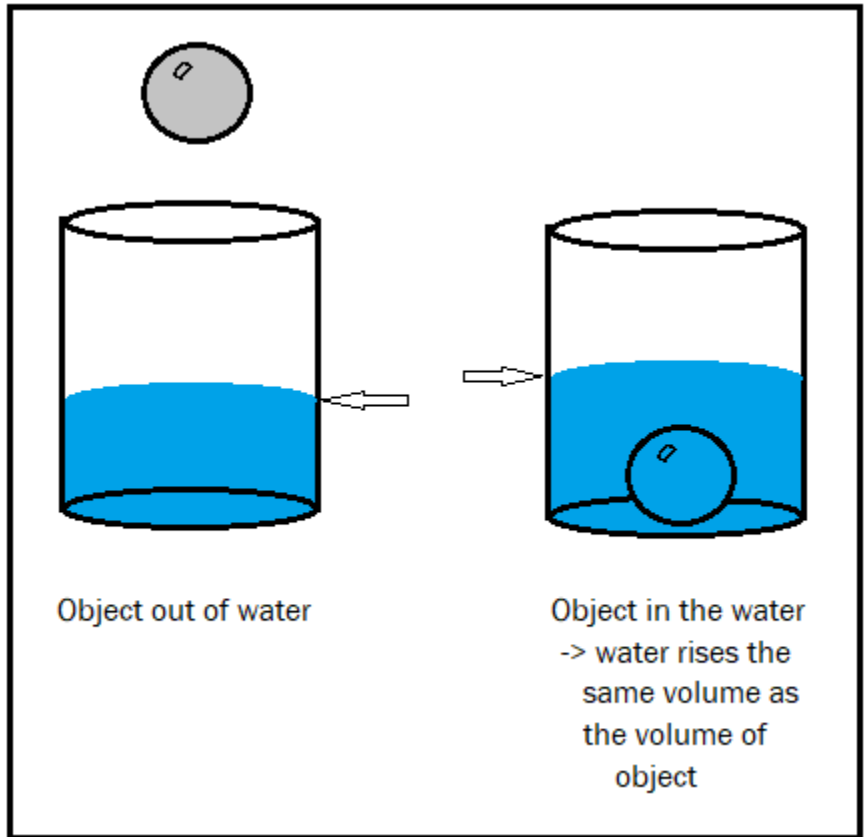


Grade 8 Science – Buoyancy and Density Concepts and Practice Problems

Name: _____ Class: _____ Date: _____

Buoyancy is the upward force exerted by a fluid on an object within that fluid. Archimedes came up with a way to quantify it in the 3rd Century BC (over 2300 years ago!). He noticed two things (perhaps not in the bathtub but that is how the story goes). The first is that when you submerge an object in another fluid, it displaces a volume of fluid equal to the volume of the object. As you can see in the diagram to the left, the object raises the level of water the exact same as the volume of the object. This way, Archimedes was able to measure the volume of irregular objects. He was able to measure the amount of fluid that the object displaced.

The second thing that he was able to measure was how much the object lost in weight which he realized as the buoyant force pushing upward. He discovered that it was equal to the weight of the displaced fluid. The force of gravity is proportional to the mass and the amount of fluid displaced is proportional to the volume. So, the force of gravity and the buoyant force depend on the mass and volume and density is mass/volume so the relative forces of buoyancy and gravity depend on the density of the object.



So, the force of gravity and the buoyant force depend on the mass and volume and density is mass/volume so the relative forces of buoyancy and gravity depend on the density of the object.

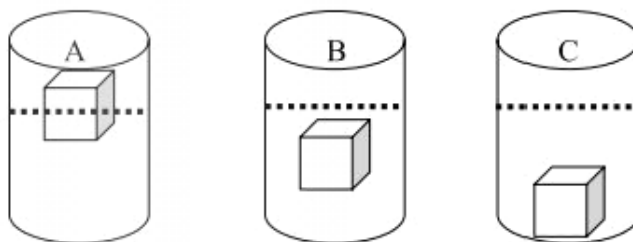
Floating means that the buoyant force is greater than the force of gravity. This makes sense since the upward force is greater and that is why it does not sink. If the force of gravity is the larger force, it would sink. Since the forces are dependent on the mass and volume, it is the density that we should look at. But it also depends on the density of the fluid since the mass of the volume of fluid displaced by the object depends on the density of the fluid. More mass is displaced in water than in air and that is why a boat floats on water but not air. To determine if something will float, we compare the density of the object and the density of the fluid it is in. If the density of the object is less than the fluid, the buoyant force will be greater and it will float. If the density of the object is greater than the fluid, the force of gravity will be greater and it will sink. With the density of water at 1g/cm^3 , we can look at the density of any object and see that it will sink if more than 1g/cm^3 and float if it is less than 1g/cm^3 .

This principle explains convection currents too since warm fluids are less dense and therefore rise and cold fluids sink because they have greater density. Overall density of ships and hot air balloons explain why some heavy things can float too. Science explains so much.

Use the information above to explain each of the questions below. Use another sheet of paper to complete the work – there is not enough space to answer some questions.

Buoyancy and Density Problems

- 1.) In what direction does the buoyant force always act? _____
- 2.) What force always opposes the buoyant force? _____
- 3.) A beach ball floating on the surface of a swimming pool weighs 2 Newton's. What is the buoyant force on the beach ball? _____
- 4.) A ship has a weight of 30,000 pounds. What is the buoyant force on the ship if it is floating in fresh water? _____
- 5.) If the ship is floating in salt water, which is more dense than fresh water, what will the buoyant force be on the ship? _____
- 6.) A 50 pound rock is thrown into a pond. It displaces 10 lbs of water. It sinks to the bottom of the pond. What is the buoyant force on the rock as it sits on the bottom? _____
- 7.) If you were to weight the rock as it sits on the bottom of a pond what would the weight of the rock seem to be. (Hint: subtract the buoyant force from the original weight of the rock) _____
- 8.) A turtle floats just under the surface of the water in a lake. If the turtle weighs 10 N what is the buoyant force on the turtle? _____
- 9.) The turtle exhales and sinks to the bottom of the pond. The turtle's weight is still 10N. What happened to the buoyant force pushing the turtle up if it now sinks tot the bottom of the pond? _____
- 10.) In the diagrams below which blocks experiences the greatest buoyant force? Assume all objects have the same volume. _____



- 11.) In the diagrams above which two blocks experience the same buoyant force? _____
- 12.) Which block above would have the greatest weight? _____ The least weight? _____
- 13.) In the diagram above if each block was the same volume and the same mass which liquid would create the greatest buoyant force on the block? _____

The Relationship between Density and Buoyancy

14.) If the density of a block of wood is 0.9g/cm^3 and the density of water is 1g/ml will the block float or sink in the water? HINT: ($1\text{ml} = 1\text{cm}^3 = 1\text{g}$ of water) _____

15.) If the density of a block of wood is 1.2g/cm^3 and it is put into a liquid with a density of 1.0g/ml will the block float or sink? _____

16.) If the following items are put into a tall cylinder how will they layer? Draw a diagram to show how they layer. Water density 1g/ml , oil density 0.8g/ml , corn syrup density 1.2g/ml , a marble density 2.3g/cm^3 , a candle density 0.9g/cm^3 .



17.) A large balloon is filled with an unknown gas. It will not float in the air. What can be said about the density of the gas in the balloon? _____

18.) If the same balloon is filled with the same amount of helium gas it will float in the air. What can be said about the density of the helium gas in the balloon? _____

19.) A block of wood has a density of 0.5g/cm^3 . It is placed in water with a density of 1.0g/ml . Will the block float in the water? _____ How much of the block will be under the water? (HINT: what is the ratio of the two densities)

20.) The buoyant force on a block of wood in #19 above is 20N . If its weight is 5N how much of the block of wood will be under the water? (HINT: like the problem above look at the ratio) _____

21.) An iceberg floats with 90% of its volume under water. If the water has a density of 1g/ml what is the density of the iceberg? _____

22.) If the iceberg weight is 100 tons what is the buoyant force on the iceberg? _____

If you cannot answer a question, please ask for an explanation in our next class.