SUBJECT and GRADE	PHYSICAL SCIENCES GRADE 10	
TERM 1	*WEEK 5*	
TOPIC	MATTER AND MATERIALS: PERIODIC TABLE	
AIMS OF LESSON	• To introduce and then discuss the structure of the Periodic Table • To elaborate on the structure of atoms and arrangements of electrons in atoms • To describe the periodicity of elements in a period or group in terms of different concepts • To relate the electron arrangement of an atom to its chemical properties • To describe the trends in reactivity of elements in groups • To indicate the positions of metals, metalloids and non-metals	
RESOURCES	***Paper based resources***	***Digital resources***
	Find the section on Matter and Materials in your textbook and refer to the topic of The Periodic Table. Read through the notes and attempt the activities.	Refer to the relevant digital resources e.g. links on the WCED ePortal of previous lessons. Use the links indicated to watch the following videos: • The Periodic Table: Atomic Radius, Ionisation Energy and Electronegativity - https://www.youtube.com/watch?v=hePb00CqvP0 • Ionisation energy and atomic radius - https://www.youtube.com/watch?v=Mmti4kKDcqA • Valence electrons and the Periodic Table - https://www.youtube.com/watch?v=yADrWdNTWEc

<table>
<tr><td>INTRODUCTION</td><td colspan="2">From the previous lesson, you have to:

• Complete the Aufbau diagrams of elements and know how to identify the energy levels etc.
• Be able to write the electronic structure of atoms in different ways

In this lesson, you will learn more about the Periodic Table:
• How the elements are arranged – in terms of increasing atomic numbers
• The difference between Groups and Periods
• How to identify core and valence electrons
• The trends displayed by elements of the Periodic Table
• Properties of some of the groups of elements
• Where the metals, metalloids and non-metals are found</td></tr>
<tr><td>CONCEPTS AND SKILLS</td><td>THE STRUCTURE OF THE PERIODIC TABLE
The periodic table displays the elements in order of increasing number of protons (or ascending atomic number).

GROUPS:
Elements are arranged in 18 <u>vertical columns</u> called groups that are numbered 1–18. Traditionally, the groups were numbered using Roman numerals (I - VIII) and these can still be seen on periodic tables. Some of the groups have names. The names are listed in the Table below.

<table>
<tr><th colspan="2">GROUP NUMBER</th><th rowspan="2">COMMON NAME</th></tr>
<tr><th>MODERN</th><th>TRADITIONAL</th></tr>
<tr><td>1</td><td>I</td><td>Alkali metals</td></tr>
<tr><td>2</td><td>II</td><td>Alkali-Earth metals</td></tr>
<tr><td>7</td><td>VII</td><td>Halogens</td></tr>
<tr><td>8</td><td>VIII</td><td>Noble gases</td></tr>
</table>

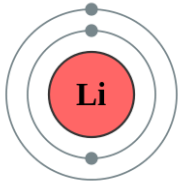
PERIODS:</td><td>CAN YOU?

Identify the concepts/skills that learners should be able to do.

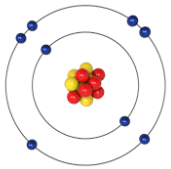
(1) Find an element on the Periodic Table when given the Group and Period numbers?

(2) Write the definitions of group numbers and periods of the Periodic Table?

(3) Explain the difference between core and valence electrons?</td></tr>
</table>

	The seven horizontal rows in the periodic table are called periods. The periods are numbered 1–7 from top to bottom. The first period contains only two elements: hydrogen and helium. WORKED EXAMPLES: 1. Aluminium (Al) is found in Group 13 (III) and period 3. 2. Oxygen (O) is found in Group 16 (VI) and period 2. **THE PERIODIC TABLE AND ELECTRON CONFIGURATIONS** Groups and periods organise all the elements with related electron configurations together. Electrons are arranged in energy levels around the nucleus of an atom. **CORE** electrons - are the electrons closest to the nucleus. **VALENCE** electrons – are the electrons in the outermost/last energy level. Example 1:  The lithium atom (Li) has 2 CORE electrons and 1 VALENCE electron.	(4) See that the element – because of its number of valence electrons – belong to a specific group on the Periodic Table? (5) Compare the last energy level and the period that the elements are found in on the Periodic Table? (6) Write the definitions of: (6.1) atomic radius (6.2) ionisation energy (6.3) electron affinity (6.4) electronegativity (7) Note the periodic trends as you move across the periods and down the groups in terms of: (7.1) atomic radius (7.2) ionisation energy (7.3) electron affinity (7.4) electronegativity 8. Comment on the reactivity of elements in Group 1,2,17 and 18, by referring to the electron arrangement and elemental nature?

Example 2:



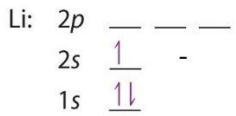
The oxygen atom (O) has 2 CORE electrons and 6 VALENCE electrons.

VALENCE ELECTRONS AND GROUP NUMBERS

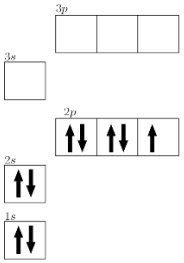
Example 1: Lithium has 1 valence electron and is found in group I
Example 2: Oxygen has 6 valence electrons and is found in group VI

Elements within the same groups have similar chemical properties because they have the same number of valence electrons. You can work out the number of valence electrons in each element from their Aufbau diagrams and you will notice that there is a pattern. The number of valence electrons corresponds to the traditional group number (in Roman numerals).

Example 1: Lithium - 1 electron in the second energy level (last)



Example 2: Oxygen – 6 electrons in the second energy level (last)



ENERGY LEVELS AND PERIOD NUMBERS

The period number tells us in which energy level an atom has its valence electrons.

Example 1: Lithium has 1 valence electron in the second energy level (outermost) – and is found in period 2.

Example 2: Oxygen has 6 electrons in the second energy level (outermost) – and is found in period 2.

PERIODICITY IN PROPERTIES OF ELEMENTS

Periodicity refers to the gradual change of physical and chemical properties as we move across the periodic table, from left to right. The elements were placed in their positions on the Periodic Table due to repeating patterns that conform to certain rules. The properties of elements vary periodically.

The following concepts describe the periodicity …

Atomic Radius:

The atomic radius is the distance from the nucleus to the outermost stable electron orbital.

Periodic trends:

The size of atoms **decreases as you go across a period** (from left to right) because, while new electrons are being added to the atoms, new protons are also being added to their nuclei. This increased positive charge holds the negative electrons more tightly.

At the beginning of the next period, electrons enter a whole new energy level, and the atom increases in size.

Atomic radius **increases down a group** as new energy levels are added in each new period.

Ionisation Energy:

The ionisation energy is the energy required to remove an electron from a neutral atom in the gaseous phase.

	Periodic trends: **Along each period there is an increase** in first ionisation energy. As you go across a period, the atoms are getting smaller and thus the negative electrons are closer to the positive nucleus. Also, the size of the positive charge in the nucleus is getting bigger. The result is that the valence electrons are held more tightly by the nucleus. **Down each group there is a decrease** in first ionisation energy. As you go down a group, the valence electrons in the outermost energy level of the atoms are further away from the positive nucleus. This means that the electrons are held less tightly, and less energy is needed to remove one. **Electron Affinity**: Electron affinity is the energy change that occurs when an atom or molecule gains an electron to form a negative ion. **Periodic trends**: Electron affinities become **more negative as we move from left to right across a period**. Electron affinities change little moving down a group. **Electronegativity**: Electronegativity is a measure of how strongly the atom attracts the shared pair of electrons in a chemical bond, in other words, the attraction for the electrons in a chemical bond. The value for each element is indicated on the Periodic Table. Example 1: Lithium has an electronegativity of 1,0 Example 2: Oxygen has an electronegativity of 3,5 This means that Oxygen has a stronger attraction for bonding electrons than Lithium. **Periodic trends**: Electronegativity generally **increases moving across a period**. Electronegativity generally **decreases moving down a group**.

CHEMICAL PROPERTIES OF GROUPS 1, 2, 17 AND 18

The chemical properties of elements in the same group are similar. This is because valence electrons determine the chemical properties of an element.

When you move down a group, each element will have the same number of valence electrons, arranged in similar orbitals in the outermost energy level.

The elements all want to achieve a stable structure (with 8 electrons in the outermost energy level). That is why so many atoms lose or gain electrons to obtain an electron configuration like that of the nearest noble gas (all noble gases have a stable electron structure). This is called the octet rule.

The octet rule states that atoms tend to combine in such a way that they will have eight electrons in their outer energy level, giving them the same electron configuration as a noble gas.

REACTIVITY OF THE GROUPS 1, 2, 17 AND 18 ELEMENTS

Reactivity - is a measure of how vigorously an atom will react with another substance. This depends on the atom's ionisation energy AND electronegativity.

In Group 1 and 2, reactivity **decreases as you go from left to right across a period** and **increases as you go down a group**.

In Group 17, **reactivity decreases as you go down the group**.

Group 1 elements: ALKALI METALS

The alkali metals are all highly reactive and are never found in elemental forms in nature. They have 1 valence electron (in the outermost energy level). This means they are far from being stable as they require 7 electrons to fill up the outermost energy level.

These elements must be stored under oil in a container. If they are exposed to air or water (even moisture in the air) they react spontaneously and vigorously.

Group 2 elements: ALKALINE-EARTH METALS

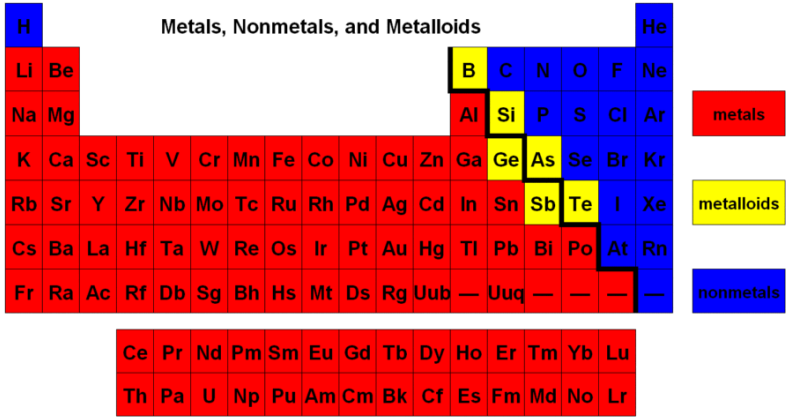
The alkaline-earth metals are not as reactive as the alkali metals and can be stored in their elemental form in sealed containers.

Alkaline-earth metals react slowly with the oxygen in the air to form a layer of metal oxide on the surface of the metal.
The alkaline-earth metals burn easily when in powder form or as a flat ribbon if placed in a flame.
The Group 2 metals become more reactive towards water as you go down the group.

Group 17 elements: HALOGENS
The halogens are very reactive with the alkali metals (Group 1) and alkaline earth (group 2) metals.
Halogens are non-metals and are always found as diatomic compounds in nature (each molecule consist of 2 atoms).

Group 18 elements: NOBLE GASES
All the elements in this group have full outermost energy levels.
They do not require any electrons to become stable – and are therefore unreactive. This means that they do not react with any other elements.

POSITION OF METALS, METALLOIDS AND NON-METALS



ACTIVITIES/
ASSESSMENT

ACTIVITY:

1. Copy the table below into your notebook and complete it by filling in the missing answers.
   You will have to use your Periodic Table to find the answers. An example has been completed for you.

ELEMENT	SYMBOL	GROUP NUMBER	PERIOD NUMBER
Lithium	Li	1	2
Calcium			
	P		
		17	3
Sodium			

2. Copy the table below into your notebook and complete it by filling in the missing answers.
   You will have to use your Periodic Table to find the answers. An example has been completed for you.

ELEMENT	SYMBOL	GROUP NUMBER	No OF VALENCE ELECTRONS	PERIOD	OUTERMOST ENERGY LEVEL
Magnesium	Mg	2	2	3	3
	S				
Chlorine					
	C				

3. Give one term/word for each of the following statements or descriptions.

3.1 The energy required to remove an electron from a neutral atom in its gaseous phase.
3.2 The ability of an atom in a molecule to attract electrons to itself.
3.3 The elements that are always found as diatomic molecules.
3.4 The electrons that are found closest to the nucleus.
3.5 The horizontal rows of the Periodic Table.
3.6 The elements found in group 7.

	4. Refer to the list of neutral atoms below to answer the following questions. Na P Cl Ar Si Mg Cl O From the list, choose the atom (you may use an atom more than once) that: 4.1 has the lowest atomic radius 4.2 has the highest ionisation energy 4.3 has 2 valence electrons 4.4 has a stable electron structure 4.5 is found in period 2 4.6 has the highest electronegativity 4.7 is found in group 15 (V) 4.8 is a metalloid 4.9 is an alkaline-earth metal 4.10 is a highly reactive element
CONSOLIDATION	• You can now explain the structure of the Periodic Table in terms of groups and periods • You can identify differentiate between core and valence electrons and the link to Group numbers • Ensure that you study the definitions of all the concepts listed above • Study the Periodic trends listed in the notes and answer the questions in the activities in your textbook • Complete the Activity • Good luck with the lesson!
VALUES	RESPONSIBILITY and INDEPENDENCE are the values specific for the lesson, you must follow the rules and learn to work on your own.