CHEMISTRY

TEACHER'S GUIDE
Grade 7

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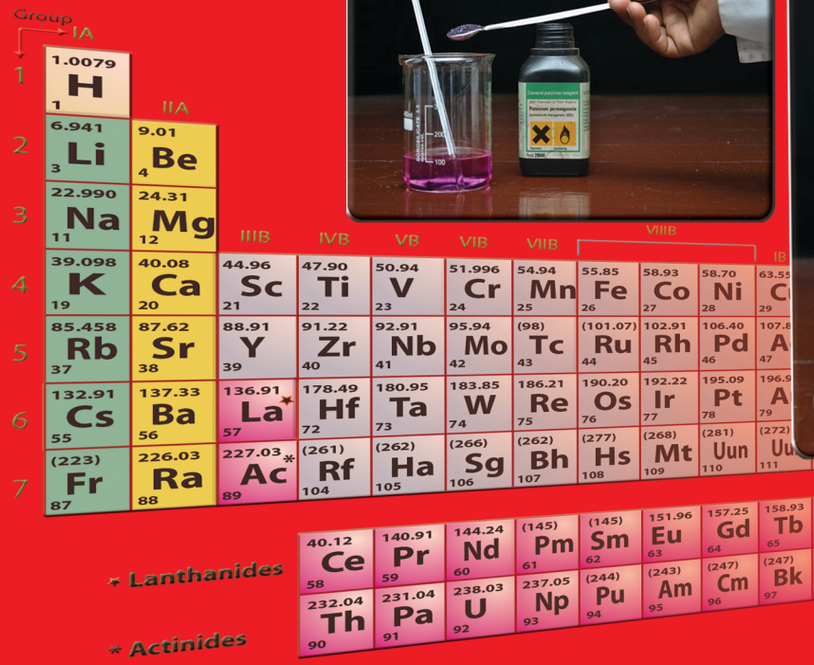

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TEACHER'S GUIDE

GRADE 7

Authors, Editors and Reviewers:

Solomon Tekleyohannes(B.Sc.)

Tesfaye Jinore(B.Sc.)

Merid Tessema(Ph.D)

Tesfa Bedassa(M.Sc.)

Evaluators:

Mulugeta Mesfin(B.Ed.)

Getahun Tadesse(B.Ed.)

Mekbib Belete(B.Sc.)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

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GENERAL INFORMATION TO THE TEACHER

The students' text of chemistry grade seven is prepared in such a manner that teachers can implement active learning methodology in the teaching–learning process. At present, it is believed that students should gain most of their knowledge from the teaching–learning process on their own and some from the teacher. The teacher is expected to give guidance and the necessary assistance, play a role as facilitator, harmonize concepts, provide students with materials required, create a conducive atmosphere for the teaching–learning process and evaluate of students' performance. The teacher needs to assist students to discover facts, realize concepts, develop skills in performing experiments and solving problems. So, the teacher should not dominate the teaching–learning process by giving lecture or explaining concepts throughout the period.

Thus, whenever you have contact with your students, you need to plan how to promote active–learning. The following information will help you understand what you are expected to do before and during the entire teaching–learning process.

1. Forming Groups

You need to organize different groups in each section you are going to teach during your first contact with the students. You may assist students to form groups based on their seats, roll numbers or on their ability as slow learners, medium and fast learners or by mixing them. After organizing groups, give them group numbers as group 1, group 2 etc and register the names of students in each group. Every group needs to have a group leader and a secretary to jot down the main points during discussions. The groups as well as their members need not be permanent throughout the year. You can reorganize groups whenever necessary. You can do so per semester or mid-semester or even per month or two months.

2. Discussion

In all units, sections and subtopics, there are activities suggested for students to help them discuss and discover concepts. When you allow them to discuss points in each activity:

- follow up how every student participates in the discussion.

- be part of the discussion in some groups for a few minutes and see how the discussion among students is going on.
- give assistance and guidance when students are in need.
- give them hints when they face difficulties or have questions on the points suggested in the activities.
- ask questions related to the points in the activity to facilitate the interaction among students during discussion.

3. Presentation

Students are expected to present:

i). the concepts they gained during discussion in each activity in all units.

ii). their observation and analysis after performing experiments in groups to the class.

iii). the content prepared on a specific topic. So you need to give emphasis to the following points in order to maximize student participation.

a. Groups should present their opinion turn by turn. For example, if you allow group 1 and group 2 to make a presentation on activity 1.1, the following groups 3 and 4 or others will present activity 1.2 etc.

b. Whenever a group gets the chance to make presentation for the second or third time, let other members of the group accomplish the task. Do not allow the same student from the same group to do so.

c. Give the opportunity to the rest of the class to ask questions or give their comments on the presentation of a particular group.

4. Experiment

Several experiments are suggested in the unit 2 and 3. Most of these experiments should be performed by students. So, you are expected to accomplish the following tasks before or when students carry out the experiment.

a. To carry out the experiment by yourself before allowing students to do it.

b. To prepare chemicals and apparatus required for the experiment.

c. To give instruction on how students should handle chemicals and apparatus during every experiment.

d. To provide materials they need for the experiment.

e. Assist them whenever they have questions or difficulties in understanding the procedures suggested for the experiment.

f. Give instructions that students should perform the experiment only based on the procedures suggested for it.

g. Never allow them to conduct an experiment on their own other than the one they are supposed to do during the period.

h. Make them write a laboratory report in groups, present their observation to the rest of the class or submit it to you for correction as suggested in the students' text.

i. Make sure that every student in each group participates in the experiment.

5. Harmonizing Concepts

You are not expected to lecture throughout the period on most of the contents in the students' text. Your major role is harmonizing concepts suggested by students during presentations after discussing activities or performing an experiment with those they are expected to know. So, you need only to build a mini – lecture.

The concepts intended for students to discover in all activities, and answers to questions on the observation and analysis part of all experiments, are included as short notes in the subject matter presentation part of every section in this teachers' guide. So you are advised to use them. While harmonizing concepts in a mini – lecture, you better include other contents of the topic that have not been covered when students discuss activities.

6. Continuous Assessment

Previously, the performance of a student has been assessed in terms of his/her achievements in quizzes, tests, homework, mid – semester and semester final examinations. Although these evaluation techniques are useful tools for the assessment, they may not give a clear picture of the performance of a student. Therefore, a student's work should be assessed throughout every topic, section and unit as well as during each period. So, you need to have a record of every student's work as a student performance list. You can make a record about each student in the performance list, based on the following points.

- Involvement in discussions.
- Participation in presentations after discussion.
- Participation in answering questions during the process of harmonizing concepts or stabilization.
- Role of the student in performing experiments.
- Role of the student in presenting concepts gained from the experiment.
- Presentation of the project work.
- Presentation of research and writing.
- Presentation of topics given to the group as homework.

- Answering questions accordingly given as
  - class work
  - homework
  - quizzes
  - tests
  - mid–semester and semester final examinations.

Here, it is very important to note that the assessment system is continuous assessment. That is, every performance of the student during the teaching-learning process should be given value and contribute its own share, as do quizzes, tests, mid-semester and semester final examinations, to the semester total.

7. Supplementary Questions

Some questions are given in this teachers' guide in each section before the answers to the exercises in the section. Use the questions indicated by an asterisk (*) only for students working above the minimum requirement level, while students working below the minimum requirement level can attempt other questions. Give these questions as class work for fast learners after they complete their work during each period so that they will not sit idle and the period will not be boring for them. Fast learners can do all the suggested questions.

8. Giving Note

You are not expected to write notes on the black board related to the contents in each section. You need to give short notes on those contents left for students to discover after discussing the suggested activities and performing experiments. Be sure to offer any note that is available in the teachers guide, but not in the students' text. However, you can write short notes related to the main points as you harmonize concepts. Tell them the main points they should emphasize, in taking notes from the text. Also tell them to jot down only the main points as fast as they can as you harmonize concepts or give a mini-lecture.

9. Answers to Exercise

In all units, the answers to the suggested exercises are given at the end of each section, and answers to the review exercises in each unit at the end of the unit. So you can refer to them whenever you are in need.

10. Suggested Methodologies

Teaching all contents of grade 7 chemistry requires implementing active learning methodologies. Active learning involves providing opportunities for students to participate in meaningful talk and to listen, write and reflect on the content, ideas, issues

and concerns of an academic subject. It is more of a student activity. The teacher is a facilitator. The teacher guides and directs the students.
Rationale for active learning includes:

- *an increase in academic achievements*
- *an increase in critical thinking skills*
- *increased student retention*
- *a more positive attitude toward the subject matter*
- *improvement in communication skills*

There are many methods that can be used to implement active learning. However, all of them are not suitable for teaching chemistry. So, some of the methodologies that can be used to promote active learning in teaching chemistry at this level are suggested as follows.

10.1 Gapped lectures

You divide your lecture into small sections (lecture for a period of 15 minutes) and give the students a quick activity of 5 to 10 minutes. After the activity, you proceed with another 15 minutes lecture followed by another activity. The activities usually emphasize the concepts included in the lecture. For example, you can apply this methodology to teach physical properties.

10.2 Cooperative (collaborative) learning

This is a form of group work and it is helpful in group project work and group assignments. This can be applicable for students in doing their group assignments or in doing suggested project work. For example, in visiting a chemical industry.

10.3 Group discussion

Is a simple interaction pattern in which 4 – 6 students work together on a given task and produce a written work or presentation. This method can be used in all sections and units at this level.

10.4 Presentation

This is an activity where students present a topic in front of their classmates. This can be done individually or as a group.

10.5 Demonstration

This is a method where the teacher shows the students how something is done.

10.6 Experiments

It usually involves a very specific and controlled method of procedures, where results are usually recorded.

10.7 Concept Map

It is a visual representation of ideas on any given topic. Students write the topic at the center of the page and then divide it into subtopics from which smaller branches will go off in different directions. For example, this method can be applied to teach grouping substances.

10.8 Question and answer (inquiry)

When this method is used, the teacher lectures and asks questions periodically relating to the information being given. It can be applied in section 1.3.

10.9 Spider diagram

Students write a topic at the middle and write ideas related to the topic around the topic and draw a line connecting each idea to the central idea. This method can be used in teaching the role of chemistry in production and society.

10.10 Visual-based active learning

This method helps students learn using real object models, pictures, drawings and charts.

10.11 Brain storming

This is an activity in which students write everything they know or think about a given topic. The ideas might be right or wrong. This can be done individually, in pairs, small groups or as a whole class with the teacher or a student recording the ideas on the board. This method is used to find out what students already know on a topic before you start teaching.

You can use the following websites to get more information on active-learning methodologies.

i). http://www.ntlf.com/html/lib/bib/91-9dig.htm

ii). http:ctl.byu.edu/active-learning-techniques/

iii). http:pdfcast.org/pdf/strategies-to-incorporate-active-learning-into-online-teaching

iv). http://ijklo.org/volume5/IJELLOv5p215-232Pundak669.pdf

11. Motivation of Students and Its Importance

Motivation of students means getting students to exert a high degree of effort in their learning activities. The teacher is expected to motivate the students to create a conducive atmosphere for the teaching learning process. To motivate students, the teacher needs to encourage them to get ready for the lesson, appreciate students for their attempts in answering questions or any other activity they perform during the teaching-learning process and give them recognition. Motivating students helps the teacher.

- to pass information to students according to the plan
- to make students active participants
- make students realize concepts easily
- make his/her teaching interesting
- achieve the desired goals etc.

Motivation also helps students to

- follow the lesson attentively
- increase their participation
- enhance their understanding
- develop interest in the subject
- achieve good results in their performance

Implementing active learning methodologies has a role of its own in motivating teachers as well. It is not as tiresome as that of lecturing although, the teacher has a lot of tasks to accomplish when applying the methods. Using active learning methodologies during the teaching learning process motivate the teacher to:

- enjoy friendly and interesting relationships with students.
- develop new teaching skills by practicing the new teaching techniques, observing their results, and contrasting them with those of the old method of lecture-based teaching.

- become more interested in the teaching profession. For example, it is interesting and satisfying to develop new skills. The teaching-learning approach guides the teacher, helping him or her to develop professionally.
- investigate each student's talents and creativity. In this way, the teacher learns more about the age group of the students he or she teaches. This process is interesting in itself and helps the teacher develop professionally.
- guide students individually as they learn on their own. In this way, the teacher learns more about the dynamics of learning and also of teaching.
- actively engage in furthering the students' development. Because the students develop important social skills and attitudes, as well as increasing their knowledge and learning skills, the teacher has the satisfaction of contributing to their community and therefore to the country as a whole.
- expand his or her own creativity by developing appropriate presentations and assembling the apparatus and the local materials required for demonstrations and experiments.
- develops a greater interest in the teaching profession. As he or she assumes direct responsibility for each student's development.

UNIT 1 CHEMISTRY AND ITS IMPORTANCE

Number of periods allotted: 4 periods

Unit Overview

This unit deals with introduction to chemistry and its applications. The unit consists of four sections. The first section (1.1) deals with the definition and essence of chemistry. Section 1.2 presents the relationship of chemistry with other branches of natural science such as biology, physics and geology. Section 1.3 gives emphasis on the role played by chemistry in production and society. The applications of chemistry in the fields of agriculture, industry, building construction, medicine and food production, and other sectors are presented in this section. The last section (1.4) describes some chemical industries in Ethiopia, their location and products.

To teach the contents in this unit, group discussion, gapped lecture, question and answer and spider diagram are suggested as methods of teaching.

Unit Outcomes

After completing this unit, students will be able to:

- *explain what chemistry is and define 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 inquiry skills along with this unit, namely, observing, communicating, asking questions and making generalizations.*

Main Contents

1.1 DEFINITION AND ESSENCE OF CHEMISTRY

Periods allotted: 1 period

Competencies

After completing this section, students will be able to:

- *define chemistry;*
- *explain the essence of chemistry*

Forward planning

Read thoroughly the contents on the definition and essence of chemistry from the student's text and other reference materials. This will help you present the contents during the teaching- learning process. Prepare a plan on how to manage students during discussion and presentation. In your plan, show the time allotted for each activity students perform during the period. Prepare the materials suggested for the start-up activity beforehand.

Teaching Aids

- water, sand, charcoal, ash, paper, salt, sugar, chalk and soap.

Subject matter presentation

It is advisable to use group discussion and gapped lecture to teach the contents in this section. You are advised to start teaching the lesson with the start-up activity. This activity enables students to think why substances differ, and why it is important to study substance. So let the students discuss this activity for a few minutes in groups and let some students from different groups present their ideas to the class. After their presentations, harmonize concepts as follows:

1. The given materials differ from one another in their properties such as taste or colour. For example, water is a liquid while all others are solids. Water is colourless, charcoal is black, and ash, paper, salt, sugar and chalk are white. Paper is smooth, soap is slippery whereas sand, charcoal, ash, salt and sugar are coarse.
2. These materials differ from one another in their composition and arrangement of their constituent particles.

Then, continue dealing with the definition and essence of chemistry. Start presenting this section with Activity 1.1. This activity is designed to assist students define natural science and chemistry on their own. Let them discuss the activity for a few minutes in groups and let some students from different groups suggest their opinion to the class.

Encourage them whether their opinion are correct or not. When you harmonize concepts, inform them that natural science is the study of nature and natural laws. It studies living and non-living things in general. Chemistry is one of the branches of natural science. Chemistry is the study of substances, their composition and behavior.

Next, continue with Activity 1.2. The activity is set to enable students discover the concern of chemistry as the study of different materials. Let them discuss this activity for a few minutes in groups. Invite some students to suggest their opinion to the rest of the class. Following the presentation, harmonize concepts as follows:

1. Tea, coffee, water, oil and milk are liquids.
2. a) Water and milk are identified by their color. Water is colorless while milk is white.
   b) Sugar and table salt are identified by their taste. Sugar is sweet and salt tastes salty.
3. Tea contains water, sugar and other different substances from the tea leaf.

After that, continue with the definition of chemistry. Define chemistry as a field of natural science that deals with the composition, structure, property and changes or transformations of a substance. Explain what the key terms in the definition such as composition, structure and transformation mean. After you define chemistry, continue with the essence of chemistry. Start with Activity 1.3. This activity is designed to enable students express their opinion about the subject chemistry and also to assist the teacher discover what information the students have about the subject. Let them discuss Activity 1.3 in groups for a few minutes. Encourage two students from different groups to present their ideas to the rest of the class. Following the presentations, harmonize concepts.

In relation to the activity, students may suggest things like bottles of different liquids, different types of apparatus, smell of substances, explosion, people in the laboratory wearing laboratory coats and safety glasses, charts and graphs and many other materials. Inform them that chemistry is all of these things. It is the study of materials by scientists using a specialized equipment, apparatus and chemicals. Inform them that chemistry is an experimental science based on measurement and observation, which lead to scientific conclusions. Then, define experiment and laboratory. Show them some common apparatus and chemicals like test tubes, beakers, measuring cylinder, flasks, acids,

bases, salts, oxides, etc. available in your school chemistry laboratory. Tell them about the essence of chemistry which refers to the most important qualities that makes it useful.

Assessment

Assess each student's work throughout Section 1.1. Watch carefully how every student is involved in discussing Activities 1.1 - 1.3 in his/her groups, present ideas after discussion, and answer questions raised during gapped lecture.

Give them Exercise 1.1 as homework, check their work and record their performances. Based on your evaluation, make sure that the suggested competencies for Section 1.1 are achieved by most of the students. Appreciate students working above the minimum requirement level and encourage them to continue working hard. For students working below the minimum requirement level, give them additional exercises to help them catch up with the rest of the class.

Supplementary Questions

1. What do we mean when we say chemistry studies the structure and transformations of substances?
2. What does the essence of chemistry refer to?

Answers to Supplementary Questions

1. Chemistry studies the structure and the change of a substance. Structure refers to the arrangement of particles that make up a given substance. Transformation refers to the changes the substance undergoes to form new substances.
2. The essence of chemistry refers to its qualities in
   a satisfying societal needs in the production of new materials
   b. finding solutions to the problems of mankind and
   c. relying on experimentally proved facts.

Answers to Exercise 1.1

1. The application of chemistry in daily life is mainly in the production of materials that we use every day such as clothes, soaps and detergents, fuels, glasses and plates, spoons, forks, knives, cosmetics, papers, pens, etc.
2. a) An experiment is a planned activity carried out using certain equipment, apparatus and chemicals.

b) Laboratory is a room or a place where experimental activities are carried out.

c) Chemistry is a brunch of natural science that studies the composition, properties, structures and transformations of substances.

3. The activities that are done during experimentation are measurement, observation, recording data, collecting data and conclusions.

1.2 RELATIONSHIP BETWEEN CHEMISTRY AND OTHER NATURAL SCIENCES

Period allotted: 1 period

Competencies

After completing this section, students will be able to:

- *discuss the relationship of chemistry with physics, biology and geology.*

Forward planning

Read the contents in Section 1.2 from the student's text and other reference books to get more information about the relationship between chemistry and other branches of natural science. Design a plan on how to manage students during discussion and presentations. In your plan, show the duration of time you allot for introducing the topic, for student's group discussion on the activities, and for harmonizing concepts and presentation of the lesson during the period.

You are advised to read this guide to get more information about the activities and the methodology you follow. Please draw Figure 1.4 on a big chart paper before class.

Teaching aids

- Diagram of Figure 1.4 on chart paper.

Subject matter presentation

To teach the contents in this section, it is advisable to use group discussion and question and answer as methods of teaching.

You may start presenting the lesson by asking students the following question: "What branches of natural science do you know?"

After you get feedback from the students, inform them that natural science has different branches such as chemistry, biology, physics and geology. Then continue with Activity 1.4. The activity is designed to enable students investigate areas of studies of the

different branches of natural science. Let them discuss this activity in groups for a few minutes. Invite students from different groups to present the ideas of their groups. After presentation, harmonize concepts using the following information for Activity 1.4.

1. The interest of the first student is related to the field of biology, the observation of the second student is related to the field of physics and the interest of the third student is related to the application of chemistry.

2. Physics is the study of the general aspects of matter and energy. Biology is the study of living things (animals and plants). Geology is the study of the earth and how it is formed.

After harmonizing concepts, ask them whether it is possible or not to make a sharp boundary between the different branches of natural science. After their response, inform the students that it is impossible to make a sharp boundary between them because they are interrelated. For example, you can mention that chemistry and biology overlap in the field of biochemistry; chemistry and physics in the field of physical chemistry; chemistry and geology in the field of geochemistry. Inform them also that the region of overlap is not only between chemistry and other branches of natural science but also among themselves.

Before you conclude the lesson, revise the main points. Please, do it first by asking students to define chemistry, physics, biology and geology. Their responses should be followed by your conclusion. Then, you can ask them what areas of studies are shared between the different branches of natural science. Give them appropriate answers to the questions.

Assessment

Assess each student's work throughout Section 1.2. Since the section consists of only a one period lesson, the assessment can be based on your observation of how every student:

- is involved in discussing Activity 1.4
- participates in presenting the idea of the group,
- answers questions you raised during the mini-lecture session or during stabilization.

Give them Exercise 1.2 as homework. Correct their work and record their performance. Based on your evaluation, check whether the suggested competency for Section1.2 is achieved by most of the students or not. Appreciate those students working above the

minimum requirement level. Give additional exercises to those working below the minimum requirement level.

Supplementary Questions

* 1. Motor vehicles use petroleum products as a fuel for their engines. Which branches of natural science are involved in the study of the processes taking place in their engines and what makes the vehicles move?
* 2. Which branches of natural science are involved in the study of the composition of glucose, its function in our body and the amount energy that can be obtained from a certain quantity of it?
* 3. Which fields of study overlap in the study of:-
    a) Chemical changes that take place in living things?
    b) The interaction of substances with different forms of energy such as light, heat and electricity?
    c) The study of the composition, properties and structure of minerals?
    d) The effects of forces that results in the formation of mountains and rift valleys?

Answers to Supplementary Questions

1. The reaction involved in the combustion of fuels in engines is studied by chemistry and the energy produced from the burning of the fuel that makes the vehicles move is studied by physics.
2. The composition is studied by chemistry, its function by biology and the amount of energy that can be obtained from a given quantity of glucose is studied by physics.
3. a. Biology and chemistry (biochemistry)
    b. Chemistry and physics (physical chemistry)
    c. Chemistry and geology (geochemistry)
    d. Physics and geology

Answers to Exercise 1.2

Part I

1. True 2. False

Part II

4. Chemistry and Biology
5. a) Geology b) Biology c) Biology and Chemistry
   d) Physics e) Chemistry
6. a) Physics b) Biology c) Chemistry

1.3 ROLE PLAYED BY CHEMISTRY IN PRODUCTION AND SOCIETY

Periods allotted: 1 period

Competencies

After completing this section, students will be able to:

- *describe the application of chemistry in the field of agriculture, medicine, food production and building construction.*

Forward planning

Read the contents thoroughly on the role played by chemistry in production and society from the student's text and other reference books. Design a plan to cover the content of the section within one period. In your plan, show the time allotted for group discussion on the activities, presentation, for harmonizing concepts, for a mini-lecture and other activities you perform during the period.

Also read the teacher's guide on this section to get more information about the activities suggested in the section and how you can deal with the contents.

Subject matter presentation

It is advised to use group discussion, question and answer and spider diagram as methods of teaching for this section.

After introducing the topic for the lesson, you can start the lesson with Activity 1.5. The activity enables them realize the role of chemistry from what they use in their daily lives and what they observe in their locality. So, let them discuss this activity for a few minutes in groups. Invite two or three students from different groups to present their opinion to the rest of the class. Following their presentation, harmonize concepts using the following information for Activity 1.5.

1. You can suggest different materials like soap, cosmetics, clothes, cup, paper, pen, kerosene and so on.

2. You may mention fertilizers, herbicides and weed killers.
3. You can suggest that air pollution is the contamination of atmospheric air by gaseous substances and particles such as carbon dioxide, sulphur dioxide, nitrogen dioxide and dust or sand that enter into it as a result of human activities. Inform them chemistry also has a role in reducing air pollution.
4. You may suggest removing dissolved solids from water and adding chlorine to water which is used to kill bacteria.

After that, you can continue with the in-text question. Allow the students to suggest their views. Following their responses, inform them that chemistry improved the life of mankind by producing new materials that satisfy societal needs. Then proceed to deal with the details on the role of chemistry. First, ask them the following questions:

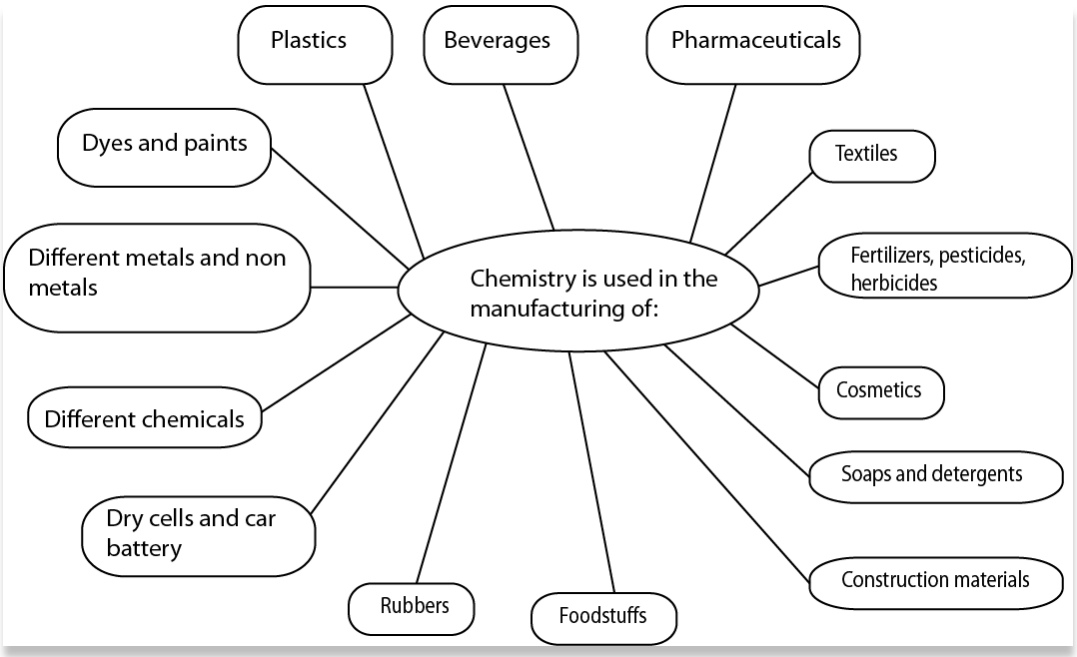
1. What is the role of chemistry in agriculture?
2. What role does chemistry play in solving food scarcity problems?
3. What is its role in food production and preservation?

Give chance to students to suggest their opinion to these questions before you continue explaining the answers. After getting feedbacks from the students, tell them that chemistry has a role in agriculture in producing fertilizers, herbicides and pesticides. The production of these agricultural chemicals helps farmers to get more crop yields which in turn helps to solve food scarcity problems.

Continue by asking students what role chemistry plays in medicine. After their attempts, inform them that it has a role in producing drugs, medical equipment and in the analysis of urine and blood samples to diagnose diseases.

Ask them again to suggest the role of chemistry in the construction industry. After that, tell them it has a role in producing cement, limestone, steel, aluminium, glass and paints which are used in the construction sector. Inform them also about the role of chemistry in petroleum refining, in the production of cosmetics, textiles, dyes, soaps and detergents, plastics, rubber, metals, non-metals, acids, bases, alcoholic and non-alcoholic drinks and other products. Chemistry plays a great role in devising ways of economical utilization of natural resources and its contribution to overcome environmental pollution problems.

To summarize the main points, ask students the roles of chemistry and, based on their suggestions, draw a spider diagram as follows.



Assessment

Assess each student's work throughout Section 1.3. You can do this from what you observe during the period when: students discuss Activity 1.5, the role of the student in presenting ideas of the group after discussion, and while raising and answering questions during your lecture.

Give them Exercise 1.3 as a home work. Check their work and record their achievements. Based on your observation and their achievements, evaluate whether or not the suggested competency for Section 1.3 is achieved by most of the students.

Supplementary questions

1. How can chemistry assist farmers to control locust from destroying plants and crops of their agricultural lands?

∗2. Water from underground sources was found to be unfit for washing. How can chemistry solve this problem and make it fit for this purpose?

∗3. There are some persons ('koralio') engaged in collecting pieces of iron, steel, tin cans and plastic materials. What is the contribution of this activity in relation to:
   a) natural resources
   b) pollution problem

∗ 4. For what purpose do they collect the materials mentioned in question-3? What is the role of chemistry in relation to the above activity?

Answers to supplementary questions

1. By producing pesticides that kill the locust.
2. By removing the dissolved substances that make the water unfit for washing.
3. a. It saves considerable amount of natural resources.
   b. It helps to reduce pollution problems.
4. For recycling (to produce new materials). Chemistry plays a role in using these substances as raw materials in industry to make new ones.

Answers to Exercise 1.3

1. In producing agricultural chemicals such as fertilizers, pesticides and weed killers.
2. By producing a variety of drugs and medical equipment.
3. Soaps and detergents
4. If chemistry had not been put to practical use, life on earth would have been difficult. This is because most of the materials we use in our daily lives are manufactured by applying chemical knowledge. Chemistry has a role in the production of almost all materials.

1.4 SOME COMMON CHEMICAL INDUSTRIES IN ETHIOPIA

Periods allotted: 1 period

Competencies

After completing this section, students will be able to:

- *name some chemical industries in Ethiopia and their products;*
- *visit a local chemical industry and present a report to the class in groups.*

Forward planning

Read the contents thoroughly on some chemical industries in Ethiopia from the students' text and also from this guide. Plan how to present the contents and how to manage students during discussion. You also need to budget your time in accordance with the activities you plan to perform during the period. Prepare a list of chemical industries on a big chart and make it ready before the period. You also need to plan when to arrange a visit to a chemical industry.

Teaching aids

- a chart showing the names of some chemical industries in Ethiopia, their products and location.

Subject matter presentation

You better use group discussion and gapped lecture to teach the contents in this section. You may start teaching the lesson with Activity 1.6. The activity is designed to help students describe what a chemical industry is and name some chemical industries in Ethiopia. Let them discuss this activity in groups for a few minutes and let some groups present their opinion to the rest of the class. After their presentations, harmonize concepts as follows:

1. A chemical industry is a plant or a factory involved in the production of chemical substances such as soaps and detergents, pharmaceuticals, fertilizers, cement and so on from raw materials.
2. You can mention some chemical industries found in Ethiopia such as those manufacturing cement, paint, alcoholic beverages, soaps and detergents. For further information, you may give them Table 1.1 in the students' text book.

Then, continue discussing the in-text question. Allow them to explain what idea the word chemical create in their mind. Following their responses, define the word chemical and inform them that a chemical can be harmful only when it is not handled with care or when it is misused. After that, give emphasis to chemical industry and explain from where they get raw materials for their manufacturing activities.

You may arrange a visit to a chemical industry one day before you plan to deal with this section. After that let students present a three minute report about the local chemical industry.

Assessment

You can assess each student's work on this section by asking them to define a chemical industry, to name some industries in Ethiopia, their products and location as well as how they managed in doing the project work. From what you observe, make sure that the suggested competencies are achieved by the students.

Supplementary questions

Which of the following products are not manufactured by chemical industries in Ethiopia?

a) Dry cells
b) Ceramics
c) Nitric acid
d) Glass
e) Plastics
f) Drugs
g) Paint
h) Alcohol
i) Soaps and detergents
j) Aluminum metal
k) Cosmetics
l) Pesticides
m) Fertilizers

Answers to supplementary questions

There are no chemical industries in Ethiopia involved in manufacturing nitric acid, aluminum metal and fertilizers. All the rest are manufactured in Ethiopia.

Answers to Review Exercises on Unit 1

Part I

1. True
2. False
3. False
4. True
5. False

Part II

6. C
7. D
8. C
9. A
10. B

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UNIT 2 SUBSTANCES

Number of periods allotted: 21 periods

Unit Overview

This unit gives emphasis to substances, their properties, their classification and types of changes they undergo.

The first section of the unit (2.1) deals with properties of substances. It begins with the definition of substances and introduces properties of substances as physical and chemical with examples. It also gives information on how students can identify substances based on their properties. In addition, it enables students develop skill in performing experiments in identifying substances.

The emphasis of Section 2.2 is on grouping substances. It begins with the need for chemists to work on pure substances. It introduces the basis for the classification of substances as pure substances and mixtures. It also presents classification of pure substances as elements and compounds. Further classifications of elements, compounds and mixtures are also included in this section.

Section 2.3 gives emphasis to the changes around us. It introduces that substances around us can undergo either physical or chemical changes. The characteristics of both physical and chemical changes are also presented in this section. This section encourages students to perform experiments and realize whether a change in a substance is physical or chemical or not.

The last section of the unit focuses on separation of mixtures. This section introduces the techniques of separation of mixtures and how these techniques of separation are practically applied in our daily life. It gives chance to students to know the names of some apparatus used in laboratories for the separation process and also to perform activities in separating mixtures.

The methodology suggested to teach this unit are gapped lectures, group discussion, experiment, analogy, brain-storming and concept mapping.

Unit Outcomes

After completing this unit, 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 mixture 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.*

Main Contents

2.1 PROPERTIES OF SUBSTANCES

Periods allotted: 3 periods

Competencies

After completing this section, students will be able to:

- *define substances;*
- *define physical properties;*
- *list some physical properties of substances;*
- *identify substances based on their physical properties;*
- *conduct experiments to identify properties of substances and make group report.*

Forward Planning

Read the contents in Section 2.1 thoroughly from the students' text and make a plan of your own that shows the contents, activities and experiments you are going to deal with during each period. Your plan needs to be designed in such a way that the whole contents of the section can be covered within three periods. In your plan, indicate the

duration of time you will allot for group discussion, presentation, in harmonizing concepts, gapped lecture, stabilization and other activities you will perform in each period. You also need to plan how to manage students during group discussions and when they perform experiments in groups.

Three experiments are suggested in this section. Make ready the materials required to perform each experiment before the period you planned for the students to do it.

Teaching Aids

- Refer to the students' text book for the materials required to perform Experiments 2.1 - 2.3

Subject Matter Presentation

Physical Properties

To teach the contents in this topic, you better use group discussion, gapped lectures and experiment as methodology.

Before you start dealing with the details on physical properties, you may begin the lesson using the start-up Activity. First, allow students in each group to show the materials they collected to the rest of the class. Then, let the students discuss the activity for a few minutes in groups. Invite students from some groups to present the points of their discussion to the rest of the class and, after that, harmonize concepts.

1. Students could identify and suggest different names for the materials such as wood, stone, sand, salt, water, glass, ink, etc.
2. Different criteria such as appearance, strength, colour, composition, etc.
3. Yes, these materials are substances.

Next, ask them to define matter and substance. After their responses, give them the appropriate definitions and proceed to physical properties. Start teaching this topic with Activity 2.1. The activity is designed to assist students describe the properties that are used to distinguish substances and realize physical and chemical properties. So, let them discuss Activity 2.1 for a few minutes in groups. Encourage some group representatives to present the conclusions of their groups to the rest of the class. Following their presentations, harmonize concepts as follows:

1. (a) Common salt and sugar can be identified by their taste. Common salt tastes salty while sugar is sweet.
   (b) Alcohol and water are identified by their smell. Alcohol has a distinct smell while water is odourless.
2. A sheet of paper is a white solid substance.

3. The ability of paper to burn is a chemical property.

Then continue your discussion by defining the property of a substance. Introduce to them that the properties of substances are classified as physical and chemical. Define chemical and physical properties and give them examples. Make sure that they have understood the difference between chemical and physical properties by asking them to tell you the differences they realized. Then proceed to Activity 2.2. This activity is designed to help students identify physical properties that can be perceived by our sense organs and that can be measured by instruments. Let them discuss this activity for a few minutes in groups and let some groups present their conclusions to the rest of the class. After their presentation, harmonize concepts as follows.

1. Melting point, boiling point and density
2. Odour, colour and taste are properties that can be perceived by the sense organs.
3. Melting point, boiling point and density are measured using instruments.
4. The ice will melt if it is kept in a cup at room temperature.

Next, introduce some physical properties of substances. These include measurable physical properties, those detected by our sense organs and physical state. After that continue to deal with physical properties detected by sense organs. Begin with Activity 2.3. This activity helps students to describe the sense organs that help us to detect colour, taste and odour. Let the students discuss Activity 2.3 in groups. Give chance to some groups to present their opinion to the rest of the class. After the presentations, inform them that colour, odour and taste are identified by our eyes, nose and tonge respectively. Inform them that the taste of lemon is described as sour. Next to that, help the students to observe that substances may have different colours and then introduce them the terms used to describe taste and odour. Introduce to them the three physical states and continue dealing with measurable physical properties. Begin with Activity 2.4. The activity will help students know the instrument used to measure melting point and boiling point as well as what freezing point means. Let them discuss Activity 2.4 for a few minutes in groups and let some groups present their opinion to the rest of the class. Following their presentations, harmonize concepts:

1. Thermometer is the instrument used to measure melting point and boiling point.
2. Freezing point is the temperature at which the liquid form of a substance changes to its solid form.
3. The solid form of a given substance melts at the same temperature as its liquid form solidifies. For example, the melting point of ice and freezing point of liquid water is 0℃.

After harmonizing concepts, define melting point, boiling point and density. Give them one or two questions to practice calculating the densities of substances. Check their

work and give corrections. Next to that, continue with electrical and thermal conductivity.

After you complete introducing physical properties of substances, let the students perform Experiment 2.1 in groups. This experiment is designed to help students develop their skills in determining densities of substances and how to check whether a substance is a conductor of electricity or not. Assist them in doing the experiment whenever they seek your help. Watch how they measure the mass and read the volume of the coins. When they finish the experiment, let them produce a group report and let some groups present their observation to the class. Make sure that their laboratory report includes the following points on the observation and analysis part of the experiment.

A. Observation and analysis

The answers of the students can be different depending on the readings they made for the mass and volume of the coins. So there can be a slight difference in the magnitude of the density of the coin.

B. Observation and analysis

1. Yes, this shows that the iron nail is a conductor of electricity.
2. The bulb will not give light. This shows that wood and plastic are non-conductors.

Identifying substances based on their physical properties

You can use analogy and experiment as methodology to teach the contents in this topic.

To apply analogy as a method of teaching, you can ask the students how they can identify people. After you get feedback from the students, the nature of people such as height, weight, hair and eye colour, finger prints, and blood types are used for the identification of people. Although all other properties are the same, no two persons can have the same finger prints. So, finger prints can be used to differentiate one person from the other. The same analogy applies to substances as well. Even if all the physical properties of two substances are similar, there exists at least one property peculiar to each substance. This property enables us to identify one substance from the other.

After you introduce to students how physical properties are used as a means for identification of substances, let them do Experiment 2.2 in groups. Allow the students to identify the properties of the substances based on the procedure and record their observation in the table given in the student's text. Write the following table on the blackboard so that students can identify the substance by comparing with the properties they analyzed from the experiment.

Substance	State	Colour	Solubility in Water
Sulphur	Solid	Yellow	Insoluble
Limestone	Solid	White	Insoluble
Charcoal	Solid	Black	Insoluble
Sugar	Solid	White	Soluble
Zinc	Solid	Grey - white	Insoluble

After they complete their work, they should write a laboratory report and present their findings to the class.

Observation and analysis

Make sure that the students identified the substances,

Label A as sulphur

Label B as charcoal

Label C as sugar

Label D as powdered zinc

Label E as limestone.

After that, continue with Activity 2.5. The activity is designed to enable students identify common elements using tables of melting points, boiling points and density. So, let them do this activity independently as class work. Write the following table of melting points, density and boiling points of the given elements on the black board.

Elements	Melting point/℃	Boiling point/℃	Density g/cm^3
Bromine	–7.2	58.5	3.10
Aluminium	660	2467	2.7
Iron	1530	2861	7.9
Copper	1085	2570	9.0
Mercury	–39	357	13.5

After they complete their work, invite some students to present their findings. Following the presentation, make sure that they identified the elements as follows:

i. Iron
ii. Aluminum
iii. Copper
iv. Mercury and Bromine

Next, continue with Experiment 2.3. Let the students do this experiment in groups. In this experiment, students are required to investigate which physical properties can be used to identify each of the metals. You are required to provide the metal samples to the students and also provide them their names. In the case of mercury, show them its state and colour only. After careful observation, let the students complete the table given in the text with the properties they observed for each metal. Let them write a group report and present to the class. Make sure that their presentation on the observation and analysis part of the experiment matches with the following points.

Observation and Analysis

1.	Mercury	2.	Copper
3.	Alumimium	4.	Lead

Assessment

You are required to assess how each student is doing throughout Section 2.1. You can do this by recording the performance of each student during the teaching-learning process in the student's performance list. Your records can be based on the participation of each student

- In discussing Activities 2.1 – 2.5
- In presenting concepts after group discussion.
- In performing Experiments 2.1 – 2.3
- In writing a laboratory report and presenting it to the class.
- In answering questions raised during mini-lectures or discussion.

Give them Exercise 2.1 and Exercise 2.2 as home work. Check their work and record their achievement. From the cumulative record you have, make sure that the suggested competencies for the section are achieved by most of the students. Appreciate those students working above the minimum requirement level and encourage them to continue working hard. In the case of students working below the minimum requirement level, you may assist them to catch up with the rest of the class either by giving them additional exercise or by arranging extra lesson time.

Supplementary Questions

∗ 1. What physical properties other than those given in the students' text do you know?

2. The density of mercury is 13.6 g/cm^3 at 20℃. What volume of mercury has a mass of 1.36 kg?

* 3. Water boils at a lower temperature at the top of Ras Dashen Mountain than the place where you live in. Explain why?

Answers to supplementary questions

1 Malleability, ductility, hardness, texture and solubility in water

2 100 cm^3

3 Because the atmospheric pressure at the top of Ras Dashen is lower compared to other places in Ethiopia.

Answer to Exercise 2.1

1. Density of water = 1.0 g/mL, density of mercury = 13.6 g/mL
2. No, because some substances are poisonous.
3. They differ in their state. Ice is a solid, water is a liquid and steam is gaseous.
4. Plastic and rubber are non-conductors.

Answers to Exercise 2.2

Part I.

1.	False	2.	True	3.	True	4.	False
5.	False	6.	True	7.	True		

Part II

8.	A	9.	B	10.	B	11.	D
12.	D	13.	C				

Part III

14 a, f, g describe chemical properties
b, c, d, e describe physical properties.

15 a. Conductivity and density.
b. Color: copper is reddish – brown and silver is white, melting point, boiling point and density can be also used.
c. Odour and density
d. Colour: sulphur is yellow while iron is gray.

Conductivity: sulphur is a non-conductor while iron is a conductor of electricity. Density, melting points and boiling points can also be used to distinguish sulphur and iron.

2.2 GROUPING SUBSTANCES

Periods allotted: 8 periods

Competencies

After completing this section, students will be able to:

- *classify substances into pure substances and mixtures;*
- *define pure substances;*
- *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;*
- *carry out an experiment in groups to distinguish compounds and mixtures;*
- *classify compounds as oxides, acids, bases and salts;*
- *give examples of oxides, acids, bases and salts;*
- *define mixtures;*
- *define homogeneous and heterogeneous mixtures;*
- *give examples of homogeneous and heterogeneous mixtures;*
- *compare and contrast homogeneous and heterogeneous mixtures.*

Forward planning

Read the contents on grouping substances from the student's text and other reference materials. Make a plan so that you can cover the whole contents in this section within eight periods. Your plan should show the contents, activities and experiments you are going to do during each period. Beside this, indicate the duration of time allotted for the activities you perform during each period: to introduce the topic, for the students to discuss the activities and presentation and to harmonize concepts. Design a plan on how to manage students during discussion, presentation and when they perform experiments.

You are advised to read this teacher's guide to get more information about the activities and methodology you can implement to teach the contents in this section.

Subject Matter Presentation

Pure Substances and Mixtures

It is advisable to use group discussion, brain – storming and gapped lecture to present the contents of this lesson.

You may start teaching the contents in this lesson by asking students to suggest the importance of grouping substances. After getting feedbacks inform the students that

grouping substances enables chemists to systematically arrange the information (knowledge) about substances in a simpler and easier way to remember and understand. Again, ask them about the need for chemists to work with pure substances and to learn techniques of purification. Encourage some students to suggest their opinion. Following their responses, inform them that the study of the properties and composition of a substance is simpler when it is a pure substance. That is why chemists need to work with pure substances.

After you complete the introduction part, continue with Activity 2.6. The activity is designed to assist students identify pure substances and mixtures they encounter in their daily lives. So, let them discuss this activity for a few minutes in groups. Invite students from some groups to present the conclusions of their groups to the rest of the class. During the presentation, record the names of the substances suggested by students as pure substances and mixtures on the blackboard. This may help you to apply brain – storming methodology. Following the presentation, harmonize concepts.

In the activity, students can suggest different substances such as tap water, sodium chloride, glass, iron, copper, ink, coins, sand, milk, sugar, tea, bread, sulphur and air. Among these substances, inform them that sodium chloride, iron, copper, sugar and sulphur are pure substances; and that tap water, glass, ink, coins, sand, milk, tea, bread and air are mixtures.

Continue to introduce to the students the basis for the classification of substances into pure substances and mixtures. Make sure that students have realized the difference between pure substances and mixtures. The schematic chart for the classification of substances is also given, which may help the students to visualize how substances are classified. You can do this by asking them to explain what pure substances and mixtures are, and then give them Exercise 2.3 as class work or homework. Correct their work.

Elements and Compounds

You may use group discussion, gapped lecture and experiment as methodology to teach contents in this topic.

You can start this topic using Activity 2.7. The activity is designed to help students realize the basis for classifying pure substances as elements and compounds. So, let them discuss this activity for a few minutes in groups. You may assign a given group two elements and one compound to discuss the activity in the case of the first question. Invite students from different groups to present the opinion of their groups to the rest of the class. Following their presentation, harmonize concepts as follows.

Among the pure substances given in the activity:

1 a) Iron, oxygen, copper, gold, sulphur, carbon, hydrogen, silver, chlorine, mercury and bromine are elements.

b) Water, sugar, table salt, carbon dioxide and sodium hydroxide are compounds.

2 Students may suggest tap water, sodium chloride, sugar, spoon, charcoal, soap, tea, injera and kerosene. Among these substances, charcoal is an element (carbon). Sodium chloride, sugar and soap are compounds. The others namely, tap water, spoon, tea, injera and kerosene are mixtures.

Inform them that pure substances are classified as elements and compounds. First, define an element and give some examples. Explain the presence of about 110 elements, 92 of which are naturally occurring while the rest are man-made. Introduce students to the three classes of elements; metals, non - metals and metalloids. Let them be familiar with the properties of metallic and non-metallic elements. Then continue with Activity 2.8. This activity is designed to help students identify elements that are metals and non-metals as well as the non-metals existing in solid and gaseous state at room temperature. Let the students discuss the activity for a few minutes in groups and let two students from different groups present their opinion to the rest of the class. After the presentation, harmonize concepts as follows:

1. Among the given elements iron, copper, gold, silver, zinc, aluminium, lead, sodium and calcium are metals while oxygen, sulphur, carbon, hydrogen, chlorine, phosphorus, nitrogen, iodine and fluorine are non-metals. To identify metals and non-metals, we can compare their appearance (luster) and electrical conductivity.

2. Among the non-metals; oxygen, hydrogen, chlorine, nitrogen and fluorine are gases while sulphur, carbon, phosphorus and iodine are solids at room temperature.

Continue with metalloids. Inform students about the properties of elements classified as metalloids and give some examples. After that, discuss compounds. First, define a compound and ask students to suggest the difference between elements and compounds.

Inform the students that two different elements are combine to form binary compounds. Then a continue activity 2.9. This activity is designed to help students to identifying the types of elements found in binary compounds. Let the students discuss the activity for a few minutes in groups and present their ideas to the class. After presentation, harmonize concepts as follows:

i. potassium and chlorine
ii. magnesium and iodine
iii. iron and sulphur

iv. copper and oxygen

Then continue your discussion by explaining why, substances are classified as compounds. In this case take water as an example and explain all the possible reasons that justify water is a compound.

Before you introduce the classification of compounds, let the students do activity 2.10 in groups. This activity helps the students to analyze some types of acids, bases and salts that are found in their environment. After their group discussions, let some students present their group ideas to the class. Then harmonize concepts as follows:

1. lemon tastes sour due to the presence of citric acid and common salt tastes salty. This difference occurs because of their category in different class of compounds.
2. Magnesium hydroxide is commonly known as 'milk of magnesia'. Since this compound is a base. It can be used to neutralize excess hydrochloric acid found in the patient suffering from gastric.

Next, introduce the classification of compounds; as oxides, acids, bases and salts. Of course at this level, the students are not supposed to know the detail properties of oxides, acids, bases and salts. Thus in your discussion, include only the definitions, how each of these classes of compounds are formed and give some common examples to each of them.

Then, continue activity 2.11. This activity is designed to help students distinguish pure substances from mixtures. Let the students discuss activity 2.11 in groups for a few minutes. Let some students from different groups present the ideas of their groups to the rest of the class. Following their presentation, harmonize concepts as follows:

1. Since pure water is a compound, it is a pure substance.
   Sodium chloride in water produces a sodium chloride solution and hence it is a homogeneous mixture.
2. Air is a mixture of nitrogen, oxygen, hydrogen, and other gases.

Then continue your discussion by defining the mixture. Explain the characteristics of mixtures. In your discussion, consider a salt solution and deal with all its characteristics. This will help the students to confirm that all those characteristics of salt solution are associated with the characteristics of mixtures and thus salt solution is a mixture. After the discussion, let the students perform Experiment 2.4 in groups. This experiment helps students to distinguish compounds from mixture. The experiment consists of two parts. Part I shows how sulphur and iron are simply mixed to give a mixture. Part II is a continuation of part I and it indicates how sulphur and iron are combined to give a new compound, iron sulphide. In part II of the experiment, the students may face difficulty during heating and breaking the test tube by plunging the hot end of it. Thus assist the students in a need of help. After they finish the experiment,

let students write a group report and inform them that in their report, they should give the answers for all the questions and observations and analysis part of the experiment. Let some students from different group present their observation to the class. Be sure that their laboratory report matches with the following points:

Part I (Questions)

1. The iron filings are attracted to the magnet.
2. A gray color, mixture of iron filings and sulphur, is observed
   These iron filings and sulphur are seen separately.

Part II (Questions)

1. The iron filings and sulphur are not seen separately.
2. Since a new product (Iron sulphide) is formed, the individual components of iron and sulphur, cannot be attracted by a magnet.

Observation and analysis

1. Part II of the experiment indicates a compound. This is because a new substance, known as iron sulphide is formed.
2. Part I of the experiment shows that it is a mixture.

Then, continue your discussion by comparing and contrasting compounds and mixtures using Table 2.3. This table will help the students to stabilize or summarize the difference between compounds and mixture.

Before introducing the classifications of mixtures, begin with Activity 2.12. This activity helps students to distinguish between homogeneous and heterogeneous mixture. Let them discuss Activity 2.12 in groups for a few minutes. Invite two or three students from different groups and let them suggest their opinion to the class. Following their presentations, harmonize concepts as follows:

1. Yes since the salt is not stirred, it exists as white crystals at the bottom of the cup. This indicates that the sugar crystal and the water components are observed separately as two phases. Thus it is a heterogeneous mixture.
2. When the salt dissolves in water, it forms a solution. This solution has a uniform composition of sugar-water mixture. Therefore, as a conclusion inform them that before stirring; the two components, sugar and water, are remained separately and can be observed even with our naked eyes. Such types of mixtures are known as heterogeneous. However, after stirring, a sugar-water solution is formed, and such mixture is known as homogeneous.

After that continue with the classifications of mixtures. Tell them that mixtures can be classified into homogeneous and heterogeneous. Also describe them how the properties

of homogeneous mixtures are different from heterogeneous. In your discussion, include all the examples of homogeneous and heterogeneous mixtures that are given in the tables separately. Let the students perform activity 2.13 in groups for a few minutes. The activity helps them to relate some compound, homogeneous and heterogeneous mixtures with their daily life activities.

Invite some students from different groups to present their opinion to the class. After their presentation, harmonize concepts as follows:

1. Heterogeneous mixture
2. Heterogeneous mixture
3. Homogeneous mixture
4. Heterogeneous mixture
5. Compound
6. Homogeneous mixture
7. Compound

Assessment

Asses each students work throughout section 2.2. You can do this by continuously recording the performance of each student during the lesson in the students' performance list. Your records can be based on the direct participation of each students in:

- Discussing activity 2.6 to 2.13
- Presenting ideas of the group after group discussion
- Performing experiments 2.4
- Writing a laboratory report and presenting it to the class
- Answering and raising questions during the lectures.

Give them Exercise 2.3, 2.4 and 2.6 as a classwork or homework. Check their work and record their achievement. Based on your performance record, make sure that the suggested competency for section 2.2 is achieved by most of the students. Appreciate those students working above the minimum requirement level, and encourage them to continue working hard. For students working below the minimum requirement level, you may assist them to catch up with the rest of the class either by giving additional exercise or by arranging extra lesson time.

Supplementary Questions

1. How are elements and compounds similar? How are they different?

2. If sugar is dissolved in pure water, what will be the nature of the mixture?

Answers to supplementary Questions

1.
   - Elements and compounds are similar because both of them are pure substance.
   - An element is composed of only one kind of atom and cannot be broken into simpler substances. On the other hand, a compound is composed of two or more elements that are combined chemically and it can be broken into simple substances.
2. The nature of the mixture will be uniform and consists of only one phase. Since this mixture is a solution, it is a homogeneous mixture.

Answers to Exercise 2.3

1. Iron, silver, chalk and baking powder are some examples of pure substances.
2. Because the components of each of the given mixtures retain their properties and also do not have constant composition.

Answers to Exercise 2.4

1. i. Sugar is formed by the chemical combination of carbon, hydrogen and oxygen.
   ii. Sugar can be decomposed into its constituent only by a chemical means.
2. Carbon (charcoal) is an elements, whereas sugar is a compound.

Answers to Exercise 2.5

1.	Acid	3.	Base	5.	Salt
2.	Oxide	4.	Salt		

Answers to Exercise 2.6

1.	a.	Mixture	c.	Pure substance	e.	Mixture
	b.	Pure substance	d.	Pure substance	f.	Pure substance
2.	a.	Mixture	d.	Compound	g.	Mixture
	b.	Compound	e.	Element	h.	Mixture
	c.	Mixture	f.	Mixture	i.	compound
3.	a.	Heterogeneous	d.	Heterogeneous	g.	Homogeneous
	b.	Heterogeneous	e.	Heterogeneous		
	c.	Heterogeneous	f.	Homogeneous		

4. i. Water cannot be separated into its constituents by physical means.
   ii. The composition of water is fixed. ($H_2O \Rightarrow$ H:O = 2:1 ratio by volume)

2.3 CHANGES AROUND US

Periods allotted: 4 periods

Competencies

After completing this section, students will be able to:

- *define physical changes;*
- *give examples of physical changes;*
- *define chemical charges;*
- *give examples of chemical changes;*
- *distinguish the physical a chemical changes using their characteristics;*
- *conduct some simple activities to show physical and chemical changes and write group report.*

Forward planning

Read the contents in section 2.3 from the student's text and other reference books to get more information about the physical and chemical changes around us. Design a plan on how to manage students during group discussion, presentation, and when they perform experiments. Be sure that your plan is designed in such a way that all the sub topics of section 2.3 should be covered within 4 periods.

In your plan, indicate the duration of time you will allot for group discussion, presentation, in harmonizing concepts of activities and gapped lecture.

Three experiments are suggested in this section. Before each experiments, make ready the required materials and chemicals. You are also advised to conduct each of these experiment by yourself before the students are supposed to perform the experiments.

Teaching aids

Refer to the students' text book for the materials required to perform experiments 2.5 - 27.

Subject matter presentation

It is advisable to use group discussion, gapped lectures and question and answer as methodology to teach this section.

You can begin the lesson using Activity 2.14. Activity 2.14 is designed to enable students analyzing the physical and chemical changes. So, let them discuss this activity for few minutes in groups. Invite some students from different groups to present the ideas of their groups to the rest of the class. After presentation, harmonize concepts as follows:

i. The chocolate or candy is going to be dissolved in the mouth. Thus this dissolving process is simply a physical change.
ii. The size of the chocolate is gradually decreases as it dissolves in the mouth for few minutes.

Then continue your discussion by introducing some common changes that occur in our environment. You may ask some students to mention some of the changes that undergo in their environment. Tell them that changes can be classified as physical and chemical. After that continue to deal with physical changes and explain them how the physical changes are occurred during the changes of state (phase), during dissolving substances and in the mechanical changes. Also explain them the characteristics of physical changes.

Before dealing the chemical changes, begin with activity 2.15. This activity helps students investigate the formation of chemical changes. Let the students discuss activity 2.15 in groups for a few minutes. Give chance to some students to present the ideas of their groups. After the presentations, harmonize concepts as follows:

1. Rust is formed by the reaction of iron metal with oxygen and moisture in the air.
2. Rusting is a chemical process. Thus it cannot be reversed to its original condition.

Next, define the chemical changes and also explain the basic characteristics of a chemical change. These characteristic may help students to distinguish the physical and chemical changes, by observing the changes that occur on the substance.

After you complete the physical and chemical changes. Let the students do experiment 2.5 in groups. This experiment is designed to enable students to investigate whether the change of state of the substance is a physical or a chemical change. After they finish the experiment, let them write a group report and present to the rest of the class. Make sure that their presentation on the observation and analysis of the experiment coincides with the following points.

Observation and Analysis

1. The color of sulphur is yellow. When sulphur is heated, it melts to form a liquid with a color of pale yellow.
2. Physical change.

Then, let the students perform experiment 2.6 in groups. This experiment is designed to help students to investigate the types of changes that occurs during rusting of iron. At the end of the experiment, students are supposed to write a group report and present to the rest of the class. Be sure that their presentation on the part of observation and analysis includes the following points.

Observation and analysis

1. The surface of the iron nails covered with rust
2. A reddish color
3. A chemical change. Because a new substance with a new property is observed.

Then, continue Activity 2.16. The activity helps students to distinguish between the physical and chemical changes. Let the students discuss 2.16 in groups for few minutes, and let some groups present their opinion to the class. Following their presentation, harmonize concepts:

1. Yes
2. In burning of wood, its composition is completely changed (chemical change). In evaporation of water only its state is changed from liquid to gaseous form (physical change).

Next, let the students conduct experiment 2.7 in groups. This experiment is also enable the students to investigate the type of changes that occur during burning of substances. After the experiment, let them fill the given table based on their observation and also write a group report. Let some groups present their observation to the rest of the class. Their observation should match with the following points:

Properties	**Before heating**	**After heating**
Color	Silver white	White ash
State (form)	Solid	Solid
Appearance	Lustrous	Dull
Ductility	Ductile	Non-ductile

Observation and Analysis

1. There is a change in the composition of magnesium.
2. Once a new product, magnesium oxide is formed it cannot be further burn, even when it is heated.
3. Chemical change.

Assessment

Assess each student's work throughout section 2.3. You can do this by recording the performance of each student during the teaching-learning process. You may record their

performance continuously on the student's performance list. Your records can be on the basis of each student participation in:

- Discussing activities 2.12 – 2.14.
- Presenting ideas of the group after discussion.
- Answering questions during gapped lecture or discussions.
- Performing experiments 2.5 – 2.7.
- Writing a laboratory report and presenting to the class.

Give them exercise 2.7 and 2.8 as a classwork or as a homework. Check their work and record their achievement. Evaluate whether or not the suggested competencies for section 2.3 is achieved by most of the students. Appreciate students working above the minimum retirement level and encourage them to continue working hard. For students working below the minimum requirement level, you may give them additional exercises or arrange them extra lesson time so that they can cope up with the rest of the class.

Supplementary Questions

Which of the following are physical changes and which of them are chemical changes? Give your reason for each case.

1. Frying an egg
2. Adding sugar to tea
3. Crushing a rock
4. Fermentation of 'Tella'
5. Magnetizing a bar of iron.

Answers to supplementary questions

1. Chemical change.
2. Physical change.
3. Physical change.
4. Chemical change.
5. Physical change.

Answers to Exercise 2.7

1. D
2. C

Answers to Exercise 2.8

I.

i. Physical change
ii. Chemical change
iii. Physical change
iv. Physical change
v. Physical change
vi. Chemical change
vii. Physical change

II. Diagram (i) represents a physical change, but diagrams (ii), (iii) and (iv) represent the chemical changes. This is because in diagram (i), all the individual atoms are remained separately, after the process occurs. In diagram (ii), the atoms are chemically combined to produce a new

compound or molecule. In diagram (iii), the compounds or molecules are separated into their individual atoms by chemical means. In diagram (iv), the atoms are combined with the given compounds to give a new compound.

2.4 SEPARATION OF MIXTURES AND ITS APPLICATION

Periods allotted: 6 periods

Competencies

After completing this section, students will be able to:

- *list methods of separation of mixtures*
- *explain methods of separation of mixtures*
- *give some specific examples of mixtures that can be separated by filtration, decantation, simple distillation, magnetic separation and using separatory funnel*
- *name apparatuses used in decantation, filtration, simple distillation, using separatory funnel.*
- *assemble apparatuses used in decantation, filtration, simple distillation, separatory funnel..*

Forward planning

Read the contents in section 2.4 thoroughly from students text book and other reference books so as to get more information about the separation of mixtures and its application. Plan how to present each contents and how to manage students during discussion and presentation. In your plan, show the duration of time you allot for each period for introducing the topic, for the group discussion on the activities, harmonizing concepts, presentation of the lesson, and stabilization of the lesson.

You have to also plan how to manage students' group discussion and during performing experiments in groups.

Four experiments are suggested in this section. Make ready the materials required to perform each experiment before the students' perform the experiments.

Teaching Aids

Refer to the students' text book for the materials required to perform Experiments 2.8 - 2.11.

Subject matter presentation

You are advised to use group discussion, gapped lectures experiments and question and answer to teach the contents in this section.

Before you deal the topic, you can begin with Activity 2.17. The activity is designed to remind the students about the separation techniques they learnt in Grade 6 Integrated science. Let the students discuss Activity 2.17 in groups for a few minutes. Invite some students to present the ideas of their groups. After presentation, harmonize the concepts by informing them

1. Sieving, filtering, decanting, etc.
2. Sieving.
3. Filtration requires a filtering medium whereas decantation does not.
4. Simple distillation.

Then, continue your mini lecture by listing down the types of separation techniques of mixtures and then explain each of the common separation methods by starting with magnetic separation of mixtures. After that, let the students perform experiment 2.8 in groups. This experiment is designed to help students to analyze how some mixtures can be separated into their components by magnetic separation. Let the students write a group report and present their observation to the class. Make sure that their presentation on the observation and analysis of the experiment coincides with the following points.

Observation and Analysis

1. The iron filings are attracted to the magnet.
2. Magnetic separation helps to separate a mixture of iron filings and sulphur, into their components. And during separation process only the magnetic component, like iron filings are attracted by a magnet, whereas the nonmagnetic components, like sulphur do not attracted.

Before you continue dealing the decantation ask some students the intext question about the decantation process. After their response, inform them that during the local coffee ceremony, the boiled coffee is allowed to stay within the 'Jebena' for a few minutes. This will result in settling of some insoluble solid particles at the bottom of the 'Jebena', which is known as sedimentation. Then by, carefully pouring the coffee from the 'Jebena' a clean coffee can be obtained. This process is known as decantation.

Then continue your discussion by explaining how the decantation method helps in separation of a mixture of a liquid and insoluble solid and also tell them that it helps to separate two immiscible liquids like oil and water.

Let the students discuss activity 2.18 in groups for few minutes. This activity helps the students to develop their skills in separating of some mixtures using both decantation and filtration processes. After the students group discussion let some students from different groups present the ideas of their groups. After presentations, appreciate their opinion and harmonize concepts as:

1. 3 phases
2. By filtration process, the sand can be separated from the oil and water mixture. Then since oil and water are immiscible liquids they can be separated by the decantation process, using a separatory funnel.

After harmonizing the concepts on the activity, introduce the filtration process. But, before you deal with the filtration process, you are advised to bring a filter paper to the class. During the discussion of filtration, inform the students that filterpaper is used as a filtering medium, and show them how the filter paper is folded inorder to fit the filter funnel. Let the students perform Experiment 2.9 in groups. This experiment helps students to develop their skills in separating of a mixture of liquid and insoluble solid using filtration. After they finish the experiment, let them write a group report. Invite some students to present their observation to the class. Be sure that their laboratory report matches with the following points.

Observation and Analysis

1. The powdered chalk does not dissolve in water because it is insoluble.
2. The water is collected in the flask.
3. The chalk remains on the filter paper.

Before you are dealing with the evaporation process, start with activity 2.19. This activity is designed to assist students analyze the evaporation of water in sunlight. Let the students do activity 2.19 in groups. Of course this activity might take two or three days to observe a change in the level of the water. Encourage some group representatives to present the ideas of their groups to the class. After their presentations, harmonize concepts.

1. The level of the water in the beaker is decreased due to the evaporation of water in the beaker. When a beaker of water is exposed to sunlight, some of the water changes into a vapor. This vapor will then escape into the atmosphere. As a result of this, the amount of water in the beaker gradually decreases.
2. Evaporation is the process of escaping of water in the form of vapor.

After explaining the evaporation process, let the students perform experiment 2.10 in groups. Experiment 2.10 enables the students separating a salt from a salt solution using evaporation. After they finish the experiment, let them write a group report on the basis

their observation and present to the rest of the class. Make sure that their observation and analysis part of the experiment matches with the following points.

Observation and Analysis

1. After evaporation, the solid salt remained on the evaporating dish.
2. No change in the level of the liquid. Evaporation does not occur if the liquid is covered.

Before you introduce the simple distillation, let the students do activity 2.20 in groups for a few minutes. Activity 2.20 is designed to help students separating mixtures using simple distillation and to distinguish between evaporation and distillation processes. Let some students present the opinion of their group to the class. After presentation, harmonize concepts.

1. Impossible. This is because during evaporation, the water escape to the atomosphere and thus it cannot be collected separately.
2. Distillation.

After that, continue your discussion by explaining the simple distillation process and also introduce them the apparatuses of distillation like condenser, adaptor, distillation flask and receiver. Then as you finish your discussion, let the students do activity 2.21 in groups. This activity is designed to help students analyzing some of the common mixture around their environment and how they can separate each of the mixture using different separation technique. Let some students present their opinion to the class. After their presentation, harmonize concepts.

1. Dissolving and filteration
2. Separatory decantation (funnel)
3. Staying the mixture at room temperature for some time and then filtering
4. Decantation (separatory funnel)

Next, let the students perform experiment 2.11 in groups. This experiment is designed to help student in separating of mixtures by the distillation process.

You are advised to assist students in set up the distillation apparatus because it might be difficult for them to setup the apparatus.

When they finish the experiment, let them write a group report and some students present their observation to the class. Be sure that their group report includes the following points on the observation and analysis of the experiment.

Observation and Analysis

1. The pure water is collected in the receiver and the salt crystal remained in the distillation flask.
2. Evaporation occurs in the distillation flask and condensation occurs in the condenser.
3. A tap water or cold water is passed through the condenser in order to cool it.

Next, introduce to the students that mixtures can also be separated into their components by the combination of the above two or more techniques. Then continue activity 2.22. This activity enables the students investigating the separation of mixtures by using combinations of two or more separation techniques. Let the students discuss activity 2.22 for a few minutes in groups and present the ideas of their group to the class. Following the presentation, harmonize concepts as follows:

1. Dissolution, filtration and then evaporation.
2. Dissolution, filtration followed by evaporation.
3. Filtration and decantation (using separatory funnel)

   or filtration followed by simple distillation.

Assessment

Assess each students work throughout section 2.4. To do this, it is better to record the performance of each student during the teaching learning process. Your records can be based on the participation of each student in:

- Discussing activities 2.15 – 2.19
- Presenting ideas of their group discussion.
- Answering questions during mini-lecture or discussion
- Performing experiments 2.8 – 2.11
- Writing a laboratory report and presenting to the class.

Give them exercise 2.7 as a homework. Check their work and record their achievement. Based on students performance record and on your observation, be sure that the suggested competencies for section 2.4 is achieved by most of the students. Appreciate those students working above the minimum requirement level and encourage them to continue working hard. For students working below the minimum requirement level, you may help them by giving additional exercises or arranging extra lesson time. By doing so, these students may cope-up with the rest of the class.

Supplementary questions

1. Which separation techniques can you use to separate mixtures of
   i. A liquid and insoluble solid
   ii. A soluble solid and insoluble solid
   iii. Two miscible liquids
   iv. Two immiscible liquids
2. How would you convert a sample of dirty water into pure water?

Answers to supplementary questions

1. (i) decantation or filtration
   (ii) dissolution, filtration and then evaporation
   (iii) distillation
   (iv) decantation (separatory funnel) or distillation.

Answer to Exercise 2.9

1. Decantation or filtration process.
2. Simple distillation.
3. Filtration and distillation.
4. Simple distillation.
5. Dissolution, filtration, evaporation.

Answers to Review Exercise on unit two

Part I

1.	False	4.	False	7.	False		
2.	True	5.	True	8.	True		
3.	False	6.	True	9.	True		

Part II

10.	D	12.	C	14.	A	16.	C
11.	D	13.	C	15.	B	17.	B

Part III

18. Refer student text book
19. Refer student text book.
20. (i) the boiling point of water is 100°C while that of alcohol is 78°C.
    (ii) The density of water is 1 g/cm^3 whereas alcohol's density is 0.79 g/cm^3.
    (iii) The odor of water is odorless; alcohol has its own characteristic smell.

21. Refer students text book.

22. (a) chemical property (b) physical property (c) physical property
(d) physical property (e) physical property (f) chemical property
(g) chemical property

23. (a) Physical change (b) Physical change
(c) Physical change (d) Chemical change
(e) Physical change (f) Physical change

24. (a) beaker, funnel, filter paper, conical flask.
(b) burner, evaporating dish, wire gauze, and beaker
(c) burner, wire gauze, distillation flask, conical flask, beaker, condenser

25. (a) density, melting point (b) density, color, melting point
(c) boiling point, density (d) melting point, density, color.

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UNIT 3 THE LANGUAGE OF CHEMISTRY

Number of periods allotted: 19 periods

Unit overview

This unit deals with the language of chemistry by discussing about chemical symbols, formulas and equations. The unit consists of four sections.

The first section (3.1) deals with symbols of elements; symbol is defined and convention on writing symbols of elements is discussed.

The next section (3.2) deals with chemical formulas. This section describes the diatomic elements, introduces about valence number and polyatomic ions, and discusses naming and writing binary compounds and other simple chemical compounds.

Section 3.3 shows qualitative and quantitative meaning of symbols and formulas. Here the terms 'subscript' and 'coefficient' are introduced and their significances on symbols and formulas are discussed.

The last section (3.4) describes simple chemical reactions and equations. First, it presents simple chemical reaction and the law of conservation of mass. Next, it describes writing and balancing of simple chemical equations using inspection and least common multiple (LCM) methods. In this section, one experiment is also conducted to show simple chemical reaction.

To teach the contents in this unit, group discussion, gapped lectures, question and answer, presentation, experiment and brain storming are suggested as methods of teaching.

Unit outcomes

After completing this unit, 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.*

Main Contents

3.1 SYMBOLS OF ELEMENTS

Periods allotted: 2 periods

Competencies

After completing this sub-unit, students will be able to:

- *define chemical symbols;*
- *write symbols of some common elements;*
- *write the names of elements from their names.*

Forward planning

Read thoroughly about symbols of elements from the students' text and other reference materials. This will help you present all the contents during the teaching learning process. Prepare a plan on how to conduct the teaching learning process. In your plan, show the time allocated for each activities students perform during the lesson. Prepare two charts that show symbols of some elements derived from English and Latin names. You can use tables 3.1 and 3.2 from students' text or you can prepare your own.

Suggested Teaching aids

- Charts that show symbols of some elements derived from English and Latin names
- Periodic table.

Subject matter presentation

It is advisable to use brainstorming, group discussion, gapped lecture and question and answer as methods of teaching for this section.

You may begin teaching the unit with **startup activity** as brainstorming. The activity helps students to anticipate what and why they learn the language of chemistry through analogy. So let the students discuss this activity for a few minutes in groups. After their discussion, let some students from different groups present their ideas to the class. Then, harmonize concepts as follows:

1. We might compare the chemical symbols of the elements with an alphabet, the chemical formulas that we construct from symbols with words, and the chemical equations that we develop from chemical formulas with sentences.

   Symbol $\longrightarrow$ Alphabet

   Formula $\longrightarrow$ Word

   Equation $\longrightarrow$ Sentence
2. In learning English language, we must start at the beginning with the alphabet. In learning the language of chemistry, we must start at the beginning with the symbols of elements.

Then, continue on dealing with symbols of elements. Start presenting this section (3.1) with **Activity 3.1.** This activity is designed to assist students predict the importance of symbols by their own. Let them discuss the activity for a few minutes in groups. You can facilitate their discussion by clarifying misconceptions (if any). Allow them to share their ideas to the class through their representatives after their discussion. Then, harmonize their discussion as follows:

1. Roll numbers take small space to write and easier during taking attendance of students.
2. Roll numbers represent names of students.
3. Just as roll numbers take small space to write and easier during taking attendance, symbols simplify writing names of elements.

After activity 3.1, continue with the definition of symbol. Define symbol as a short hand notation for the chemical name of an element. Explain how the elements are

symbolized. In most cases, the first one or two letters of the name are used as the element's symbol. The first letter of a symbol is always capital and the second is small. Explain also that if two or more elements have similar alphabets in their English names, symbols are derived from their Latin names. You can ask the in-text question given in the student's text.

"Why all elements are not symbolized by the first letter of their names?"

Allow students to suggest their views. Following their responses, inform them that:

"Since there are only 26 letters in English alphabet, some chemical symbols have two letters."

Then hang on two charts you brought to the class to show symbols of some elements derived from English name and Latin name. Before you conclude the lesson, hang on the periodic table in the class and let students practice writing the symbols of common elements.

Finally give Exercise 3.1 as a homework.

Assessment

Assess each student's work throughout section 3.1. This can be done by preparing a performance sheet and recording the performance of every student. You can make records based on student's performance in:

- discussing the start-up activity and activity 3.1.
- presenting their views after discussion
- answering the questions you raised during the lessons
- answering the questions in exercise 3.1.

Based on your assessment, check whether the suggested competencies for section 3.1 are achieved by most of the students or not. Appreciate those students who are working above the minimum required level and encourage them to continue working hard. For low achievers, give additional exercises.

Supplementary Questions

1. Write the symbols of the following elements.
   a. bromine
   b. oxygen
   c. lead
   d. tin
   e. sodium
   f. sulphur
2. Match the following elements listed under "A" with their symbols listed under "B"

"A"	**"B"**
i. Carbon	a. Co
ii. Calcium	b. Cl
iii. Chlorine	c. Cu

iv. Cobalt d. Ca
v. Chromium e. C
vi. Copper f. Cr

3. In the square below are the names of 22 elements all written across or down for instance, TIN. Now study the square and see if you can find the other 21.

T	I	N	C	H	L	O	R	I	N	E	H
P	N	E	O	N	E	Z	S	N			Y
H	I	R	O	N	A	I	O	D		S	D
O	T	G	O	L	D	N	D	I	M	I	R
S	R		C			C	I	U	A	L	O
P	O	T	A	S	S	I	U	M	G	V	G
H	G	Z	R	U			M		N	E	E
O	E	I	B	L	C	O	P	P	E	R	N
R	N	N	O	P	I	R	O	N	S		
U		C	N	H		B	A	R	I	U	M
S		A	L	U	M	I	N	I	U	M	
F	L	U	O	R	I	N	E		M		

Answers to supplementary questions

1. a. Br b. O c. Pb d. Sn e. Na f. S

2. i.e ii. d iii. b iv. a v. f vi c

3.

Across	Down
1. Chlorine	10. Phosphorus
2. Neon	11. Nitrogen
3. Iron	12. Zinc
4. Gold	13. Carbon
5. Potassium	14. Sulphur
6. Copper	15. Lead
7. Barium	16. Zinc
8. Aluminium	17. Sodium
9. Fluorine	18. Indium
	19. Magnesium
	20. Silver
	21. Hydrogen

Answers to Exercise 3.1

1. (b) Because when an element has a two-letter symbol like Al, the first is capitalized but the second is not.

2.

Name of the element	Symbol
Oxygen	O
Potassium	K
Carbon	C
Phosphorus	P
Zinc	Zn

Name of the element	Symbol
Barium	Ba
Sodium	Na
Helium	He
Fluorine	F
Boron	B

3.2 CHEMICAL FORMULAS

Number of Periods allotted: 8 periods

Competencies

After completing this section, students will be able to:

- *define chemical formulas;*
- *list formulas of elements that are diatomic molecules;*
- *define valence numbers as the combining power of an atom;*
- *write formulas of some binary compounds;*
- *name binary compounds;*
- *define polyatomic ions;*
- *give examples of polyatomic ions;*
- *write the chemical formulas of common compounds that contain polyatomic ions;*
- *name compounds containing polyatomic ions.*

Forward Planning

Read the contents in the section 3.2 from the students' text and other reference books to get more information about chemical formulas. Design a plan on how to conduct the lesson. In your plan, show the duration of time you allot for starter activities (introducing the lesson), for main activities (developing the lesson) and concluding activities (summarizing the lesson). Prepare two big charts that show:

i. Chemical symbols and formulas of diatomic elements

ii. Valence numbers of some elements and polyatomic ions.

You can use tables 3.3, 3.4 and 3.5 from the student's textbook or you can prepare your own.

You are advised to read this guide before the lesson to get more information about the activities and the methodology you follow.

Suggested teaching aids

Charts that show:

- **Chemical symbols and formulas of diatomic elements**
- **Valence numbers of some elements and polyatomic ions.**

Subject Matter presentation

It is advisable to use group discussion, question and answer, gapped lecture, presentation and concept map as methods of teaching for this section.

You can start this lesson with **Activity 3.2**. The activity is designed for students to easily differentiate symbols from formulas. Let them discuss this activity in groups for few minutes. Then invite some of the groups to present their ideas to the class. After their presentations, harmonize concepts as follows:

- Co is a notation that denotes the symbols for the element cobalt
- CO stands for the compound carbon monoxide.

These two notations consist of the same letters. However in the symbol the second letter is in small letter (i.e small 'o'). Letters used in writing symbols must be distinct and legible, otherwise, the element being represented may be incorrectly interpreted.

After **Activity 3.2**, you can remind students about 'a compound' they studied in unit 2. A compound is represented by using the symbols for the elements of which it is composed. This is called the formula of the compound or element (if it is composed of molecules). Then give formulas of elements and compounds as examples.

Formulas of diatomic elements

Ask orally whether students know elements which exist as diatomic or polyatomic molecules.

After their responses, define molecule as the smallest particle of an element or a compound that exists freely in nature. Hydrogen, fluorine, chlorine, bromine, iodine, oxygen and nitrogen in their elemental form exist as diatomic (two-atom) molecules. A form of elemental phosphorus and sulphur consist of molecules composed of four and eight atoms respectively. There is also a second elemental form of oxygen, known as ozone which is composed of three atoms.

Elements like phosphorus, sulphur and ozone (one form of oxygen) that consist of molecules composed of three or more atoms are called polyatomic elements.

After this hang on the chart that displays chemical symbols and formulas of diatomic elements. You also inform that noble gases such as helium, neon and argon can exist freely as individual atoms. You can describe this using real life phenomenon; i.e our atmosphere is composed mostly of nitrogen and oxygen molecules, and a small amount of argon atoms. To end this topic gives them **Activity 3.3**. The activity is designed to enable students relate molecules formula with the real objects around them and internalize the concept.

After they discuss the activity in groups for few minutes and present their findings to the class, harmonize concepts as follows:

- Bicycle can be complete and works as vehicle if it contains two tyres as nitrogen molecule (N_2) consists of two atoms.
- Bajaj (Tricycle) can be complete and works as vehicle, if it contains three tyres as ozone molecule (O_3) consists of three atoms.
- A car can be complete and works as vehicle if it contains four tyres as phosphorus molecule (P_4) consists of four atoms.

Valence Number

You can begin this topic by asking students that how the constituent elements in the compound are combined. After their responses harmonize the concept as follows:

Every element has its own combining power to combine with other elements. These relative capacities of elements enable to combine and form a compound. This combining power of an element is called valence number.

Next to this, show them how the valence numbers of elements are determined from the formula of compounds by taking hydrogen element as a standard (i.e valence number of H is 1). After this hang the chart that displays the valence numbers of some elements

and polyatomic ions, and give **Activity 3.4.** This activity helps to strengthen students' understanding about valence number. Let them discuss this activity in groups and present. Their ideas to the class. After their presentations, harmonize concepts as follows:

Since atoms of different elements have different "combining powers" (valence numbers), the formulas of compounds are written in a way that balance the combining power of the constituent element.

Finally let students do **Exercise 3.2** as a classwork independently.

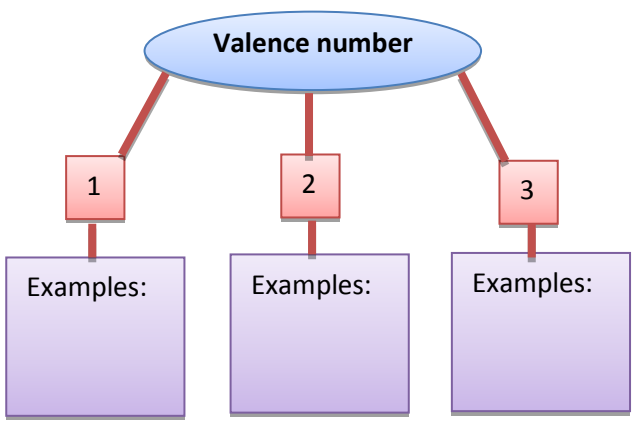
Formulas of binary compounds

You can start this lesson with **Activity 3.5.** The activity enables students to know what binary compounds are. Let them discuss this activity in groups and present their ideas to the class. After their presentations, harmonize concepts as follows:

Models B, C and D represent binary compounds because binary compounds consist of two different kinds of elements, but they are not exactly two in number. They can be more than two in number.

Next you can use the **concept map** active learning methodology to revise the previous lesson.

Draw the following concept map on the blackboard and let students complete it by giving examples.



After their trial, let them refer to their text book to check their work. Then give them the

definition of binary compound with examples. Next discuss and describe the steps in writing formulas of binary compounds.

Naming binary compounds

You can start this lesson with **Activity 3.6** as brainstorming. The activity enables them realize the importance of systematic way of naming compounds. So, let them discuss this activity for a few minutes in groups. Invite some groups to present their opinion to the rest of the class. Following their presentation, harmonize concepts as follows:

As the number of compounds grew, it became more difficult to name them. Hence a systematic way of naming compounds is suggested by scientists.

After this, discuss and describe the rules in naming binary compounds using example. During explaining how to name binary compounds involve students to answer by themselves first for those examples given in their textbook.

Finally give exercise 3.3 as a homework.

Polyatomic ions

Define polyatomic ion and give their examples. Then hang on the chart that displays the valence numbers of some elements and polyatomic ions.

Writing chemical formulas

Remind the steps used in writing formulas of binary compounds and allow them to use the same steps here.

Naming simple chemical compounds

Describe them how to name simple chemical compounds that contain polyatomic ions using examples. Finally give **Exercise 3.4** as classwork.

Assessment

Assess each student student's work throughout section 3.2. This can be done by preparing a performance sheet and recording the performance of every student. You can make records based on a student's performance in:

- discussing **Activities 3.2 – 3.6**
- presenting their views after discussion
- answering the questions you raised during the lessons
- answering the questions in **Exercises 3.2 – 3.4.**

Based on your assessment, check whether the suggested competencies for section 3.2 are achieved by most of the students or not. Appreciate those students who are working above the minimum requirement and encourage them to continue working hard. For low achievers, give additional exercises.

Supplementary questions

1. Which of the following are formulas of elements? Which are formulas of compounds?

a. SO_3 c. CS_2 e. MgO
b. Br_2 d. S_8 f. P_4

2. Name the elements and compounds in the previous question.
3. Which of the following is the formula of a diatomic element? Which are formulas of binary compounds?

a. NO_2 d. $(NH_4)_2S$ f. $CaSO_4$
b. CO e. N_2 g. $ZnCl_2$
c. K_2O

4. Name all of substances in the previous question.
5. A molecule of neon is monoatomic. What does this statement mean?

Answers to Supplementary questions

1. Formulas of elements: Br_2, S_8, P_4.

   Formulas of compounds: SO_3, CS_2, MgO

2. a. SO_3 sulphur tri oxide
   b. Br_2 Bromine molecule
   c. CS_2 carbon disulphide
   d. S_8 sulphur molecule
   e. MgO Magnesium oxide
   f. P_4 phosphorus molecule
3. Formula of diatomic element: N_2

   Formulas of binary compounds: NO_2, CO, K_2O, $ZnCl_2$

4. a. NO_2 = Nitrogen dioxide
   b. CO = Carbon monoxide
   c. K_2O = Potassium oxide
   d. $(NH_4)_2S$ = Ammonium sulphide
   e. N_2 = Nitrogen molecule
   f. $CaSO_4$ = Calcium sulphate
   g. $ZnCl_2$ = Zinc chloride.
5. Neon is an element that can exist as molecule when it consists of one atom only.

Answers to Exercises

Exercise 3.2

1. C
2. A. 2 B. 3 C. 4

Exercise 3.3

1. X_2O_3
2. A. Ca_3N_2 = Calcium nitride
   B. $AlCl_3$ = Aluminium chloride
   C. MgS = Magnesium sulphide
   D. SO_3= Sulphur trioxide
   E. NO = Nitrogen monoxide
   F. PCl_3 = Phosphorus trichloride
3. A. $MgCl_2$ C. K_2O
   B. $AlBr_3$ D. CaO

Exercise 3.4

1. a. KOH c. $MgCO_3$
   b. $(NH_4)_2\ SO_4$ d. $Mg_3(PO_4)_2$
2. a. Li_2SO_4 Lithium sulphate b. $(NH_4)_3\ PO_4$ Ammonium phosphate
   c. $Ca(NO_3)_2$ calcium nitrate d. $Fe(NO_3)_2$ Iron (II) nitrate.

3.3 QUALITATIVE AND QUANTITATIVE SIGNIFICANCE OF SYMBOLS AND FORMULAS

Periods Allotted: 2 periods

Competencies

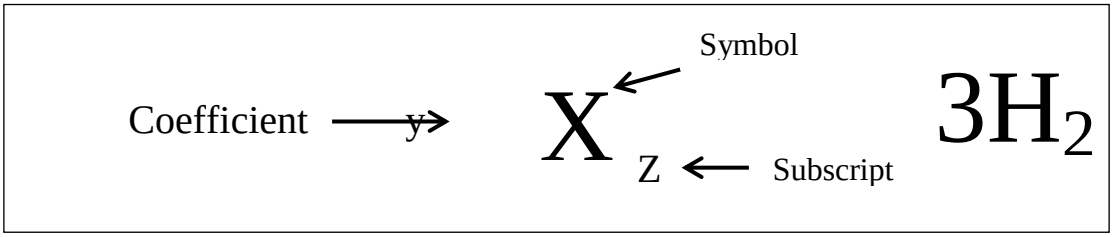
After completing this section, students will be able to:

- *define subscript and explain its significance;*
- *define coefficient and explain its significance;*
- *describe the qualitative meanings of chemical symbols and formulas;*
- *explain the quantitative meanings of chemical symbols and formulas.*

Forward planning

Read thoroughly about qualitative and quantitative significance of symbols and formulas from the student's textbook and other reference books. Make a plan of your own on how to manage students during discussion, presentation and assessment. In your plan show the time allotted for each activity you are going to perform during the period in which you deal with this activity.

Draw a figure in a chart that shows the symbol, subscript and coefficient as follows:



Suggested teaching aids

A chart that shows a symbol, subscript and coefficient.

Subject matter presentation

It is advisable to use group discussion and question and answer as methods of teaching for this section.

You can start this lesson with **Activity 3.7.** The activity is designed for students to understand the difference between quality and quantity in terms of language of chemistry. Let them discuss this activity in groups for few minutes. Then invite some of the groups to present their ideas to the class. After their presentations, harmonize concepts as follows:

The level of water in a glass will decrease due to evaporation. That is a glass of water is changed in quantity. However, the composition water, which is hydrogen and oxygen, does not change. Generally evaporation may change the quantity of water in a glass but not the identity (quality) of water.

After **Activity 3.7,** show how symbols and formulas describe both qualitative and quantitative aspects of the substances by using sufficient examples.

First, hang the chart you brought to the class on the blackboard, and describe the positions of the coefficient and subscripts written to the symbol of an element.

You can use the following additional examples (other than those mentioned in the student's textbook)

⇒ For qualitative significance of a symbol

- The symbol Al represents an element of aluminium
- The symbol Ne represents an element of neon

⇒ For qualitative significance of a formula

- An ammonia molecule, NH_3, contains nitrogen and hydrogen elements
- A table salt, NaCl, contains sodium and chlorine elements.

⇒ For quantitative significance of a symbol

- K quantitatively stands for one atom of potassium
- Br quantitatively stands for one atom of bromine
- 3K quantitatively stands for three atoms of potassium
- 5Br quantitatively stands for five atoms of bromine.

⇒ For quantitative significance of a formula

- I_2 quantitatively stands for one molecule of Iodine
- SO_2 quantitatively stands for one molecule of sulphurdioxide
- S_8 quantitatively stands for one molecule of sulphur
- $4I_2$ quantitatively stands for four molecules of Iodine.

Finally give **Exercise 3.5** as a classwork.

Assessment

Assess each student's work throughout section 3.3. This can be done by preparing a performance sheet and recording the performance of every student. You can make records based as student's performance in:

⇒ discussing and presenting their views on **Activity 3.7**.
⇒ answering the questions in **Exercise 3.5**.

Based on your assessment, check whether the suggested competencies for section 3.3 are achieved by most of the students or not. Appreciate those students working above the minimum required level and encourage them to continue working hard. For low achievers, give additional support while you are checking their classwork.

Supplementary questions

1. Describe the qualitative, quantitative meanings and composition of $5NO_2$ in terms of the number of atoms and molecules.
2. Are P_4 and 4P same? If they are different explain their difference.

Answers to supplementary questions

1.

Quantitative meaning	Qualitative meaning
5 molecules of NO_2	Nitrogen dioxide molecules

♦ $5NO_2$ consists of 5 atoms of nitrogen and 10 atoms of oxygen.

2. P_4 indicates one molecule of phosphorus that contains 4 atoms of phosphorus
   4P indicates 4 atoms of phosphorus that are not combined.

Answers to Exercise 3.5

1.

	Representation	Qualitative meaning	Quantitative meaning
a.	$2Cl_2$	Molecules of chlorine	Two molecules of chlorine each composed of two atoms
b.	4Cl	Atoms of chlorine	Four atoms of chlorine
c.	$3S_8$	Molecules of sulphur	Three molecules of sulpher each composed of eight atoms.
d.	$5MgF_2$	Formula units of magnesium fluoride	Five formula units of magnesium fluoride that consist of five magnesium atoms and ten fluorine atoms.

2. C

3.4 SIMPLE CHEMICAL REACTIONS AND EQUATIONS

Periods allotted: 7 periods

Competencies

After completing this section, students will be able to:

- *define chemical reaction;*
- *conduct an experiment to show simple chemical reaction;*
- *state the law of conservation of mass;*
- *explain inspection and LCM (least common multiple) methods of balancing equation;*
- *convert word equation into formula equation;*
- *balance simple chemical equation by inspection;*
- *balance simple chemical equation by LCM (least common multiple).*

Forward planning

Prior reading about simple chemical reactions and equations from the students' text, reference books and other resources is very useful. Make a plan of your own on how to

manage students during discussion, presentation and assessment. In your plan show the time allotted for each activity you are going to perform during the periods in which you deal with the section. Prepare ahead the necessary teaching and learning materials for this section. Do the **Experiment 3.1** that you are going to demonstrate to the students before the class by yourself. Draw a figure in a chart that shows reactants and products.

You are advised to read this guide to get more information about the activities, methodology and experiment you are going to actualize.

Teaching Aids

- Refer to the student's text to prepare the necessary chemicals and materials required to perform experiment 3.1.
- A chart that shows reactants and products.

Subject matter presentation

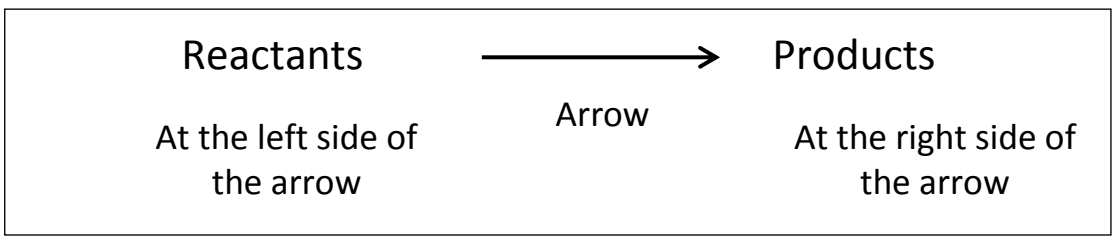
It is advisable to use group discussion, demonstration, gapped lecture, question and answer, and presentation as methods of teaching for this section.

You can start this lesson with **Activity 3.8.** The activity helps students to understand the concept of chemical reaction. Let them discuss this activity in groups for few minutes. Then invite some of the groups to present their ideas to the class. After their presentations, harmonize concepts as follows:

When a bundle of wood is burnt during a "campfire ceremony", heat and light are released or liberated with smoke. Finally we get a collection of ash instead of wood.

Simple chemical reaction

You can start this lesson by revising about chemical changes that they already learnt in Unit 2. Next define chemical reaction and ask them to list the chemical reactions they experience in their daily life. Encourage also them to tell the raw materials (starting substances) and the new substances formed. After their trial give some chemical reactions and describe the reactants and products. Hang on the chart you brought to the class so as to show reactants and products.



After this, continue to demonstrate **Experiment 3.1.** The experiment enables them to

develop skills on how to show simple chemical reactions. Here the simple reaction is burning of magnesium in air. Tell them to watch carefully and record their observations. When the demonstration is complete, allow them to write reports in groups and to submit it. When you check their reports make sure that they respond to the questions in the observation and analysis part as follows:

1. Heat is needed for starting (beginning) a chemical reaction between magnesium and oxygen.
2. The reacting substances are magnesium and oxygen.
3. Magnesium metal is silverish lustrous metal and oxygen is colorless, whereas the product magnesium oxide is white powder.

The law of conservation of mass

Begin this lesson by asking the following questions:

- Are new atoms formed or lost during chemical reactions?
- Are the atoms in the reactants equal to the atoms in the products?

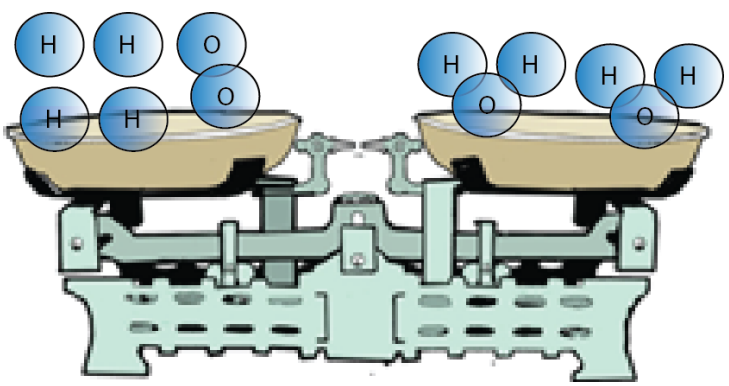
Give chance to two or three students to respond. After their response, state the law of conservation of mass. Next, give the following chemical reaction so as to help students visualize and understand the law of conservation of mass.

Example:

Chemical reaction of hydrogen and oxygen molecules to produce water.

Hydrogen molecules + Oxygen molecule → Water molecules.

$2H_2 + O_2 \rightarrow 2H_2O$



Simple chemical equations

You can use the above example (chemical reaction of hydrogen and oxygen to produce water) to describe about chemical equation.

A chemical equation (or balanced chemical equation) shows formulas of reactants, then an arrow, and then the formulas of products, with equal numbers of atoms of each element at the left and right of the arrow.

In short, the representation of a chemical reaction with symbols and formulas of the substances is known as a chemical equation.

You need to explain how to write the chemical equation using examples given in the students' text.

Chemical reaction → Word equation → Chemical equation

It is advisable to use illustrations and drawings as shown in the students text so as to make clear for the students at this age level.

Discuss also the steps in writing simple chemical equation using example. Remind them that the law of conservation of mass is the basis to writing chemical equation for a chemical reaction.

Here you can draw a table with some information on the blackboard as shown below and call upon one student to complete it. Allow the rest of the class to comment. Finally give them the correct answers.

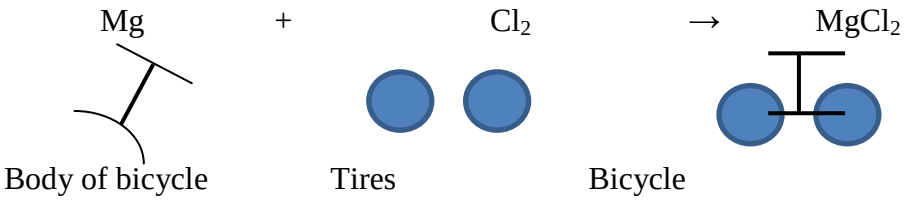
Complete the following table for the chemical reaction of sodium and chlorine to form sodium chloride.

Form of equation	Chemical equation
Word equation	
Symbols and formulas	
Unbalanced chemical equation	
Balanced chemical equation	

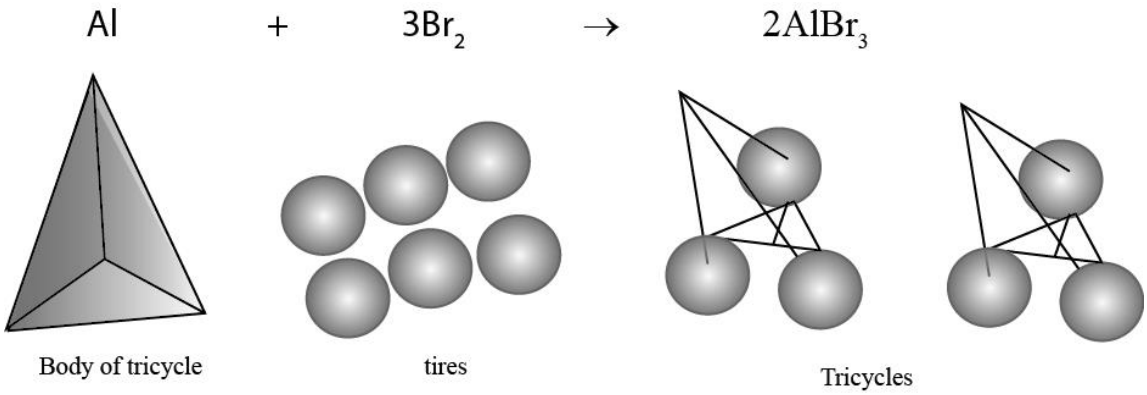
Balancing chemical equation

You may start this lesson with **Activity 3.9**. This activity is designed to understand how to balance chemical equation. Let them discuss the activity for a few minutes in groups. Allow them to share their ideas to the class through their representatives after their discussion. Then harmonize their discussion as follows:

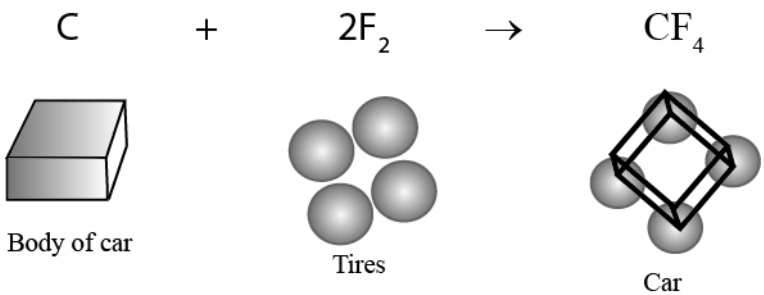
Magnesium combines with two chlorines to be a compound like a bicycle needs two tires to be a complete bicycle.



Aluminium combines with three bromines to be a compound like a tricycle needs three tires to be a complete tricycle. Since we can buy only in pair, we have to buy 6 tires (**3 pairs**) to make **two tricycles**. These correspond with the coefficient 3 and 2 for Br_2 and $AlBr_3$ respectively.



Carbon combines with four fluorine's to be a compound like a car needs four tires to be a complete car. Therefore, we need to buy 4 tires (2 **pairs**). i.e coefficient 2 in front of F_2.



After activity 3.9, continue with methods of balancing simple chemical equations. Explain the rules for balancing chemical equations using inspection and least common multiple (LCM) methods. Try to use several examples. During your explanation, encourage students' participation. Note that equations cannot be balanced by changing or adjusting the subscript of the elements or compounds. You have to show the following example to conform this concept.

To balance $H_2 + O_2 \rightarrow H_2O$ you may write a subscript 2 under the O atom in H_2O and make H_2O_2.

$$H_2 \quad + \quad O_2 \quad \rightarrow \quad H_2O_2$$

This equation is balanced. However, H_2O_2 is a compound known as hydrogen perioxide, which is not the same as water, H_2O.

Finally give **Exercise 3.6** as homework.

Assessment

Asses each student's work throughout section 3.4. this can be done by preparing a performance sheet and recording the performance of every student. You can make records based on the student's performance in:

- discussing and presenting their views on **Activities 3.8** and **3.9.**
- answering the questions you raised during the lessons.
- answering the questions in **Exercise 3.6.**
- conducting **Experiment 3.1.**

Supplementary questions

1. Balance the following chemical equations (you can use either inspection or LCM method).
   a. $N_2 + H_2 \rightarrow NH_3$
   b. $Al + Cl_2 \rightarrow AlCl_3$
   c. $Mg + HCl \rightarrow MgCl_2 + H_2$

Answers to supplementary questions

1. a. $N_2 + 3H_2 \rightarrow 2NH_3$ b. $2Al + 3Cl_2 \rightarrow 2AlCl_3$
   c. $Mg + 2HCl \rightarrow MgCl_2 + H_2$

Answers to Exercise 3.6

1. An atom of carbon reacts with one molecule of oxygen to produce one molecule of carbon dioxide.
2. a. $S + O_2 \rightarrow SO_2$
   b. $Fe + S \rightarrow FeS$
3. a. $H_2 + Cu_2O \rightarrow 2Cu + H_2O$ b. $2KClO_3 \rightarrow 2KCl + 3O_2$
   c. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$ d. $Mg + 2HCl \rightarrow MgCl_2 + H_2$
4. Law of conservation of mass states that "mass can be neither created nor destroyed".

Answers to Review exercise

Part I

1. True 3. True 5. True
2. False 4. False

Part II

6. B 8. D 10. C 12. D 14. C
7. B 9. B 11. C 13. C 15. D

Part III

16. a. Na_3PO_4 c. SO_3
    b. MgI_2 d. CuO
17. a. Magnesium hydride b. Barium sulphate
    c. Aluminium oxide d. Nitrogen monoxide
18. a. $2Al + 3I_2 \rightarrow 2AlI_3$
    b. $4Na + O_2 \rightarrow 2Na_2O$
    c. $2K + 2H_2O \rightarrow 2KOH + H_2$

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UNIT 4 THE STRUCTURE OF SUBSTANCES

Number of periods allotted: 15 periods

Unit overview

This unit deals with the structure of substances. It is an abstract concept because it requires convincing students about the presence of extremely small particles which millions of them collected together cannot even be seen by our naked eye.

The first section (4.1) discusses historical development of the atomic nature of substances by comparing and contrasting the discreteness and continuity theory of matter. In this section, one experiment is designed to be conducted in order to show discreteness of matter.

In section 4.2 Dalton's and modern atomic theories are presented. The short comings of Dalton's atomic theory are also described here. Due to the scope of grade 7 chemistry curriculum details of the modern atomic theory are not discussed here.

Section 4.3 describes the structure of the atom. It explains first about the two parts of an atom and the three subatomic particles. Next some elements (terms) of the modern atomic theory like atomic number, mass number, isotope, atomic mass, energy level, electronic configuration, valence electron and ion are discussed.

The last section 4.4 discusses about molecules. It gives emphasis to differentiate molecules of elements from molecules of compounds.

Question and answer, group discussion, presentation, gapped lecture, and brainstorming are methods of teaching used in this unit.

Unit outcomes

After completing this unit, 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, and asking questions.*

Main Contents

4.1 HISTORICAL DEVELOPMENT OF THE ATOMIC NATURE OF SUBSTANCES

Periods allotted: 1 period

Competencies

After completing this section, 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.*

Forward planning

Read about historical development of the atomic nature of substances from the student's text and other reference books. Design a plan to cover the content of the section within one period. In your plan, show the time allotted for group discussion on the activities, presentation, for harmonizing concepts, for experiments and other activities. Try out the experiment before the lesson by yourself. Prepare yourself on the activities and exercise.

Teaching aids

- Chart that shows comparison between the discreteness and continuity theory of matter.

Subject matter presentation

It is advisable to use question and answer, group discussion, and presentation as methods of teaching.

You may start this lesson with the start-up activity. The activity is designed to brainstorm students on continuous or discrete nature of substances. Let them discuss this activity in groups for a few minutes and let some students from different groups present the group ideas to the class. After their presentations, harmonize concepts as follows:

1. Individual grains of teff or sorghum, wheat or corn can be seen with our naked eye.
2. All of them are made up of small particles, in much the same way as a house is made up of individual bricks.
3. Teff or sorghum looks like continuous when viewed from about 3 meters far.
4. Water looks continuous when it is gently poured to the ground from a jug.
5. A sheet of paper is considered as collection of particles.

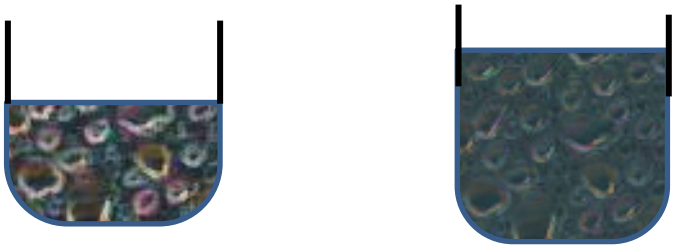
Then, continue on dealing with the thoughts of ancient Greek philosophers (Aristotle and Democritus) on nature of matter. Describe their thoughts and give for students activity 4.1. This activity is designed for students to forward their ideas on the two thoughts (continuous and discrete nature of matter). Let them discuss in groups for a few minutes. Invite two students from two groups to debate their ideas. After their debate harmonize as follows:

Tell students the invisibility of particles to the naked eye and that is why we perceive materials as continuous. Explain that even scientists themselves did not understand about particles until quite recently. They had been work for 2000 years before the idea of atoms was accepted in the early 19^{th} century.

Like students who debate on the two different ideas mentioned in activity 4.1, for many centuries there were two different theories about the nature of matter. Some people believed that matter is continuous, that is, the same all through without any spaces. Others held that matter is discrete or particulate – that is, made up of tiny pieces or particles with spaces in between them.

Next to activity 4.1, let students do experiment 4.1 in groups. The experiment is used as evidence for the discrete nature of matter. Tell them to do the experiment carefully and record their observations. After they do the experiment, allow them to answer the questions. Make sure that they respond the questions as follows:

1. You see the potassium permanganate slowly dissolves until the whole solution is purple.
2. Even if the purple color fades out by adding more water, potassium permanganate does not disappear. This means as a solution is diluted, the particles spread throughout the whole of the volume.
3. The chemical nature of potassium permanganate does not change after dilution.



5 mL 20 mL

Figure 5.1 Dilution of potassium permanganate solution.

Finally give exercise 4.1 as homework.

Assessment

Assess each student's work throughout section 4.1. Watch carefully how every student is involved in discussing the start up activity and activity 4.1 in his/her groups, present ideas after discussion, answer questions raised during the gapped lecture and answer exercise 4.1.

Based on your evaluation make sure that the suggested competencies for section 4.1 are achieved by most of the students. Appreciate students who are working above the minimum requirement level and encourage them to continue working hard. For students working below the minimum requirement level, give them additional exercises to help them catch up with the rest of the class.

Supplementary Activity

Do you think, is there a smallest possible piece of matter?

To find out, you might tear a sheet of aluminium foil into half, and then tear the halves into quarters and tear the quarters into eighths. Do you think you could tear the aluminium foil forever, always producing smaller and smaller pieces?

Answers to supplementary Activity

Ultimately we reach at a point where we could not tear the aluminium foil. Hence aluminium foil is composed of extremely small particles called atoms, as are all other elements.

Answers to Exercise 4.1

1. Democritus suggested that everything in the world was made up of small indestructible particles called atoms. The word atom was derived from the Greek word 'atomos' meaning indivisible.
2. A substance is continuous means it could be divided endlessly into smaller pieces.
3. Dalton's theory led to the concept of atom.

4.2 ATOMIC THEORY

Number of Periods allotted: 2 periods

Competencies

After completing this section, students will be able to:

- *state Dalton's atomic theory;*
- *describe the shortcomings of Dalton's atomic theory;*
- *state modern atomic theory.*

Forward Planning

Read about atomic theory thoroughly from the student's text and other reference books. Make a plan of your own on how to manage students during discussion, presentation and assessment. In your plan show the time allotted for each activity and exercise. Prepare yourself on the activities and exercises before the class.

Subject Matter presentation

It is advisable to use group discussion, gapped lecture, and presentation as methods of teaching.

It is not easy to invite students to the discussion regarding the atomic theory. This is because; it is an abstract concept at this grade level.

The teacher could just explain the historical development of atomic theory after Greek philosophers. Tell them that John Dalton who supports the atomists' theory forms the major turning point about the concept of the nature of matter. His atomic theory was also based on experimental findings.

Next discuss about Dalton's atomic theory. Then give **Activity 4.2**. The activity is designed to enable students illustrate Dalton's atomic theory. Let them discuss this activity in groups for a few minutes. Invite two or three students from different groups to present their opinion to the rest of the class. Following their presentation, harmonize concepts.

1. Dalton's atomic theory held that in any chemical reaction atoms could change patterns (shown in figure in the students text), but the total number of atoms in the reactants and products would be the same.
2. Two atoms of hydrogen are required for one atom of oxygen to form water. This is the law of constant composition which explained by Dalton in his postulate number 6.

Then explain the short comings of Dalton's atomic theory. However you have to mention that Dalton's atomic theory is considered as the basis for the modern atomic theory.

Continue to give **Activity 4.3** to strengthen understanding of students on the short comings of Dalton's atomic theory. You also harmonize concepts as follows after their presentation.

1. All atoms of oxygen do not have the same mass. The element oxygen has three isotopes with atomic masses 16, 17 and 18. The discovery of isotopes disproved that atoms of the same element are different.
2. Oxygen atom can be broken down into simpler particles.

Finally give them **Activity 4.4.** The activity is designed to enable students discuss some statements of modern atomic theory. Let them discuss this activity for a few minutes. Invite two students from different groups to present their ideas to the rest of the class. Following their presentation, harmonize concepts as follows:

1. Copper atom is divisible. The small particles in copper atom are electrons, protons and neutrons.
2. No other element that contains 13 protons like aluminium

Continue your lesson by describing modern atomic theory. Give emphasize on the two wrong statements made by Dalton's atomic theory and corrected by modern atomic theory.

At the end of the lesson give exercise 4.2 as a homework.

Assessment

You can assess each students work on this section by asking them to state Dalton's atomic theory, modern atomic theory and the difference between the two theories.

The assessment can also be based on your observation of how every student is involved in discussing and presenting activity 4.2 to 4.4, and answering exercise 4.2.

From what you observe, make sure that the suggested competencies are achieved by students. Appreciate those students who are working above the minimum requirement. Give special support for those who are working below the minimum requirement.

Answers to Exercise 4.2

1. The main ideas of Dalton's Atomic theory are:
   - Matter is composed of a large number of atoms, which are small particles that cannot be created or destroyed or divided.
   - All atoms of an element are identical in every way.
   - Chemical combination takes place between small whole number of atoms of the elements concerned.

2. The shortcomings of Dalton's atomic theory are:
   - Atoms are indivisible
   - Atoms of the same element are identical
3. Mass
4. Electron, proton and neutron
5. Masses.

4.3 THE STRUCTURE OF THE ATOM

Number of periods Allotted: 10

Competencies

After completing this section, students will be able to:

- *describe the atomic nucleus and electronic shell as the two parts of an atom;*
- *define atomic number and mass number;*
- *calculate the number of protons, electrons and neutrons from atomic number and mass number;*
- *define isotopes;*
- *give isotopes of hydrogen, chlorine and carbon as examples of isotopes;*
- *define atomic mass;*
- *define energy levels (atomic shells);*
- *represent energy levels (atomic shells) by letters and numbers;*
- *describe the maximum number of electrons each energy level (atomic shell) can accommodate;*
- *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;*
- *define valence electrons;*
- *determine the number of valence electrons of the first 18 elements;*
- *define ion;*
- *give examples of positive and negative ions.*

Forward planning

Take enough time to prepare for this section. Read the contents on the structure of the atom from the student's text and other reference books to grasp the subject matter. Make a plan of your own on how to manage students during group discussion, presentation and assessment. In your plan show the time allotted for each activity and exercise. Prepare charts that show the diagrammatic representation of atoms. Prepare also a chart that shows the nature and location of sub-atomic particles.

You are advised to read this guide before the lessons to get more information about the activities and the methodologies you follow.

Teaching aids

- Chart that shows
  i. the diagrammatic representation of the atom (Figure 4.3)
  ii. the diagrammatic representation of the electron configuration of elements (Table 4.5).
- A table chart that sows nature and location of subatomic particles (Table 4.1)
- Periodic table.

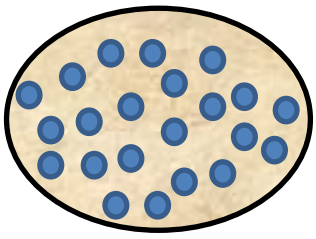
Subject matter presentation

You are advised to use group discussion, question-and-answer, and gapped lecture as methods of teaching.

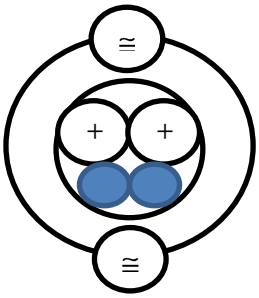
The subatomic particles

You can start this topic by asking students to tell three fundamental subatomic particles. Then let the students discuss Activity 4.5 in groups. This activity brainstorms that how can subatomic particles arranged in atom. After they discuss for a few minutes invite some of the groups to present their opinions to the class. Then harmonize concepts as follows:

1. In orange and many other fruits their seeds are dispersed in the soft matter as shown below.



2. In helium atom the two protons and two neutrons are located at the center of the atom, in the nucleus whereas the two electrons are revolving around the nucleus.



After activity 4.5, describe the structure of atoms. First describe the two regions (atomic nucleus and atomic shell) of an atom diagrammatically and then discuss the location, charge and relative mass of sub-atomic particles. Give emphasis to 'relative mass' and explain why it is introduced to describe the mass of subatomic particles and its difference from actual mass of subatomic particles.

Here you are also advised to give Activity 4.6. This activity helps students to practically observe the presence of charge on electron. Let them do this activity in groups. After their presentations, harmonize concepts as follows:

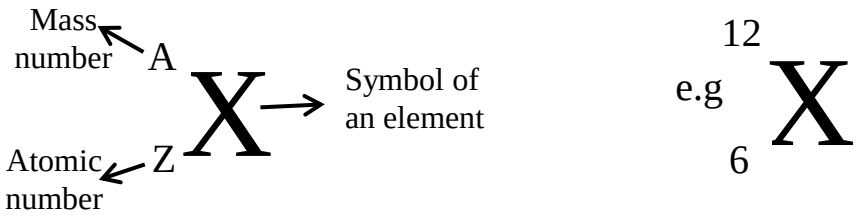
1. The pieces of paper are attracted towards the pen.
2. The attraction between the pen and paper shows that they are oppositely charged
3. Negative and positive charges attract each other

Dear teacher! Let the students have some hint that electrons are transferred from one of the materials to the other during rubbing. Consequently, one of them will be charged negatively because of excess electrons. The other will be positively charged because of electron deficiency.

You can summarize this topic by using the chart (nature and location of subatomic particles) you brought to class or Table 4.1 from the student's text.

Atomic number and mass number

You can start this topic by defining directly 'Atomic number' and 'mass number' and by showing their symbolic notation. Then illustrate how they are written or described with the symbols of elements as shown below.



Make as large as possible as shown above. Because students at the age of this grade level will be attracted and easily understand.

Here you can use the periodic table to show the atomic number and mass number of some elements. However you have to inform them that they will study in detail about periodic table in the next unit (Unit 5).

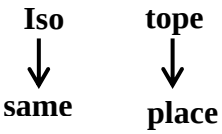
Next show how number of protons, electrons and neutrons are determined (calculated) from atomic number and mass number using examples.

Finally give Exercise 4.3 as a classwork.

Isotopes

You may start presenting this topic by asking students the following questions:

- Do you know the origin of the term "Isotope"? How many words does it consist? What do they mean? After you get responses from students answer as follows. The term isotope is of Greek origin that consists of two words **iso** means **same** and **tope** means **place**. This questioning and answering helps them to define isotope.



Then give them the definition of isotope as atoms of the same element with different masses (or number of neutrons). Next give examples of elements that have isotopes and show how they are designated.

Ask also students why isotopes of an element have the same chemical properties. After you get feedback from students answer as follows. The chemical properties of an element are determined by the electrons and protons in its atoms; neutrons do not take part in chemical reactions. Therefore isotopes of an element with the same number of electrons have similar chemical properties. However, they differ in physical properties such as density.

Atomic mass

You can start this topic lesson by asking the following question.

Are mass number and atomic mass the same? If they are the same how could the atomic mass of chlorine be 35.5?

After you get feedback from some students explain as follows. Since mass number is the sum of protons and neutrons, it could not be fractional like 35.5 which is the atomic mass of chlorine. This is because no half a proton and half a neutron in the nucleus of an atom. Hence mass number is not same as atomic mass.

Next to this introduction, give Activity 4.7. This activity will help students to recognize that the atomic mass is the average of the masses of the isotopes. Let them do this activity in groups. After their presentations, harmonize concepts as follows:

1. Atomic mass of boron (10.8) is greater than the isotopic mass of ^{10}B and less than that of ^{11}B.
2. 10.8 does not represent the mass of any of the isotopes.

Note that Isotopic masses are numerically the same as mass numbers of the isotopes. However, atomic masses are different from mass numbers.

Next to activity 4.7 define atomic mass and explain how to calculate from abundance of atoms of elements by giving examples. Finally give Exercise 4.4 as a classwork.

Energy level

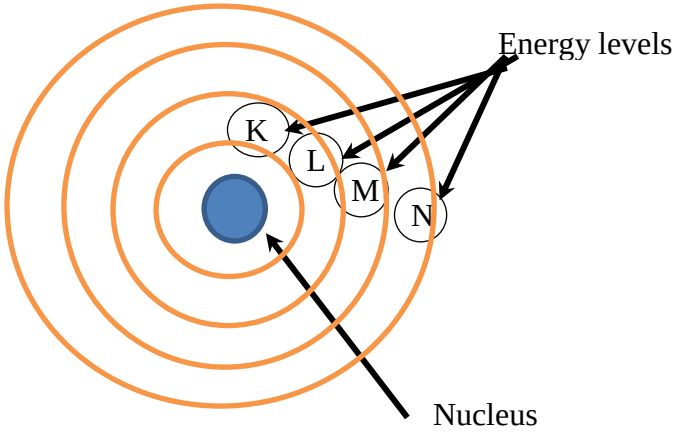
You can start this lesson with Activity 4.8. This activity helps students to know why energies of electrons at different energy levels differ. Let them do in groups. After their presentations harmonize concepts as follows;

i. The block has the highest energy when dropped from a height of 1.5 m.
ii. When the height of the blocks increases their energy increases.

iii. When the block is lifted farther from the ground it will possess higher energy. In a similar way, when an electron is far away from the nucleus it occupies high energy level.

After activity 4.8, give short definition of energy level. Electrons in atoms are arranged around their nuclei in positions known as energy levels (shells). Describe different energy levels which differ by energy. Explain how they are represented by letters and numbers.

You are advised to describe energy levels diagrammatically as shown below. You can use figure 4.4 from the student's textbook.



Electronic configuration

In the presentation of this topic, you should restrict your discussion up to elements of atomic number 18. First define electronic configuration and describe the number of electrons that can be placed in each shell. Next write the electronic configuration of the first 10 elements. Finally give them **Activity 4.9.** This activity helps them to write the electronic configuration of elements whose atomic numbers are 11-18. You can invite students to write their answers on the chalk board. Ask other students whether they agree on the answers given or not and let them correct. Finally give the correct answers as follows:

Element	Atomic number	Electronic configuration
Na	11	2, 8, 1
Mg	12	2, 8, 2
Al	13	2, 8, 3
Si	14	2, 8, 4
P	15	2, 8, 5

S	16	2, 8, 6
Cl	17	2, 8, 7
Ar	18	2, 8, 8

Next to activity 4.9, show them diagrammatic representation for the electronic configuration of the first 6 elements. Use table 4.6 from student's textbook.

Finally give them exercise 4.5 as in homework. You should give also the project work to construct atomic models in group. Tell them the type of materials they can use and give them enough time to do their project.

Valence electrons

In the discussion of valence electrons, the students must not be confused with valence, which they have learnt before. Describe what valence electrons and valence shell are and explain how to determine the number of valence electrons. You can use diagrammatic representation of electronic configuration to describe more clearly. Tell also for students that valence electrons are involved in forming chemical compounds. They will study in grade 8.

Ion

You can start this topic lesson by asking the question given in the student's textbook.

"Atoms normally are electrically neutral. Do you think that they remain neutral after a chemical reaction?"

During chemical reaction, atoms either loss electrons from their valence shell or gain electrons to their valence shell. Hence they don't remain neutral after a chemical reaction.

Define ion, describe how they are formed and list some examples of positive ions and negative ions.

In the discussion of ions you should limit yourself to the ions that come from atoms. It is not necessary to explain ions that come from group of atoms (radicals).

Finally give Exercise 4.6 as a classwork.

Assessment

Assess each student's work throughout section 4.3 and record their performance on a performance sheet. The assessment should be based on your observation of how every student:

- is involved in discussing and presenting activities 4.5 to 4.9.

- answers questions of exercises 4.3, 4.4 and 4.5.
- answers questions you raised during the gapped lecture sessions.

You can use self-assessment and peer assessment where ever necessary.

Appreciate students who are working above the minimum requirement and encourage them to continue working hard. For low achievers, identify their learning difficulties and help them to achieve the minimum requirement.

Supplementary questions

1. What are the atomic numbers and mass numbers of elements whose atoms are made up of

a. 4 protons, 5 neutrons, 4 electrons;

b. 14 protons, 14 neutrons, 14 electrons;

c. 19 protons, 20 neutrons, 19 electrons?

2. How many protons, neutrons, and electrons are there in atoms of the following elements?

a. Boron (atomic number 5, mass number 11)

b. Fluorine (atomic number 9, mass number 19)

c. Argon (atomic number 18, mass number 40)

3. The atomic masses of the two stable isotopes of copper, ^{63}Cu (69%) and ^{65}Cu (31%) are 63 and 65, respectively. Calculate the average atomic mass of copper. The percentages in parenthesis denote the relative abundances.

4. Determine the number of valence electrons for the following elements.

a. $_{12}Mg$ b. $_{16}S$ c. $_{37}Rb$

Answers to supplementary questions

1. a. Atomic number = 4 mass number = 9
   b. Atomic number = 14 mass number = 28
   c. Atomic number = 19 mass number = 39
2. a. 5 protons, 6 neutrons, and 5 electrons
   b. 9 protons, 10 neutrons, and 9 electrons
   c. 18 protons, 22 neutrons, and 18 electrons
3. average atomic mass of Cu is 63.5
4. a. 2 b. 6 c. 1

Answers to Exercise 4.3

1. 17 protons, 17 electrons, and 18 neutrons
2.

Notation of the elements	Number of protons	Number of electrons	Number of neutrons	Z	A
$^{24}_{12}Mg$	12	12	12	12	24
$^{27}_{13}Al$	13	13	14	13	27
$^{31}_{15}P$	15	15	16	15	31
$^{12}_{6}C$	6	6	6	6	12

3. a. 3 b. 5 c. 9 d. 20

Answers to Exercise 4.4

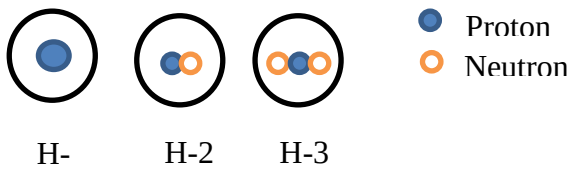
1. i. There are 3 different elements.
   a. B is one element
   b. A and C are atoms of the same element (2^{nd} element)
   c. D and E are atoms of the same element (3^{rd} element)

   ii. A and C are isotopes of element 1, D and E are isotopes of element 2.

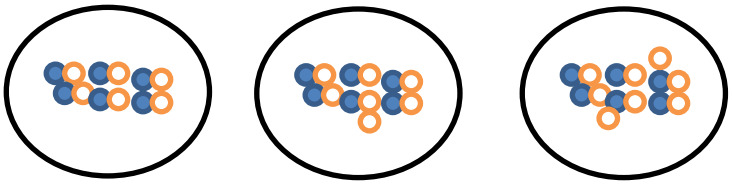
2. i. H-1 or H, H-2 or ^{2}H and H-3 or ^{3}H

Isotopes	Number of protons	Number of neutrons	Number of electrons
H-1 or ^{1}H	1	0	1
H-2 or ^{2}H	1	1	1
H-3 or ^{3}H	1	2	1

3. i. For Hydrogen 1



ii. For carbon

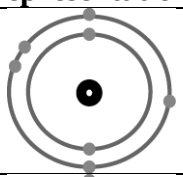
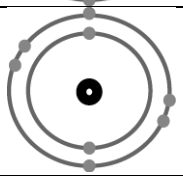
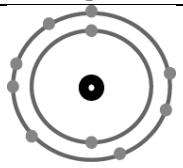
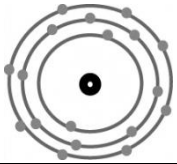
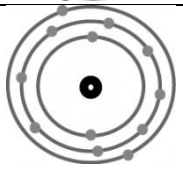
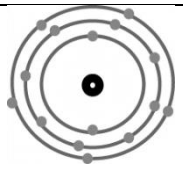


C-12 C-13 C-14

4. Atomic mass of B = $\left(10 \times \frac{20}{100}\right) + \left(11 \times \frac{80}{100}\right)$

= 2 + 8.8= 10.8

Answers to Exercise 4.5

Elements	Atomic number	Electronic configuration	Diagrammatic representation
N	7	2, 5	
O	8	2, 6	
Ne	10	2, 8	
$^{36}_{18}Ar$	18	2, 8, 8	
$^{24}_{12}Mg$	12	2, 8, 2	
$^{31}_{15}P$	15	2, 8, 5	

Answers to Exercise 4.6

1.

Atoms	Number of electrons		Valence electrons		Atoms	Number of electrons	Valence electrons
H	1		1		Ne	10	8
He	2		2		Na	11	1
Li	3		1		Mg	12	2
Be	4		2		Ap	13	3
B	5		3		Si	14	4
C	6		4		P	15	5
N	7		5		S	16	6
O	8		6		Cl	17	7
F	9		7		Ar	18	8

2. i. 10 electrons
   ii. 10 electrons
   iii. 10 electrons
3. An atom is electrically neutral. This is because the number of protons and electrons are equals in the atom. But an ion is not neutral because the number of protons and electrons are not equal.

4.4 MOLECULES

Periods allotted: 2 period

Competencies

After completing this section, students will be able to:

- *define molecules;*
- *give examples of monoatomic, diatomic and polyatomic molecules;*
- *differentiate molecules of elements from molecules of compounds.*

Forward planning

Prior reading about molecules from the student's text and other reference books is very useful for the teacher. This section contains one exercise only. Do it before the lesson

and check the answers from this guide. Prepare charts that show diagramatically monoatomic, diatomic and polyatomic molecules. Make a plan of your own how to manage this lesson. In your plan show the time allotted for your presentation and exercise given to students.

Teaching Aids

- Charts that show diagramatically mono-atomic, diatomic and polyatomic molecules.

Subject matter presentation

To teach the contents in this section, it is advisable to use brainstorming, question and answer, and presentation as methods of teaching.

You may start this section by asking students the following question:

"What is the difference between atom and molecule?"

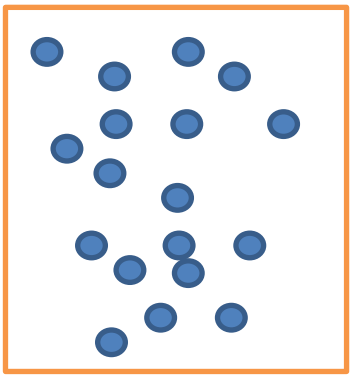
After you get feedback from some students let us remind what they have learnt in section 4.1 and 4.2 about atoms.

An atom is the smallest individual particle of an element and does not exist freely in nature. However, a molecule can exist freely in nature.

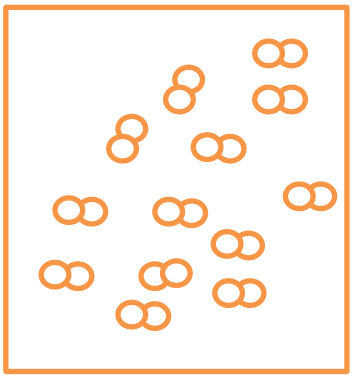
Next define molecule as the smallest particle of an element or a compound that can exist freely in nature.

Molecules of elements

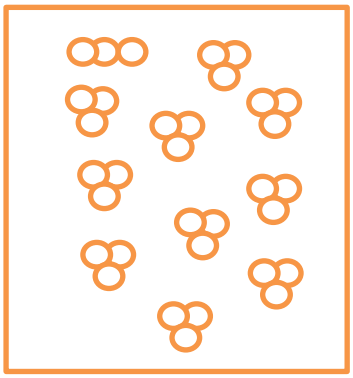
Explain about molecules of elements by giving examples of monoatomic, diatomic and polyatomic molecules. Here it is advisable to use the diagrams of monatomic, diatomic and polyatomic molecules that you brought to the class.



Argon (Ar)
Monoatomic
molecule



Hydrogen (H_2)
Diatomic
molecule



Ozone (O_3)
Polyatomic
molecule

Molecules of compounds

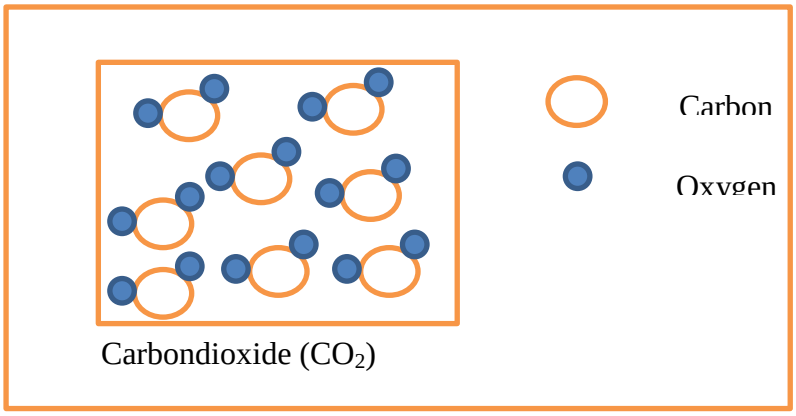
You can start this lesson with Activity 4.10. It is designed to enable students so as to differentiate molecules of compounds and molecules of elements. After the students group presentation harmonize concepts as follows.

1. HCl
2. 

H Cl HCl

3. In molecules of compounds, these are atoms of different elements, whereas in molecules of elements, there are atoms of same element.

Then explain about molecules of compounds by giving examples. You can use also the diagram of molecules of compounds here.



You can ask students orally to tell some examples of monoatomic, diatomic and polyatomic molecules. You also make sure that the students differentiate between the molecules of elements and the molecules of compounds by asking them orally.

Finally give them exercise 4.6 as a homework.

At the end of the unit give them a project work written in the student's text. Brief them on the type of improvised materials they can use to construct atomic models. Give them enough days for their project to do and submit.

Assessment

Assess each student's work by observing how a student is involved in answering questions raised during presentation. Your assessment should be based also on their trial to do questions given in Exercise 4.7.

The project work evaluation should be for the whole unit.

Appreciate students working above the minimum requirement and encourage them to continue working hard. For low achievers, identify their learning difficulties and help them to achieve the minimum requirement.

Supplementary questions

1. Classify the following molecules as molecules of elements or molecules of compounds.

a.	Ne	d.	O_2	g.	PCl_5	j.	Kr
b.	BF_3	e.	CH_4	h.	SF_6	k.	HI
c.	SO_2	f.	P_4	i.	Br_2	l.	H_2

2. Classify the molecules of elements from question number 1 as monoatomic, diatomic or polyatomic molecules.

Answers to supplementary questions

1. Molecules of elements

a.	Ne	i.	Br_2				
d.	O_2	j.	Kr				
f.	P_4	l.	H_2				

Molecules of compounds

b.	BF_3	g.	PCl_5
c.	SO_2	h.	SF_6
e.	CH_4	K.	HI

2.

Monoatomic Molecules	Diatomic molecules	Polyatomic molecule
a. Ne	i. Br_2	f. P_4
j. Kr	l. H_2	

Answers to Exercise 4.7

1. A molecule is the smallest particle of an element or a compound that can exist freely in nature.
2. i. a. Argon element
   b. Carbon and oxygen elements
   c. Nitrogen elements
   d. Carbon and chlorine elements
   e. Sulphur elements

   ii.

Monoatomic Molecule	Diatomic molecule	Polyatomic molecule
Ar	N_2	S_8, CO_2, CCl_4

   iii.

Molecules of elements	Molecules of compounds
Ar	CO_2
N_2	CCl_4
S_8	

3. H is the hydrogen atom that does not exist freely in nature. H_2 is a molecule that can exist freely in nature.

Answers to unit Review exercises

I.

1.	A	5.	A	9.	D
2.	B	6.	B	10.	B
3.	C	7.	C	11.	B
4.	C	8.	A		

II.

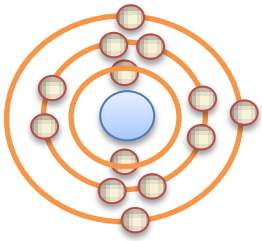
12. Democritus
13. Protons
14. 15, 16, 15
15. 18
16. Compounds
17. A. 2 B. 10, 8 C. 2, 1 D. 6 hydrogen atoms

III.

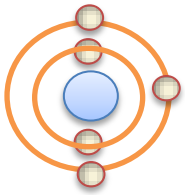
18. Atoms can be broken down into subatomic particles. During modern atomic theory, subatomic particles were discovered.
19. Atomic nucleus and atomic shell
20. Proton, electron and neutron
21. Proton and neutron
22. Mass number is the sum of number of neutrons and number of protons. But atomic mass is the average mass of the isotopes of the element.
23.

Z	A	Number of neutron	Number of proton
7	14	7	7
15	31	16	15
13	27	14	13

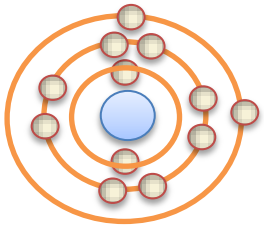
24. Isotopes are atoms of the same element with different masses (number of neutrons)
25. Oxygen element has three isotopes
    O-16, O-17 and O-18
    Nitrogen element has two isotopes
    N-14, and N-15
26. a. $_{13}Al$ 2, 8, 3



b. $_{5}B$ 2, 3



c. $_{12}Mg$ 2, 8, 2



27. a. $^{23}_{11}Na$ 2, 8, 1
    b. $^{28}_{14}Si$ 2, 8, 4
    c. $^{35}_{17}Cl$ 2, 8, 7

28. a. 2 b. 7 c. 6

29. H_2, O_2, N_2, F_2, Cl_2, Br_2, I_2

30. He, Ne, Ar, Kr

31. A. An atom is electrically neutral but an ion is not electrically neutral.

    B. An atom does not exist freely in nature, whereas a molecule can exist freely in nature.

    C. A molecule that consists of same type of elements is known as molecule of element.

    A molecule that consists of two or more different types of elements is known as molecule of compound.

    D. **Monoatomic** molecules are molecules that contain **one** atom of the element.

    Diatomic molecules are molecules that contain **two** atoms of the element.

    Polyatomic molecules are molecules that contain **three** or **more** atoms of the element.

References

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UNIT 5 PERIODIC CLASSIFICATION OF THE ELEMENTS

Number of periods allotted: 11 periods

Unit overview

This unit deals with periodic classification of the elements. The unit consists of four sections. The first section (5.1) narrates historical development of periodic classification of the elements by describing the two scientists (Dobernier and Newlands) attempts.

Next Mendeleev's periodic classification is described in section 5.2. In this section periodicity is described; Mendeleev's periodic law is stated, and Mendeleev's contributions and short comings on periodic classifications are discussed.

Section 5.3 presents modern periodic table through modern periodic law. It gives more emphasis for the structure of the periodic table; period and group concepts are explained, the relationship between the electronic configuration and arrangement of elements is described and the trend of some periodic properties are discussed.

Finally the importance of modern periodic table is discussed in section 5.4 .

To present this lessons in this unit group discussion, presentation, gapped lecture, concept mapping, question and answer, and visual based active learning are suggested as methods of teaching.

Unit outcomes

After completing this unit, students will be able to:

- *narrate the historical development of periodic classification of elements;*
- *state Mendeleev's periodic law, discuss the contribution 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.*

Main Contents

5.1 HISTORICAL DEVELOPMENT OF THE PERIODIC CLASSIFICATION OF THE ELEMENTS

Periods allotted: 1 period

Competencies

After completing this section, students will be able to:

- *narrate the historical development of periodic classification of elements.*

Forward planning

Prior reading about historical development of periodic classification of the elements from the student's text book and other reference books is worthwhile. Prepare the chart of Newland's periodic table. Design a plan to cover the content of this section within one period. In your plan show the time allotted for every activities you and students perform during the period.

Teaching Aid

- Chart of Newland's periodic table.

Subject matter presentation

It is advisable to use group discussion, presentation, gapped lecture as methods of teaching in this section.

You can start this unit with start-up activity. This activity helps to see the concept of regularity in a given classification. After students discuss in group for a new minutes, invite one or two students to present their ideas. Following their presentation harmonize concepts.

There are 365 days which are classified in a week and month.

1. There are 7 days in a week
2. There are 30 days in a month
3. Each season contains 3 months. These 3 months of each reason have similar weather conditions. For example, in a winter reason; June, July and August months are rainy months.

Note for (teacher)

When a great many new things are discovered there is a lot of new information to be remembered. Hence to remember things easily classifying them into groups is very important. Before the middle of the eighteenth century very few elements were known. A system for classifying them was not really necessary. But as chemistry became more scientific and new elements were discovered almost, every year, Chemistry needed to find a way of dividing them into groups.

Next, narrate **law of triads** and **law of octaves** using examples. Tell them that the atomic mass is a basic property in grouping of elements according to Doberneir and Newland's. The short comings of the two laws should also be discussed.

Finally give them exercise 5.1 as a classwork.

Assessment

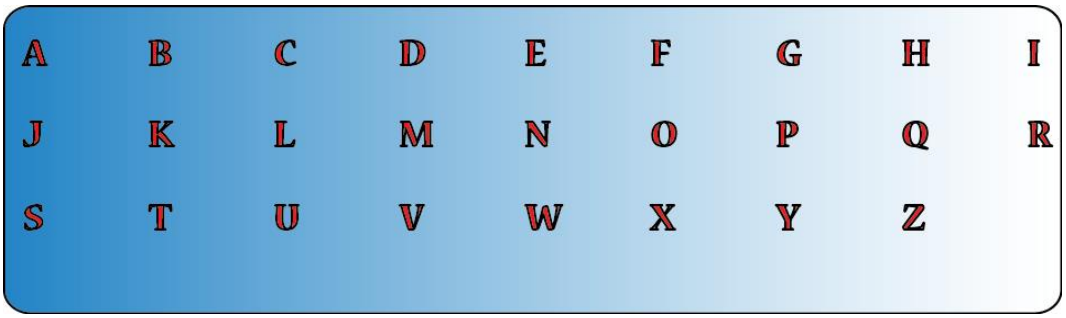
The assessment can be based on your observation of how every student:

- is involved in discussing Start-up Activity
- participates in presenting the idea of the group
- answers questions of Exercises 5.1

Record their performance and check whether the suggested competency for section 5.1 is achieved by most of the students or not. Appreciate those students who are working above the minimum requirement level. For those who are working below the minimum requirement level arrange additional lesson time.

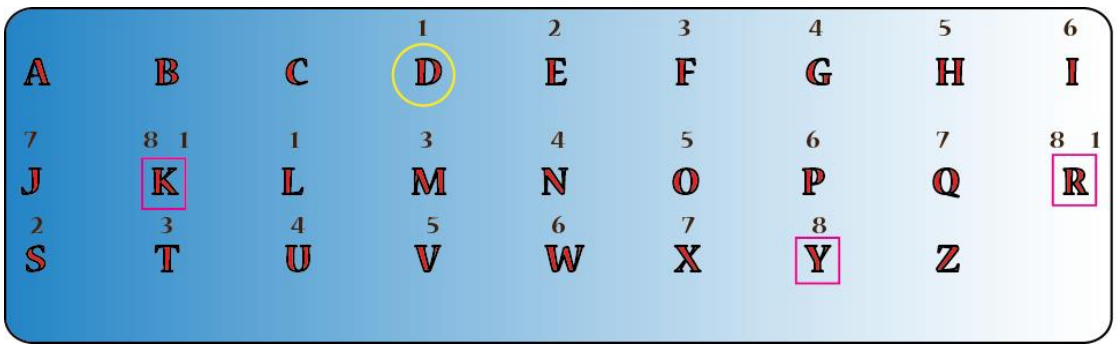
Supplementary Questions

You are given the following elements A to Z arranged in increasing atomic mass.



Which elements do you think have similar properties with element D based on law of octaves.

Answers to supplementary questions



Elements K, R and Y have similar properties with element D because the eighth element after a given one element has similar properties to the first one according to the law of octaves.

Answers to Exercise 5.1

1. Atomic mass of Br = $\frac{35.5+127}{2} = 81.3$
2. The elements which have similar properties with
   i. beryllium are magnesium and calcium
   ii. carbon is silicon
   iii. sodium are lithium and potassium.

5.2 MENDELEEV'S PERIODIC CLASSIFICATION

Periods allotted: 2 periods

Competencies

After completing this section, students will be able to:

- *describe periodicity;*
- *state Mendleev's periodic law; and*
- *discuss the contribution and short-comings of Mendeleev's periodic classification of elements.*

Forward Planning

Read the contents on Mendeleev's periodic classification from the student's text and other reference books. Prepare the chart of Mendeleev's periodic table. Design a plan on how to manage students during discussion, presentation and assessment. In your plant show the time for each activity. Prepare yourself on the activity and exercise that are going to be given for students.

Teaching aid

- **Chart of Mendeleev's periodic table**

Subject Matter presentation

It is advisable to use group discussion, presentation and gapped lecture as methods of teaching in this section. You are advised to start this section lesson with Activity 5.1 This activity will help students to explore Mendeleev's periodic classification. So let the students discuss this activity for a few minutes in group and present their ideas to the class. After their presentations harmonize concepts as follows:

1. Periodic mean a regular repeated pattern.
2. A certain day comes (appears) every seven days. For example **Sunday** comes every 7 days.
   See the following table that shows 30 days in a month.

Sunday	Monday	Tuesday	Wednsday	Thusday	Friday	Satureday
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

As we observed from the table, Sunday comes at the 1^{st}, 8^{th}, 15^{th}, 22^{nd}, and 29^{th}, days of a month. This is the periodicity of days.

3. Seasons like summer, winter, autumn and spring show periodicity. For example, the rainy season in Ethiopia comes every year for three months (June, July and August) which is summer.

After doing activity 5.1 state Mendeleev's periodic law and show how periodicity among the elements occurred, using examples. Explain that Mendeleev's periodic table is an advanced and improved table than the previous ones. You should also describe the genius work of Mendeleev which he left gaps for the undiscovered elements and name the elements and place them in the right position in the periodic table.

Thus, the main achievements of Mendeleev's is that he

- grouped the elements more accurately based on their properties
- made bold prediction of the existence of undiscovered elements and left gaps for them in his periodic table.

You may show students the predicted and observed properties of Gallium (Eka-Aluminum) as shown below. Explain how predicted and observed properties and compounds are very close.

Properties	Eka-Aluminum (Ea)	Gallium (Ga)
Atomic mass	68	69.9
Melting point	Low	29.78 ^{0}c
Density	5.9 g/cm^3	5.94 g/cm^3
Formula of oxide	Ea_2O_3	Ga_2O_3

Next elaborate some of the shortcomings of Mendeleev's periodic classification by giving examples mentioned in the textbook.

Finally give exercise 5.2 as a homework.

Assessment

You should assess each student's work based on your observation of how every student:

- is involved in discussing activity 5.1
- participated in presenting their idea of the group
- answers questions of Exercise 5.2

Record their performance and check whether the suggested competencies for section 5.2 all achieved by most students or not. Students who are working above the minimum requirement should be praised and their achievements recognized. They should be encouraged to continue working hard and not become complacent. Students who are working below the minimum requirement should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Supplementary questions

1. How did Mendeleev organize the elements into the periodic table?
2. What important relationship did Mendeleev observe between elements in a given group?

Answers to Supplementary questions

1. Mendeleev arranged the elements according to increased atomic mass.
2. Elements in a given group exhibit similar physical and chemical properties.

Answers to Exercise 5.2

1. Mendeleev's periodic law states that "the properties of elements are periodic functions of their atomic masses".

2. i. Newlands table could not work for elements beyond calcium. But Mendeleev's table included all the elements known by his time.

   ii. Mendeleev left vacant space for the elements that were not discovered during his time.

   iii. Mendeleev developed the concept of periodicity of properties of elements by formulating a law known as Mendeleev's periodic law.

3. i. Most of the elements obey Mendeleev's periodic law. That is, elements are grouped more accurately based on their properties.

ii. Mendeleev's periodic table left vacant space for that were not discovered during Mendeleev's time. This initiated chemists to search for the missing elements.

4. The short-comings of Mendeleev's periodic table were:

i. Some elements arranged in a wrong order in his periodic table. That is an element of higher atomic mass was placed before an element of lower atomic mass.

ii. He did not give a separate place for isotopes in his periodic table.

5.3 MODERN PERIODIC TABLE

Periods Allotted: 7

Competencies

After completing this, section students will be able to:

- *state modern periodic law;*
- *define period and group;*
- *tell 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 atoms.*
- *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 groups of the elements in the periodic table;*
- *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 un-metallic character of elements down the group.*

Forward planning

Read thoroughly the content of modern periodic table from the student's text and other reference books. Since this section contains four activities (Activity 5.2, 5.3, 5.4 and 5.5) and three exercises (exercise 5.3, 5.4 and 5.5), it is advisable to read and do these activities and exercises before the class. Plan how to present the contents and how to manage students during discussion, presentation and assessment. You also need to budget your time in accordance with the activities you plan to do during the periods. Prepare a chart of modern periodic table.

Teaching aid

- A chart of modern periodic table.

Subject matter presentation

It is advisable to use group discussion, presentation, gapped lecture, question and answer, and visual based active learning as methods of teaching in this section.

You can start this section by asking students that why do we need the new and modern periodic table. After you get feedback from some students, tell them that chemists made many discoveries that brought about changes in the periodic table.

When you introduce the modern periodic law, remind them Mendeleev's periodic law. Help students to notice the shift in the key property in classifying the elements, i.e Atomic mass to Atomic number.

In general, the periodic law has under gone two principal elaborations since its original formulation by Mendeleev.

i. The first revision involved extending the law to include a whole new family of elements, the existence of which was completely unsuspected in the 19^{th} century. This group comprised the first three of the noble or inert gases: argon, helium, and neon, discovered in the atmosphere between 1894 and 1898.

ii. The second development in the periodic law was the interpretation of the cause of the periodicity of the elements in terms of atomic number.

The modern periodic law is most commonly expressed in the form of a periodic table.

Structure of Modern periodic table

Under this topic, start presenting about periods and groups. Use diagrams of modern periodic table when you explain about the number of elements in each period and the representation of each groups and their common names.

Note that

- Students should be reminded of the work they carried out on electronic configuration (Unit 4) 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.

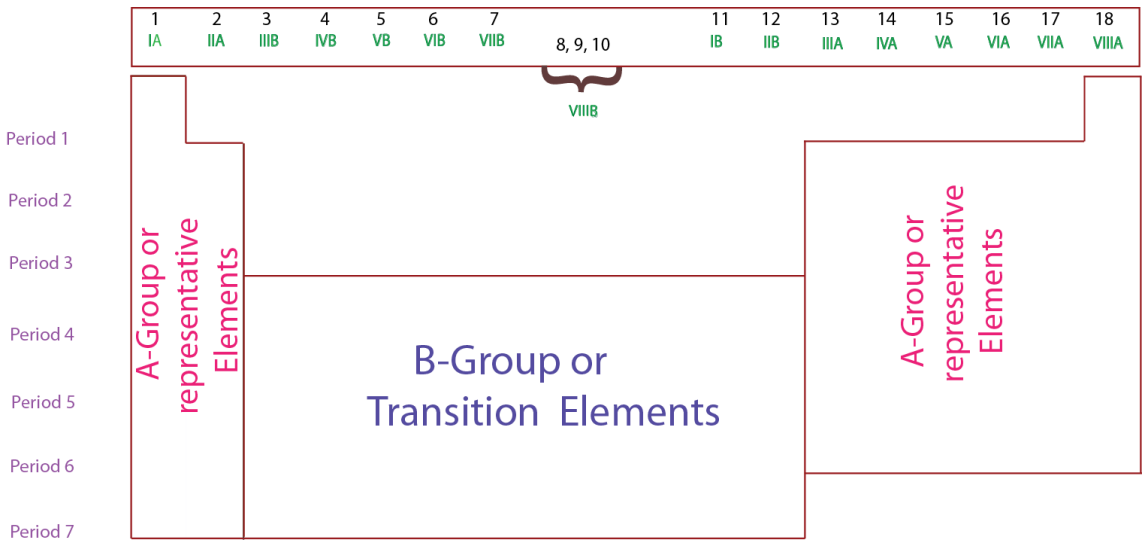
Electronic configuration of helium, neon and argon elements.

$_{2}He$ 2

$_{10}Ne$ 2 , 8

$_{18}Ar$ 2 , 8 , 8

- 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.
- The groups or vertical columns of the periodic table have traditionally been labeled from left to right using Roman numbers followed by the symbol A or B, the A refers to the main group or representative elements and the B refers to the sub-group or transition elements. Another labelling scheme which is gaining popularity simply numbers the groups sequentially from 1 to 18 (Arabic numbers) across the periodic table.



To end this topic give exercise 5.3 as a classwork.

Electronic configuration and arrangement of elements

Start this topic lesson with **Activity 5.2**. Let the students discus this activity in group for a few minutes and present their ideas to the class. After their presentations harmonize concepts as follows:

Elements X and Y are likely to have similar properties because they are found in the same group. Elements found in the same group have similar properties due to the same number of valence numbers.

This tells them that electronic configurations of elements helps to explain the repetition of properties. Next describe the relationship between the electronic configuration and position of the elements in the periodic table by using examples. You should help students to notice the direct relationship between number of shells of an element and its period in the period table. You should also help them to recognize the relationship between the number of valence electrons of an elements and its group number among A-group elements. Don't involve B-group (transition elements) to determine their position in the periodic table.

- The number of shells is equal to the period number of an element.
- The valence electron is equal to the group number of an element.

Before ending this topic lesson give **Activity 5.3**. This activity helps students to compare the electronic configuration of some common elements with their position in the periodic table from the diagram. Let the students discuss this activity in group and show their answers to you. After you correct for some groups, write the correct answers in the blackboard as follows.

i. The elements that have the same number of valence electrons are

1.	H, Li and Na	2.	Be and Mg
3.	B and Al	4.	C and Si
5.	N and P	6.	O and S
7.	F and Cl	8.	He, Ne and Ar

ii. The elements which have the same number of shells are
   1. H and He
   2. Li, Be, B, C, N, O, F and Ne
   3. Na, Mg, Al, Si, P, S, Cl and Ar.

iii. Group IA: H, Li and Na
   Group VA: N and P
   Group VIIA: F and Cl
   Group VIIIA: He, Ne, Ar

iv. Period 1: H and He
   Period 2: Li, Be, B, C, N, O, F and Ne
   Period 3: Na, Mg, Al, Si, P, S, Cl and Ar

v. Group IVA and period 3: Si

Group VIIA: and period 2: F

After activity 5.3, explain classification of elements as metals, non-metals and metalloids and show their general positions in the periodic table.

Finally give them exercise 5.4 as a homework.

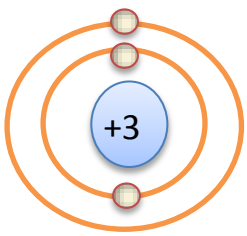
Some periodic properties in the periodic table

Begin this lesson by revising the main points on the relationship of electronic configuration and arrangement of elements. Next introduce about periodic property. There are many periodic properties. But it is limited to threat only three periodic properties, namely: nuclear charge, atomic size and metallic and non-metallic properties. The trends of these properties should be thought only within A-group elements.

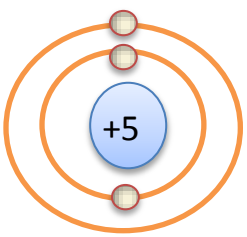
Trends across a period

First discuss these periodic properties trends across a period Describe nuclear charge and show how the nuclear charge increases across a period due to increment of atomic number. Describe atomic size. Before you show trend of atomic size across a period, give them **activity 5.4**. This activity helps students to predict the trend of atomic size across a period. Let the students discuss this activity in group for a few minutes and present their ideas to the class. After their presentations harmonize concepts as follows:

i. The five students attract the two students stronger than the three students. Hence, the two students are easily pulled towards the five students
ii. In a similar way, the two inner electrons are pulled to the boron nucleus as compared to the inner electrons of lithium.



Lithium

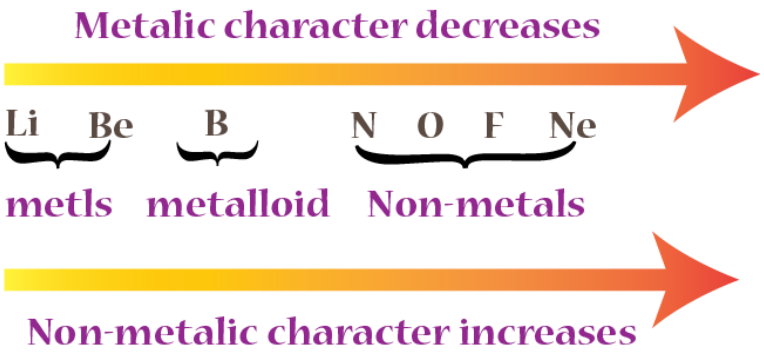


Boron

As a result, lithium is greater in gine than boron.

Next to this activity explain how the atomic size decreases across a period due to the increment of nuclear charge. You can use the diagrams of elements in the same period to describe this trend across a period. It is advisable to use the analogy of activity 5.4 to make this trend clear for students.

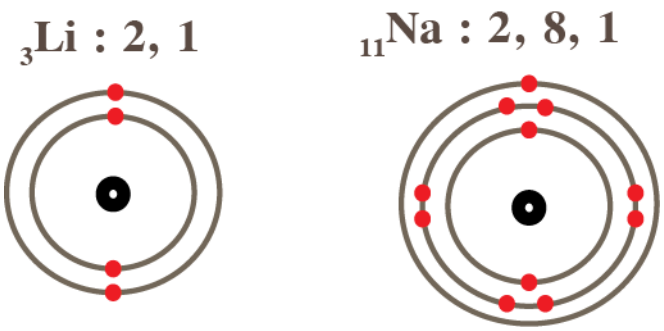
When you explain trends across a period for metallic and non-metallic properties, use periodic table to illustrate clearly. It is advisable to use period 2 elements to show the trends across a period.



Finally give Exercise 5.5 as a classwork.

Trends down a group

First describe how the nuclear charge increases down a group due to increase in the number of protons in the nucleus (atomic number). You can use the diagrams of elements to show this trend down a group. Give **active 5.5** before you describe the trend of atomic size down a group. Let the students discuss this activity in group for a few minutes and present their ides to the class. After their presentations harmonize concepts as follows:



Lithium has two shells but sodium has three shells. Thus sodium is obviously greater in size than lithium. The atomic size is directly related to the number of shells.

Next to this activity explain how the atomic size increases down a group. This is due to the addition of new shells in steps down a group. You can use the diagrams of elements in the same group to describe this trend down a group.

When you explain trends down a group for metallic and non-metallic properties, take Groups IA to IIIA elements to see the metallic trends whereas take groups IVA to VIIA elements to see non-metallic trends.

Finally summarize the periodic trends using the periodic table.

Assessment

Continuous assessment must be done throughout the section. The assessment should be based on your observation of how every student:

- is involved in discussing activities 5.2 to 5.5
- participates in presenting their idea of the group.
- answers questions of exercise 5.3 to 5.5. be sure that all the competencies suggested in this section are achieved by most students. students working above the minimum required level should be praised and their achievements recognized. students working below the minimum requirement level should be given extra attention in class and additional lesson time during breaks or at the end of the day.

Supplementary questions

Use the following table to answer questions 1 to 4.

IIIA	IVA	VA	VIA
$_{5}B$	$_{6}C$	$_{7}N$	$_{8}O$
$_{13}Al$	$_{14}Si$	$_{15}P$	$_{16}S$
$_{31}Ga$	$_{32}Ge$	$_{33}As$	$_{34}Se$

1. Which one of the following elements is smallest in atomic size?
   A. B B. C C. N D. O
2. Which one of the following elements has the least nuclear charge?
   A. B B. Al C. Ga D. C
3. Which one of the following elements is metalloid?
   A. Al B. Si C. P D. S
4. Which one of the following elements is most metallic?
   A. Ga B. Ge C. As D. Se
5. Nuclear charge increases as one goes down a group in a periodic table. Why did not it cause a decrease in atomic size?
6. Helium has got 2 electrons in its valence shell. But it is not grouped in Group IIA why?

Answers to supplementary questions

1. D 2. A 3. B 4. A

5. Within a given period we said that increase in nuclear charge brings about shrinking of atomic shells. In a similar way down a given group increase in nuclear charge tends to decrease the atomic size. However the number of shells plays a greater role in nuclear charge tends to decrease the atomic size. Hence increase in atomic shells predominates the tendency of increased nuclear charge to shrink the shells.

6. Helium is exceptional. Most of its physical and chemical properties go with that of group VIIIA elements. Even though its valence electron is 2, it violates the direct relation between valence electron and group number.

Answers to Exercise 5.3

1. All representative elements located at left and right side of the periodic table are A-group elements.
2. Transition elements located at the center of the periodic table are B-group elements.
3. In Group IA – 7 elements
   Group IIA – 6 elements
   Group IIIA – 5 elements
   Group IVA– 5 elements
   Group VA – 5 elements
   Group VIA – 5 elements
   Group VIIA – 5 elements
   Group VIIIA – 6 elements
4. 18 elements

Answers to Exercise 5.4

1. Metals – Tin (Sn) and lead (Pb)

   Non-metals – Carbon (C)

   Metalloids – Silicon (Si) and Germanium (Ge)

2. Copper (Cu), Silver (Ag), Gold (Au), Iron (Fe) and Zinc (zn)

3. Group IVA and period 3

4. a) period 2 and group IIA

   b) period 2 and groupVIIA

   c) period 3 and group IIA

   d) period 3 and group VIIIA

Answers to Exercise 5.5

1. Since both lithium and boron both have two shells, it seems difficult to compare their atomic size on the bases of number of shells.
   In lithium three positive charges attract two electrons and in boron five positive charges attract two electrons. Attraction in boron is stronger. Stronger attraction brings about shrinking of the atomic shells. Hence the shells of boron are closer to one another causing boron to smaller in size than lithium.
2. Na is most metallic and argon is most non-metallic.
3. Metals: Sodium, magnesium and aluminium
   Metalloid: Silicon
   Non-metals: phosphorus, sulphur, chlorine and argon.

5.4 IMPORTANCE OF MODERN PERIODIC TABLE

Periods allotted: 1 period

Competencies

After completing this section, students will be able to:

- *prepare a periodic table chart*
- *tell the importance (advantages) of periodic table as quick reference of atomic number, atomic mass and properties of elements.*

Forward planning

Read the content about importance of modern periodic table from the student's text book and other reference books. Prepare your plan to complete the lesson in one period.

Teaching Aids

- Chart of modern periodic table

Subject matter presentation

It is advisable to use question and answer, presentation and concept mapping as methods of teaching for this section.

You can start this lesson with Activity 5.6. Let them do in groups. After their presentation give them the correct answers as follows:

i. Element B

ii. Element D

iii. Element E is more reactive than element G. This is because reactivity increases down a group due to increasing atomic shell.

iv. Element C is the most reactive non-metallic element

v. Elements E, H and I.

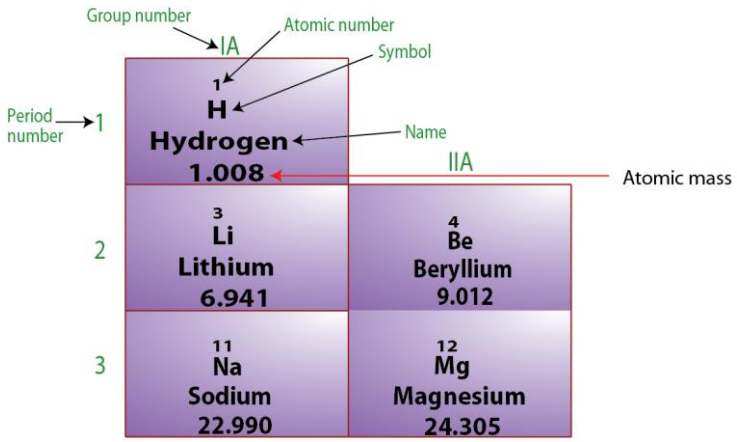
vi. Element F.

vii. Element H.

You may continue this lesson by asking some leading questions about the importance of modern periodic table as follows.

- What information could you obtain from the periodic table?

Let students forward their answers. After their attempts, the importance of modern periodic table using charts. You can use the following illustration to describe some importance of modern periodic table.



Finally give them the project work to prepare a periodic table. They may need a week or more time to complete. This project work will help students to revise all concepts about the modern periodic table. Don't let them to include Lanthanide and Actanide series.

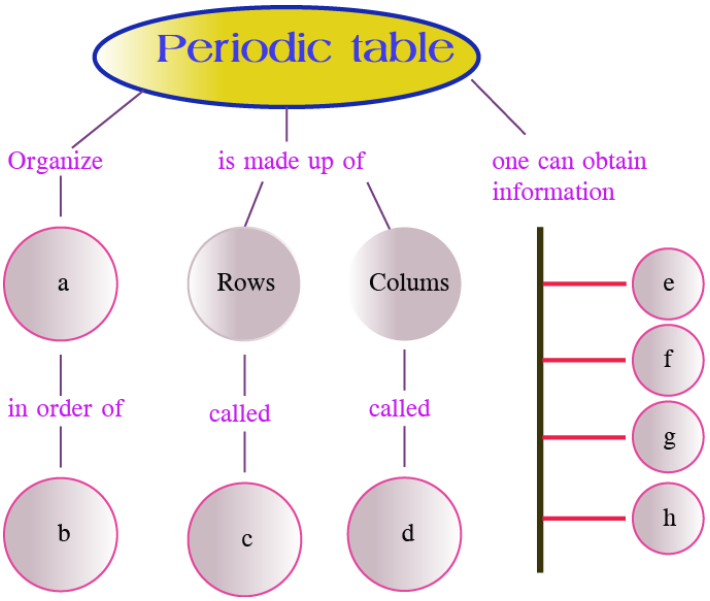
Assessment

Here the assessment should be based on your observation how students participate on answering the oral questions you raised at the beginning of the lesson. Cheek the suggested competencies for this section are achieved by most of the students. Appreciate their students who are working above the minimum requirement. For those who are working below the minimum requirement level arrange additional lesson time.

Note: You can use the following activity as assessment to summarize this lesson.

Activity (Concept Mapping)

Complete the following concept map.



Answers to activity

a.	Elements	b.	Atomic number	c.	Periods
d.	Groups	e.	Atomic number	f.	Elements symbol
g.	Elements name	h.	Atomic mass		

Answers to Review exercise on unit 5

Part I

1.	False	2.	False	3.	False	4.	True
5.	True	6.	True	7.	False		

Part II

8.	B	9.	D	10.	B	11.	C
12.	B	13.	A	14.	B	15.	B
16.	C	17.	A	18.	B Part III		
19.	Periodic			20.	Periods		
21.	Atomic size			22.	Three		

Part IV

23. Because elements are arranged according to increasing atomic numbers by modern periodic law. Modern periodic law states that “the properties of the elements are periodic functions of their atomic numbers”.

24. Since atomic mass is equal to mass number for most elements the mass number of an element is 23.

    To find number of protons,

    A = number of protons + number of neutrons

    = A – number of neutrons.

    = 23 – 12 = 11

    For neutral atoms number of protons and electrons is equal. Thus there are 11 electrons.

    The electronic configuration of the element is 2, 8, 1

    Therefore element belongs to group IA.

20. Atomic size of the elements increases down a group due to the addition of new shells down a group.

21. Given: Atomic number, z of an element x = 17 form neutral atom, z = number of protons = number of electron.

    i. Number of protons = 17

    ii. Number of electrons = 17

    iii. Electronic configuration: 2, 8, 7

    iv. Number of valence electrons = 7

    v. Number of shells = 3

    vi. The element x belongs to period 3 and group VIIA.

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GRADE 7
CHEMISTRY SYLLABUS

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

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)*	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. 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.

Competencies	*Contents*	*Suggested activities*
• 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 • Define physical properties • List some physical properties of substances	• Physical properties	• Students should be asked to define substance. • Students should understand the difference between physical properties and chemical properties. Physical properties discussed could include: • 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.

Competencies	*Contents*	*Suggested activities*
• Conduct experiments to identify properties of substances and make group report		Students could use tables of melting points and/or boiling points to identify common elements. Students could identify metals by observing their physical properties e.g. • Copper – brown colour • Iron and steel – magnetic • Aluminium – low density • Lead – high density • 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	• Elements and compounds	Students should appreciate that there are a number of substances that cannot be made into simpler substances and these are

Competencies	*Contents*	*Suggested activities*
metals, non-metals and metalloids • Give examples of metals, non-metals and metalloids • Explain the differences between elements and compounds		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 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

Competencies	*Contents*	*Suggested activities*
• Carryout an experiment in group to distinguish compound and mixture. • Classify compounds as oxides, acids, bases and salts • Give examples of oxides, acids, bases and salts		different from the properties of the elements from which it is formed. 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. 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 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;

Competencies	*Contents*	*Suggested activities*
		• 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 • 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.

Competencies	*Contents*	*Suggested activities*
• 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
• List methods of separation of mixtures • Explain methods of separation of mixtures • Give some specific examples of mixtures that can be separated by filtration, decantation, simple distillation, magnetic separation and using separatory funnel	**2.4 Separation of mixtures and its application** *(6 periods)* • 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 • 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.	• 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

Competencies	*Contents*	*Suggested activities*
• Assemble apparatuses used in decantation, filtration, simple distillation, separatory funnel.	• 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

Competencies	*Contents*	*Suggested activities*
• Perform simple activities in group to carry out the separation of mixtures using local materials and write a group report.		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 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

Competencies	*Contents*	*Suggested activities*
		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
• 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)

Competencies	*Contents*	*Suggested activities*
		• 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^+

Competencies	*Contents*	*Suggested activities*
		• 1 hydroxide OH, nitrate NO_3^- • 2 sulphate, SO_4
• 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;

Competencies	*Contents*	*Suggested activities*
		$Mg(NO_3)_2$, 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 Multiple) methods of balancing equation	• Writing simple chemical equation • Balancing chemical equation • Inspection method • LCM method	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.
• 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)		Magnesium + Oxygen → 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,

Competencies	*Contents*	*Suggested activities*
		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

Competencies	*Contents*	*Suggested activities*
		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.
	4.2 Atomic theory *(2 periods)*	
• State Dalton 's atomic theory • Describe the short comings of Daltons 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 Students should discuss the different statements made by Dalton in the light of current knowledge. From this discussion they

Competencies	*Contents*	*Suggested activities*
• State modern atomic theory	• Modern atomic theory	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. 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.

Competencies	*Contents*	*Suggested activities*
• Define atomic mass	• Atomic mass	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. 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

Competencies	*Contents*	*Suggested activities*
• 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.
• 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

Competencies	*Contents*	*Suggested activities*
	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: • Narrate the historical development of periodic classification of elements	***5. Periodic classification of the elements*** *(11 periods)* **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)

Competencies	*Contents*	*Suggested activities*
	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. 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	**5.3 Modern periodic table** *(7 periods)*	Students should appreciate that in the modern Periodic Table the elements are arranged in order of increasing atomic number rather than the atomic mass.
• Define period and group	• Period and group	Students should study the modern

Competencies	*Contents*	*Suggested activities*
• 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	• Modern Periodic law • Electronic configuration and arrangement of elements • Structure of modern periodic table	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

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	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: • 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

Competencies	*Contents*	*Suggested activities*
		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.