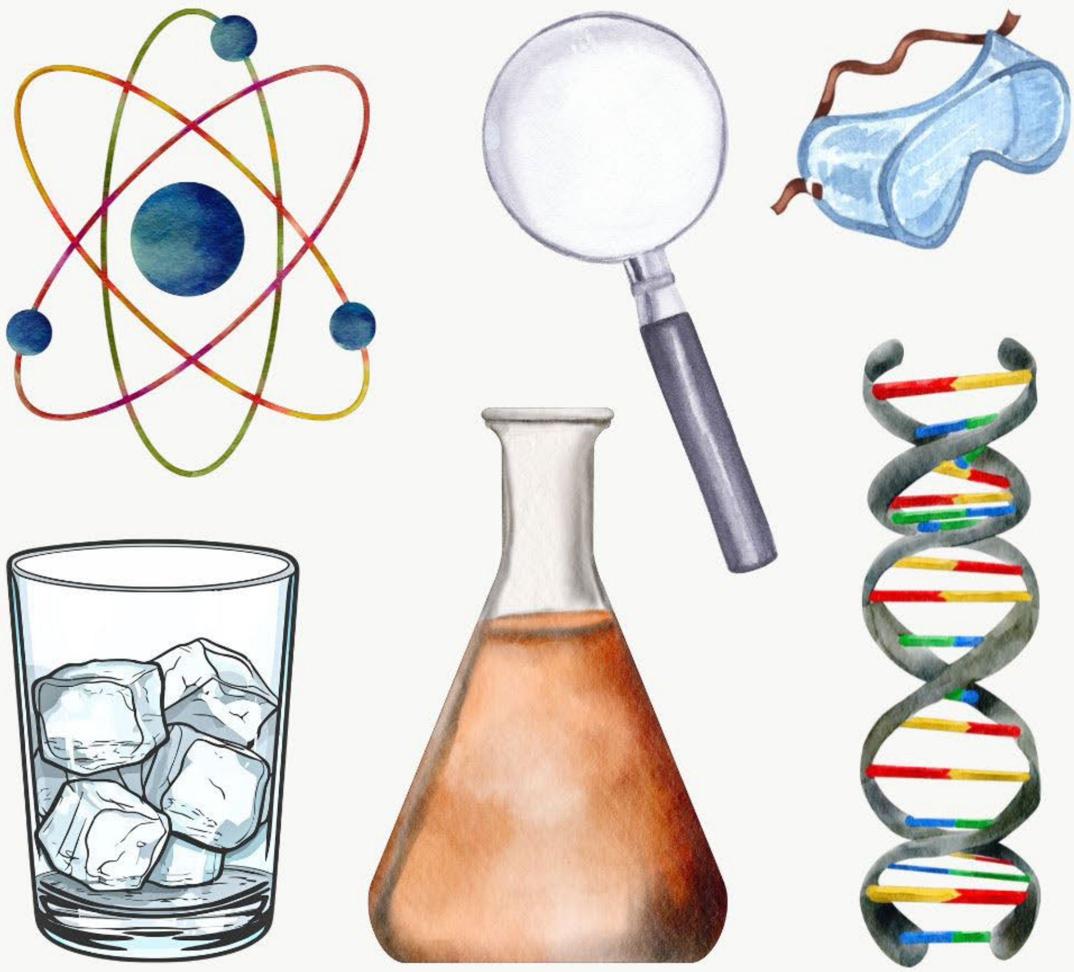
MY HOMESCHOOL

SIMPLY CHEMISTRY

MOLECULES, MIXTURES AND THE MAGIC OF WATER



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Simply Chemistry: Molecules, Mixtures and the Magic of Water

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Year 7A Course Edition 1

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Introduction

At My Homeschool, your child will study a variety of scientific disciplines, such as biology, Earth science, space science, physics, and chemistry. Scientists and scientific knowledge will also be examined, as well as the ways in which science affects individuals and businesses. In addition, we help your child develop their science skills by allowing them to conduct experiments, observe, document, ask questions, and evaluate data.

Our science resources combine the ideas of Charlotte Mason and modern teaching methods. The melding of these two approaches gives children the delight of learning about science through a range of literary and digital mediums. It also utilises a core idea in the Charlotte Mason method where children make connections between all the knowledge they are acquiring across all subjects – she calls this the science of relations.

Key Focus Area: Chemistry

In this science module students study the physical properties of the three states of matter, with a particular emphasis on water. They learn to differentiate between atoms, mixtures, and compounds, as well as how different mixtures can be separated based on their physical characteristics. Through problem-solving, planning, and conducting investigations, students explore the physical properties of water and its ability to change states. They also investigate the density of water and other solutions using mathematical formulas. Additionally, students examine how various solutions are formed at different concentrations and learn to separate mixtures by understanding their physical properties, applying these techniques to everyday situations.

How To Use This Resource

Your weekly planner will give you the schedule for using this handbook. In most cases there are two lessons per week.

There are also 4 practical lessons assigned to this course. These are associated with lessons. However, you may wish to do them at a separate time to the reading lesson. Simple equipment is required for these lessons that can be found in the kitchen. The only **additional supply you will need is some playdough, plasticine or clay for Practical 1's lesson on buoyancy**. These lessons should be written up in a science notebook. A template has been provided for writing up your lesson.

Science Narrations & Notebooking

After each reading lesson students should orally narrate (tell someone what they have learnt). Question prompts have been given to help get the conversation going. Answers to these questions can be found in the back of this resource.

After each lesson students are also encouraged to complete a written narration or summary of the lesson in their science notebook. A botany book with blank and lined pages is recommended so that students can add additional details and illustrations.

Chemistry Links Science Videos

We know Charlotte Mason didn't use videos in her lessons – it wasn't an option! However, this is a great medium for teaching various topics, and we make use of that at My Homeschool. Videos do change from time to time (depending on availability) but the key ideas taught in the videos remain the same.

Chemistry Links are found in the Virtual Cupboard of your Year 7A course. They include videos and research links to relevant web pages.

YEAR 7 CURRICULUM OUTCOMES: SOLUTIONS AND MIXTURES

This resource covers the Australian Curriculum, NSW Syllabus and WA Curriculum for Year 7.

Australian Curriculum Codes v9

AC9S7U05: Use particle theory to describe the arrangement of particles in a substance, including the motion of and attraction between particles, and relate this to the properties of the substance

AC9S7U06: Use a particle model to describe differences between pure substances and mixtures and apply understanding of properties of substances to separate mixtures

NSW Outcomes 2026

SC4-SOL-01, SC4-WS-03, SC4-WS-04, SC4-WS-07

Related Life Skills NSW Outcomes: SCLS-SOL-01, SCLS-WS-03, SCLS-WS-04, SCLS-WS-07

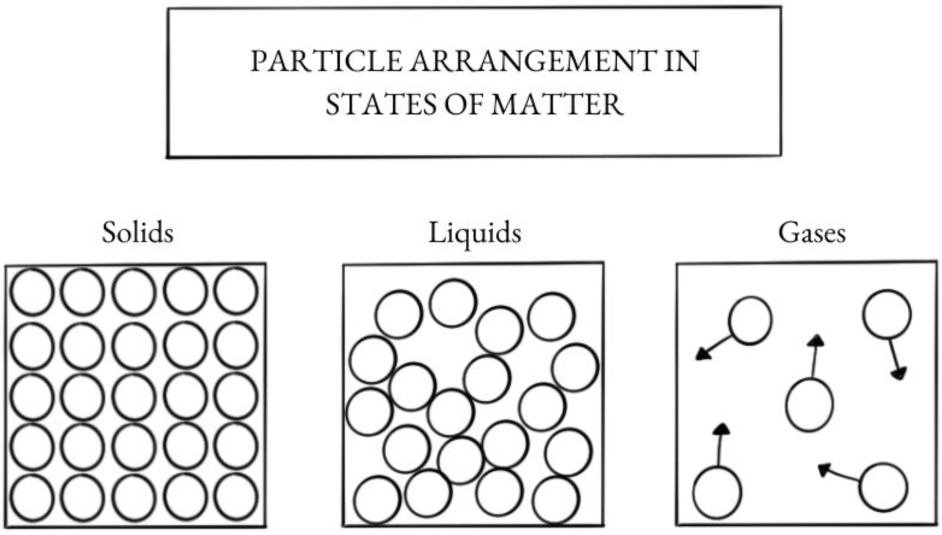
Lesson 1: Properties of Water

Chemistry is the study of matter and its changes. Matter is all around you. It is anything that has mass and takes up space. Water is matter, the air you breathe is matter, the food you eat is matter, and the chair you sit on is matter. As you can see, matter exists in many different forms. However, in all its forms, matter is alike in one important way: all matter is made from atoms.

If you took a grain of rock salt and crushed it into smaller pieces, it would still be salt. If it was ground into even tinier grains, the smallest would still be salt. It would still act and taste like salt. That grain of rock salt is made of billions of salt molecules. If we could cut one of those molecules apart, we would discover that it is made of atoms. Table salt, for example, is made from two types of atoms: sodium and chlorine. If someone asked, 'Would you like sodium chloride on your chips or hamburger?' you could say, 'Yes,' because that's the scientific name for ordinary table salt.

The Three States of Matter

Matter comes in different forms, or states, and you've most likely seen the three most common states: solid, liquid, and gas. Let's take water as an example of how these states of matter behave and interact on Earth.



Solid

All solids have a fixed shape and volume. When water is in its solid form—ice—it has a fixed shape and volume. The molecules in ice are packed closely together and only vibrate in place. This is why ice feels hard and rigid. Water freezes into ice at 0°C, and as you'll see, it can change back into a liquid or a gas under different conditions.

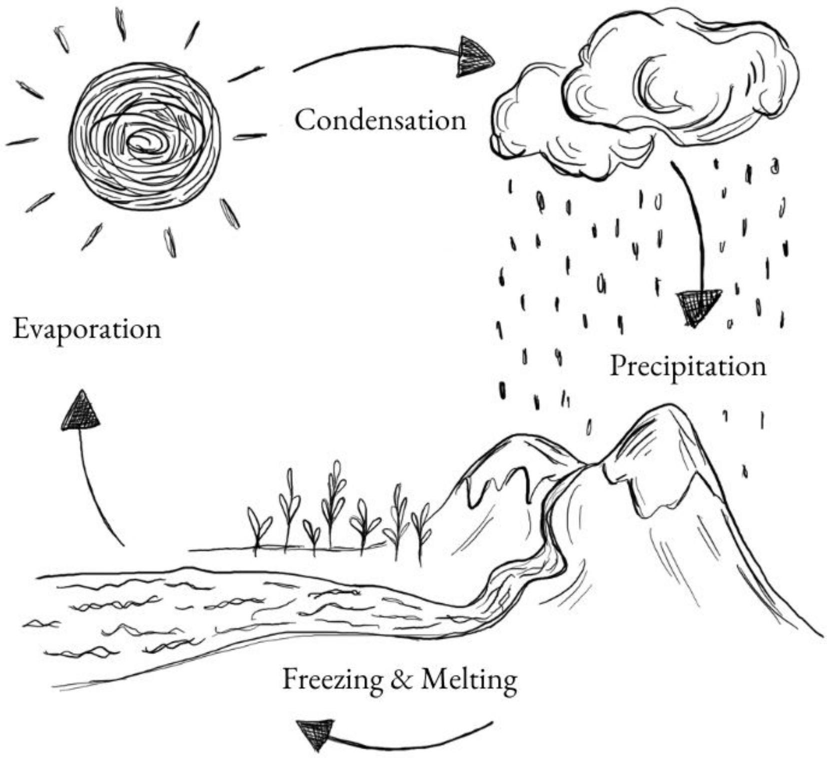
Liquid

Liquids also have a fixed volume but they take the shape of the container. Liquid water is the form we are most familiar with in everyday life. In this state, water has a fixed volume but takes the shape of the container it is in. The molecules in liquid water move around more freely than in ice, but do not spread out like a gas.

Gas

Gas has no shape or fixed volume. In its gas form, water becomes water vapour, which we cannot see with the naked eye. The molecules in a gas are far apart and move very quickly. When water evaporates from oceans, lakes, and rivers, it turns into water vapour and rises into the air. This gas phase of water is vital for processes such as the water cycle, which keeps Earth's water constantly moving.

The Movement of Water on Earth



Water is unique because it regularly changes between solid, liquid, and gas as part of the natural processes happening around us. These changes are a key part of the water cycle, which moves water between the atmosphere, land, and oceans.

Evaporation: This is when liquid water heats up and turns into water vapour. It happens when the sun warms the water in oceans, rivers, or even puddles, and the water molecules gain enough energy to escape into the air as a gas.

Condensation: Once the water vapour rises high into the atmosphere, it cools down. The molecules slow down and come closer together, forming liquid water again. This process is called condensation. It forms clouds, which are made of tiny water droplets.

Precipitation: Eventually, the water droplets in clouds combine to become larger and heavier. When they get too heavy, they fall back to Earth as rain, snow, or hail. This process is known as precipitation.

Freezing and Melting: In cold regions or during winter, liquid water can freeze and turn into solid ice. Glaciers and ice caps are large bodies of frozen water. When temperatures rise, this ice melts back into liquid water, feeding into rivers and oceans.

This constant movement of water—changing from a liquid to a gas and back again, or from a liquid to a solid—is essential for life on Earth. Without this movement, known as the water cycle, the Earth would be very different. The water cycle helps to distribute heat across the planet and brings fresh water to land, which plants, animals, and humans all depend on.

Properties of Matter

Now that we've talked about the three main states of matter, let's explore the key properties that all forms of matter share. Understanding these properties will help you to identify and compare different materials in your daily life.

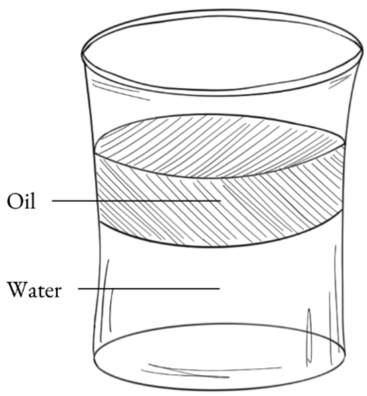
Mass and Volume

- **Mass**: This is the amount of matter in an object. We usually measure mass in grams or kilograms.
- **Volume**: This is the amount of space that an object takes up. For liquids, volume is measured in litres or millilitres, while for solids, we can calculate the volume based on their shape.

Density, Buoyancy and Surface Tension

Density is a property that combines both mass and volume. It tells us how much matter is packed into a certain space. You can think of it as how tightly the molecules are arranged in an object. For example, ice floats on water because it is less dense—its molecules are spaced further apart than those in liquid water. Density is a useful property when we want to compare substances.

Activity 1: Add some water to a glass, then add the same amount of oil. Observe what happens.



Buoyancy is closely related to density. It refers to an object's ability to float in a fluid (like water or air). An object will float if its density is less than the density of the fluid it's in, and it will sink if its density is greater. This is why ice floats on water, and why ships, despite being made of dense metal, float—because their overall density (including the air inside them) is less than that of water.

Another interesting property related to water is **surface tension**. Surface tension occurs because the molecules at the surface of a liquid, like water, are more tightly attracted to each other, creating a 'skin' on the surface. This is why small, dense objects like a paperclip can float on water even though they are denser than water—they rest on the surface without breaking the surface tension. Both buoyancy and surface tension show how density plays a role in the way objects interact with fluids.

TEST WHAT YOU KNOW

Answer the below questions orally. Watch the ***Chemistry Links*** videos and write up what you have learnt in this lesson in your science notebook. Use the questions as writing prompts for your notebook and include relevant illustrations.

Questions to Answer

1. What is matter?
2. What are the three main states of matter?
3. How do molecules behave in a solid?
4. What happens to water molecules when they turn into gas?
5. What happened when you poured oil on top of water?
6. Explain how water vapour forms clouds.
7. What is evaporation?
8. Why does ice float in water?
9. How is mass different from volume?
10. Describe one way water moves between its different states on Earth.

Lesson 2: Understanding the Density of Water and Other Solutions

Density is a fundamental concept in both physics and chemistry, representing how much mass is packed into a given volume of a substance. It helps us understand why some objects float while others sink, and it plays a crucial role in many scientific and industrial processes, including the study of water and solutions.

The density **(ϱ)** of a substance is defined as its mass per unit volume. This is the formulae we use to calculate density:

$$\varrho = \frac{m}{V}$$

Where:

- ϱ is the density (typically in kilograms per cubic metre)
- m is the mass of the substance (in kilograms or grams)
- V is the volume of the substance (in cubic metres or cubic centimetres)

For example, the density of **pure water** at room temperature (20°C) is approximately 1.00g/cm3, which means that 1 cubic centimetre of water has a mass of 1 gram.

Why is Density Important?

Density is important because it helps explain the behaviour of different materials. For instance, if the density of an object is lower than the density of water, the object will float in water (e.g. wood or oil). Conversely, if the density of an object is higher than water, it will sink (e.g. metal or a rock). Understanding density is also crucial in the context of **solutions**—mixtures where a solute is dissolved in a solvent.

For example, saltwater (solution) is salt (solute) dissolved in water (solvent).

The Density of Water

Water is often used as a reference point in studies of density. Its unique properties make it an excellent substance for comparison:

Pure water has a density of approximately 1.00 g/cm^3 at 4°C, which is considered its most dense state.

As water cools and approaches freezing, it becomes less dense, which is why ice floats on water.

This phenomenon is unusual because most substances become denser as they cool. In water, the hydrogen bonds between molecules create a unique structure when frozen, leading to lower density in the solid phase (ice) than in the liquid phase.

The Density of Solutions

When a solute (such as salt or sugar) is dissolved in water, the density of the resulting solution changes. In general, **adding a solute to a solvent increases the density of the solution**, because the total mass increases while the volume might increase only slightly.

For example, if you dissolve **sodium chloride (NaCl)** in water to make saltwater, the mass of the solution increases due to the added salt, but the volume doesn't increase much. As a result, the density of the saltwater solution is higher than that of pure water.

The Effect of Temperature on Density

Temperature can significantly affect the density of water and solutions. As water heats up, the molecules move faster and spread out, leading to a decrease in density. For example, the density of water at 100°C is approximately 0.958 g/cm^3, which is less than its density at room temperature.

In most cases, increasing the temperature will reduce the density of the solution, as both the solvent and the solute expand when heated.

Applications of Density in Real Life

The concept of density is widely applied in various fields, including:

- **Shipping**: Engineers calculate the density of cargo to ensure ships don't become too heavy and sink.
- **Medicine**: In medical diagnostics, the density of bodily fluids (such as blood and urine) can provide important clues about a person's health.
- **Environmental Science**: Understanding the density of different layers of water in oceans helps scientists study ocean currents and climate patterns.

Mathematical Formula for the Density of Solutions

To calculate the density of a solution, you can use the formula:

$$\rho \text{ (solution)} = \frac{m \text{ (solute)} + m \text{ (solvent)}}{V \text{ (solution)}}$$

Where:

- ρ solution is the density of the solution.
- *m* solute is the mass of the solute (e.g. salt).
- *m* solvent is the mass of the solvent (e.g. water).
- *V* solution is the volume of the solution.

It is important to remember when using this formula the m(solute) and the m(solvent) need to be measured in the same units e.g. both in grams, or both in milligrams

If we assume the volume of the solution remains constant (or nearly constant) when the solute is added, the formula simplifies to: $\rho = \frac{m}{V}$

Example: Calculating the Density of a Saltwater Solution

Suppose we dissolve 58.44 grams of sodium chloride (NaCl) in 1 litre (1000 cm^3) of water. The density of pure water is 1.00 g/cm^3.

1. Mass of solute (salt): 58.44 g

2. Mass of solvent (water): 1000 g (since 1 litre of water = 1000 g)

3. Volume of the solution: 1000 cm^3 (we assume the volume change is negligible)

Now, applying the formula for density:

$$\varrho \text{ solution} = \frac{58.44g + 1000g}{1000cm^3} = \frac{1058.44g}{1000cm^3} = 1.058 g/cm^3$$

Thus, the density of the saltwater solution is **1.058 g/cm^3**, slightly higher than the density of pure water.

TEST WHAT YOU KNOW

Answer the questions. Watch the ***Chemistry Links*** videos. Complete Practical 1: Investigating How Shape Affects Buoyancy and write up the results in your notebook.

Questions To Answer

Note that the volume in these activities is given in millilitres, not cm^3 as in the example above. This means your answer will be given in terms of g/ml

1. Calculate the density of a sugar solution. Dissolve 20 grams of sugar (solute) in 100 millilitres (mL) of water (solvent volume). The mass of water is 100 grams (since 1 mL of water equals 1 gram). What is the density of the sugar solution? Apply the density formula:

$$\varrho \text{ (solution)} = \frac{m \text{ (solution)}}{V \text{ (solution)}}$$

Steps:

1. ***m*** **- Mass of solute (sugar)**:
2. ***m*** **- Mass of solvent (water)**:
3. **Total mass of solution**:
4. **Volume of the solution**:

Answer: The density of the sugar solution is ______________________

2. Calculate the mass using density and volume. The density of vegetable oil is approximately **0.92 g/mL**. If you have 200 millilitres of oil, what is its mass?

Steps:

We know the formula for density is:

$$\varrho = \frac{m}{V}$$

We can rearrange the formula to solve for mass m:

$m = \varrho \times V$

Now put in the values.

The mass of vegetable oil = __________________

PRACTICAL 1—INVESTIGATING HOW SHAPE AFFECTS BUOYANCY

Aim: To investigate how the shape and dimensions of an object affect its ability to float in water.

Materials:

- Clay, plasticine or playdough
- A bowl of water

Method:

1. Take a piece of clay, plasticine or playdough and divide it into 2 or 3 portions.
2. Shape each portion into different forms, for example:
    - A long, wide shape
    - A smaller, compact shape
    - Another shape of your choice
3. Gently place each shape into a bowl of water, one at a time.
4. Observe whether each shape floats or sinks.

Results:

- Record your observations for each shape:
- Did the shape float or sink?
- Did different shapes behave differently in the water?

Conclusion:

- Based on your observations, draw conclusions about how the dimensions of an object affect buoyancy. Consider:
- Did the longer, wider shape float more easily than the compact one?
- How does the distribution of weight (or shape) affect whether an object sinks or floats?

Here is a template of how the experiments can be written up. Use this as a guide to write your own experiment.

1. **Title**:
2. **Aim**:
3. **Materials**:
4. **Method**:
5. **Results**:
6. **Conclusion**:

Example of how the experiment could be written up.

Title: Investigating How the Shape of an Object Affects Buoyancy

Aim: To investigate how the shape of an object made from plasticine influences its ability to float or sink in water.

Materials:

- Plasticine
- A bowl of water

Method:

1. Take some plasticine and divide it into three portions.
2. Shape the portions into different forms:
   - Shape 1: A long, wide shape (like a raft).
   - Shape 2: A small, compact shape (like a ball).
   - Shape 3: A flat, thin shape (like a disc).
3. Place each shape in a bowl of water, one at a time, and observe whether it floats or sinks.
4. Record your observations for each shape.

Results:

- Shape 1 (long, wide shape): Floated on the surface.
- Shape 2 (small, compact shape): Sank to the bottom.
- Shape 3 (flat, thin shape): Floated but partially submerged.

Conclusion:

The experiment shows that the dimensions and shape of an object affect its buoyancy. Larger surface areas (like the long, wide shape) allow the object to displace more water, helping it float, while more compact shapes sink because they displace less water relative to their weight.

Lesson Answers

Lesson 1 Answers

1. Matter is anything that has mass and takes up space.
2. The three main states of matter are solid, liquid, and gas.
3. In a solid, molecules are closely packed together and vibrate in place.
4. Water molecules spread out and move quickly when they turn into gas.
5. The oil sat on top because it was less dense.
6. Water vapour rises into the atmosphere, cools, and condenses into water droplets to form clouds.
7. Evaporation is the process where liquid water turns into water vapour.
8. Ice floats in water because it is less dense than liquid water.
9. Mass measures the amount of matter in an object, while volume measures the space it occupies.
10. Water evaporates, condenses into clouds, and falls as precipitation.

Lesson 2 Answers

1\. Answer Steps:

1. m - Mass of solute (sugar): 20 grams
2. m - Mass of solvent (water): 100 grams
3. Total mass of solution: 20 grams + 100 grams
4. Volume of the solution: 100 ml (we assume the volume stays the same)

   Answer: The density of the sugar solution is 1.2 g/ml.

2\. Answer Steps:

1. Density (ρ): 0.92 g/ml
2. Volume (V): 200 ml

   Answer: The mass of the vegetable oil is 184 grams.

Lesson 3 Answers

1. 34% salt.
2. The Dead Sea is far more dense than freshwater.
3. Buoyancy is the upward force exerted by a fluid and it increases as density increases, making it easier to float.
4. Buoyancy and surface tension.
5. Magnesium, potassium and calcium are all thought to help improve skin conditions.
6. It would be more beneficial to swim in the Dead Sea if you had a skin condition such as eczema due to the very high salt content and the presence of chemicals such as magnesium, potassium and calcium. These minerals are believed to soothe the skin bringing relief and the high salt content acts as a natural exfoliator leaving the skin feeling clean and refreshed. If you were to swim in the normal ocean the salt water may leave the skin feeling fresh, but the significantly lower salt content would have far less impact on the skin condition.