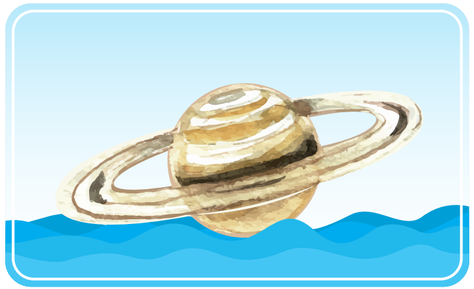
Experiment with the floating planet

As you have already learned Saturn could float on water! This is because Saturn is made from gases and liquids which have lower density compared to water. Density is a measurement that compares the amount of matter an object has to its volume. Every pure substance has a unique density value. An object with much matter (mass) in a certain volume has high density. Meanwhile, an object with little matter in the same amount of volume has low density. Objects with smaller densities float in liquids with greater densities while objects with greater densities sink in liquids with lower densities.



- Have you ever wondered how a massive ship can travel across the seas, while a little pebble sinks to the bottom?
- Why do same objects float?

Are you ready to discover what buoyant force is and how it determines if an object will float?
Let's perform the next page's experiment to get answers for all these questions!

01

Learning about: **Buoyancy**

Floating planet
Among the planets of our solar system, Saturn has the smallest density. This is due to the large amount of gases and liquids that the planet is made up. Contact the below experiment to discover when objects float!

Discover:
- Archimedes Principle.
- How does buoyant force determine whether an object will float or sink?

Level Of Difficulty ★★★☆☆

Materials Needed:
- Engino® (STH14).
- Sink (at least 8cm deep) full of water.
- Small pebbles and a small Plastic bag.

Procedure:
1. Find the instructions and build the **Floating Planet** model.

2. Place your model into the sink. Then answer the questions of **exercises 1** and **2**.

3. Remove the model from the sink and fill it inside with the small Engino® parts as it is shown on the right. Do **exercise 3**.

1. Does your model float or sink? Choose the correct answer by placing a ✓.

☑ Float ☐ Sink

2. Why do you think this is happening?

This is happening because the density of the plastic the model is made of is lower than the density of the water.

3. Will the model sink or float this time? Put a ✓ to indicate your expectation.

☑ Float ☐ Sink

Place the model onto the water and check what happens!

02

Procedure:

4. Remove all the additional parts from the interior of your model. This time you will add a few small pebbles (see below). Repeat the experiment to check whether it will float or not. Answer the question of **exercise 4**.

5. Take your model out of the sink and wrap it with a plastic bag. You can use the one found in the box, in which the plastic parts were packed! Make sure to seal it with an adhesive tape, to prevent water float inside. Place it back to the sink and see what happens! Do **exercises 5** and **6**.

4. What do you observe with the pebbles inside? If planet Saturn was made of solid rocks too, what do you think would happen to its overall density?

When pebbles are placed into the model, the model sinks. If planet Saturn was made of solid rocks it could also sink. The overall density is increased when rocks are added into the model.

5. Which factor has significantly changed compared to the previous experiment?

☐ Mass ☑ Density ☐ Both of them

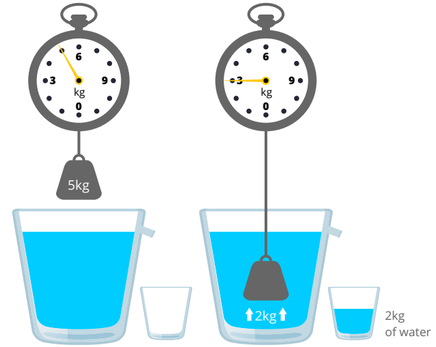
6. There are 4 different materials involved in this experiment. These are **plastic, water, rock** and **air**. Can you place them in descending order according to their density?

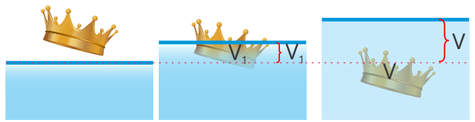
	Name of Material
1	*rock*
2	*water*
3	*plastic*
4	*air*

Theory

Archimedes Principle

One of the most famous scientists from antiquity is **Archimedes**. During his bath, he noticed that the level of water in his bathtub was raising while he was sinking into it. Indeed, the more of his body was sunk into water, the higher the level would rise. He came to the conclusion that **the volume of the displaced water, is equal to the volume of body which is sunk into it.** With further experimentation, Archimedes realised that objects weigh less when sunk into water! He understood that there must be a force that works in opposition to weight.

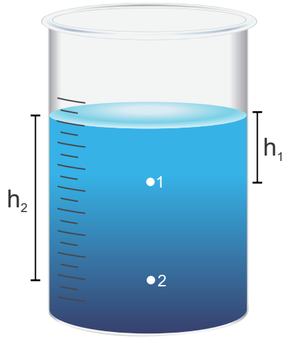


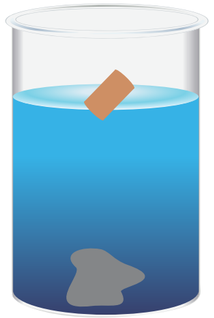


Archimedes stated that ***"any object, wholly or partially immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object."*** This is known as the **Archimedes Principle.** This is a fundamental principle of physics which explains why some objects can float, instead of sinking! Due to his cleverness, a king asked him to determine whether his crown was purely made of gold. To solve the puzzle, Archimedes borrowed pure gold, of the same weight, from a different goldsmith. The two had the same weight when measured outside of water. However, the two bodies weighed different into water! The crown proved to be impure!

Hydrostatic Pressure and Buoyant Force

Fluids can exert pressure just because the piled-up layers are pushing the layers beneath them. Therefore, the amount of pressure that fluids can exert due to their weight (the force that pulls any object down to Earth) is called **hydrostatic pressure**. The hydrostatic pressure depends on the depth, since deeper layers feel more weight. Also, denser fluids produce stronger pressure as more mass is condensed into the same volume. Although Archimedes discovered the buoyant force he could not truly explain how this force was generated. Buoyancy can be explained by understanding hydrostatic pressure. In fact, buoyancy is generated due to the difference of hydrostatic pressure between two points.



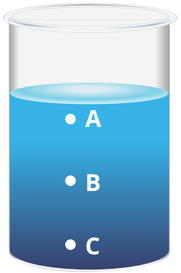


When an object is partially immersed into a fluid, its bottom area is subjected to hydrostatic pressure. Thus it feels an upwards push. The value of the Buoyant force determines whether the object will float or sink. If the force of buoyancy is larger than the weight of the object, then the object will **float!** Contrary, if the buoyancy is smaller than the weight of the object, it will **sink!** For instance, a cork floats while a pebble sinks if placed in a cup of water. The value of the buoyant force depends on the density of the liquid and the displaced volume of the liquid. The greater the density of the liquid the greater the buoyant force. Likewise, the greater the displaced volume the greater the buoyant force.

Quiz

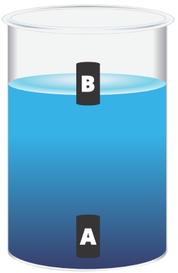
Exercise

a) Which one of the 3 points has the more hydrostatic pressure? Explain your answer.



Point C feels more hydrostatic pressure since it is deeper than the other points. The deeper the point is, the more hydrostatic pressure is exerted on it.

b) Complete the gaps of the following sentences with the words **greater** and **lower**.



The buoyant force acting on object A is ..*lower*.. than its weight. Meanwhile the buoyant force acting on object B is ..*greater*.. than its weight.

Knowledge check: check what you have learned.

- [ ] What does **Archimedes principle** state?
- [ ] What is **hydrostatic pressure**?
- [ ] What is **buoyant force**?
- [ ] How does **buoyant force** determine whether an object will **float** or **sink**?
- [ ] Which **factors** affect **buoyant force**?