LIVE INTERACTIVE LEARNING @ YOUR DESKTOP

Density - Introducing a Free Online Resource for Middle School Chemistry

Presented by: James Kessler

October 4, 2012

6:30 p.m. – 8:00 p.m. Eastern time

Introducing today's presenter…

James Kessler
Manager, K-8 Science Office
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ACS staff helping on the chat:
Adam Boyd
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American Chemical Society

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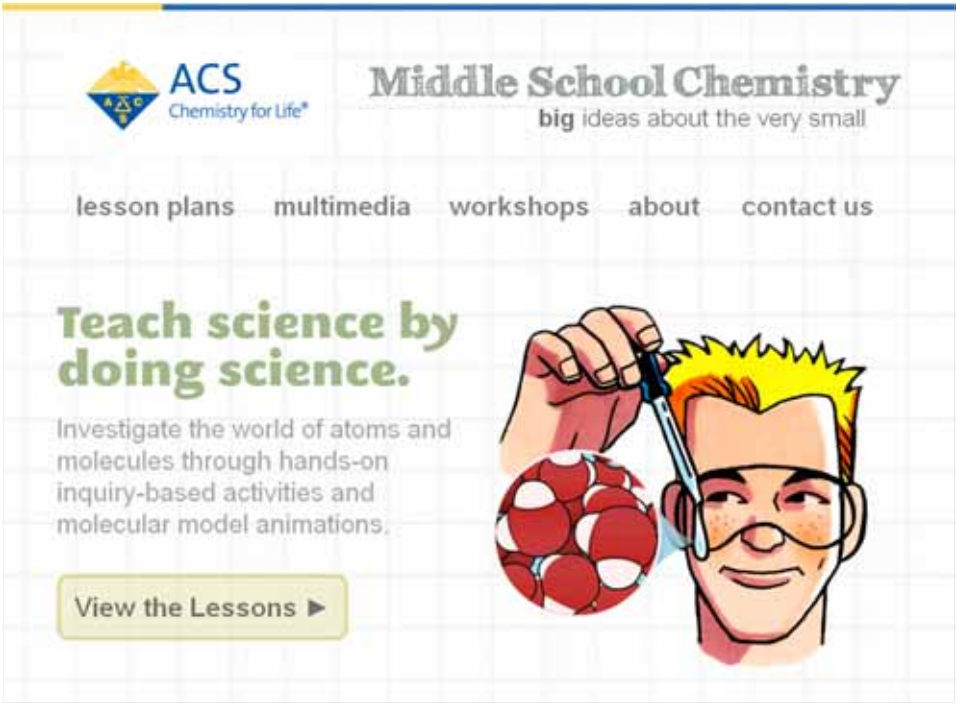
Big Ideas about the Very Small

Chapter 3: Density

Welcome

What is middleschoolchemistry.com?



Free online resource for teaching basic concepts in chemistry at the middle school level.

Six chapters of activity-based lesson plans which align with state standards in physical science and inquiry.

Two main goals:

- Help students understand common every day observations on the molecular level.
- Help students to design and conduct scientific experiments.

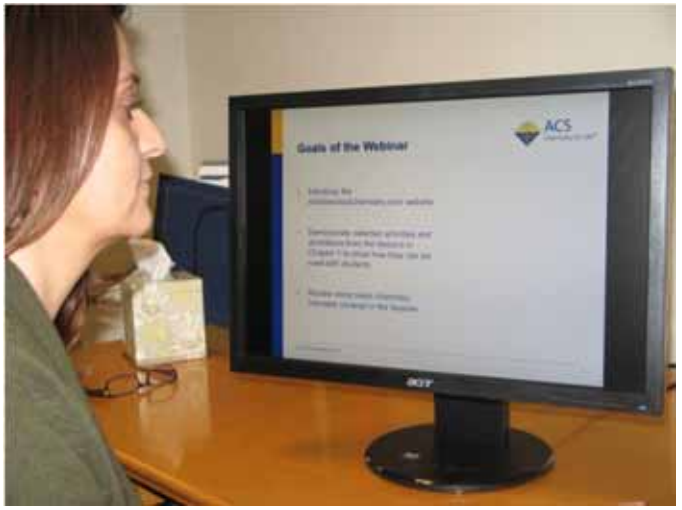
What's in a Chapter?

- Lesson Plans (5E):
  - Hands-on activities
  - Student Activity Sheets
  - Multimedia
  - Extra Teacher Background
- Student Reading
- Test Bank

Goals of the Webinar

- Demonstrate selected activities and animations from the lessons in Chapter 3 to show how they can be used with students

- Review some basic chemistry concepts covered in the lessons



Big Idea for Chapter 3:

On the molecular level, what makes one substance more or less dense than another?

Use the “Fascination Number Line” to indicate your level of fascination with this question.

Have never thought about it and happy that way

Willing to listen if it doesn’t take too long

Stay up nights pondering this

How well do your students understand density?

A. They have an excellent understanding of this concept

B. They have some understanding, but need reinforcement

C. They struggle with this concept

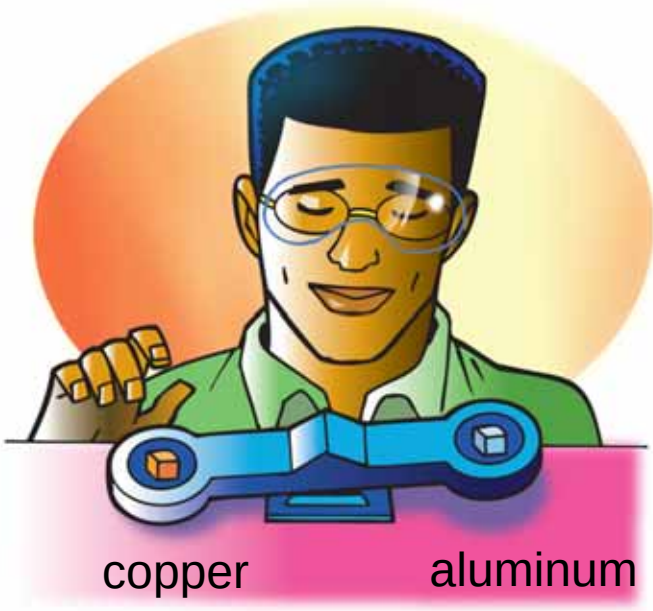
D. The concept of density is totally new to them

E. Other – type in chat

Lesson 3.1: What is Density?

Engage → Explore → Explain → Evaluate → Extend

Demonstration: Equal volumes of copper and aluminum on a balance

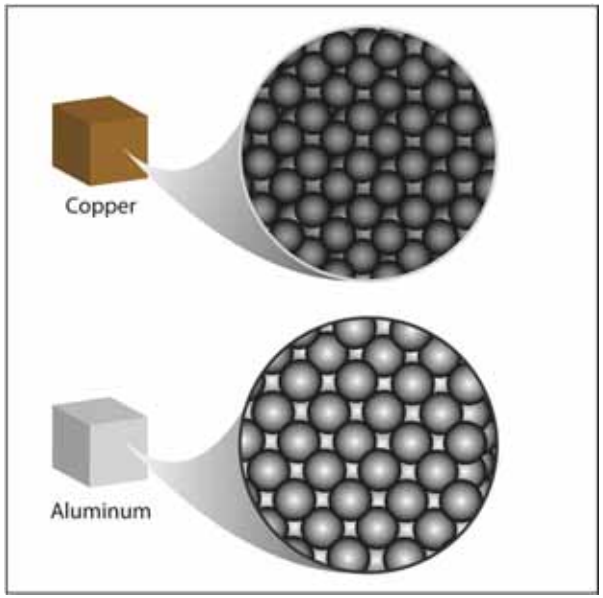


If you compare copper and aluminum cubes of exactly the same size and shape (equal volumes) on a balance, the copper has a greater mass.

How can this be?

Density on the Molecular Level

Engage → Explore → Explain → Evaluate → Extend



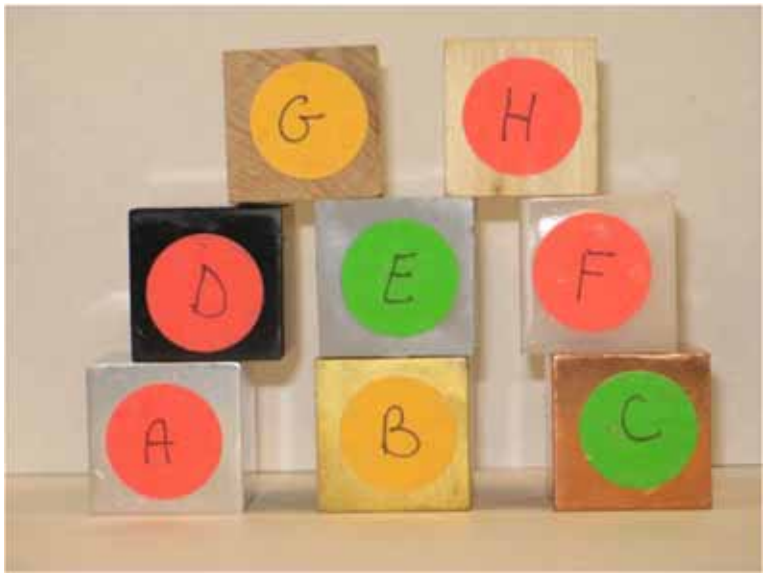
What could give copper more mass than aluminum in the same volume?

- The copper atoms might be smaller than aluminum atoms.
- Copper atoms might have more mass than aluminum atoms.
- Copper atoms might be arranged differently so more can fit in the same volume.

The measurement of mass per amount of volume is called *density*. Density = mass/volume or D = m/v

Same Volume but Different Mass

Engage → **Explore** → Explain → Evaluate → Extend



If you know the density, you can identify the cube, but how do you find the density of each cube?

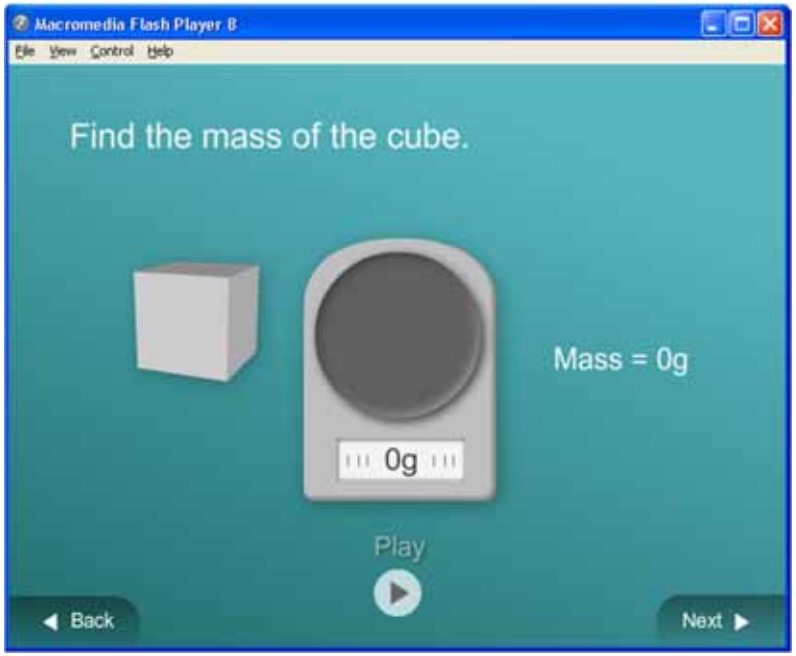
Metal (4)
Copper
Brass
Steel
Aluminum

Plastic (2)
Polyvinylchloride (PVC)
Nylon

Wood (2)
Oak
Pine or Poplar

Calculating Density

Engage → **Explore** → Explain → Evaluate → Extend

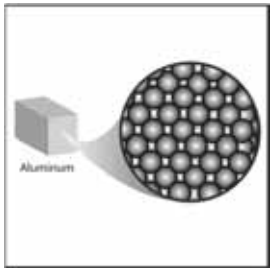


You have to find the **volume** and you have to find the **mass**.

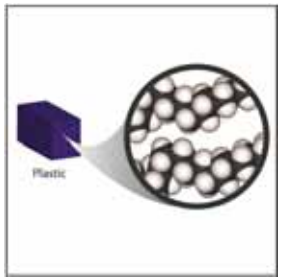
How do you do it?

Why Do the Cubes have Different Densities?

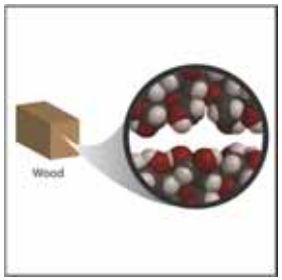
Engage → Explore → **Explain** → Evaluate → Extend



2.9 grams/cm3



0.9 – 1.4 grams/cm3



0.5 - 0.9 grams/cm3

Aluminum – Not very dense for a metal but about 3 times more dense than plastic or wood. Why?

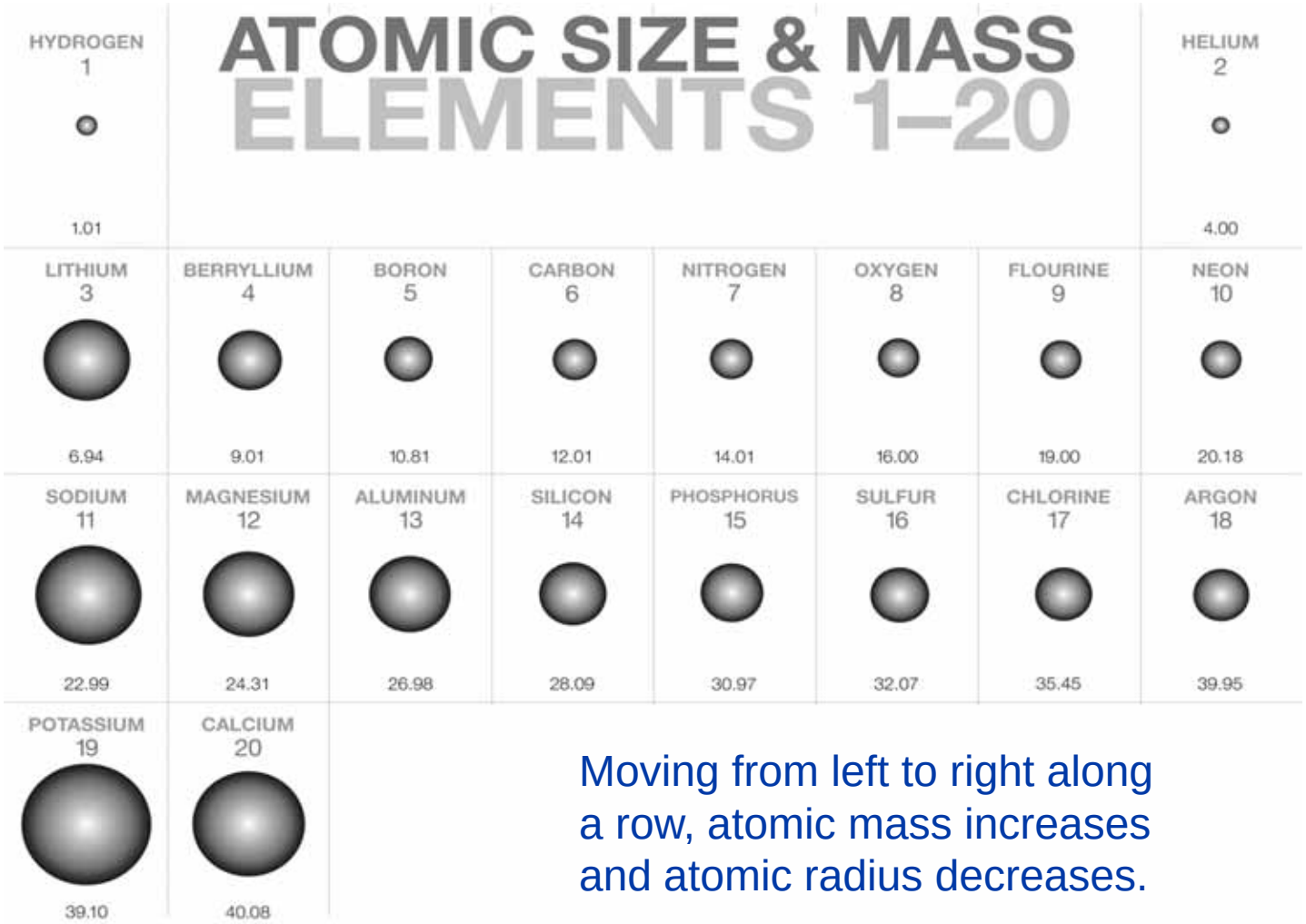
Aluminum - atoms have an atomic mass of 27

Plastic - carbon (12), Hydrogen (1)

Wood - carbon (12), Hydrogen (1), and oxygen (16)

Even though aluminum atoms are larger, their extra mass makes up for it and they are closer together so more fit in the same volume.

Atomic Size and Mass



Moving from left to right along a row, atomic mass increases and atomic radius decreases.

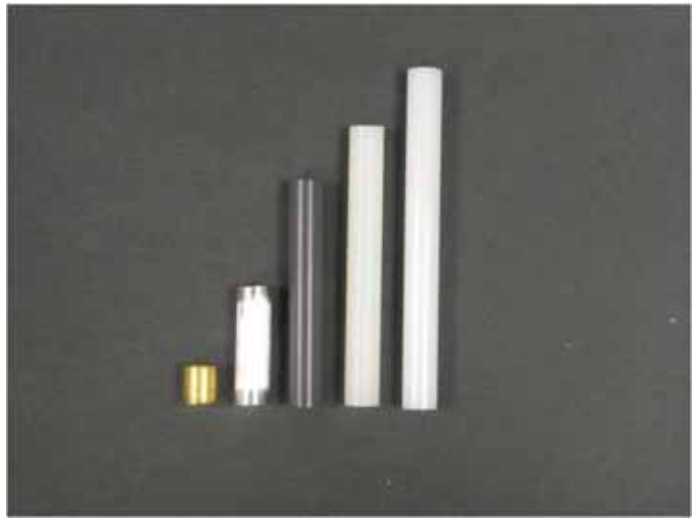
Chat Discussion

What activities have you done that are similar to this one or get at the concept that Density = Mass/Volume?

What other ideas do you have?

Questions? Comments?

Lesson 3.2:
Same Mass but Different Volume



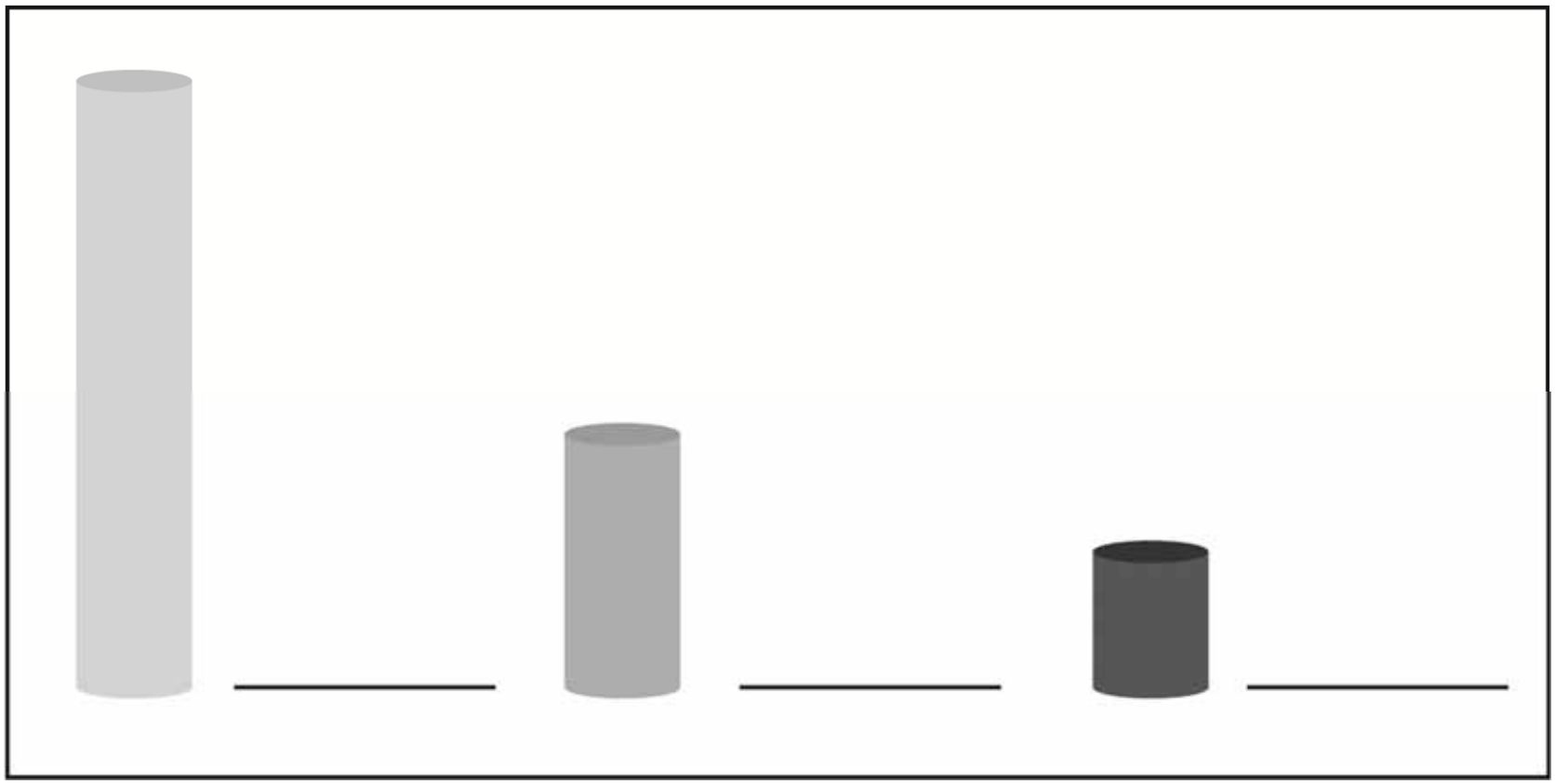
Metal (2)
Brass (copper and zinc)
Aluminum

Plastic (3)
Polyvinylchloride (PVC)
Nylon
Polyethylene

Each has a mass of 15 grams.

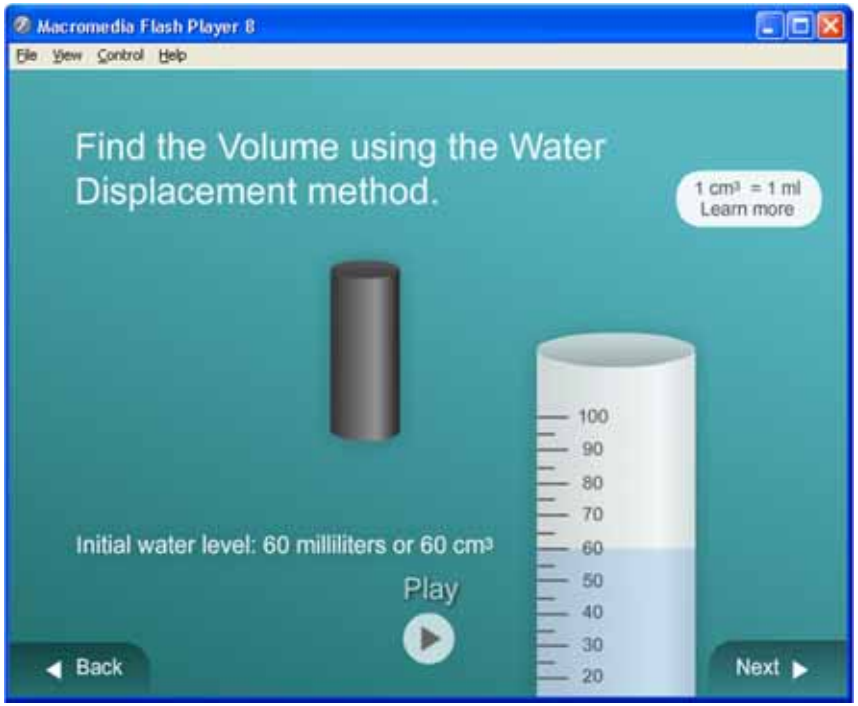
Ask students to predict which is the most dense, least dense, and which is in between.

Predicting Density of Objects with the Same Mass



Use the text box tool.
1 = MOST DENSE. 2 = SECOND MOST DENSE. 3 = LEAST DENSE.

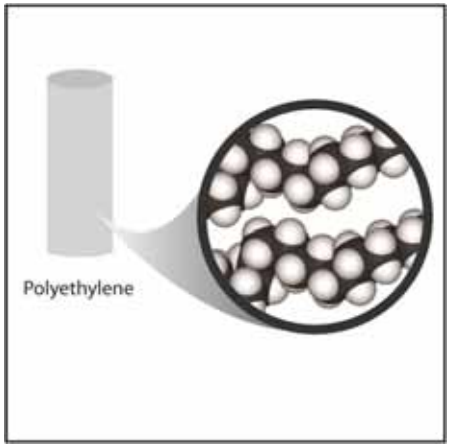
Finding the Density of a Cylinder

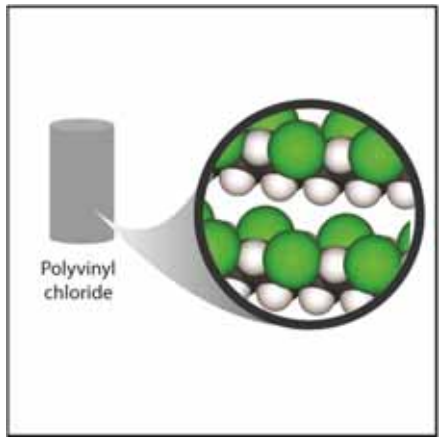


You have to find the volume and you have to find the mass.

How do you do it?

Comparing Two Kinds of Plastic





- The molecules in polyethylene contain carbon and hydrogen.
- The polyvinyl chloride molecule is also composed of carbon and hydrogen but also contains chlorine.
- Chlorine atoms are much more massive (atomic mass 35.5) than carbon and hydrogen. They are a bit larger but their extra mass outweighs their size and polyvinyl chloride is more dense than polyethylene.

Chat Discussion

What activities have you done that are similar to this one that use the water displacement method to calculate volume?

What other ideas do you have?

Questions? Comments?

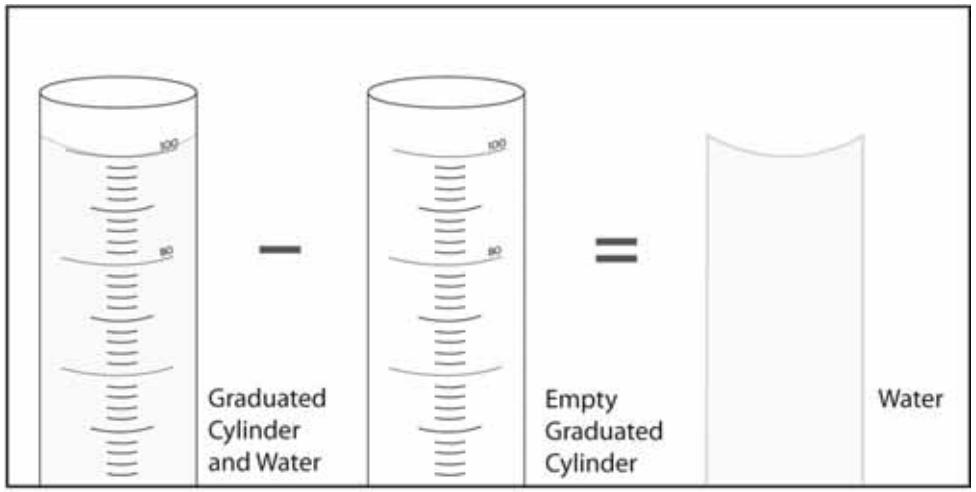
Lesson 3.3 – Density of Water

Student volunteer lifts two buckets – one with a small amount of water and another with more water.

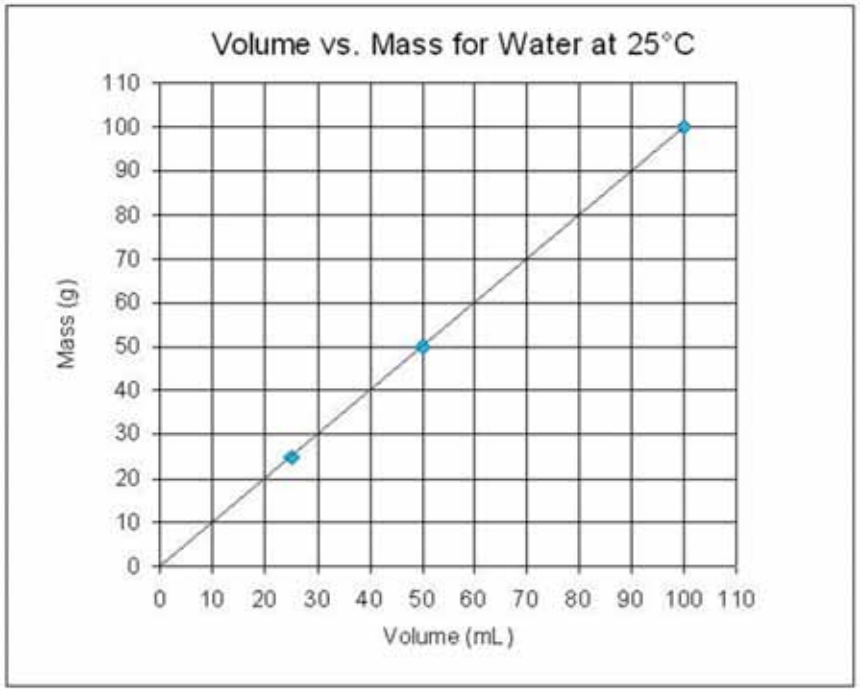
Ask whether the water is more dense in one bucket than the other.

Ask whether water can even have a density.

Ask how the density of water could be measured.



For Different Volumes of Water – The Density is the Same



100 mL has a mass of 100 g.
Density = 100g/100mL = 1g/cm3

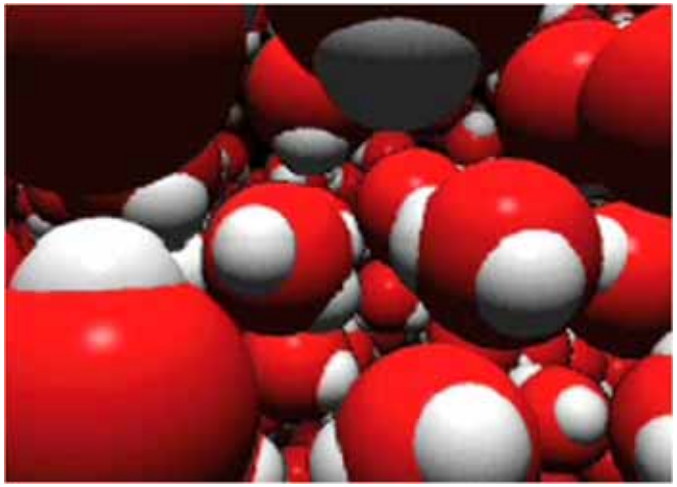
50 mL has a mass of 50g
Density = 50g/50mL = 1g/cm3

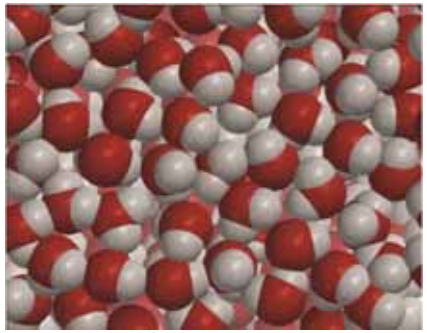
25 mL has a mass of 25 g.
Density = 25g/25mL = 1g/cm3

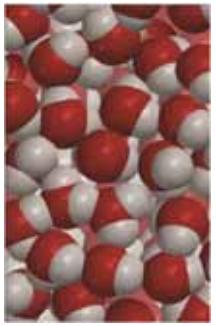
Regardless of the volume, the density of water is about 1 gram/cm^3.

Why is it always the same?

Water Molecules are Consistent Throughout a Sample





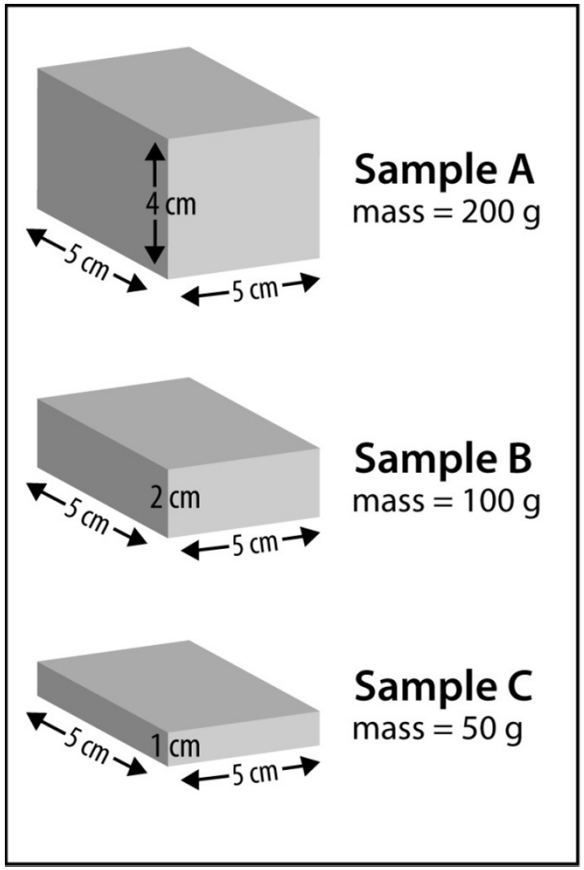


Water molecules all have the same mass and are spread evenly throughout a sample of water.

Half the volume is half the number of water molecules and half the mass.

This is true for any substance that is homogenous throughout.

Homogeneous Solid



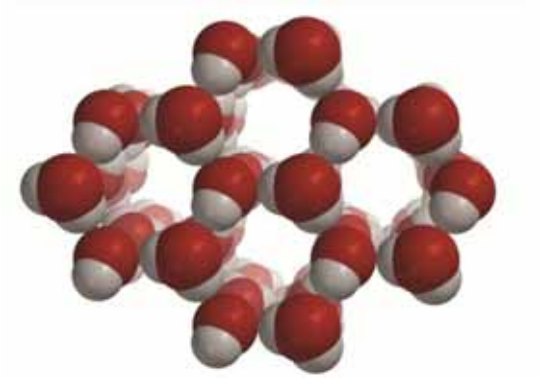
From the Student Activity Sheet:
Find the density of each block.

Sample A
Volume = 100 cm3
Mass = 200 g
Density = 200/100 = 2 g/cm3

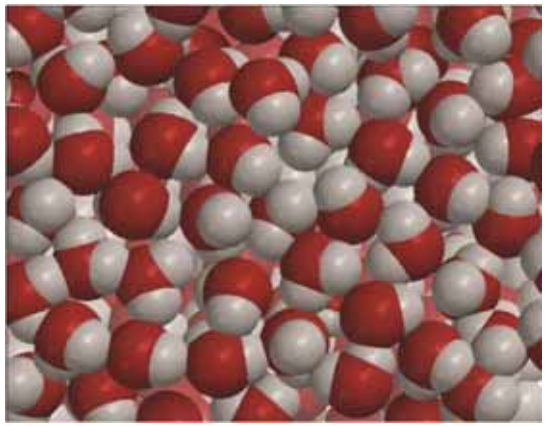
Sample B
Volume = 50 cm3
Mass = 100 g
Density = 100/50 = 2 g/cm3

Sample C
Volume = 25 cm3
Mass = 50 g
Density = 50/25 = 2 g/cm3

Density of Water and Ice



Ice



Liquid Water

In the crystal structure of ice, the water molecules are further apart than in liquid water.

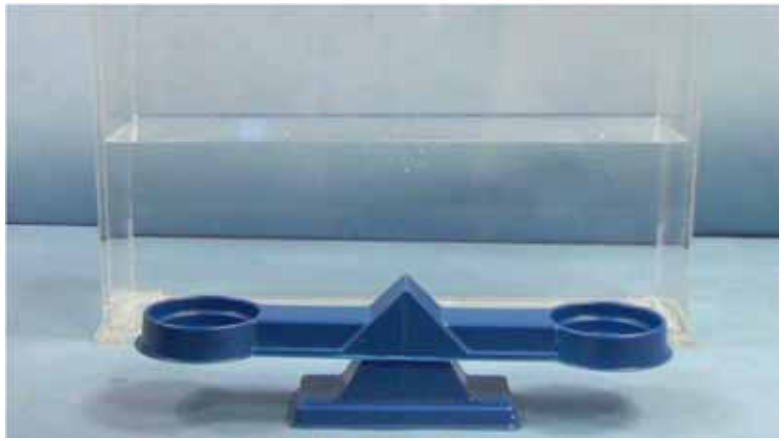
So a volume of ice has fewer water molecules in it than the same volume of liquid water.

Since it has fewer water molecules in the same volume, the ice has less mass and therefore a lower density.

That's why ice floats on water.

Questions? Comments?

Lesson 3.4 – Sink and Float



The wax weighs more than the clay, yet the wax floats and the clay sinks.

How can this be?

Is it only about the difference between the wax and the clay or does it also have to do with the water?

Comparing Wax to an Equal Volume of Water

Compare the mass of the wax to the mass of an equal volume of water.

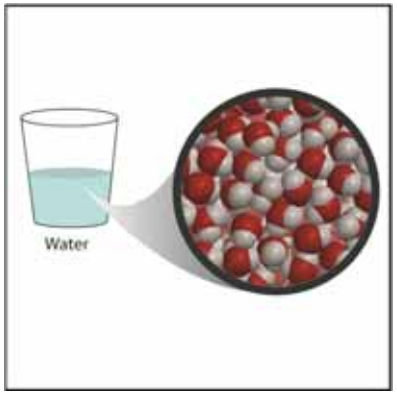
Since you are comparing the same volume, the one that has more mass must be more dense.

The one with less mass must be less dense.

Since the wax is less dense than water, the wax floats on the water.

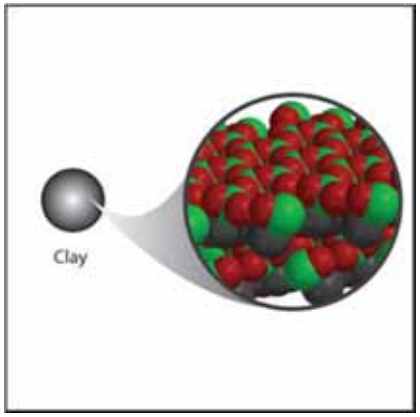
Wax and Water on the Molecular Level

Wax:
Made of hydrogen atoms and carbon atoms.
They are very light.
Molecules are long and intertwined.

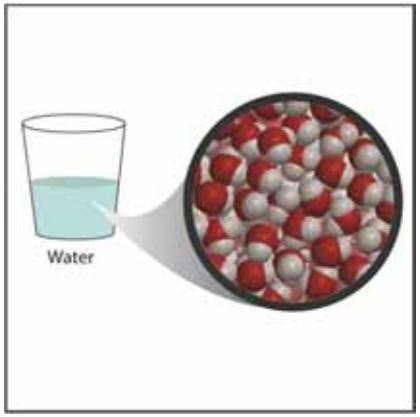


Water:
Made of hydrogen and oxygen atoms. The oxygen is heavier and a little smaller than carbon.
Molecules are very close together.

Clay and Water on the Molecular Level

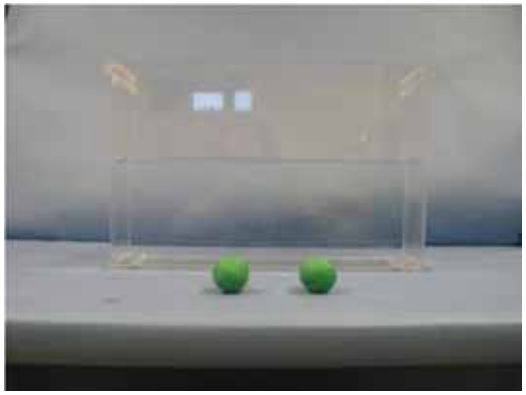


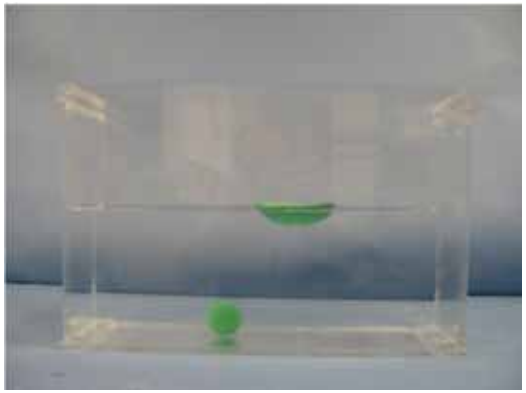
Clay:
Made from heavier atoms like aluminum and silicon.
Packed very close together.



Water:
Made from hydrogen and oxygen atoms which are light compared to those in clay.

How Can a Clay Object Float?





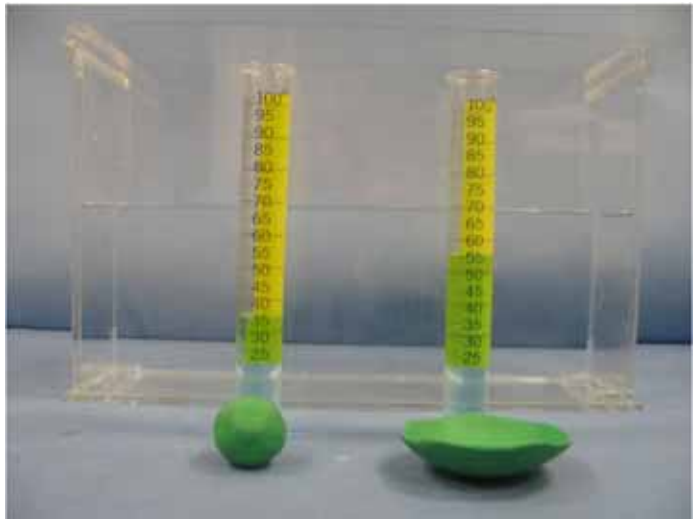
Clay is more dense than water so clay should sink.

An object like a clay ball or a clay cube does sink.

But, if you increase the volume of the clay object into a large enough bowl, the clay bowl can float.

Why?

Changing the Shape Can Change the Volume

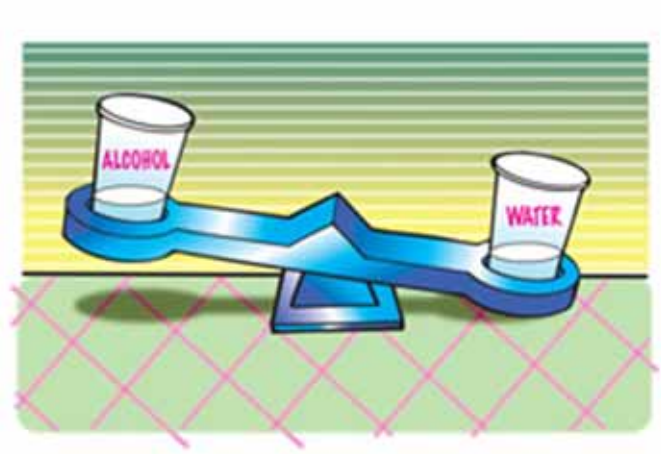


The mass of the clay bowl is the same but the volume is increased enough that the overall density decreases.

If you compare the volume of the ball and the volume of the bowl, using the water displacement method, the bowl displaces about 50% more water than the ball.

When the volume is large enough, the density decreases enough so that it is less dense than water – so the bowl floats.

Can Liquids Float and Sink?

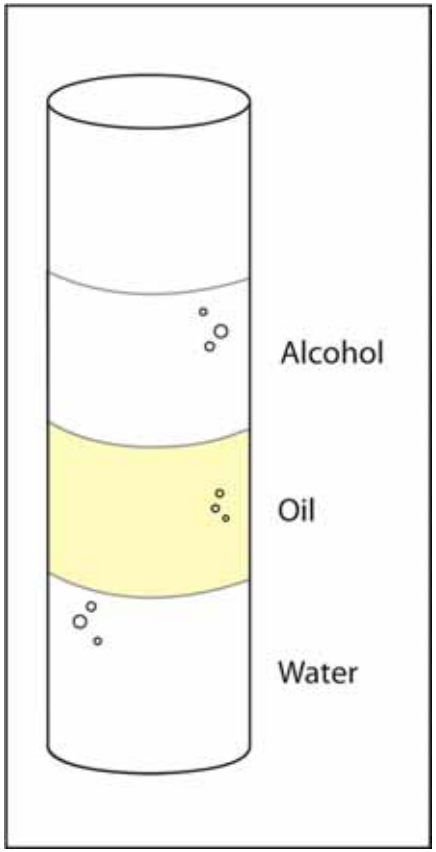


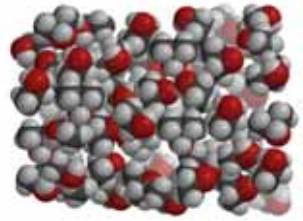
Show students two identical candles. Place one in isopropyl alcohol (candle sinks) and one in water (candle floats).

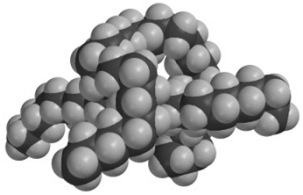
If the candles have the same density, how can this be?

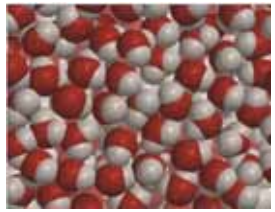
Do liquids have density? Do you think these liquids have the same density? How could you find out?

The Famous Density Tower









Water is most dense. It's made from hydrogen atoms and oxygen atoms.

Oil is less dense than water. It's made from hydrogen and carbon. Carbon is lighter than oxygen so this makes sense.

Alcohol is made of carbon and hydrogen so it's pretty light like oil. But it also has oxygen, but not much. You might think it would be a little more dense than oil but the molecules must not pack very closely.

This makes alcohol less dense than oil.

Changing the Density of Water

The carrot sinks so the carrot must be more dense than water.

What happened to the density of the water when salt was dissolved in it?

Type your ideas in the chat!

Changing the Density of Water

The carrot sinks so the carrot must be more dense than water.

What happened to the density of the water when salt was dissolved in it?

The mass increased when the salt was added but the volume didn't increase very much.

So the density of saltwater is greater than the density of fresh water.

The density of the saltwater became greater than the density of the carrot.

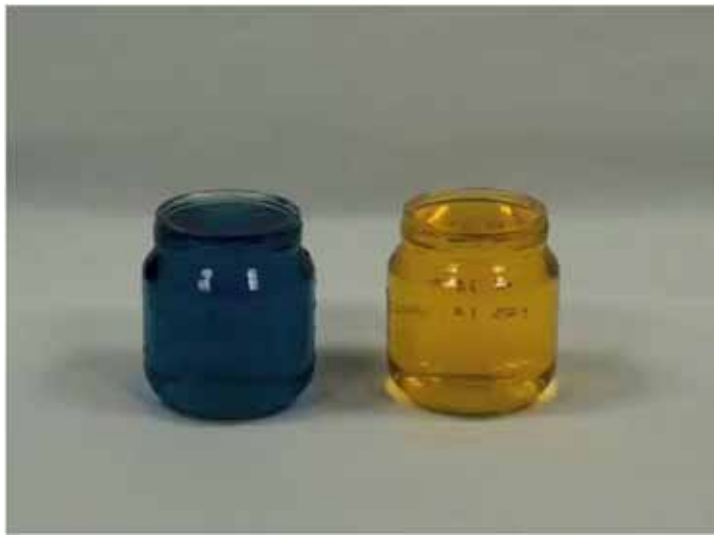
Chat Discussion

What activities have you done that are similar to this one that changed the density of water?

What other ideas do you have?

Questions? Comments?

Lesson 3.6 - Does Temperature Affect Density?



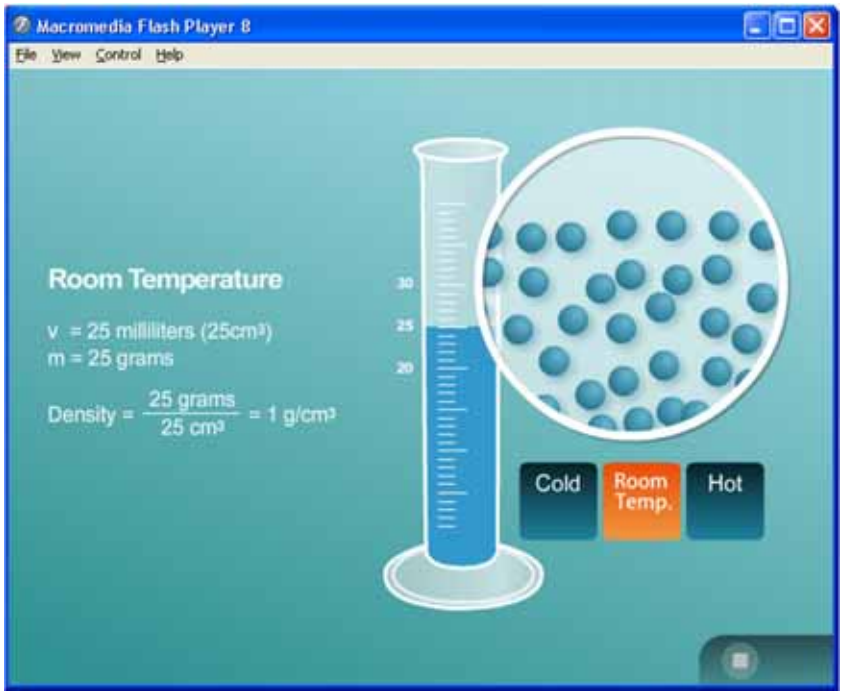
Hot water (yellow) is placed on cold water (blue).

The hot floats on the cold. Why?

The hot is less dense than the cold.

Why is it less dense?

Temperature and Density



Water molecules are further apart in hot water.

So there are fewer water molecules in a volume of hot water than an equal volume of cold water.

If there are fewer molecules, there is less mass.

If there is less mass in the same volume, the hot water is less dense and floats on the cold more dense water.

Temperature and Floating and Sinking

Cold blue water is slowly added to clear room temperature water.

Cold water is more dense than room temperature water and sinks.

Hot yellow water is slowly added to clear room temperature water.

The hot water is less dense than room temperature water and floats.

Questions? Comments?

Thanks to today's presenter!

James Kessler
Manager, K-8 Science Office
American Chemical Society

ACS staff helping on the chat:
Adam Boyd
Senior Education Associate, Office of K-8 Science

Patti Galvan
Kids & Chemistry Program Manager

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