

## UNDERWATER PHYSICS AND CHEMISTRY

### Understanding density



**Activity 1:** Can you make an egg float?

#### Interesting facts:

Density is a measure of how much stuff can fit in a certain amount of space. Fresh water is made up of hydrogen and oxygen (H<sub>2</sub>O). Salt water also has sodium and chlorine atoms in it that dissolve into the water. In other words, the salt water that we are going to make has more stuff in it and is therefore denser than ordinary water.

So how can we prove that the saltwater is denser than ordinary water? By understanding that the higher the density of the water, the easier it is for things to float in it. You can think of the salt water as having more parts with which to hold up the floating object.

**(a) Experiment:** Compare the density of fresh and salt water.

**Apparatus** (the scientific word for equipment)

2 glasses	Salt
Egg	Spoon
Water	

#### Method

1. Fill the glasses with water.
2. Add 6 tablespoons of salt to one of the glasses of water and mix well.
3. Place an egg in each of the glasses.
4. What happens to the egg in the glass of fresh water?
5. What happens to the egg in the glass of salt water?

**Conclusions** (what do you think the results of the experiment have taught us?)

---

---

**(b) Follow-up activities:**

The average person will sink in ordinary water but can float like a boat in saltwater. The Dead Sea is 33% salt by mass. People find it very odd how "floaty" they are when they swim in the Dead Sea.

1. What else can you find out about the Dead Sea? Does the high salt level make it difficult for creatures to live there?

2. How have some creatures evolved to be able to live in the Dead Sea.

## UNDERWATER PHYSICS AND CHEMISTRY

### Understanding Surface tension



**Activity 2: Can you turn a matchstick into a speedboat?**

#### Interesting facts:

Now we are going to look at surface tension. If you imagine that you're a tiny drop of water right in the centre of a tank of water, water drops have an attractive force between them (just like magnets) so drops would be pulling you in every direction. Because the drops are all pulling equally, all these forces would cancel out so that you don't move.

Now if you imagine that you're a water drop at the surface; you're being pulled in every direction from the side and from below but you're not being pulled from the top at all because you've just got air above you there. So what would be the effect on you? Well you might find that you're being squished down a bit and you end up with a denser layer on top of the water. This results in what scientists call surface tension.

#### **(a) Experiment: Breaking the surface tension of water.**

**Apparatus** (the scientific word for equipment)

Bowl	Matchsticks
Washing-up-liquid	Water

#### **Method**

1. Fill the bowl with water.

2. Place a few matchsticks on the surface of the water.
3. Take a matchstick and dot washing-up-liquid on to the end of it.
4. Gently dip the end of the matchstick into the water
5. What happens to the floating matchsticks?
6. Why did the matchsticks speed away?

**Conclusions** (what do you think the results of the experiment have taught us?)

---

---

**(b) Follow-up activities:**

Some creatures use the surface tension of the water to help them find their prey. These creatures are called water striders.

1. How many creatures can you find that are water striders?
2. What creatures do water striders feed on?

## Teacher's support sheets:

### Activity 1 (a):

#### Density equation:

The density of a material is its mass divided by its volume. The equation for density is

$$\rho = m/V$$

where:

- $\rho$  is the density ( $\rho$  is the Greek letter **rho**. Don't ask me why they use that letter. Someone just decided it was a good idea)
- $m$  is the mass
- $V$  is the volume
- $m/V$  is  $m$  divided by  $V$

The volume of a material is affected by its temperature and pressure on the material. Thus, the density can change with different temperatures and pressures.

Also note that mass is not weight, which is mass affected by gravity. Under the same conditions of pressure and temperature, the density of a material is the same on the Earth, Moon and Mars, even though the weight would be different due to different forces of gravity.

## Density chart

The following chart allows you to compare the density of various materials under the same conditions of atmospheric pressure and temperature (unless stated otherwise).

The density of solids and liquids are usually stated in  $\text{g/cm}^3$ , while gases are usually in  $\text{kg/m}^3$ .

State	Material	Density ( $\text{g/cm}^3$ )
<b>Liquids</b>		
	Mercury	13.6
	Seawater	1.03
	Water	1.00
	Ethyl alcohol	0.81
<b>Solids</b>		
	Gold	19.3
	Iron	7.8
	Aluminum	2.7
	Ice ( $0^\circ\text{C}$ )	0.92
<b>Gases</b>	<b>(at normal pressure and a given temperature)</b>	<b>Density (<math>\text{kg/m}^3</math>)</b>
	Air ( $0^\circ\text{C}$ )	1.29
	Air ( $10^\circ\text{C}$ )	1.25
	Hydrogen ( $0^\circ\text{C}$ )	0.090
	Helium ( $0^\circ\text{C}$ )	0.178

### Activity 1 (b):

<http://geography.howstuffworks.com/oceans-and-seas/dead-sea-dead.htm>

[http://en.wikipedia.org/wiki/Dead\\_Sea](http://en.wikipedia.org/wiki/Dead_Sea)

Useful links for researching The Dead Sea.

### Activity 2 (a):

#### How it works:

Due to the washing-up liquid being a higher density than the water, it forms an oily layer on top of the water. This layer breaks the surface tension by forming a barrier between the surface of the water and the air above it. As the washing-up-liquid spreads outwards the matchstick is propelled forward.

### Activity 2 (b):

#### Example of a Water Strider:

##### **Species description:**

The semi-aquatic pond skaters (or alternatively water striders) are elongate insects with long and slender middle and hind legs. The head projects forward from the thorax and has a pair of large eyes. The thorax is elongate and bears the three pairs of legs and two pairs of wings. The front legs are short and relatively robust as they are used for grasping. The middle pair of legs supply the propulsion with steering provided by the two hind legs. Most species of pond skater have the ability to fly, but in many species adults can exist in either a winged or wingless state. *L. rufoscutellatus* follows the typical body plan of the family, the most obvious feature being its large size relative to other Irish species, adults being approximately 15-17mm long. The adults are

always fully winged which are folded neatly along the length of the abdomen. The upper side is reddish-brown, especially on the thorax. The antennae are similarly coloured and are long, at least half as long as the body. Pond skaters are predators feeding on insects caught on the water surface. They detect the presence of prey by picking up vibrations on the water surface.

**Life cycle:**

The life cycle of the species has not been studied in Ireland, but it is likely to follow the pattern of related species. Adults probably overwinter away from water in vegetation. In Ireland, adults of *L. rufoscutellatus* have been recorded between April and late September. Nymphs have been recorded in County Clare in early summer and in County Cork in August. The little data available seems to suggest the new generation of adult appears in late summer or early autumn. The species is known to be able to fly.

**Similar species:**

This is an easily recognized species amongst the Irish pond skaters. Size is sufficient to distinguish it from all other Irish species except for the river-inhabiting *Aquarius najas*. This, however, is a much darker insect, appearing black, and it also has short antennae that are less than half the body length. The two species occupy different habitats and have never been seen together in Ireland.



**How to see this species:**

Pond skaters should be looked for in sheltered, usually open, areas of water; their method of detecting and hunting prey means all species avoid windy, exposed situations and most also avoid dense vegetation. They can be caught by sweeping the surface with a pond net. Pond skaters flee at the slightest sign of disturbance of the water surface so patience is required. *L.*

*rufoscutellatus* is difficult to find as it seems sporadic in its occurrence and unlike other Irish pond skaters it does not occur in large aggregations. Males are known to be territorial defending a circular area with a radius of 50cm and usually at least 20m away from another individual. In Finland, in one study, the density of *L. rufoscutellatus* was found to be between 100 and 1000 times lower than co-occurring species. The male territories are formed amongst marginal vegetation, which further hinders detection. In Ireland, adults of *L. rufoscutellatus* have been recorded between April and late September. The species has been recorded from lakes and ponds in Counties Antrim, Armagh, Fermanagh and Tyrone. Relevant access permissions should always be sought prior to visiting any sites.