Chemistry Syllabus
Grade 7

General Objectives of Grade 7 Chemistry

1. To Develop Understanding and Acquire Knowledge of:

- the meaning and essence of chemistry.
- common chemical industries in Ethiopia.
- classifications of substances
- Physical and chemical changes.
- meaning of chemical symbols and formulas.
- historical development of the atomic nature of substances.
- Dalton's Atomic Theory and modern atomic theory.
- periodic classification and trends in some properties of the elements in the periodic table.

2. To Develop Skills and Abilities of:

- applying methods of separation of mixtures
- writing simple chemical reactions and changing word equation to formula equation.
- balancing simple chemical equations by inspection and Least Common Multiple (LCM) methods.
- identifying substances on the basis of their physical properties.
- demonstrating scientific enquiry skills: observing, classifying, comparing and contrasting, communicating, asking questions, designing experiments, drawing conclusions, applying concepts and problem solving.

3. To Develop the Habit and Attitude of:

- appreciation of application of chemistry in satisfying the material, cultural and intellectual need of the society.
- realising that chemistry is a means of understanding nature.
- appreciation of the importance of periodic classification of the elements.
- Cooperativeness, daring to try and thinking rationally.

Unit 1: Chemistry and its importance *(4 periods)*

Unit outcomes: Students will be able to:

- explain what chemistry is and describe its' essence
- describe the relationships between chemistry and other natural sciences,
- appreciate the application of chemistry in production,
- describe some common chemical industries in Ethiopia
- describe scientific enquiry skills along this unit observing, communicating, asking questions and making generalizations

Competencies	***Contents***	***Suggested activities***
Students will be able to:	***1. Chemistry and its importance*** **1.1 Definition and essence of chemistry** *(1 period)*	
• Define chemistry	• Definition	Students should be asked what they think chemistry is. Write terms on the board like: • Natural science • Study of nature • Study of materials • Behaviour of materials From these terms distil a simple definition of chemistry in terms of studying the properties or reactions of materials when treated in different ways.
• Explain the essence of chemistry	• Essence	Students should be asked what pictures the word 'chemistry' conjures' in their minds. They are likely to suggest things like: • Bottles of different coloured liquids • Pieces of apparatus • Smells • Explosions • People in laboratory coats wearing safety glasses • Charts and graphs Students should appreciate that chemistry is all of these things. It is the study of materials by scientists, using a range of specialised equipment and apparatus. Chemistry is about taking measurements and making observations, and using them to come to conclusions. Chemistry is about looking for patterns in the way materials behave. Students could be shown some common pieces of apparatuses and chemicals test tubes, beakers measuring cylinders, flasks , acids, bases, salts etc.

Competencies	*Contents*	*Suggested activities*
• Discuss the relationship of chemistry with physics, biology and geology	**1.2 Relationship between chemistry and other natural sciences** *(1 period)*	Students should appreciate that chemistry is one of natural sciences and that this group also includes biology, geology and physics. Students could be asked to write one sentence about each natural science saying exactly what areas or aspects of nature are studied e.g. • Biology – study of living things • Chemistry – study of the chemical properties of materials • Geology – study of the earth and how it was formed • Physics – study of the physical properties of materials Students should appreciate that there are regions of overlap between the disciplines e.g. • Chemical reactions that take place in living things combine chemistry and biology • The effects of forces that result in the formation of mountains combine physics and geology Students could be asked to identify other topics where the different scientific areas overlap.
• Describe the application of chemistry in the field of agriculture, medicine, food production and building construction.	**1.3 Role played by chemistry in production and society** *(1 period)*	Students should be asked to write down five examples of materials from everyday life which were developed as a result of the expertise of chemists. For example they may choose: • Drugs which can be bought from the pharmacy are used in hospitals • Fuels used to power motor vehicles • Fertilizers used by farmers to increase crop yields • Cosmetics used to care for the skin and make people look more attractive • Building materials used in construction Use the students' ideas to construct a large spider diagram showing the many different fields in which chemistry plays an important role.
• Name some common chemical industries in Ethiopia and their products	**1.4 Some common chemical industries in Ethiopia** *(1 period)*	Students should be able to name some of the common chemical industries in Ethiopia. These will include: • Cement (Muger, Diredawa, Mekele - Mosobo) • Sugar (Metehara, Wonji, Finchaa) • Soap (Repi, Adama) • Paper and pulp (Wonji) • Pharmaceuticals (A.A., Adigrat) • Sulfuric Acid and Aluminium sulfate (Awash Melkassa) • Caustic soda (Zeway) • Soda ash (Bulbula) • Tyre (A.A.)
• Visit a local chemical industry and present it to the class in group.		Students could be asked to find out about local chemical industries and prepare a three-minute presentation which they could give the class. Emphasis should be placed on raw materials and the finished products.

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the Competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level
Students working at the minimum requirement level will be able to define and explain the essence of chemistry, discuss the relationships between chemistry and other natural sciences, describe the application of chemistry in production and list some common chemical industries in Ethiopia, their raw materials and products.

Students above minimum requirement level
Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level
Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 2: Substances *(21 periods)*

Unit outcomes: Students will be able to:

- describe the properties of substances and identify certain substances using their physical properties.
- conduct an experiment to differentiate elements, compounds and mixtures.
- explain physical and chemical changes.
- describe and demonstrate methods of separation of mixtures and apply them in their daily life.
- demonstrate scientific inquiry skills along this unit: observing, classifying, comparing and contrasting, communicating, asking questions, designing experiments, drawing conclusions, applying concepts and problem solving.

Competencies	***Contents***	***Suggested activities***
Students will be able to:	***2. Substances***	
	2.1 Properties of substances *(3 periods)*	• Students could be shown some common substances in a class.
• Define substances		• Students should be asked to define substance.
• Define physical properties	• Physical properties	• Students should understand the difference between physical properties and chemical properties. Physical properties discussed could include:
• List some physical properties of substances		• Melting point • Boiling point • Density • Conductivity using dry cell battery • Colour • State
• Identify substances based on their physical properties	• Identify substances based on their physical properties	Students could be given a substance and asked to find some of its physical properties by observation and measurement e.g. for a metal block the student could: • Observe the state and the colour • Check conductivity • Measure density Students could be given an unknown substance and identify it by comparing its properties with those given in data tables. Students could use tables of melting points and/or boiling points to identify common elements.
• Conduct experiments to identify properties of substances and make group report		Students could identify metals by observing their physical properties e.g. • Copper – brown colour • Iron and steel – magnetic • Aluminium – low density • Lead – high density

Competencies	*Contents*	*Suggested activities*
		• Mercury – liquid at room temperature
• Classify substances into pure substances and mixtures	**2.2 Grouping substances** • Pure substances and mixtures	Students should appreciate the need for chemists to work with pure substances and to learn techniques of purification. A pure substance contains a single or more components. If two or more components are present in varying proportion the substance is a mixture and the components retain their properties.
• Define pure substance		Students could make lists of common substances which are pure and those which are mixtures. Common mixtures could include: • Tap or bottled water – contains dissolved solids • Ink – contains a mixture of dyes • Milk-contains proteins, carbohydrates, fasts, water, minerals. Common pure substances could include: • Iron • Oxygen • Copper • Gold • Sugar • Table salt • Carbon dioxide
• Define elements and compounds • Classify elements as metals, non-metals and metalloids • Give examples of metals, non-metals and metalloids • Explain the differences between elements and compounds	• Elements and compounds	Students should appreciate that there are a number of substances that cannot be made into simpler substances and these are called elements. There are 92 naturally-occurring elements. Students could name some common elements. Make a list of these on the board. Students could classify the elements into metals and non-metals. Students could classify the non-metals into solids and gases at room temperature. This work could be linked back to physical properties by refering students to your tables of melting points and boiling point of the elements to identify one metal and one non-metal which are liquids at room temperature. Students should understand that some elements exhibit some properties of metals and some properties of non-metals. Such elements are called semimetals (metalloids) eg. Boron, Silicon, Germanium, Arsenic, Antimony, tellurium and pollonium. Students should appreciate that elements combine chemically to form compounds. Give some examples of binary compounds and ask them which from which elements they are formed e.g. • Sodium chloride – sodium and chlorine • Potassium bromide – potassium and bromine • Magnesium iodide – magnesium and iodine • Iron sulphide – iron and sulphur • Copper oxide – copper and oxygen

Competencies	***Contents***	***Suggested activities***
		Emphasise that a compound is not a mixture of elements but elements which have undergone a chemical change. The properties of a compound are completely different from the properties of the elements from which it is formed.
• Carryout an experiment in group to distinguish compound and mixture.		Students could carry out an experiment in which they heat a mixture of iron and sulphur in a soda glass tube and compare the properties of the iron sulphide with the original mixture. This will emphasise the differences between a mixture and a compound.
• Classify compounds as oxides, acids, bases and salts		Students should appreciate that compounds can be classified into different groups on the basis of their composition and their chemical properties e.g. • Oxides • Acids • Bases • Salts
• Give examples of oxides, acids, bases and salts		Students could be asked to give examples of compounds from each group. Oxides. eg. • Carbon dioxide • Iron oxide and • Copper oxide Acids e.g. • hydrochloric acid, • nitric acid, • sulphuric acid, • Acetic acid and • Citric acid Bases – students should focus on common alkalis e.g. • sodium hydroxide, • calcium hydroxide (lime water) and • ammonia solution (Ammonium hydroxide) Salts e.g. • Sodium chloride; • Copper sulphate, and • Sodium hydrogen carbonate Students could be given the names of some compounds and asked to identify which group they belong to e.g. • Citric acid, • Magnesium sulphate, • Potassium hydroxide and

Competencies	*Contents*	*Suggested activities*
		• Sulphur dioxide
• Define mixtures • Define Homogenous and Heterogeneous mixtures Give examples of Homogeneous and Heterogeneous mixtures	• Mixtures • Homogeneous mixtures • Heterogeneous mixture	Students should understand the terms homogenous and heterogeneous when applied to mixtures and give examples of each: • Homogenous mixture – components that can not be seen by necked eye or using magnifying glass. Tea (shai) is a mixture of water, sugar and Tea. • Heterogeneous mixture – components that can be seen by necked eye or using magnifying glass e.g. milk, blood.
• Compare and contrast homogenous and heterogeneous mixtures		Students could be asked to tell some of the changes they observe in their environment. Students should define physical and chemical changes.
	2.3 Changes around us *(4 periods)*	Students should appreciate that substances can undergo two types of changes and know the characteristics of each.
• Define physical changes • Give examples of physical changes	• Physical changes	Physical changes: • Easy to reverse • No new substance(s) produced
• Define chemical changes • Give examples of chemical changes	• Chemical changes	Chemical changes: • Difficult or impossible to reverse • New substance(s) made Students should not discuss physical and chemical changes interms of heat changes.
• Distinguish the physical and chemical changes using their characteristics		Students could observe some changes and discuss whether they are physical changes or chemical changes on the basis of these definitions e.g. • Burning of paper– chemical change • Water boiling – physical change
• Conduct some simple activities to show physical and chemical changes and write group report.		Students could investigate some changes themselves and determine whether they are physical changes or chemical changes by using simple experiment. e.g. • Melting an ice • Iron nail going rusty • Making an iron bar magnetic • Heating magnesium ribbon
	2.4 Separation of mixtures and its application *(6 periods)*	
• List methods of separation of mixtures • Explain methods of	• Methods of separation of mixtures	Students should list the methods of separation with which they are already familiar from Integrated Science Grade 6. These include: • Separation by hand • Sieving

Competencies	***Contents***	***Suggested activities***
separation of mixtures • Give some specific examples of mixtures that can be separated by filtration, decantation, simple distillation, magnetic separation and using separatory funnel		• Filtering • Decanting • Evaporating • Simple distillation Students should appreciate that separation techniques are a method of obtaining pure substances. Students should carry out experiments to separate mixtures using a variety of techniques including the following
• Name apparatuses used in decantation, filtration, simple distillation, using separatory funnel. • Assemble apparatuses used in decantation, filtration, simple distillation, separatory funnel.	• Magnetic separation	Magnetic separation: • Iron filings and sulfur– illustrates separation of magnetic and non-magnetic substances • Iron filings and sand. It is wise to place the magnet in a poly ethene before doing this experiment as it can be difficult to remove all of the iron filings from the magnet
	• Filtration	Filtration: • A mixture of chalk particles (or some other insoluble solid particles) and water
	• Evaporation	Evaporation • A mixture of sodium chloride (or any other soluble salt) and water forms a solution which can be separated by evaporation – if the solution is left in an open dish on a window sill the water will evaporate the salt will be left behind. Evaporation is quicker if the solution is placed in a broad dish, such as an evaporating basin, which exposes a large surface area of the solution to the air
	• Decantation	Decantation • Pouring boiled coffee from the pot ('Jebena') to the cup • A mixture of cooking oil and water can be separated by decanting - the cooking oil and water form two layers. The top layer, the cooking oil, can be removed by careful pouring. This is best done when the mixture is in a narrow tube such as a measuring cylinder.
	• Simple Distillation	Simple Distillation • A mixture of two miscible liquids boiling points can be separated by simple distillation For example i) Mixture of water (B.P. 100^0) and alcohol (ethanol B.P. 78^0c) ii) Obtaining pure water from salt solution Students should be made familiar with the use and care of the apparatuses used in these techniques. Students could undertake separation using a combination of techniques. For example, a mixture of salt and sand can be separated by first adding water to dissolve the salt, filtering to

Competencies	*Contents*	*Suggested activities*
• Perform simple activities in group to carry out the separation of mixtures using local materials and write a group report.		remove the sand and finally evaporation of the filtrate to give the salt. The black powder found inside electric cells consists of a mixture of powdered carbon and manganese (IV) oxide, which are both insoluble, and ammonium chloride, which is soluble in water. Students could be set the task of obtaining a pure sample of ammonium chloride from the black powder removed from a spent electric cell. Students should apply the above techniques to separating mixtures of local materials.

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the Competencies, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

Students working at the minimum requirement level will be able to: Describe the properties of substances and identify certain substances using their physical properties, differentiate elements, compounds and mixtures, define physical and chemical changes and explain their differences, describe methods of separation of mixtures.

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 3: The Language of chemistry *(19 periods)*

Unit outcomes: Students will be able to:

- write symbols of some common elements and give names from their symbols
- write the formulas of diatomic elements and simple compounds
- name simple common compounds
- explain the qualitative and quantitative meanings of chemical symbols and formulas
- write simple chemical reactions and change word equation to formula equation
- balance simple chemical equations by using inspection and LCM methods
- describe scientific enquiry skills along this unit: classifying, comparing and contrasting, communicating, asking questions, drawing conclusions and applying concepts

Competencies	***Contents***	***Suggested activities***
Students will be able to:	***3. Language of Chemistry***	
	3.1 Symbols of elements (2 *periods)*	Students should appreciate that chemistry, like the other branches of science, has symbols and words which are specific to the subject. These include: • Chemical symbols • Chemical formulae • Names of apparatus and processes
• Define chemical symbols	• Meaning of symbols	Students should define that chemicals symbols are a form of shorthand
• Write symbols of some common elements • Write the names of elements from their symbols	• Writing symbols	Illustrate this by writing the names of several elements on the board with their symbols alongside. Students should appreciate that: • symbols are much easier and quicker to write • the same symbols are used throughout the world so chemists all over the world can understand them Students could find and practice writing the symbols for common elements from a large Periodic Table which gives both the names and symbols of the elements. Do not attempt to explain the Periodic Table at this stage; this will be discussed and explained in detail in Unit 5. Emphasise the importance of upper and lower case letters when writing the symbols e.g. the symbol for chlorine is Cl, not cl, cL or CL. Students should practice writing symbols from names and names from symbols. Students may notice that many symbols are the first or first two letters of the name of the element e.g. O for oxygen, Ca for calcium etc. But this is not always the case. Students could research why some common elements have symbols which appear to bear little resemblance to their names e.g. iron, Fe; lead Pb; sodium, Na

Competencies	***Contents***	***Suggested activities***
• Define chemical formulas	**3.2 Chemical formulas** (8 *periods)*	Students should be reminded from their work in Unit 2 that a compound consists of two or more elements which have been chemically combined. It follows therefore, that in order to represent a compound we combine the symbols of the elements to make a chemical formula.
• List formulas of elements that are diatomic molecules	• Formulas of diatomic elements	Students should understand that, except the nobel gases, all elements do not exist as atoms. Students should know that there are elements that exist as diatomic and polyatomic molecules. Students should be given a list of elements that exist as diatomic elements including H_2, O_2, Cl_2, Br_2 I_2, and F_2.,
• Define valence numbers as the combining power of an atom	• Valence number	Students should appreciate that atoms of different elements have different 'combining powers' which we call valence number. Give students a simple table to show the combining power of some common elements including: • 1: sodium, potassium, copper (I) • 2 :magnesium, calcium, iron (II), copper (II) • 3: aluminium, iron (III) • 2: oxygen, sulphur • 1: chlorine, bromine, iodine Point out that a small number of elements have more than one combining powers. For example, in some of its compounds iron shows a combining power of 2 and is written as iron(II) – while in others it shows a combining power of 3 and is written as iron (III)
• Write formulas of some binary compounds	• Formulas of Binary compounds	Students should practice writing the formulas of compounds in which the metal and non-metal have the same combining power e.g. potassium bromide, KBr; copper(II) sulphide, CuS. Ask students to suggest how we write the formulas of a compound in which the combining powers of the atoms are not the same e.g. magnesium chloride. Magnesium has a combining power of 2 while chlorine has a combining power of 1 therefore we need two chlorines to go with one magnesium
• Name binary compounds	• Naming binary compounds	Students could understand that the name of non-metal that is written at right side in the formula in binary compounds should have an "ide" ending. e.g. HCl - hydrogen chloride
• Define polyatomic ions • Give examples of polyatomic ions • List the valence number of common elements and polyatomic ions	• Polyatomic ions	Students should practice writing the names and formulas of compounds in which the metal and non-metal have different combining powers. Students should understand that certain groups of atoms are found together in a number of different compounds. They should learn the names, formulas and combining powers of these groups including: • 1 ammonium, NH_4^+ • 1 hydroxide OH, nitrate NO_3^- • 2 sulphate, SO_4

Competencies	***Contents***	***Suggested activities***
• Write the chemical formulas of common compounds that contain polyatomic ions	• Writing chemical formulas	Students should practice writing the names and formulas of compounds which contain one of these groups and an atom with the same combining power e.g. ammonium chloride, NH_4Cl, potassium hydroxide, KOH, calcium sulphate, $CaSO_4$
• Name compounds containing polyatomic ions	• Naming simple chemical compounds	Finally, students should practice writing the names and formulas of compounds which contain one of these groups and an atom with a different combining power e.g. ammonium sulphate, $(NH_4)_2SO_4$, iron(II) nitrate, $Fe(NO_3)_2$ Students should practice writing the chemical formulas of common named chemicals and the names of chemicals from their formulas
• Define subscript and explain its significance • Define coefficient and explain its significance	**3.3 Qualitative and quantitative significance of symbols and formulas** (2 *periods)*	Students should understand that, in the context of a chemical formula, qualitative relates to which elements are present and quantitative relates to the number of atoms or groups of each
• Describe the qualitative meanings of chemical symbols and formulas • Explain the quantitative meanings of chemical symbols and formulas	• Qualitative meaning • Quantitative meaning	Students should describe the significance of coefficients and subscripts in the formulas of elements and compounds eg. O_2 The subscript 2 shows qualitatively oxygen is a molecule and quantitatively there are atoms of O in oxygen molecule. $3H_2O$ The coefficient 3 shows that there are 3 molecules of water. The subscript 2 shows that there are 2 atoms of hydrogen in a water molecule. There is also 1 atom of oxygen in a water molecule though not written as subscript under "O". Students should interpret some formulas in this way e.g. CaO, calcium and oxygen, one atom of calcium and one atom of oxygen; $Mg(NO_3)_2$, magnesium and nitrate, one atom of magnesium and two nitrate groups.
	3.4 Simple chemical reactions and equations (*7 periods)*	
• Define chemical reaction • Conduct an experiment in group to show simple chemical reaction	• Simple chemical reaction The law of conservation of mass • Simple chemical equation	Students should understand that a chemical reaction takes place when one or more substances, called the reactants, undergo chemical change and new substances, called the products, are formed. Reactants → Products Students should conduct an experiment on simple chemical reaction. This could be burning of magnesium in the air to produce magnesium oxide.
• State the law of conservation of mass Explain inspection and LCM (Least Common	• Writing simple chemical equation • Balancing chemical equation	Students should know that mass is conserved during a chemical reaction i.e. no atoms are lost or gained – they are simply rearranged. Students should examine chemical equations for some simple reactions. Start with a word equation and develop into symbol, and then a balanced chemical equation, e.g.

Competencies	*Contents*	*Suggested activities*
Multiple) methods of balancing equation • Convert word chemical equation in to formula equation. • Balance simple chemical equation by inspection • Balance simple chemical equation by L.C.M. (Least Common Multiple)	• Inspection method • LCM method	Magnesium + Oxygen $\rightarrow$ Magnesium Oxide $Mg + O_2 \rightarrow MgO$ $2Mg + O_2 \rightarrow 2MgO$ Count the number and type of atoms on each side of the unbalanced equation and point out that an oxygen atom has been lost. Explain that the coefficient, 2, is necessary to balance the Oxygen atom in MgO. Finally we need to write 2 as coefficient for Mg atom to balance the whole equation. Write the number as a coefficients that precedes the symbols or formulas of compounds. Once the formulas is written, the subscript should not be charged while balancing. Students should practice writing balanced chemical equations using the same technique. Initially they should be focused on simple equations. Once they have mastered the technique this should be extended to more difficult examples. Students should develop the habit of checking for balance each time they write and equation by counting the number of each atom on each side of the equation. In addition they should develop the technique of balancing using LCM method

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

Student working at the minimum requirement level will be able to: define terms like chemical symbols, chemical formulas, valence number, chemical reaction and chemical equation, write symbols of some common elements and give names from their symbols, write the formulas of simple compounds, name simple common compounds, state law of conservation at Mass, Write simple chemical reactions and change word equation to formula equation, balance simple chemical equations by using inspection and LCM methods.

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 4: The Structure of substances *(15 periods)*

Unit outcomes: Students will be able to:

- narrate the historical development of the atomic nature of substances
- state Dalton's Atomic Theory and Modern Atomic Theory
- describe the structure of an atom
- explain the terms like atomic number, mass number, atomic mass and isotope.
- appreciate the importance of study of subatomic particles in understanding properties of substances.
- explain the arrangement of electrons in the main energy levels and write the electron configuration of the first 18 elements.
- differentiate molecules of elements from molecules of compounds.
- demonstrate scientific inquiry skills along this unit: observing, comparing and contrasting, making model, communicating, asking questions

Competencies	***Contents***	***Suggested activities***
Students will be able to: • Narrate the historical development of the atomic nature of substances • Compare and contrast the continuity and discreteness (discontinuity) theory of matter	***4. Structure of substances*** **4.1 Historical development of the atomic nature of substances** *(1 period)*	Students should appreciate that the particulate nature of matter was discussed by the ancient Greeks. They argued that if a substance was divided in half enough times, there would come a time when only a single particle remained. This was not supported by any practical work. Students could research the theory of a fundamental building block proposed by the ancient Greeks and the meaning of the word 'atom'. Students could carry out a simple dilution experiment to support this theory of discontinuity. They should take a test tube of a coloured substance, such as potassium manganate (VII), formed using a single small crystal, pour half away and top up with water. This can be repeated a number of times before the colour becomes too weak to be seen by the naked eye. The particle responsible for the colour must be very small – and there must be many of them even in a single crystal. Students could carry out other experiments, such as the diffusion of a chemical with a distinctive odour, to show that even a small amount, such as one drop, spreads within a large room so it can be smelt in all places – therefore the particles responsible for the smell must be very small and there must be many of them in a single drop. • A box of paper clips can be used to illustrate the concept of an atom. The paper clips can be spread out and their number divided in half a number of times. Eventually we arrive at one paper clip which is the equivalent of an atom. What we have is still recognizable as a paper clip and still does the job of a paper clip. If we try to divide this further what we end up with is two pieces of wire which no longer resemble a paper clip and are no longer able to do the job of a paper clip. In terms of atoms, once we break up an atom it no longer has the properties of the substance.

Competencies	*Contents*	*Suggested activities*
	4.2 Atomic theory *(10 periods)*	
• State Dalton 's atomic theory	• Dalton 's atomic theory	Students should learn about the work of John Dalton and the atomic theory he proposed at the begining of the nineteenth century. He suggested that: • All elements consist of very small particles called atoms • Atoms are indivisible • All atoms of the same element are exactly alike and have the same mass and properties • Atoms of one element are different from atoms of any other element. • When atoms combine, they do so in small whole numbers
• Describe the short comings of Daltons atomic theory		Students should discuss the different statements made by Dalton in the light of current knowledge. From this discussion they should realise that although some of Dalton's statements are not entirely correct, it was nevertheless a bold attempt to summarise the properties of atoms. The shortcomings were: • Atoms are indivisible. But they can be broken down into subatomic particles – students will learn about atomic structure later in this unit • All atoms of an element are exactly alike. But atoms of the same element may not have the same mass – students will learn about isotopes later in this unit. Students could research into Dalton's idea of atoms as tiny spheres with hooks on them. With these hooks, one atom could combine with another in definite proportions. This could be linked into the idea of combining power used in Unit 3.
• State modern atomic theory	• Modern atomic theory	Students should discuss the modern atomic theory, This could be given as a series of simple statements such as; • Each element is made of atoms • Atoms are themselves built up from many smaller particles called protons, electrons and neutrons. • All atoms of the same element have the same number of protons (and electrons) but may have different numbers of neutrons • Atoms of different elements are different • Atoms of different elements combine in small whole numbers to form compounds • In any given compound, the elements and the ratio of atoms of the elements is always the same • In ordinary chemical reactions, atoms are not made, destroyed, or changed Each statement should be discussed and, where appropriate, illustrated using examples.

Competencies	*Contents*	*Suggested activities*
	4.3 The structure of the atom *(10 periods)*	
• Describe the atomic nucleus and electronic shell as the two parts of an atom	• The subatomic particles • Relative mass, the charge and location	Use the statement in the modern atomic theory to introduce the structure of an atom. Students should understand the key features of the atom including: • A nucleus contains neutrons and protons • Almost all of the mass of an atom is in the nucleus • Electrons in shells revolving around the nucleus • Equal number of protons and electrons Students should be aware of the relative mass, charge and location of sub-atomic particles within an atom. This could be given as a table
• Define atomic number and mass number • Calculate number of protons, electrons and neutrons from atomic number and mass number	• Atomic number and mass number • Determination of the electrons, protons and neutrons	Students should be familiar with the terms atomic number and mass number. Students could use a Periodic Table to look up the atomic numbers and mass numbers of common elements from both their names and their atomic symbols. This will provide a useful way of revising work done in Unit 3. Students should be aware that in an atom; • the number of protons is equal to its atomic number • the number of electrons is equal to the number of protons • and the number of neutrons is the difference between the mass number and the atomic number Students should deduce the numbers of particles in atoms of different elements from the atomic number and mass number
• Define isotopes • Give isotopes of hydrogen, chlorine and carbon as examples of isotopes	• Isotopes	Students should be made aware that all atoms of an element have the same number of protons – so the atomic number is the same – but may have different numbers of neutrons – so the mass number maybe different. Atoms of the same element with different numbers of neutrons are called isotopes. Students should be shown the different ways in which the names/symbols for isotopes may be written. Students should discuss some common examples of isotopes including: • hydrogen-1, hydrogen-2, hydrogen-3 • carbon-12, carbon-13, carbon-14 • chlorine-35, chlorine-37 Students should discuss how the isotopes of each of these elements differ in mass or number of neutrons. Students could draw diagrams or make models to illustrate the isotopes of hydrogen and of carbon.

Competencies	***Contents***	***Suggested activities***
• Define atomic mass	• Atomic mass	Students should appreciate that all isotopes of an element have the same chemical property. They differ in physical properties only, such as density Students could be given the table of a number of particles and asked to say which are isotopes of the same element and which are not. Students could be asked to look carefully at the data given on a Periodic Table, and particularly the atomic masses of chlorine (35.5) and copper (63.5). Ask students why this is – does it mean that atoms of these two elements have half a proton or half a neutron? Hopefully they will discount such an explanation. Students should appreciate that a sample of an element may contain a mixture of two or more isotopes, and that each will contribute to the average mass of an atom of the element. We call this the atomic mass. Point out to students that atomic masses do not have a unit
• Define energy levels (atomic shells) • Represent energy level (atomic shells) by letters and numbers • Describe the maximum number of electrons each energy level (atomic shell) can accommodate	• Energy level	Remind students the structure of the atom and in particular the electrons which exist in shells surrounding the nucleus. Students should know that there is a limited number of electrons that can be placed in each shell. Limit the discussion of electronic configuration to the first 18 elements of the Periodic Table. Students should understand that the maximum number of electrons in the first three shells is 2, 8 and 18 respectively. Students should understand that each shell represents an energy level. The energy levels increase moving away from the nucleus.
• Define electronic configuration • Write the electronic configuration of the first 18 elements in the main energy levels (atomic shells). • Show the diagrammatic representation of the first 18 elements. • Construct an atomic model of one of the first 18 elements	• Electronic configuration	Students could be given a list of the first 18 elements and asked to write the electron configuration of each one. When this is complete show students that the element that corresponds with a full shell of electrons is always at the extreme right-hand side of the Periodic Table i.e. He, Ne and Ar. This can be linked in to the work on the Periodic Table in the next unit. Students could draw diagrams or make models to show the electron configuration of an element. Students could combine their knowledge of the structure of the nucleus of an atom with its electronic configuration to make a model of an atom.

Competencies	*Contents*	*Suggested activities*
• Define valence electrons • Determine the number of valence electrons of the first 18 elements	• Valence electrons	Students should be familiar with the term 'valance electrons' as the electrons in the outermost shell of an atom and the electrons that will be involved in forming compounds
• Define ion • Give examples of positive and negative ions	• Ion	Students should understand the meaning of ions. Students could be asked to give some examples of positive and negative ions
	4.4 Molecules *(2 periods)*	
• Define molecules		Students should be familiar with the term molecule as two or more atoms of the same element or different elements combined together chemically from their work in Unit 3.
• Give examples of monatomic, diatomic and polyatomic molecules	• Molecules of elements	Students could be asked to give examples of molecule of elements Monoatomic - He, Ne, Ar Diatomic - H_2 , O_2, F_2 , Cl_2 , Br_2, I_2 Polyatomic - O_3, P_4, S_8
• Differentiate molecules of elements from molecules of compounds	• Molecules of compounds	Molecule of compounds - HCl, CO_2, NH_3, CCl_4 Let the students tell the differences between molecules of elements and compounds

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

Student working at the minimum requirement level will be able to:
State Dalton's Atomic Theory, describe the shortcomings of Dalton's atomic theory, state Modern atomic theory, describe the relative mass, the charge and the location of fundamental subatomic particles, define terms like atomic number, mass number, atomic mass, isotope, valence electrons, main energy levels and molecules, determine the number of electrons, protons and neutrons from atomic number and mass number, write the electron configuration of the first 18 elements, distinguish molecules of elements from molecules of compounds..

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Unit 5: Periodic classification of the elements *(11 periods)*

Unit outcomes: Students will be able to:

- narrate the historical development of periodic classification of elements.
- state Mendleev's periodic Law, discuss the contributions and shortcomings of his periodic classification of elements.
- state the Modern Periodic Law
- explain the relationship between the electronic configuration of the atoms and arrangement of the elements in the periodic table.
- explain the structure of the modern periodic table.
- describe the trends in nuclear charge, atomic size, metallic and non-metallic character of elements across the period and down a group of the modern periodic table.
- appreciate the importance of periodic classification of elements.
- demonstrate scientific inquiry skills along this unit: observing, classifying, communicating, asking questions, interpreting data, applying concepts and making generalizations

Competencies	***Contents***	***Suggested activities***
Students will be able to:	***5. Periodic classification of the elements*** *(11 periods)*	
• Narrate the historical development of periodic classification of elements	**5.1 Historical development of periodic classification of the elements** *(1 period)*	Students may already be familiar with the Periodic Table if it was used to provide them with data in Units 3 and 4. Students should appreciate that as chemists acquired more knowledge they were able to identify certain substances which could not be made into simpler substances by the techniques known at the time. These were termed elements and chemists tried to place them in groups according to their properties. Students could research into the classification of elements attempted by early chemists including the following. Students could discuss the strengths and weaknesses of these – but should judge them in the context of the time they were written. • Dobereiner (triads) • Newlands (octaves)
	5.2 Mendeleev's periodic classification (*2 periods)*	
• Describe periodicity • State Mendeleev's periodic law • Discuss the contribution and short-comings of Mendeleev's periodic classification of elements	• Periodicity • Mendleev's Periodic law	Students should research the contribution which Mendeleev made to the classification of elements and the development of the modern periodic table. Students should understand the term periodicity. They should be aware that Mendeleev realized that the physical and chemical properties of elements vary periodically with increasing atomic mass; a relationship that became known as the periodic law. Students should be shown the periodic table proposed by Mendeleev in 1869. They should understand that Mendeleev arranged the elements according to increased atomic mass in the form of a grid manner that has seven rows called periods and eighteen columns called groups.

Competencies	*Contents*	*Suggested activities*
		In this arrangement elements which have similar chemical properties appear in the same group. Students should appreciate the insight of Mendeleev's periodic table in leaving spaces for elements which had yet to be discovered. Ultimately, they were discovered and Mendeleev's foresight was vindicated
• State the modern periodic law • Define period and group • Tell the total number of periods and groups in the modern Periodic Table. • Determine the period and group numbers of some elements based on their atomic numbers. • Describe the relationship between the number of periods and the number of main shells of the atom. • Tell the total number of elements in each periods of the Periodic Table. • Describe the relationship between the number of groups and the valence electrons of the atoms • Write the names of each main group of the elements in the Periodic Table	**5.3 Modern periodic table** *(7 periods)* • Period and group • Modern Periodic law • Electronic configuration and arrangement of elements • Structure of modern periodic table	Students should appreciate that in the modern Periodic Table the elements are arranged in order of increasing atomic number rather than the atomic mass. Students should study the modern Periodic Table and count the number of periods and the number of groups. Students should give the group and period of named elements and identify elements by their group and period. Students should be reminded of the work they carried out on electronic configuration and how the elements which had full outer shells of electrons were to be found on the extreme right-hand side of the Periodic Table. Students should count the number of elements in each of the first three periods of the Periodic Table and confirm that this corresponds with the maximum number of electrons that can be placed in each of the first three electron shells i.e. 2, 8 and 8. Students should compare the electronic configuration of some common elements with their position in the Periodic Table. From this they should deduce that: • The number of electron shells is equal to the period • The number of electrons in the outer shell is equal to the group From this students should become aware that the number of valance electrons in an atom is the same as the number of the group in which the element is found. Students could be given the names of symbols of some elements and ask to predict the number of valence electrons in each from its position in the Periodic Table. Students should be made aware of the traditional names of some of the groups of the Periodic Table including: • Group 1 – alkali metals • Group 2 – alkaline earth metals • Group 7- halogen • Group 8 – noble gases Students should be aware of a group of metals called the transition metals, which appear between Group 2 and 3. They should be able to give examples of transition metals e.g. iron, copper. Students should recognize that there are metallic and non-metallic elements. They should be aware that:

Competencies	***Contents***	***Suggested activities***
• Describe the variation of atomic size, nuclear charge, metallic and non-metallic character of elements across the period. • Describe the variation of atomic size, nuclear charge, metallic and non-metallic character of elements down the group	• Some periodic properties	• Metallic elements are found to the left and centre • Non-metallic elements are found to the right • Between metals and non-metals there are a small number of elements that show a mixture of metallic and non-metallic properties and that these are called semi-metals or metalloids Students could be given examples of elements and asked to state whether they are metals, non-metals or metalloids. Students should be aware that crossing a period from left to right: • There is a gradual change from metallic to non-metallic elements • Nuclear charge increases as protons are added • Atomic size decreases slightly as electrons in the same shell are attracted by a progressively larger positive nuclear charge Students should discuss the reasons for these trends. Students should be aware that passing down a group: • Nuclear charge increases • Atomic size increases in steps as more electron shells are added • For groups 1 to 3 metallic character increases down a group • For groups 4 to 7 non-metallic characteristic decreases down group Students should discuss the reasons for these trends. Students could prepare a chart of the Periodic Table
• Prepare a periodic table chart • Tell the importance (advantages) of Periodic Table as a quick reference of atomic number, atomic mass and properties of elements	**5.4 Importance of modern periodic table** *(1 period)*	Students should explain how useful the Periodic Table is as a data base from which they can obtain information for any element including: • Atomic symbol • Period • Group • Atomic number • Mass number • Electron configuration Some trends in the properties of elements

Assessment

The teacher should assess each student's work continuously over the whole unit and compare it with the following description, based on the specific objectives, to determine whether the student has achieved the minimum required level.

Students at minimum requirement level

Students working at the minimum requirement level will be able to:
State Mendleev's periodic Law, Modern Periodic Law, tell the number of elements in each period and name the main group elements, explain the structure of the modern periodic table, describe atomic size, nuclear charge, metallic and non-metalic character of elements across the period down a group of the modern periodic table and tell the importance of the periodic Table.

Students above minimum requirement level

Students working above the minimum requirement level should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent.

Students below minimum requirement level

Students working below the minimum requirement level will require extra help if they are to catch up with the rest of the class. They should be given extra attention in class and additional lesson time during breaks or at the end of the day.