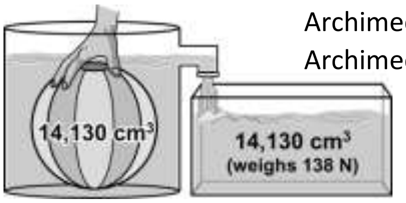
Chapter 16: Archimedes Principle Name:__________________________

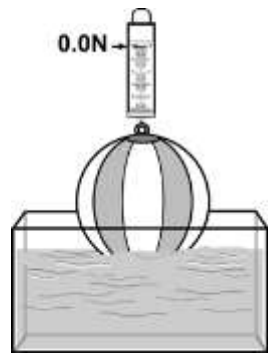
Have you ever tried to hold a beach ball underwater? It takes a lot of effort! That's because the buoyant force is much larger than the gravitational force acting on the beach ball.



Archimedes principle can be used to calculate the buoyant force acting on the beach ball. Archimedes principle states: The buoyant force acting on an object in a fluid is equal to the weight of the fluid displaced by the object.

A beach ball has a volume of 14,130 cm^3. This means that if you push the ball underwater, it displaces 14,130 cm^3 of water. Archimedes principle tells us that the buoyant force on the ball is equal to the weight of that water.

Because the weight of 14,130 cm^3 of water is 138 newtons, the buoyant force acting on the beach ball is 138 newtons.



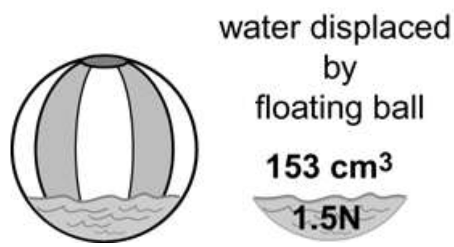
In air, a beach ball weighs 1.5 newtons. However, if you measure the weight of a floating beach ball in water, a spring scale reads 0.0 newtons. The apparent weight of the ball is 0.0 newtons.

The buoyant force acting on the floating beach ball is equal to:
(The gravitational force acting on the ball) - (Apparent weight of ball in water)

$$1.5 \text{ N} - 0.0 \text{ N} = 1.5 \text{ N}$$

Explanation:

The buoyant force acting on the floating beach ball is equal to the gravitational force pulling the ball downward. The floating ball displaces only 153 cm^3 of water. 153 cm^3 of water weighs 1.5 newtons. The ball displaces an amount of water equal to its own weight.



Example:

A 5-cm^3 block of lead weighs 0.55 N. The lead is carefully submerged in a tank of mercury. One cm^3 of mercury weighs 0.13 N. What is the weight of the mercury displaced by the block of lead? Will the block of lead sink or float in the mercury?

Given	Solution
Volume of block = 5 cm^3 Weight of lead block = 0.55 N **Looking for** Weight of mercury displaced Will the lead sink or float? **Relationships** 1 cm^3 mercury weighs 0.13 N	The lead will displace 5 cm^3 of mercury. 5 cm^3 mercury X 0.13 N/1 cm^3 mercury = 0.65 N The buoyant force of mercury, 0.65 N, is greater than the weight of the lead, 0.55 N. Therefore, the block of lead will float.

Practice:

1. A 10 cm^3 block of paraffin (a type of wax) weighs 0. 085 N. It is carefully submerged in a container of gasoline. One cm^3 of gasoline weighs 0.0069 N.
    a. What is the weight of the gasoline displaced by the paraffin?

    b. Will the block of paraffin sink or float in the gasoline?

2. A 30 cm^3 chunk of platinum weighs 6.3 N. It is carefully submerged in a tub of molasses. One cm^3 of molasses weighs 0.013 N.
    a. What is the weight of the molasses displaced by the platinum?

    b. Will the platinum sink or float in the molasses?

3. A 15 cm^3 block of gold weighs 2.8 N. It is carefully submerged in a tank of mercury. One cm^3 of mercury weighs 0.13 N.
    a. Will the mercury be displaced by the gold?

    b. Will the gold sink or float in the mercury?

4. Compare the densities of each pair of materials in questions 1-3 above.
    a. paraffin versus gasoline

    b. platinum versus molasses

    c. gold versus mercury

Material	Density (g/ cm3)
gasoline	0.7
gold	19.3
lead	11.3
mercury	13.6
molasses	1.37
paraffin	0.87
platinum	21.4

5. Does an object's density have anything to do with whether or not it will float in a particular liquid? Justify your answer.

6. Based on density, explain whether the object would float or sink in the following situations:
    a. A block of solid paraffin (wax) in molasses.

    b. A gold ring in molten platinum.

    c. A piece of platinum in molten gold.

    d. A drop of gasoline in mercury.

    e. A drop of mercury in gasoline.