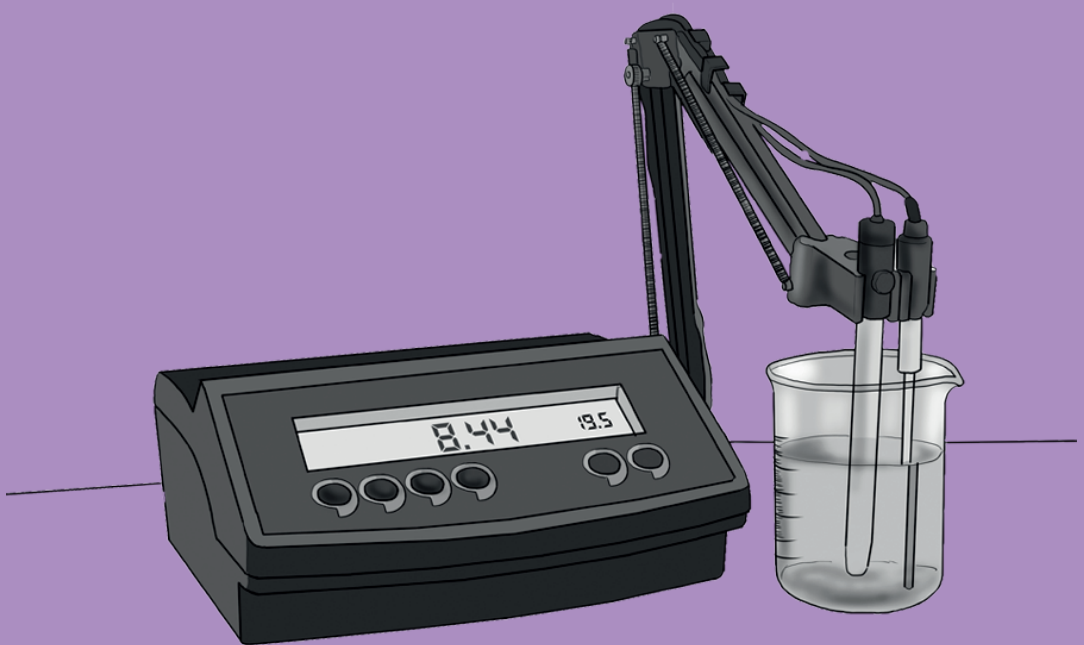
South Sudan

Secondary Chemistry 2

Teacher's Guide



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Secondary 2

Chemistry

Teacher's Guide 2

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Table of contents

Introduction

Book organisation

This teacher's guide is organised into two main sections Part 1 is the general introduction section detailing information on competence based curriculum and pedagogical issues.

The main elements of part 1 are:

- Background in formation to the new curriculum - It gives a brief overview of the general requirements of the new South Sudan competence-based including the guiding principles, the competences the students are expected to acquire, crosscutting issues to be addressed during learning.
- Basic requirements for an effective Chemistry lesson - It highlights the teacher and learner's roles for effective teaching and learning of Chemistry, teaching and learning resources, grouping learners for learning and teaching methods

Part 2 provides a topic -to - topic guide to the teacher on how to facilitate learners to acquire the knowledge, skills and attitudes envisaged in each unit. This part is therefore structured into units

The main elements of each unit guide are:

- Unit heading
- Learning objectives
- Contribution t o learner's competences: The section explains how the unit/ topic will facilitate the learner to acquire to the specified competences. These competences will be discussed in detail later in the next section.
- Cross cutting issues to be addressed

  The section outlines the specific cross cutting issues that will be addresses through infusion as the learners do the activities and interacts with concepts planed for the unit This is meant to make the teacher conscious on and be on the look out for suitable opportunities through out the teaching and learning process in the entire unit to address the cited cross cutting issues. These issues will be discussed in detail later in this section.

  Note: a unit or topic may not necessarily address all the cross cutting issues outlined in the curriculum

- Suggested teaching and learning activities- This section provides guidance to the teacher on how to facilitate students to learn by doing the activities outlined in the student's book. It also guides the teacher on how to assess the learning.

Background Information on the new curriculum

The aim of the South Sudan Competence-based curriculum is to develop in the learners competences that will enable them interact with the environment in more practical ways.

It clearly defines the knowledge, skills and attitudes that the learner should acquire by doing the specified learning activities.

a. Learner's competences to be attained

Competencies are statements of the characteristics that learners should demonstrate, which indicate they have the ability to do something to the required level of performance. The following are the four competencies envisaged in this curriculum:

1. Critical and creative thinking

Chemistry lessons and activities facilitate learners to acquire these competences by giving then opportunities to:

- Plan and carry out investigations, using a range of sources to find information
- Sort and analyse information and come to conclusions
- Suggest and develop solutions to problems, using their imaginations to create new approaches
- Evaluate different suggested solutions

2. Communication

Chemistry lessons and activities facilitate learners to acquire these competences by giving then opportunities to:

- Read and comprehend critically a variety of types and forms of texts during research activities.
- Write reports on scientific investigations and activities.

- Speak clearly and communicate ideas and Chemistry related information coherently.
- Listen and comprehend scientific facts presented by fellow classmates, group members, teachers and resources persons.
- Use a range of media, technologies and languages to communicate messages, ideas and opinions.

3. Cooperation

Chemistry lessons and activities facilitate learners to acquire these competences by giving then opportunities to:

- Work collaboratively towards common objectives when doing activities.
- Be tolerant of others and respectful of differing views, when working together
- Adapt behaviour to suit different situations
- Negotiate, respect others' rights and responsibilities, and use strategies to resolve disputes and conflicts
- Contribute to environmental sustainability

4. Culture and identity

Chemistry lessons and activities facilitate learners to acquire these competences by allowing them to:

- Take pride in South Sudanese identity and the diverse nature of South Sudanese society.
- Build understanding of South Sudanese heritage in relation to the wider world
- Appreciate and contribute to the development of South Sudanese culture
- Value diversity and respect people of different races, faiths, communities, cultures, and those with disabilities.

(b) Cross-cutting issues to be addressed during learning

These are issues that are of high national priority and hence have been incorporated in the learning process. The three cross-cutting issues for that should be addressed through the teaching/learning process are:

1. Environment and sustainability

A well-conserved environment is obviously key to our health and survival. It is therefore important for the Chemistry teacher to make use of the opportunities that arise in the process of teaching and learning Chemistry through activities to sensitise learners on the importance of conserving the environment. One way is by ensuring that the learners always dispose off the waste materials at the end of an activity in ways that do not pollute the env ironment.

2. Peace education

Peace is critical for a society to flourish and for every individual to focus on personal and national development.

The Chemistry teacher needs to be in the fore front in educating his/her students on the need for peace, for example by encouraging group work in the learners activities and showing the them ways of solving peacefully interpersonal problems that occasionally arise during interactions and discussions.

3. Life Skills

Learners need to progressively acquire some skills abilities and behaviors that will help them effectively deal with the events and challenges of everyday life . Such skills include first aid, communication skills, conflict resolution, basic ICT skills etc. The Chemistry teacher should as much as possible facilitate the learners to acquire these skills whenever an opportunity arises in the lesson execution

Basic requirements for an effective Chemistry lesson

(a) Teacher's role and basic skills for effective Chemistry lesson

The teacher is the most important resource for an effective. Chemistry lesson. (a) Some of the key roles of the Chemistry teacher include:

1. Organising the classroom to create a suitable learning environment.
2. Preparing appropriate materials for learning activities.
3. Engaging students in variety of learning activities.
4. Encouraging and accepting student autonomy and initiative.

5. Allowing student responses to drive lessons, shift instructional strategies,
6. Familiarizing themselves with learners understandings of concepts before sharing their own understandings of those concepts.
7. Encouraging learners to engage in dialogue, both with the teacher and one another.
8. Engaging students in experiences that pose contradictions to their initial hypotheses and then encouraging discussion.
9. Providing time for learners to construct relationships and create metaphors.
10. Using a variety of teaching and assessment methods.
11. Adjusting instructions to the level of the learner.
12. Nurturing learners' natural curiosity.
13. Motivating learners to make them ready for learning.
14. Coordinate learners' activities so that the desired objectives can be achieved.
15. Assessing learners' activities and suggest solutions to their problems.
16. Assist learners to consolidate their activities by summarising the key points learnt.

(b) Some of the key skills that the Chemistry teacher should have include:

1. Creativity and innovation.
2. Makes connections/relations with other subjects.
3. A high level of knowledge of the content.

   Effective disciplining skills manage adequately the classroom
4. Good communicator.
5. Guidance and counselling.

Learner 's role in learning Chemistry

Learning takes place only when the learner acquires the intended knowledge, skills and attitudes. As such, learning is a highly personal and individual process. Thus, a learner must be actively engaged in the learning exercise.

For active participation in learning, the learner should:

1. Raise questions about what is observed.
2. Suggest solutions to the problems observed.
3. Take part in planning investigations with appropriate controls to answer specific questions.
4. Carry out investigations to search for answers with the help of materials in search of patterns and relationships while looking for solutions to problems.
5. Working collaboratively with others, communicating their own ideas and
6. Considering others' ideas.
7. Expressing themselves using appropriate Chemistry terms and representations in writing and talk.
8. Engaging in lively public discussions in defence of their work and explanations.
9. Applying their learning in real-life contexts.
10. Reflecting critically about the processes and outcomes of their inquiries.

Teaching and learning resources

These refer to things that the teacher requires during the teaching process. They include:

- The classroom
- Textbooks
- Wall charts and wall maps
- Materials and apparatus
- Various tools and equipment
- Chemistry models
- Resource persons
- Firms such as hydroelectric power stations, engineering firms among others

(a) Classroom as a learning environment

A Classroom generally refers to the place where learning takes place. Learners learn from everything that happens around them, such as the things that they hear, see, touch, taste, smell and play with.

Classroom organisation

- It is important for the teacher to make the classroom an attractive and stimulating environment. This can be done by:
- Carefully arranging the furniture in the classroom in an organised way. to allow free movement of learners and the teacher.
- Putting up learning and teaching aids on the walls. Examples are wall charts, pictures and photographs.
- Displaying teaching models.
- Providing objects for play for example toys.
- Having a display corner in the classroom where learners display their work.
- Setting a corner for storing materials so as not to obstruct learners or distract them.
- Spreading out the learners evenly so that they do not interfere with one another's activities.
- Setting up the materials for the series of lessons or activities going on for a number of days or weeks in a location where they do not interfere with other daily activities
- Organizing the sitting arrangement such that learners face the lighted areas of the room.
- Choosing the most appropriate location for the teacher and the chalkboard such that they are visible to all learners and the teacher has a good view of all learners in the class.

(b) Apparatus and materials

For learners to study Chemistry through the activity method, a number of materials and apparatus are required. The important role played by materials in learning has been felt for centuries. This is noted for instance in the old Chinese proverb that says:

When I hear I forget

When I see I remember

When I do I under sta nd

Since Chemistry is highly practical subject, materials help the teacher to convey his/ her points, information or develop skills simply and clearly, and to achieve desired results much faster.

Some of the materials that a teacher requires for Chemistry activities and calculations can be collected from the local environment.

Many others can be improvised while some have to be purchased. Whether collected, improvised or purchased, there are certain materials that are valuable to have around almost all the time.

These include:

(i) Chemistry Kit

A Chemistry kit is a special box containing materials, apparatus and equipment necessary to conduct an array of experiments. The content of the Chemistry kit depends on the curriculum requirements per level. Most Chemistry kits are commercially available and target particular levels of learners. However, the teacher is encouraged to come up with a kit based on the syllabus requirement

(ii) Models

A model refers to a three-dimensional representation of an object and is usually much smaller than the object. Several models are available commercially in shops. Examples of Chemistry models include models of electric motors, hydraulic systems among others. These models can be purchased by schools for use during Chemistry activities.

(iii) Resource persons

A resource person refers to anybody with better knowledge on a given topic area. Examples include health practitioners such as doctors, nurses and laboratory technologists, agricultural extension officers, environmental specialists among others. Depending on the topic under discussion, the teacher can organise to invite a resource person in that area to talk to learners about the topic. The learners should be encouraged to ask as many questions as possible to help clarify areas where they have problems.

(iv) Improvisation

If each learner is to have a chance of experimenting, cheap resources must be made available. Complicated apparatus may not always be available in most schools. Such sophisticated equipment made by commercial manufacturers are usually expensive and majority of schools cannot afford them. The teacher is therefore advised to improvise using locally available materials as much as possible.

(vi) Scheduling learning activities and venues

Some of the activities suggested in the student's good planning and scheduling in order to get accurate results. An example is observing some effects of environmental factors on plant growth illustrated in unit 14. The teacher should therefore think ahead while making the scheme of work so that the prevailing weather pattern and the most appropriate timing are considered..

Grouping learners for learning activities

Most of the Chemistry activities suggested in the student's book are carried out in groups and therefore the teacher should place 2 or 3 desks against each other and then have a group of learners sitting around those desks.

In certain activities, the teacher may wish to carry out a demonstration. In this case, the learners should be sitting or standing in a semicircle, or arranged around an empty shape of letter "U" such that each learner can see what the teacher is doing clearly and without obstruction or pushing. If the learners are involved in individual work, each learner can work on the floor or on the desk or a portion of the desk if they are sharing. In this case, they need not face each other.

Grouping learners for learning has increasingly become popular in recent years. In fact, the shift from knowledge-based to competence curriculum will make grouping the norm in the teaching process.

Learning grouping can be formed based one or a number of the following considerations:

- Similar ability grouping
- Mixed ability grouping
- Similar interests grouping
- Common needs grouping
- Friendship grouping
- Sex-based grouping

Grouping learners in a Chemistry class has several advantages that include:

1. The individual learner's progress and needs can easily be observed.
2. The teacher-learner relationship is enhanced.
3. A teacher can easily attend to the needs and problems of a small group.
4. Materials that were inadequate for individual work can now be easily shared.
5. Learners can learn from one another.
6. Cooperation among learners can easily be developed.
7. Many learners accept correction from the teacher more readily and without feeling humiliated when they are in a small group rather than the whole class.
8. Learners' creativity, responsibility and leadership skills can easily be developed.
9. Learners can work at their own pace.
10. The type of "grouping" that a teacher may choose may be dictated by:
11. The topic or task to be tackled.
12. The materials available.
13. Ability of learners in the class (fast, average, slow).

Class size

There is no one method or approach to teaching that is appropriate to all lessons. A teacher should, therefore, choose wisely the method to use or a combination of methods depending on the nature of the topic or subtopic at hand.

Teaching methods

There are a variety of possible methods in which a teacher can help the learners to learn. These include:

(a) Direct exposition

(b) Discovery or practical activity

(c) Group, class or pair discussion

(d) Project method

(e) Educational visit/ field trips

(f) Teacher demonstration

(g) Experimentation/Research

The particular technique that a teacher may choose to use is influenced by several factors such as the:

- Particular group of learners in the class.
- Skills, attitudes and knowledge to be learned.
- Learning and teaching aids available.
- Local environment.
- Teacher's personal preference
- Prevailing weather condition.
- Requirements of Chemistry syllabus.

(a) Direct exposition

This is the traditional way of teaching whereby the teacher explains something while the learners listen. After the teacher has finished, the learners may ask questions. However, in a competence-based curriculum, this technique should be used very minimally.

(b) Guided Discovery

In this technique, the teacher encourages learners to find out answers to problems by themselves. The teacher does this by:

1. Giving learners specific tasks to do.
2. Giving learners materials to work with.
3. Asking structure or guided questions that lead learners to the desired outcome. Sometimes learners are given a problem to solve and then left to work in an open-ended manner until they find out for themselves.

This is the most preferred method of teaching in the implementation of competency- based curriculum.

(c) Group/class discussion or pair work

In this technique, the teacher and learners interact through question and answer sessions most of the time. The teacher carefully selects his/her questions so that learners are prompted to think and express their ideas freely, but along a desired line of thought. The method leads learners from the known to unknown in a logical sequence; and works well with small groups. The method boosts confidence in learners and improve interpersonal and communication skills.

The main disadvantage of this method is that some learners maybe shy or afraid to air their opinions freely in front of the teacher or their peers. It may give them more confident learners a chance to dominate the others.

(d) Project method

In this approach, the teacher organises and guides a group of learners or the whole class to undertake a comprehensive study of something in real life over a period of time such as a week or several weeks.

Learners using the project method of studying encounter real life problems, which cannot be realistically brought into a normal classroom situation. A project captures learners' enthusiasm, stimulates their initiative and encourages independent enquiry. The teacher, using the project method, must ensure that the learners understand the problem to be solved and then provides them with the necessary materials and guidance to enable them carry out the study.

The main disadvantage of this method is that if a project is not closely supervised, learners easily get distracted and therefore lose track of the main objective of their study. Studying by the project method does not work well with learners who have little or no initiative.

(e) Educational visits and trips and nature walks

This is a lesson conducted outside the school compound during which a teacher and the learners visit a place relevant to their topic of study. An educational visit/nature walk enables learners to view their surroundings with a broader outlook that cannot be acquired in a classroom setting. It also allows them to learn practically through first- hand experience. In all "educational visit/nature walk lessons", learners are likely to be highly motivated and the teacher should exploit this in ensuring effective

learning. However, educational visits are time consuming and require a lot of prior preparation for them to succeed. They can also be expensive to undertake especially when learners have to travel far from the school.

(f) Demonstration lessons

In a demonstration, the teacher shows the learners an experiment, an activity or a procedure to be followed when investigating or explaining a particular problem. The learners gather around the teacher where each learner can observe what the teacher is doing. It is necessary to involve the learners in a demonstration, for example by:

1. Asking a few learners to assist you in setting up the activity.
2. Requesting them to make observations.
3. Asking them questions as you progress with the demonstration. This will help to prevent the demonstration from becoming too teacher centred. When is a demonstration necessary?

A teacher may have to use a demonstration, for example when:

1. The experiment/procedure is too advanced for learners to perform.
2. The experiment/ procedure is dangerous.
3. The apparatus and materials involved are delicate for learners to handle.
4. Apparatus are not enough for all learners or groups.

Part 1

The Atmosphere and properties of common gases

Refer to page 1-22 of student's book

Learn about	Key inquiry questions
Learners should build on what they already know about atmospheric air and now describe its composition qualitatively and quantitatively and carry out practical investigations to determine the percentage of gases by volume. They should describe the separation of oxygen, nitrogen and the noble gases from liquid air by fractional distillation and design and perform experiments to investigate the properties of common gases in terms of kinetic molecular theory and use them to explain the properties of common gases.	• How do you investigate composition of air? • How does kinetic molecular theory explain properties of gases?

Knowledge and understanding	Skills	Attitudes
• Describe the composition of atmosphere.	• Carry out practical investigations to determine the percentage of gases by volume. • Investigate the properties of common gases. • Design and perform experiments to investigate the properties of common gases Select, organise and present information from a variety of sources.	• Use kinetic molecular theory to explain the properties of common gases. • Appreciate the importance of the atmosphere.

Contribution to the competencies:
Critical and creative thinking: through investigation of composition air. Communication: presenting group work to class. Co-operation: group work.
Links to other subjects:
Biology, Physics, Geography: pollutions of air; environment and sustainability.

Introduction to the unit

This unit will help leaners understand what the atmosphere consists of.The activities will help learners to understand that air is a mixture of several components with varying percentage composition. They will also learn the importance of air to life processes such as respiration of living organisms.

The unit is also about sources of air composition and pollution. This will help learners prevent air pollution so as to make the environment safe and habitable.

There are many opportunities in this unit for learners to determine why air is referred to as a mixture.There are many discussions and activities to be carried out and learners should be encouraged to think and communicate clearly especially in the group activities in order to share their thoughts and answers.

The activities in this unit focuses on the atmosphere as well as the composition of the atmosphere. The listed activities here include discussions and predictions, but the main focus is on observations and explanation of conclusions. It is possible however to design an investigation which you can set as a research project or homework activity for your learners in order to provide them with additional knowledge and understanding.

Competences to be attained

1. Co-operation

Encourage learners to work as a team through group discussions.Allow learners to freely interact with one another. Let them associate with one's culture and abilities through resources sharing and exchange of ideas. The principle of co-operation should be listening to understand but not listening to respond. All learners to be given equal opportunities irrespective of their abilities. Ensure every learner enjoys the sense of work regardless of their skin colour or physical fitness.

2. Communication

During group discussion, encourage learners to discuss in English. This way will build on the command for the language as well as ability to participate in other discussions. Ask them questions and give them a chance to attempt answering in the simplest way possible. This way, they will build on their confidence and soon develop the love and passion for the subject. Allow some room for learners to make mistakes and then correct them in nice way lest they will feel demoralized.

3. Critical and creative thinking

Introduce the unit by posing general questions to the learners they try to look for the answers to these questions, you will make them develop a thinking culture as they try to relate the unit with the questions given to them. These questions should however trigger the idea of what they should expect from the unit. Present photographs and make learners discuss the activities in those photograph, they give out their findings, you will be building a thinking habit in them.

Cross cutting issues

1. Environmental awareness and sustainability

Some industrial activities release poisonous gases to the atmosphere such as carbon (iv) oxide. Which poses danger to living organism. Environmental pollution may however be curbed through practice of safe disposal of wastes such as fitting the chimneys in industries with substances that can absorb the poisonous gases. Learners should be encouraged to plant more trees and refrain from such activities that pollutes our environment.

2. Peace and values of education

Throughout the unit, learners are actively involved in discussing issues as a group. Learners should be made aware of the need to accommodate everyone's ideas and opinions. Through the discussions they will at times agree or disagree on issues at hand. They should be made to embrace the views of others and treat them as a learning process. Any form of intolerance should be highly condemned.

3. Life skills

A well maintained atmosphere equals a fulfilling life. Learners should be sensitized on the need to conserve our environment. They should actively participate in activities such as: National tree planting day, National cleaning day. Learners should be made to understand the need to embrace one another regardless of their cultural background or nationality.

Involve them in activities that fosters coherence, respect, gender inclusivity and patriotism.

1.1 Air is a mixture

Refer to page 2 of student's book.

a) Work to do

In groups

- Allow learners to state what mixtures are and give examples of what mixtures are referring to previous knowledge from chemistry book 1 on separation of mixtures and compounds
- Also let the learners mention some of the mixtures they come across in their day to day life.
- After they have defined what mixtures are, allow them to say whether they think air is a mixture or not. Let them give reasons for their answers. This will help you evaluate whether they understand what the atmosphere consists of

  (Allow the learners to discuss their findings on what mixtures are and to share their answers)

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

During class presentation look for language command, confidence in defending group findings and ability to convince. Assess whether they are able to confidently give and defend their thoughts and answers without being emotional. Guide on emotional control where necessary.

Activity 1.1: What percentage of air is used up when a candle burns?

Refer to page 3 of student's book

Activity 1.2: What percentage of air is used when copper is burned in fixed volume of air?

Refer to page 5 of student's book

In groups

- Ask learners to recall what ingredients are contained in a fire extinguisher, this will allow the learners to have an idea of what this activity is all about given that carbon dioxide does not support burning.
- Ask the learners to identify the apparatus they will be working with.
- You can go ahead and carry out the experiment.En first just to demonstrate what is expected and the precautions to take in order to avoid any errors. This will also instil some confidence in learners to carry out the experiment.
- The experiment you performed and the results can be used as the control.
- Allow the learners to carefully carry out the experiment. Ensure that the learners work together with each other. The less able learners can take the measurements of the NaOH before and after the experiment while the able learners can light the candle and carefully cover the candle with the gas jar.
- Allow learners to give out their results from the experiment. Let them explain why there was a rise in the level of NaOH.
- In activity 1.2, the learners should be able to follow the procedure after you have demonstrated how the apparatus are arranged in the experiment using your results as control.
- You can ask learners what they expect from the experiment in terms of the chemical reaction and the physical changes.
- You can also ask the learners how they will know that any reaction has taken place.

Expected answer

Copper reacts with oxygen gas to form copper II oxide which is black in colour

(Allow learners to discuss the results amongst themselves. Give slow learners enough time to perform the experiment)

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

Ask the learners diagnostic questions that are aimed at assessing knowledge and understanding.

1.2 Determining the percentage of air used when iron rusts

Work to do: Refer to page 7 of student's book

In groups

- Allow learners to carry out the activity, this will enable them to understand that for iron to rust, there are a number of factors that need to be considered.
- Leaners should be able to see rust in the iron nail in boiling tube 1.
- There will be no rust in boiling tube 2. This is because boiled water has no oxygen and oil prevents oxygen from getting in.
- In boiling tube 3, due to the presence of calcium chloride, ther will be no rest. This is because it absorbs water vapour in the boiling tube which is needed for rust to occur.

Activity 1.3 and 1.4:

Refer to page 7 of student's book

In groups

- Introduce the activity by asking the learners to identify the apparatus.
- Learners need to understand from this experiment that rusting is an oxidation reaction of iron with oxygen.
- From the measurements before and after the experiment, learners should be able to calculate the percentage of air that is required for rusting to occur.

- You can allow the learners to predict the average percentage of air that will be used, let them compare that to the experimental results which should be about 20%. Remind them that this is approximately the percentage of oxygen in air.
- Ask the learners how they could determine the reaction was complete. You could also suggest that they leave the experiment for some few more days to see if there will be any further reactions. Let them predict what will happen.
- Let them give their outcome after those days and compare to their prediction. Allow them to explain why there was change or not.

Expected answers

- Iron reacts with oxygen to form iron oxide.
- All the oxygen was used up so there will be no change in the water level.
- If any of the learners got a change in the level of water it means that the experiment was not covered completely.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

During class presentation look for language command, confidence in defending group findings and ability to convince.

b. Conversation

Ask learners probing questions to test their knowledge and understanding on how rust occurs.

What percentage of air is used when phosphorus smoulders in air?

Activity 1.5: To investigate the percentage of air used when red phosphorous smoulders in a fixed amount of air

Refer to page 9 of student's book

In groups

- Learners need to understand from this experiment that phosphorus smoulder when exposed to air that is why it is stored under water.
- Form the measurements before and after the experiment, learners should be able to calculate the percentage of air that was used.
- You can allow the learners to predict the average percentage of air that will be used, let them compare that to the experimental results.
- Ask the learners how they could determine the reaction was complete. Allow the learners to also test the PH of the water using the knowledge they acquired from book 1 chemistry

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Product

Appraise each learner on:

- Their understanding of how to apply the laboratory rules on how to handle toxic chemicals.
- How they use the knowledge gained to calculate the percentage of air used.

1.3 Determining the presence of carbon (IV) oxide in air

Activity 1.6: To investigate whether air contains carbon (IV) oxide

Refer to page 10 of student's book

In groups

- Introduce the lesson by asking the learners what they know about the air we breathe in and the air we breathe out. Ask the learners about the colour and smell of carbon dioxide in the atmosphere.
- Put emphasise on the fact that oxygen is the active part of air as earlier learnt.
- Encourage learners to appreciate the need for following procedure in an experiment.
- Guide the learners in discussing the findings of the activity as they discuss they improve their co-operation and interpersonal skills. Let the learners compare their findings to their predictions and use the theoretical evidence to support the experimental results.
- Use diagnostic questions to enhance critical thinking and problem solving skills.
- Display the chart on the percentage composition. This way, you will be reinforcing understanding of slow learners.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

Allow learners to confidently share their answers and predictions with the rest of the class. encourage them to also defend their answers in the process. Correct them where necessary. Their cooperation and interpersonal skills may be assessed by finding out how they interact with other learners during discussion and how they share responsibilities.

1.4 Determining the presence of water vapour in the air

Activity 1.6: Investigating the presence of water vapour in the atmosphere

Refer to page 11 of student's book

In groups

- From the activity, learners should already have an idea on what water vapour is. Allow every learner to perform that activity so that each of them has that knowledge in mind.
- Introduce the activity and let the learners open all the windows to ensure free air circulation before they begin the activity.
- Ask the learners to suggest reasons why free air circulation is needed in the room.
- Allow the learners to predict what they will be observing at the end of the experiment.
- Allow learners to compare their results to the predictions. Ask them do research based on the observations they made.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

During class presentation look for language command, confidence in defending group findings and ability to convince.

b. Conversation

Ask learners probing questions to test their knowledge and understanding. The learners should also talk among themselves on the same issues to gauge their knowledge.

1.5 Oxygen

Activity 1.8: Laboratory preparation of oxygen gas

Refer to page 12 of student's book

As a class

- Introduce the activity by allowing the learners to name some of the apparatus they know that can be used in oxygen gas preparation. Allow the learners to brainstorm on this.
- Give each learner an opportunity to participate in the experiment. Let them suggest why certain chemicals are used such as hydrogen peroxide and manganese dioxide.
- Allow them to support their answers with a chemical equation.
- Let learners take note on the observations and explain the observations.
- Let the learners determine whether the test they carried out is valid by comparing the results to the theoretical results.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the class discussion observe and listen to each and every learner's contribution to the discussion. Check for tolerance to others views, commitment and engagement.

c. Product

Appraise each learner on:

- Their understanding and ability to prepare and test for the presence of oxygen gas.

Kinetic molecular theory

Refer to page 18 of student's book

As a class

- Introduce the lesson by lighting a scented candle and placing it at a safe corner in the room away from flammable substances. Let the candle continue burning for some time.
- Allow learners to predict what will happen.
- Using the knowledge on kinetic theory from book 1 chemistry, ask learners to explain why they can smell the candle scent.
- Allow them to answer the questions provided to them using the knowledge of kinetic theory.

Expected answers

- Gases move in random motion therefore allowing the scent of the perfume to be felt after sometime.
- Movement of gases increase with increased temperature. When temperature decreases, so does the pressure in collision therefore it causes deflated tires.
- High altitudes result in increased pressure making the water to boil faster.

Answers to Check your progress 1.1

Refer to page 20 of student's book

a) The level of water in the test tube rises.

b) Ensure diagram shows a rise of water in test tube and a decreased in the trough.

2. (a) Copper reacted with oxygen to form copper(II)oxide which will have more mass.

   (b) $2Cu\ (s) + O_2\ (g \longrightarrow 2CuO\ (s)$

   (b) The brown copper metal changes colour to black copper(II)oxide.

3. Volume of air used: - 100-79=21cm^3

   Percentage of air used = 21/100 x 100= 21%

4. Old roofing appear brown due to rust.

5. Water turns cobalt chloride paper from blue to pink.

6. $2Ca(s) + O_2(g) \longrightarrow 2CaO(s)$

   $2Cu(s) + O_2(g) \longrightarrow 2CuO(s)$

7. (a) Delivery tube is touching the contents in the round bottomed flask.

   (b) Gas P – Oxygen, Apparatus X – Flat bottomed flask, substance Q – manganese (IV) oxide.

   (c) Alkaline.

   (d) It is slightly soluble in water.

   (e) It is used in hospitals by patients with breathing problems

   It is used by deep see divers and mountain climbers

   It is used to produce oxy-acetylene flame used in welding

   f) Catalyst

8. (a) Step 1 Removing carbon (IV) oxide, Step II – Fractional distillation

   (b) Dust particles and carbon (IV) oxide.

   (c) Argon.

9. Kinetic energy.

10. Gas particles have no volume.

    There is not attraction force between gas particles

11. Gas particles will attain more Kinetic energy and they tend to move faster. More collisions result, leading to an increase in pressure of the gas.

12. D

Part 2

Atomic structure, the periodic table and bonding

Refer to page 23-60 of student's book

Learn about	Key inquiry questions
Learners should build on what they already know about atoms and understand atomic number, mass number, isotopes, relative atomic mass, and how electrons are arranged in energy levels. They should know the numbers of protons, neutrons and electrons in atoms and ions given an atomic mass and calculate relative atomic masses from isotopic compositions. Learners should interpret and use symbols such as $^{23}_{11}Na$ and use their knowledge of atomic structure in building the periodic table (old and modern), predict the position of an element, and analyse the electronic configurations to determine groups and periods of elements. They should appreciate how knowledge of atoms contributes to our understanding about electricity. Learners should understand the formation of ions, ionic bonding, covalent bonding, metallic bonding and Hydrogen bonding, and differentiate between ionic and covalent compounds. They should carry out experiments to investigate properties of ionic compounds and covalent compounds.	• How are electrons arranged in energy levels? • Why do we study electronic configuration? • How do physical and chemical properties of substances relate to their structures and bonding? • How can we use a knowledge of the periodic table to predict the characteristics of elements.

Knowledge and understanding	Skills	Attitudes
• Understand simple atomic structure, the periodic table and bonding. • Know the numbers of protons, neutrons and electrons in atoms and ions given an atomic mass. • understand the formation of ions.	• Calculate relative atomic masses from isotopic compositions. • interpret and use symbols such as $^{23}_{11}Na$ • Design experiments to investigate properties of ionic and covalent compounds drawing on a range of sources. • Carry out experiments to investigate properties of ionic compounds and covalent compounds.	• Appreciate how knowledge of atoms contributes to our understanding about electricity.

Contribution to the competencies:
Creative and critical thinking: predicting and analysing of properties elements. Communication: use effective of media to present group work. Co-operation: group work.
Links to other subjects:
Physics: understanding flows of electricity; matter; metallic bond and intermolecular force Biology: cell biology; molecular bonds. Geography: water and mineral salts.

Introduction to the unit

This unit is about structure of the atom, arrangement of elements in the Periodic Table, and also aims at explaining the nature of ionic, covalent and metallic bonds and their physical properties.

There are many opportunities for the learners to discover and improve their critical thinking and communication skills. There are many discussions to be held and predict about the periodic table, atoms and bonds and learners should be encouraged to communicate effectively in order to share discovery and theoretical knowledge for the benefit of others. It is important for the learners to appreciate contribution of scientists such as Mendeleev and Moseley in the development of the modern Periodic Table and also how the knowledge of atoms contributes to our understanding about electricity.

Competencies to be attained

- **Communication** – As learners present their findings of activities in front of others in class.
- **Cooperation, interpersonal management and life skills** – This is acquired as the learners interact during the lesson and group activities.
- **Creative and critical thinking**-This is acquired when learners predict and analyze the properties of elements during activities.

Cross cutting issues

- **Peace and values education**- Encourage the learners to interact favourably and to give ear to each other's opinions. There should also be no kinds of stereotypes; be it regarding gender or physical challenges among the learners.
- **Inclusive learning** – All learners whether disabled or normal should participate actively in the lesson.

2.1 Structure of the atom

Activity 2.1: Structure of the atom

Refer to page 24 of student's book

Individually

- Introduce the lesson by asking the learners to do the introduction activity. Try to create a picture of the arrangement of the components of the atom by the use of an orange.
- Using guided discovery, let the learners appreciate the fact that the atom is the smallest particle into which an element can be divided.

Properties

- Allow the learners to define what an atom is using the knowledge from their chemistry book 1. This way they can remind themselves what atoms are.
- Let them also mention what an atom is composed of.

Expected answers

- An atom is the smallest particle into which an element can be divided without losing the chemical properties of the element.
- Atoms are usually small they cannot be seen without the aid of a microscope.
- Components of an atom are known as the sub-atomic particles. Protons and neutrons are found in the central location within an atom which is the nucleus. Electrons are found outside the nucleus but within the atom.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Assess learners' knowledge from the way they answer the questions about atoms. Let them share their definitions and understanding of the atom confidently with the rest of the class. This should be an easy task since they already learnt about the atomic structure in book 1 chemistry.

Listen and gauge learner's language competence during class discussion and correct accordingly as you encourage them to improve.

Atomic characteristics

Refer to page 25 of student's book

In pairs

- Since the learners had already highlighted the components of the atom when talking about the structure of the atoms, just quickly mention the components.
- Allow learners to mention and remind themselves of the charges that each component has, this was learnt in chemistry book 1. Allow them to point out the differences and similarities among the sub-atomic particles.
- Let the learners internalize the symbols of the atomic number and mass number.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. conversation

- Assess learner's knowledge and understanding by communicating with the learners and listening to their answers as they discuss where the components of the atom are found.
- Assess skills acquisition by asking learners to write the charges of the sub-atomic particles, determine the mass and atomic numbers; determine the number of protons, neutrons and electrons from the mass and atomic numbers
- Assess attitudes and values by use of open minded questions such as; an atom is the smallest particle that takes part in a reaction. Explain. You can also do that by finding out if they appreciate the existence of isotopes. Use analogy of a family sharing a common name.
- Listen and gauge learner's language competence during class discussion as they share their answers and correct accordingly.

Isotopes

Discussion corner:

Refer to pages 28 of student's book

In pairs

- Introduce the lesson by reviewing with learners about atomic numbers and

mass numbers learnt in the previous lesson. Mention how the mass number of atoms is derived (mass of protons + mass of neutron) and that electron mass is considered negligible (i.e. insignificant).

- Use the analogy of a family with different names and a common surname to help learners understand and come up with explanations of what isotopes are or what they think isotopes are. Allow them to study the discussion corner which will also help them in coming up with a simple definition.
- Allow learners to do some research on what isotopes are then compare that to their earlier definitions and understanding.

Relative atomic mass

Refer to page 30 of student's book

- List some of the elements i.e. first 20 elements of the periodic table and their mass numbers. Now define the terms relative atomic mass (R.A.M). Discuss isotopy of elements making it clear that it contributes to why some elements do not have absolute R.A.M. whole numbers.
- Show the learners how to determine relative atomic mass of elements.
- In addition, work out your own set examples.
- Go around in class viewing the learners work and help where necessary. You can also ask a few learners to calculate on the board so as to help other learners understand.
- Give the learners a few problems to solve in class as class activity. They can also do it as group work. Provide them with take away problems for solving.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Ask diagnostic questions in the course of the lesson to gauge their knowledge and understanding of how RAM is calculated.

b. Product

Appraise each learner on:

- Their understanding of how calculate the R.A.M of an element and how to determine an isotope.

Answers to Check your progress 2.1

Refer to page 33 of student's book

1. Protons and neutrons

2. $X=\left(\frac{10\times18.7}{100}\right)+\left(\frac{11\times81.3}{100}\right)$

$X=10.813$

3. Electrons - 11, protorns - 11 and Neutrons - 12

Arrangement of electrons in an atom

Activity 2.2:

Refer to page 34 of student's book

In pairs

- Introduce the lesson by simulation i.e. guided discovery and knowledge of previous lessons in chemistry book 1 to enable learners understand how the electrons are arranged in the energy levels.
- Let the learners understand that there are unique energy levels which carry more than the expected number of electrons.
- Let the learners draw an energy level diagram of sodium on the board. Allow them to discuss the structure and explain why the diagram is drawn that way. Allow them to compare their drawing to the theoretical diagram of sodium. Allow them to discuss their outcome.
- This allows the learners to learn more on how electrons are distributed in the energy levels.
- Ask the learners to write electronic configuration of the other elements in the activity and share their answers with the rest of the class.

(Ensure the learners have some knowledge of the periodic table which they also learnt from their previous lessons in book 1. If not, give them time to carry out some research just to remind themselves on what the periodic table is).

Expected answers

An element like sodium has atomic number 11. The 1st energy level can only be filled by 2 electrons, 2nd energy level is filled by 8 electrons and the 3rd energy level is filled by 1 electron making the arrangement 2.8.1.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During discussions observe and listen to each and every learner's contribution to the discussion as you go to each group.

b. Conversation

Ask learners probing questions to test their knowledge on importance of the periodic table.

c. Product

Appraise each learner on:

- Their acquired skills on how to write the electronic configuration of the 1st 20 elements. Correct when necessary.

Answers to Check your progress 2.2

Refer to page 36 of student's book

1.

a) 14

b) 13

c) 2.8.3

2.

Sub atomic particle	Symbol	Charge	Location in atom
Electron	E	-1	Energy level
Neutron	N	0	Nucleus
Proton	P	+1	Nucleus

3. Terms:

a) Atomic number is the number of protons in the nucleus of an atom.

b) Mass number is the total number of protons and neutrons in an atom.

c) Relative atomic mass of an element is defined as the average mass of an atom of the element compared with 1/12 of the mass of carbon -12.

d) Isotopes are atoms of same element with the same number of protons but different number of neutrons.

2.2 The periodic table of elements

Activity 2.3:Drawing the Periodic table

Refer to page 37 of student's book

In pairs

- Introduce the lesson by emphasizing on the fact that from the electronic configuration we can locate the position of elements in the Periodic Table.
- Learners should state elements with the same number of electrons in the outermost energy level and those with the same number of energy levels.
- Let learners list down the 20 elements then discuss and share with the class where they think the elements are located in the periodic table. Allow every learner to participate in this activity.
- Correct learners where necessary and ask them to compare theoretical findings to their answers, reminding them that knowledge of the 20 elements electronic configuration is critical in determining the position of the element in the periodic table.

  (Give learners time to discuss amongst themselves the 20 elements of the periodic table. Provide them with the necessary research materials.)

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the discussion observe and listen to each and every learner's contribution

to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

The learners should also talk among themselves to gauge their knowledge. Ask diagnostic questions to assess knowledge and understanding by observing as learners discuss about the 20 elements in the periodic table and their electronic configuration. Encourage them to share the answers with the class.

Assess skills acquisition by asking learners to:

- Determine the position of an element from its electronic configuration.
- Classify elements which belong to the same group from a list.

Answers to Check your progress 2.3

Refer to page 41 of student's book

1. (i) 2.8.2; 2.8.3; 2.8.7

   (ii) Group II, III, VII

   (iii) X&Y

   (iv) Z

   (v) 2,3 and 7

2. Ensure that learners have placed each elements where it belongs in the periodic table.

2.3 Ion formation

Activity 2.4:

Refer to page 42 of student's book

Individually

- Introduce the lesson by revisiting the previous lessons on electronic configuration.
- Allow the learners to draw the electronic arrangements and discuss their findings. What is different about these elements from elements like sodium, magnesium and other metals.

Expected answers

The elements have all their energy levels filled up unlike sodium and magnesium.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Assess knowledge and understanding by allowing the learners to use the knowledge from their previous lesson to identify where the elements belong in the periodic table. Allow them to share their answers with the class and correct where necessary.

Activity 2.5: Formation of lithium and magnesium ions

Refer to page 44 of student's book

In pairs

- Remember that the students should fully participate in the lesson. This can be done through questioning.
- These suggested questions can give a guideline

  I. What is the electron arrangement of lithium? Ans 2.1

  II. In order to achieve the octet or duplet rule, what should happen?

  At this point, you can go further to explain that it is easier to lose an electron to attain duplet arrangement of 2. In this case lithium will lose an electron to form a lithium ion.

  Write electron structure and electron arrangement for the ion formation of lithium. Indicate the contents of the nucleus as illustrated in the learner's Book.

  Show the imbalance of the electrons in the ion formed. In the neutral lithium atom there are three protons that are positively charged and four neutrons that are neutral. In the energy levels, there are three electrons that are negatively charged. When the lithium atom loses an electron, the net charge of the nucleus remains +3 whereas the outside of the nucleus reduces to –2. Net charge of the ion is +3-2 = +1. Lithium ion is represented as Li^{+}. Students sometimes write Li^{+1} which is not right.

- Go through example 2 with the learners, formation of magnesium ion as illustrated in the learner's book. Remember to remind the learners that the symbol of magnesium ion.is Mg^{2+} and NOT Mg^{+2} or Mg^{++}

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the discussion, observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

During presentation, observe learners' engagement and participation in the discussions.

b. Conversation

- To assess the understanding of the students you could give the following questions as assignment and check their work.
  I. Write the structures and electron arrangement for the formation of aluminium ion.
  II. Write the correct symbol of aluminium ion.
- Assist those students who may have difficulties in answering.
- You can now summarize the concept by defining a cation as a particle formed when there is loss of electrons to form positively charged ions. Give students more assignments on formation of cations for practice.

Activity 2.6:Formation of flouride and sulphite ions

Refer to page 44 of student's book

In pairs

- The same method of question and answer applies.
  I. What is the electron arrangement of fluorine? Ans: 2.7
  II. In order to achieve the octet or duplet rule, what happens? It can lose seven electrons to achieve an electron arrangement of 2 or gain one electron to

achieve an electron arrangement of 2.8. But for fluorine it is easier to gain an electron than to lose.

- Let the students write electron arrangement and structure of the formation of fluoride ion. Fluorine forms its ion by gaining an electron. The net charge of the ion is +9-10 = -1. The symbol of fluorine ion is F^- but NOT F^{-1}.
- At this point they can try on their own the formation of Sulphur ion as you check their work.
- Summarize by defining an anion as a negatively charged ion formed by gaining of electron(s). Give them further assignment from the revision exercises in the Student's Book.
- In general, metals found on the left side of the periodic table, lose electrons and non-metals on the right side of the periodic table gain electrons.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the discussion, observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

During presentation, observe learners' engagement and participation in the discussions.

b. Product

Appraise each learner on their ability to write the ion formation of different elements.

Ionisation energy and electron affinity

Refer to page 45 of student's book

- Start by allowing learners to brainstorm on their understanding of Ionisation energy. Previously, you have been teaching of ease to lose or gain electron(s) and difficulty to lose or gain electron(s) without emphasizing why this is so.
- Let learners understand that the nucleus of the atom is positively charged and attracts electrons which are negatively charged. To remove an electron these

forces of attraction must be overcome. Energy must be used to pull off the electron(s).

- From this knowledge, allow learners to predict on what Ionisation energy is. Let them compare their prediction to the theoretical definition.
- Illustrate Ionisation energy by using a general equation as given in the learners' book. $M(g) \rightarrow M^+(g) + e^-$

Electron affinity

Refer to page 45 of student's book

- Remind learners that during formation of ion by non-metals electrons are gained to form negative ions.
- Remind learners that there are electrons within the energy level and the energy levels are far from the nucleus, there is some resistance to accommodate another electron due to repulsion from other electrons. Force is required to move the electron into energy level and it is electron affinity.
- NOTE: It is very important to use very simple language at this level. At a higher level the technical language can be used. What is important at this level is to communicate to the students.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Observe as the learners discuss what Ionisation energy and electron affinity is. This will help you to assess knowledge acquisition on formation of ions. Listen to their answers as each student participates in sharing with the class and correct accordingly.

Allow the learners to carry out further research on Ionisation energy and electron affinity and compare that to their understanding from the activities carried out.

2.4 Bond formation

Activity 2.7: Ionic bond

Refer to page 46 of student's book

In pairs

- Begin the lesson by asking learners to draw on the board how ions are formed. This is to allow them to refresh their memories on ion formation from the previous lessons.
- Allow them to study sodium chloride ion formed in activity 2.7.
- Ask them to carry out a research on the different types of bonds that exist. Let them predict the bond formed by sodium chloride. Allow them to explain their answers.

Expected answer

- Ionic bond – sodium atom completely loses 1 electron from its outermost energy level to chlorine atom.

Properties of ionic compounds

Activity 2.8: To investigate the properties of ionic compounds

Refer to page 49 of student's book

In groups

- Begin by asking the learners to identify the material and apparatus they are about to use and if they recognise them.
- Allow the learners to predict what will happen at the end of the experiment.
- Allow learners to carry out the experiment taking precautions to avoid any contaminations.
- Ask them to keenly observe what happens and give reasons to their experimental observation.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Ask learners probing questions to test their knowledge on the importance of ionic bond. Learners should also talk amongst themselves on the same issues to gauge their knowledge.

Answers to Check your progress 2.4

Refer to page 51 of student's book

1) Ionisation energy is the minimum energy required to remove electron(s) from an atom in gaseous state while electron affinity is the ability of an atom to attract an electron.
2) Having 8 electrons in the outermost energy level of an atom to achieve stability.
3) Through:
    a) Sharing electrons
    b) Attraction between negatively charged and positively charged ions.
    c) A pool of electrons being attracted to positive nuclei in a metallic structure.
4) Check student's work to confirm the drawings.

Covalent bonding

Activity 2.9: Bonding in hydrogen molecule

Refer to page 52 of student's book

In pairs

- Allow learners to study the diagram in activity 2.9.

- From the research they did on the different types of bond, allow them to give their opinion and reason on what type of bond that is.
- Also allow them to mention other atoms that bond in that manner to form an ion.

Expected answer

- Covalent bond is formed when 2 or more atoms share electrons.

  Examples: hydrogen, hydrogen chloride etc.

Properties of covalent bonds

Activity 2.10: To investigate the properties of covalent compounds

Refer to page 53 of student's book

In groups

- Begin by asking the learners to identify the material and apparatus they are about to use and if they recognise them.
- Allow the learners to carry out the experiment and predict in each case what will happen.
- Allow them to share their prediction with the class and give reasons why. At the end of the experiment, allow the learners to compare their experimental observations with the rest of the class and with their predictions.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Assess knowledge and understanding as learners compare their predictions to their experimental results and depending on the outcome, allow them to explain their findings.

Allow them to use theoretical evidences to support their answers and predictions with the rest of the class. Contribute and correct where necessary.

Metallic bonding

Properties of metals

Activities 2.11 & 2.12:

Refer to pages 55-56 of student's book

In pairs

- Begin by asking the learners to study the structure in activity 2.11. Allow learners to research on what metals consist of.
- This knowledge will allow learners to carry out activity 2.12 with ease. Allow them to mention any metals that conduct electricity. This will enable you to know what prior knowledge the learners have about different metals. This will help the learners to link what they already know with the new content they are just about to learn.
- Mention any equipment made of metal and ask learners to suggest why the equipment mentioned is made of metal.
- Display to the learners charts on various metals. This will help remind them of what they learnt before.
- Show learners different metals in the laboratory. This will help to incorporate lifelong learning in the learners. It will enable learners know the colour of different metals and how they are stored in the laboratory.
- Allow them to discuss some other properties of metals based on the knowledge of what metals consist of.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. conversation

Ask learners some diagnostic questions in the course of the lesson to gauge their knowledge and understanding of the properties of metals such as:

I. Explain why metals have high melting and boiling points?

II. Why do you think aluminium conducts electricity more than magnesium?

III. Why are cooking utensils made of metals?

Ensure that you have done adequate research on metals before the classroom session so as to address any questions the learners may come up with concerning metals. Do not be quick to dismiss a learner's answer. Probe them further so that they can give more information.

b. Observation and listening

In order to assess skills a learner obtains from the practical activity, walk around the laboratory to assess how they connect circuits and how they heat metals. Even as you guide them, be keen on how confident they are performing the exercise.

Allow them to share their opinions and further explanations acquired through research with the rest of the class. Applaud and correct where necessary.

Hydrogen bonding

Activity 2.13:

Refer to page 57 of student's book

In pairs

- Allow learners to study the figure in activity 2.13. ask them to identify the bonds.
- Let the students know that water has both hydrogen bonds and van der Waal's forces. Allow them to research further on the bonds and collect their books go through their research.
- Use ammonia as another example of hydrogen bonding.

Answers to Check your progress 2.5

Refer to page 58 of student's book

1.

i. Potassium loses an electron very easily to attain a noble gas electronic configuration (argon). While chlorine reacts by gaining an electron to attain also argon electron arrangement. Potassium chloride formed when potassium and chlorine reacts is made of potassium ion (K^+) and chloride ion (Cl^-). These ions are stable hence unreactive.

ii. When a metal conductor is heated, the delocalised electrons gain kinetic energy and move randomly with increased speed. The increased thermal vibrations of positive centers hinder the free movement of the electrons, hence less electrical conductivity.

Ions are used in solutions (electrolytes) to conduct electricity, while solids (metals and graphite) use delocalised electrons.

2. Check learners books to see that they have drawn the correct diagrams.

3.

(a) C

(b) A

(c) D

(d) B

4.

(i) AB_2 – check learners' books to see that they have the correct formula and drawing.

5.

(i) S- High melting and boiling points. Conducts electricity in solution form.

(ii) P and Q.

6.

(a) They are both good conductors of heat and have high melting-points.

(b) Silicon forms a giant atomic structure (giant covalent structure). The covalent bonds between these atoms are very strong and hence the high melting point. Two chlorine atoms are bonded covalently to form chlorine molecule. The molecules are held together by weak attractive forces (van der Waal forces) and hence a low melting point.

7.

Silicon dioxide, diamond and graphite form giant atomic structures (giant covalent structures). The covalent bonds between the atoms are very strong and hence difficult to break them to separate the atoms. Therefore, to melt them, the heat energy in rooms is not enough.

8. Electrovalent bond is formed when there's complete transfer o electrons from one atom to another.

9.

(a) 12

(b) Group II, period 3

(c) Metallic bond.

(d) By using delocalized electrons.

Part 3 Formation of salts and Electrolysis

Refer to page 61-132 of student's book

Learn about	Key inquiry questions
Learners should understand how salts are formed by carrying out practical investigations and suggest a method of preparing a given salt from suitable starting materials. Learners should define and understand electrolysis, electrolytes and non-electrolytes and the effects of concentration on mobility of ions. They should explain how and why electrolysis can be used to separate some salts and apply the concept of selective discharge based on: (i) cations: linked to the reactivity series. (ii) anions: halides, hydroxides and sulphates e.g. aqueous copper(II) sulphate and dilute sodium chloride solution (essentially the electrolysis of water) and predict the likely products of an aqueous electrolyte, given relevant information. They should explain the application of electrolysis in daily life and relate the laboratory methods of preparing salts to domestic ones and appreciate the roles of electrolysis daily life.	• How to prepare salts in laboratory? • How do you determine solubility of salts? • Explain how and why electrolysis can be used to separate salts.

Knowledge and understanding	Skills	Attitudes
• Understand how salts are formed. • Explain how and why electrolysis can be used to separate some salts.	• Carry out practical investigations and suggest a method of preparing a given salt from suitable starting materials. • Predict what will happen based on theory	• Appreciate the applications of electrolysis.

Contribution to the competencies:

Critical and creative thinking: through investigation of composition air.

Communication: presenting group work to class.

Co-operation: group work.

Links to other subjects:

Physics: properties.

Biology: food and blood pressure.

Agriculture: neutralization of acidic soil and use of electrolyte water as sterilizers in farming.

Introduction to the unit

This unit will help learners gain more knowledge on what salts are apart from the common salts that we encounter on a daily basis. The activities will help in shedding more light on the soluble and insoluble salts. There are a number of different methods used to prepare different salts; depending on their solubility in water and reactivity.

There are many discussions to be held and predictions to be made to improve knowledge, critical thinking and communication which should be done effectively in order to share their knowledge for the benefit of others.

Competencies to be attained

- **Critical thinking** – as learners use the study questions to study the subject content
- **Communication** – as learners discuss, make presentations and read the procedures.
- **Cooperation and interpersonal skills** – as learners interact through group work.

Cross-cutting issues

- **Inclusive learning** – all learners should participate actively in class activities and during discussions.
- **Financial education** – learners should use chemicals in the specified quantities to avoid wastage.
- **Peace** – learners should accommodate views from other people during the discussions.

3.1 Methods of preparing salts

Activity 3.1 and 3.2: Preparation of zinc (II) sulphate

Refer to page 61 and 63 of student's book

In groups

- Introduce the lesson by asking learners to name other types of salts other than table salt. Let learners mention the importance of table salt. Do they know the chemical name of the salt? Inquire from them.
- Allow learners to predict what will happen and support their answers using chemical equations.
- Using the knowledge from previous experiments allow learners to state why copper II sulphate needs to be added to the reaction.
- Allow learners to give reasons why zinc is added some remain unreacted. Allow discussions. Make the lesson as interactive as possible by asking questions in every step.
- Allow learners to explain their observations.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

You can assess their knowledge and understanding from the way they predict what will happen in every step and from their explanations of the predictions. Allow learners to share their answers and evidences with the rest of the class. They can also do a research project on the other alternatives for preparing zinc (II) sulphate. Collect their books for marking.

c. Product

Appraise each learner on how they use their knowledge to predict the outcome of the experiment.

Obtaining crystals

Refer to page 64 of student's book

- To obtain crystals of zinc (II) sulphate, boil the filtrate to evaporate excess water.
- Test the boiling filtrate from time to time to find out if the solution is saturated. You can do this by:

(a) Dipping a glass rod into the hot solution to remove a little of the liquid. The solution cools quickly on the glass rod. If the crystals form on the glass rod stop heating and let the solution in the dish cool slowly. Cover the solution with a filter paper to keep off dust particles. Leave it overnight.

(b) Pour a little of the hot solution into a test tube and cool with cold water. If small crystals form, then let it cool slowly until the next session.

- When good crystals form, pour off the liquid. The liquid decanted is called the liquor.
- Rinse the crystals with a little distilled water.
- Dry the crystals between two filter papers or sunshine.

(ii) Reaction of a dilute acid with an insoluble metal oxide or hydroxide

Activity 3.3: Preparation of copper (II) sulphate from copper (II) oxide

Refer to page 66 of student's book

In groups

- Introduce the lesson by reminding learners that copper (II) oxide is an insoluble metal. Ask them to identify the chemicals and apparatus that they will be using.
- Using the knowledge from the previous activity, ask learners to predict which acid can be used in the preparation of copper (II) sulphate.
- Allow learners to predict what will happen and support their answers using a chemical equation.
- Allow learners to give reasons the acid needed to be warmed. Ask prompting questions in every step to assess learners' knowledge.
- Allow learners to explain their observations before and after crystal formation.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

You can assess their knowledge and understanding from the way they predict what will happen in every step and from their explanations of the predictions. Allow learners to share their answers and evidences with the rest of the class. They can also do a research project on the other alternatives for preparing copper II sulphate. Collect their books for marking.

c. Product

Appraise each learner on how they use their knowledge to predict the outcome of the experiment.

(iii) Reaction of dilute acids with metal carbonates and metal hydrogen carbonates

Preparation of lead (II) nitrate from lead (II) carbonate

Activity 3.4:

Refer to page 69 of student's book

In groups

- Introduce the activity by asking learners what happens when acids react with metals.
- Allow the learners to discuss and compare their chemical equations. Let them try to determine which is correct by supporting their answers based on the previous knowledge from book 1.
- Introduce activity 3.4. allow learners to predict what will happen at the end of the experiment.
- Let them make an observation and explain why what they are observing at that time is occurring.

- How can they prove what they are observing? For instance, when effervescence occurs, it means production of a gas. How can they determine the gas produced?

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

Allow learners to discuss about the reactions between acids and metals. Encourage the learners to talk about the reactions by asking questions and helping where necessary. This enables them encounter a wider range of ideas from sharing with other learners.

Allow them to compare the theoretical knowledge to their predictions, this helps learners focus more on the essential parts. This will also help boost their confidence as they share their answers and proof with the rest of the class.

Give them research projects or work to do as homework and collect their books for marking. This will allow you to assess which areas they need further clarification.

c. Product

Appraise each learner on how they use their knowledge to predict the outcome of the experiment.

Expected answers

- Acids react with metal carbonates to form salt, carbon dioxide and water

iv) Reaction of a dilute acid with an alkali

Preparation of sodium chloride from sodium hydroxide

Activity 3.5:

Refer to page 71 of student's book

In groups

- Introduce the activity by asking learners what happens when an acid reacts with an alkali.
- Allow the learners to discuss their answers and chemical equations. Let them try to determine which is correct by supporting their answers based on the previous knowledge from book 1.
- Introduce activity 3.5. by allowing learners to predict what will happen at the end of the experiment.
- Let them make an observation and explain why what they are observing at that time is occurring. Encourage them to keep an eye on the colour changes when the acid is added to the alkali solution.
- Allow learners to determine an alternative way of preparing sodium chloride. Let them support this by use of chemical equations.

Expected answers

Sodium chloride can also be prepared by use of its carbonate and a mineral acid to form sodium chloride, water and carbon (IV) oxide.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion. You can also go around the groups as they are performing the experiment to assess their attitude. Check for tolerance to others views, commitment and engagement.

b. Conversation

Allow learners to discuss the chemical equations, this helps you to assess their knowledge in writing the equations and understanding. Allow them to compare their predictions with their experimental results.

You can correct them where necessary as you encourage them to share their answers and predictions confidently with the class.

c. Product

Appraise each learner on how they use their knowledge to predict the outcome of the experiment.

b) Preparation of insoluble salts

i. Preparation of insoluble salts by precipitation

Activity 3.6: Preparation of lead II sulphate

Refer to page 75 of student's book

In groups

- Introduce the activity by asking learners what happens when lead II nitrate reacts with dilute sulphuric acid. You can just quickly inform the learners that most compounds of lead are insoluble exception being lead II nitrate. They will learn about this later in the unit.
- Allow the learners to discuss their answers and chemical equations. Let them try to determine which is correct by supporting their answers.
- Introduce activity 3.6. by allowing learners to predict what will happen at the end of the experiment. They should be able to come up with answers such as their will be an insoluble lead II sulphate formed. Ask the learners why the lead (II) sulphate is insoluble.
- Let them make an observation and explain why what they are observing at that time is occurring. This is especially important during the reaction process.
- Allow learners to discuss and come up with the right equation for the reaction that took place.

Expected answers

- When lead (II) nitrate reacts with dilute sulphuric acid, the sulphuric acid forms a coating on the lead II nitrate resulting in a white insoluble lead II sulphate.
- They should also mention that the reaction stops after sometime after the white insoluble coating has been formed.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

You can assess their knowledge and understanding from the way they predict what will happen in every step and from their explanations of the predictions. Allow learners to share their answers and evidences with the rest of the class.

c. Product

Appraise each learner on how they use their knowledge to predict the outcome of the experiment.

3.2 Ionic equation

Formation of coloured precipitates

Activity 3.7:

Refer to page 78 of student's book

In groups

- Allow learners to use the same procedure they used in the preparation of sodium chloride (neutralization method) to prepare the salts in activity 3.7.
- You can 1st ask them to just mention what they expect to get as the product in each case. Let them do this answering session as a class before they begin the experiment.
- Using the knowledge, they have acquired in the previous lesson on ionic equation, allow learners to write down the ionic equation in every reaction. Let them say whether it is soluble or insoluble.
- Ask them to do a research on the solubility part.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Allow learners to discuss the chemical equations, this helps you to assess their knowledge in writing the ionic equation. Allow them to compare their predictions with their experimental results. Assist those learners who are having difficulties in writing the ionic equations. Allow learners to share their findings on the solubility of the salts.

Work to do:

Refer to page 81 of student's book

- Allow learners to write the ionic equation of iron (III) chloride with sodium hydroxide.
- Ask them use to use the example provided in their learner's book.

Expected answer

Iron(III)chloride + sodium hydroxide $\longrightarrow$ sodium chloride + iron(III)hydroxide

$FeCl_3(aq) + 3NaOH(aq) \longrightarrow 3NaCl(aq) + Fe(OH)_3(aq)$ (brown)

$Fe^{3}+(aq) + 3OH(aq) \longrightarrow Fe(OH)_3(s)$(brown)

ii. Preparation of insoluble salt by direct combination of elements.

Activity 3.8: Preparation of sodium chloride by direct combination of sodium and chlorine

Refer to page 82 of student's book

In groups

- Allow the learners to come up with an equation for the reaction of sodium and chlorine.
- Allow them to predict what will happen at the end of the experiment. They can also say if they have come across sodium chloride in their day to day life and suggest some of the uses of sodium chloride.

Expected answers

- Learners should in this case mention the table salt which is the most common edible form of sodium chloride.
- It is used as a condiment and food preservative.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. conversation

Allow learners to discuss and write the formula for the reaction this will help you assess whether they are already familiar with the product formed from this reaction.

Activity 3.9: To find out what happens when certain salts are exposed in the air

Refer to page 83 of student's book

In groups

- Start the lesson by reminding learners of the activity they carried out in unit 1 to determine presence of water vapour in the air.
- This will help learners have an idea of what the activity they are about to do is all about. Allow learners to predict what will happen to each salt after the experiment, will it change colour, will it be soluble or will it loose water?
- The activity will take 3-7 days but before that, let learners compare their predictions to the theoretical findings.
- Allow learners to also compare their experimental results to their predictions and theoretical findings.
- Allow learners to say whether they were able to get the right results from their experiment

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the class presentation, check for tolerance to others views, commitment and engagement.

b. Conversation

You can assess their knowledge and understanding from their predictions. Allow them to compare their predictions to their theoretical findings and share with the rest of the class. Once they receive their experimental results, allow each group to share their results with the rest of the class.

Determining solubility of salts

Activity 3.10: To make a saturated solution

Refer to page 85 of student's book

In groups

- Start the lesson by asking learners if at any point they ever tried putting so much sugar in their cup of tea to a point where it could not dissolve anymore.
- Allow the learners to suggest what name is given to that kind of solution. They can use the knowledge acquired from unit 1 in book 1 chemistry.
- You can ask them to state whether they could be able to obtain the undissolved sugar and what procedure they could use to do that.
- Encourage them to share their thought with the class.
- Introduce activity 3.10, ask learners to identify the apparatus and chemicals provided to them.
- Allow learners to observe what happens as they perform the activity. They can also make a prediction on what will happen when the solution is warmed. Let them share their answer with the class.

Expected answers

- The solution is saturated.
- It can be obtained by crystallisation.
- Warming allows more solid to be absorbed.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

Asking learners about sugar being dissolved in tea helps to assess knowledge and understanding. The scenario also creates long term memory in the minds of learners. Learners coming up with ways of obtaining the sugar enables you to assess critical thinking and communication skills when they share their answers with the class. Allow the learners to also compare their experimental finding to their predictions and share with the class. Correct where necessary.

Activity 3.11: To investigate solubility of some salts

Refer to page 86 of student's book

In groups

- Begin the lesson by asking learners if they can identify the salts in front of them.
- Remind them of activity 3.7 where they were investigating the formation of coloured precipitates.
- Using that knowledge, ask learners to predict in their specific groups the soluble and insoluble salts.
- Allow them to share their group discussion with the class. They can choose a secretary from the group who will read out their prediction as the other group members assist him/her by giving reasons for that answer.

(Ensure every group participates in this discussion)

Expected answers

Learners should come up with such explanation for their answers:

- All K, Na and ammonium salts are soluble.

- All nitrates and hydrogen carbonates are soluble.
- All sulphates are soluble with exception of lead sulphate and barium sulphate. Calcium sulphate is slightly soluble.
- All chlorides are soluble except silver chloride. Lead chloride is only soluble in hot water.
- All carbonates are soluble with exception of K, Na, and ammonium carbonate

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Product

Appraise each learner on how they use their knowledge to predict the outcome of the experiment.

3.3 Action of heat on salts

Activity 3.12: To investigate the action of heat on carbonates and hydrogen carbonates

Refer to page 89 of student's book

Activity 3.13: To investigate the effect of heat on nitrates

Refer to page 92 of student's book

Activity 3.14: to investigate the effect of heat on sulphates

Refer to page 97 of student's book

In groups

- You can start the lesson by asking learners what they expect when a carbonate and hydrogen carbonate is heated. Allow them to state the test for carbon dioxide which is produced.
- Allow them to carry out experiment 3.12 as they predict the observation in each reaction.
- Before they begin activity 3.13, allow learners to write the chemical equation when a nitrate is heated. How do they test for the presence of oxygen gas produced?

- Same goes to activity 3.14, allow learners to write down the chemical equation showing the products formed.
- Let learners compare their predictions to the experimental findings. They can also back this up with theoretical findings.
- Advise them to take the necessary precautions when heating the substances. Remind them of the laboratory rules from book 1 chemistry.
- Remind learners that they should not smell the gases directly.

  (Give the learners enough time to perform the activities ensuring every learner participates)

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement during class presentations.

b. Conversation

You can assess their knowledge and understanding from their discussions on the products formed and how to test for the gases produced during the reaction.

c. Product

Appraise each learner on how they use their knowledge to predict the outcome of the experiment.

Uses of salts

Activity 3.15: Research activity

Refer to page 99 of student's book

In pairs

- Allow learners to carry out research on uses of salts.
- Allow them to present to the class.

Answers to Check your progress 3.1

Refer to page 100 of student's book

1. A salt is a compound formed when hydrogen ions of an acid are fully or partially replaced by a metal ion.

2.

   (a) Acid salt is formed when not all the hydrogen ions of the acid have been replaced by metal ions whereas normal salts all the hydrogen ions of an acid are replaced by metal ions.

   (b) Anhydrous salts do not have water of crystallisation whereas hydrated salts contain water of crystallisation.

   (c) Deliquescent salts absorb water from the air and dissolve in it. While efflorescent salts lose water of crystallisation to the air. Hygroscopic substances absorb water from the air but do not form a solution

3. Reaction of two compounds resulting in the formation of an insoluble product.

4. The crackling sound produced by lead (II) nitrate when it's heated.

5. (a) Lead metal when reacted with dilute sulphuric acid, it forms an insoluble salt which coats the metal preventing further reaction.

   (b) Lead nitrate is soluble, therefore, you can prepare lead sulphate by adding dilute sulphuric (VI) acid on lead (II) nitrate.

6. Methods of making normal salts:

   (a) Action of acid on a metal

   $Zn\ (s) + H_2\ SO_4\ (aq) \longrightarrow ZnSO_4\ (aq) + H2\ (g)$

   (b) Double decomposition

   $Pb\ (NO_3)_2\ (aq) + H_2SO_4\ (aq) \longrightarrow PbSO_4\ (S) + 2HNO_3(aq)$

   (c) Neutralisation reaction

   $HCl\ (aq) + KOH \longrightarrow (aq)\ KCl\ (aq) + H_2O\ (l)$

7. To obtain crystals of zinc sulphate, boil the filtrate to evaporate excess water.

Test the boiling filtrate from time to time to find out if the solution is saturated. You can do this by:

(a) Dipping a glass rod into the hot solution to remove a little of the liquid. The solution cools quickly on the glass rod. If crystals form on the glass rod stop heating and let the solution in the dish cool slowly. Cover the solution with a filter paper to keep off dust particles. Leave it overnight.

(b) Pour a little of the hot solution into a test tube and cool with cold water. If small crystals form, then let it cool slowly until the next lesson. When good crystals form, pour off the liquid. Rinse the crystals with a little distilled water.

Dry the crystals between two filter papers or in sunshine.

8.

(i) Neutralisation reaction.

(ii) Prepared by precipitation reaction between silver nitrate and sodium chloride.

(iii) Prepared by precipitation reaction between lead nitrate and sodium chloride.

(iv) Prepared by direct combination.

9. Carbonates decompose on heating to metal carbonate, water and carbon (IV) oxide other decompose to their respective metal oxide and carbon (IV) oxide. Carbon (IV) oxide does not relight a glowing splint.

Some nitrates decompose form metal nitrite and oxygen gas whereas others decompose to metal oxide, nitrogen (IV) oxide and oxygen gas.

10.

Solutions	**Silver nitrate**	**Sodium sulphate**
Sodium chloride	√	x
Barium chloride	√	√
Lead nitrate	x	√
Calcium chloride	√	√
Magnesium sulphate	x	x

11. Fertilisers, baking, softening hard water etc.

3.4 Electrolysis

Activity 3.16: Investigating conductivity of aqueous solution

Refer to page 101 of student's book

In pairs,

- Introduce the lesson by recapping on unit 3 of book 1 chemistry on acids and bases. Inform learners that this lesson will be about electrolysis.

  (Ensure that all the liquid solutions to be tested are labelled to avoid mix up).
- Using that knowledge ask learners if the solutions provided can be able to conduct electricity.
- You can start by carrying out the experiment first so that the learners can observe. Let them note the observations and compare their prediction to the results at the end of each experiment.
- Allow them to carry out the rest of the experiment.
- Those students who were not able to get the results right might have contaminated their solutions. Allow them to realize that using different apparatus for each experiment is important to avoid contamination.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Ask learners questions during the experiment, like why some solutions conduct electricity and not others. From the answers the learners give, you will be able to assess knowledge and understanding. Let them compare their predictions to their findings from the experiment. Allow them to compare those two to the theoretical findings.

b. Observation and listening

While they work on the experiment, you can go round looking at the way they are working and how they handle the solutions. Check for tolerance to others views, commitment and engagement.

3.5 Electrolysis of molten compounds

Activity 3.17: Testing the conductivity of molten substances

Refer to page 103 of student's book

In groups

- Begin by informing learners that lead (II) bromide or lead (II) iodide produces poisonous fumes and they will need to take precautions by performing the experiment under the fume chamber.
- Ask learners to identify the apparatus and chemicals and which one will conduct electricity in its molten state.
- They can then go ahead and do experiment 3.18. allow them to compare their predictions to their experimental results.

Activity 3.18: To investigate conductivity of molten lead (II) bromide

Refer to page 109 of student's book

In groups

- Remind learners that the experiment will be performed in a fume chamber.
- At this point, learners should already have an idea if lead II bromide in its molten state conducts electricity. Let them answer this using the knowledge from the previous experiment.
- Let the learners know that in this experiment, they will be observing keenly what takes place at the anode and cathode.
- Allow the learners to suggest what they expect to observe at the end of the experiment and also provide reasons for their answers.
- At the end of this experiment, learners should compare their results to the predictions.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

You can assess their knowledge and understanding from the way they answer the diagnostic questions.

Preferential discharge

Activity 3.19: To investigate preferential discharge in the electrolysis of dilute sodium chloride solution, dilute sulphate acid and magnesium sulphate

Refer to page 112 of student's book

In groups

- Guide learners in setting up apparatus and instruct them to follow the laid down procedures for the experiment. Assist them where necessary when setting up the experiment.
- Ask learners what they expect at the cathode and anode. Using the knowledge of preferential discharge, ask the learners to predict what they expect at the end of the experiment
- Allow them to compare the prediction to the experimental results.
- You can then go ahead and explain the results from sodium chloride using ionic equations.
- Allow a few learners to come forward and explain how magnesium sulphate solution and dilute sulphuric acid are preferentially distributed at the cathode and anode.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

You can assess their knowledge and understanding from the way they answer the diagnostic questions.

Electrolysis of copper (II) sulphate solution using different electrodes

Activity 3.20: to investigate how the nature of an electrode affects electrolysis of copper (II) sulphate solution

Refer to page 116 of student's book

Activity 3.21: Electrolysis of copper (II) sulphate solution using copper electrodes.

Refer to page 117 of student's book

In groups

- Guide leaners in setting up apparatus and instruct them to follow the laid down procedures for the experiment. Assist them where necessary when setting up the experiment.
- They should make proper observations, record the results from the experiment. Allow learners to discuss the difference noted at the cathode and anode in both experiments.
- Allow them to come up with suggestions why the carbon electrodes did not change whereas the copper electrodes went through some changes.
- At this point give a summary of electrolysis of copper (II) sulphate.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion. While they work on the experiment, you can go round looking at the way they are working, and how they interact with each other, how they share responsibilities, this will help you to assess co-operation. Check for tolerance to others views, commitment and engagement.

b. Conversation

You can assess their knowledge and understanding from the way they answer the diagnostic questions.

3.6 Quantity of electricity

Refer to student's book 119

Teaching methodology

- Class discussion can be used to relate the electricity passed to amount of substances liberated at the electrodes.
- Class demonstration to determine the amount of copper liberated during electrolysis by different quantities of electricity.

Introduction to quantity of electricity

- Introduce this concept by linking what they have learned in electrolysis and the quantity of electricity.
- Introduce them to the formula used to calculate the quantity of electricity.
- Use the example that has been given in the Student' Book to a calculate the quantity of electricity i.e $\theta = It$ or $C = A \times S$
- For the students to understand better demonstrate experiment below.

Experiment

To determine the amount of copper liberated during the electrolysis of copper(II) sulphate solution by passing different quantities of electricity.

Teaching/learning resources

Apparatus and chemicals

- sensitive balance (electrical/digital)
- 2 strips of copper electrodes (same size)

- battery/dry cells (6V)
- rheostat (variable resistant)
- connecting wires
- emery papers
- ammeter
- stop clock/stop watch
- copper(II) sulphate solution

Presentation of activities

- Ask the students to stand around the preparation table. Make sure that every student can see the demonstration well.
- Follow the procedures as outlined in experiment 4.11 in the Student's Book. Encourage the students to take responsibility and participate when doing the experiment. Also, interact with them through questioning.
- They should note down any changes in colour and any other changes. Since they already have an idea of what is going on in the experiment, remind them that they should record only the results from the experiment and not what they think the results should be.
- Ask them to draw a table similar to Table in their notebooks. They should record the results in that table.
- Ask them to plot a graph using the results obtained.
- You can now introduce Faraday's first law. Show them using the examples given in the Student's Book how to apply the law in calculations.

Development of skills

By the end of this sub-topic, the following skills should be developed by the learners.

- State Faraday's first law of electricity.
- Relate quantity of electricity passed to amount of substances liberated at the electrodes.
- Observation - as they observe what happens in electrolysis of copper(II) sulphate using copper electrodes.

- Makimg conclusions - make conclusions from the above observations.
- Recording - as they record data in their notebook.
- Drawing - of a graph from data obtained.
- Writing balanced redox equations.
- Calculating as they calculate quantity of electricity from given information.
- Problem solving - the uses the acquired knowledge and skills to relate the quantity of electricity passed to amount of substances liberated at the electrodes.

3.7 Application of electrolysis

Activity 3.23: Research activity

Refer to page 128 of student's book

In pairs

- Begin the lesson by asking learners to carry out research activity on the applications of electrolysis in their day to day life and in industries.
- Allow them to make a presentation in class on their findings
- From their findings, introduce application of electrolysis as outlined in the learner's book.
- Discuss each application using charts, diagrams and videos as they take notes. Bring to the learner's attention the equation involved and how the reactions take place during extraction of metals, refining of metals, and manufacture of sodium hydroxide, chloride and hydrogen.
- Inform learners that one of the most important applications of electrolysis is electroplating of metals. Carry out a demonstration so that learners can understand this concept.
- Discuss electroplating as outlined in the learner's book.
- Explain to learners the reactions that take place in the electrodes i.e. anode and cathode and the overall equation for the reaction.

- At this point give a summary of electroplating.
- End the lesson and topic by instructing learners the self-tests.

Answers to Check your progress 3.2

Refer to page 131 of student's book

1.

i. Electrolysis is the decomposition of a substance by an electric current.

ii. Cathode-negative terminal; anode-positive terminal

iii. A strong electrolyte undergoes complete dissociation to form ions while a weak electrolyte undergoes incomplete dissociations producing less ions.

iv. An electrolyte is a substance that decomposed by electric current to produce ions that conduct electricity while a non-electrolyte is a substance that does not dissociate in solution hence a poor conductor of electricity. Examples of electrolytes are salt solutions and dilute acids while examples of non-electrolytes include sugar solution, alcohol.

2. A metallic conductor uses delocalized electrons to conduct electricity while an electrolyte uses ions to conduct current.

3.

(a) i.Bromine ions move to the anode- brown vapour is observed at the anode.

ii.lead ions move to the cathode- brown metal is formed at the cathode.

(b) Lead (II) iodide does not conduct electricity in its solid state, it has to be melted.

4. The positive ions in the electrolyte are deposited in the cathode causing an increase in mass of the cathode, negative ions move to the anode. The electrode dissolves causing a decrease in mass of the electrode.

(check the learner's book to see that they have the correct diagram showing movement of electrons at the cathode and anode).

5. Cathode-hydrogen gas; anode- oxygen gas

6.

(a) Factors-position of ion in the electrochemical series, concentration of the competing ions in the electrolyte, nature of the electrode.

(b) Check learner's book to see that they have explained how the electrolysis of copper(II)sulphate takes place (refer from activity 3.19).

7. Check learners' work to see that they have the correct electrolysis of lead(II) iodide. (check activity 3.17)

8. Refer to learners' book for the application of electrolysis.

9. 2.96g

10. Ca = 0.62g, Chlorine =1.1g

Part 4

Carbon, its atomic structures and compounds

Refer to pages 133-166 of student's book

Learn about	Key inquiry questions
Learners should find out about carbon, its atomic structures, its allotropes (e.g. diamond and graphite) about know the compounds of carbon e.g. oxides and carbonates and the structure of graphite and understand why it conducts electricity whereas diamond does not. Learners should explain the physical properties of the allotropes of carbon in terms of bonding, and relate the uses to their properties. Learners should understand the role of carbon compounds (humus) in the ecosystem, provides nutrients for plants and is a good water reservoir.	• Why do we study structure of carbon? • How do structures of carbon relate to its physical properties? • How would you show that graphite is made up of carbon atoms? • How does carbon in carbon dioxide contribute to global warming and how does an understanding of the carbon cycle help?

Knowledge and understanding	Skills	Attitudes
• Understand carbon, its atomic structures and compounds. • Understand why carbon conducts electricity whereas diamond does not.	• Research second hand evidence from a wide range of sources. • Investigate and report of the significance of carbon compounds. • Present reasoned explanations for phenomena, patterns and relationships.	• Appreciate the importance of carbon to all life on Earth.

Contribution to the competencies:
Critical and creative thinking: through investigation of composition air.
Communication: presenting group work to class.
Co-operation: group work.
Links to other subjects:
Biology: carbon atoms links to amino acids, fats and sugar.
Physics: structure and bonding relates to properties of matter and energy changes.
Agriculture: humus is made of carbon that provides nutrients for plants and conserves soil water for ecosystem.

Introduction to the unit

This unit will help learners understand the structure of carbon and its allotropes. The activities will help learners to understand that the physical properties of carbon vary depending on the allotropic form.

There are many discussions to be held about carbon and its compound and learners should be encouraged to communicate clearly and effectively in order to share their thoughts and knowledge for the benefit of others.

The activities in this unit focus on the different forms of carbon. It is however possible to find alternative and additional activities that you may choose to set as a research project or homework for the learners in order to improve their knowledge and understanding

Competences to be attained

1. **Co-operation**

   Encourage learners to work as a team through group discussions. Allow learners to freely interact with one another. Let them associate with one's culture and abilities through resources sharing and exchange of ideas. The principle of co-operation should be listening to understand but not listening to respond. All learners to be given equal opportunities irrespective of their abilities. Ensure every learner enjoys the sense of work regardless of their skin colour or physical fitness.

2. **Communication**

   During group discussion, encourage learners to discuss in English. This will build on the command of language as well as ability to participate in other

discussions. Ask them questions and give them a chance to attempt answering in the simplest way possible. This way, they will build on their confidence and soon develop the love and passion for the subject. Allow some room for learners to make mistakes and then correct them in nice way lest they will feel demoralized.

3. Critical and creative thinking

Introduce the unit by posing general questions to the learners they try to look for the answers to these questions, you will make them develop a thinking culture as they try to relate the unit with the questions given to them. These questions should however trigger the idea of what they should expect from the unit. Present photographs and make learners discuss the activities in those photograph, they give out their findings, you will be building a thinking habit in them.

Cross-cutting issues

- **Inclusive learning** – All learners should participate actively in class activities.
- **Financial education** – learners should use chemicals efficiently to avoid wastage.
- **Health check** – learners should be careful when handling chemicals and laboratory equipment.

4.1 Introduction

Activity 4.1: Observing photographs

Refer to page 133 of student's book

In groups

- Begin by asking learners to look at the pictures in the learners' book. Allow the learners to say whether they are familiar with the pictures and name each item.
- Allow them to discuss and share with the class the uses of those items.
- Encourage learners to suggest other activities that produce carbon.
- Allow the learners to work in groups and do work to do in the learners' book. This will enable learners to cooperate with their friends by listening to their opinions hence develop interpersonal skills

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Allow learners to suggest the kind of activity going on in the pictures this way you will be able to assess their knowledge and understanding of this unit. Allow learners to come up with other activities where carbon is released or used to assess critical thinking. Ask the learners to investigate on the common form of fuel used in their locality this is to assess knowledge and understanding.

4.2 Allotropes of carbon

Activity 4.2 and 4.3 Diamond and graphite

Activity 4.2:

Refer to student's book pages 136 and 137

In groups

- Guide learners on how to do research as they do activity 4.2 and 4.3.
- Allow the learners to discuss their findings and share with the class. As they discuss, they will develop problem solving skills and develop critical thinking.

Expected answers

Elements that exhibit allotropy:

- Oxygen
- Sulphur
- Phosphorous

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Assess attitudes and values by finding out if they appreciate the importance of carbon and its allotropes' significance to the economy. Assess knowledge by asking learners questions linking applications of carbon allotropes to day-to-day life.

Answers to Check your progress 4a

Refer to page 138 of student's book

1. The existence of an element in more than one form but in the same physical state.
2. Diamond & graphite.
3. Diamond.
4. Check learner's work to see that they have compared the allotropes of carbon in terms of structure, bonds formed, appearance, uses, etc.

4.3 Amorphous carbon

Activity 4.4: burning substances

Refer to page 138 of student's book

In groups

- Begin the lesson by asking learners to take precaution while carrying out the activity. Avail all the required substances for the activity. Let the learners identify the substances and describe them.
- Allow them to carry out activity 4.4 in learner's book. Let them make observations and note them down.
- Ask the learners to check the meaning of the word amorphous from the dictionary then do further research on what amorphous carbon is. Check that they are able to use the dictionary and the Internet.
- Now you can define what amorphous carbon is to the whole class.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Allow learners to discuss other forms of fuel apart from charcoal to test acquisition of knowledge and understanding. Ask learners questions such as uses of different forms of carbon in daily life to assess if they appreciate the importance of carbon.

b. Product

Appraise each learner on their ability to use the internet for research.

Properties of carbon

Activity 4.5:

Refer to page 139 of student's book

In groups

- Allow learners to predict what happens when you burn a piece of carbon. Let them share their thoughts with the class. They can write a chemical equation to support the answer.
- Ask them to now perform activity 4.5 then test for the presence of carbon dioxide.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Allow learners to test for the presence of carbon (IV) oxide using the knowledge acquired from past lessons. This will help you assess knowledge and understanding. Allow them to compare their finding to the experimental results. As they share their findings, assess communication and correct where necessary.

Reducing property of carbon

Activity 4.6: Heating carbon with copper (II) oxide

Refer to page 140 of student's book

In groups

- Introduce this activity by allowing learners to define what reducing agents are and what oxidising agents are. This should assess knowledge and understanding gotten from unit 4 chemistry book 1 on redox reactions.

  Expected answer: reducing agent is a substance that reduces another substance by removing oxygen from it, giving hydrogen to the substance or

giving electrons to the substance.

Oxidising agent on the other hand is a substance that oxidises another substance.

- From their definitions, you can then ask learners to predict what is likely to happen when carbon is passed through copper II oxide.
- Let them share their thoughts with the class.
- At this point it advisable to encourage them to always prove/support their answers with chemical equations. In this way they also improve their skills in writing down the chemical equations.
- Allow them to carry out the activity putting emphasise on the observations.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion. Allow learners to compare their predictions to their experimental results. Let them share their results with the class and correct where necessary. Go round the groups as they perform the activity, assist where the learners are having difficulties and also check on how they are writing down their observations.

b. Conversation

You can assess their knowledge and understanding from the way they predict what will happen and from their explanations of the predictions.

Give further activity to the learners and collect their books for marking this will especially help you in finding out whether the learners appreciate the use of carbon as reducing agent.

Answers to Check your progress 4.2

Refer to page 142 of student's book

1. Armophous carbon is the impure form of carbon.
2. Carbon reduces black copper (II) oxide into brown copper.
3. Acts as a reducing agent.

4.4 Oxides of carbon

Laboratory preparation of carbon (IV) oxide

Activity 4.7:

Refer to page 143 of student's book

In groups

- Begin the lesson by ensuring that learners understand that carbon (IV) oxide is responsible for extinguishing fire when a burning candle is covered with a container. (learnt in unit 1). Raising of dough in bread, responsible for the fizzing sound in soda and it's an ingredient in the fire extinguisher (also learnt in unit 1). Allow them to research all this and give their thoughts in work to do.
- Avail the apparatus they will be working with in activity 4.7. Allow them to observe and mention the apparatus.
- Inform them that they will be using those apparatus and chemicals to prepare carbon (IV) oxide.
- Let them predict what will be formed when carbon (IV) oxide is dissolved in water. What test can they use to prove their answer?
- What about when it's passed through calcium hydroxide, let them share their thoughts with the class. What kind of changes do they expect to see?
- What about if burning magnesium is lowered into it? Let them come up with a chemical reaction for this and share with the class.
- Allow learners to compare their predictions to their answers as they carry

out the activity.

- You can then take them through the preparation of carbon II oxide in the learner's book. You can carry out the activity as they watch.
- Allow them to note the difference in the apparatus and chemicals used. Make learners aware that carbon II oxide is a poisonous gas.
- You can then take them through the properties of carbon II oxide in the learner's book.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During the group discussion observe and listen to each and every learner's contribution to the discussion as you go to each group. Check for tolerance to others views, commitment and engagement.

b. Conversation

Assess knowledge and understanding by allowing learners to discuss and share their thoughts on what will happen. Ask learners questions such as uses of carbon (IV) oxide in daily life to assess if they appreciate the importance of carbon.

Remind the learners that carbon dioxide and carbon II oxide are oxides of carbon. The confirmatory test for carbon (II) oxide is calcium hydroxide which forms a white ppt. in the presence of carbon dioxide.

Answers to Check your progress 4.3

Refer to page 146 of student's book

1) Rain water contains dissolved carbon dioxide from the atmosphere which falls as weakly carbonic acid.
2) When carbon (IV) oxide is poured over burning candle, it will be extinguished. Carbon (IV) oxide forms a blanket that prevents entry of oxygen.
3) It used in fire extinguishers.

4) Burning oil will float on water making the fire to spread further that is why it is advisable to use fire extinguisher instead.

Answers to Check your progress 4.4

Refer to page 152 of student's book

1) Bubble carbon (II)oxide and carbon dioxide separately through lime water. Carbon dioxide will form a white precipitate whereas carbon (II) oxide will not.

2) Carbon (II) oxide combines with the haemoglobin in the blood to form carboxyhaemoglobin which reduces the capacity of red blood cells to transport oxygen to the tissues.

3) It is used as a fuel.

   It is used in the extraction of some metals.

4)

   Co_2 (g) + 2C (s) $\longrightarrow$ 2CO (g)

   2C (s) + O_2 (g)$\longrightarrow$ 2CO (g)

5) Carbon (II) oxide does not support combustion, it reacts with water to form carbonic acid, it reacts with alkalis to form salt and water.

   Carbon (II) oxide burns in oxygen to form carbon di oxide, it reduces metals lower in the reactivity series to their corresponding metals.

4.5: Carbonates

Work to do:

Refer to page 153 of student's book

- Let learners use their knowledge from unit 3 on action of heats on carbonates to answer the questions here.
- Allow them to make a list of carbonates.
- Finish by reminding them that the reactivity series helps to explain the action of heat on carbonates.
- With that knowledge, ask learners to do activity 4.8 in their Student's book.

Action of heat on carbonates

Activity 4.8: To investigate the effects of heat on carbonates

Refer to page 153 of student's book

In groups

- Allow learners to predict what will happen when the carbonates provided are heated. Encourage them to come up with chemical equations to support their answers.
- Let them share their thoughts with the class.
- Allow them to carry out the activity make observations of any colour changes, gases produced.
- Allow them to compare their predictions with the experimental results.
- You can now explain to them the products formed by carbonates when they are heated.

Activity 4.9: To investigate the action of dilute acids on carbonates and hydrogen carbonates

Refer to page 155 of student's book

In groups

- Allow learners to predict what will happen when an acid reacts with a carbonate or hydrogen carbonate. Encourage them to come up with chemical equations to support their answers.
- Let them share their thoughts with the class.
- Allow them to carry out the activity make observations.
- Allow them to compare their predictions with the experimental results.
- You can now explain to them the products formed from the learner's book.
- Ask the learners to investigate on some products that contain carbonates as an ingredient.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Conversation

Ask formative questions like why some carbonates did not decompose on heating. Let them use terms like carbonates decompose with ease as you go down the reactivity series. This helps in assessing critical thinking, knowledge and understanding, also when they come up with the chemical equations on the reaction of dilute acids with carbonates and hydrogen carbonates.

You can give further activity for better understanding of the reaction of carbonates. Also remind learners that carbonates of metals lower in the reactivity series on heating decompose to form metal oxides and carbon dioxide whereas dilute acids react with carbonates and hydrogen carbonates to form salt, carbon (IV) oxide and water

Answers to Check your progress 4.5

Refer to page 156 of student's book

1. Sodium carbonate and potassium carbonate.
2. Formation of an insoluble salt calcium sulphate which forms a coating on the unreacted carbonate preventing further contact with the acid.
3. After five minutes – formation of a white precipitate

   $Ca(OH)_2 (aq) + CO_2 (g) \longrightarrow Ca CO_3 (s) + H_2O (l)$

   At the end of the experiment, the white precipitate dissolves to form a colourless solution

   $CaCO_3 (s) + H_2O (l) + CO_2 (g) \longrightarrow Ca(HCO_3)_2 (aq)$

4.

a) $Na_2 CO_3$ (s)– No effect

b) $ZnCO_3 (s) \longrightarrow ZnO (s) + CO_2$ – A yellow substance is formed which turns to white upon cooling.

c) $KHCO_3(s) \longrightarrow K_2HCO_3(s) + CO_2(g) + H_2O(l)$ – A white substance is formed

5. Refer to activity 4.9 on the action of dilute acids on carbonates.

4.6: Large scale manufacture of sodium carbonate by Solvay process

Activity 4.10:

Refer to page 157 of student's book

In pairs

- Let learners observe the paper in their book. Allow them to come up with suggestions of how they think paper is made. Let them discuss the importance of treating drinking water.
- Inform learners that they will be having a field trip to the water treatment plant. During the field trip day, mention some of the water treatment plants in the region.
- Give highlight of what the learners should learn during the trip. Mention the areas of focus.
- Encourage them to note down whatever they learn during the trip for their report which you will then need to collect for marking.

Assessment opportunities

Check whether the lesson objectives have been met by:

a. Observation and listening

During discussion, observe and listen to each and every learner's contribution to the discussion. Check for tolerance to others views, commitment and engagement.

During class tours, observe learners' engagement and participation in the discussions, their curiosity to learn new things.

Activity 4.11: Simple demonstration of solvay process in the school laboratory

Refer to page 158 of student's book

In pairs

- Let the learners work in groups and carry out the activities in learners' book as they discuss.

- Allow them to suggest if they know of any alternative way of making sodium carbonate.
- As students study in groups, they learn to cooperate with their friends and listen to their opinions, this in turn will improve their interpersonal skills.
- let the learners present their report on the field trip and discussed work to the whole class and emphasize the effective ways of manufacturing sodium carbonate and its contribution in the development of the country's economy.

The carbon cycle

Refer to page 161 of student's book

Introduce the lesson by telling learners that carbon makes about 18% of our body mass. Mention some of the importance of carbon in our bodies.

Carry out class a discussion on some of the significance and effect of both carbon (IV) oxide and carbon (II) oxide in the enviroment.

Encourage learners to always plants trees both at home and at school. Encourage them to them to also take part in some of the activities such as the world environment day. Caution them agaist cutting trees and encourage them to use other renewable sources of energy such as wind,solar and biogas so as to minimise carbon (IV) oxide gas to the environment.

Assessment opportunity

Ask the learners to make a simple organic manure (Humus)

Answers to Check your progress 4.6

Refer to page 164 of student's book

1.

a) Carbon dioxide gas

b) Carbon (ii) oxide will burn with a pale blue flame to form carbon (II) oxide. There is plenty supply of oxygen in this region.

2.

a) Allotropes are different forms of an element in the same physical state.

b) Graphite it has delocalised electrons in the structure.

3. Carbon atoms in diamond are joined by strong covalent bonds which are hard to break.

4. Graphite is used as a lubricant or in pencil leads.

   Diamond is used in cutting metals and drilling through hard rocks, making jewellery.

5.

   (a) White precipitate

   (b) Copper (II) oxide + Carbon $\longrightarrow$ Copper + Carbon (IV) oxide

   $2CuO\ (s) + C\ (s) \longrightarrow 2Cu\ (s) + Co2\ (g)$.

   (b) Used in extraction of some metals; used as fuel.

6. Solid carbon (IV) oxide sublimes leaving no wetness.

7. When bubble through lime water, it will form a white precipitate.

8.

   a) Substance A – Sodium carbonate, B – Ammonium chloride, C – Calcium hydroxide, D – water.

   b) Gas X – Ammonia, Gas Y – Carbon (IV) oxide

   c) P (Calcium chloride) is used to dry gases.

   d) M – Coke

   $C\ (s) + O2\ (g) \longrightarrow Co2\ (g)$

   $CaCo3\ (s) \rightarrow CaO\ (s) + Co2\ (g)$

   e) Reactions in the chambers produce a lot of heat (Exothermic reactions).

   f) Sodium carbonate is used in water treatment.

   Sodium carbonate is used in glass making.

   Sodium carbonate is used in paper industries.

   g) Potassium hydrogen carbonate and ammonium chloride have almost the same solubility making it difficult to separate the two by filtration.

9. Copper (II) oxide reacts with dilute sulphuric acid to form a blue solution of Copper (II) sulphate. Carbon does not react with dilute sulphuric acid.

10.

(a) When sodium hydrogen carbonate is heated it produces carbon (IV) oxide which forms a white prepicitate with lime water. Sodium carbonate cannot be decomposed on heating.

(b) Sodium carbonate solution produces a white precipitate of magnesium carbonate when reacted with magnesium sulphate solution without heating. For sodium hydrogen carbonate, heating is required to get a white prepicitate of magnesium carbonate.

11.

(a) Check student's book to see how they have explained the greenhouse effect.

(b) In diamond, carbon atoms are bonded together by strong covalent bonds producing a crystal which is a single giant molecule. There are strong covalent bonds (carbon-hydrogen in methane), but the molecules are joined by weak van der waals forces. The heat energy in the room is enough to overcome the attractive forces between the molecules and separate the molecules.

(c) Sulphuric acid and barium carbonate react to form barium sulphate and carbon (IV) oxide. Barium sulphate which is insoluble forms a coating on the unreacted barium carbonate and the reaction ceases.

12. The student's should mention the allotropes of carbon as the pure forms of carbon and the armophous carbon as the impure form of carbon.

13. Student's should explain how carbon cycle works.

South Sudan

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