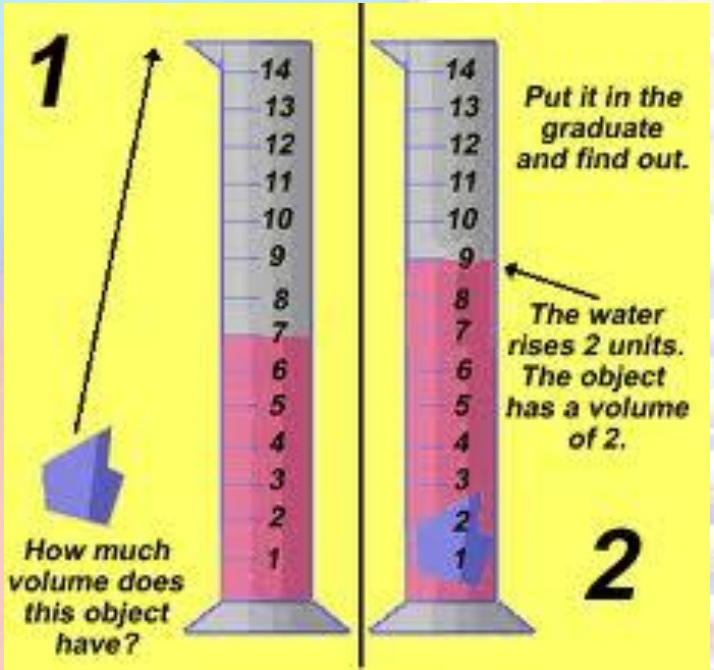
Density and Buoyancy Notes

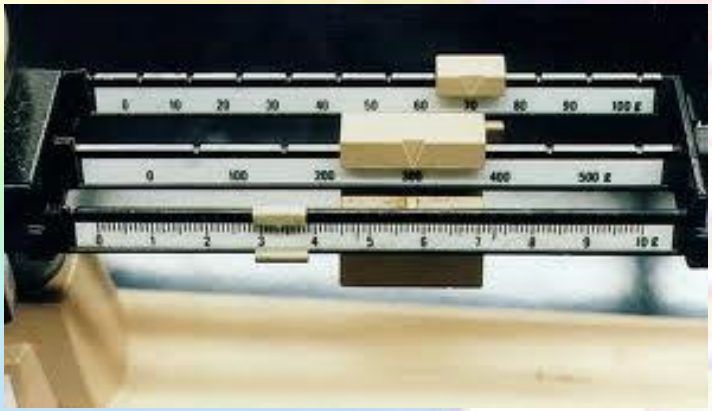
Measuring Mass and Volume

- A balance can be used to measure the mass of an object.
- If the object is a liquid, pour it into a graduated cylinder to measure the volume.



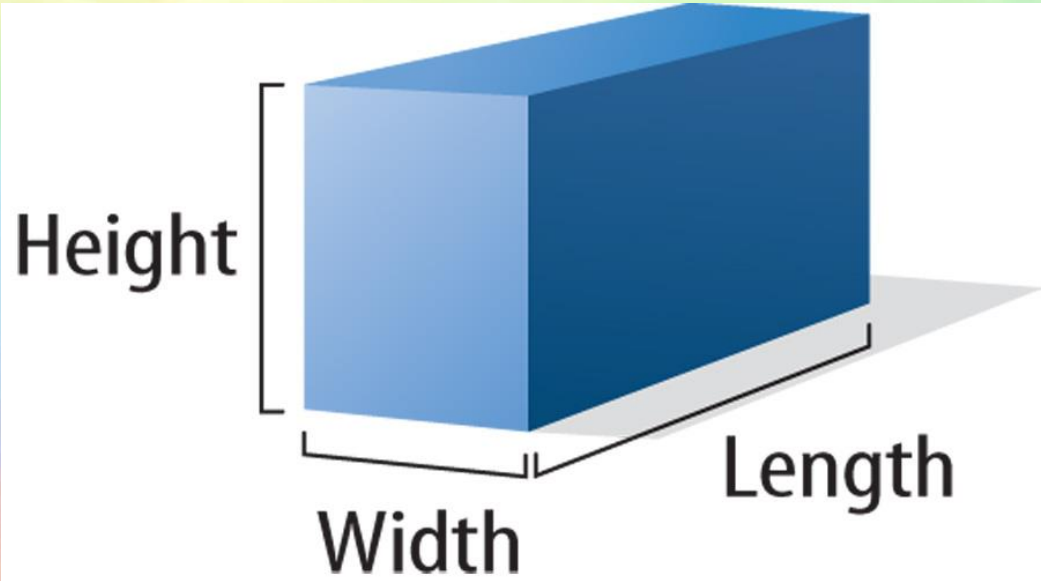
Mass

- The amount of matter a substance has.



Measuring Volume

- A **rectangular solid** is a six-sided block in which all sides are rectangles.



Measuring Volume (cont.)

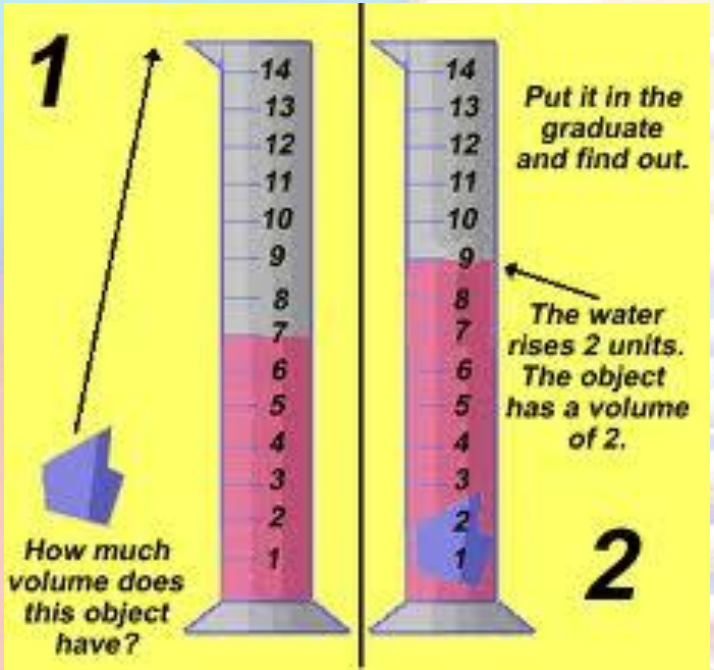
- If the object is a rectangular solid, calculate the volume using the equation volume:

$$\text{volume (cm}^3\text{)} = \text{length (cm)} \times \text{width (cm)} \times \text{height (cm)}$$
$$V = l \times w \times h$$

- If the object is an irregular solid, you must calculate volume using the displacement method.

Using the Displacement Method

- Displacement occurs when an object is placed in a liquid.
- The object pushes aside (displaces) an amount of liquid equal to its volume.



Density Notes

Density

- **Density** is the amount of mass per unit volume of a material.
- Matter is made of particles—atoms or molecules.
- Density depends on how tightly packed the particles are.

Calculating Density

$$\text{density (in g/cm}^3\text{)} = \frac{\text{mass (in g)}}{\text{volume (in cm}^3\text{)}}$$

$$D = \frac{m}{V}$$

- Units are always mass unit divided by volume unit, such as g/cm^3.
- Using the density equation, if any two variables are known the missing variable can be calculated.

Try It!!!!!! Write in your notebook

- If an object has a volume of $10cm^3$ and a mass of 50g, what is it's density?
- If an object has a volume of $10cm^3$ and a density of 2 g/cm^3 what is the Mass?
- If an object has a density of 10 g/cm^3 and a mass of 2g what is its Volume?

Density and Materials

- Density depends only on the material the object is made from.
- No matter how small the pieces of a chocolate bar are, they always have the same density because they are all made of chocolate.

Density and Materials (cont.)

- The density of a material depends on the mass of the particles it is made from.
- A single gold atom contains about 7 times the mass of a single aluminum atom, so gold is more dense than aluminum.

Density and Materials (cont.)

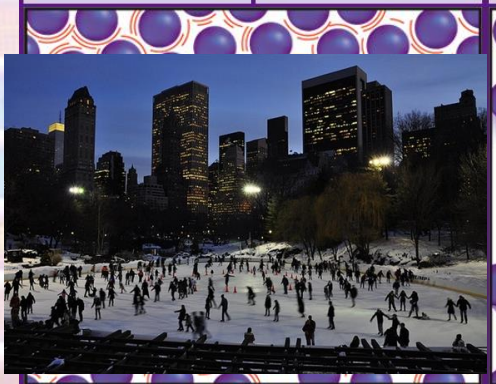
- As distance between particles increases, density decreases.
- Gas particles are very far apart compared to liquids and solids, and gases are usually less dense than solids and liquids.



Density and Materials (cont.)

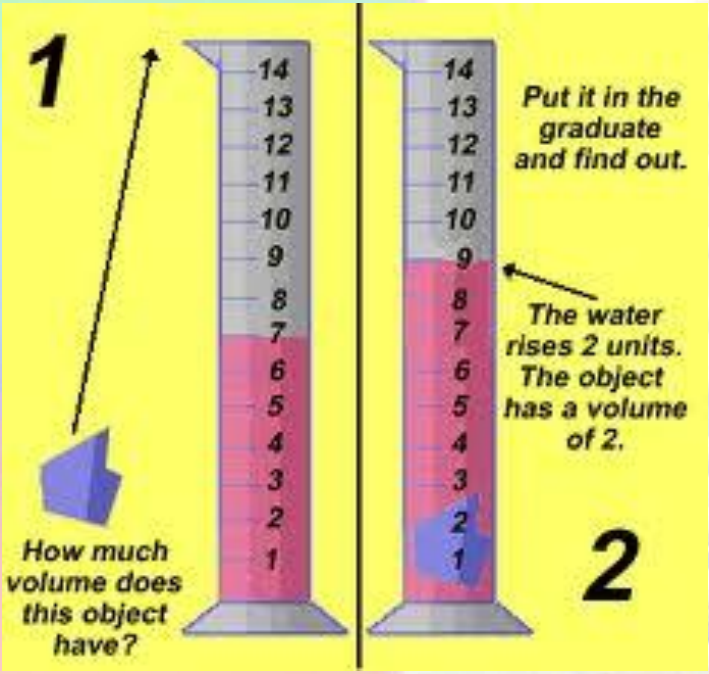
Table 1 Densities of Some Common Materials

Solids		Liquids		Gases	
Material	**Density (g/cm^3)**	**Material**	**Density (g/cm^3)**	**Material**	**Density (g/cm^3)**
Butter	0.86	Gasoline	0.74	Hydrogen	0.00009
Ice	0.92	Sunflower oil	0.92	Helium	0.00018
Aluminum	2.70	Water	1.00	Air	0.00129
Copper	8.96	Milk	1.03	Oxygen	0.00143
Gold	19.28	Mercury	13.55	Carbon dioxide	0.00198



Measuring Density

- To measure density you must know the mass of an object and the volume of the object.



Density as a Physical Property

- A physical property is a property of a material that can be measured without changing the material.
- Measuring density does not change one material into another, so it is a physical property.

LESSON 1 Review

CheckPoint

Density equals _____ divided by volume.

A force

B matter

C solid

D mass

LESSON 1 Review

CheckPoint

Density _____ as the distance between particles in an object _____.

A increases; decreases

B increases; increases

C decreases; decreases

D none of the above

LESSON 1 Review

CheckPoint

Calculate the volume of a rock that has a mass of 12 g and a density of 3 g/cm^3.

A 9 cm^3

B 15 cm^3

C 4 cm^3

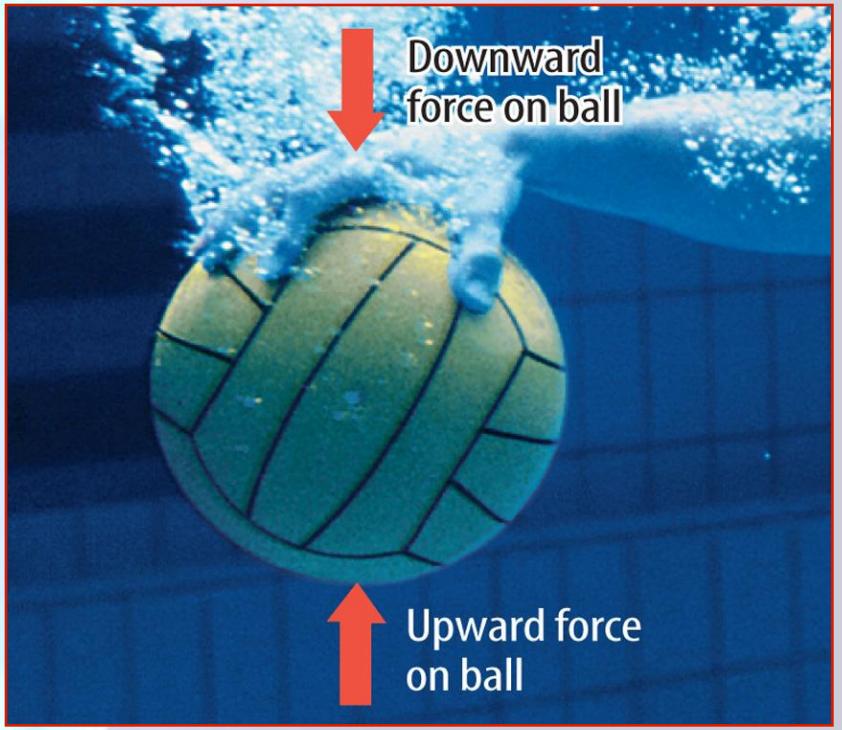
D 4 cm

Buoyancy Notes

Pressure in a Fluid

- Liquids and gases are **fluids**—materials that can flow and have no definite shape.

- Objects in a fluid experience a buoyant force resulting from the pressure exerted by the fluid.



What is pressure?

- **Pressure** is the force per unit of area applied on the surface of an object.
- Pressure depends on the force applied and the area of contact over which the force is applied.

Calculating Pressure

- To calculate pressure, use the equation:

$$\text{pressure (in pascals)} = \frac{\text{force (in newtons)}}{\text{area (in meters squared)}}$$

$$P = \frac{F}{A}$$

- A pressure of 1 Pa is equal to the force of 1 Newton applied over an area of 1 m^2, or 1 Pa = 1 N/m^2.

Pressure and Fluid Height

- For any fluid, pressure depends only on the height of the column of fluid above the surface.

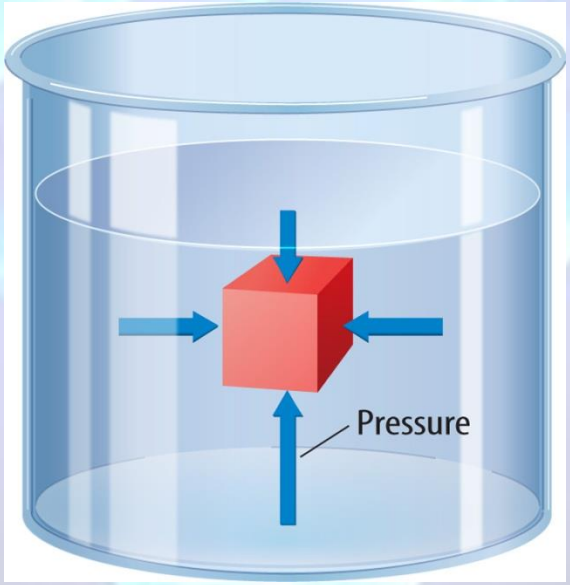
- Increasing the height of the column of fluid increases the pressure.

Pressure and Depth

- Pressure increases with depth.
- The water column pushing down becomes taller and heavier with increasing depth.

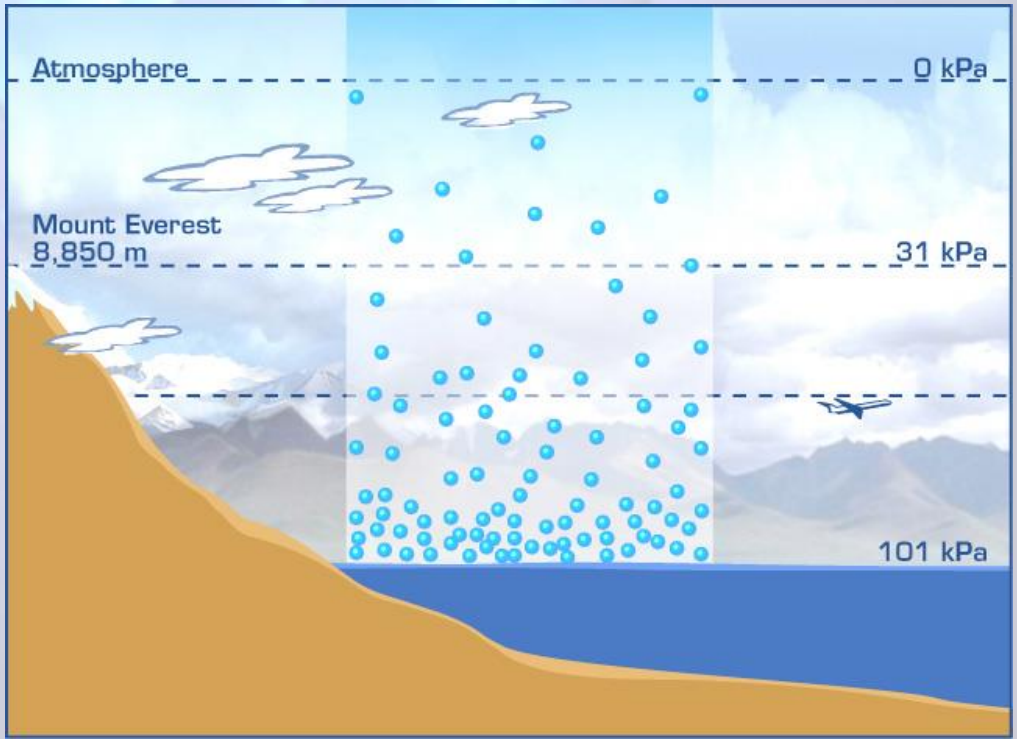
Pressure in All Directions

- Fluids exert a pressure in all directions on an object.
- The pressure is perpendicular to the surface of the object.



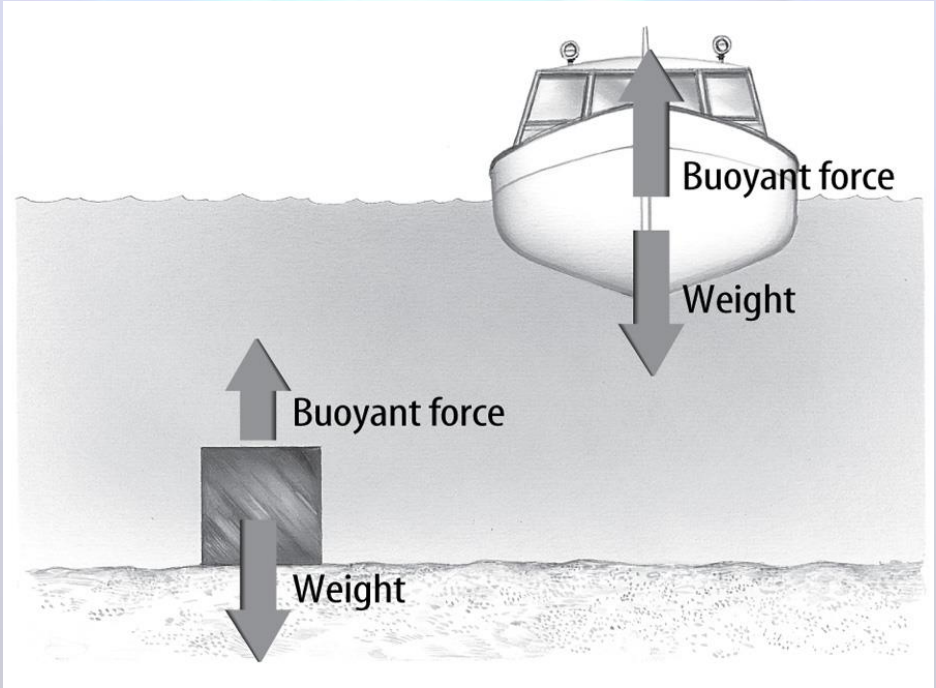
Atmospheric Pressure

- **Atmospheric pressure** is the force exerted per unit area by air particles.
- Atmospheric pressure decreases as elevation increases.



What causes buoyant force?

- **Buoyant force** is the upward force on an object in a fluid exerted by the surrounding fluid.

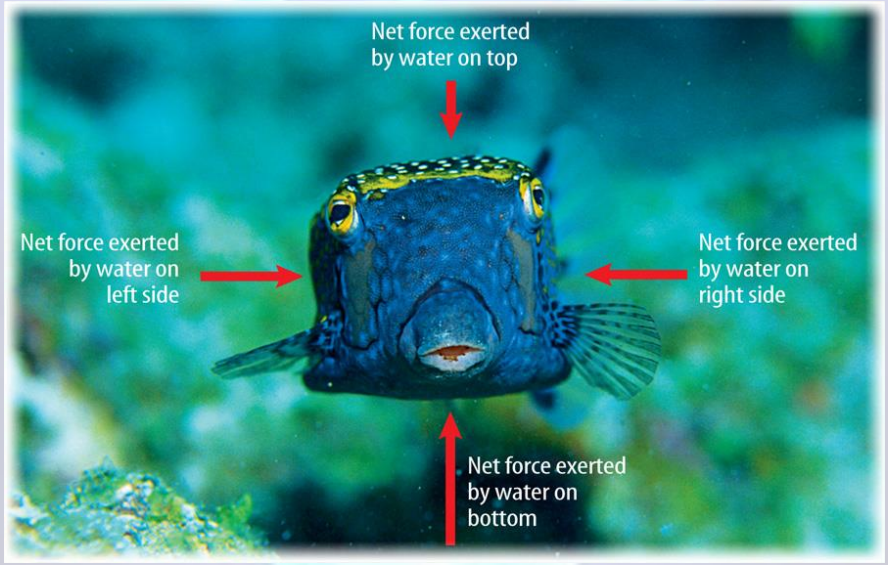


What causes buoyant force? (cont.)

- Buoyant force is the result of increasing pressure at increasing depth.
- **Pressure on the top of the object is less than the pressure on the bottom of the object**, *resulting* in an ***unbalanced force***.

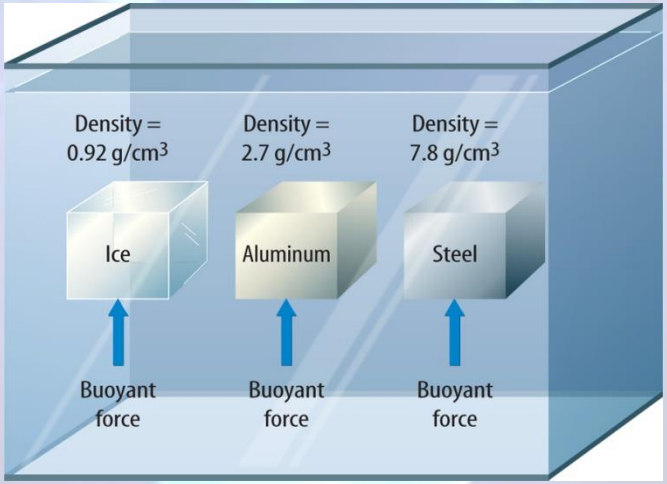
Buoyant Force and Depth

- The pressure exerted by a fluid increases as depth increases.
- The buoyant force remains constant on a submerged object.



Archimedes' Principle

- According to the **Archimedes' principle,** the buoyant force on an object is equal to the weight of the fluid the object displaces.
- The buoyant force does not depend on the object's density or weight.



LESSON 2 Review

CheckPoint

Pressure is the _____ per unit area.

A mass

B volume

C force

D pascal

LESSON 2 Review

CheckPoint

Which direction does the buoyancy force act on an object?

A upward

B downward

C to the left of the object

D to the right of the object

LESSON 2 Review

CheckPoint

Where is the pressure the greatest on an object in a fluid?

A top

B bottom

C sides

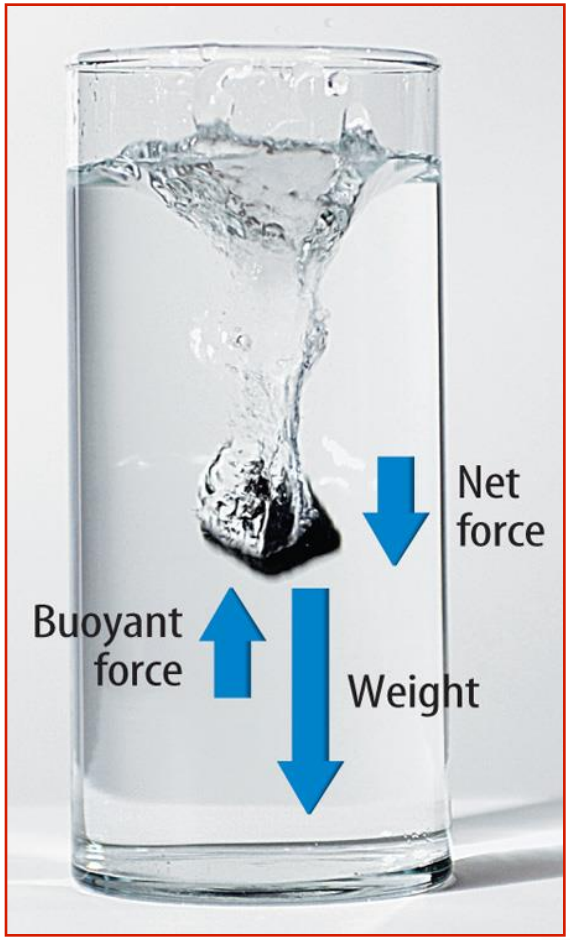
D none of the above

Why do objects sink or float?

- An object will float in a fluid if the density of the object is less than the density of the fluid.
- Fluids exert pressure on any object in the fluid.
- Gravity and the buoyant force act on the object in opposite directions.

Sinking and Buoyant Force

- If the upward buoyant force is less than the object's weight, the net force on the object is downward.
- The object accelerates downward because of the unbalanced force.

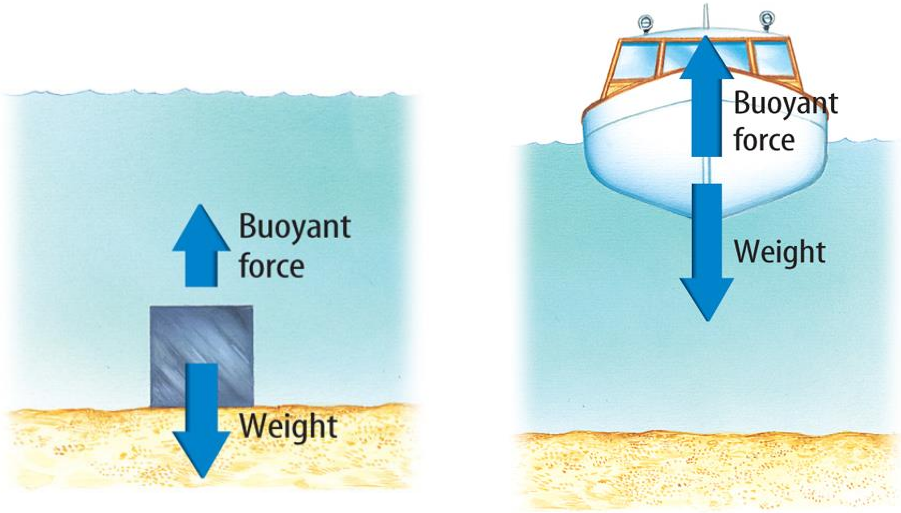


Floating and Buoyant Force

- When an object in a fluid isn't accelerating, the forces are balanced.
- The weight of the woman is balanced by the buoyant force pushing upward on the woman.

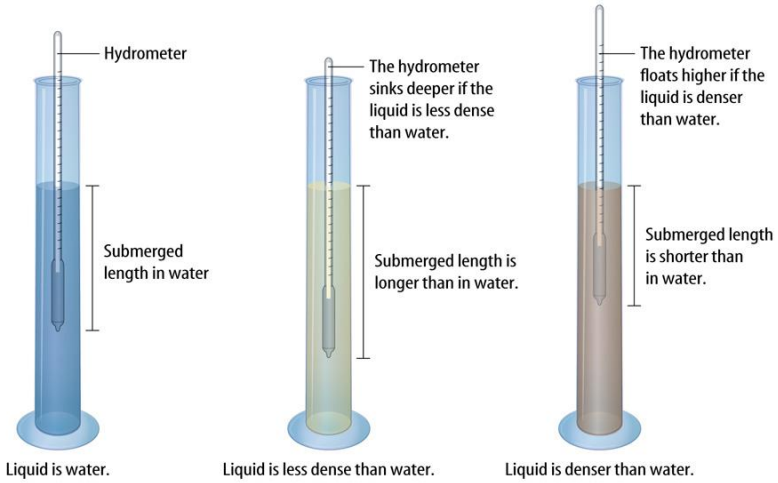
How can metal boats float?

- Almost all metals have a density greater than the density of water.
- The overall density of the ship is less than the density of water because a large volume of the ship is filled with air.



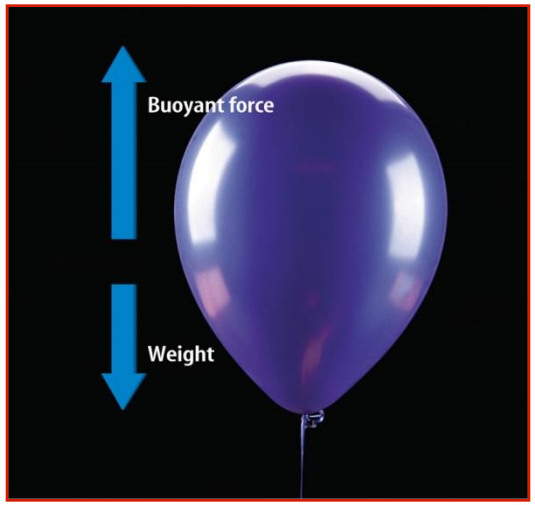
Measuring Density with a Hydrometer

- A **hydrometer** is an instrument that measures the density of a liquid.
- When placed in a liquid, it sinks to a certain depth depending on the density of the liquid.



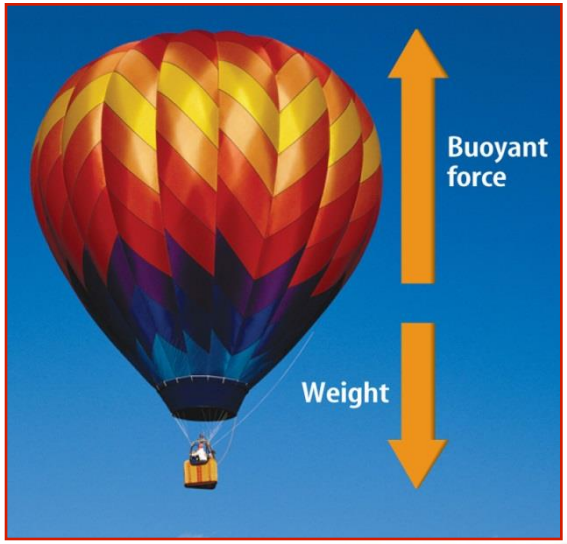
Floating and Sinking in the Atmosphere

- Air produces a buoyant force.
- Helium balloons float in air because its weight is less than the buoyant force.
- The density of the balloon is less than the density of the surrounding air.



Floating and Sinking in the Atmosphere (cont.)

- Hot-air balloons float when their weight is less than the weight of displaced air.
- Heat from the burner heats the air particles and causes them to move farther apart.
- The density of the balloon decreases and becomes less dense than the surrounding air.



LESSON 3 Review

CheckPoint

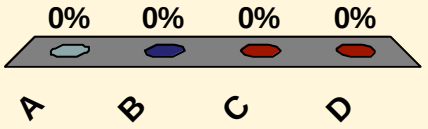
What does a hydrometer measure?

A mass of a solid

B density of a solid

C mass of a liquid

D density of a liquid



LESSON 3 Review

CheckPoint

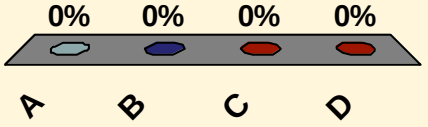
Why does a hot-air balloon float?

A The surrounding air is denser than the balloon.

B The surrounding air is less dense than the balloon.

C The balloon is denser than the surrounding air.

D The balloon has less mass than the surrounding air.



LESSON 3 Review

CheckPoint

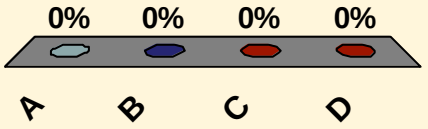
Why does an object sink in water?

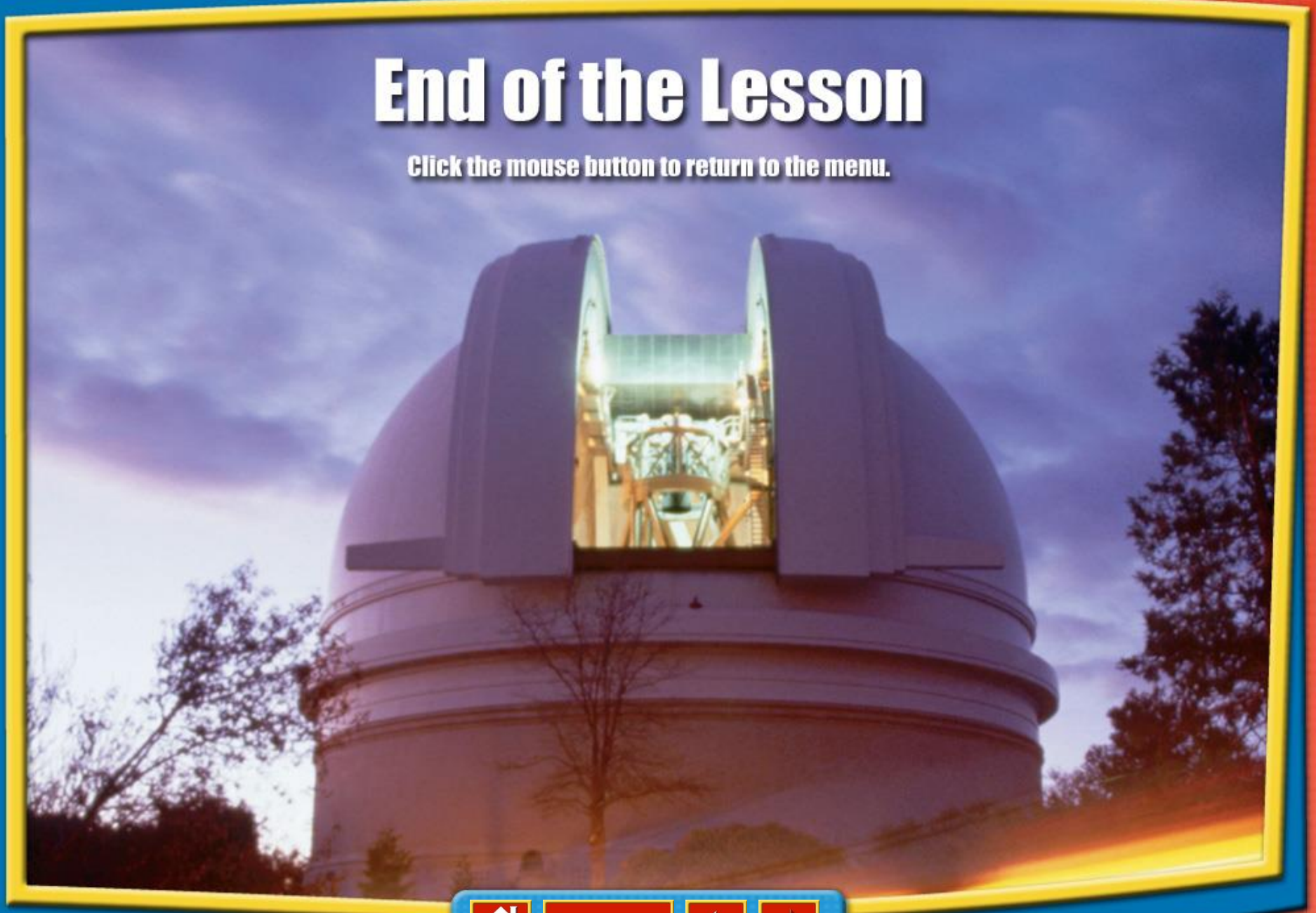
A The object is denser than water.

B The buoyant force is greater than the object's weight.

C The buoyant force is greater than the object's mass.

D The object is less dense than water.




End of the Lesson
Click the mouse button to return to the menu.
HOME
Resources

Chapter Resources Menu

Click on a hyperlink to view the corresponding feature.

CHAPTER Assessment

CheckPoint

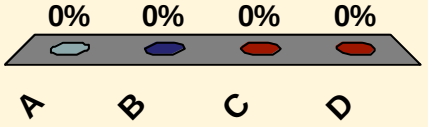
Gold has a density of 19.3 g/cm^3 and silver 10.5 g/cm^3. Which statement is true?

A Gold will float in water but silver will sink.

B Silver will float in water but gold will sink.

C The volume of 19.3 g of gold is less than the volume of 21 g of silver.

D Gold weighs more than silver.



CHAPTER Assessment

CheckPoint

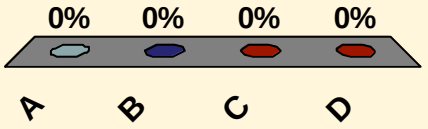
What does the weight of the fluid displaced by an object held under water equal?

A the normal force on the object

B the mass of the object

C the buoyant force on the object

D the volume of the object



CHAPTER Assessment

CheckPoint

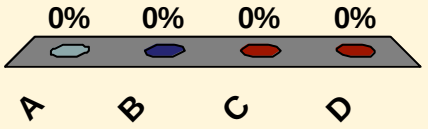
Gold has a density of 19.3 g/cm^3. What is the volume of 19.3 g of gold?

A 19.3 cm^3

B 5 g/cm^3

C 15 g/cm^3

D 1 cm^3



CHAPTER Assessment

CheckPoint

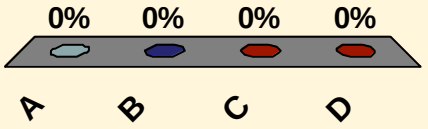
Which exerts the greatest pressure at the bottom of the column?

A a column of water 5 m high

B a column of water 3 m high

C a column of water 1 m high

D cannot be determined



CHAPTER Assessment

CheckPoint

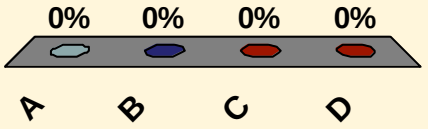
A column of fluid 5 m high weighs 100 N. The column covers an area of 0.25 m^2. What is the pressure exerted by the fluid at the top of the column?

A 25 pascals

B 20 pascals

C 5 pascals

D 0 pascals



Standards Practice

CheckPoint

SCI 8.a

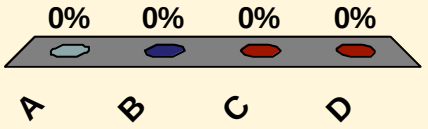
Density is mass per unit _____.

A force

B matter

C pressure

D volume



Standards Practice

CheckPoint

SCI 8.b

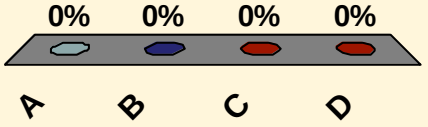
A 15g object is placed in a graduated cylinder of water. The water level is at 24 ml. When the object is removed, the water level is at 19 ml. What is the density of the object?

A 5 g/cm^3

B 4 g/cm^3

C 3 g/cm^3

D 19 g/cm^3



Standards Practice
CheckPoint
SCI 8.c

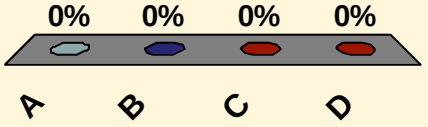
A toy boat weighs 120 N. If the boat floats in water, which describes the buoyant force acting on the boat?

A 60 N upward

B 240 N upward

C upward and equal to the weight of water displaced by the boat

D upward and equal to the total volume of the boat



Standards Practice

CheckPoint

SCI 8.d

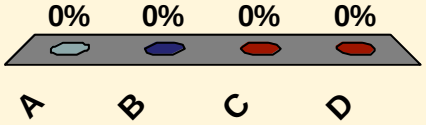
An object with a mass of 9 g displaces 3 ml of water. It is placed in a fluid with a density of 2 g/cm³. The object _____ in the fluid.

A floats

B sinks

C loses mass

D becomes denser



Standards Practice

CheckPoint

SCI 8.d

An object that is _____ than water will _____.

A less dense; sink

B denser; float

C less dense; lose mass

D denser; sink