Archimedes Principle and Buoyancy

Pre-Class Questions

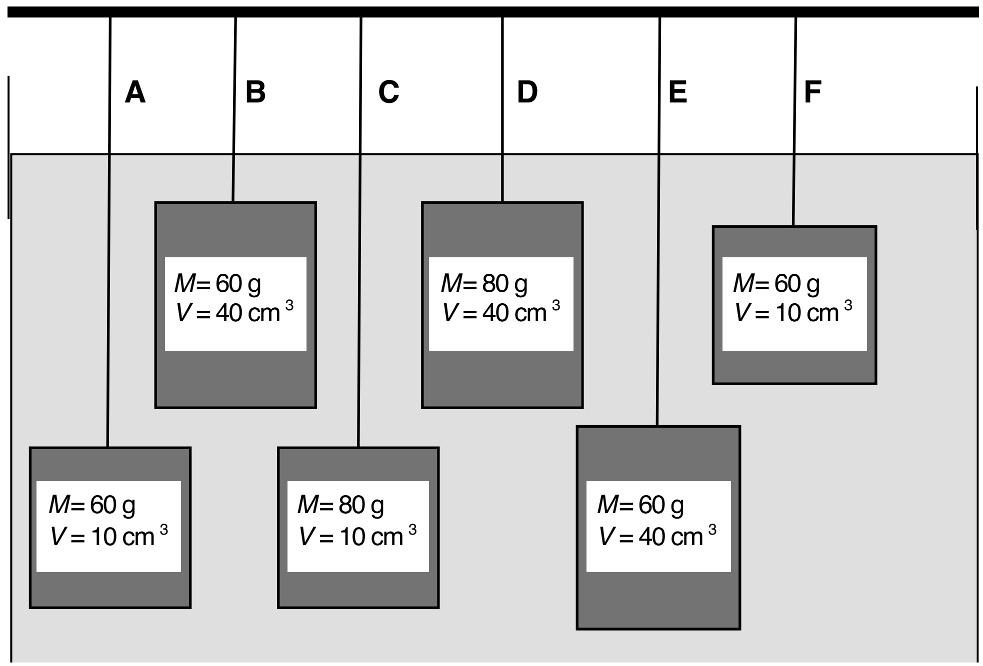
Problem Set (due next time)
Ch 13 - 29, 32, 33, 36

Lecture Outline

1. Archimedes' Principle
2. Examples Involving Buoyant Force

Shown below are six objects that have different masses and different volumes. These blocks are suspended at two different depths in water by being hung by a string from a supporting rod.

Rank these situations, from greatest to least, on the basis of buoyant force on the blocks by the water.



Greatest Force 1____ 2____ 3____ 4____ 5____ 6____ Least Force

Or, all of the buoyant forces on the blocks by the water are equal. _____

Or, there are no buoyant forces on the blocks by the water. _____

Or, it is not possible to determine the buoyant forces on the blocks by the water. _____

Please carefully explain your reasoning.

CONCEPTUAL **Physics** PRACTICE PAGE

Consider a balloon filled with 1 liter of water (1000 cm^3) in equilibrium in a container of water, as shown in Figure 1.

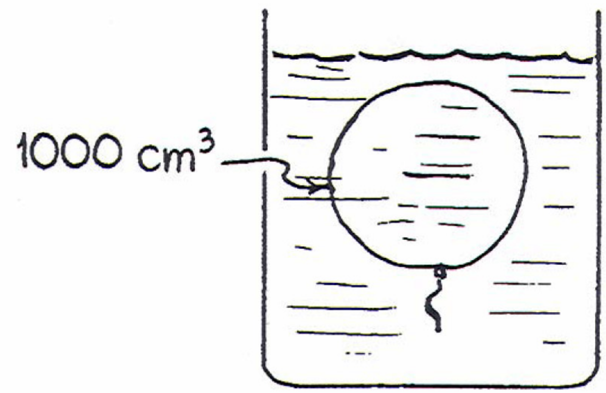


Figure 1

a. What is the mass of the 1 liter of water?

____

b. What is the weight of the 1 liter of water?

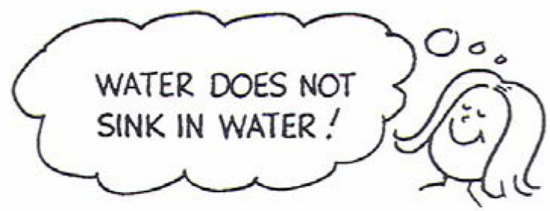
____

c. What is the weight of water displaced by the balloon?

____

d. What is the buoyant force on the balloon?

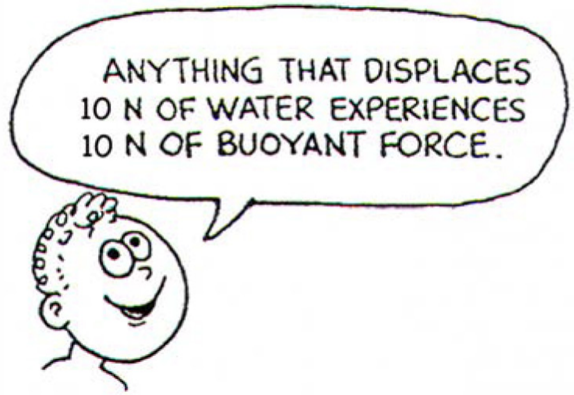
____



e. Sketch a pair of vectors in Figure 1:
one for the weight of the balloon and the
other for the buoyant force that acts on it.
How do the size and directions of your vectors compare?

CONCEPTUAL **Physics** PRACTICE PAGE

As a thought experiment, pretend we could remove the water from the balloon but still have it remain the same size of 1 liter. Then inside the balloon is a vacuum.



a. What is the mass of the liter of nothing?

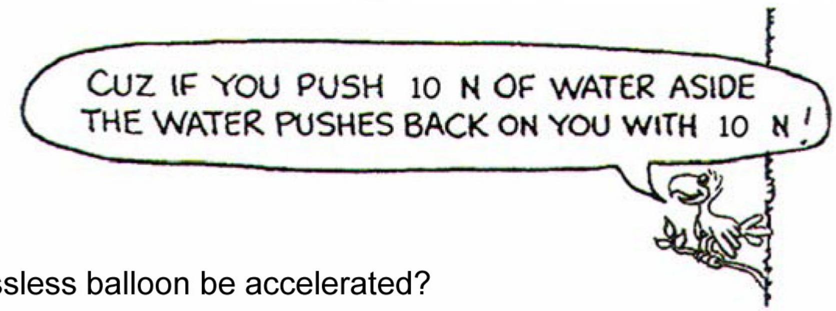
____

b. What is the weight of the liter of nothing?

____

c. What is the weight of water displaced by the nearly massless 1-liter balloon?

____



d. What is the buoyant force on the nearly massless balloon?

____

e. In which direction would the nearly massless balloon be accelerated?

____

CONCEPTUAL Physics PRACTICE PAGE

Assume the balloon is replaced by a 0.5-kilogram piece of wood that has exactly the same volume (1000 cm^3), as shown in Figure 2. The wood is held in the same submerged position beneath the surface of the water.

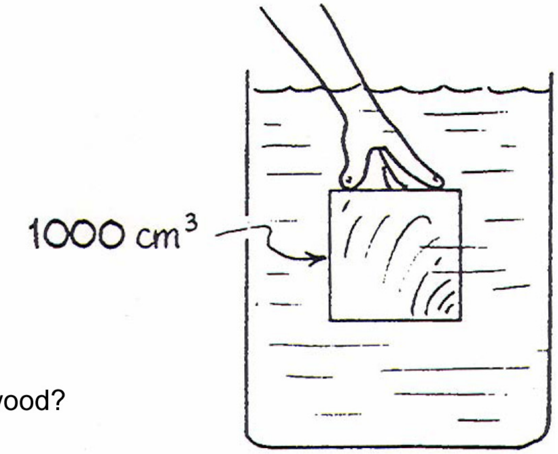


Figure 2

a. What volume of water is displaced by the wood? ____________________

b. What is the mass of the water displaced by the wood? ____________

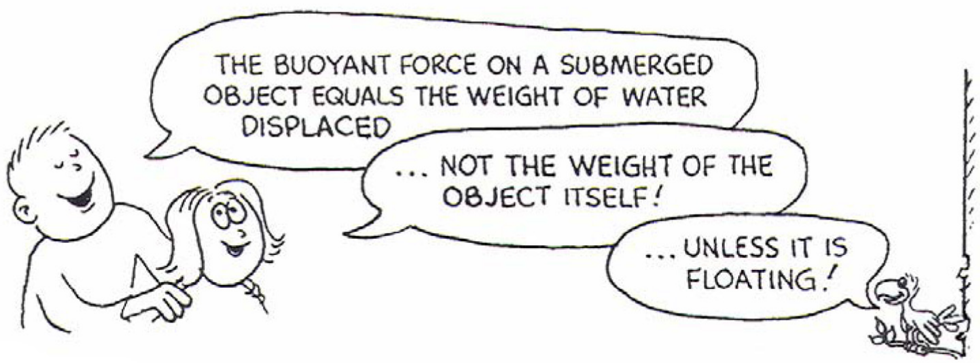
c. What is the weight of the water displaced by the wood? _____________

d. How much buoyant force does the surrounding water exert on the wood? ___________

e. When the hand is removed, what is the net force on the wood?

____

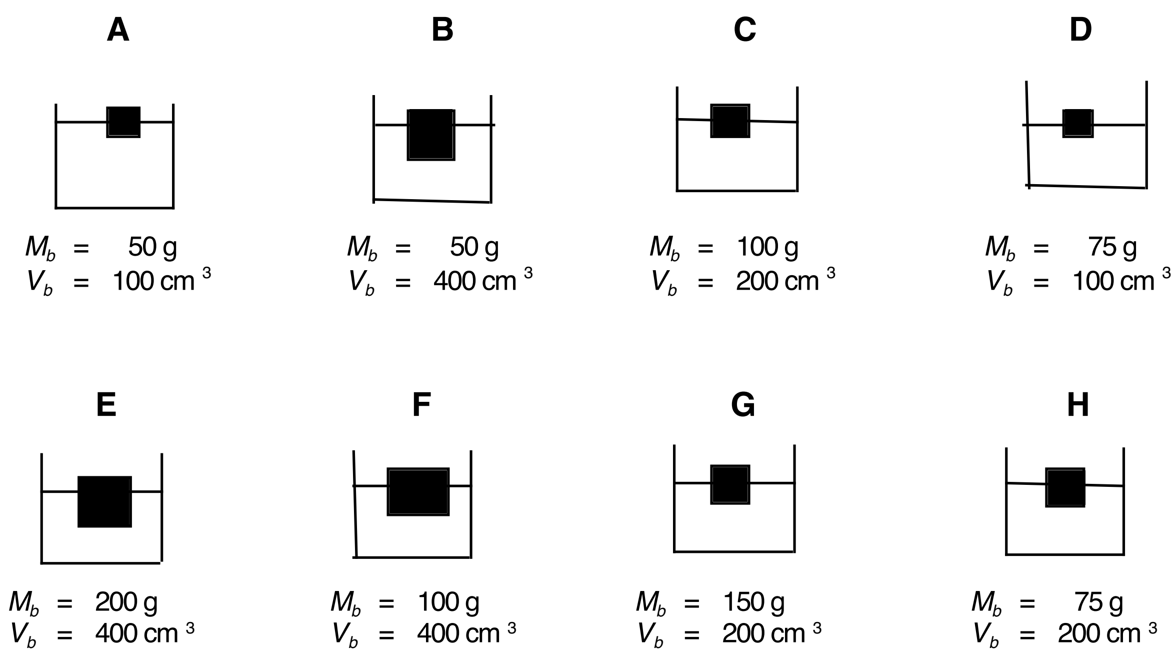
f. In which direction does the wood accelerate when released? ______________________



Example 1: A block of metal has a mass of 70.0g in air but a scale reads only 44.1g in water. Find the density of the metal.

Shown below are eight containers that have the same volume of the same liquid in them. Blocks of various solids are floating on top of the liquid. The blocks vary in both size and mass. Specific values for the masses labeled as M_b and volumes labeled as V_b of the blocks are given in each figure.

Rank these situations, from greatest to least, on the basis of the buoyant force by the liquid on the blocks. That is, put first the situation that has the greatest buoyant force by the liquid on the block, and put last the situation that has the lowest buoyant force by the liquid on the block.



Example 2: How big is "the tip of the iceberg?"

Lecture 34 - Summary

Archimedes' Principle – "The buoyant force is equal to the weight of the fluid displaced by the object."

Mathematically, $F_B = m_f g = \rho_f V g$