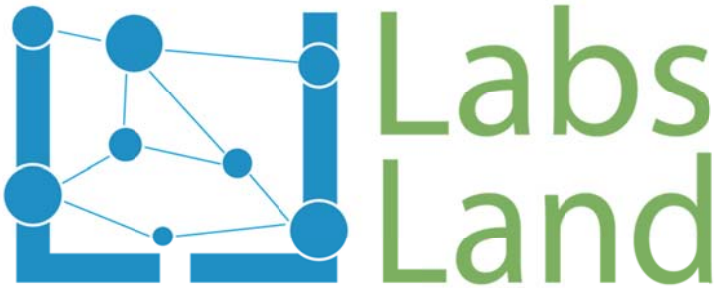

ARCHIMEDES REMOTE LAB: Relative Density

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Labs Land

Content

1 The Lab

The Remote Laboratory is the same as the one that we used in the previous experience, *why do objects float?* In this experiment, we always threw different objects on the same liquid to see which ones floated and which ones did not, to observe the previous thing against the values of mass and volume of each object to conclude that if the mass was smaller than the volume, then the object floated; and that if the mass was greater than the volume, then the object sank.

As before, we can throw and collect objects over the liquid in a tube. In addition, for each tube we can see the mass and volume of the object, the density of the liquid and the level of the liquid, both before and after the launch. You can also take detailed pictures of what you see.

Next paragraphs explain again the remote lab interface.

To access this laboratory, you only have to register at labsland.com and access through the link indicated by the following figure:

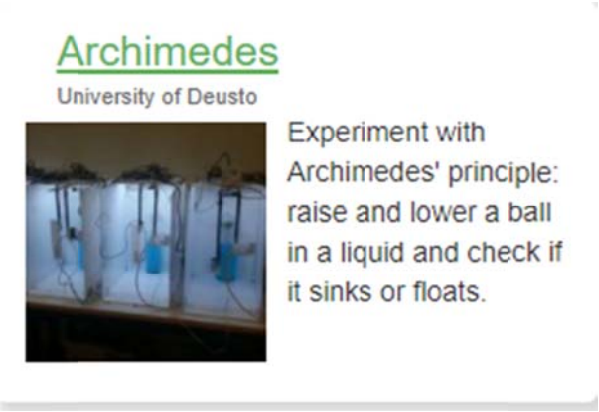

Figure 1. Access to the Archimedes Remote Laboratory of the University of Deusto from LabsLand site

Each of the objects has an associated mass and volume. This data can be viewed on the remote lab user interface.

Below you can see some additional images. To the left a ball full of marbles before lowering, and to the right the same ball after activating the lowering arrow has submerged, does not float.

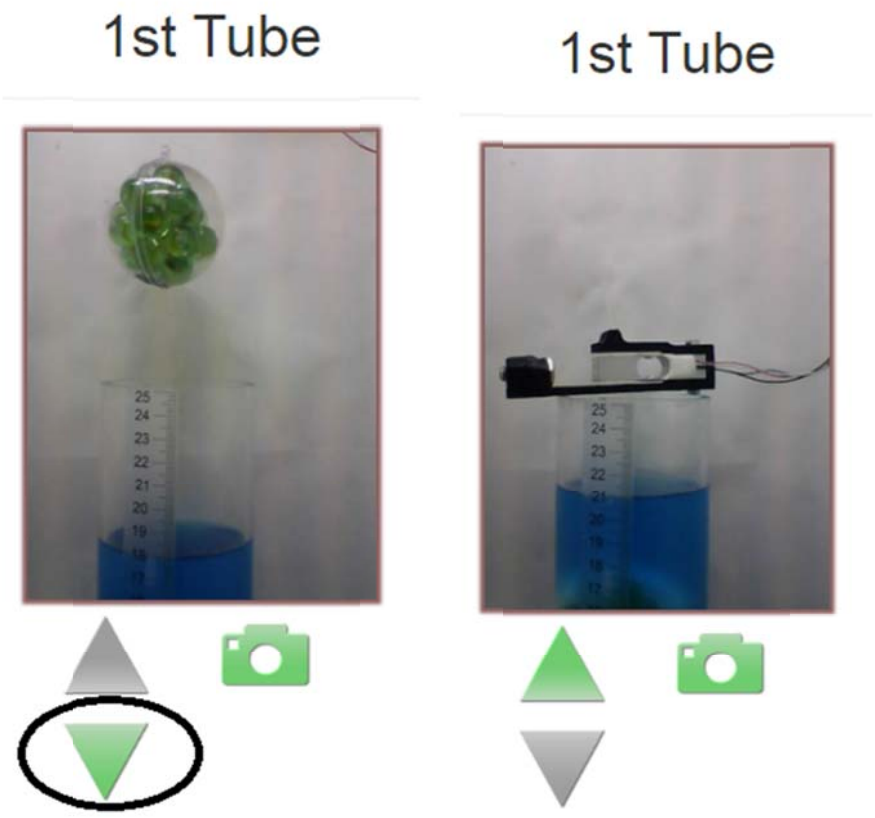

Figure 2. Example of how to raise and lower a ball in the Archimedes experiment

In detail, in this laboratory the user can find:

1. Tubes of 7 centimetres in diameter which are provided with a ruler to visualize and measure the level of the liquid they contain.
2. The tubes are filled with water and alcohol and another liquid with different densities.
3. Different objects to be introduced and removed from the liquid. Objects will be similar and different from each other: the same volume and different weight, the same weight and different volume, different weight and volume, but the same density, etc.

In addition, the user has a control interface with:

4. Two arrows that allow you to raise and lower objects in the tubes. These arrows are connected to a motor that executes the user command.
5. A webcam to observe the experiment in real time and see if the object floats or not.
6. A "camera" function that allows you to take pictures of objects in and out of the liquid

7. A graph showing the object's weight change over the course of the experiment

Finally, the interface provides a series of values with information about each of the experiments:

8. A panel with information regarding the object: its mass, diameter, density and volume.
9. A panel with information about the liquid: its density and the diameter of the tube.
10. The information captured by the sensors of the experiment in real time: object weight and liquid level in the tube.

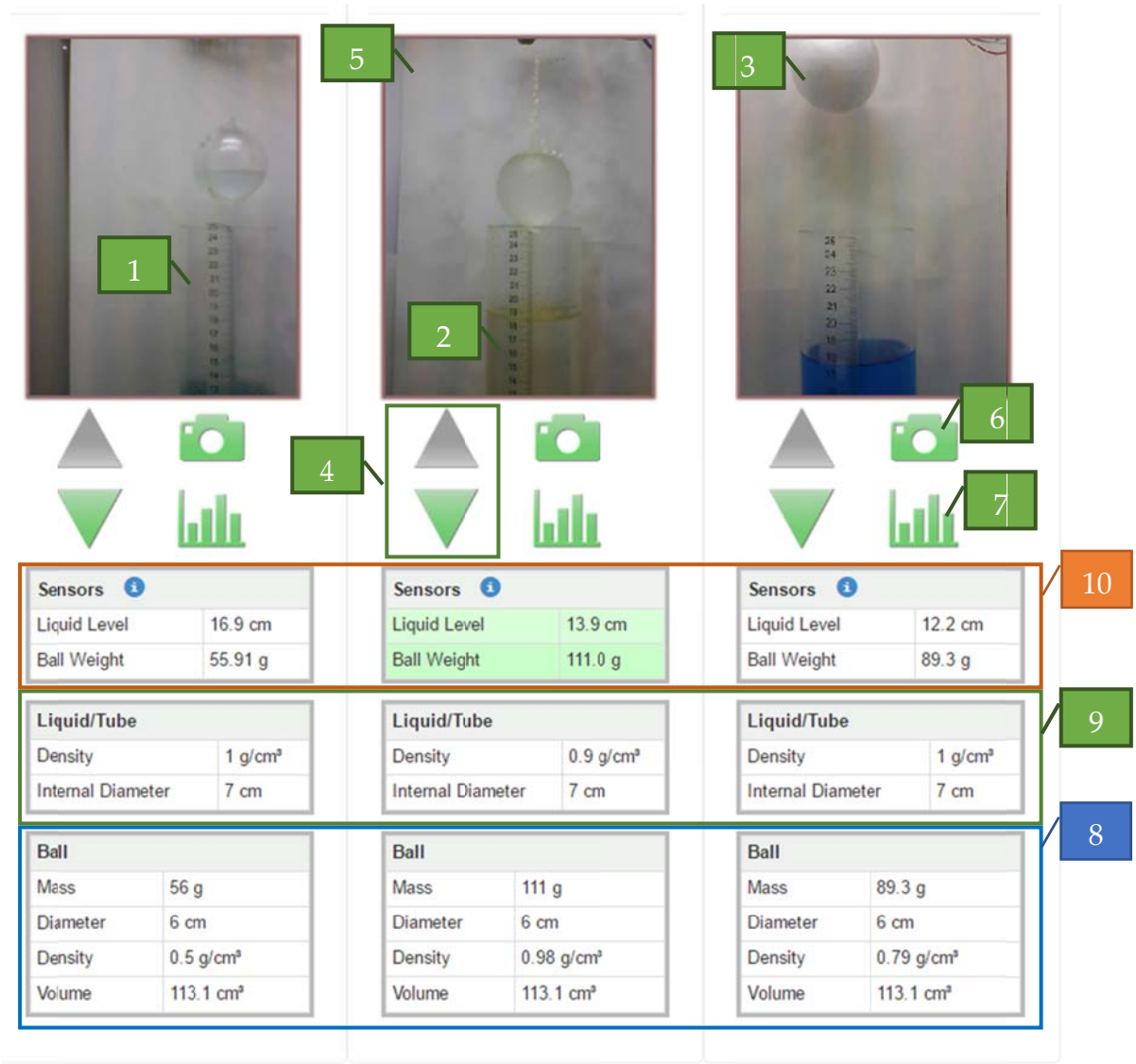

Figure 3. Archimedes Remote Laboratory user interface

2 Hypothesis that may arise during the experiment

Well, at this point it makes sense to make assumptions based on the following questions:

- Does buoyancy depend solely on the density of the object?
- Does buoyancy depend solely on the density of the liquid?
- Does it depend on both things whether an object sinks or floats?
- Can an object float in one liquid and sink into another?

3 Experiments to validate responses to the hypotheses put forward

The experiment is very simple and formative. Since we have fixed that the independent variables are object's density and liquid's density, then it is enough to fix one variable and give different values to the other, and then do the same by exchanging the variables.

That is to say, choose a few objects of different densities and also different liquids in which you can immerse all the previous objects. Set the liquid (fixed a variable), throw different objects (variation of the second variable) and note whether it floats or not, then change the liquid and throw the same objects to note whether they float or not.

The experiment is very simple to propose, although it is very formative because it allows the scientific method to be approached with rigour. Basically, it consists of fixing the variables that affect the observed fact (mass and volume), changing a variable (the mass) keeping the other one fixed (the volume) and observing and writing down whether the object sinks or floats and then repeating changing the variable varied (volume) keeping the other one (mass) fixed.

The attached table should help you carry out the experiment.

Liquid	Object	Liquid density	Object density	Floats	Sinks
Water (density =1)	Object 1:				
	Object 2:				
	Object 3:				
	Object 4:				
Vegetal Oil (densisty < 1)	Object 1:				
	Object 2:				
	Object 3:				
	Object 4:				
Water with sugar (densisty >1)	Object 1:				
	Object 2:				
	Object 3:				
	Object 4:				

You must fill in the table carefully. You can share this work or the results with colleagues.

4 Conclusions

Conclusions must now be drawn on the basis of the data. To do this, you should look for answers to the four questions above:

- Does buoyancy depend solely on the density of the object?
- Does buoyancy depend solely on the density of the liquid?
- Does it depend on both things whether an object sinks or floats?
- Can an object float in one liquid and sink into another?

The answers are given in the table above. Here's a clue:

- Searches for two identical objects floats in one liquid and sinks into another? If yes, what is the density of the liquid compared to the object when it sinks? And when it floats?
- Searches for an object with a density greater than 1 g/cm3 and indicates whether it floats in any liquid. If yes, what is the density of the liquid?

- Searches for an object with a density of less than 1 g/cm3 and indicates whether it sinks into any liquid. If yes, what is the density of the liquid?

At this point you will have found that the buoyancy of an object is a matter of liquid density. Thus an object floats if its density is lower than that of the liquid that receives it, and vice versa, an object sinks its density is higher than that of the liquid that receives it.

One more question: do you think that the same ship can carry more bananas in the Mediterranean Sea than in the Atlantic Ocean? Could this be turned into money?

The density of the Mediterranean is 1,036 to 1,038 g/cm3, and the density of the Atlantic is 1,027 g/cm3. And in the Dead Sea with a density of 1,240 g/cm3?