01 Matter

Almost everything in the universe is made of matter...

- matter has volume
- matter has mass
- matter is made up of atoms or, when atoms hook up with other atoms, molecules
The characteristics that we use to identify matter and distinguish them from one another are called properties.

Properties are categorized either as…
- physical properties: are those that we can observe with our senses
- chemical properties: are those that relate to how the substance changes in composition or how it interacts with other substances
02 Specific Physical Properties of Matter

State or Phase

A state of matter is a class of materials, usually…
• solid
• liquid
• gas
• plasma

Solids

Materials that are solids…
• have a stable, definite shape, and
• have a definite volume

In a solid, the particles are packed closely together, they cannot move freely, they can only vibrate. The movement and temperature are very low. Solids can only change their shape by force, such as breaking or cutting a solid object.
Liquids

Materials that are liquids…
- do not have a definite shape
- have a definite volume (determined by the container)

In a liquid, the particles are farther apart, and they can slide past each other easily. The movement and temperature, in comparison to a solid, are higher.
Gases

Materials that are gases…
- do not have a definite shape
- have a definite volume (determined by the container that is closely sealed)

In a gas, the particles are far apart from each other, and they can move around quickly. The movement and temperature are the higher than those of both solids and liquids.
Plasmas

Plasmas, known as the fourth state of matter…
- are "hotter" than gas

A plasma occurs when the temperature is between…
- 1,000 and 1,000,000,000 degrees Celsius

Some examples of plasma are…
- flames
- lightning
- aurora (northern lights)
- neon lights
- stars (including our own sun)
04 Additional Physical Properties

Intensive Properties

Intensive properties are properties that do not depend on the amount of the matter present…

- colour
- odour
- lustre: how shiny a substance is
- malleability: the ability of a substance to be beaten into thin sheets
- ductility: the ability of a substance to be drawn into thin wires
- viscosity: the resistance of a fluid to flow
- diffusion: the tendency of molecules to intermingle with one another over time (fluids and gases)
- conductivity: the ability of a substance to allow the flow of energy or electricity
- hardness: how easily a substance can be scratched
- melting or freezing point: the temperature at which the solid and liquid phases of a substance are in equilibrium at atmospheric pressure
- boiling point: the temperature at which the vapour pressure of a liquid is equal to the pressure on the liquid (generally atmospheric pressure)
- density: the mass of a substance divided by its volume
Extensive Properties

Extensive properties are properties that do depend on the amount of matter present…

- **mass**: amount of matter in a object (grams)
- **weight**: gravitational force of attraction of the earth acting on an object
- **volume**: amount of space a substance occupies
- **length**
Lesson 03: Classification of Matter

01 Introduction

Matter can be classified two ways…by…

- state
- composition

02 State Classification

State classification includes…

- solids
- liquids
- gases

03 Composition Classification

Composition classification includes…

- mixtures and substances
- elements and compounds
Mixtures and Substances

Normally, matter is all mixed up. That is, matter is usually found in mixtures…
• a combination of two or more different kinds of matter

The parts of a mixture are called substances…
• one kind of matter

Each substance has its own properties which do not change. This is how chemists can tell one substance apart from another, and why knowing the properties of matter is important.
Elements and Compounds

Most substances on Earth are in the form of compounds. A compound is a substance which has its own properties but which can be broken down into other substances.

To see if a substance is a compound or an element, chemists will often utilize chemical reactions.

If a chemical reaction…
- does happen and the substance separates into two or more different substances, it was a compound
- does not happen, the substance is an element
Sorting matter into these groups turns out to be very important and helpful for learning how matter is put together.

In later sections of this unit, you will learn how elements are organized.
04 Breakdown of Matter

When determining how to classify matter, diagrams such as the following one are useful in this process…
Lesson 04: Physical Separation of Substances

01 Introduction

In chemistry a separation process is used to transform a
- mixture of substances into
- two or more distinct substances

Interestingly, almost every substance found in nature is as a mixture of more two or more substances.

Sand for instance is composed of a variety of minerals and each of the minerals is its own substance…

<table>
<thead>
<tr>
<th>Mixture of Substances: Sand</th>
</tr>
</thead>
</table>
Many times there is a need to separate mixtures into individual substances.

The separation processes can be either…
- chemical in nature or
- physical in nature

In this lesson we look only at the physical processes…
02 Physical Separation of Substances

The following are all methods to physically separate substances...

- **hand separation**: pick out the different parts with your hands, use a magnet, or, use a sieve (strainer)
- **filtration**: separate solid particles, big enough to be seen, from a liquid using a filter paper and pump to draw liquid through quickly
- **evaporation**: when a solid is dissolved in a liquid, the solid remains, the liquid evaporates
distillation: used to separate two liquids with different boiling points (evaporated liquid is chilled, condenses and is collected on the right)
- solvent extraction: there is two possibilities: (1) separate two solids mechanically mixed by dissolving one of them, (2) separate a liquid and solid from a liquid solution
- **recrystallization**: prepare a saturated solution then slowly evaporate the solvent and very pure crystals form and precipitate to the bottom
• **gravity separation:** to separate solids from a mechanical mixture (laboratory centrifuge is an example)
• paper, thin layer and column chromatography: separates small amounts of solids in liquids
Lesson 05 and 06: Phases and Phase Changes

01 Physical and Chemical Changes

There are two types of changes in nature…

<table>
<thead>
<tr>
<th>Chemical Changes</th>
<th>Physical Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>new substances are formed</td>
<td>new substances are not formed</td>
</tr>
<tr>
<td>involve chemical reactions</td>
<td>involve changes in state or phase</td>
</tr>
</tbody>
</table>

Let's take a closer look at physical changes...
02 Phases / States of Matter

Remember that matter can exist, more or less, in four phases or states...

- **solid**: molecules are very close together, cannot move around, has a definite shape and volume
- **liquid**: molecules are close together, move around slowly, has the ability to take the shape of a container
- **gas**: molecules are widely separated, move around freely, move at high speeds, has no definite volume or shape
- **plasma**: composed of free-floating ions (+ charge) and free electrons (- charge), has no definite volume or shape

Matter can also change from one phase to another…
03 Phase Changes / State Changes

All matter can move from one phase or state to another, though, it may require…

- extreme temperatures, or
- extreme pressures

Phase changes include…
- melting: solid to liquid
- freezing: liquid to solid
- evaporation: liquid to gas
- condensation: gas to liquid
- sublimation: solid to a gas
- deposition: gas to a solid
Commonly, phase changes are described using what are called **heating curves**...

Features of the heating curve include...

- **non-horizontal portion of curve**: where temperature changes take place
- **horizontal portion of curve**: where no temperature changes take place but a phase change does take place