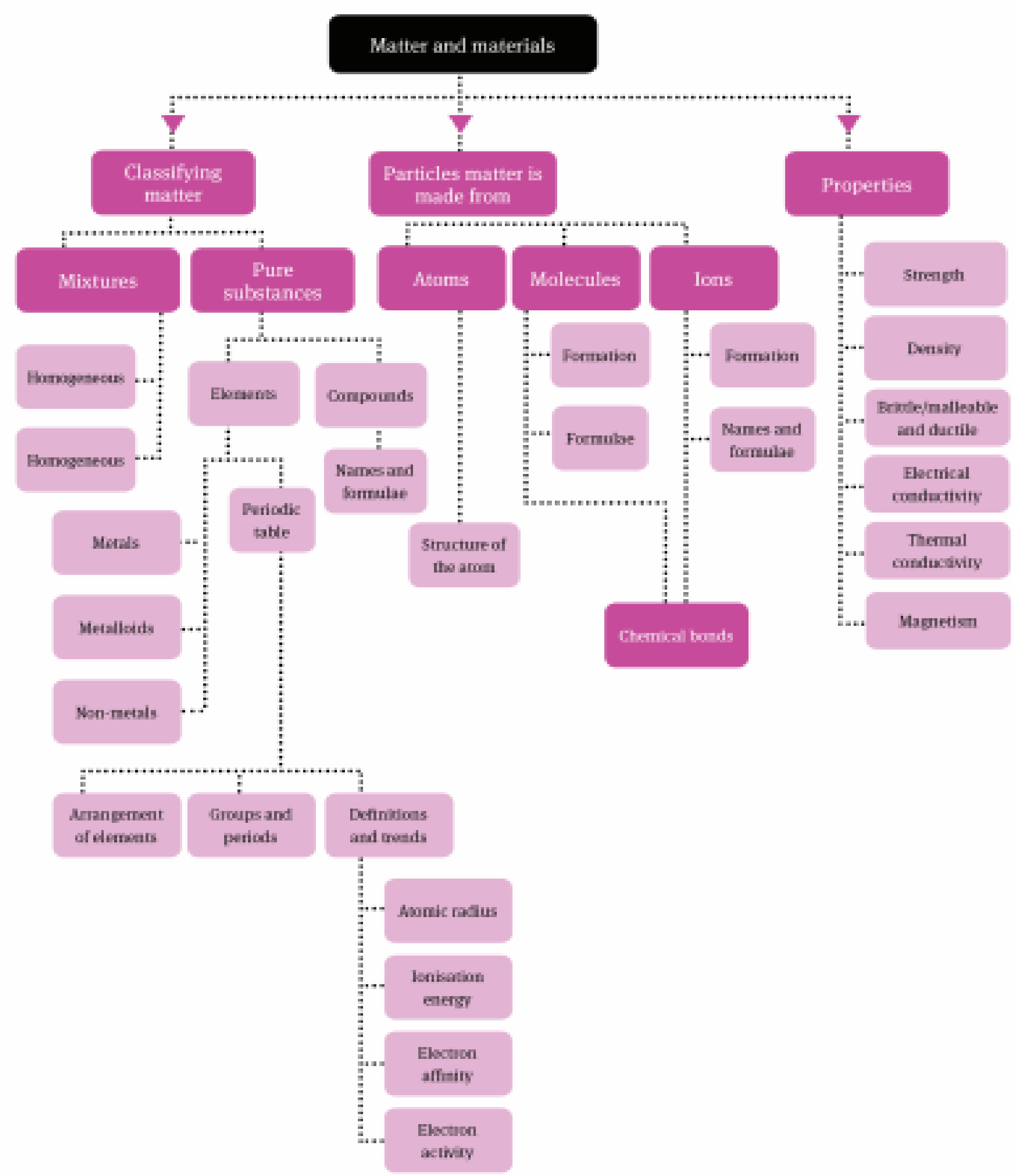
Grade 10 physical science 2020

Term 1

Matter and materials



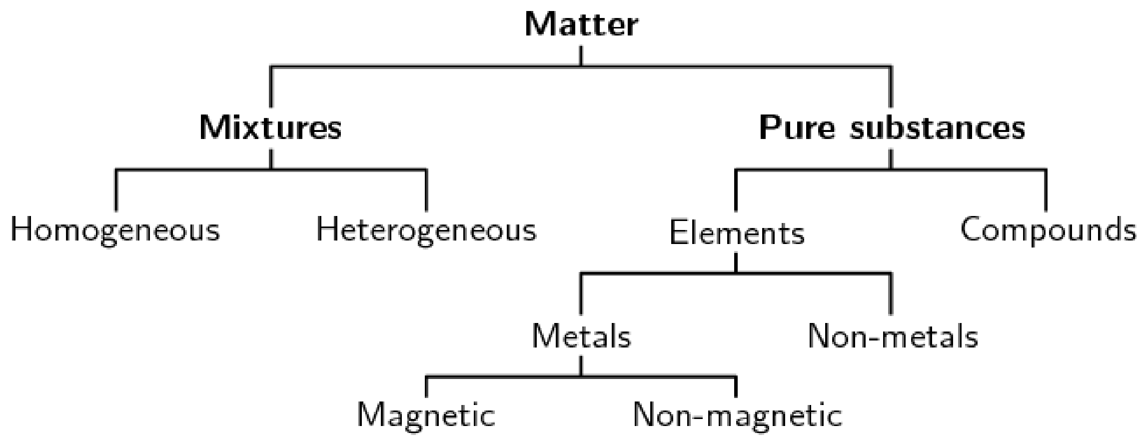
Matter is anything that has mass and volume (takes up space). All the objects that we see in the world around us, are made of **matter**. Matter makes up the air we breathe, the ground we walk on, the food we eat and the animals and plants that live around us. Even our own human bodies are made of matter!

Different objects can be made of different types of **materials** (the matter from which objects are made). For example, a cupboard (an *object*) is made of wood, nails, hinges and knobs (the *materials*). The **properties** of the materials will affect the properties of the object. In the example of the cupboard, the strength of the wood and metals make the cupboard strong and durable. It is very important to understand the properties of materials, so that we can use them in our homes, in industry and in other applications.

Some of the properties of matter that you should know are:

- Materials can be **strong** and resist bending (e.g. bricks, rocks) or **weak** and bend easily (e.g. clothes)
- Materials that conduct heat (e.g. metals) are called **thermal conductors**. Materials that conduct electricity (e.g. copper wire) are **electrical conductors**.
- **Brittle** materials break easily (e.g. plastic). Materials that are **malleable** can be easily formed into different shapes (e.g. clay, dough). **Ductile** materials are able to be formed into long wires (e.g. copper).
- **Magnetic** materials have a magnetic field (e.g. iron).
- **Density** is the mass per unit volume. Examples of dense materials include concrete and stones.
- The **boiling and melting points** of substances tells us the temperature at which the substance will boil or melt. This helps us to classify substances as solids, liquids or gases at a specific temperature.

The diagram below shows one way in which matter can be classified (grouped) according to its different properties. As you read further in this chapter, you will see that there are also other ways of classifying materials, for example according to whether or not they are good electrical conductors.



Mixtures

We see mixtures all the time in our everyday lives. A stew, for example, is a mixture of different foods such as meat and vegetables; sea water is a mixture of water, salt and other substances, and air is a mixture of gases such as carbon dioxide, oxygen and nitrogen

> **<u>A mixture</u>** is a combination of two or more substances, where these substances are not bonded (or joined) to each other and no chemical reaction occurs between the substances.

In a mixture, the substances that make up the mixture:

- **are not in a fixed ratio**

Imagine, for example, that you have 250250 mLmL of water and you add sand to the water. It doesn't matter whether you add 2020 gg, 4040 gg, 100100 gg or any other mass of sand to the water; it will still be called a mixture of sand and water.

- **keep their physical properties**

In the example we used of sand and water, neither of these substances has changed in any way when they are mixed together. The sand is still sand and the water is still water.

- **can be separated by mechanical means**

To separate something by “mechanical means”, means that there is no chemical process involved. In our sand and water example, it is possible to separate the mixture by simply pouring the water through a filter. Something *physical* is done to the mixture, rather than something *chemical*.

We can group mixtures further by dividing them into those that are heterogeneous and those that are homogeneous.

Heterogeneous mixtures

A **heterogeneous** mixture does not have a definite composition. Cereal in milk is an example of a heterogeneous mixture. Soil is another example. Soil has pebbles, plant matter and sand in it. Although you may add one substance to the other, they will stay separate in the mixture. We say that these heterogeneous mixtures are *non-uniform*, in other words they are not exactly the same throughout. Examples of heterogeneous mixtures are mixed vegetables, oil in water etc

Homogeneous mixtures

A **homogeneous** mixture has a definite composition, and specific properties. In a homogeneous mixture, the different parts cannot be seen. A solution of salt dissolved in water is an example of a homogeneous mixture. When the salt dissolves, it spreads evenly through the water so that all parts of the solution are the same, and you can no longer see the salt as being separate from the water. Think also of coffee without milk. The air we breathe is another example of a homogeneous mixture since it is made up of different gases which are in a constant ratio, and which can't be visually distinguished from each other (i.e. you can't see the different components). Examples of homogeneous mixtures are sugar solution, coffee, etc.

Acticity 1

Copy and complete the following table

Substance	Non-mixture or mixture	Heterogeneous mixture	Homogeneous mixture
tap water			
brass (an alloy of copper and zinc)			
concrete			
aluminium foil (tinfoil)			
Coca Cola			
soapy water			
black tea			
sugar water			
baby milk formula			

Pure Substances

Any material that is not a mixture, is called a **pure substance**. Pure substances include **elements** and **compounds**. It is much more difficult to break down pure substances into their parts, and complex chemical methods are needed to do this.

We can use melting and boiling points and chromatography to test for pure substances. Pure substances have a sharply defined (one temperature) melting or boiling point. Impure substances have a temperature range over which they melt or boil. Chromatography is the process of separating substances into their individual components. If a substance is pure then chromatography will only produce one substance at the end of the process. If a substance is impure then several substances will be seen at the end of the process.

Elements

An **element** is a chemical substance that can't be divided or changed into other chemical substances by any ordinary chemical means. The smallest unit of an element is the **atom**. An **element** is a substance that cannot be broken down into other substances through chemical means.

There are 112112 officially named elements and about 118118 known elements. Most of these are natural, but some are man-made. The elements we know are represented in the **periodic table**, where each element is abbreviated to a **chemical symbol**.

Compounds

A **compound** is a chemical substance that forms when two or more different elements combine in a fixed ratio. Water (H_2O), for example, is a compound that is made up of two hydrogen atoms for every one oxygen atom. Sodium chloride ($NaCl$) is a compound made up of one sodium atom for every chlorine atom. An important characteristic of a compound is that it has a **chemical formula**, which describes the ratio in which the atoms of each element in the compound occur.

We can also use symbols to represent elements, mixtures and compounds. The symbols for the elements are all found on the periodic table. Compounds are shown as two or more element names written right next to each other. Subscripts may be used to show that there is more than one atom of a particular element. (e.g.H_2Oor NH_3). Mixtures are written as: a mixture of element (or compound) A and element (or compound) B. (e.g. a mixture of Fe and S).

WORKED EXAMPLE : MIXTURES AND PURE SUBSTANCES

For each of the following substances state whether it is a pure substance or a mixture. If it is a mixture, is it homogeneous or heterogeneous? If it is a pure substance is it an element or a compound?

1. Blood (which is made up from plasma and cells)
2. Argon
3. Silicon dioxide (SiO_2)
4. Sand and stones

Apply the definitions

An element is found on the periodic table, so we look at the periodic table and find that only argon appears there. Next we decide which are compounds and which are mixtures. Compounds consist of two or more elements joined in a fixed ratio. Sand and stones are not elements, neither is blood. But silicon is, as is oxygen. Finally we decide whether the mixtures are homogeneous or heterogeneous. Since we cannot see the separate components of blood it is homogeneous. Sand and stones are heterogeneous.

Write the answer

1. Blood is a homogeneous mixture.
2. Argon is a pure substance. Argon is an element.
3. Silicon dioxide is a pure substance. It is a compound.
4. Sand and stones form a heterogeneous mixture.

Activity 2

1. Copy and complete following table by ticking whether each of the substances listed is a *mixture* or a *pure substance*. If it is a mixture, also say whether it is a homogeneous or heterogeneous mixture.

Substance	**Mixture or pure**	**Homogeneous or heterogeneous mixture**
fizzy colddrink		
steel		
oxygen		
iron filings		
smoke		
limestone $(CaCO_3)$		

2. In each of the following cases, say whether the substance is an element, a mixture or a compound.

1. Cu
2. iron and sulfur
3. Al
4. H_2SO_4
5. SO_3

Names and formulae of substances

The following are some guidelines for naming compounds:

1. The compound name will always include the **names of the elements** that are part of it.

A compound of **iron** (FeFe) and *sulfur* (SS) is **iron***sulf*ide (FeSFeS)
A compound of **potassium** (KK) and *bromine* (BrBr)
is **potassium***brom*ide (KBrKBr)
A compound of **sodium** (NaNa) and *chlorine* (ClCl)
is **sodium***chlor*ide ($NaCl$NaCl)

2. In a compound, the element that is on the left of the Periodic Table, is used *first* when naming the compound. In the example of $NaCl$NaCl, sodium is a group 1 element on the left hand side of the table, while chlorine is in group 17 on the right of the table. Sodium therefore comes first in the compound name. The same is true for FeSFeS and KBrKBr.

3. The **symbols** of the elements can be used to represent compounds e.g. FeSFeS, $NaCl$NaCl, KBrKBr and H_2OH2O. These are called **chemical formulae**. In the first three examples, the ratio of the elements in each compound is 1:1. So, for FeSFeS, there is one atom of iron for every atom of sulfur in the compound. In the last example (H_2OH2O) there are two atoms of hydrogen for every atom of oxygen in the compound.

4. A compound may contain **ions** (an ion is an atom that has lost or gained electrons). These ions can either be simple (consist of only one element) or compound (consist of several elements). Some of the more common ions and their formulae are given below. You should know all these ions.

Compound ion	**Formula**	**Compound ion**	**Formula**	**Compound ion**	**Formula**
Hydrogen	H^{+}	Lithium	Li^{+}	Sodium	Na^{+}
Potassium	K^{+}	Silver	Ag^{+}	Mercury (I)	Hg^{+}
Copper (I)	Cu^{+}	Ammonium	NH^{+4}	Beryllium	$Be2^{+}$
Magnesium	Mg^{2+}	Calcium	Ca^{2+}	Barium	Ba^{2+}
Tin (II)	Sn^{2+}	Lead (II)	Pb^{2+}	Chromium (II)	Cr^{2+}
Manganese (II)	Mn^{2+}	Iron (II)	Fe^{2+}	Cobalt (II)	Co^{2+}
Nickel	Ni^{2+}	Copper (II)	Cu^{2+}	Zinc	Zn^{2+}
Aluminium	Al^{3+}	Chromium (III)	Cr^{3+}	Iron (III)	Fe^{3+}
Cobalt (III)	Co^{3+}	Chromium (VI)	Cr^{6}	Manganese (VII)	Mn^{7+}

Compound ion	Formula	Compound ion	Formula
Fluoride	F^{-}	Oxide	O^{2-}
Chloride	Cl^{-}	Peroxide	O_2^{-2}
Bromide	Br^{-}	Carbonate	CO_2^{-3}
Iodide	I^{-}	sulfide	S_2^{-}
Hydroxide	OH^{-}	Sulfite	SO_2^{-3}
Nitrite	NO^{-2}	Sulfate	SO_2^{-4}
Nitrate	NO^{-3}	Thiosulfate	$S_2O_2^{-3}$
Hydrogen carbonate	$HCO{-}^{3}$	Chromate	CrO_2^{-4}
Hydrogen sulfite	HSO^{-3}	Dichromate	$Cr_2O_2^{-7}$
Hydrogen sulfate	HSO^{-4}	Manganate	MnO_2^{-4}
Dihydrogen	H_2PO^{-4}	Oxalate	$C_2O_2^{-4}$

phosphate			
Hypochlorite	ClO^{-}	Hydrogen phosphate	HPO_2^{-4}
Chlorate	ClO^{-3}	Nitride	N^{3-}
Permanganate	MnO^{-4}	Phosphate	PO_3^{-4}
Acetate (ethanoate)	CH_3COO^{-}	Phosphide	P_{3-}