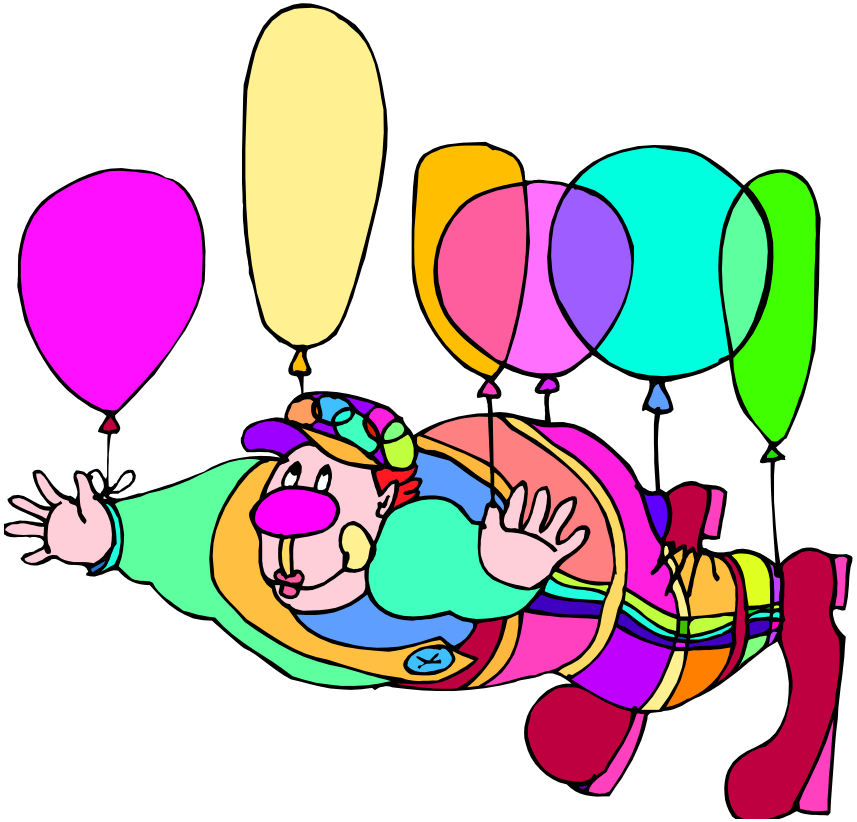
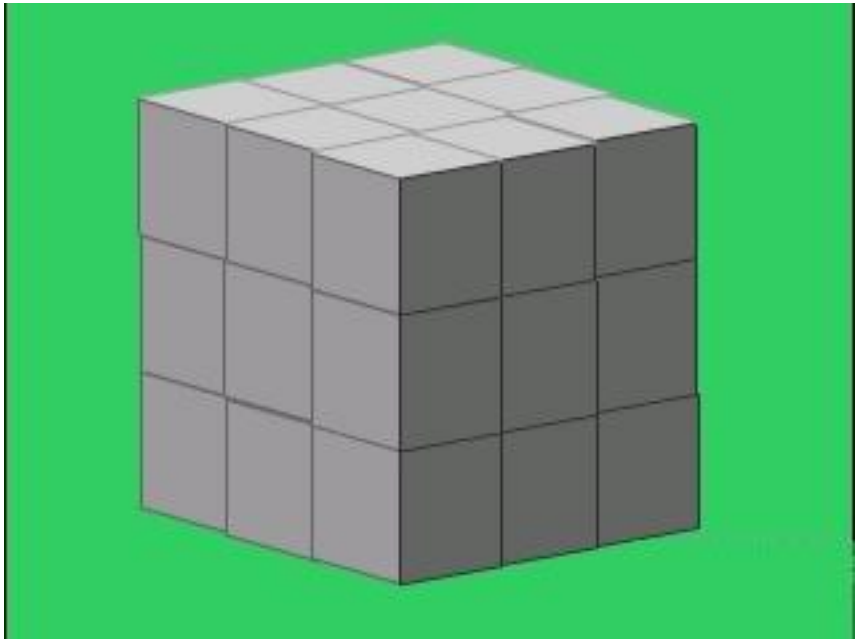
Buoyancy



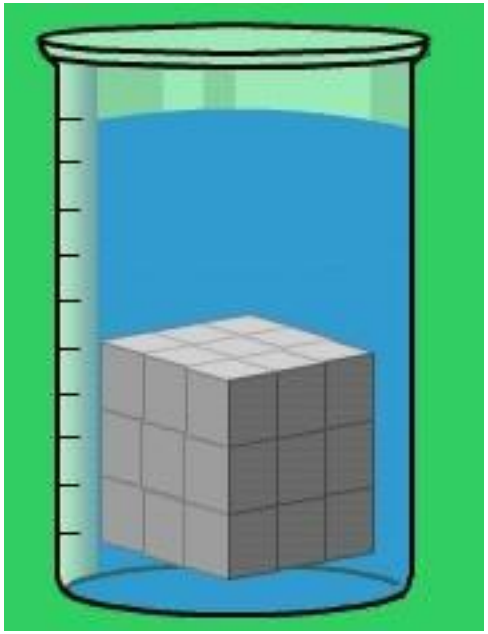
"What floats your boat?"

Sink or float?



Test

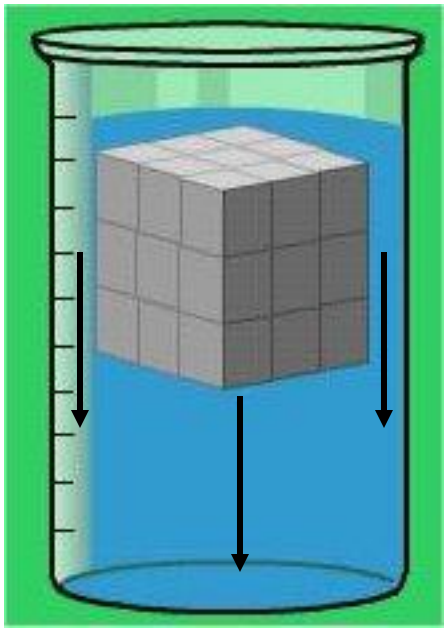
The cube sinks to the bottom.



WHY?

Weight

Due to the pulling force of gravity both the cube and the water have the property of weight.



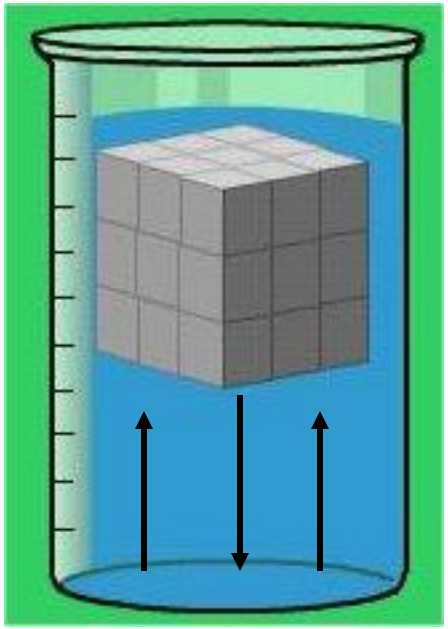
Gravity

Gravity is pulling downward on the total mass of the cube.
(Mass = amount of matter)

Upward Force

But look, the cube isn't pulled to the bottom – it floats to the top. Is gravity broken?

Either gravity has "gone away" or there is another force that is pushing up as gravity is pulling down.



Gravity

Opposing gravity force

The pushing up force must be stronger for the object to float.

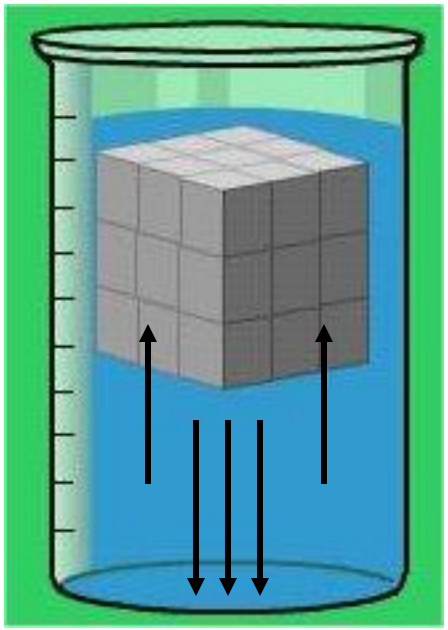
The pushing down force must be stronger for the object to sink.

Opposing Force

What causes the pushing up force?

Two objects can not occupy the same space.

When the object pushes into the water, as it is pulled down by gravity, the water pushes back.



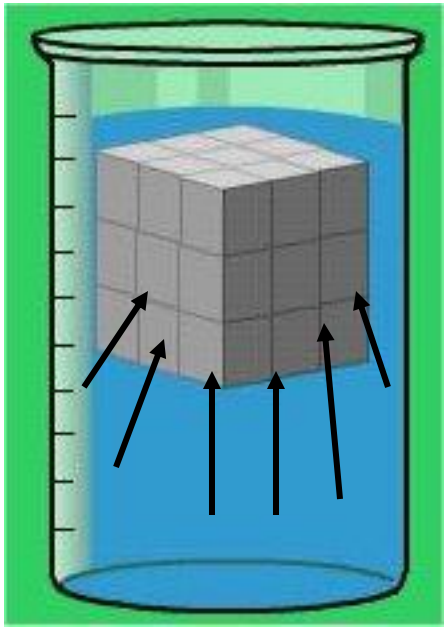
If the object has enough force (weight) to push the water out of the way, it sinks.

If the object does not have enough downward force the water pushes it to the surface, it floats.

Buoyant Force = Opposing Force

This force that tries to push an object to the surface of a liquid is called the “buoyant force”.

The object initiates the pushing, the water pushes back. So, actually, the **object creates the buoyant force**.



Gravity

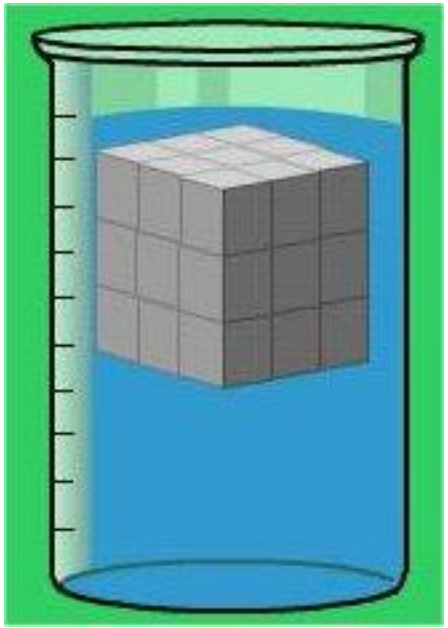
Buoyant force

The strength of the buoyant force depends on the volume of the object and the weight of the water (liquid, gas).

The volume of the object = the volume of water being pushed out.

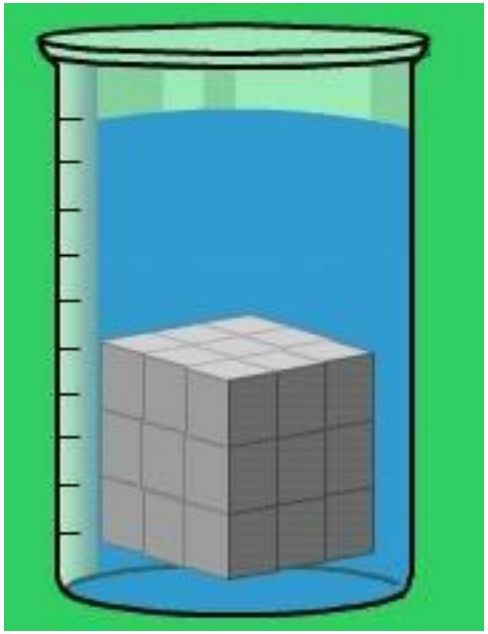
Let's Review
Float

If cube floats to the top, the water has won the pushing contest. The water provides the buoyant force. The cube is buoyant.



Let's Review Sink

If cube sinks to the bottom, the cube has won the pushing contest. It has enough weight force to push the volume of water out of the way.

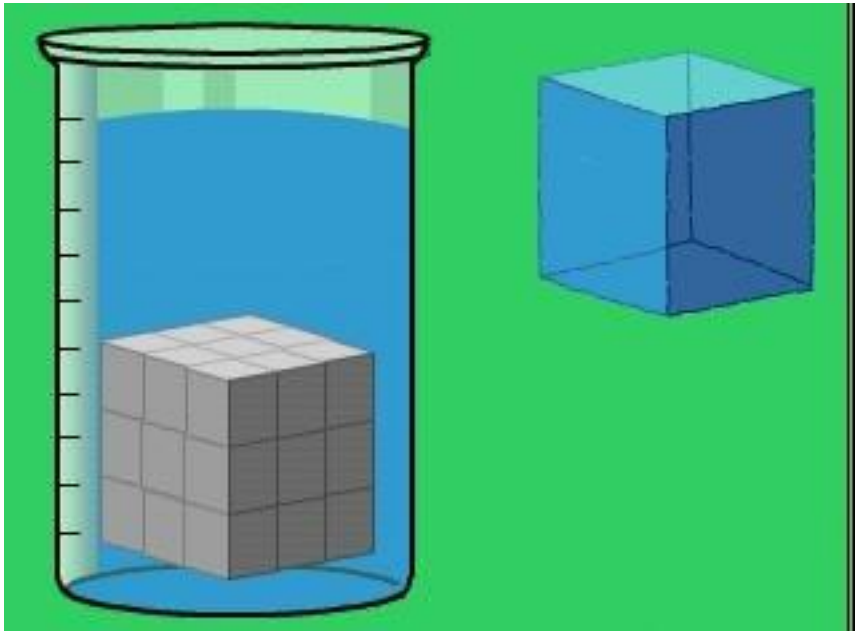


Yes, the weight of the object does matter. Weight is affected by the amount of matter in the object.

How much water does the object have to push out of the way in order to sink?
An ocean full?
A pool full?
A glass full?

Displacement

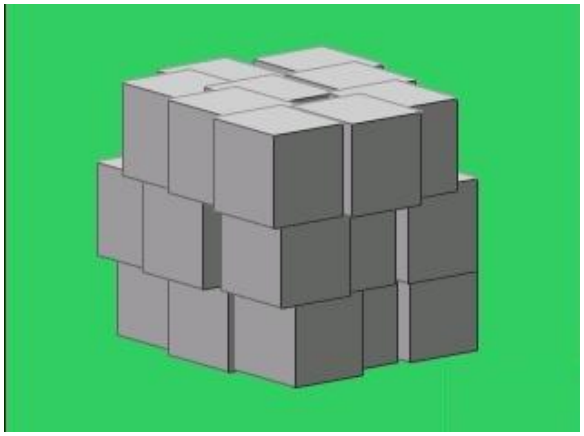
The amount of matter (water) that has to be pushed out of the way is equal to the amount of space the object takes up.

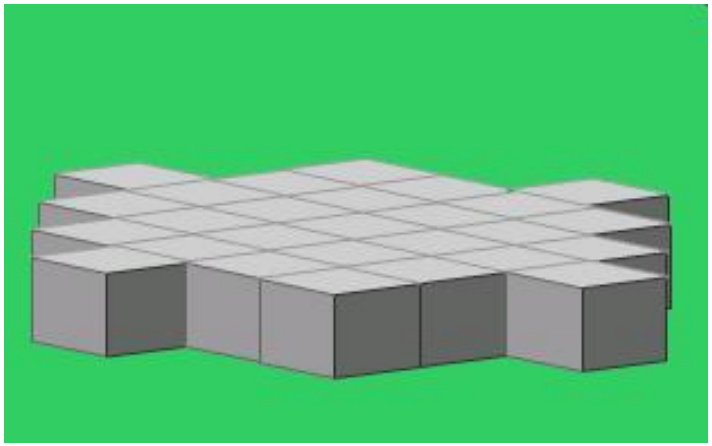


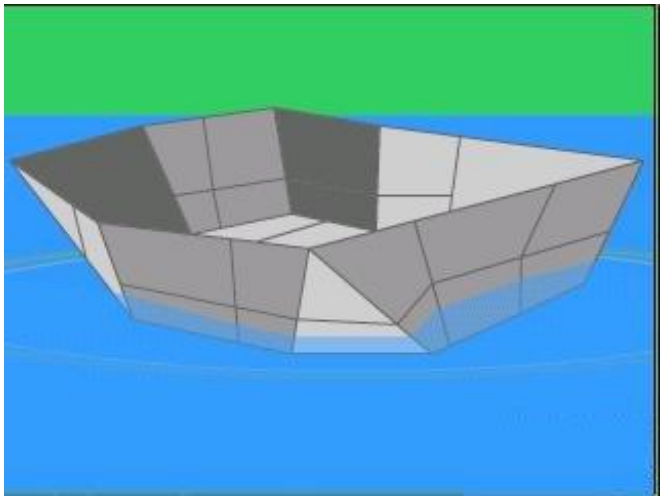
The **<u>volume</u>** of water that needs to be displaced is one equal to the <u>volume</u> of the object.

Unravel the "now it sinks, now it floats" mystery

Starting with a cube of clay that sinks -



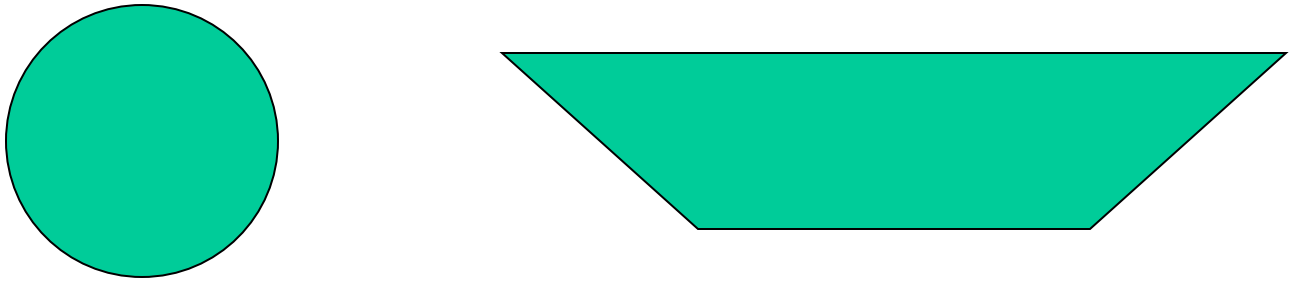




If we make a boat out of the same amount of matter that was in the cube, why does the cube sink and the boat float?

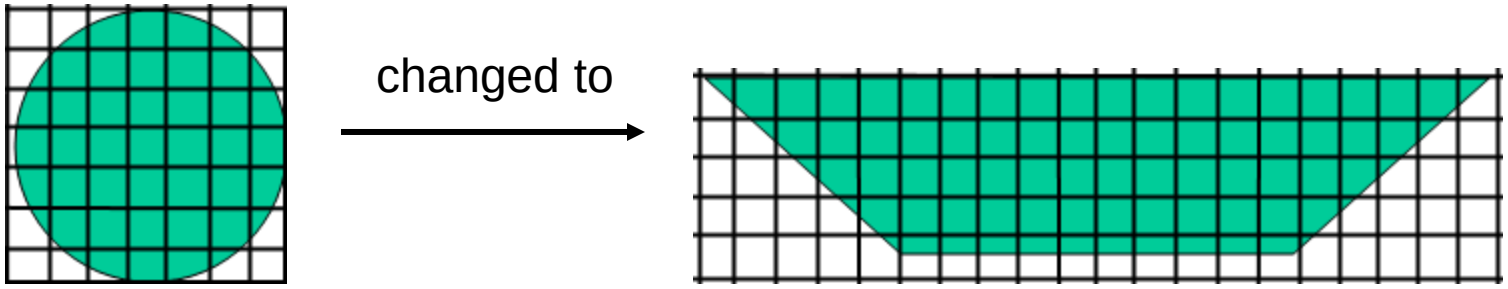
What have we changed?

We have changed the volume. So, buoyancy isn't just about weight, it's about volume too.



Volume is how much space something takes up.

Which object takes up more space?

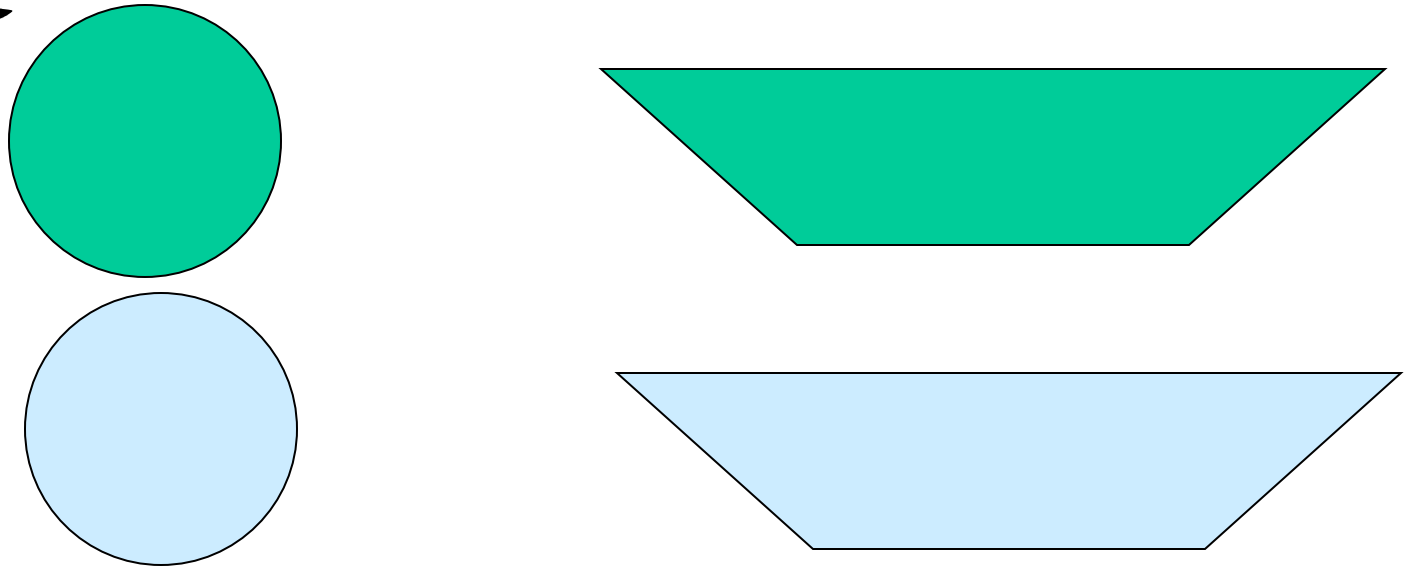


Which object has its matter packed into a smaller space?

Which object has its matter spread out over a larger space?

Keep in mind that volume is three-dimensional!

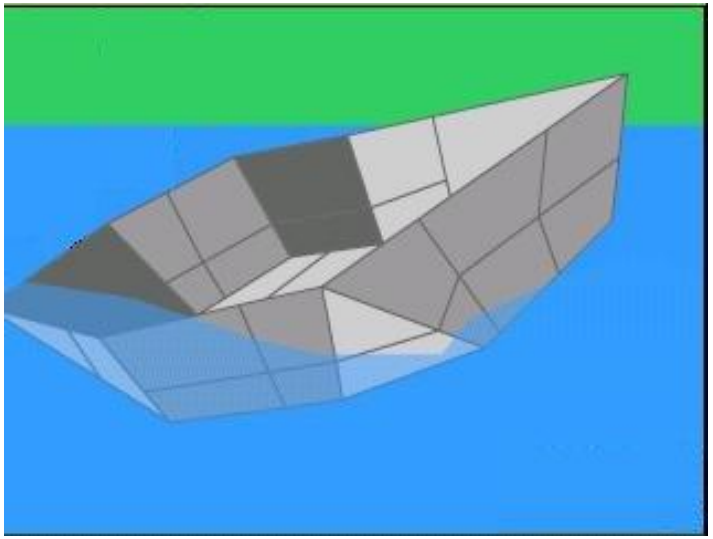
Air space is a factor



By adding space filled with air you are adding very, very little mass. The weight of this mass is spread over a volume.

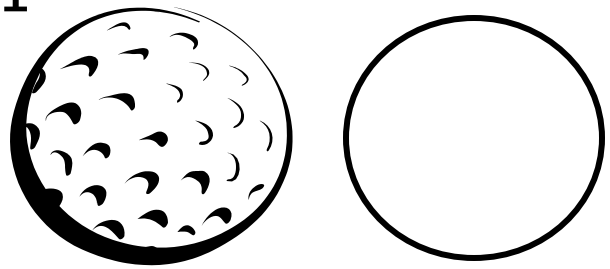
Now you need enough weight to push a bigger volume of water out of the way to allow the boat to sink.

Sink the boat by …



THE 3 Key Buoyancy Concepts for 3rd Graders

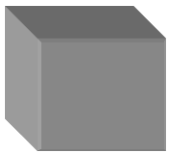
1



Golf ball vs ping pong ball

Sinking force: The object's <u>weight</u> determines the downward force (amount of matter x gravity).

2



Metal block vs metal ship

Buoyant force: The object's <u>size, shape, amount of space it takes up</u> determines the upward force.

3 **Displacement**: When an object sinks in water the water level rises as the water is pushed out of the way by the object.

Buoyancy Vocabulary

Force is a push or a pull. Gravity pulls. Gravity is a force. Magnets pull certain objects and push or pull other magnets. Magnetism is a force.

Buoyant force is initiated by something trying to push water or air out of the way. The water or air pushes back creating the buoyant force.

Mass is how much matter is in something.
Mass is measured in grams.

Weight is how much pushing force an object (a mass) has due to the pull of gravity.
Weight is measured in Newtons or Pounds.

Volume is how much space something takes up.
Volume is measured in Liters or Quarts (& Cubic Centimeters or Cubic inches.

Displacement is the movement of something out of its space.
Displacement can be measured as a volume.

Buoyant force floats my boat!

The weight and size of my boat helps to float my boat and to sink it!