DENSITY and BUOYANCY

What is a Fluid?

- One property that they have in common is the ability to flow and to alter their shape.
- Liquids and gases are both fluids.
- Liquids have a definite volume and gases do not.

Hint

CHECK ANSWERS

Fluid is a liquid or a GAS

Density

- Density = mass / volume
- Mass density is represented by the Greek letter ρ(rho) but we'll use a capital D for density.
- SI units are kg/m^3.


@nile.red
via @ifyouhigh

Making a Lava Lamp

An object's density can help identify the object.

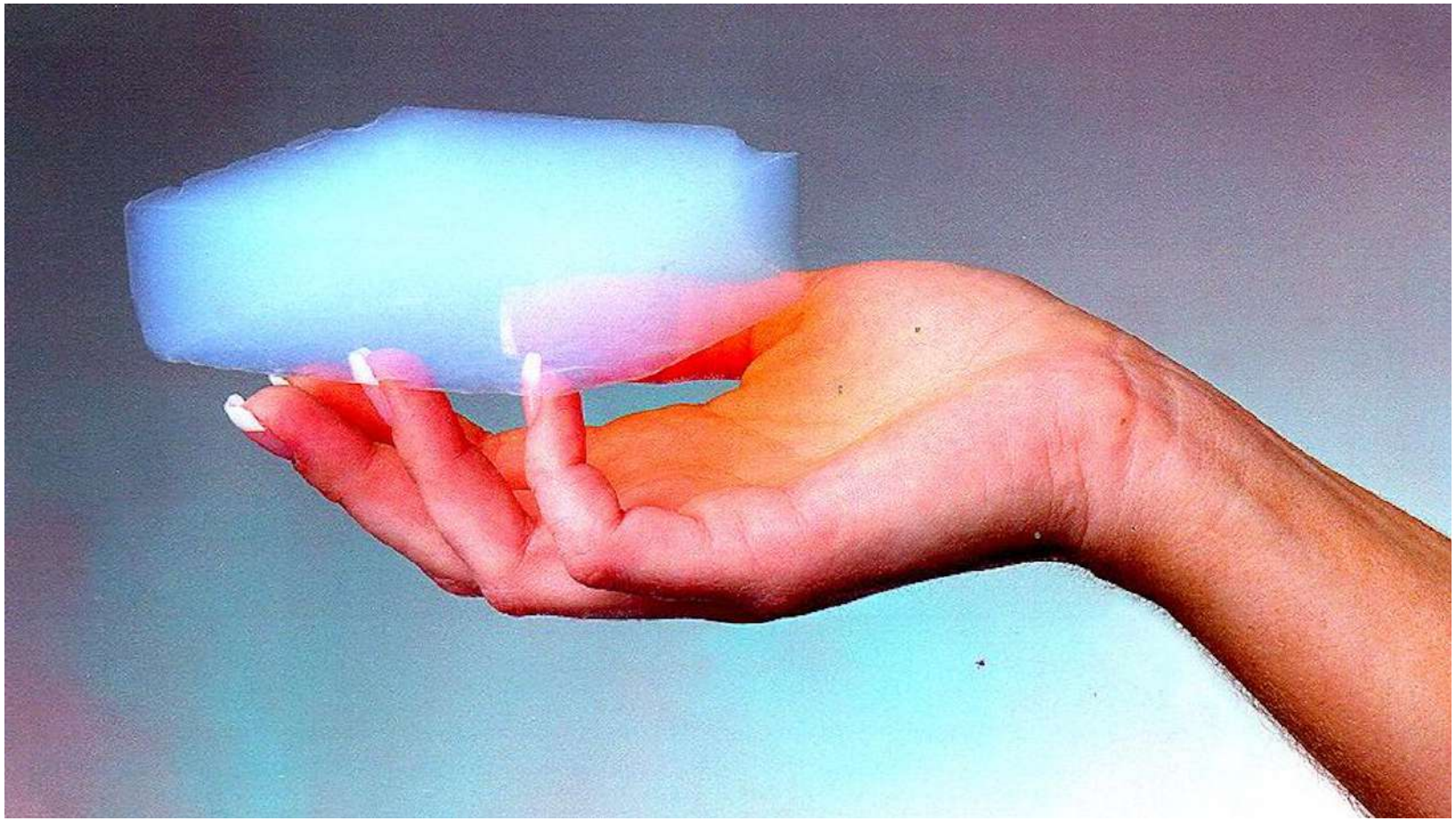
Densities of Some Substances (g/cm^3)

aluminum	2.70
helium (gas, 0°C)	1.78×10^{-4}
copper	8.95
gold	19.3

air (gas, 0°C)	1.29×10^{-3}
ice	0.92
water	1.00
steel	7.80

Aerogel

- Graphene Aerogel is the world's lightest material that only weighs 0.16 milligrams per cubic centimeter.



The density of an object is the object's mass divided by the object's volume: $D = \frac{m}{V}$. Calculate the missing values.

Density (D)	Mass (m)	Volume (V)
	15 g	3.0 cm^3
	2.3 kg	2.0 m^3
7.9 kg/m^3	1.5 kg	
8950 kg/m^3		0.15 kg/m^3

An object's mass is related to its density and volume. Therefore, an object's weight is related to its density.

Mass and Density	Weight and Density
$D = \frac{m}{V}$	$W = mg$
$m = DV$	$W = DVg$

An object with a density less than the density of water will

An object with a density greater than the density of water will

Buoyancy is a property of fluids.

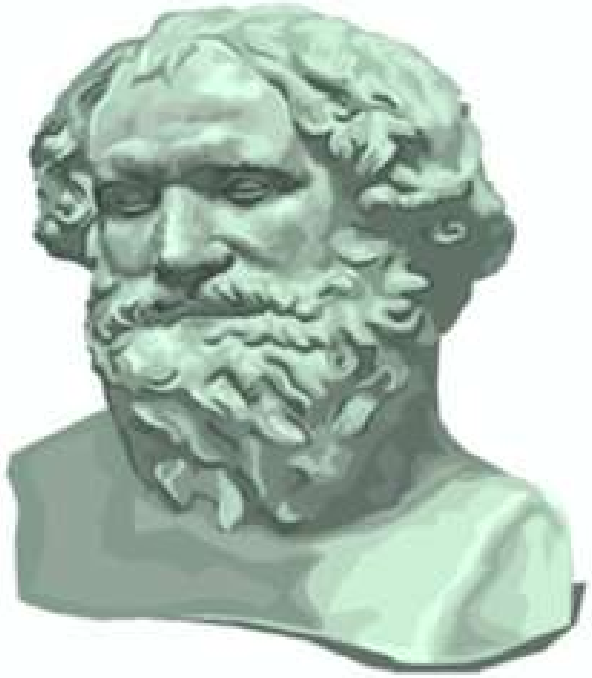
The buoyancy force pushes up on an object in a fluid.

Biography

Archimedes is known for discovering the laws of bouyancy.

Biography

Archimedes was born in 287 BC in Syracuse a Greek colony in Sicily.



Biography

When Archimedes was living in Syracuse he was in the service of King Heiron. The king came to Archimedes one day with a problem.

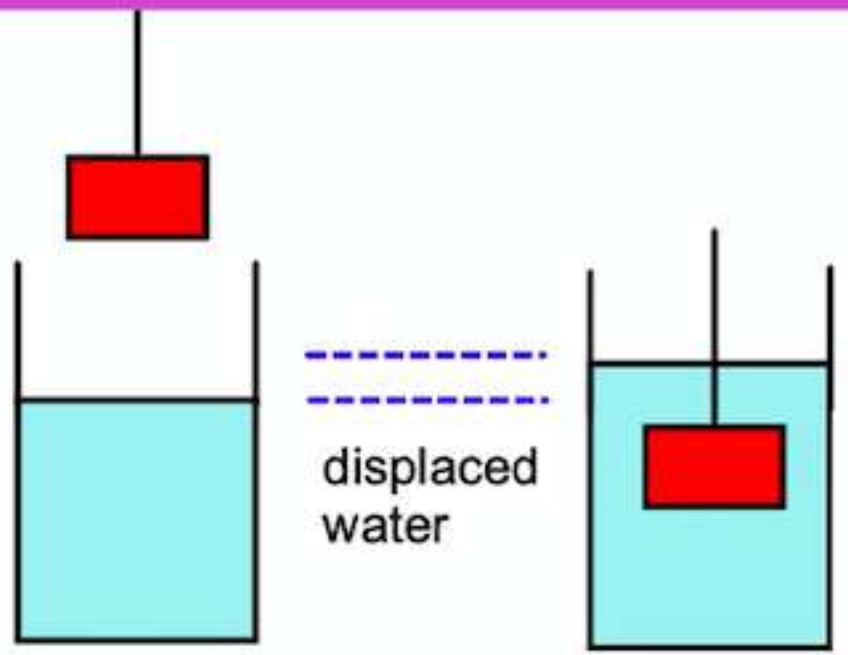
The king had given the goldsmith some gold to make a crown. The king liked the crown but felt the goldsmith possibly had cheated him by filling the crown with silver- and keeping the more valuable gold for himself.

Archimedes continued to think about how he could determine whether or not the crown was pure gold. It was not until he got into the bathtub, he realized how he could determine the make up of the crown.

Since the density of gold and silver differs, Archimedes discovered the goldsmith's dishonesty.

Does weight added make the water rise?

Immerse an object in water, and the object will displace some water. Fill in the blank with the correct term.

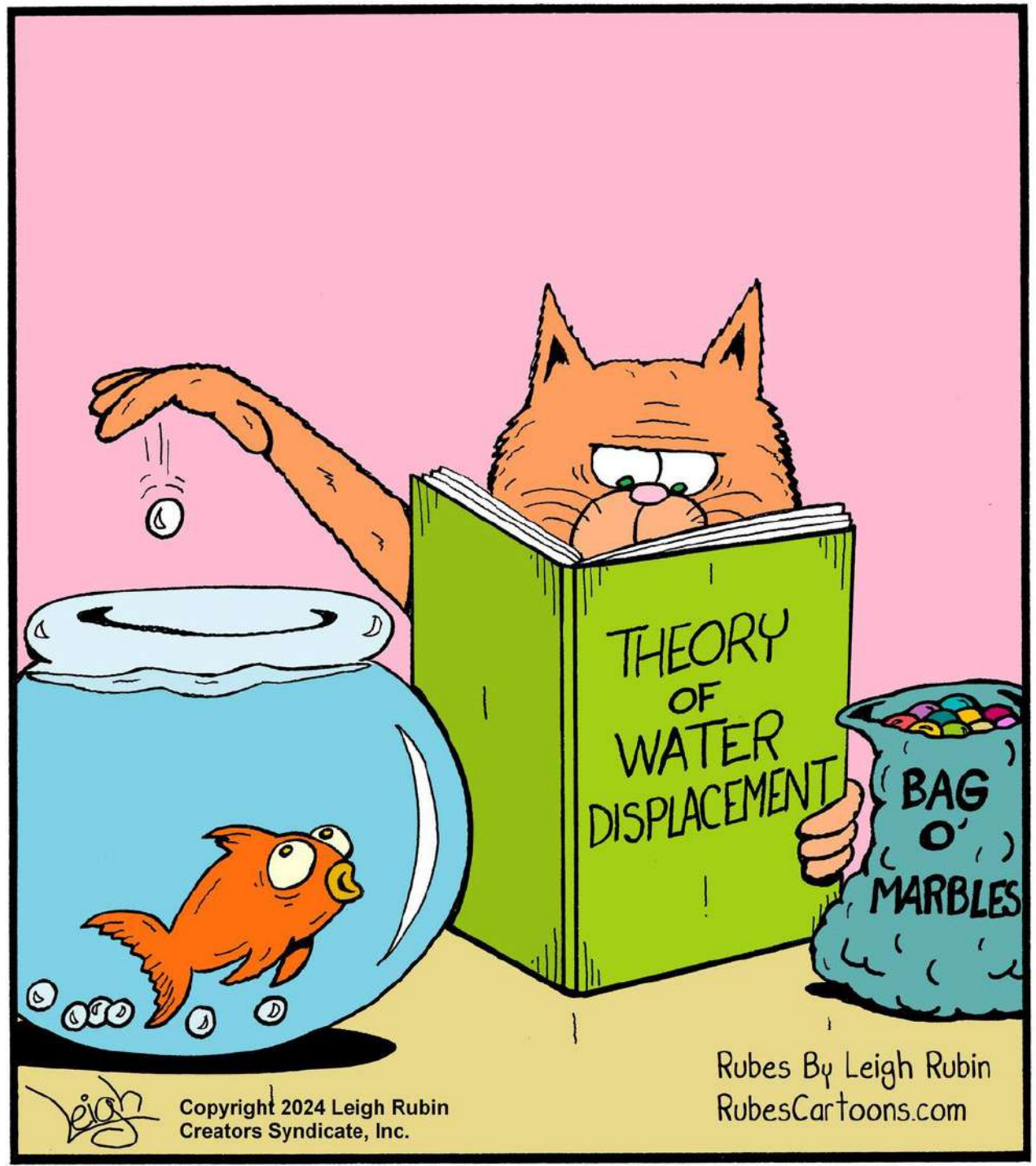


The weight of the displaced water is the _____.

Remember!

Archimedes' Principle

CHECK ANSWERS


THEORY OF WATER DISPLACEMENT
BAG O' MARBLES
Rubes By Leigh Rubin
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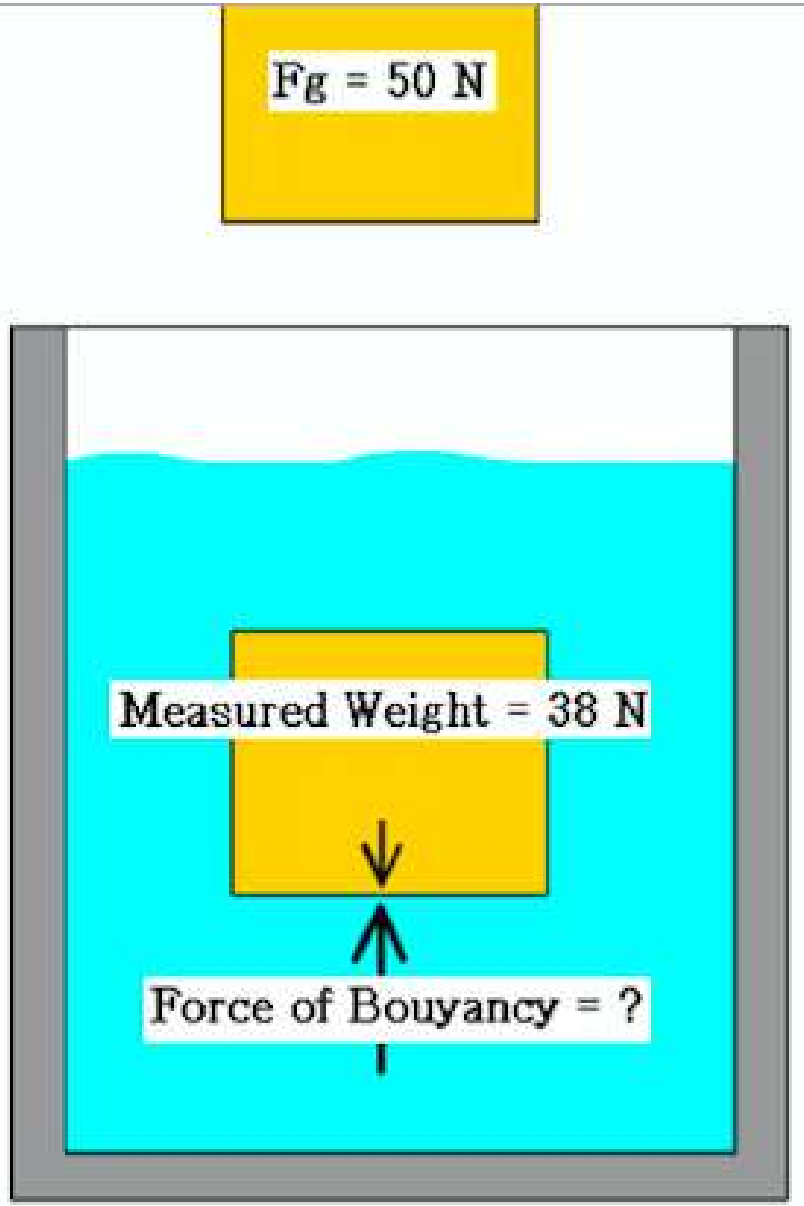
- If submerged:
- $F_B = F_g -$ apparent weight (measured)




DSC

Action and Reaction Forces

As the water surface rises, the finger will be subject to upward buoyancy. According to Dun's third law, the finger will have a downward reaction force on the water. The deeper the finger, the greater the force.

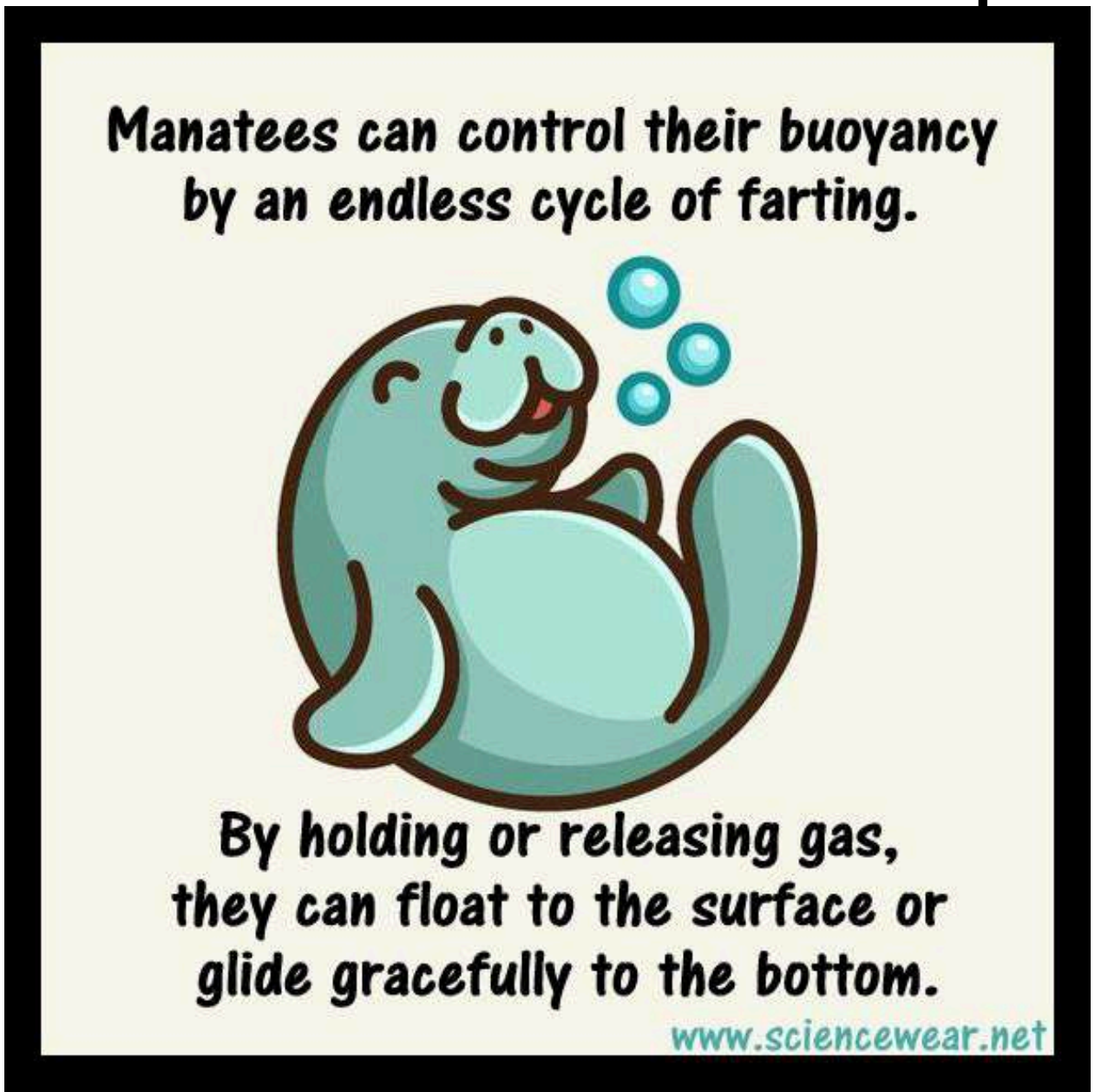
All About Physics

Changing Buoyancy

- A fish can adjust its average density by inflating or deflating an organ called the swim bladder.
- A fish fills its swim bladder with gas by gulping air at the surface.
- It empties its bladder by secreting gas from the gas gland in the swim bladder.

Barotrauma

No swim bladder? No problem!




FabFacts
Shark have no air bladder,
so they must swim constantly
or else they will sink.

Sharks (no swim bladder)

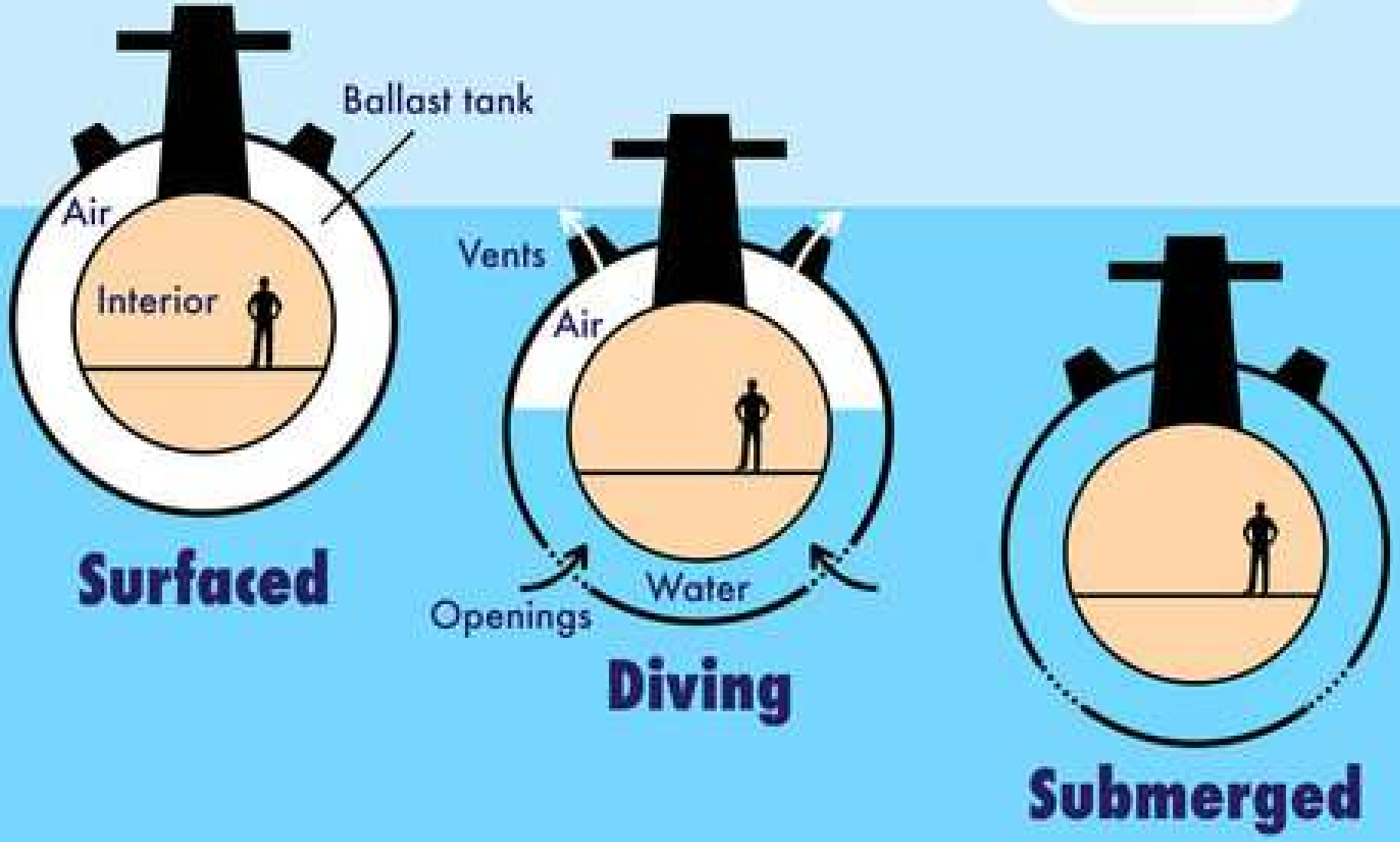
- 1. They are not made of bone but instead cartilage which is much lighter or less dense than bone.
- 2. They have a large liver which helps with buoyancy.
- Density of sea water is about 1.03 g/cm3
- Density of a shark is about 1.1 g/cm3
- Sharks are not naturally buoyant so they use their tail and fins.

Sharks don’t have swim bladders

Changing Buoyancy

- A submarine also can change its buoyancy similar to a fish.
- Instead of a swim bladder, a sub has a ballast tank that can pump in compressed air and pump out water to rise to the surface.
- To dive, the ballast tank takes in water and pushes out the compressed air.

How submarines work



Force and Density of objects are directly related

- $F_g / F_B = D_o / D_f$
- D_o = Density of Object
- D_f = Density of Fluid
- D_f (of Water) = 1000 kg/m^3
- Density of Water is a known like gravity = -9.8

Sample Problem 9A

- To find if a gold crown is real gold, we measure it and get a weight of 7.8N. The we stick it in a tank of water and measure it to be 6.86N. Is it gold?

- Knowns?
- Unkwown?
- Equation?

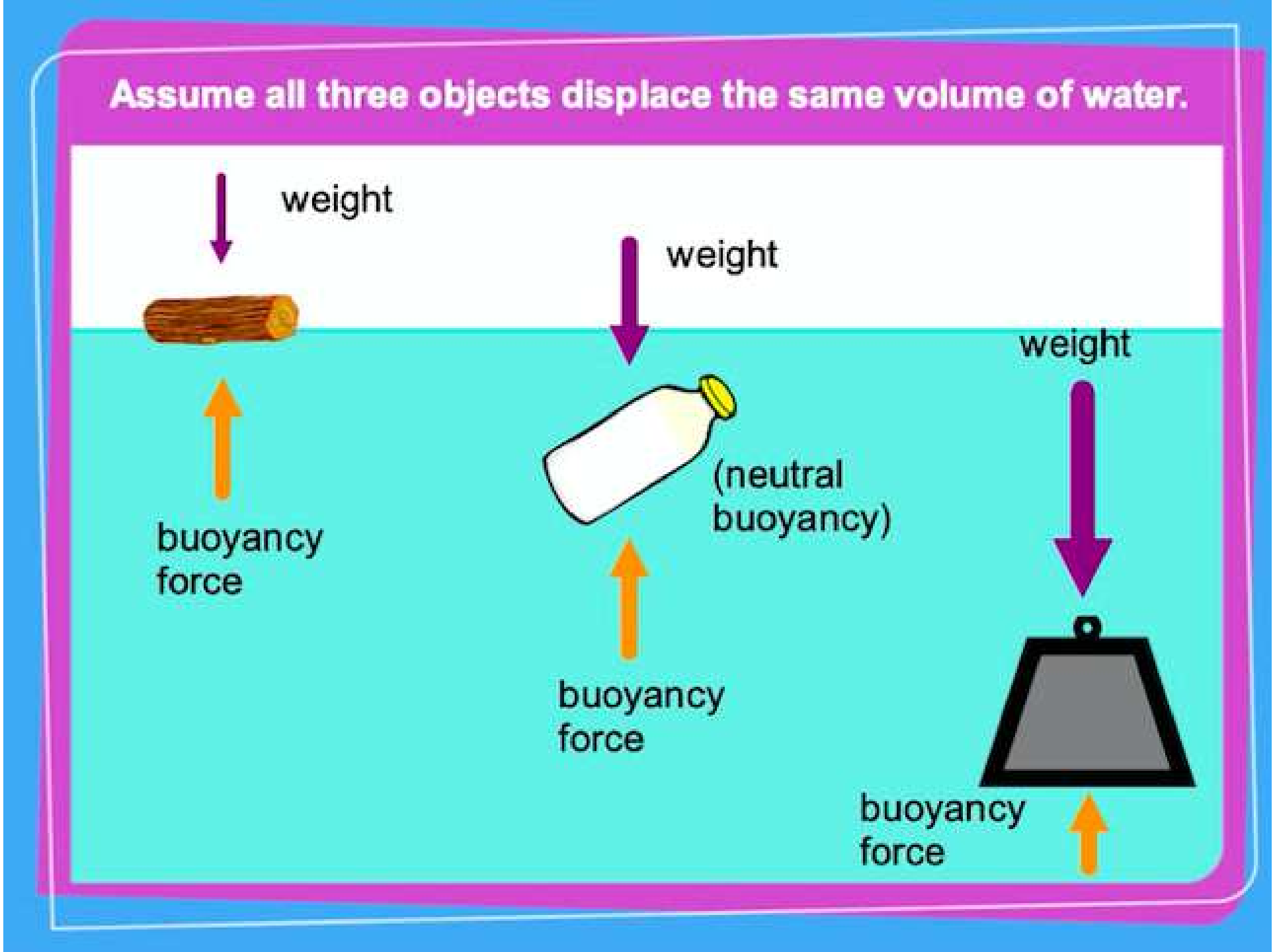
More Equations

- Weight is F_g
- $F_g = D_f V g$
- $F_B = D_f V g$ (If object is floating)
- $V = l \times w \times h$ (rectangle)
- $V = 4/3\ \pi r^3$ (sphere)

Last Equation

- $M_t = (D_f V) - m_o$ (Used to find how much weight a floating object can hold)
- If I have a floating mattress or other object, the question is how much mass can the mattress or object hold before sinking?
- m_o = the mass of the floating object

The difference between an object's weight and the buoyancy force determines whether the object will sink or float.


Assume all three objects displace the same volume of water.
weight
buoyancy force
weight
(neutral buoyancy)
buoyancy force
weight
buoyancy force

Why do some objects float...

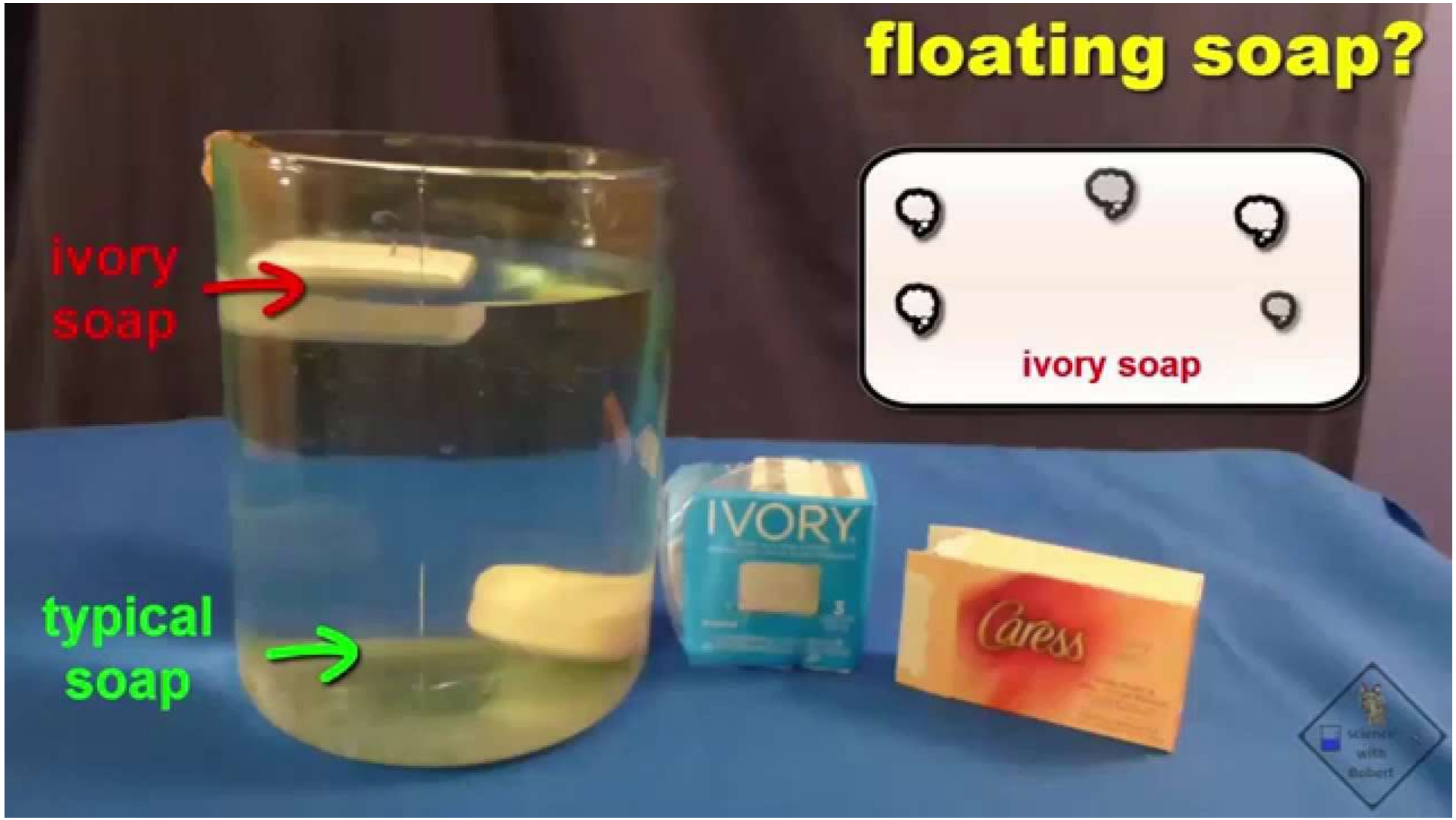
while other objects sink?

Pumice Rock

Coke versus Diet Coke

Galileo’s Thermometer

Ivory Soap versus Others



Steel Balls; How does a steel ship float?

The hull of a ship is designed to contain a large volume of ____. The density of_____ is less than the density of steel. The overall density of the ship is _____ than the density of _____. The ship _____.

The hull of a ship is designed to contain a large volume of air. The density of air is less than the density of steel. The overall density of the ship is less than the density of water . The ship floats .

Float or sink?

weight is less than buoyancy force

weight equals buoyancy force

weight is greater than buoyancy force

_____ _____ _____

_____ _____ _____

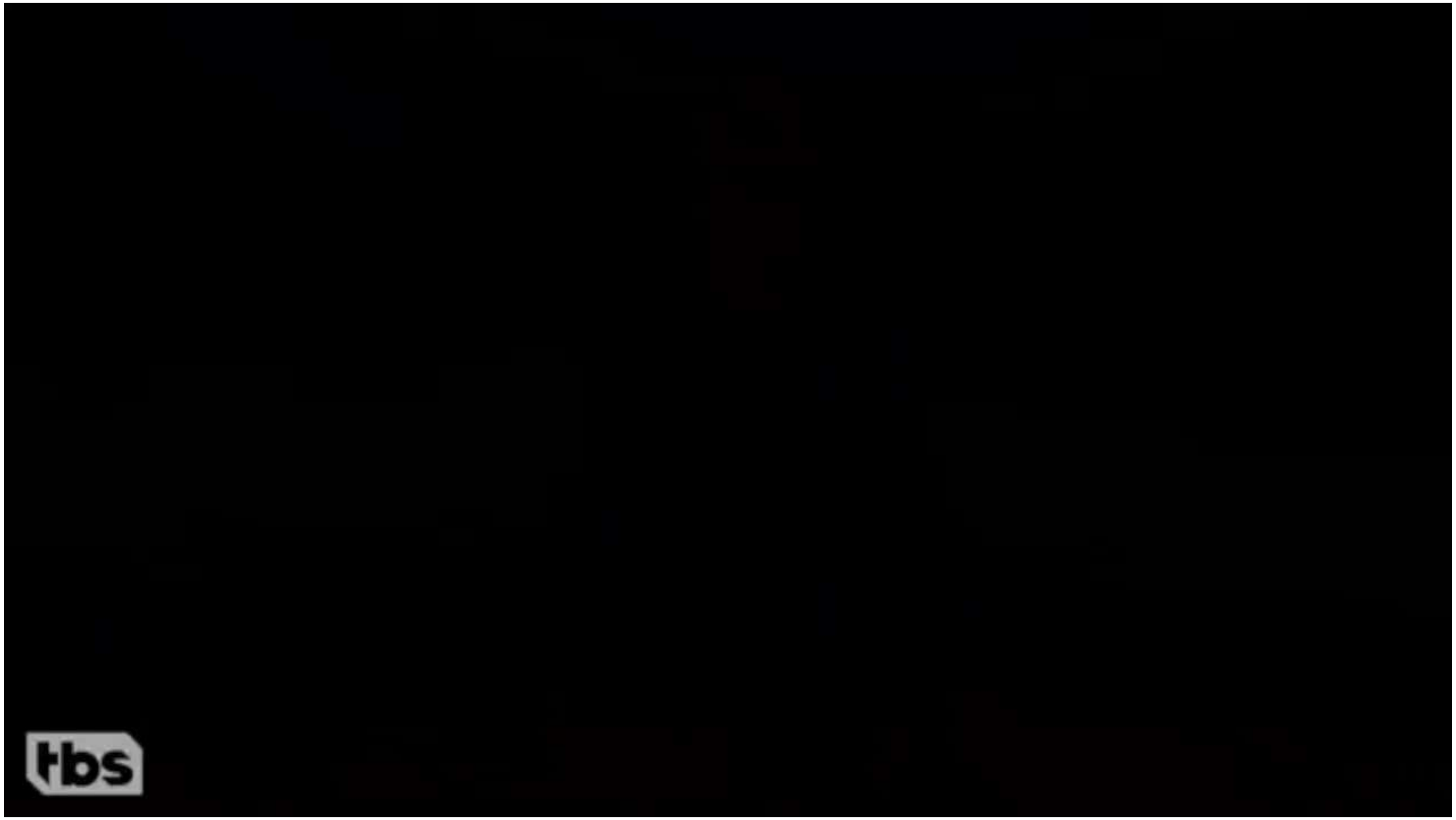
Complete the table by dragging in either the log or weight to determine if the listed objects will float or sink in water.

Object	Density (g/cm3)	Sink or Float
Moon	3.35	
penny	8.95	
ice	0.92	
gold medal	19.3	
silver pendant	10.5	
Saturn	0.69	

float

sink

CHECK ANSWERS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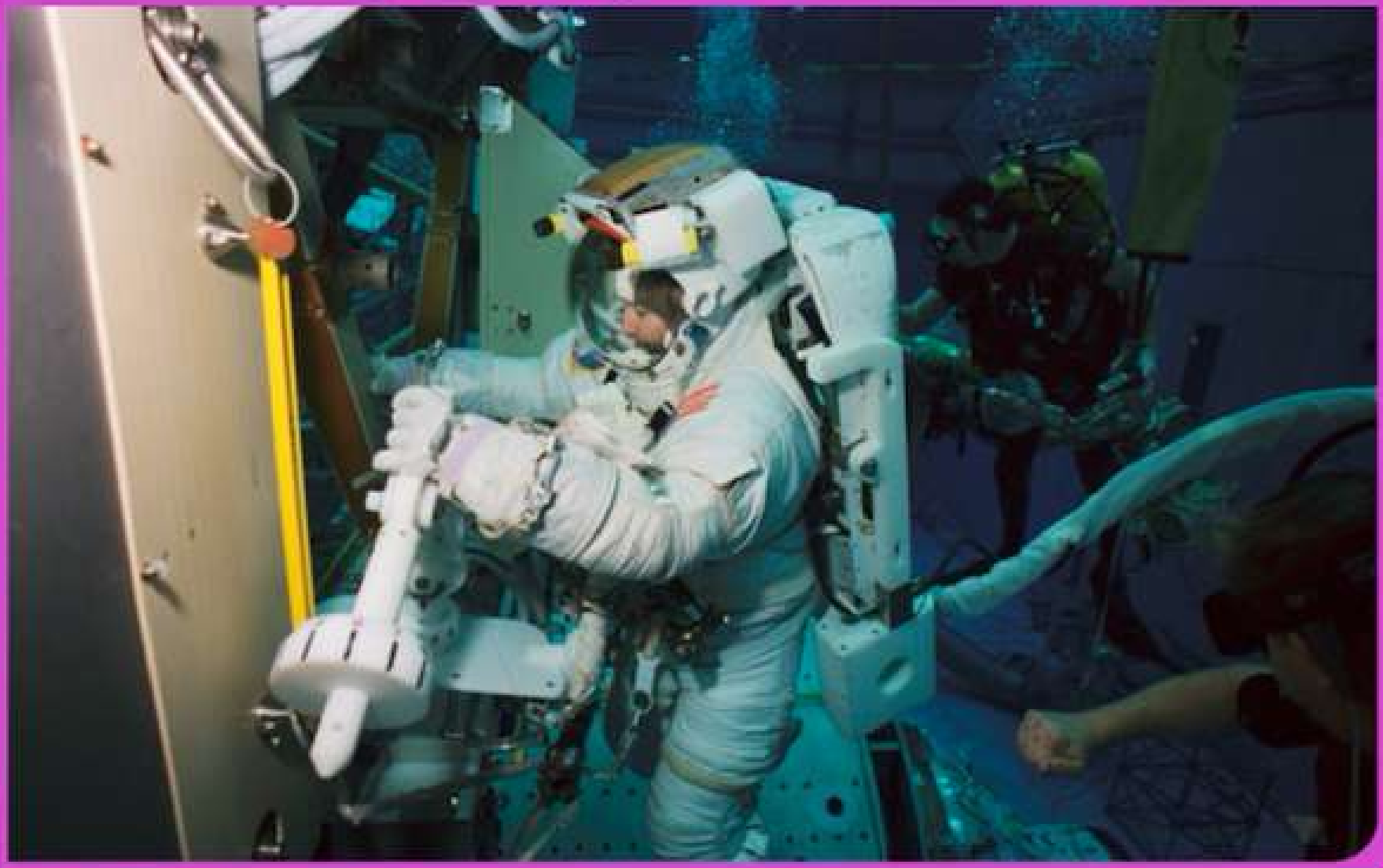
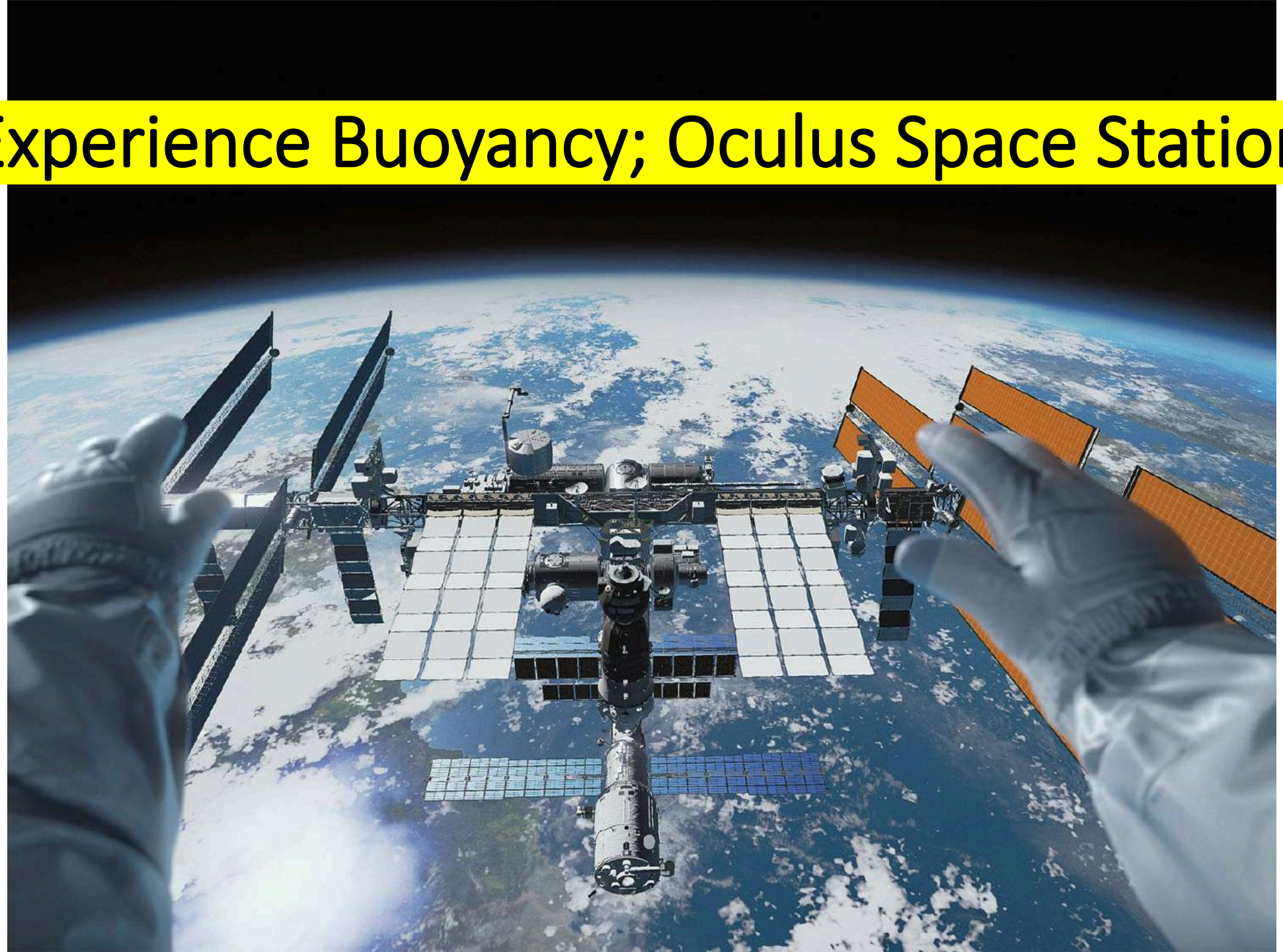
Being in space is similar to being in a neutral buoyancy environment.

Swimming tanks can simulate a neutral buoyancy environment.

Astronauts train at the Neutral Buoyancy Lab in Houston, Texas, before going into space.



Experience Buoyancy; Oculus Space Station



Vaping is bad! But cool video….

Catching a Bubble & Do Bubbles Float?