

# **ARCHIMEDE'S PRINCIPLE**

CLASS 1T

SCHOOL "ALFANO 1"

SALERNO

Opportunity to test Archimede's principle occurred to the students from storyline. Julia had some plastic bottles of sweet Coca-cola. However she was suffering from an illness called "diabetes". The question is \_ how could she find out which of the bottles contained sugar and which of them contained the sweetener?

The students debate about the question and Peter suggested to use some ants (light wouldn't have attracted them).

Antony proposed to climb a tree , to drop them and measure the falling time (the light one would have reached the ground after the normal one).

At last John suggested to throw them into the sea to observe which of the two would float.

At this point the students make experiment  
The light coca cola floats



A discussion arose and the teacher addressed many questions to the students :

Does the waterline depend on weight of the objects?

Does it depend on form?

Does it depend on density of fluid?

The answers to the questions are flowed  
from simple experiments

First experiment

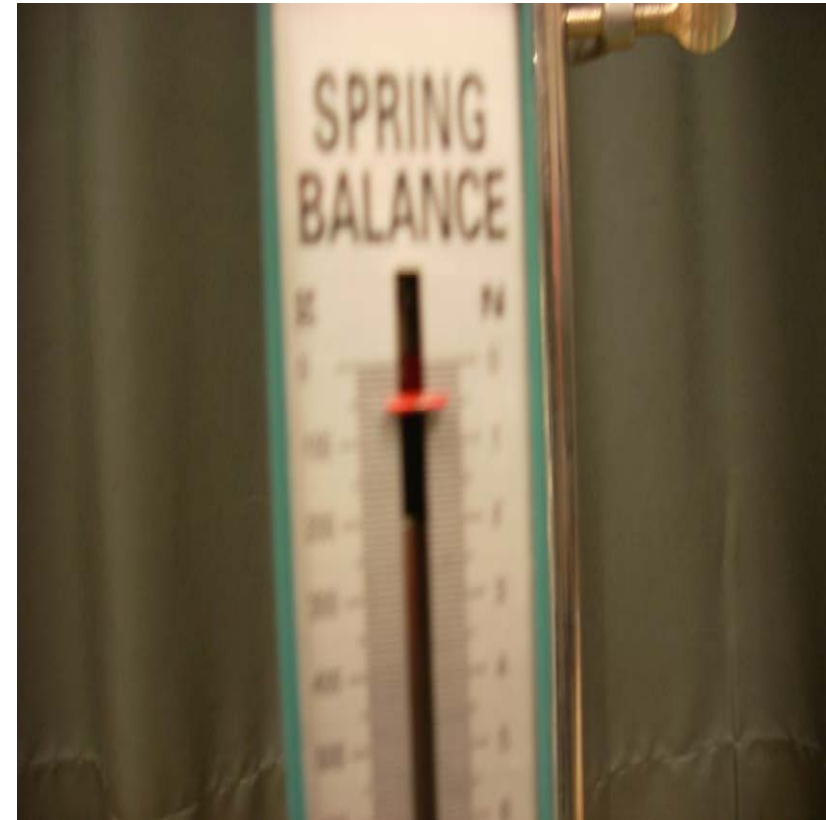
Material occorrent:

Spring balance, objects, swilling

The object is suspended from the spring balance first in the air



and then in water



The students explained the result saying that the water pushed up the object reducing the tractive effort of the dynamometer.

Then, from the strength diagram and from body equilibrium, the students supposed that the push up is equal to the difference between

$$\mathbf{P}_{\text{in air}} - \mathbf{P}_{\text{in water}}$$

To measure the push up the students make an experiment and use the hydrostatic balance.



It presents on a side a scale-pan to settle the weights while on the other side there are two cylinders one full and another empty.

The two cylinders have equal volumes.

# Experiment: To weigh the two cylinders





To soak the full cylinder into the water and to note the unbalance

To test what the balance is obtained filling with water the empty

The experiment proves that Archimede 's push up is equal to the weight of the fluid's shifted volume.

Mathematically Archimede 's push up is:  $F_A = \rho_{\text{flu}} V g$ , where  $\rho_{\text{flu}}$  is the fluid density,  $g$  is the acceleration of gravity and  $V$  is the fluid shifted volume. The body weight is  $P = \rho_{\text{sol}} V g$ , where  $\rho_{\text{sol}}$  is the density of the dipped body.

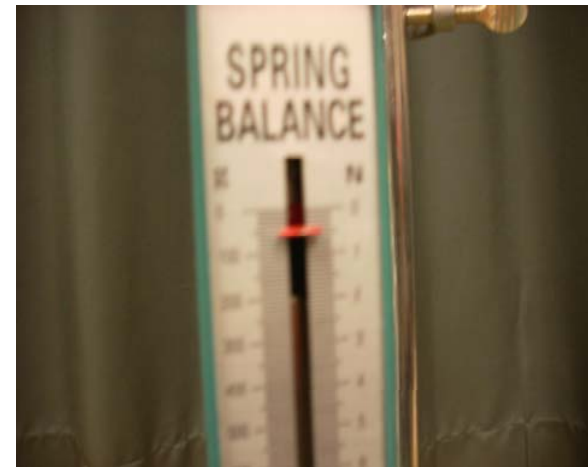
There Will be three possibilities

- a) The body sinks if  $F_A < P$ , or  $\rho_{\text{flu}} < \rho_{\text{sol}}$
- a) The body is balanced if  $F_A = P$ , or  $\rho_{\text{flu}} = \rho_{\text{sol}}$
- b) The body floats if  $F_A > P$ , or  $\rho_{\text{flu}} > \rho_{\text{sol}}$

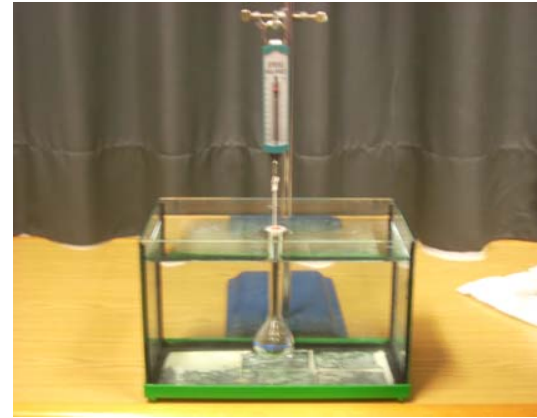
Now the students ask if Archimede 's push up depends on the weight of the object



First object



## Second object



The experiment data shows that Archimede 's push up  
 doesn't depend on the weight of the object

Weight <sub>in air</sub> Weight <sub>in water</sub>	Archimede 's push up	$W_{in\ air} - W_{in\ water}$
(2,0±0,1) N	(0,6±0,1) N	(1,4 ±0,1)N
(2,7 ±0,1)N	(1,3 ±0,1) N	(1,4 ± 0,1)N

Then, the students ask if Archimede 's push up depends on the density of the fluid.



They use air



They use oil



They use water

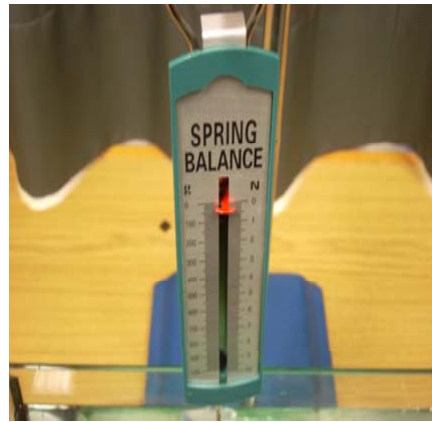


The experiment data shows that Archimede 's push up depends on the density of the fluid

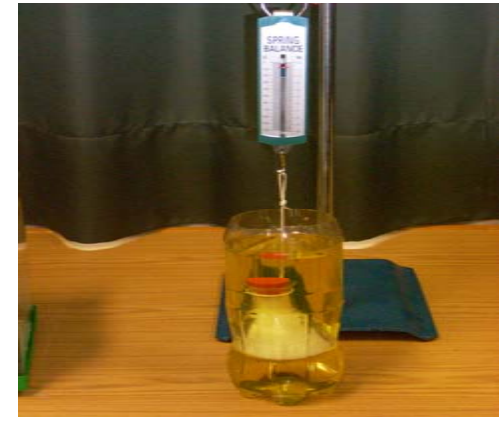
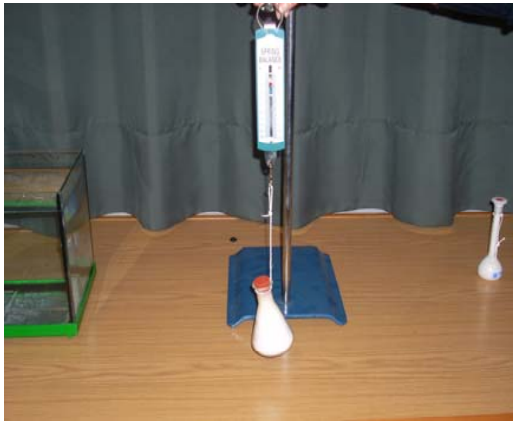
Weight <sub>in air</sub>	Weight <sub>in water</sub>	Archimede 's push up $W_{in air} - W_{in water}$	Weight <sub>in air</sub>	Weight <sub>in oil</sub>	Archimede 's push up $W_{in air} - W_{in oil}$
(2,0±0,1) N	(0,6 ±0,1)N	(1,4 ±0,1)N	(2,0 ±0,1)N	(0,7 ±0,1)N	(1,3 ±0,1)N
(2,7 ±0,1)N	(1,3 ±0,1)N	(1,4 ±0,1)N	(2,7 ±0,1)N	(1,4 ±0,1)N	(1,3 ±0,1)N

The end the students ask if Archimede 's push up depends on the form of the objects

First shape



# Second shape



The experiment data shows that Archimede 's push up doesn' t depend on the shape of the objects

	Weight <sub>in air</sub>	Weight <sub>in water</sub>	Archimede 's push up $W_{in\ air} - W_{in\ water}$	Weight <sub>in air</sub>	Weight <sub>in oil</sub>	Archimede 's push up $W_{in\ air} - W_{in\ oil}$
1 <sup>a</sup> form	(2,0±0,1) N	(0,6 ±0,1)N	(1,4 ±0,1)N	(2,0 ±0,1)N	(0,7 ±0,1)N	(1,3 ±0,1)N
2 <sup>a</sup> form	(2,0 ±0,1)N	(0,6 ±0,1)N	(1,4 ±0,1)N	(2,0 ±0,1)N	(0,7 ±0,1)N	(1,3 ±0,1)N

# Final test

***1. Which of the following statements is false?***

- The pressure in a fluid is transmitted unchanged in all directions
- The pressure in a fluid increases if the density increases
- Archimedes' push is directed upwards
- The pressure in a fluid depends solely on depth

***2. On the surface of some water put in a container, two surface discs, different in surface, mass and nature are placed. Which of the two will float?***

- The pressure in a fluid is transmitted unchanged in all directions
- The pressure in a fluid increases if the density increases
- Archimedes' push is directed upwards
- The pressure in a fluid depends solely on depth

***1. As you know, a cube of ice floats on water. If the container with water and ice were on the moon, Archimedes' push***

- Would increase
- Would increase
- Would remain the same
- There would be no push

***2. Two bodies, whose volume is  $60 \text{ cm}^3$  each, have respectively. a 40g. mass and 80g. mass. If they were placed in water***

- the former would float and the latter would sink
- the former would sink and the latter would float
- Both of them would float
- Both of them would sink

# They write out the unknown words

## **GLOSSARY**

To bilance = *bilanciare*

Density = *densità*

To float = *galleggiare*

Fluid = *fluido*

Hydrostatic = *idrostatica*

Object = *oggetto*

Push up = *spinta*

Scale\_pan = *piatto della bilancia*

To sink = *affondare*

To soak = *immergere*

Spring balance = *dinamometro*

Swilling = *vasca*

Weight = *peso*