IB PHYSICS

Name: _____

Period: _____ Date: _____

DEVIL PHYSICS

BADDEST CLASS ON CAMPUS

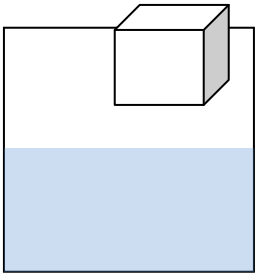
DENSITY, BUOYANCY AND FORCE DIAGRAMS

This lab was adapted from a lab submitted to PhET by Chris Bires of Spring Valley HS on 10/13/2010 and was updated 4/8/2014.

Introduction

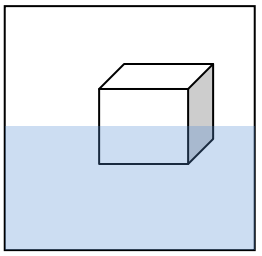
You've heard that oil floats on water. You also know that ice cubes normally float in a glass of water. Why? What causes some things to float in water (corks, ice, dogs) and some to sink in water (rocks, metal spoons, mobsters)? Density is often described as the amount of mass crammed into a volume, and is illustrated by the formula shown below. The units for density are expressed g/cm^3, g/mL, kg/m^3, and kg/L. In this simulation, we will use kg/L. Water's density is 1.00 kg/L.

Important Formulas: $\rho = m/V$ $\vec{F}_{Buoyant} = \rho_{fl} g V$ $\vec{W}_{object} = m\vec{g}$ $a = F_{net}/m$



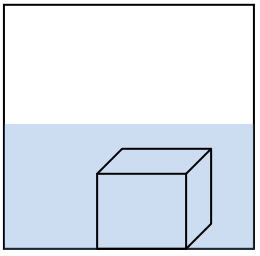
Procedure:

- Go To: http://phet.colorado.edu/en/simulation/density
- Click 'Run Now'. If that doesn't work, click 'Download'
- Take a few minutes and familiarize yourself with the simulation before moving on.



Free Body Diagrams for Floating Objects:

- Grab the various blocks, lift them over the water and drop into the water a few times.
- In the boxes at the right, draw free body diagrams for a **falling block**, **a floating wood block,** and **a block under water resting on the bottom of the tank**. →. If you are planning on submitting this lab electronically, use the 'Shapes' function of Word to draw force vectors and 'Textbox' to add labels.



- When is the block accelerating? _____
- What should be the **net force** in the vertical direction when the block is **floating**?

_____

The %-Density Ratio *Trick*

- Estimate the percentage of the wood, ice, and Styrofoam block that will be under water while those blocks are floating. Write your estimates in the chart below.

% Wood under water	% Ice under water	% Styrofoam under water

- Compare your estimations to the densities shown on the chart. Place the charted densities in the table below.

Density of Wood	Density of Ice	Density of Styrofoam

- How do these compare? _____
- Using the density of the object and the density of the fluid, create a formula to show how much of a floating object would be submerged in **any** fluid. ***Remember: the density of water is 1.00 kg/L and units have to cancel in your formula.***

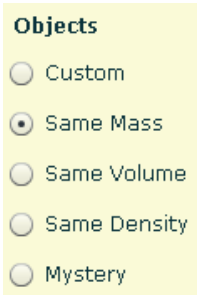
  % under water = _____

Calculating Density

Using the simulation for each scenario listed on the box at the right, complete the tables below. If the block goes all the way to the bottom, write "bottom". To determine volume of an object when it floats, hold it under the water to determine the fluid displacement (increase in water volume).

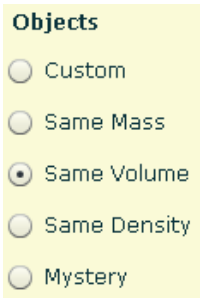
Same Mass

Block	% submerged or "bottom"	Mass, kg	Volume, L	Density, kg/L
Blue		5.00		
Yellow		5.00		
Green		5.00		
Red		5.00		



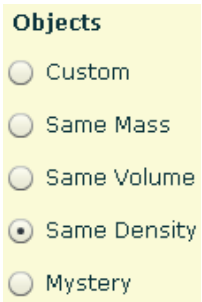
Same Volume

Block	% submerged or " bottom "	Mass, kg	Volume, L	Density, kg/L
Blue			5.00	
Yellow			5.00	
Green			5.00	
Red			5.00	



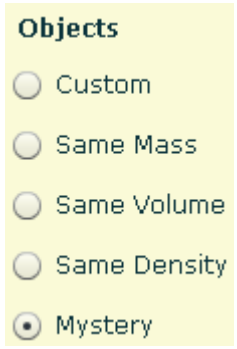
Same Density

Block	% submerged or " bottom "	Mass, kg	Volume, L	Density, kg/L
Blue				0.80
Yellow				0.80
Green				0.80
Red				0.80



Mystery

Block	% submerged or " bottom "	Mass, kg	Volume, L	Density, kg/L
Yellow, A				
Blue, B				
Green, C				
Red, D				
Purple, E				



Conclusion Questions

1. Increasing the volume of an object without increasing its mass *increases / decreases / doesn't change* the object's density (circle)
2. Increasing the mass of an object without increasing its volume *increases / decreases / doesn't change* the object's density (circle)
3. An object with a density of .67 kg/L would float *1/3 , 1/2 , 2/3* **under** water. (circle)
4. An object that rises to the surface and stabilizes **floating partially above the surface** has a buoyant force that is *equal to / larger than / less than* the downward weight.
5. An ice cube dropped into a glass of 100% ethanol (density=. 789 kg/L) would *sink / float*.
6. Using the formula you found for the %-density ratio, determine the percentage of a wood block (ρ = 0.400 kg/L) that would be submerged in ethanol.

   _____

7. Determine the density of an unknown metal that displaces 4.5 L of water and is found to have a mass of 25.4 kg.

   _____

8. What volume of water will a 1.00 kg metal block displace with a density of 7.00 kg/L?

   _____

9. What volume of water will a 1.00 kg **plastic** block (ρ = **0.60** kg/L) displace when **floating**? (careful)

   _____

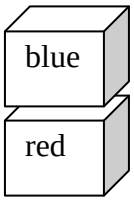
10. Imagine holding the above plastic block under water. When released, what is the upward **acceleration** of the block? (use g = 10 m/s^2)

    _____

    _____

    _____

11. The red block in the "***Same Volume***" floats in water. The blue block sinks in water. Using your data from the chart above and your knowledge of buoyant forces and weights, what volume of the blue block would float **above** the water line if the blue block was placed on top of the red block in the water?



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The answers on this lab are a product of my own work and effort. Though I may have received some help in understanding the concepts and/or requirements, I did the work myself.

_____

Student Signature
(for electronic submission, type student number in lieu of signature)

ROOM FOR IMPROVEMENT

Comments: