale, Proportion, and Quantity: Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Objective

As a result of watching the Spotlite video, learning the vocabulary collaboratively, and discussing the definition of density, students explain that the density of an object does not change when the size of the object changes.

Time Frame

Between two and three 45-minute class periods:

Day 1 - Engage and Explore

Day 2 - Explain and Elaborate/Extend

Day 3 – Evaluate

Materials

Assessment

Per student: copy of pretest and posttest

Frayer Model Activity

• Per small group: copy of a digital Frayer Model (alternatively, this can be printed)

• Per classroom: chart paper for posting final vocabulary definitions

Background Information

- Density is the ratio of the mass to the volume of an object.
- The formula for calculating density is: Density (D) equals mass (M) divided by volume (V) or D=M/V.
- If an object's mass, relative to its volume, is unchanged, then its density remains constant.
- Law of Conservation of Matter: If the number of atoms stays the same (no matter how they are arranged), then the total mass stays the same.
  (Conversely, if the number of atoms changes, the object's mass changes.)

Target Vocabulary: volume, density, mass, ratio, atom, Law of Conservation of Matter

Safety

Review digital citizenship before students use online resources.

This icon identifies the suggested directions and information to read to students.

Remind students to save responses. Suggested steps: Under "file" choose "save as." Type your name in front of the document name. Choose "save."

Engage

Pre-Assessment

Probe for students' prior knowledge using the pre-assessments.

1. Pretest items are located on page 12. Student packets contain a pretest.
2. Essential question
3. Discussion questions (this page)

Essential Question
How does the density of a material change as the amount of that material changes?

Today's Lesson

In today's lesson you will learn about density. Using interactive Frayer Models, you will learn key vocabulary that will help you form a clearer understanding of the characteristics of density and how density is calculated.

What do you already know about density?

True or False: The density of a sample material is dependent on the amount of the material present.

Select the best answer.
True
False

Spotlite Video

Next, you will watch a short video about density. As you watch the video, pay close attention to any new vocabulary.
(Example vocabulary: volume, density, mass, ratio, Law of Conservation of Matter, atom)

Video Link- NASA Spotlite: Are You Dense?
NASA eClips™ Website - https://nasaeclips.arc.gov
NASA eClips™ YouTube - https://youtu.be/JfYWe9q0hck

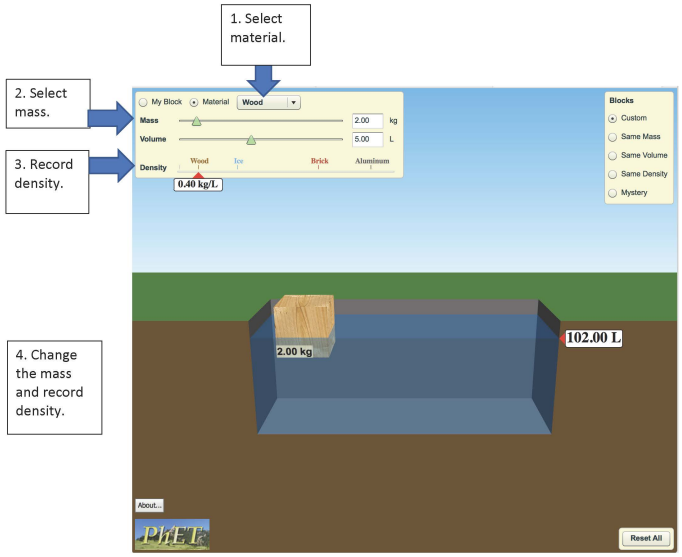
Use these questions to lead the class in a discussion.

1. What is density?
2. What did you learn about density from watching the video?
3. How does the density of a material change as the amount of that material changes?
4. Explain the Law of Conservation of Matter.
5. How do you find the density of a substance?

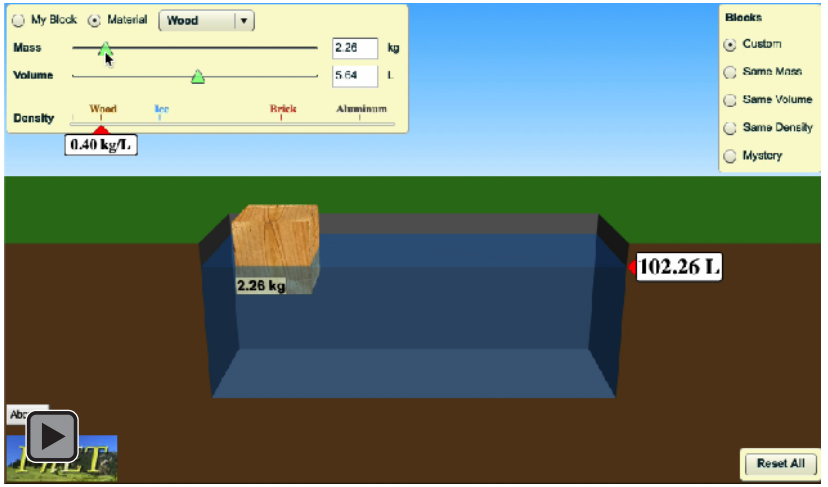
Explore

Explore Activity

In this PhET simulation you can see the buoyancy of objects made with different materials. Buoyancy is the force that causes an object to rise or float in a fluid. When you change the mass of an object does the density of that object change?



Link to simulation:
https://phet.colorado.edu/sims/density-and-buoyancy/density_en.html



Press play to see a screen capture of the simulation.

Think-Pair-Share

What did you learn about how mass affects the density of an object? Give some examples from this simulation to support your answer.

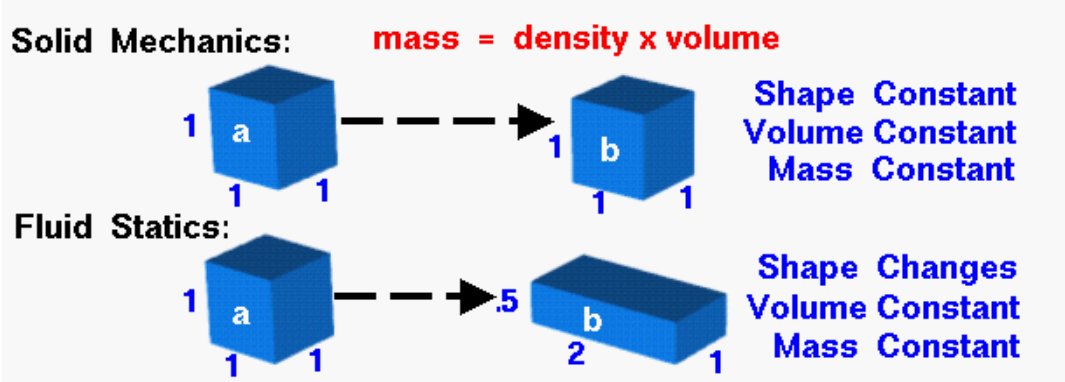
Explore

Let's compare your answers.

The density of the wood block is 0.40 kg/L.
The density of the ice cube is 0.93 kg/L.
The density of the brick is 2.00 kg/L.
The density of the aluminum is 2.70 kg/L.
When any of the blocks' mass changes relative to its volume, the density does not change.

If the density remains constant, the volume also remains constant. The shape can change, but the mass remains the same.

For more information on the Conservation of Mass, check this web page from NASA's Glenn Research Center.
https://www.grc.nasa.gov/WWW/K-12/rocket/mass.html



Explain

Vocabulary Development

It's almost impossible to learn science concepts without also learning vocabulary words. Those vocabulary words help people discuss science concepts, so they're important. However, knowing vocabulary words is not the same as understanding science concepts. This section is designed to help your students do more than memorize definitions as they connect the vocabulary to the science concepts that they have explored.

As a class, use the Frayer Model to help students develop a conceptual understanding of key vocabulary.

1. Place the word "**volume**" in the center of the graphic organizer. (See page 11 for a fillable Frayer Model.) Facilitate a discussion with students exploring why this word is key vocabulary to this study.
2. Ask students to brainstorm characteristics of "**volume**" and add responses to the area with the corresponding heading on the graphic organizer.
3. Ask students to continue their exploration as they research the topic using a variety of resources including their textbook and notes.
4. Next, ask students to add examples and non-examples in the Frayer Model. Emphasize the higher-level thinking skill of comparing and contrasting.

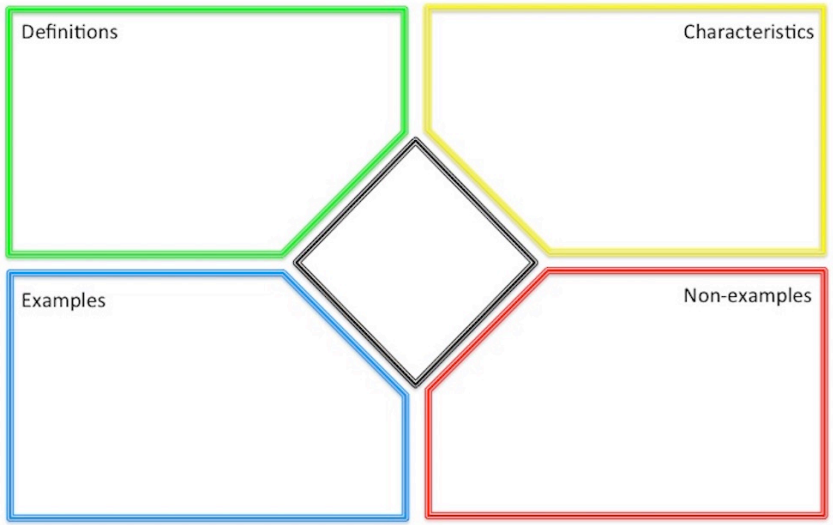
How are the examples alike/different than the non-examples?

5. Using the information provided, ask students to develop their own definition of the word "**volume**" that is clear and concise. An example is in the Answer Key section of this document (page 14).
6. After completing the example together, assign a new vocabulary word to each group of students to work on collaboratively.

Now complete a new Frayer Model with a partner. Select one word from the key vocabulary list and fill in the graphic organizer. We will share some as a class.

Frayer Model for Vocabulary Development

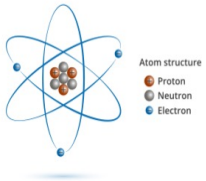
Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.

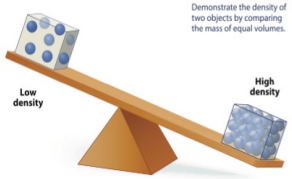


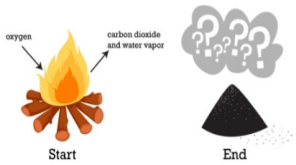
7. Groups will share their Frayer Models and lead discussions to check for understanding of each vocabulary word. Refer to definitions in the Answer Key (page 8).
8. Compile and post final definitions so all students have access for later reference.

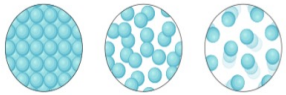
You will review key vocabulary. Pay attention to how your definitions compare to standard definitions.

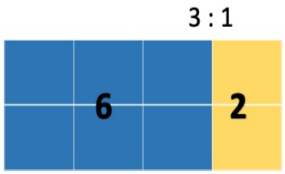
Explain

Word	Definition
ATOM 	Atoms are the smallest part of an element that maintain the chemical properties of that element.

Word	Definition
DENSITY 	Density is the amount of matter in a certain unit of volume or space. It is the measure of how tightly packed molecules are within a substance.

Word	Definition
LAW OF CONSERVATION OF MATTER 	The Law of Conservation of Matter is a principle of matter conservation that states that the mass of an object or collection of objects never changes over time, no matter how the constituent parts rearrange themselves.

Word	Definition
MASS 	Mass is the amount of matter in an object or substance.

Word	Definition
RATIO 	A ratio is a comparison of two quantities.

Word	Definition
VOLUME 	Volume is the amount of space an object or substance takes up.

Image credits: Shutterstock.com

Visit the NASA eClips™ Virtual Vocabulary for more definitions.

Elaborate/Extend

It is important for the students to explain what's going on by applying what they have learned. It is not unusual for students to have a bit of difficulty with elaborate activities. Student are not used to doing "novel" activities and being asked to apply what they know.

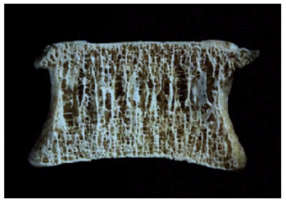
NASA Connection

Bone Density
When traveling in space, one specific area of concern is bone density, which is a measure of how strong the bone is. Bone density is measured by the amount of mineral in a skeletal area, or the Bone Mineral Density (BMD).

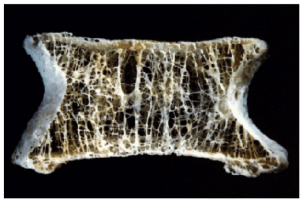
Bone loss increases when the human body is in a reduced gravity environment. Astronauts on the ISS, or on a future long-duration mission, may lose an average of 1% BMD per month while in space. An astronaut's bones may weaken in a way similar to osteoporosis. Osteoporosis is a condition in which bones loses minerals (especially calcium) making them weaker, more brittle, and susceptible to fractures.

Use the definition of density to explain why the normal bone and the osteoporotic bone pictured above would have different densities.

normal bone



osteoporotic bone



Source: Mosekilde, L. Z rheumatol 2000;59:Suppl 1:1-9

You have a homogeneous block of cheese (it has the same materials throughout). You slice off and eat a section of the cheese. How does that affect the density of the remaining cheese?

Evaluate

Post-Assessment

Check students' understanding with these activities.

Identify Misconception

What is a common misconception about the density of materials and how can you correct it?

Discussion Questions

1. What is density?
2. How does the density of a material change as the amount of that material changes?
3. Explain the Law of Conservation of Matter.
4. How do you find the density of a substance?

Carefully rewatch the NASA Spotlite video to assess your understanding of the density of materials.

Video Link- NASA Spotlite: Are You Dense?
NASA eClips™ Website - https://nasaeclips.arc.gov
NASA eClips™ YouTube - https://youtu.be/JfYWe9q0hck

Vocabulary Review

Fill-in-the-blanks using vocabulary about density. Some words may be used more than once.

1)_____ (Density) is the amount of matter for a given volume. mass

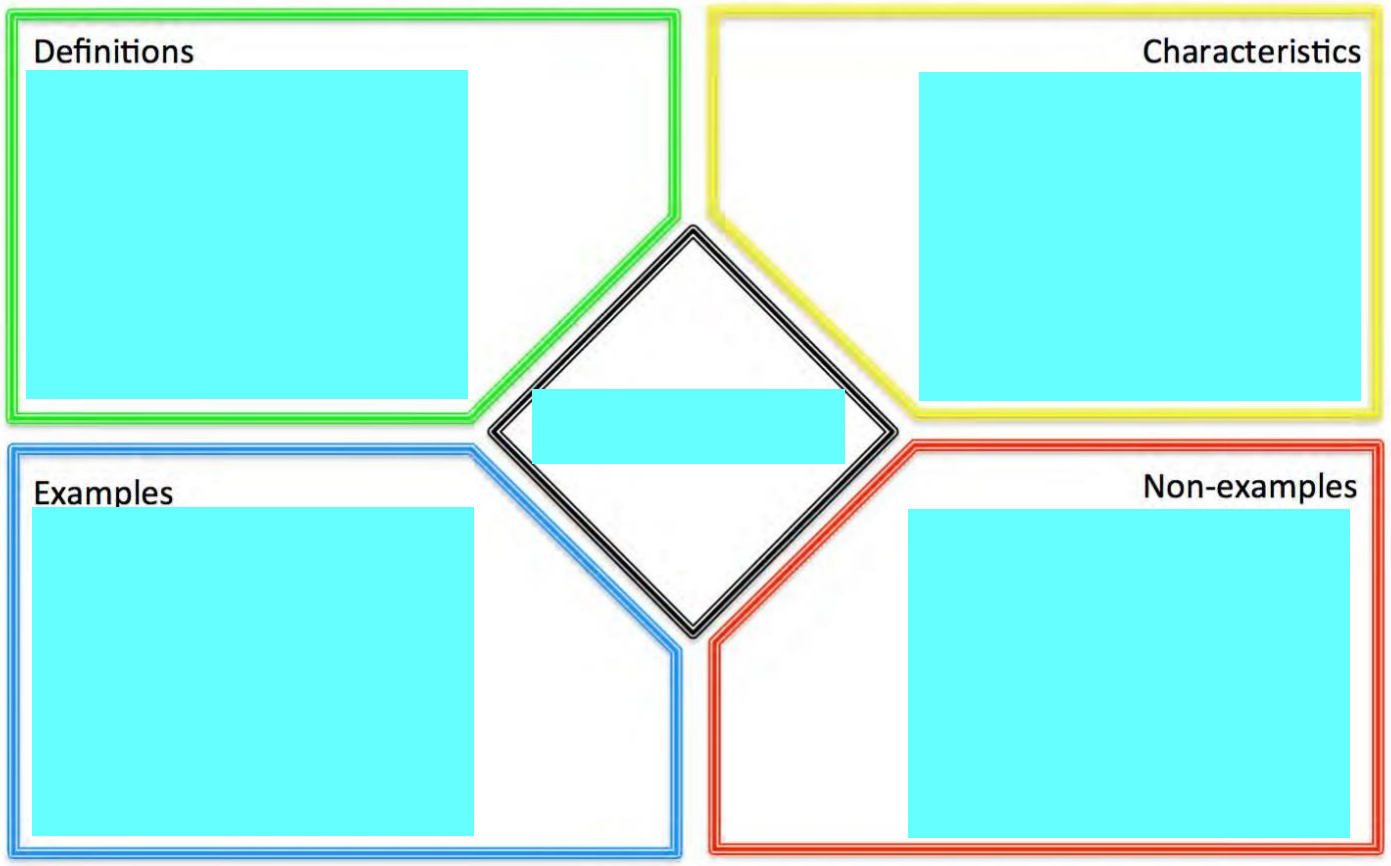
Density is calculated by dividing the amount of matter, or 2)_____ (mass), by the amount of space, or 3)_____ (volume), it occupies. mass mass

If a material is the same throughout, a change in the size of the material will not change its 4) _____ (density). mass

Resources

Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



Visit the NASA eClips™ Virtual Vocabulary for more definitions.

Resources

Density Pretest / Posttest
NASA Spotlite Interactive Lesson

Read each question and select the best choice.

1. If the amount of a material (that is consistent throughout) changes, its density will:

Select the best answer.
A. increase dramatically
B. decrease slightly
C. remain the same
D. increase slightly

2. The _____ of an object is a ratio of the object's mass to its volume.

Select the best answer.
A. density
B. matter
C. weight
D. velocity

3. If an object's mass, relative to its _____, is unchanged, then its density remains constant.

Select the best answer.
A. velocity
B. weight
C. speed
D. volume

4. Students in a lab determined the density of 45 ml of water to be $1 g/cm^3$. Exactly 15 ml of water is removed. What will be the density of the water?

Select the best answer.
A. 30 g/cm3
B. 15 g/cm3
C. 1 g/cm3
D. 45 g/cm3

5. Identify the correct formula for determining the density of a substance.

Select the best answer.
A. volume/mass
B. volume/weight
C. weight/mass
D. mass/volume

Answer Key

Density Pretest / Posttest
NASA Spotlite Interactive Lesson

Read each question and select the best choice.

1. If the amount of a material (that is consistent throughout) changes, its density will:

A. increase dramatically
B. decrease slightly
C. **remain the same*****
D. increase slightly

2. The _____ of an object is a ratio of the object's mass to its volume.

A. **density*****
B. matter
C. weight
D. velocity

3. If an object's mass relative to its _____ is unchanged, then its density remains constant.

4.

A. velocity
B. weight
C. speed
D. **volume*****

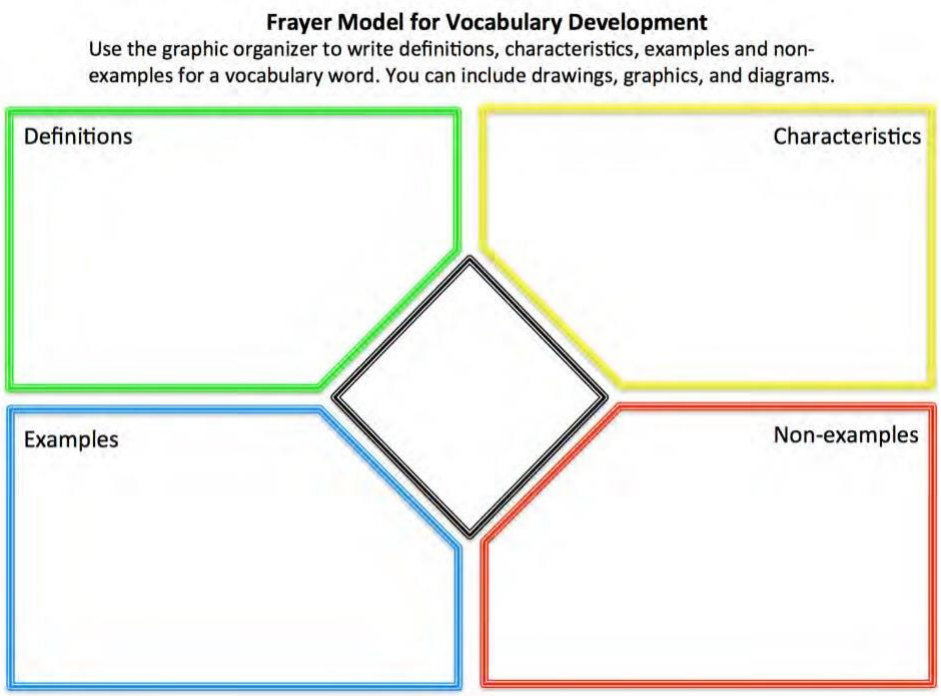
4. Students in a lab determined the density of 45 ml of water to be 1g/cm^3. Exactly 15 ml of water is removed. What will be the density of the water?

A. 30 g/cm^3
B. 15 g/cm^3
C. **1 g/cm^3 *****
D. 45 g/cm^3

5. Identify the correct formula for determining the density of a substance.

A. volume/mass
B. volume/weight
C. weight/mass
D. **mass/volume*****

Answer Key



Vocabulary Word
volume

Characteristics

- quantity of a three dimensional space
- capacity

Examples

cubic units
2 liter bottle of soda

Non-examples

-weight
-perimeter

Definition
The volume of an object is how much space it occupies, and it is typically expressed in milliliters (mL), cubic centimeters (cm^3 or cc), liters (L) or cubic meters (m^3).

Product Information

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