Does it float or does it sink?

What factors make things float or sink?

Does the surface matter?

Do solutions behave like water?

What about other liquids?

Equipment required:

Large waterproof container
Glass
Metal and plastic utensils
Orange
Egg
Salt
Oil
Aluminium foil
Coins

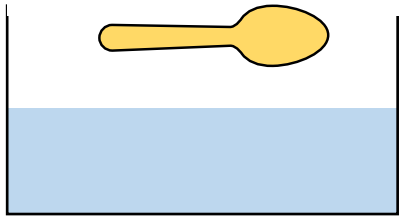
Can you explain the findings?

Floating and Sinking

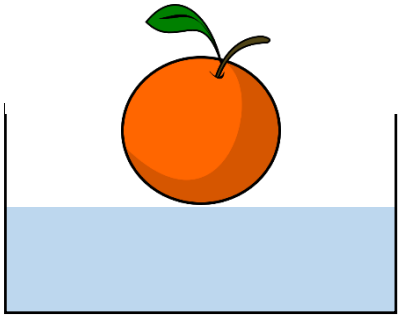
DEPARTMENT OF CHEMISTRY

UNIVERSITY OF OXFORD

1 Place a plastic utensil in water. Repeat with metal utensil.

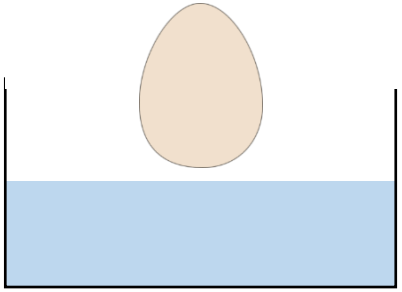


2 Place an unpeeled orange in water.

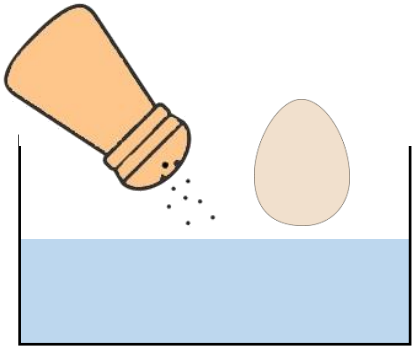


3 Peel the orange. Place peeled orange in water.

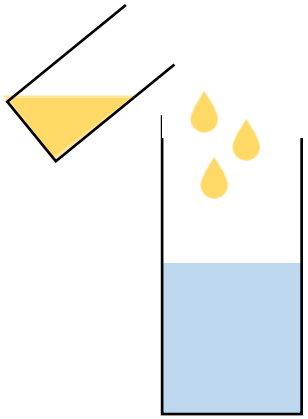
4 Place an egg into water.



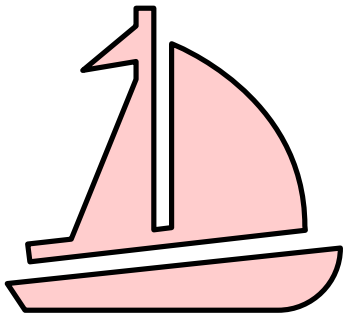
5 Add salt to the water. Place egg into salty water.



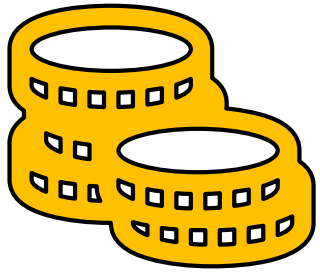
6 Half fill glass with water. Add oil.



7 Make aluminium foil boat.



8 How many coins will sink the boat?



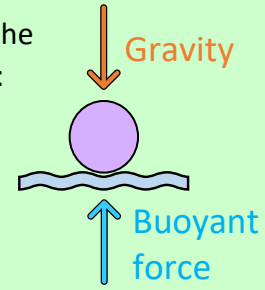
The science behind the scenes…

Density is a measure of a substance's mass per unit volume. Different materials have different densities, and these can determine whether an object sinks or floats in a specific medium (=the liquid/solution we place the object in).

Objects will **sink** if they are more dense than the medium they are placed in, and will **float** they are less dense than the medium they are placed in. If an object floats, it is said to be **buoyant**. The more porous a material is, the less dense it is, as it will have a smaller mass per unit volume.

There are two forces acting on an object when placed in water, and the balance between these two forces controls whether it sinks or floats:

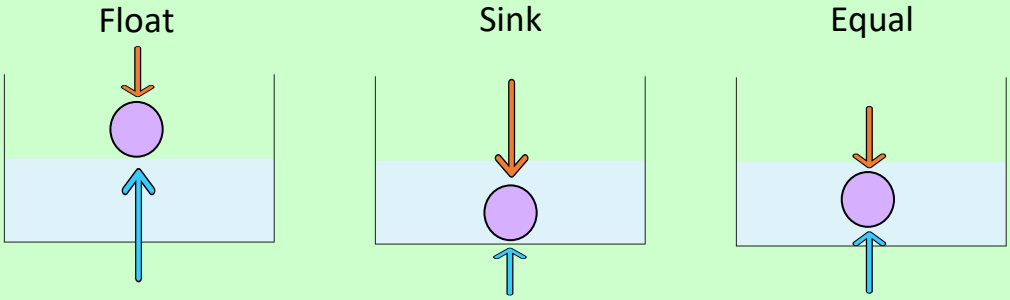
- **Gravity** acts on all objects, pulling them down towards the earth's surface. This force acts to **sink** the object.
- A **buoyant** force acts in the opposite direction to gravity, as a result of the medium it is placed in. This force acts to make the object **float**.



When the buoyant force is larger than the force of gravity, the object will rise to the surface of the liquid and **float**.

When the force of gravity is **larger** than the buoyant force propelling the object upwards, the object **sinks**.

When these two forces are **equal** and in equilibrium with each other, the object will stay put at the depth that it is placed in at (no movement).



Changing the **medium** can change whether the object sinks or floats. Different mediums have **different densities**, which changes the strength of the buoyant force the medium exerts on the object. For example, dissolving a solid in water will increase the density of the water solution. The solid **fills** the gaps between water molecules, increasing its mass per unit volume (density) and increasing the buoyant force the medium will exert of the object.

The aim of this experiment is to see how different factors affect the density of objects, and their ability to float.

Practical investigation:

Equipment:

- ☐ Large waterproof container
- ☐ Glass
- ☐ Metal and plastic utensils
- ☐ Orange x 1
- ☐ Egg x 1
- ☐ Salt
- ☐ Oil
- ☐ Aluminium foil
- ☐ Coin

Method:

1. Fill container with water.
2. Place plastic utensil in water, record whether it sinks or floats.
3. Place metal utensil in water, record whether it sinks or floats.
4. Place a peeled orange in water, record whether it sinks or floats.
5. Peel the orange. Place peeled orange in water, record whether it sinks or floats.
6. Place an egg in the water. Record observation.
7. Add salt to the water. Place the egg into the salt water and record what happens.
8. Fill glass with water. Add a small amount of oil and record observation.
9. Replace the salty water in the container with fresh water.
10. Make an aluminium foil boat.
11. Test how many coins that can be added to the boat before it sinks.

Questions:

(a) Why do the plastic and metal utensils behave differently, despite having similar shapes?
[Densities! Plastic is less dense than water, so floats; metal is more dense than water, so sinks]

(b) Does peeling the orange affect its how it behaves? Why might this be?
[An unpeeled orange floats, whereas once peeled, it sinks. The skin of an orange is porous (has lots of holes in it that are filled with air) and so when this is removed, the orange becomes more dense (decreasing its volume but with only a small change in its mass).]

(c) How does adding salt to the water affect the buoyancy of the egg? Why might this be?
[Adding salt makes the egg float. Salt dissolves in water, which means the salt molecules fill the gaps between the water molecules. This increases the density of the water medium, and the egg then becomes less dense than the new medium, so floats.]

(d) What is happening when oil is mixed with water? Why?
[Oil forms a layer above water. Oil and water do not mix as they have different properties, and oil is less dense than water so sits above (floats)]

(e) Why does the foil boat float but sinks when loaded with too many coins?
[Aluminium foil is thin and has a low density. Coins have a higher density so adding them to the boat increases the overall density of the boat. The boat sinks once the overall force of gravity from the boat and the coins becomes larger than the buoyant force holding the boat up]

(f) **Challenge**: how do rubber armbands help us swim?
[Rubber armbands are filled with air, which is much less dense than water, so improves our buoyancy and ability to float]

Science isn't just useful in the labs…

Humans have a density that is roughly the same as water, so combined with work we do in the pool to stay afloat, we can stay at the surface of the pool and swim!

Inflatable armbands are used as swimming aids, especially for young children when learning to swim. Inflatable armbands are filled with air, which is very light and has a very low density. The armbands provide buoyancy to the wearer, improving their ability to float in water, and helps with swimming.

Photo citations:
https://clipartix.com/free-egg-clipart-image-50762/
https://clipartix.com/orange-clipart-image-55466/