

# Density

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## What is Density?

Density is a measure of the amount of matter or mass (weight) that can fit in a given space (volume). Density is mass divided by volume.

The more items that can fit into a fixed space, like a box, the DENSER the box becomes. For example, New York City is DENSELY populated because there are a lot of people living in a small area. 20 people in an elevator is DENSER than 2 people in an elevator. A pillowcase full of feathers is LESS DENSE than a pillowcase full of bowling balls.

Steel is MORE DENSE than cotton balls or cotton candy because the same weight of steel, for example, 1 pound, takes up less space than 1 pound of cotton balls or cotton candy do.

## Why is Density important?

Density is important because it affects whether objects will float or sink. It is an important property to consider when building things like ships and hot air balloons. How big a truck you would need if you were going to move 1000 bricks depends on density – the density of the bricks.

A long time ago, around 250 BC, the Greek mathematician Archimedes was given the task of determining whether a jeweler had cheated the King by replacing some of the gold in the King's crown with silver. Archimedes thought about the problem while relaxing in a bath. As he got into the bath, he noticed that water spilled over the sides. He realized that the amount of water that spilled was equal in volume to the space that his body occupied. This fact suddenly gave him with a way of telling apart a mixed silver and gold crown from a pure gold crown. Because a measure of silver occupies more space than an equivalent measure of gold – silver is LESS DENSE than gold, Archimedes placed the jeweler's crown and a pure gold crown of equivalent weight in two tubs of water. He found that more water spilled over the sides of the tub when the jeweler's crown was submerged. The jeweler was cheating the King!

Density is not the only thing which decides if an object will float or sink, we also need to think about the **buoyancy of the object**. A piece of aluminum foil will float if it is laid flat onto of a bath of water but it will sink if you roll the foil into a tight ball. Why? When the foil is flat there is a large area of water holding the foil up but when the foil is in a ball there is less area for the water to act on the foil.

## Goal of experiment 1:

To show the student that the weight of water displaced is equal to the weight of the object floating in the water. (This experiment does not work for items that sink)

## Items needed for the experiment

Transparent glass or pail

Water

Marker

2 inch x 2 inch x 2 inch piece of pine,

2 inch x 2 inch x 2 inch piece of oak

## Instructions for the demonstration

1. Half fill the pail/ glass with water
2. mark the water line
3. place a block of wood – pine in the water
4. see how much water is displaced
5. remove the pine and place the block of oak in the water
6. see how much water is displaced

## Conclusions

1. The blocks are the same size but the amount of water displaced is different
2. heavier the object, more water is displaced (correct but only true for objects which don't sink)
3. denser the object, more water is displaced.
4. when molecules that make up an object are packed tightly together, object has a higher density than one where the molecules are not tightly packed together. Oak is MORE DENSE than pine.

When you place a block of wood in a pail of water, the block displaces some of the water, and the water level goes up. If you could weigh the water that the wood displaces, you would find that its weight equals the weight of the wood.

This doesn't mean that if you had a few blocks of wood that were exactly the same size and shape, they would each displace the same amount of water. A block of wood made of oak, for example, sits deeper in the water (and therefore displaces more of the water) than does a block of pine. The reason is that it's heavier for its size, or denser -- in this case, the molecules that make it up are more closely packed together than the molecules that make up the pine.

**Goal of Experiment 2:** Show how when the object is DENSER it will sink

### Items needed for the experiment:

Tub filled with water

One can of Diet Coke

One can of Coke

### **Instructions for the demonstration**

Ask the children what happens when you put the can of coke in the water? Sink or float?

Write down the answer on the Board

Ask the children what happens when you put the can of Diet Coke in the water?

Write down the answer on the board

Put the can of Coke into the water..it will sink

Put the can of Diet Coke into the water. It will Float. WHY?

Conclusions:

1. Both cans have exactly the same volume.
2. Because the Diet Coke floats and the Coke sinks, the Coke must be MORE DENSE.
3. Because the volumes of the two cans are the same, if the Coke is more dense, it must be heavier.
4. Because the can of Coke has sugar dissolved in it, the sugar makes the can heavier and therefore it sinks. The artificial sweetener in Diet Coke is much more powerful than sugar and so much less sweetener is added to the diet drink (39 grams sugar compared to 0.188 grams sweetener)

**Goal of Experiment 3:** is to show how density of the liquid determines if an object put into it sinks or floats

### **Items needed for the experiment:**

1 Hard boiled egg plus a few extra in case you need them

Tub filled with water

Salt

### **Instructions for conducting the experiment:**

Ask the children if the egg will sink or float

Record the answer on the Board

Put the hardboiled egg into the water and it will SINK

Let the children add 10 or more tablespoons of salt to the water and stir it.

Put the hardboiled egg into the water and the egg will FLOAT. If it does not, add more salt till it does.

This is because the water is 'denser' when it has salt in it. In other words the density of the water with salt is higher than the density of water only. Therefore, less water is displaced when the hardboiled egg is put into it allowing the egg to FLOAT.

**Goal of Experiment # 4:** to help students learn to test their own hypothesis.

**Items needed for the experiment:**

Plastic container to conduct the experiment  
Assorted items – paper clips, cork, etc.  
Activity sheet to record hypothesis and finding

**Instructions on how to conduct the demonstration:**

Hand out the activity sheet, container and assorted items  
Ask the children to record their prediction on whether each item will sink or float

Fill the container with water and try the items again  
Record the results on the activity sheet

Ask the children why they think some things sink and others float?

Why does the aluminum foil pan float on water but sink if submerged? Float the pan and keep adding weights to see what happens.

Name \_\_\_\_\_

**Sink or Float  
Activity Sheet**

**SINK OR FLOAT?**

Guess whether each object will sink or float when you put it in water. Circle your guess.

Put the object in the water. Circle **float** or **sink** to show what happens.

Put the object in the water again. Circle **float** or **sink** to show what happens the second time.

<b>OBJECT</b>	<b>GUESS</b>	<b>1<sup>st</sup> TRY</b>	<b>2<sup>nd</sup> TRY</b>
Cork	float	float	float
	sink	sink	sink
Paper Clip	float	float	float
	sink	sink	sink
Foam Block	float	float	float
	sink	sink	sink
Popsicle stick	float	float	float
	sink	sink	sink
Plastic Screw	float	float	float
	sink	sink	sink
Aluminum Foil Pan	float	float	float
	sink	sink	sink
String	float	float	float
	sink	sink	sink
Steel Bolt	float	float	float
	sink	sink	sink
Zinc Washers	float	float	float
	sink	sink	sink
Your choice _____.	float	float	float
	sink	sink	sink

The four activities reinforce the skills and performance indicators for physical science, matter and properties.

#### NYS Standard 4: The Physical Setting

Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

P.I. - 3.1 Observe and describe properties of materials, using appropriate tools.

3.1a [Experiment 1, 3]

3.1b [Experiment 1, 4]

3.1c [Experiment 1, 4]

3.1d [Experiment 1]

3.1e [Experiment 1, 2, 3, 4]

3.1f [Experiment 1, 3, 4]

3.1g [Experiment 3]

P.I. - 3.2 Describe chemical and physical changes, including changes in states of matter.

3.2a [Experiment 1, 2]

3.2c [Experiment 3]

Key Idea 5: Energy and matter interact through forces that result in changes in motion.

P.I. - 5.1 Describe the effects of common forces (pushes and pulls) of objects, such as those caused by gravity, magnetism, and mechanical forces.

5.1a [Experiment 1]