RWANDA BASIC EDUCATION BOARD

SAMPLES OF SCRIPTED LESSONS

CHEMISTRY

LOWER SECONDARY (S1-S3)

FOREWORD

Dear teachers,

Rwanda Basic Education Board (REB) is honoured to present the book of Chemistry lessons sampled from scripted of ordinary level. This booklet serves as a reference to competence-based teaching and learning that infuses the 5E Instructional Model to ensure consistency and coherence in the learning of Mathematics and Science content.

In line with efforts to improve the quality of education, the Government of Rwanda emphasizes the importance of aligning teaching and learning materials with the syllabus to facilitate their learning process. Many factors influence what pupils learn, how well they learn and the competences they acquire. Those factors include the relevance of the specific content, the quality of teachers' pedagogical approaches, the assessment strategies, and the instructional materials.

In this regards, Rwanda Basic Education Board (REB) is implementing the "Rwanda Quality Basic Education for Human Capital Development" Project. Some of the Project's objectives are: (a) increase teacher content knowledge; (b) improve classroom teaching practices; (c) ensure availability of critical teaching materials and ICT tools in the classroom; and (d) provide continuous support to teachers in their work. The sub-component 1.2 of the project has the aim of enhancing teacher effectiveness for improved student learning through different ways of supporting professional development of Mathematics and Science teachers.

Firstly, the project is helping teachers to use technology and improve their way of teaching through a complete yet simple package to be used in the classroom. This package includes the scripted lessons developed in one note.

Secondarily, the project helped teachers from schools without electricity by developing the sample scripted lessons as presented in this booklet. They are developed to serve you as reference of lessons that respect the 5E Instructional Model. This model consists of cognitive stages of learning that comprise 5 phases: Engage, Explore, Explain, Elaborate, and Evaluate.

Though this approach, students redefine, reorganize, elaborate, and change their initial concepts through self-reflection and interaction with their peers and their environment. As a result, learners interpret objects and phenomena observed in their real-life experience and internalize those interpretations in terms of their current conceptual understanding.

Even though this booklet contains the guidance on the main steps of the lesson, you are requested to regularly plan your lessons as usual basing on the current situation of your class environment: level of pupils, teaching materials, and motivating situation available at your school.

I wish to sincerely express my appreciation to the people who contributed towards the development of this booklet, particularly, REB staff, UR-CE Lecturers, Teachers, and experts from Local and international Organizations for their technical support.

Dr. MBARUSHIMANA Nelson

Director General, REB

ACKNOWLEDGEMENT

I wish to express my appreciation to the people who played a major role in the development of this book for Chemistry lessons sampled from scripted lessons of lower secondary (S1-S3). It would not have been successful without active participation of different education stakeholders.

Special thanks are given to University of Rwanda, College of Education and schools in Rwanda that allowed their staff to work with REB in the development chemistry scripted lessons books. Their commitment and invaluable inputs were very critical to finalize this document.

I owe gratitude to the Rwanda Basic Education Board staff particularly those from Curriculum, Teaching and Learning Resources Department who were involved in the whole process of the development work.

Finally, my word of gratitude goes to REB-SPIU under RQBE Project for their usual support in terms of human and financial resources towards improving the quality of education.

Joan MURUNGI

Head of CTLR Department

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INTRODUCTION

Rwanda Basic Education Board (REB) is implementing the "Rwanda Quality Basic Education for Human Capital Development" Project.

The subcomponent 1.2 of this project is being implemented by REB in collaboration with University of Rwanda College of Education (UR-CE). The subcomponent aims at enhancing teacher effectiveness for improved student learning through support of professional development of Mathematics and Science teachers.

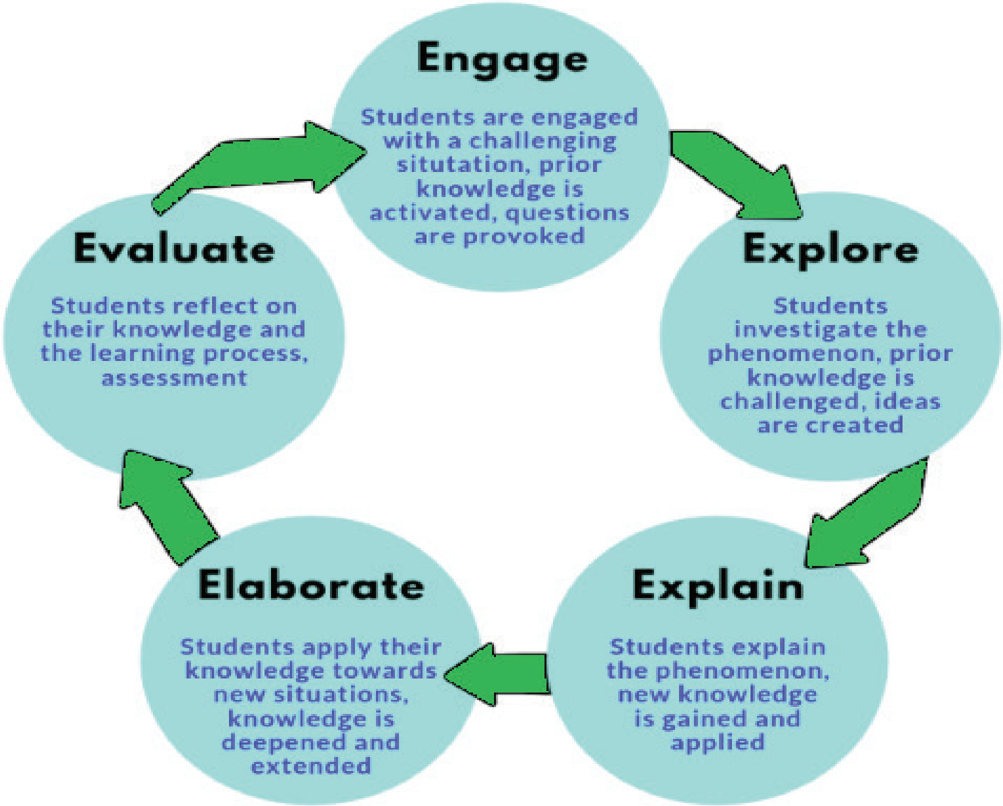
Firstly, the project is helping teachers to use technology to improve their way of teaching through a complete yet simple package that includes the scripted lessons developed in One Note to be used in the classroom. These scripted lessons in One Note incorporate the 5E instructional Model.

Secondarily, the project helps teachers from schools without electricity by developing, in Microsoft word, the sample scripted lessons. This booklet contains such lessons and serves as a reference to competence-based teaching and learning that infuses the 5E Instructional Model to ensure consistency and coherence in the learning of the mathematics and science content.

The detailed explanation of this model is given in the following paragraphs.

The 5Es instructional model

"The 5E Model of Instruction is a teaching and learning model that promotes active learning. It states that teaching and learning progresses through five phases: **Engage, Explore, Explain, Elaborate and Evaluate.**



In this model, students are involved in more than listening and reading. They learn to ask questions, observe, model, analyse, explain, draw conclusions, argue from evidence, and talk about their own understanding. With the 5 Es instructional model, students work collaboratively with peers to construct explanations, solve problems, and plan and carry out investigations."

Phase 1: Engage

The first phase of the 5E Model engages students by having them mentally focus on a phenomenon, object, problem, situation, or event. The activities in the Engage phase are designed to help students make connections between past and present learning experiences, expose prior conceptions, and organize thinking toward the essential questions and learning outcomes of the learning sequence.

The role of the teacher in the Engage phase is to present a situation, identify the instructional task, and set the rules and procedures for the activities. The teacher also structures initial discussions to reveal the range of ideas, experiences, and language that students use which become resources for upcoming lessons.

Teaching Strategies

- Raises questions or poses problems
- Elicits responses that uncover students' current knowledge
- Helps students make connections to previous work
- Posts learning outcomes and explicitly references them in the lesson
- Invites students to express what they think
- Invites students to raise their own questions

Phase 2: Explore

Once students have engaged in activities, they need time to explore ideas. Explore activities are designed so all students have common, concrete experiences which can be used later when formally introducing and discussing scientific and technological concepts and explanations. Students have time to investigate objects, events, or situations. As a result of their mental and physical involvement in these activities, students question events, observe patterns, identify and test variables, and establish causal relationships.

The teacher's role in the Explore phase is to facilitate learning. They initiate activities and allow time and opportunity for students to investigate objects, materials, and situations. The teacher coaches and guides students as they record and analyse observations or data and begin constructing models or initial explanations.

Teaching Strategies

- Provides or clarifies questions or problems
- Provides common experiences
- Observes and listens to students as they interact
- Acts as a consultant for students
- Encourages student-to-student interaction
- Asks probing questions to help students make sense of their experiences and redirect them when necessary
- Provides time for students to puzzle through problems

Phase 3: Explain

The Explain phase consists of two parts. First, the teacher asks students to share their initial models and explanations from experiences in the Engage and Explore phases. Second, the teacher provides resources and information to support student learning and introduces scientific or technological concepts. Students use these resources and information, as well as ideas of other students, to construct or revise their evidence-based models and explanations. In engineering, students design solutions to problems based on established criteria.

Teaching Strategies

- Encourages students to explain concepts and definitions in their own words
- Asks for justification (evidence) and clarification from students

- Formally provides definitions, explanations, and information through mini-lecture, text, internet, or other resources
- Builds on student explanations
- Provides time for students to compare their ideas with others and if desired revise their ideas

Phase 4: Elaborate

Once students have constructed explanations of a phenomenon or design solutions for a problem, it is important to involve them in further experiences that apply, extend, or elaborate the concepts, processes, or skills they are learning. Some students may still have misconceptions, or they may only understand a concept in terms of the exploratory experience. Elaborate activities provide time for students to apply their understanding of concepts and skills. They might apply their understanding to similar phenomena or problems.

Teaching Strategies

- Expects students to use vocabulary, definitions, and explanations provided previously in new contexts
- Encourages students to apply the concepts and skills in new situations
- Provides additional evidence, explanations, or reasoning
- Reinforces students' use of scientific terms and descriptions previously introduced
- Asks questions that help students draw reasonable conclusions from evidence and data

Phase 5: Evaluate

It is important that students receive feedback on the quality of their explanations. Informally, this may happen throughout the learning sequence. Formally, the teacher can also administer a summative evaluation at the end of the learning sequence. The Evaluate phase encourages students to assess their understanding and abilities and allows teachers to evaluate individual student progress toward achieving learning goals and outcomes.

Teaching Strategies

- Asks open-ended questions such as, "Why do you think…?" "What evidence do you have?" "How would you answer the question?"
- Observes and records notes as students demonstrate individual understanding of concepts learned and performance of skills
- Uses a variety of assessments to gather evidence of student understanding
- Provides opportunities for students to assess their own progress

When this model is used in the lessons, learners interpret objects and phenomena they observe in their real-life experience and internalize those interpretations in terms of their current conceptual understanding.

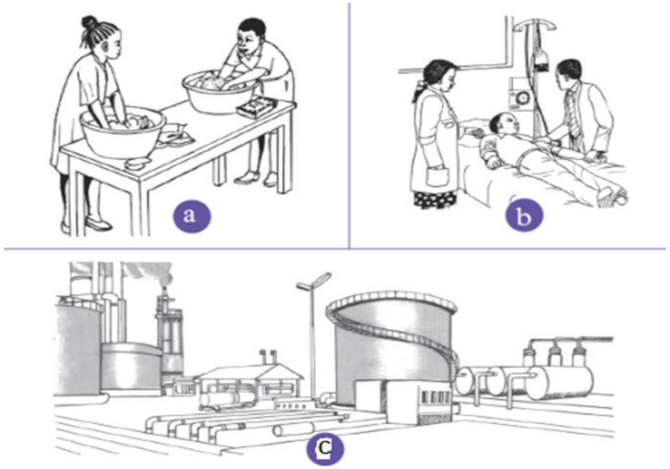
The following part contains examples of lessons selected from scripted lessons prepared in One Note. They can serve teachers as reference of lessons with the structure of 5Es instructional model.

SCRIPTED LESSONS FOR SENIOR ONE

Scripted lesson from Unit 1

SUBJECT: Chemistry	**GRADE:** S1	**UNIT 1:** Introductory to chemistry
LESSON TITLE: Definition and importance of Chemistry **Teaching & learning materials:** Charts, chalkboard, books, pens		**Duration:** 40 minutes
Section	**Step- by- step instruction and content**	**Notice to the teacher**
Student readiness **(3min)**	**Learning objectives:** By the end of the lesson, learners will be able to: – Define chemistry – Explain the importance of chemistry in our daily life	– Welcome learners in the lesson and connect their expectations to the learning objectives – Identify the learners with special needs and plan how to help them accordingly. – Tell students the materials needed and given them a small time to take them.

Introduction **(7min)**	 **Teacher:** Observe the images above and ask questions on them. **Students:** – What do you observe on the chart? – What are the sources of these materials? **Students' answers:** Pen, toothpaste, medicine, clothes. These materials are made from factories, from chemical industries,…..	– Ask students to observe the pictures and give them time to raise questions – Students should be given time to think and share with others their answers. – After many questions and answers proposed by students, indicate the key question of the lesson. – Indicate the Key question of the new lesson to the class only when students could not give it. **Key question**: How is chemistry important in our daily life?

	Teacher: Observe the images that follow and ask questions on them.  **Students:** – What are people doing on a and b figures? – What does the figure c represent? **Students' answers:** – Washing on figure a – A nurse and a patient in the hospital on figure b – C is an industry/ factory	

	Teacher: Soaps used in washing clothes, ink used in pens, toothpaste, medicines are chemical products, Clothes are obtained from industries using chemical principles. **Teacher:** What is the composition of these materials? How are they obtained. Answers to these questions will be found in the new lesson.	
Lesson development **(20min)**	**Teacher:** Today we are going to deal with the definition and importance of Chemistry in our daily life. **Lesson title: Definition and importance of chemistry in our daily life.** **Teacher:** Present your findings to the class. Students may give different suggestions. **Teacher:** From learner's ideas, teacher clarifies the definition of chemistry. Chemistry is a branch of science that studies the composition, structure and properties of substances under different conditions.	– Communicate the new lesson and write its title on the chalkboard. – Ask students to recall their research activity and present their findings from. – Check the meaning of the word "Chemistry'' in the dictionary or Internet. – Discuss the meaning of the word Chemistry in your group. – Write the definition of Chemistry in your notebook.

	For example, you may be interested to know what happens when a piece of wood burns or during souring of milk. You may also want to know what happens when a nail undergoes rusting. All these are studied under Chemistry as a subject. **Teacher:** List materials you use in your daily life. **Student:** Soap, basin, metallic or plastic plates, oil, drugs, shoes, toilet papers, sugar, shoe polish, lemonade, knives, spoons, …….. **Teacher:** Dear students, all these materials you mentioned are made from industries using knowledge of chemistry. So chemistry is much needed in our lives.	– Compare your definition with that of other group members. Are they the same? – Ask students to list materials used in our everyday life. – Summarize the ideas of learners by clarifying the importance of chemistry in our lives.
Assessment **(5 min)**	**Teacher:** 1. What is chemistry 2. Outline any 4 importance of chemistry in our lives **Student:** 1. Chemistry is a science that deals with the study of a structure, composition, properties and changes that undergoes 2. Making fertilizers, making clothes, getting job, making salt, soap, …	– Ask learners to make a recall on a key concept and give the evaluation one by one – Ask leaners to do individually the activity of formative assessment. – Provide opportunities to students for asking questions. – Provide opportunities to students for corrective or positive feedback on formative assessment

<table>
<tr>
<td>Lesson summary and conclusion

(5 min)</td>
<td>Teacher:
– What is chemistry.
– Importance of Chemistry:

Chemistry plays a very important role in our lives. We should take the study of Chemistry very seriously.

Indeed, when we fall sick, we visit the hospital to get treatment. The doctor advises us to buy drugs from the pharmacy.

Pharmacists in pharmaceutical companies, manufacture drugs that we use when we are sick. We wash clothes using soaps and detergents.

We make bread using baking powder made in industries. We also refine oil from crude oil. In all these, we use the knowledge of Chemistry as a subject.

Home work:
1. Outline 5 daily activities where chemistry is involved in your home

Student’s answers:
a) Being a good farmer, pharmacist, nurse, nutritionist, chemistry teacher, …</td>
<td>Use different questions to help students recall key concepts of the lesson, and ensure that the summary is written down by all students The teacher summarizes the ideas of learners by clarifying the importance of chemistry in our lives.</td>
</tr>
</table>

	b) Cooking, cleaning, farming, treating water, brushing, burning light c) Outline 5 reasons why studying chemistry is important. **Research activity to prepare next lesson of chemistry:** a) Find and explain some of the areas where knowledge in Chemistry is applied in industry. b) Give examples of industries in our country and materials they make *Thank you for your participation in this lesson.*	

Scripted lesson from Unit 1

SUBJECT: Chemistry	**GRADE:** S1	**UNIT 1:** Introductory to Chemistry
LESSON TITTLE: Application of Chemistry in industry		**Duration:** 40 min
Teaching & learning materials: Manila papers, chalkboard, books, pens, chart		
Section	**Step- by- step instruction and content**	**Notice to the teacher**
Student readiness **(3min)**	**Learning objectives:** By the end of the lesson learners will be able to: – Demonstrate the application of chemistry in daily life. – Relate the use of common industrial products in our country to the importance of chemistry.	– Welcome learners in the lesson and connect their expectations to the learning objectives. – Identify the learners with special needs and plan how to help them accordingly. – Tell students the materials needed and given them a small time to take them.

Introduction **(7min)**	**Teacher:** What is the previous lesson learned in chemistry? **Student:** The meaning of chemistry and its importance. **Teacher:** Define chemistry. **Student:** Chemistry is a science which studies the matter; its composition, structure and properties. **Teacher:** Name any two importance of chemistry in daily life **Student:** Soap, toothpaste, juices, soda, plates, shoes, …… all these are made using chemistry knowledge. **Teacher:** Outline 5 daily activities where chemistry is involved in your home **Student:** Cooking, cleaning, farming, treating water, brushing, burning charcoal, …. **Teacher:** Outline 5 reasons why studying chemistry is important. **Student:** Studying chemistry would help to be pharmacist, nurse, good farmer, …. Knowledge of chemistry helps to make soap, toothpaste, juices, soda, plates, shoes, …… all these are made using chemistry knowledge in industries/ factories….	– Ask students to recall elements of the previous lesson learned in chemistry. – Ask students to answer questions from home work of the previous lesson. – Give them time to think and share with others their answers. – Indicate the Key question of the new lesson to the class only when students could not give it. **Key question:** What are the applications of Chemistry in industry?

Lesson development **(20min)**	**Teacher:** Today we are going to discuss about the application of chemistry in industry. **Lesson title: Application of chemistry in industry.** **Teacher:** Name industries/ factories found in Rwanda. **Students findings:** Factories/industries found in our country: **Skol** and **Bralirwa** produce drinks with or without alcohol, **Sulfo** to make soap and ointments, **Rwandafoam** to make mattress, **Wasac** for the treatment of water, **Utexrwa** for clothes, **Kipharma** for some medicines/drugs, **Ameki color** making paints. ….. **Teacher:** Well done. Chemistry has contributed to the understanding of how various materials are manufactured in industries. A good knowledge of Chemistry also helps us to choose safer and better products. The following are some of the areas where knowledge in Chemistry is applied: – **Water treatment:** Domestic water is treated with chemicals such as chlorine to make it safe for human consumption.	– Communicate the new lesson and write its title on the chalkboard. – Ask students to present the findings from their research activity. Lead them when they present their findings and write any good result given. – Congratulations to students for their presentations. Complete their findings by other applications of chemistry in industry. Details on applications will be consolidated by the teacher and students using questions/answers method.

	– **Food and beverage industries:** The knowledge of Chemistry enables nutritionists to calculate the nutrient composition of drinks and canned foods during the manufacturing process. This knowledge is also extensively used in the production of traditional brews in Rwanda. Such brews include banana wine, sorghum beer among others. Extraction of butter from milk has been done traditionally to obtain butter used in cooking various types of food. This process also applies the knowledge of Chemistry. – **Manufacture of soaps and detergents:** In Rwanda, soap is manufactured from oil. This oil is extracted from locally available plant materials. Some chemicals such as sodium chloride and sodium hydroxide are also added during this process. The soap products can be improved by adding color and perfume to make them more attractive. Knowledge of Chemistry is important in this process – **Manufacture of medicines:** Human and animal medicine are made in pharmaceutical companies. This also applies to vaccines that are used to prevent diseases. The manufacturer of medicine and vaccines apply the knowledge of Chemistry. Traditional medicine in Rwanda are also extracted from leaves and barks of some trees by applying the same knowledge	– Request learners to follow the explanations of the keyword or new concept.

	– **Manufacture of fuels:** Most of the fuel used in Rwanda comes from crude oil. Processing of crude oil occurs in a refinery. Examples of fuels include petrol, diesel, kerosene and jet fuel. These fuels are used to run various machines. – **Other products:** Manufacture of products such as clothes, paints, fertilizers and plastic products is done by applying the knowledge of Chemistry.	Provide opportunity for positive feedback to student
Assessment **(5 min)**	**Teacher:** How is the knowledge of Chemistry important in the following areas? (a) Water treatment (b) Agriculture (c) Transport industry (d) Pharmaceutical industry **Student:** Water is treated by chlorine Fertilizers and pesticides products are done by applying the knowledge of Chemistry. **Transport industry:** Most of the fuel used in Rwanda comes from crude oil which is a chemical product **Pharmaceutical industry:** The manufacturer of medicine and vaccines apply the knowledge of Chemistry.	– Give students to think on the answer for the evaluation – Appreciate the students for their participation

Lesson summary and conclusion **(5min)**	The summary of the lesson contains: **Areas where chemistry is applied in industry.** – Water treatment – Food and beverage industries – Manufacture of soaps and detergents – Manufacture of medicines – Manufacture of fuels. **#. Conclusion** Many of the products we use at home and in school are important to us in one way or another. Such products include: books, papers, clothes, plastics, tissue papers, toothpaste, bottled water and foods of different kinds. Many consumer products are manufactured in industries through the application of the knowledge obtained from the study of Chemistry. **Home Work:** – Explain why the use of plastic materials is regulated in our country. – Explain the importance of the recycle of plastic products. – How would you ensure that the soaps and detergents you buy from shops are of high quality? *Thank you for your participation in this lesson.*	– Remind leaner to follow carefully – Ask questions that will facilitate to consolidate the summary and give time to write the summary in the notebook. – Recall and emphasize key concept

Scripted lesson from Unit 1

SUBJECT: Chemistry	**GRADE:** S1	**UNIT 1:** Introductory to Chemistry
LESSON TITTLE: Contribution of Chemistry to the Economy of Rwanda		**Duration:** 40 min
Teaching & learning materials: Manila papers, chalkboard, books, pens, chart		
Section	**Step- by- step instruction and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to State the contribution of Chemistry to the economy of Rwanda.	– Welcome learners in the lesson and connect their expectations to the learning objectives. – Identify the learners with special needs and plan how to help them accordingly. – Tell students the materials needed and given them a small time to take them.

Introduction **(8 min)**	**Teacher:** In previous lessons we have seen the application and importance of chemistry. Now I want you to answer the following questions related to that previous lessons: **Teacher:** State two uses of chemistry in our daily life **Student:** Chemistry helps us to manufacture many products such as soaps, medicines, chemical fertilisers, pesticides, etc **Teacher:** Give applications of chemistry in industry **Student:** Manufacture of soaps and detergents, manufacture fuels, medicines, other products such as clothes, paints, fertilizers and plastic products. Knowledge in chemistry is also used in water treatment and foods and beverage industries. Chemistry helps us in water treatment and foods and beverage industries.	– Ask questions related to the previous lesson and indicate the key question. – Indicate the Key question of the new lesson to the class only when students could not give it. **Key question:** How does chemistry play a major role in Rwandan economy to ensure sustainable development?
Lesson development **(20 min)**	**Lesson title: Contribution of Chemistry to the Economy of Rwanda** **Teacher:** What knowledge of chemistry helps us in chemistry? **Student:** The knowledge of Chemistry helps us to transform natural raw materials into products that we use in our daily lives. These products improve our health, productivity and safety. The industries from which the products are manufactured provide jobs and these in turn bring about economic development of Rwanda.	– Communicate the new lesson and write its title on the chalkboard. – Ask students to work in pairs to find and demonstrate the contribution of chemistry to our life and to the Rwandan economy in general.

	Teacher: Talk about how Chemistry has helped and is helping to shape the economy of Rwanda. 1. Look around your school and discuss about the contribution of chemistry in your daily life while staying at school. Is the study of chemistry important in your school? 2. Share with your group mates 'important contributions of chemistry to the development of your native sector. 3. What do you understand by "made in Rwanda policy"? Discuss and present your findings At the end of activity, the teacher asks three groups to present their findings and asks which group had the same observations, so that to make general conclusion. Students present their findings. **Teacher:** According to your findings how does chemistry help to develop the economy of Rwanda? The chemistry knowledge involves in effective application of **"The Made-in -Rwanda policy"**. *The **Made-in-Rwanda** policy is designed to help boost local industrial contribution to the economic growth while promoting the brand of the Rwandan locally made products at the global stage, which will reduce the country's burden of relying on imports while promote locally made products from Rwanda.*	– Guide presenters to formulate well all ways through which chemistry contributes in the economy of Rwanda (Teacher with other groups who are not presenting) – Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback. Note that each group must participate in the presentation, their findings written progressively on the chalk board constitute the note to be taken in the notebook by students.

Chemistry helps to develop the economy of Rwanda as follows:

1. Through the knowledge of Chemistry, **medicines** and **vaccines** are made available. Some of these medicines reduce infant mortality and hence increasing the size of the population. A healthy population ensures availability of labour to work on farms and in industries.

2. **Manufacture of fertilizers** and animal feeds help to increase agriculture and animal production

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Animal feeds and Fertilizers
3. Many products like processed food, spices like red pepper and beverages like milk and tea which are made from chemistry are exported to earn foreign currency.

Rwanda tea</td>
<td>Emphasize new concepts.</td>
</tr>
</table>

	4. Infrastructure development has been attained in terms of road construction using chemicals (petroleum products. Efficient transport and communication systems enable easy and faster movement of goods from the production point to the market. This facilitates trade.  Roads construction 5. The knowledge of Chemistry is applied in the **mining industry** to extract minerals which act as raw materials for industries.	At each step, provide a pause time for students to think and say or write their ideas. Request again learners to be ready and follow carefully instructions note key points.

	  Tungsten (Wolfram) mining 6. **Treating drinking water** by the use of chlorine and other disinfectants helps to reduce the rate of disease outbreaks.	

Yanze water treatment plant (Kigali)

7. Through the knowledge of Chemistry, people become aware of the importance of **conserving the environment. Conserving the environment** leads to income from tourists.

Through the knowledge of Chemistry, people become aware of the importance of **conserving the environment.** They hence avoid activities such as deforestation and overstocking, which can cause environmental degradation.

Non-conserved forest

Conserved forest(Nyungwe National park)

8. Many people are employed directly or indirectly in industries like Bralirwa breweries Ltd, Cimerwa Ltd, Inyange industry Ltd, Sina Gerard Urwibutso Ltd, Sulfo Rwanda, AGROPY Ltd, Volkswagen etc. These industries has reduced unemployment problem and they pay also taxes to generate revenue which support government plans for development.

Rwanda Special Economic Zone (Masoro)

5. Assessment **(5 min)**	**Teacher:** Chemistry knowledge is used in manufacture of weapons such as bombs, guns and missiles. In context of Rwanda, is this important in our country? **Suggested answer:** Weapons are important to our country to ensure human security and protect our achievements (roads, towns, schools and other infrastructures). But the use weapons should strictly be controlled to prevent robbery, murder. (Accept that this is not important but emphasize on explanations given). Transport industry is among the rapid growing industries in Rwanda. Modern transport means help to carry goods and passengers from one place to another in a shortage of time. Explain how the knowledge of chemistry immensely contributes to the development of this sector. – In transport industry - the knowledge of chemistry is applied in fuel processing, in road construction, making material selection during manufacturing of vehicles, design of less polluting vehicles, making and in making lubricating oils. (Accept other correct answers).	– Ask leaners to do in group of 3 the activity of formative assessment. – Provide opportunities to students for asking questions. Give them corrective feedback or positive feedback as well.

Lesson summary and conclusion **(5 min)**	**Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The knowledge of chemistry is important in about all activity that helps in the welfare of Rwandan so that they work to develop the country. Chemistry knowledge is important in pharmaceuticals, in transport, in agriculture, making cosmetics, making construction materials, water treatment, diseases prevention, etc. Chemistry related careers provide jobs to a majority of Rwandan citizens. **Homework:** Briefly explain how the following have contributed to the economy of Rwanda. a) Development of vaccines b) Manufacture of fertilisers and animal feeds c) Efficient transport and communication system *Thank you for your participation in this lesson.*	– Use different questions to help students recall key concepts of the lesson and ensure that the summary is written down by all students. – Summarize the main points verbally and conclude

Scripted lesson from Unit 2

SUBJECT: Chemistry	GRADE: S1	UNIT 2: Laboratory safety and apparatus
LESSON TITTLE: Laboratory safety precautions and warning labels		**Duration:** 40 min
Section	**Step by step instructions and contents**	**Notice to the teacher**
Student readiness **(2min)**	**Learning objectives:** learners will be able to: – State the safety rules and precautions usually followed in a chemistry laboratory. – Appropriately interpret warning signs about dangers and warnings.	– Welcome learners in the lesson and connect their expectations to the learning objectives. – Identify the learners with special needs and plan how to help them accordingly. – Tell students the materials needed and given them a small time to take them.

Introduction **(8min)**	**Teacher:** What is the previous lesson we learned last time? **Student:** Contribution of Chemistry to the Economy of Rwanda. Definition of laboratory and Laboratory safety rules. **Teacher:** Explain how chemistry is important in about all activity that helps in the welfare of Rwandan so that they work to develop the country. **Student:** Chemistry knowledge is important in pharmaceuticals, in transport, in agriculture, making cosmetics, making construction materials, water treatment, diseases prevention, etc. **Teacher:** What is a chemistry laboratory made of? **Student:** It is made of 3 important parts: Preparation room, Storage room, Student working area, Fume chamber, **Teacher:** Give quickly one by one laboratory safety rules. 23 rules will be given by 23 students, girls and boys.	– Ask questions related to the new lesson to introduce it. – For the safety rules, one rule will be given by one student. Observe gender balance. – Indicate the Key question of the new lesson to the class only when students could not give it. **Key question:** What measures to take to put you away of danger when in laboratory

<table>
<tr>
<td>Lesson development

(20 min)</td>
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Teacher: Let us start the new lesson.

Lesson title: Laboratory safety precautions and warning labels

Teacher: What guides motorists to slow down or take a turn while using certain parts of the road?

Student: Roads signs or symbols.

Teacher: Why do you think road signs are important?

Student: They ensure safety and proper use of the roads.

Teacher: What is a label?

Student: Material (piece of paper, plastic, ...) attached to an object and giving information about it.

Teacher: Why do most products have a label?

<table>
<tr><th colspan="2">Symbol</th><th>Meaning</th></tr>
<tr><td></td><td>Highly inflammable</td><td>– Easily catches fire and burns.</td></tr>
<tr><td></td><td>Toxic</td><td>– It can lead to death.</td></tr>
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– Indicate the new lesson and write the title on the board.

– Ask questions to help students to develop progressively the new lesson.

– Explain each meaning of the symbols
</td>
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 Irritant	– It irritates the skin when in contact
 Radioactive	– Dangerous to human health and can cause cancer.
 Corrosive	– Can easily burn you when in contact with your skin. It can also damage wood and metal.
 Explosive	– It can easily explode and release small particles which can injure you.
 Harmful	– Poisonous when inhaled or ingested and can lead to death
 Electric shock	– It can cause electric shock leading to death.

	Teacher: Do the following activity. Respect all instructions. 1. Cut Manila paper into seven square pieces. 2. Using a marker pen, draw various safety symbols on these pieces of manila. 3. Write the meaning of each symbol below it in capital letters. 4. Pin the symbols on the noticeboard of your classroom to remind others of their safety while in the laboratory. 5. Role-play the meaning of each symbol. For example, make a loud noise resembling an explosion. Let your friends try to move away from the scene in an organized way. Also, scratch your skin on the hand as if in pain. Let your friend do first aid on you by pouring a lot of water on the affected part.	
Assessment **(5 min)**	**Teacher:** Individually, let us do the following exercises. – Discuss the importance of using labels on containers in chemical laboratory. – Complete the table showing laboratory safety symbols and their meanings	Provide opportunities to students for corrective feedback or positive feedback on formative assessment.

Lesson Summary and conclusion **(5 min)**	**Teacher:** Draw warning labels used in laboratory and give their meanings. Discuss importance of using symbols and labels labels. *Thank you for your participation in this lesson.*	Use different questions to help students recall key concepts of the lesson and ensure that the summary is written down by all students. During harmonization/ making a general summary, provide time students to ask questions on what they do not understand well.

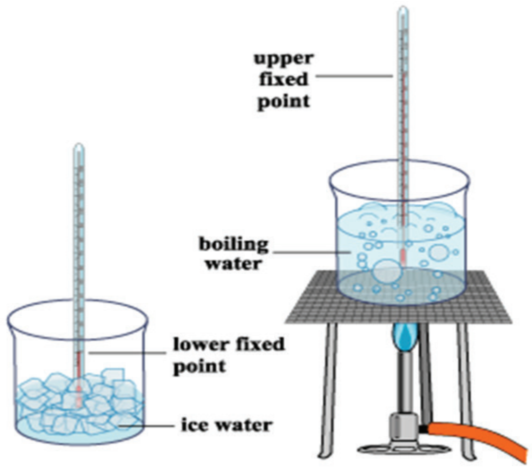
Scripted lesson from Unit 3

SUBJECT: Chemistry	GRADE: S1	UNIT 3: States and changes of state of matter
LESSON TITTLE: Physical change and chemical change **Teaching & learning materials:** Paper, wood, matches, chalkboard, water, ice, iodine, ,book and pens, figures.		**Duration:** 40 min
Section	**Step by step instructions and contents**	**Notice to the teacher**
Student readiness **(2min)**	**Learning objectives:** At the end of the lesson, learners will be able to distinguish physical from chemical change clearly.	– Welcoming students, gain their attention and communicate objectives of the lessons. – Identify students with special need to be helped accordingly.
Introduction **(5 min)**	**Teacher:** What is the previous lesson learned last time? **Student:** Changes of states of matter. **Teacher:** Name different types of change of states of matter and explain them.	– Ask questions related to the last lesson. This will serve as a prerequisite of today's lesson.

	Student: **Melting:** change from solid state to liquid state. **Evaporation:** change from liquid state to gas state. **Freezing:** change from solid state to liquid state. **Condensation:** change from gas state to liquid state. **Sublimation:** change from solid state to gas state. **Deposition:** change from gas state to solid state. **Teacher:** Let me inform you that there are two types of changes that matter can undergo, namely physical and chemical changes.	
Lesson development **(25 min)**	**Lesson title: Physical and chemical changes of matter** **a) Experiments demonstrating physical changes** **-Heating ice** **Apparatus and reagents:** Ice, thermometer, beakers, Bunsen burner and tripod stand, wire gauze. **Procedure:** 1. Half-fill a beaker with some ice.	– Indicate the new lesson and write the title on the chalkboard – Ask questions to help students to develop progressively the new lesson.

	2. Arrange the apparatus as in the figure here after. The teacher demonstrates how to arrange the apparatus and students imitate. 3. Heat the ice gently while carefully stirring with a stirring rod What do you observe? **Student:** Solid ice becomes progressively liquid. **Teacher:** Name this change of state. **Student:** Melting. 4. Cool the liquid formed using cold water. What do you observe? **Student:** Liquid water becomes ice in solid state. **5. Teacher:** Heat again ice for more time. What do you observe? **Student:** Ice becomes liquid and when we continue heating liquid becomes gas/vapours. **Teacher:** Name this last change of state. **Student:** Evaporation **Teacher:** What do you observe when the steam formed is in contact with the cooler part of the test tube?	

	Student: The steam becomes liquid. **Teacher:** Name the change of state that occurs. **Student:** Condensation. **Teacher:** Conclude from what we saw from the experiment of heating ice. **Student:** When a piece of ice is heated, it changes into liquid water. The water slowly changes into vapours with continued heating. The process through which water changes state from liquid to gas is known as evaporation. When the vapour is cooled, it changes back into liquid form. This process is called condensation. During these change of states, melting, freezing, evaporation no new substances are formed. The processes are also reversible. Such changes are known as physical changes. **Teacher:** What are physical changes? **Student:** *Physical changes are reversible and no new substances are formed.*	



-Heating iodine

Apparatus and reagents:

Boiling tubes, iodine, spatula, a pair of tongs weighing balance, Bunsen burner.

Procedure:

1. Place a few iodine flakes in a boiling tube and hold the boiling tube with a pair of tongs.
2. Heat the boiling tube gently over a non-luminous flame.

Teacher: What do you observe? And name the change of states that occur.

Student: When iodine flakes are heated, they form purple vapours. This change is called sublimation. The vapour solidifies on the cooler parts of the boiling tube to form a sublimate of pure iodine. This change of state is called deposition. The iodine changes directly from solid to vapour. On cooling, the vapour turns back to solid without undergoing the liquid state.

Teacher:

Conclusion from what we saw from the experiment of heating iodine.

Sublimation and deposition are reversible and are not accompanied by formation of new substances. ***Therefore, Sublimation and deposition are physical change.***

b) Experiments demonstrating chemical changes

Apparatus and reagents: Test tubes, Bunsen burner, wooden splint, a piece of paper, magnesium ribbon, iron nails, water, pair of tongs.

– **Burning a piece of paper**

Teacher: Burn a piece of paper with matches. What do you observe?

Student: Ash is formed.

	Teacher: Is the change from a piece paper to ash a physical change? **Student:** A change from a piece paper to ash is not a physical change because it not reversible and the ash is new substance, – **Burning a magnesium ribbon** **Teacher:** Using the pair of tongs, heat a piece of magnesium ribbon on a Bunsen burner flame. Allow the magnesium to burn. Caution! Burning magnesium produces intense light that can cause temporary loss of sight. Do not look directly at the light source. What do you observe? **Student:** When magnesium is burnt in air, it produces a brilliant white flame and ash. Energy is given out in form of heat and light. **Teacher:** Is burning magnesium in air a physical change? **Student:** burning magnesium in air is not a physical change as it is impossible to convert ash to magnesium metal. Ash and magnesium are 2 substances which are totally different.	

	Teacher: Is there a new substance that is formed when a piece of wooden splint is broken down? Is this a physical change? **Student:** When a piece of wooden splint is broken into small pieces, it does not change to a new substance. Only the shape changes. So it is not a physical change. **Teacher:** Dear students, let us conclude. When a piece of paper is burnt, it changes to ash. We cannot get back wood from the ash. This reaction is thus irreversible. Similarly, when magnesium is burnt in air, it forms powder. It is not possible also to get back the magnesium ribbon from the powder. The white powder formed is called magnesium oxide. It is as a result of combining magnesium with oxygen in air. All these processes are not reversible, they are **irreversible**. They are therefore called permanent changes. Permanent changes are **chemical changes**.	
Assessment **(3 min)**	3. Classify each of the following changes into physical and chemical change A. Burning wood B. Heating water C. Heating ice	Ask leaners to do individually assessment. Provide opportunities to students for asking questions. Give them corrective feedback or positive feedback as well.

	D. Burning match E. Cooking a raw egg **Student's answer:** A. Chemical change B. Physical change C. Physical change D. Chemical change E. Chemical change	
Lesson summary and conclusion (5 min)	**Physical and chemical changes of matter** There are two types of changes that matter can undergo; namely: • Physical change • Chemical change A chemical change is a permanent change while physical change is temporarily change. **Physical changes** A physical change is also known as a temporary change. Some of the characteristics of a physical change are:	To consolidate the summary of the lesson, use questions/answers method. Many students have to participate in the development of the summary.

	1. No new substance is formed. 2. The mass of the substance does not change. 3. It is easily reversible. **Examples of physical changes:** All changes of states (freezing, melting, sublimation, deposition, evaporation, condensation) are physical changes as during these processes there no new substances formed, these processes are all reversible and the mass of substances do not change. **Chemical changes** All chemical processes are not reversible, they are **irreversible**. Meaning that they are therefore called permanent changes. Permanent changes are **chemical changes**. Some of the characteristics of chemical changes include: 1. New substances are formed. 2. It is difficult to change the new substance back into the original substance. (irreversible). Chemical change: is change where new substance is formed while physical change is when there is no new substance formed.	

	Examples of chemical changes: Burning charcoal, heating sugar, …as the changes lead to the formation of new products which cannot change back into the original substance. (irreversible). **Conclusion:** A chemical change is a permanent change while physical change is temporarily change.	

Scripted lesson from Unit 4

SUBJECT: Chemistry	GRADE: S1	UNIT 4: Pure substance and mixture
LESSON TITTLE: Mixtures		**Duration:** 40 min
Teaching & learning materials: Water, oil, beans, peas, sand, lemon juice, salt or sugar, book, chalkboard		
Section	**Step- by- step instruction and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of the lesson, learners will be able to: – State the types of mixtures – Explain homogeneous and heterogeneous mixtures	– Welcoming students, communicate objective of a lesson to learn today and identify student with educational special needs to be helped accordingly.
Introduction **(5min)**	**Teacher:** Name the previous lesson we learned last time. **Student:** Last time we learned pure substances. **Teacher:** What is a pure substance? **Student:** Pure substances are substances composed of only by one type of particles.	Ask questions on the last lesson to introduce the new one. This will serve as a prerequisite of today's lesson.

	Teacher: Is tape water a pure substance or not. Explain your answer. **Student:** Tape water is not pure because it is composed by more than one type of particles, water and many mineral salts. **Teacher:** Today we are going to see what happens when pure substances are mixed. This is our key question of today.	
Lesson development **(25 min)**	**Title of the lesson: Mixtures** **Teacher:** Perform the following activity **Activity1** **Teacher:** You are provided with a beaker half full of drinking water and a dish of sugar. Add a spoonful of sugar to water in the beaker and do not stir. a) How does the water taste? b) Why do you think it tastes that way? 2. Now stir the tea and taste it again. a) How does it taste? b) Why do you think it tastes that way? **Student:** Well-stirred water tastes sweeter than the unstirred water.	– Indicate the new lesson and write the title on the board. – Ask questions to help students to develop progressively the new lesson.

	Stirring helps to dissolve sugar evenly within the water. However, in the unstirred, sugar tends to settle at the bottom of the cup. This leaves the upper part of the tea without sugar. **Teacher:** Substances in the beakers are they pure or not. Explain. **Student:** They are not pure as they are composed by more than one particle, water and sugar. **Teacher:** Sugar dissolved or non-dissolved in water form a mixture. What is a mixture? **Student:** A mixture is a substance composed by more than one particle. **Teacher:** There are two types of mixtures; **homogeneous and heterogeneous mixtures**. You are provided with the following mixtures: Oil and water in a beaker, salt and water, maize and beans, sand and water, alcohol and water, milk, drinking water, water and grains of orange, water and ash, drinking water, copper and iron powder, sugar and salt.	

Group these substances into homogeneous and heterogeneous mixtures.

Homogeneous mixture	Heterogeneous mixture
Salt and water	Oil and water
Alcohol and water	Maize and beans
Milk	Sand and water,
Drinking water	Water and grains of orange
Sugar and salt	Water and ash
	Copper and iron powder

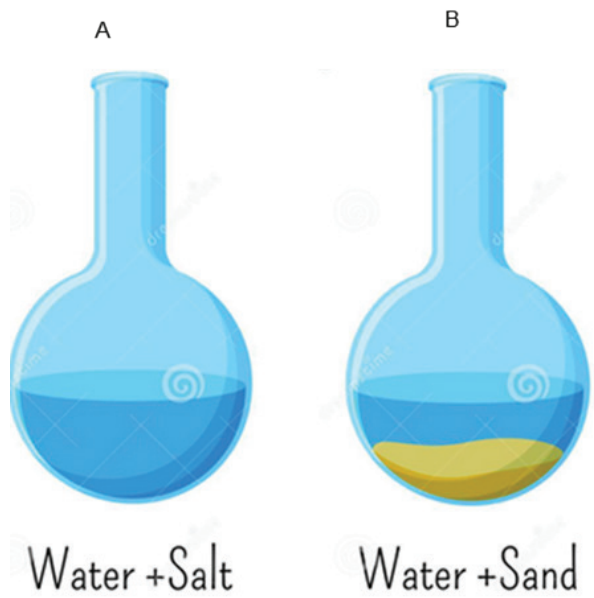
i. Homogeneous mixture.

It is a composition of two or more substances whose components distribute uniformly into each other. An homogenous mixture can be of a liquid-liquid mixture (ex: Alcohol and water), a liquid-solid mixture (ex. Salt and water), a gas-gas mixture or a solid-solid mixture (ex. Sugar and salt). A homogenous mixture made up of a liquid-solid mixture is referred to as a solution. The solid substance that dissolves is called a solute while the liquid in which the solute dissolves is called a solvent. A solution is therefore a homogenous mixture formed when a solute completely dissolves in a solvent.

ii. Heterogeneous mixture.

It is a composition whose components are unevenly distributed into each other.

Examples of heterogeneous mixtures are sand and water, beans and peas. The following picture will help you to distinguish these two types of mixture where A is an homogeneous and B heterogeneous mixture



A **B**

<table>
<tr>
<td>Assessment

(3 min)</td>
<td>Teacher: 1. You are provided with the following list of mixtures and name them as homogeneous or heterogeneous. Mineral water, Cup of tea Coffee and beans, Water and soil, Ikigage, Serwakira, Water and petroleum, Banana wine (urwagwa), Blood.

Student:
<table>
<tr><th>Homogeneous mixtures</th><th>Heterogeneous mixtures</th></tr>
<tr><td>Mineral water</td><td>Coffee and beans</td></tr>
<tr><td>Cup of tea</td><td>Water and soil</td></tr>
<tr><td>Banana wine (Urwarwa)</td><td>Ikigage</td></tr>
<tr><td>Blood</td><td>Serwakira,</td></tr>
<tr><td></td><td>Water and petroleum,</td></tr>
</table>
Thank you for your participation in this lesson.</td>
<td></td>
</tr>
<tr>
<td>Lesson summary and Conclusion

(5 min)</td>
<td>The summary of this lesson is made by answers from the following points:
1) What is a mixture?
2) Name the 2 types of mixtures?
3) Differentiate homogeneous and heterogeneous mixtures.
4) State different types of homogeneous mixtures and give examples to each type.</td>
<td>– Ask student to do the exercise per group of 2.

Guide students to find answers to consolidate the summary.</td>
</tr>
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Scripted lesson from Unit 5

SUBJECT: Chemistry	GRADE: S1	UNIT 5: Atoms, elements and compounds
LESSON TITTLE: Symbols of chemical elements **Teaching & learning materials:** Periodic tables		**Duration:** 40 min
Section	**Step- by- step instruction and content**	**Notice to the teacher**
Student readiness **(3min)**	**Lesson Objectives:** At the end of the lesson, learners will be able to write the symbols of different chemical elements	– Begin by welcoming students and gaining their attention, communicate objective of the lesson. – Help students with special needs to follow and participate in the lesson
Introduction **(7min)**	**Teacher:** Today we are going to study a new lesson, before we start it, let us do the following activity. **Teacher:** Given the following abbreviations: MINEDUC, REB, SET, SST. What do they represent?	Ask questions to introduce the new lesson and let students to answer them freely.

	Student answer: Ministry of Education, Rwanda Basic Education Board, Science and Elementary Technology. **Teacher:** You are asked to represent your names using symbols, what would be your name symbols? **Student answer:** To use one first letter or two first letters. **Teacher:** Why do people have different names? **Student answer:** Different people have different names because they are different **Teacher:** Sometimes some names are represented by abbreviations. Some of these names are John Baptist, Jean Marie Vianney, John Peter. Give their corresponding abbreviations or symbols. **Student answer:** J.B, J.M.V, J.P **Teacher:** Well. In chemistry elements are represented by symbols. Today we are going to see their corresponding symbols	

<table>
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<td>Lesson Development

(20min)</td>
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Elements with symbols derived from their latin names

Element	Latin	Chemical symbol
Potassium	Kalium	K
Sodium	Natrium	Na
Iron	Ferrum	Fe
Lead	Plumbum	Pb
Silver	Argentum	Ag
Copper	Cuprum	Cu
Mercury	Hydragyrum	Hg
Gold	Aurum	Au

Note: In Chemistry, elements are given certain names considering where they were discovered or who discovered them. It is from these names that symbols are obtained. The symbols of elements are different and specific to each element. This creates orderliness when organising information about different elements. The system of writing symbols uses letters taken from the name of the element. This could be the English or Latin name of the element. The symbol of an element may consist of one or two letters. The first letter of a chemical symbol must always be a capital letter. The letters should not be joined. These symbols

</td>
<td>

- The teacher announces the new lesson and write the titles of the unit and the lesson on the board.
- Ask questions to help students to develop progressively the new lesson.
- Ask student to observe the table and explain how symbols are made.
- Give examples to support the students' answers

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<td>are an international code. This means that all over the world, they are written in the same way no matter how people spell the name of the element in their language. The symbol of an element thus remains the same in all languages.</td>
<td></td>
</tr>
<tr>
<td>Assessment

(5min)</td>
<td>Complete the table below:
<table>
<tr><th>Names</th><th>Symbols</th></tr>
<tr><td>Potassium</td><td></td></tr>
<tr><td></td><td>Sodium</td></tr>
<tr><td>Iron</td><td></td></tr>
<tr><td></td><td>Lead</td></tr>
<tr><td>Silver</td><td></td></tr>
<tr><td>Copper</td><td></td></tr>
<tr><td></td><td>Mercury</td></tr>
<tr><td>Gold</td><td></td></tr>
<tr><td></td><td>Calcium</td></tr>
<tr><td>Cobalt</td><td></td></tr>
<tr><td></td><td>Chlorine</td></tr>
<tr><td>Magnesium</td><td></td></tr>
<tr><td></td><td>Manganese</td></tr>
</table>
– Suggest how you can easily remember the first 20 elements by using either a song, a poem, acronyms, etc.</td>
<td>– Assess learners basing on the key questions to verify the achievement of learning objectives.
– Explain why the given answer is correct.
– Provide constructive feedback
– Verify if their application activity is well done i.e if the table is copied
– Allow some students to present a son, poem, acronyms, etc. and choose the better ones</td>
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</table>

Lesson summary and conclusion **(5 minutes)**	– **Teacher:** How the symbol of chemical element is constructed – The symbol of chemical element consists of one or two letters where the first letter is always a capital letter. The system of writing symbols uses letter taken from the name of the element in English or Latin name.	Ask questions to help students to develop progressively the summary. – Ask students to copy 20 first chemical elements in the notebook. This table constitutes the summary of the lesson

Scripted lesson from Unit 6

SUBJECT: Chemistry	**GRADE:** S1	**UNIT 6:** Arrangement of elements in the periodic table
LESSON TITTLE: Debereiner's triads and Newlands'octaves		**Duration:** 40 min
Teaching & learning materials: Picture representing how products are arranged in supermarket and the periodic table		
Section	**Step by step instructions and contents**	**Notice to the teacher**
Student readiness **(3min)**	**Learning objectives:** By the end of this lesson, learners will be able to describe some early attempts to classify known elements by Dobereiner's triads and Newlands octaves.	– Begin by welcoming, gaining students' attention and communicating objectives of the lesson. – Help students with special needs to follow and participate in the lesson.
Introduction **(7 min)**	**Teacher:** How are you students? Last time we learnt atoms, elements and compounds. Before we start our new lesson, we are going to do the following review questions.	– Give learners opportunity to reflect on the introductory questions.

	Review questions: Explain the following terms: a) atom b) element c) compound **Learner's answers:** a) an atom is the smallest particle of matter which can take part in chemical reaction b) an element is the type of matter composed of atoms that all have the same atomic number c) a compound is a molecule that contains at least two different elements **Teacher:** An element X has an atomic number of 11. – Write down electronic configuration of an element X – How many electrons are there in outermost shell of element X? **Learner's answer:** – X: 2;8;1 – Element X has one electron to its outermost shell.	– Form groups of 5 learners based on gender balance. – Build on their questions and communicate the key questions. – Build on learners' ideas to expand their knowledge through enough explanation Notes are read slowly to give students a chance to visualize.

Lesson Development **(20min)**	**Lesson title: Debereiner's triads and Newlands'octaves** **Teacher:** Study question: according to your prior knowledge on elements, why do you think Chemists developed the periodic table of elements? Learners answer to the study question: Chemists developed the periodic table of elements to organize and analyze chemical and physical behavior of the elements. **Teacher:** There are some chemists who attempted to classify elements, the earliest scientists we can say are: J.W Dobereiner John A.R Newlands J.W Dobereiner's triads How elements are classified according to Dobereiner and Newland? In 1828, J.W Dobereiner, a German chemist, realized that elements with similar chemical properties could be arranged in groups of three. He named these groups of three, "triads".	Ask questions that help students to consolidate the summary In group of five, discuss why scientists thought the development of the Periodic Table. Assess learners basing on the key questions to verify the achievement of learning objectives. Explain why the given answer is correct. Provide constructive feedback

Dobereiner's Triads.				
Group	Elements and their Atomic Mass			Arithmetic mean of Atomic mass
A	Lithium(Li)	Sodium(Na)	Potassium(K)	$\frac{7.0 + 39.0}{2} = 23.0$
	7.0	23.0	39.0	
B	Calcium (Ca)	Strontium(Sr)	Barium(Ba)	$\frac{40.0 + 137.0}{2} = 88.5$
	40.0	87.5	137.0	
C	Chlorine(Cl)	Bromine(Br)	Iodine(I)	$\frac{35.0 + 127.0}{2} = 81.0$
	35.0	80.0	127.0	
	55.8	58.9	58.6	

By 1829, he discovered a halogen triad made up of chlorine, bromine and iodine. Later, he found alkali metal triad of lithium, sodium and potassium. Two other such groups of triads were:

Group 1	**Group2**
Beryllium	Sulphur
Magnesium	Selenium
Calcium	Tellurium

John A.R Newlands law

In 1865, John A.R Newlands, an English chemist, arranged elements in "ascending order of their atomic masses". He observed that any one element had properties similar to those of the element eight places from it; in the same way as the eighth note in an octave of music.

Ask leaners to do individually the activity of formative assessment. Provides opportunities to students for asking questions. Give them corrective feedback or positive feedback as well.

He called this relationship the Law of octaves. To show the pattern clearly, he arranged the elements in seven vertical groups as follow:

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	P
Cl	K	Ca	Cu	Ti	Mn	Fe

In the table, the eighth element from lithium is sodium and the eighth element from sodium is potassium. According to Newlands' Law of Octaves, the properties of these elements must be similar.

Newlands was the first to give a number to an element and left spaces for elements not yet known by then. The periodic repetition of elements with similar properties in Newland's Octaves led to the name.

Newland's Law of Octaves was not taken seriously as it only worked well for the first seventeen elements. For others, most of the eighth elements did not have similar chemical properties with the proceeding element, in the same group

We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned about:

	Naturally, human beings like organized things. Sometimes they do so just for display. However, most of the elements were categorized and arranged in a particular order so that they can be easily found. In some cases, special materials are placed in specific places.	
Assessment **(5min)**	1. In 1828, J.W Dobereiner, a German chemist, arranged elements in groups and he named these groups the........... 2. Atomic mass of the second element in the triad is the average of the atomic mass of 1st element and 3rd element. a) True b) False 3. John Newlands, an English chemist, arranged elements in ascending order of a) Atomic masses c) Their number of protons b) Their atomic number d) All the above are correct **Answers to the assessment:** 1. Triads 2. True 3. a	

Lesson summary and conclusion **(5 min)**	The summary is composed by: How elements are classified according to Dobereiner and Newland. Years of discovery triads and octaves **Conclusion:** Remember that; Chemists developed the periodic table of elements to organize and analyze chemical and physical behavior of the elements. **Homework** Describe the attempts made by the following scientists to classify elements: Dobereiner and Newlands` **Thank you for your participation in this lesson**	Asks learners to make summary on arrangement of element in the periodic table. Remind the key points studied and thank the student for their attention

Scripted lesson from Unit 7

SUBJECT: Chemistry	GRADE: S1	UNIT 7: Water and its composition
LESSON TITTLE: Sources and uses of water **Teaching & learning materials:** Charts, manila papers, chalks.		**Duration:** 40 min
Section	**Step by step instructions and contents**	**Notice to the teacher**
Student readiness **(2 min)**	**Learning objectives:** By the end of this lesson, you should be able to identify the sources and uses of water	– Begin by welcoming students and gaining their attention, communicate objective of the lesson. – Help students with special needs to follow and participate in the lesson
Introduction **(8 min)**	**Teacher:** Observe the following figures A and B and answer the following questions.	– Guide students to give correct answers when observing the figures

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<tr>
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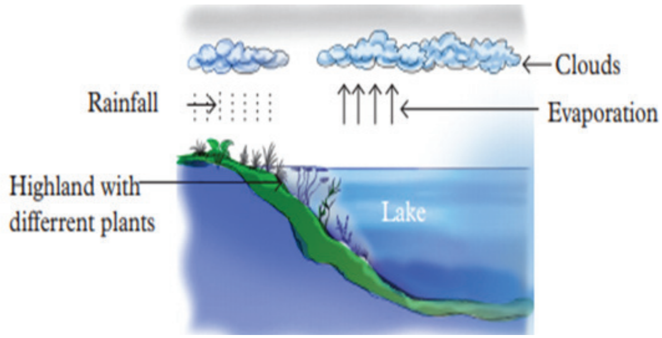
A



B

</td>
<td>– Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback.</td>
</tr>
</table>

	– What do figures A and B represent? – Where do you get that water? – Enumerate activities in which water is used. **Learner's answers:** – A: Source of water, Cycle of water; B: Uses of water – River, lake, ocean, rain, … – Drinking, washing and cooking.	
Lesson Development **(25 min)**	**Teacher:** Today we are starting lesson one of unit seven. **Lesson title:** Sources and uses of water **Teacher:** 1. Give and Discuss some of the uses of water. 2. Identify at least 3 sources of water used to accomplish those tasks **Learners' answers:** Water is used in cooking, washing (cloves, kitchen materials, human body), beautification project, producing goods, cooling machines, watering crops, putting out fires and dust control, plants need plants for growth, animals need water for drinking.	– Communicate the new lesson and write the title on the chalkboard – Give time to learners to present their findings from their research on sources and uses of water – The teacher and peers analyse answers in order to give constructive feedback.

	Three sources of water: a) Groundwater The water is present beneath earth's surface in soil pore spaces and in the fractures of rock formations. b) Surface water This includes water present on the surface of the earth it occurs in form of rivers, lakes, seas and oceans c) Rain water It is in the atmosphere as clouds which come back to the earth in form of rain. It collects on the earth in form of surface and underground water **Teacher:** Water covers over 70% of the earth's surface. It provides a habitat to aquatic organisms. The human body is also majorly composed of water. The major sources of water include underground water, surface water and rainwater. Water is also useful in our body for digestion and excretion. In industries, water can be used in various processes for instance cooling machines.	

<table>
<tr><td>Assessment

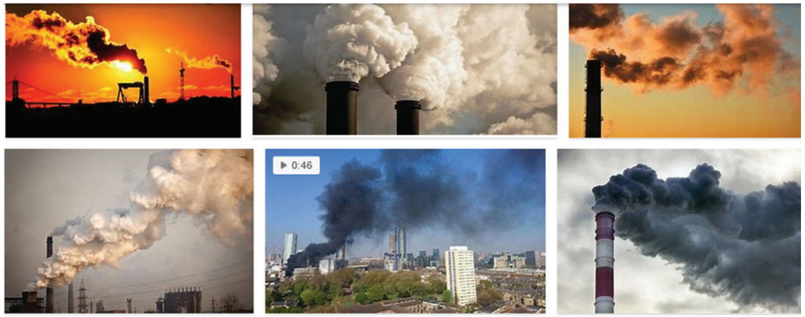
(5 min)</td><td>Teacher: Workout in groups of 2 students to answer the questions that follow:
1. Enumerate the sources of water.
2. State two ways in which water is useful in our bodies.
3. What can you advise your friend who leaves the tap running after fetching water?
Learners' answers:
1. Surface water, ground water and rain water
2. In our body:
a. Water is used in digestion
b. Water is mostly needed in kidney for excretion
3. After fetching water we have to close the tap.</td><td>Provide opportunities to students for corrective or positive feedback on assessment</td></tr>
<tr><td>Lesson summary and Conclusion

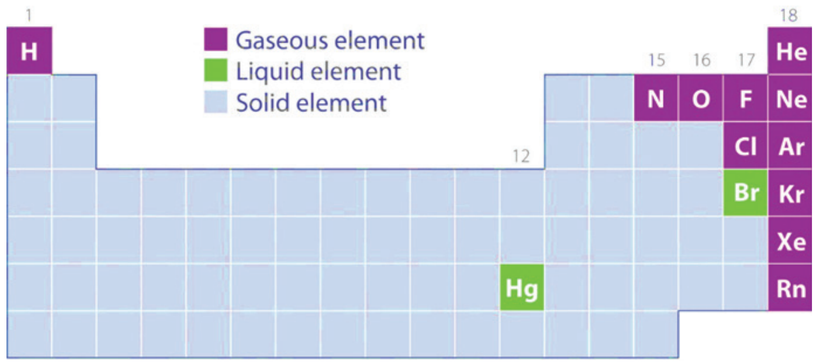
(5 min)</td><td>Teacher: We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned.
Students: Sources of water include underground water, surface water and rainwater.
Water is used in many domestic activities such as washing, drinking and cooking.
In industries, water can be used in various processes for instance cooling machines.
Thank you for your participation in this lesson.</td><td>Use different questions to help students recall key concepts of the lesson and ensure that the summary is written down by all students.

During harmonization/ making a general summary, provide time for students to ask questions on what they do not understand well.</td></tr>
</table>

Scripted lesson from Unit 8

SUBJECT: Chemistry	**GRADE:** S1	**UNIT 8:** Air, Composition and pollution
LESSON TITTLE: Components of air and their percentages		**Duration:** 40 min
Teaching & learning materials: Wall charts of air pollution, chalks		
Section	**Step- by- step instruction and content**	**Notice to the teacher**
Student readiness **(2min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to: – State main components of air and their percentages. – Explain the importance of air.	– Welcoming students. – Gaining students' attention, and communicate objective of the lesson. – Identify all students with special education needs to be helped.

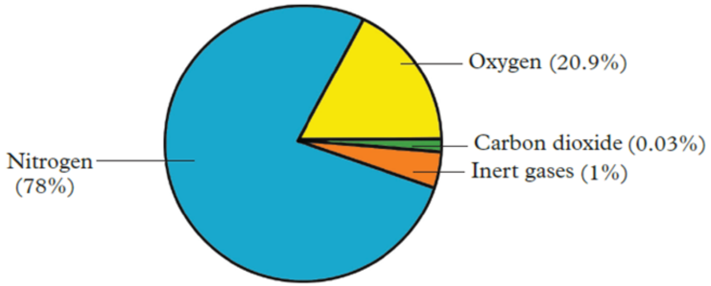
Introduction **(8min)**	**Teacher:** look carefully at the wall chart and make comments on what they observed.  After hearing from the student's findings and observations. The teacher can also ask a couple of questions as follows: **Observation Questions:** – What are you observing in the figure? **Student:** We can see that on all those figures, there are industries which emit smokes to the atmosphere. **Teacher:** Can you tell us some of those smokes (gases)? **Student:** They include air, carbonic gas, sulfur dioxides, nitrogen oxides etc	– Give learners opportunity to reflect on the introductory questions. – Allow learners to ask question about the topic of the day. – Build on their questions and communicate the key questions.

Lesson development activities **(25 min)**	**Teacher:** Let's look at the Components of air and their percentages. The knowledge got form UNIT 4 we discussed days ago, in Senior 1, Pure substances and mixtures is going to help you understand this lesson. **Lesson title: Components of air and their percentages** **Teacher:** Recall on mixtures and the Periodic Table of elements. I want everybody to look at the wall chart in front of you then make comments, thereafter share them to the rest of the class.  **Observation questions:** Give examples of elements on the Periodic table that are gases.	– Communicate the new lesson and write its title on the chalkboard – Emphasize new concepts – At each step, provide a pause time for students to think and say or write their ideas. – Help learners form groups based on gender responsive. – Help learners to relate what they have learnt to real life experience by discussing the given case study. – Facilitate learners during presentation of their findings. – Use different questions to probe students to understand the content/ Questions/ answers method

	Gases include: Hydrogen, Nitrogen, Oxygen, Fluorine, Helium, Neon, Chlorine, argon etc … Do you know any other gas except the one on periodic table? Yes, for example: carbonic gas, air, CO_2 and water vapor… Where can you find these gases? In the atmosphere. Is air a mixture or a pure substance? Give an example of element or compound found in air. Air is a mixture. The gases in air include: O_2, N_2 are elements found in air while CO_2, SO_2 are compound found in air. **Teacher's input:** Okay very Good once, Air is a mixture of different gases. Now we are going to look at those gases one by one. The atmosphere is a mixture of gases, more than 150km thick around the Earth. 1/5 of its volume is active air or oxygen and 4⁄5 is inactive air, which is made up of nitrogen and small amounts of other gases.	

Component	% composition by volume	Boiling points (°C)
Nitrogen	78.08%	-196
Oxygen	20.95%	-183
Carbon dioxide	0.038%	-78
Argon	0.93%	-189.2
Xenon	0.000009%	-107.1
Neon	0.0018%	-246.0
Hydrogen	0.0005%	-257.9
Helium	0.0005%	-268.9
Krypton	0.0001%	-152.3
The amount of water vapor varies from place to place and time of day.		

The pie chart below summarizes the composition of air.



	The air in towns contains traces of carbon monoxide (from engines) and sulphur dioxide (from coal fires). The following item, is to look at the importance of air: Nitrogen is vital for plants. It is used by plants to synthesis foods as proteins. Nitrogen in air makes it inert. Without nitrogen, most chemical processes would lead to explosions. Without nitrogen to dilute the oxygen, fuels would burn too fast. Oxygen is used in respiration to provide energy. Air such as O_2 which is an active is used for burning. Carbon dioxide is needed by green plants to make photosynthesis. CO_2 is used in extinguisher to put out fire. Ozone protects the ultraviolet light from the sun. Moving air (wind) can be used to rotate turbines for electricity production. Air is used to inflate tyres of vehicles.	

Assessment **(5 min)**	1. The main gas in composition of air is: Nitrogen, Oxygen. Argon, Water 2. The component of air that participate in respiration is: Nitrogen, Oxygen, Argon, Water 3. The component of air used in fire extinguisher is: Oxygen, Carbon dioxide, Nitrogen, Inert gas 4. The percentage composition of oxygen in air is: 78%, 1%, 21%, 0.03% 5. Explain the importance of N_2 and CO_2 found in air **Expected answers:** 1. Nitrogen, 2. Oxygen, 3. Carbon dioxide, 4. 21%, 5. Nitrogen is used in Prevention of explosion Carbon dioxide is involved in photosynthesis of plants. It is used in extinguisher to put out fire.	Provide opportunities to students for corrective or positive feedback on assessment

Lesson summary and conclusion **(5 min)**	**Concept summary:** – Air is a homogenous mixture of gases. – Oxygen makes up 21% of air volume. – Introduction of harmful or poisonous substances into the atmosphere is called air pollution. – Some of the gases which cause air pollution include carbon monoxide, carbon dioxide, sulphur dioxide and sulphur trioxide **Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: Air is a homogenous mixture of gases (nitrogen, oxygen, carbon dioxide, inert gases, etc). Nitrogen is responsible for plant growth. Carbon dioxide is used by green plants to make photosynthesis. Oxygen is needed by humans and animals for respiration. **Thank you for your participation in this lesson.**	– Provide reviewed summary to the students and give them opportunities to answer and ask for clarifications. – Provide opportunities for corrective feedback or positive feedback to students.

Scripted lesson from Unit 9

SUBJECT: Chemistry	**GRADE:** S1	**UNIT 9:** Waste materials
LESSON TITTLE: Sources of wastes and types of waste materials		**Duration:** 40 min
Teaching & learning materials: Learner's book, charts, chalkboard, the surrounding, various types of waste materials		
Section	**Step- by- step instruction and content**	**Notice to the teacher**
Student readiness **(2min)**	**Lesson Objectives:** By the end of this lesson, learner will be able to: – Identify different sources of wastes. – Categorize waste materials according to their state of matter.	– Welcoming learners in the lesson – Connect the learners' expectations to the learning objectives – Identify the learners with special education needs to be helped accordingly.

Introduction **(8min)**	**Teacher:** Observe the following figure and answer to the questions.  **Guiding questions:** 1. What do you observe on this image? 2. Are there things that you do not need? 3. Where did they come from? **Suggested answers from learners:** • A mixture of many materials composed by papers, utensil in plastic and metals, clothes, ……Which constitute waste materials.	– Tell students the materials needed and give them a small time to take them. – Give learners opportunity to reflect on the introductory questions. – Allow learners to ask questions about the topic of the day. – Build on their questions and communicate the key question.

	• Yes, Some of these things result from daily use. They have become defective and unwanted. Examples of such things in the school compound are broken desks, old exercise books and writing materials. • They can come from homes, industries, schools, hospitals, markets, …… **Teacher:** Alright. You did a very good work. Now this leads us to the next section of our lesson today.	
Lesson Development **(20min)**	**Teacher:** Today we are starting with types of waste materials and their sources, the lesson of unit 9 which is Waste materials. It will be easy for you as you have the prerequisites needed which are discussion that you have done about definition of waste material. **Lesson title: Sources of waste and Types of waste materials** **Activity 1:** Observe the following images  **A**  **B**  **C**	– Communicate the new lesson and write its title on the chalkboard – Emphasize new concepts – At each step, provide a pause time for students to think and say or write their ideas. – Help learners form groups based on gender responsive. – Use different questions to probe students to understand the content/ Questions/ answers method

	Teacher: Answer the following questions. a) What do you observe in the above images? b) Are the images A, B and C the same? Explain your answer. c) Classify the wastes found in (a) according to their state of matter (solid, liquid and gas.) **Student:** a) Plastics, used water, industry, chimney, fumes. b) They are the same because all of them show unused things. c) Solid waste(A), liquid wastes(B), gaseous waste(C) **Teacher:** In lesson 1 of this unit 9 of senior 1 you discussed about definition of waste materials. You were discussing also some of the ways waste materials can be put to good use and the importance to keep our environment clean. **Activity 2.** **Teacher:** Observe the environment around you and describe it. a) Which kind of waste materials can you see? b) Classify them into types depending on the state of matter.	– Use different questions to probe students to understand the content/Questions/ answers method – The teacher helps students to conclude.

Suspected learners' answers:

a) Within the school environment, there are waste materials such as old waste papers, books, newspaper, broken desks, broken apparatus, waste from the store, waste from the kitchen, from laboratory, ….

b) The waste materials can be placed into three major groups:

- Solid wastes
- Liquid wastes
- Gaseous wastes

Teacher: Waste materials can be categorized according to states of matter.

a) Solid wastes: These can be either **biodegradable** or **non-biodegradable wastes**.

Biodegradable waste: Ex. Food leftover

	Non-Biodegradable waste: Ex. Plastics a) **Biodegradable solid wastes**: these are solid wastes that can be broken down into simple compounds by microorganisms. **Examples** of such biodegradable solid wastes include remaining of plants and animals, papers and cotton wool clothes. b) **Non-biodegradable solid wastes:** These are solid wastes which cannot be broken down by microorganisms. **Examples** include polythene bags, metals scraps, piece of glass and plastics. 1) **Liquid wastes:** These waste include household wastes such as water from the kitchen, the bathroom and urinal. It is also includes liquid chemicals from industries. 2) **Gaseous wastes:** These include the following categories of wastes: a) **Industrial:** Sulphur dioxide, hydrogen chloride gases. b) **Laboratory:** chlorine, ammonia gases c) Wastes obtained from the combustion of fossil fuel: carbon monoxide, Sulphur dioxide, carbon dioxide and nitrogen dioxide.	

Assessment **(5min)**	**Teacher:** Workout in groups of 4 learners each question that follow: 1) Given the following list of waste materials: broken test tubes, bottles, used chemicals, waste papers, bathroom water, kitchen and dining leftovers. Put them in appropriate categories. 2) In pair, classify the following wastes into biodegradable and non-biodegradable: Grass cuttings, water bottles, polythene bags, human and animal excreta, torn papers, stones, pig dung. **Student:** 1. – **Solid waste:** broken test tubes, bottles, waste papers, kitchen and dining leftovers – **Liquid waste:** used chemicals, bathroom water. 2. **– Biodegradable:** human and animal excreta, torn papers, pig dung. **- Non-biodegradable:** Grass cuttings, water bottles, polythene, stones, bags	– Provide review opportunities for students. – Provide opportunities for corrective feedback or positive feedback to students.

Lesson summary and conclusion. **(5min)**	**Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. Let us summarize and conclude on: 1. Identify different types of wastes. Waste materials can be categorised according to their sources and nature. According to their nature, waste materials can be categorised into the following classes: **1. Solid wastes:** These can be either biodegradable or non-biodegradable. **a) Biodegradable solid wastes:** These are solid wastes that can be broken down into simple compounds by microorganisms. Examples of such biodegradable solid wastes include remains of plants and animals, wastes from animals, papers and cotton wool clothes. **b) Non-biodegradable solid wastes:** These are solid wastes which cannot be broken down by microorganisms. Such wastes include polythene bags, metal scraps, pieces of glass and plastics. Some pesticides, such as DDT are also non-biodegradable if they find their way into the soil.	– Provide review opportunities for students. – Provide opportunities for corrective feedback or positive feedback to students.

	2. Liquid wastes: These include household wastes such as water from the kitchen, the bathroom and urinal. It also includes liquid chemicals from industries. **3. Gaseous wastes:** They include the following categories of wastes: (a) Industrial – sulphur dioxide, hydrogen chloride gases (b) Laboratory – chlorine, ammonia gases (c) Waste obtained from the combustion of fossil fuels – carbon monoxide, sulphur dioxide, carbon dioxide and nitrogen dioxide 3. To differentiate biodegradable wastes and non-biodegradable wastes. 4. Category of Wastes materials (solid, liquid and gaseous wastes). 5. Sources of waste materials Now I want to give you homework assignment so that you try to apply what we have learned to day. **Homework:** 1. Identify different types of waste materials? 2. Which of the following is non-biodegradable waste a) leaves	

	b) nails Glass c) meat d) fruit peelings 3. Which is not solid waste from the following: Food leftover, insecticides, plates, metallic materials. Give an example of a solid, liquid and gas waste found at your school. 4. Differentiate between biodegradable and non-biodegradable wastes.	

Scripted lesson from Unit 10

SUBJECT: Chemistry	GRADE: S1	UNIT 10: Chemical equations

LESSON TITTLE: Interpreting and translating word equations into chemical equations **Duration:** 40 min

Teaching & learning materials: Reference materials and chalkboard, periodic table, and learner's book for senior one

Section	Step- by- step instruction and content	Notice to the teacher
Student readiness **(2min)**	**Lesson Objectives:** By the end of the lesson, learners will be able to: – Translate a word equation into a chemical equation and vice-versa. – Write chemical equations with state symbols.	– Welcoming learners in the lesson – Connect the learners' expectations to the learning objectives – Identify the learners with special education needs to be helped accordingly.

<table>
<tr>
<td>Introduction

(8min)</td>
<td>Teacher: Last time, we discussed about balancing chemical reactions and how to find names from chemical formula and vice versa. Now I want you to answer the following questions related to the previous lessons:
1. What is a chemical equation?
2. How is a chemical reaction represented?
3. Identify the reactants and the products in the chemical equation below:
$N_2(g) + O_2(g) \rightarrow NO_2(g)$
4. What is the difference between word equation and chemical equation?
5. How a chemical equation written?
6. Complete the following table.
<table>
<tr><th>Compound names</th><th>Compound formula</th></tr>
<tr><td>Magnesium chloride</td><td></td></tr>
<tr><td></td><td>$Ca(OH)_2$</td></tr>
<tr><td>Potassium sulphate</td><td></td></tr>
<tr><td></td><td>Sodium nitrate</td></tr>
<tr><td>Lithium oxide</td><td></td></tr>
<tr><td></td><td>$CaCO_3$</td></tr>
<tr><td>Sodium phosphate</td><td></td></tr>
<tr><td>Carbon dioxide</td><td></td></tr>
</table>
</td>
<td>– Recall on the previous lessons by asking questions on these lessons. This will serve as a prerequisite of today’s lesson.

Students must be given time to think and note down their answers which will be analyzed by the teacher and peers in order to give constructive feedback.</td>
</tr>
</table>

Expected learners' answers:

1. A chemical equation is a representation of a chemical reaction. A chemical equation is a short hand way of representing a reaction.
2. A chemical reaction can be represented by a word equation or by use of chemical symbols. For example:

   Reactant A + Reactant B → Product C + Product D
3. $N_2(g) + O_2(g) \rightarrow NO_2(g)$

   Reactants Product
4. **Word equation:** reactants and products are represented in word.

   Chemical equation: reactants and products are represented using chemical symbols for each element.
5. A chemical formula is written using chemical symbols and valences.
6.

Compound names	**Compound formula**
Magnesium chloride	**$MgCl_2$**
Calcium hydroxide	$Ca(OH)_2$
Potassium sulphate	**$K2SO_4$**

<table>
<tr><td></td><td>

$NaNO_3$	Sodium nitrate
Lithium oxide	Li_2O
Calcium carbonate	$CaCO_3$
Sodium phosphate	**Na_3PO_4**
Carbon dioxide	**CO_2**

</td><td></td></tr>
<tr><td>Lesson development

(20 min)</td><td>Teacher: Today we are starting with a new lesson which is Interpreting and translating word equations into chemical equations and vice-versa, It will be easy for you as you have the prerequisites needed which are the knowledge got on naming chemical compounds.

Lesson title: Interpreting and translating word equations into chemical equations

Teacher: Form groups of 5 learners and try to carry out the following activities.

Activity 1

1. Convert word equations into chemical equations.

a) Sodium hydroxide + Nitric acid → Sodium nitrate + water</td><td>– Communicate the new lesson and write its title on the chalkboard
– Emphasize new concepts
– At each step, provide a pause time for students to think and say or write their ideas.
– Help learners form groups based on gender responsive.
– Use different questions to probe students to understand the content/ Questions/ answers method</td></tr>
</table>

	b) Sodium + Iodine → sodium iodide c) Potassium oxide + Water → Potassium hydroxide d) Hydrogen phosphate + Sodium → Sodium phosphate + hydrogen **Learners' answers:** a) $NaOH(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l)$ b) $2Na(s) + I_2(g) \rightarrow 2NaI(s)$ c) $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$ d) $H_3PO_4(aq) + 3Na(s) \rightarrow Na_3PO_4(aq) + 3/_2H_2(g)$ **Activity 2.** Convert chemical equations into word equations. a) 4Li(s) + O2(g) → 2Li2O(s) b) $2Na(s) + 2H_2O(aq) \rightarrow 2NaOH(aq) + H_2(g)$ c) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ d) $K_2O(s) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + H_2O(l)$ **Learners' answers:** a) Lithium + oxygen → Lithium oxide b) Sodium + Water → Sodium hydroxide + hydrogen c) Hydrogen + Chlorine → Hydrogen chloride d) Potassium oxide + Hydrogen sulphate → Potassium sulphate + water	– Use different questions to probe students to understand the content/Questions/ answers method

<table>
<tr>
<td></td>
<td>
Teacher: With the knowledge of symbols of elements, radicals and their valences, we can derive the correct formula of a compound.
A word equation can be interpreted and translated into a chemical equation and vice-versa.
When writing into chemical symbol equations the states symbols are necessary.
Meaning of symbols used in Chemical Equations
<table>
<tr><th>Symbols</th><th>Explanation</th></tr>
<tr><td>$\rightarrow$</td><td>“yields” -separates reactants from products</td></tr>
<tr><td>(s)</td><td>designates a reactant or product in solid state; placed after the formula</td></tr>
<tr><td>(l)</td><td>reactant or product in liquid state</td></tr>
<tr><td>(g)</td><td>reactant or product in gaseous state</td></tr>
<tr><td>(aq)</td><td>reactant or product in aqueous state</td></tr>
</table>
</td>
<td>
– Summarize learners’ ideas to explain how a chemical word reaction is written and when is complete and represent it by a chemical equation
– Use different questions to probe students to understand the content/Questions/ answers method.
– The teacher requests again learners to be ready, to perform, to observe, to discuss and follow carefully explanations then note key points.
Provide opportunities for corrective feedback or positive feedback to students.
</td>
</tr>
</table>

Assessment/ Evaluation **(5min)**	**Teacher:** Go back to your groups (the ones we formed earlier) and carry out the following activities. 1. Convert the following word equations into symbolic chemical equations. a) Zinc + oxygen → zinc oxide b) Aluminium + chlorine → Aluminium chloride c) Calcium carbonate → calcium oxide + carbon dioxide d) Chlorine + Ozone → Oxygen + chlorine monoxide **Expected answers for students:** 1.a) $Zn(s) + O_2(g) \rightarrow ZnO(s)$ b) $Al(s) + Cl_2(g) \rightarrow AlCl_3(s)$ c) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ d) $Cl_2(g) + O_3(g) \rightarrow O_2(g) + ClO(g)$	Provide review opportunities for corrective feedback or positive feedback to students. Provide review opportunities for students.
Lesson Summary and conclusion **(5min)**	**Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: – Translate a word equation into a chemical equation and vice-versa. – Write chemical equations with state symbols.	– Ask questions to students that help to construct the summary of the lesson and the conclusion

	Now I want to give you homework assignment so that you try to apply some of what we have learned today. **Homework:** 1. Write word equation for the following reaction – Carbon burning in excess oxygen to form carbon dioxide. 2. Translate this chemical equation into word equation $K(s) + Cl_2(g) \rightarrow 2KCl(s)$ 3. Write a balanced chemical equation for the following reaction: – Calcium metal burns in oxygen to form calcium oxide. 4. Write the word equation for the following chemical equation: $Fe(s) + S(s) \rightarrow FeS(s)$ $C(s) + O_2(g) \rightarrow CO_2(g)$ $CO_2(g) + H_2O(l) \rightarrow C_6H_{12}O_6(s) + O_2(g)$ $CuSO_4(aq) + NaOH(aq) \rightarrow Cu(OH)_2(s) + Na_2SO_4(aq)$ ***Thank you for your participation in this lesson.***	

Scripted lesson from Unit 11

SUBJECT: Chemistry	GRADE: S1	UNIT 11: Acids, bases and pH
LESSON TITTLE: Definition of acid, base and alkali		**Duration:** 40 min
Teaching & learning materials: Reference books and textbooks, chalkboard.		

Section	Step- by- step instruction and content	Notice to the teacher
Student readiness **(2min)**	**Lesson Objectives:** By the end of this lesson, learner will be able to: – Define acid, base and alkali – Write an equation for the dissociation of acid and base to predict some sources of natural acids.	– Welcoming learners in the lesson. – Begin also by gaining students' attention revisiting pertinent skills and knowledge previously taught and communicate objective of the lesson – Identify the learners with special education needs. – Gain the learners attention.

Introduction **(8min)**	**Teacher:** I think everyone here has eaten orange and lemon fruits. If yes, describe their tastes. **Student:** The taste of these fruits is sour. **Teacher:** Observe the figures that follow and write answers to the questions.  *Fig.1: Car battery and soap* *Source: https://www.istockphoto.com* 1. a) Do you know any acid? b) If yes, give an example 2. Do you know any chemical substance found in the car battery? 3. Do you know any chemical substance used in making soap? **Expected learners 'answers:** 1. (a) Yes. (b) Example: Hydrochloric acid, Nitric acid, Sulphuric acid	– Tell students the materials needed and given them a small time to take them. – Students must be given time to think and note down their answers which will be analyzed by the teacher and peers in order to give constructive feedback.

	2. One of the chemical substance found in the car battery is sulphuric acid. 3. The chemical substance used in making soap is sodium hydroxide/ caustic soda. **Teacher:** Know that sulfuric acid is an acid and sodium hydroxide is a base.	
Lesson Development **(20min)**	**Teacher:** Today we are starting with, Definition of acid, base and an alkali, the lesson of unit 11 which is Acids, bases and pH. **Lesson title: Definition of acid, base and alkali** **Teacher:** a) How an acid can be defined? b) What do you understand by the term Base? Give examples. Discuss carefully to the questions here above. **Teacher:** 1. An acid is a substance which when dissolved in water dissociates to give hydrogen ion(s) ($H+$) as the only positively charged ions.	– Indicate the title of the lesson – Move around in the class to check on students' answers and facilitate them. – At the end, invite student to compare their results with the expected answers. – Make comments on leaners' answers and give right answers

	Examples showing that acids are dissociated in water: a) $HCl\ (aq) \rightarrow H^+(aq) + Cl^-(aq)$ b) $HNO_3(aq) \rightarrow H^+(aq) + NO^{3-}(aq)$ c) $H_2SO_4\ (aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$ The hydrogen ion (H^+) gives acids their characteristic properties. 2. A base is a substance which when dissolved in water dissociates to give hydroxide ions (OH-) as the only negatively charged ions. Examples of bases include NaOH, KOH and $Ca(OH)_2$. On dissociation these bases give the following ions: a) $NaOH\ (aq) \rightarrow Na^+(aq) + OH^-(aq)$ b) $KOH\ (aq) \rightarrow K^+(aq) + OH^-(aq)$ The hydroxide ion (OH^-) gives bases their characteristic properties. Teacher summarizes learners' ideas and introduces the scientific names of the two types of substances. A base that dissolves in water is called an alkali. Acids can either be commercial or natural. Commercial acids are bought from shops or chemical outlets.	– Form groups of five students and give to each group the five solutions and indicators. – Give instructions – Ask learners to present their findings. – Build on learners' ideas to expand their knowledge.

	Examples of commercial acids include hydrochloric acid (HCl), sulphuric acid (H2SO4) and nitric acid (HNO3). Natural acids are found in a variety of things such as citric acid found in oranges and lemons, acetic acid found in vinegar and hydrocyanic acid found in cassava. **Application activities:** **Teacher:** carry out the following activities. 1. Complete the following dissociation equations and identify which substances is an acid and which is a base? a) $H_2CO_3(aq)$ b) $NH_4OH(aq)$ **Learners answers:** a) $H_2CO_3(aq) \rightarrow 2H^+(aq) + CO_3^{2-}(aq)$ b) $NH_4OH(aq) \rightarrow NH_4^+(aq) + OH^-(aq)$ Compound H_2CO_3 is an acid because it releases H^+ ion as the only positive ion. Compound NH_4OH is a base because it releases OH^- ion as the only negative ion.	– At each step, Student must be given time to think and say or note down their ideas. – Use different questions to probe students to understand the content/Questions/answers method – Request again learners to be ready and follow carefully explanations note key points Provide opportunities for corrective feedback or positive feedback to students.

Assessment **(5min)**	Teacher: Dear students, do individually the following exercise. 1. An acid can be defined as: a) substance that produces OH^- ions in water b) substance that produces H^+ ions in water c) substance containing both H^+ and OH^- ions 2. The hydroxide ions(OH-) gives a characteristic of: a) water b) salt c) base d) acid 3. Bases are sometimes called alkalis a) True b) False 4. Write a balance equation for the dissociation of: a) H_2SO_4 in water b) $Ca(OH)_2$ in water	Provide review opportunities for students to give answers and write questions and answers in their notebooks.

	5. A liquid is determined to be an acid or base depending on the type of..............in the liquid. a) Electrons b) Protons c) Ions d) Elements e) Neutrons **Expected answers:** 1. b 2. c 3. a a) $H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$ b) $Ca(OH)_2(aq) \rightarrow Ca_2^+(aq) + 2OH^-(aq)$ 5. c	
Lesson Summary and conclusion **(5 min)**	Teacher: We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: – Define acid, base and alkali – Write an equation for the dissociation of acid and base – Predict some sources of natural acids ***Thank you for participation in this lesson.***	– Ask questions to students that help to construct the summary of the lesson and the conclusion

Scripted lesson from Unit 12

SUBJECT: Chemistry	**GRADE:** S1	**UNIT 12:** Inorganic salts and their properties
LESSON TITTLE: Definition and nomenclature of salts **Teaching & learning materials:** Learner's book, chalkboard, periodic table, different salts, charts.		**Duration:** 40 min
Section	**Step by step instructions and contents**	**Notice to the teacher**
Student readiness **(2 min)**	**Learning objectives:** By the end of this lesson, learner will be able to: – Define the term salt. – Name different types salts	– Welcome learners in the lesson. – Connect the learners' expectations to the learning objectives – Identify the learners with special education needs. – Gain the learners attention.

Introduction **(8 min)**	**Teacher:** Observe carefully the image and make comments.  **Guiding questions from the teacher** 1. What do you observe? 2. a. Give some examples of salt that you know. b. What are the uses of these salts? c. What do you think could be the source of these salts? d. What are their chemical names **Expected answers from learners:** Many chemical substances which are coloured classified as inorganic salts. These chemicals are labelled as follow: $CaSO_4$, $K_2Cr_2O_7$, $CuSO_4$, $KMnO_4$	– Guide students to give correct answers when observing the figures – Listen to the learner's explanations and make some comments. – Emphasize new concepts. At each step, Student must be given time to think and say or note down their ideas. – Tell students the materials needed and give them a small time to take them.

	a) Some examples of salts NaCl, ……. b) Salts should be used for flavoring and for preserving food. They are also used in tanning, dyeing and bleaching, and the production of soap, and chlorine. Today, it is widely used in the chemical industry. c) Sources of salts: water, soil, rocks. …… d) The names of salts are given according to the rules **Teacher:** Alright students. Now this leads us to the next section of our lesson today. Are you ready? Very Good!	– forms a group of 5 which include boys and girls and answer the given activity. – Teacher moves around in class observing the learners' answers.
Lesson development **(20min)**	**Teacher:** Today we are starting with a new lesson of the unit 12 Inorganic salts and their properties. **Lesson title:** Definition and nomenclature of salts **Teacher:** Compare the structures of compounds in column A and column B in the table below:	– Indicate the new lesson and write the title on the board. – Ask questions Use different questions to help students to develop progressively the new lesson by questions/ answers method

A	B
HCl	NaCl
H_2SO_4	K_2SO_4
H_2CO_3	$CaCO_3$
HNO_3	$Mg(NO_3)_2$
HBr	NH_4Br
HCN	KCN

Student: The compounds in column A are acids and the compounds in the column B are formed by replacing H in acids by a metal or ammonium ion.

Teacher: Good. Note that the compounds in column B are called salts.

Try to find the definition of salts based on their structure.

Student: Salts are compounds formed when the hydrogen ions in an acid are replaced by a metal or ammonium ion.

Teacher: Good. When all the hydrogen ions of an acid are replaced by a metal or ammonium radical, we get a normal salt. All chloride and nitrate salts are **normal salts**.

– Provide opportunities for corrective feedback or positive feedback to student.

– Request again learners to be ready and follow carefully explanations note key points.

So give examples of such normal salts

Student: Normal salts: $NaCl$, K_2SO_4, $CaCO_3$, $Mg(NO_3)_2$

NH_4Br, KCN

Teacher: When the hydrogen ions of an acid are partially replaced, we obtain an acid salt.

Acids	**Acid salts**
H_2SO_4	$KHSO_4$ (1H only is replaced)
H_3PO_4	NaH_2PO_4 (1H only is replaced)
	Na_2HPO_4 (2H only are replaced)

Teacher: write the formula of an acid salt formed from carbonic acid.

Student: NaHCO3

Teacher: The number of hydrogen atoms in each molecule of an acid, replaceable directly or indirectly by a metal or ammonium radical, is called **the basicity of that acid**.

Both hydrochloric and nitric acids contain only one replaceable hydrogen atom hence are said to be **monobasic**.

Monobasic acids form one series of salts i.e **normal salts**.

By using questions / answers Students give answers that should constitute the content of the lesson.

	Sulphuric and carbonic acids have two replaceable hydrogen atoms per molecule of the acid. They are **dibasic**. These acids form two series of salts. – Where all hydrogen atoms of the acid are replaced i.e, normal salt. Consider the following illustrations. $Zn(s) + H_2SO_4(aq) \rightarrow \underset{\text{(normal salt)}}{ZnSO_4(aq)} + H_2(g)$ Note that zinc sulphate has no hydrogen atom which can be replaced. It is therefore described as a normal salt. – Where only a part of the hydrogen atoms of the acid are replaced i.e, acid salt. Consider the following illustrations. $H_2SO_4(aq) + NaOH(aq) \rightarrow NaHSO_4(aq) + H_2O(l)$ (acid salt) Note that sodium hydrogen sulphate salt still has one hydrogen atom, which can be replaced by a metal or ammonium ion. This is why it is known as an acid salt. **Activity: Naming salts** Names of salts are derived from the metal or ammonium ion from which they are formed and the parent acid. When naming salts, the name starts with the metal or ammonium ion in the salt, followed by the respective acid radical.	

Example: Naming of salts from different acids

Acid and its formula	Radical name	Type of salt	Examples
Hydrochloric (HCl)	Chlorides	Normal	Sodium Chloride Calcium Chloride
Nitric acid (HNO_3)	Nitrates	Normal	Potassium nitrate Lead(II) nitrate
Sulphuric acid (H_2SO_4)	Sulphates	Normal	Magnesium sulphate Lithium Sulphate
	Hydrogen sulphates	Acid	Sodium hydrogen sulphate
Carbonic acid (H_2CO_3)	Carbonate	Normal	Zinc carbonate Calcium carbonate
	Hydrogen carbonate	Acid	Calcium hydrogen carbonate

Assessment **(5min)**	**Teacher:** Answer the questions that follow: 1) What do you understand by the term salt? 2) Write the salts formed from the combination of: a) Carbonic acid and sodium hydroxide b) Hydrochloric acid and magnesium c) Sulphuric acid and potassium hydroxide d) Nitric acid and iron (III) State whether the formed salts are normal salts or acid salts. **Suspected learners' answers:** A salt is a compound formed when the hydrogen ions of an acid are wholly or partially replaced by a metal or ammonium ion. a) Na_2CO_3 c) K_2SO_4 or $KHSO_4$ b) $MgCl_2$ d) $Fe(NO_3)_3$ **Teacher:** Now I want to give you homework assignment so that you try to apply some of what we have learned today.	– Provide review opportunities for students to give answers and write questions and answers in their notebooks.

Lesson Summary and conclusion	**Teacher:** We are coming to the end of our lesson today. As we conclude, let's review some of the following key points that we learned. • Definition of salts and their types • Understand the criteria used to name salts and find formula of salts from their corresponding acids **Homework:** 1. Which of the following compound is a salt. A. CO B. NaCl C. H_2O D. P_2O_3 2. Which of the following acids form normal salt A. H_2SO_4 B. H_2CO_3 C. HCl D. All of above	– Ask questions to students that help to construct the summary of the lesson and the conclusion

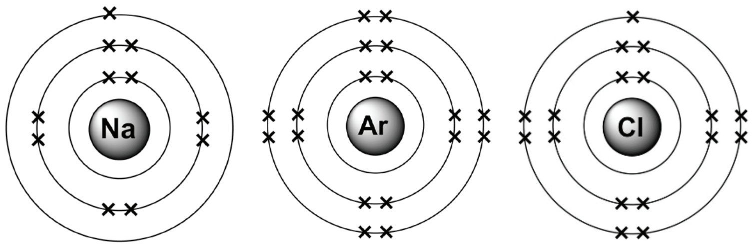
	3. Which of the following acid form acid salt A. HNO_3 B. HCl C. H_2SO_4 D. All of above 4. Write the formula and the name formed by: a. Magnesium and hydrogen sulfide b. Aluminium hydroxide and hydrogen sulphate **Teacher:** Thank you for your participation in this lesson.	

SCRIPTED LESSONS FOR SENIOR TWO

Scripted lesson from Unit 1

SUBJECT: Chemistry	**SENIOR:** S2	**UNIT 1:** Chemical bonding
LESSON TITTLE: Stability of atoms		**Duration:** 40 min
Teaching & learning materials: Molecular models, Appropriate chemicals, Electrolytes, Wires and bulbs.		

Section	Step- by- step instruction and content	Notice to the teacher
Student readiness **3min**	**Lesson Objectives:** By the end of this lesson, learners will be able to: – Describe how atoms gain stability – Illustrate the stability of metals and non-metals – Explain why atoms form bonds.	– Welcoming students. – Begin by gaining students' attention, revisiting pertinent skills and knowledge previously taught and communicate objective of the lesson. – Identify all students with special education needs to help them accordingly.

Introduction **(7min)**	**Teacher:** Consider the following electronic structure of sodium, chlorine and argon.  **A** **B** **C** Consider the above figure and raise two questions. **Guiding questions:** **Teacher:** How many electrons do the above atoms have at the outermost shell? **Student:** Sodium has 1 electron; Argon has 8 electrons and chlorine has 7 electrons. **Teacher:** When the outermost shell becomes complete? **Student:** I think the outermost shell becomes complete when it bears 8 electrons (octet).	– Recall on the previous lessons by asking questions on these lessons. – Tell students the materials needed and give them a small time to take them. – Provide review opportunities for students. – Give time to students to think and note down their answers which will be analyzed by the teacher and peers in order to give constructive feedback. – Use the guiding questions to show expected answers.

	Teacher: Which one from the above atoms has a complete outermost shell? **Student:** Argon	
Lesson development **(20 min)**	**Teacher:** Let's look at the Stability of atoms. The knowledge got from UNIT 5/Senior 1 Atoms, Elements and Compounds will help to understand well the Stability of Atoms. **Lesson title: Stability of Atoms** **Teacher:** In groups of 2 discuss on the following statements/scenarios. – Take a glass full of water. Try adding water into it. Are you able to add? – Now take another glass of water but a half filled. – Try adding water into it. Now, are you able to add or not? **Discussions:** When the glass was already filled, there was no space to add more water into it. Thus, the water in the glass remained stable. But if the glass is half filled we are able to add more water onto it.	– Communicate the new lesson and write its title on the chalkboard. – At each step, provide a pause time for students to think and say or write their ideas. – Allow learners to ask question about the topic of the day. – Build on their questions and communicate the key questions. **Key question:** When an atom is stable and this stability is acquired? – Now let the learners think and discuss about the three statements/scenarios. Afterward let them explain their findings.

	Teacher's input: Now we are going to link your findings to atoms and elements. A noble gas has a fully filled outermost shell just like the glass full of water. That's why we say the noble gases are stable. An atom is said to be stable if they have eight electrons on their outermost shell (octet) or two electrons in the outermost shell (duplet). So the other elements form group 1 to 7 (or G1 to G17) are not stable. These elements gain stabilities either: – By losing one or more electrons (to another atom). Atoms with 1, 2 or 3 electrons in the outermost shell lose electrons to achieve stability. In this case ion are formed, which are their stable forms. **Example:** Stability of Sodium atom	– Here the teacher emphasizes new concepts. – Use different questions to probe students to understand the content/ Questions/ answers method

<table>
<tr>
<td>Assessment

(5 min)</td>
<td>1. The noble gases have stable electronic structure. How do you explain that?
2. How do other atoms (metals and non-metals) gain their stability)?
3. What is meant by the following terms:
• A Cation?
• An Anion?
4. How the following atoms get stability: Al, Br, Ca, N

Student:
1. The noble gases have stable electronic structure because they have 8 electrons on the outmost shell or 2 electron (He).
2. Other atoms gain stability by losing electrons or by gaining electrons: metals lose electrons while non-metals gain electrons.
3. – A cation: is an ion with positive charge
– An anion: is an ion with negative charge
4. Al: loses 3 electrons, Br gain 1 electron, Ca loses 2 electrons, N gains 3 electrons

Qn1. Using dot and cross diagram to illustrate how Magnesium (z = 12) gets stability.</td>
<td>– Provide opportunities to students for corrective feedback or positive feedback on formative assessment

Give the homework and agree on the date for submission.

Tell the students to go home and do more research in books (if possible ask for help either a student in upper level) so that they get to answer to those questions in the assignment.</td>
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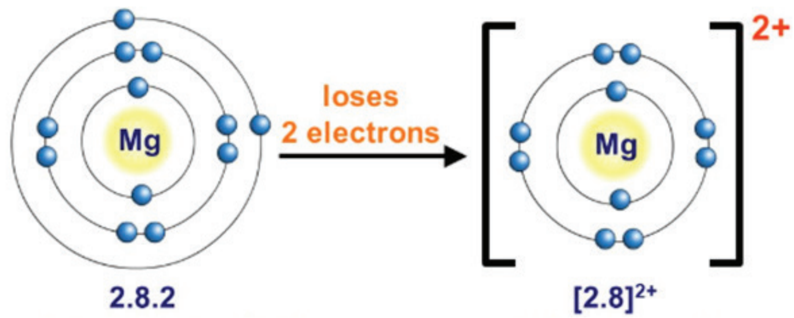
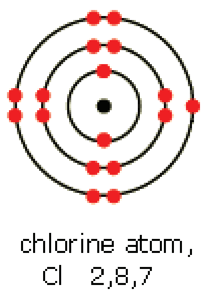
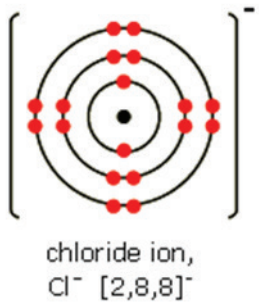
	Expected answers ***Ans1.*** *Mg atom gets stability by loosing 2 electrons.* A magnesium atom loses the two outer electrons (electron transfer) and becomes a magnesium ion 	
Lesson summary and conclusion **(5min)**	– **Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. – When is an atom stable? Answer to following questions. – How atoms get stability – How elements of group I, II and III get stability? – How elements of group 5,6 and 7 get stability?	– Use different questions to help students recall key concepts of the lesson and ensure that the summary is written down by all students. – During harmonization/ making a general summary, provide time students to ask questions on what they do not understand well.

	Homework: **Qn1.** Complete the statement below: An ion is formed when an atom __________ or __________ electron(s). A positively charged ion is known as __________ whereas a negatively charged ion is __________. **Qn2.** The following diagrams show electronic model of chlorine.  **A**  **B** e) What has happened for structure (A) to change to structure (B)? f) Why does structure (B) have an electron that is different from the others? g) Draw diagrams to show how Oxygen will behave as shown in (a) and (b) above.	– Agree with students on the date of submission of the Homework..

Excepted answers:

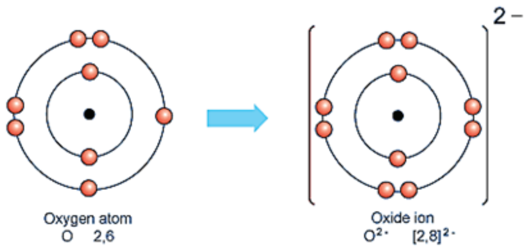
Ans1. *An ion is formed when an atom loses or gains electron(s). A positively charged ion is known as a cation whereas a negatively charged ion is an anion.*

Ans2.

a) Structure (A) has gained one electron in order to change to structure (B).

b) It has gained one electron to form a negative chloride ion, an anion.

c) Stability in oxygen atoms:



Scripted lesson from Unit 2

SUBJECT: Chemistry	**Grade:** S 2	**UNIT 2:** Trends in properties of elements in the periodic table.
LESSON TITTLE: Classification of elements		**Duration:** 40 min
Teaching & learning materials: Metals, bulb, dry cells, wires, and samples of metallic elements and non-metallic elements and the periodic table of elements.		
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to: – Classify elements into metals, non-metals and metalloids, – Indicate the position of metals, non-metals and metalloids on the periodic table.	– Welcoming students. – Begin by gaining students' attention, revisiting pertinent skills and knowledge previously taught and communicate objective of the lesson. – Identify all students with special education needs to help them accordingly.

Introduction **(8 min)**	**Teacher:** With your friend that you sit together, observe the groups of objects that follow and share with the rest of the class your findings.   **Guiding questions:** – What are differences between various subgroups? – What are the similarities between objects of the same group?	– Ask students to group the objects on the picture in different sub-groups according to their similarities and raise any other two questions related to the formed subgroups – Let the students make comments. – Give learners opportunity to reflect on the introductory questions. – Allow learners to ask question about the topic of the day. – Build on their questions and communicate the key questions

<table>
<tr>
<td></td>
<td>Suggested answers from learners:

– Listen to the learner’s explanations and make some comments.

Teacher: Alright Boys and Girls. You did a very good job. Now this leads us to the next section of our lesson today. Are you ready?

Very Good!</td>
<td></td>
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<tr>
<td>Lesson Development

(20 min)</td>
<td>Teacher: Now I’m taking you through “<u>The Classification of Elements</u>”. The knowledge got from UNIT 5 Atoms, Elements and Compounds, will help to understand well how Elements are classified.

Lesson title: Classification of Elements (How Elements are classified on the Periodic Table of Elements?)

Teacher:

In front of the class we have a big chart of the Periodic Table of Elements. Explore the periodic table below and write down your observation.</td>
<td>– Communicate the new lesson and write its title on the chalkboard.

– At each step, provide a pause time for students to think and say or write their ideas.

– Allow learners to ask question about the topic of the day.

Build on their questions and communicate the key questions.

Key question: What are the classes of elements?</td>
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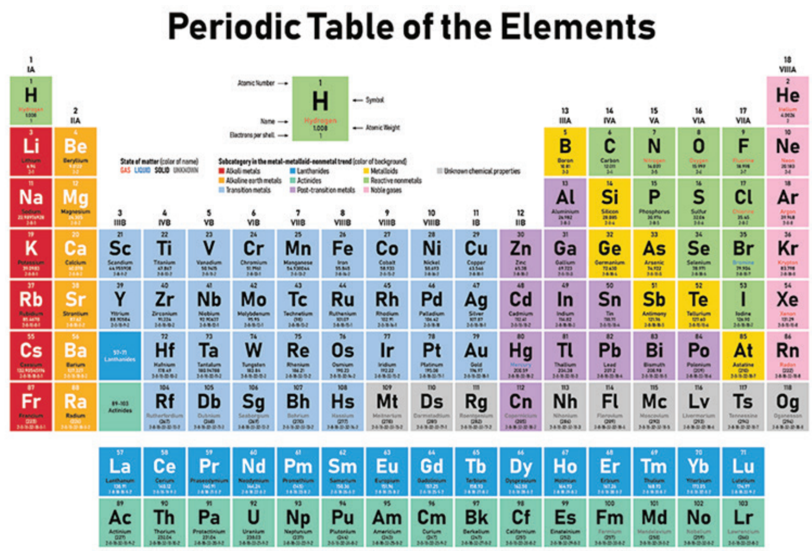


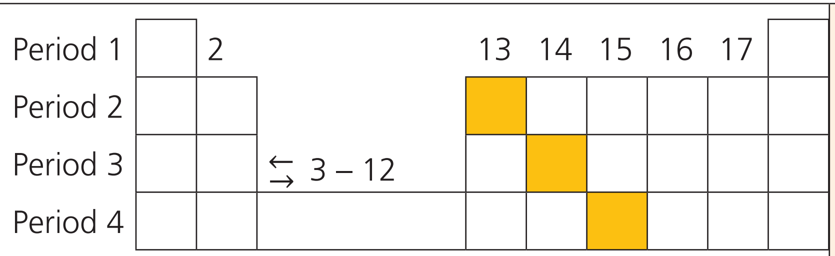
Learner's observations: We have different parts on the periodic table, some are metals, non-metals and metalloids.

Refer to the periodic table then explain how elements are classified.

Explanations: The elements in the periodic table are classified into: metals, non-metals and metalloids or Semi-metals.

Classification of element is categorizing: elements into groups based on similarities and differences in their properties.

	Sometimes the criteria for classifying elements into metals and non-metals are basically based on electronic configuration of the elements. The metals appear at the left-hand side and middle part of the periodic table. The non-metals appear at the upper right-hand side of the periodic table. Metalloids lie in between metals and non-metals. **Teacher's input:** Classification of elements into metals, metalloids and non-metals **Metals and non-metals** Looking at the electronic configuration of elements, if the outermost energy shell has 1 to 3 electrons, these elements are mostly metals. On the other hand, if the outermost energy shell has 4 to 8 electrons, the elements will now fall into non-metals. **Note:** There is an exception on this, despite the fact that they have the same electron configuration with elements in the same columns, Hydrogen and Boron are not metals. Observe the following grid and answer the question that follows it.	

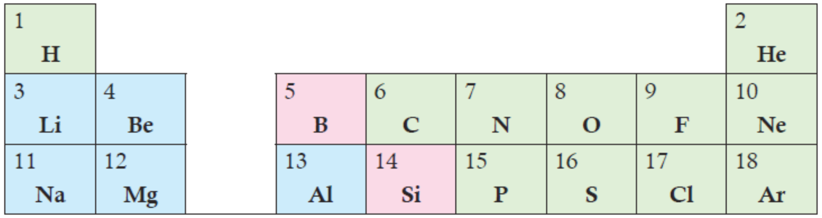


Shade with two different colors where metals and no-metals are found.

Assessment

(5 min)

1. How many non-metals are there in the following figure?



   – Five, Eleven, Six, Seven

2. Choose the symbol of metalloid from the following.

   Na, Si, S, Ne

3. Name two metalloids.

4. Metalloids have properties of both metals and non-metals. (True or False)

	5. Which of the following metals exists in the liquid state? Sodium, Silver, Mercury, Neon ***Expected answers:*** *1. Eleven* *2. Si* *3. Silicon and Germanium* *4. True* *5. Mercury*	
Lesson Summary and Conclusion **(5 min)**	**Transition metals** These are found between Group II and III. Transition metals are classified in series. There is a chemical similarity within a series. **Concept Summary:** Elements can be classified as metals, metalloids and non-metals. The metals appear at the left-hand side and middle part of the periodic table. The non-metals appear at the upper right-hand side of the periodic table. Elements in-between the metals and non-metals are known as metalloids.	– Use different questions to help students recall key concepts of the lesson, and ensure that the summary is written down by all students – Summarize the ideas of learners by clarifying in which groups transitional metals are found, their similarities within series.

Homework

Observe the following grid and answer the question that follows it.

Period 1		2		13	14	15	16	17	
Period 2									
Period 3			⇆ 3 – 12						
Period 4									

Shade with two different colors where metals and no-metals are found.

Scripted lesson from Unit 3

SUBJECT: CHEMISTRY	GRADE: S 2	UNIT 3: Water pollution
LESSON TITTLE: Water pollution and its main pollutants		**Duration:** 40 min
Teaching & learning materials: Wall charts of water pollutions, glass, beaker, clean water, polluted water and some wastes from around the school.		
Section	**Step -by- step instructions and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to: – Define water pollution. – Identify the main water pollutants.	– Welcoming students. – Begin by gaining students' attention, revisiting pertinent skills and knowledge previously taught and communicate objective of the lesson. – Identify all students with special education needs.

<table>
<tr>
<td>Introduction

(8 min)</td>
<td>Teacher: observe the following pictures provided and refer to them in order to describe what is happening.

A 

B 

After hearing from the student’s ideas and observations, the teacher can also ask a couple of questions as follows:</td>
<td>– Ask the students to look carefully at the pictures provided and refer to them in order to describe what is happening.
– Ask the students to look carefully at the pictures provided and refer to them in order to describe what is happening.
– Give time to students to think and note down their observations and share them to the class.</td>
</tr>
</table>

	Learners observations: Picture A, the water source is full of waste products bottles, polythene bags, plant remains etc … Picture B, children are playing around a dirty stream and that's where their families live.	– Emphasize new concepts. – At each step, provide a pause time for students to think and say or write their ideas.
Lesson Development **(25 min)**	**Teacher:** Let's look at the Water Pollution. The knowledge got from UNIT 10 we discussed days ago, in Senior 1, Water is going to help you understand this Lesson. **Lesson title: Water Pollution** **Teacher:** I want everybody to look at the wall chart in front of you and also look at the two glasses of water then make comments, thereafter share them to the rest of the class. 	– Communicate the new lesson and write its title on the chalkboard – Use different questions to probe students to understand the content/Questions/ answers method – Give learners opportunity to reflect on the introductory questions.

	 **Observation questions:** **Teacher:** What do you see on those two pictures? **Students:** On picture we can see people and other animals wasting the water body. **Teacher:** Is the water in that stream clean or safe for use? **Students:** It is not safe to be used because people, industry and animals have thrown in wastes materials either from industry, animals and chemical from fertilizers. **Teacher:** What effects will those items cause on the water body? **Student:** I think they can make the water harmful which later can cause diseases.	– Emphasize new concepts – At each step, provide a pause time for students to think and say or write their ideas. – Help learners form groups based on gender responsive.

	Teacher: What do you think is the source of that? **Students:** The sources can be human wastes, industrial wastes, chemical wastes etc … **Teacher's input:** Okay very Good once we thrown those things in the water they make it harmful and this results into water pollution. **<u>Definition:</u>** Water Pollution: is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). As you said it earlier, water pollution can be caused by many agents. Let's look at some of these, we call them "*Water Pollutants*". **<u>Definition:</u>** water pollutant: these are substances which causes water pollution. They later make the water harmful. Water pollutants can be in form of solid, liquid or gaseous. Water pollutants can also be classified as organic, inorganic, radioactive and biological. **Teacher:** Can you think of the different water pollutants? **Students:** Human faces, Plastics bottles, Industrial wastes, oils from petrol station etc…	– Help learners to relate what they have learnt to real life experience by discussing the given case study. – Facilitate learners during presentation of their findings.

	Teacher: Okay now let's talk about them. Those you state above can be grouped into: sewage, chemical wastes, radioactive wastes, oils and plastics and alien species. **Sewage** This refers to waste water, human wastes and other industrial wastes that are transported through pipes. Sewage contains micro-organisms which pollute water. **Chemical wastes** They include: polluting dyes, used products from factories (e.g. bleaching agents), acid and hydrocarbon emissions to the atmosphere, acids from car batteries, household chemicals like soaps and detergents. **Radioactive wastes** These are wastes that contain radioactive substances. These emit harmful radiations into the environment. Water spread such radioactive substances causing more damage to the environment. Oil, plastics	– Use different questions to probe students to understand the content/ Questions/ answers method.

	Oil is transported in large tankers on seas and oceans. Oil refineries dump their wastes oil in water. Accidents that occur during extraction of oil from seabed contribute to pollution of water bodies. Plastics wastes include polythene bags, plastic containers, when dumped in a water source they accumulate in it. Alien plants (foreign plants) These plants grow rapidly in water killing indigenous plants. They include: hyacinths, alligator weeds, giant weeds. **Concept Summary:** Water pollution is the addition of any foreign substance (organic, inorganic, radioactive or biological) to water which produces harmful effect and decreases the usefulness of water. The substances which cause water pollution are known as water pollutants. The major pollutants of water include – Sewage, Nutrient-rich waste water, Chemical waste, Radioactive waste, Oil pollution, Plastic, Alien species and other forms.	

Sewage is the term used for wastewater that often contains faeces, urine and laundry waste. Sewage disposal is a major problem in developing countries as many people in these areas don’t have access to sanitary conditions and clean water.

Application activities:

Now in groups of four I want you to think about the effects that Polluted water can lead to. Find out any four effect. After that I want each group to share. Here is the picture that you can refer to when thinking about the effects of water pollution.

	Expected answers: Death of aquatic (water) animals. The main problem caused by water pollution is that it kills life that depends on these water bodies. Dead fish, crabs, birds and seagulls, dolphins, and many other animals often wind up on beaches, killed by pollutants in their habitat (living environment). **Diseases.** Eventually, humans are affected by this process as well. People can get diseases such as hepatitis by eating seafood that has been poisoned. In many poor nations, there is always outbreak of cholera and diseases	
Assessment **(5 min)**	1. What is the meaning of water Pollution? Water pollution: is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). 2. Name the causes of water pollution? They include: Sewage, Oils and Plastics, Alien species, radioactive wastes and chemical wastes. 3. Can give any two effects of water pollution? Death of aquatic animals and the spread of diseases.	Ask leaners to do the activity and give answers immediately

4.Lesson summary and Conclusion (5 min)	**Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: – The meaning of Water Pollution, – The causes of water pollution, – The effects of water pollution. *Thank you for your participation in this lesson.*	

Scripted lesson from Unit 4

SUBJECT: Chemistry	**GRADE:** S2	**UNIT 4:** Pure substances and mixtures
Lesson title: Effective ways of waste management **Teaching & learning materials:** Charts, manila papers, chalkboard, plastic materials, textbook		**Duration:** 80 min

Section	Step –by- step instructions and content	Notice to the teacher
Student readiness **(4 minutes)**	**Objectives:** By the end of the lesson learners will be able to: – Describe the steps involved in effective waste management – Explain the importance and benefits of waste recycling	– Welcome learners, gain learners 'attention – Identify learners with special education needs and communicate the learning objectives
Introduction **(11 minutes)**	**Teacher:** Observe clearly the image below. What do you think about it?	– Ask students to observe the pictures and answer to the questions – Allow learners to ask question about the topic of the day. – Build on their questions and communicate the key questions.

	 Source:flexiprep.com **Students:** waste materials are collected and put in different containers based on their nature.	**Key question:** Effective ways of waste management
Lesson Development **(55 minutes)**	**Lesson title: Effective ways of waste management** **Teacher:** observe the following pictures answer the questions a) What do you observe on this picture?  	– Indicate the title of the lesson – Move around in the class to check on students' answers and facilitate them.

	b) How do you manage this type of wastes at home? c) Can you transform them into useful materials? **Concept clarification** Explain what do you understand by waste materials **Learners 'answer** **Waste materials:** Waste materials are those useless materials left into the nature. They are known as rubbish or garbage. Examples: peels of fruit, left-over cooked food, old shoes, broken bottles,..... **Teacher:** Referring to the picture below explain what is waste management. 	– At the end, invite student to compare their results with the expected answers. – Make comments on leaners' answers and give right answers

Learners 'answer: Waste management may be defined as the discipline associated with control of generation, storage, collection, transfer and transport, processing and disposal of wastes.

Teacher: Observe the diagram below. Discuss the terms given in waste hierarchy to manage waste. Make presentation with your group on the same. Give your views and suggestions in presentation.

Most preferable

Least preferable

	– **Prevention** **Teacher:** Discuss the different ways of preventing waste materials. **Learners' answer:** Prevention and avoidance means preventing or avoiding of the waste completely. It seeks to prevent waste from being generated. Waste prevention strategies include using less packaging, designing products to last longer. For example, we can stop using plastic carrier bags, and instead long-life bags, such as canvas bags. – **Minimization or reducing** **Teacher:** Discuss the different ways of reducing waste materials. **Learners' answer:** The Mobius' cycle is a method represented by 3Rs which means Reduce, Recycle, and Reuse. The easiest method of waste management is to reduce creation of waste materials. It is done by reducing the amount of wastes going to dustbins.	

– **Reuse:**

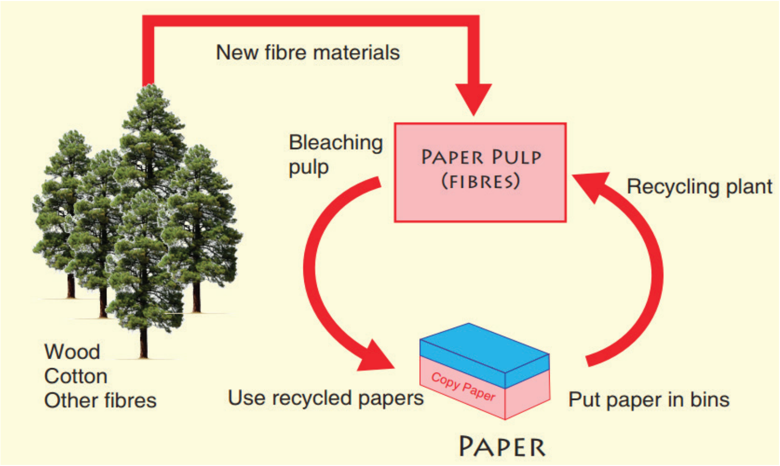
Teacher: Explain the importance of reusing of some waste products.

Learners' answer: This is simple; reduce wastes by not wasting something, but reusing it. We should reuse items we normally throw away.

For example; we should use sacks or clothed bags for multiple times instead of throwing them away after just one use. Milk bottles are also often collected, washed, refilled and used for keeping sugar for example.

– **Recycling**

Teacher: Carefully, observe the diagram below and write down your observation.

	 **source:** comprehensive chemistry, S2 syllabus. **Learners 'answer** Recycling is a series of activities that includes collecting used, reused, or unused items that would otherwise be considered to be wastes. It includes sorting and processing the recyclable products into raw materials. Worldwide papers used in academic domains are usually recycled. Recycling involves putting energy into a waste item to convert it to something else entirely, sometimes with lower grade and value.	

	– **Energy recovery** **Teacher:** The picture below shows charcoal briquette made from waste materials list, wastes which can be used to make the briquette.  https://www.charcoalbriquettemachine.com/news/page/2/ **Learners' answer** Energy recovery from waste is the conversion of non-recyclable waste materials into usable heat, electricity or fuel through a variety of processes including heating. This is often called waste-to-energy (WTE) because it converts non-recyclable waste materials into electricity and heat. Energy recovery can also be achieved with bio-mass waste.	

	– **Disposal** **Teacher:** Discuss the proper's of waste disposal. "Disposal" is also known as "burying". Once something is in disposal and buried, there is no real harm the waste can do as it degrades naturally. **Learners' answer:** "Disposal" is also known as "burying". Once something is in disposal and buried, there is no real harm the waste can do as it degrades naturally.	
Assessment **(5 min)**	**Teacher:** Perform the following question on your own on a piece of paper and submit your answer sheets. Disposal is known as............. A. Weeding B. Alloying C. Chemical bonding D. Burying 2) Recovering the waste can produce A. Fuel B. Water C. Heat D. Both (a) and (c)	Ask learners to do the activity and give answers immediately.

	3) Landfill is an effective way of A. Reuse B. Recycle C. Disposal D. Reduce 4) The most favored option of waste hierarchy is A. Minimising B. Prevention C. Energy recovery D. Disposal 5) Glass bottles can be A. Reduced B. Reused C. Recycling D. All the above 6) The most favorable option of waste hierarchy is A. Minimising B. Prevention C. Energy recovery D. Disposal	

	7) Can you list down some waste materials that contribute to the garbage? **Learners 'answers:** 1) D 2) D 3)3 4) B 5) D 6) B 7) The famous components are Food, remnant , Paper, Grass, Plastic, Metal, Textile, Glass, Wood, Leather , Cans ,Sugarcane, Cotton, Coal and lignite, Cement, Iron and Steel, Electronic objects.	
Lesson summary and Conclusion **(5 minutes)**	**Teacher:** We are at the end of our lesson. Conclusively let's review some of the key points that we learned about: – Prevention of waste – Minimization of waste – Reuse of waste – Recycling of waste – Energy Recovery of waste – Disposal of waste **Homework assignment:** – Discuss pollution effect caused by waste materials. – Hospitals and school laboratories produce wastes. – Suggest ways to manage these types of waste. *Thank you for your participation in this lesson.*	– Use different questions to help students recall key concepts of the lesson, and ensure that the summary is written down by all students – Summarize the ideas of learners by clarifying ways of waste management.

Scripted lesson from Unit 5

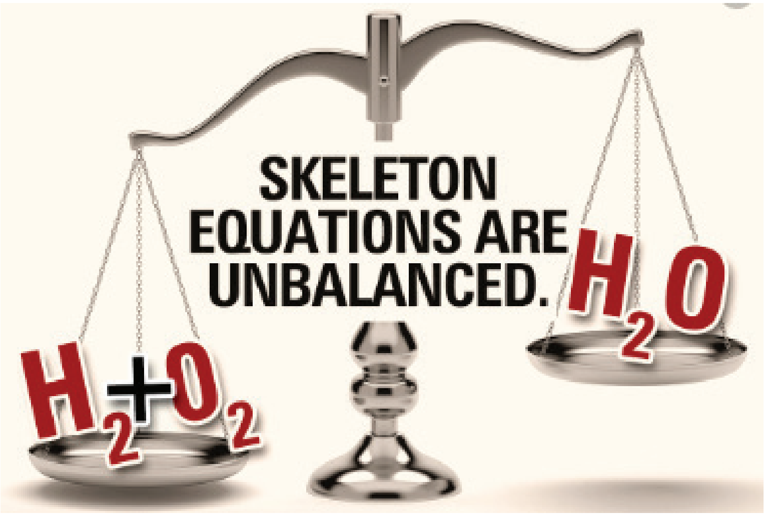
SUBJECT: Chemistry	**GRADE:** S2	**UNIT 5:** Categories of chemical reactions

Lesson title: Types of reactions **Duration:** 40 min

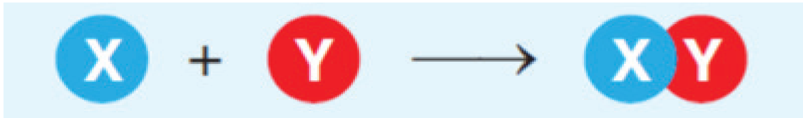
Teaching & learning materials: Periodic table, test tube, test tube holder, hydrogen chloride, ammonia, piece of chalk, manila paper, marker, ……….

Section	Step –by- step instructions and content	Notice to the teacher
Student readiness **(2 minutes)**	**Objectives:** By the end of this lesson, learners will be able to explain the meaning of combination reaction	– Welcome learners, gain learners' attention and communicate objectives of the lesson. – Give learners the opportunity to reflect on the introductory questions, the materials needed and give them a small time to take them.

Introduction **(8 minutes)**	**Teacher:** Perform the following experiment and answer the related questions: – Prepare a mixture of iron powder and sulfur powder using about 0.5g of each substance – Heat gently the mixture in a test tube. – Allow the test tube to cool down and record the observations. **Learners'answer:** when we started heating a mixture of iron filing and sulfur, the sulphur melted and reacted with the iron filings to form the compound iron (II) sulphide. In this reaction, two different elements combine to form a single product. This is an example of combination reaction.	– A-In groups of 4, learners raise questions related to their observations. Each group shares one question whose answers will be obtained from the 3other groups – Learners must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback – Based on the questions from student, try to come to the key question of the lesson class **Key question:** What is a combination reaction ?

Lesson Development **(20minutes)**	**Teacher:** Today we are starting with Types of chemical reactions, the lesson of unit 5 which is categories of chemical reactions. It will be easy for you as you have the prerequisites needed. **Title of the lesson: Types of reactions**  **Source:** https://sciencestruck.com/skeleton-equations-explained-with-examples	Indicate the title of the lesson- Move around in the class to check on students' answers and facilitate them. At the end, invite student to compare their results with the expected answers. Make comments on leaners' answers and give right answers.

	Teacher: In a group of 4, observe the image shown above and answer the following questions: a) What are the reactants? b) What are the products? c) Is the balance balanced? d) If the balance is not balanced, where do we have lighter species than the other? e) How much of each species do we need to add to balance both sides of the balance? **Learners' answers:** a) Reactants: H_2 and O_2 b) Products: O_2 c) No, the balance is not balanced d) The species at the right side (H_2O) is lighter e) To equilibrate both sides of the balance, we need to put $2H_2O$ at the right and $2H_2$ at the left side. **Teacher:** By equalizing the number of atoms on the right and on the left, the equation $2H_2+O_2 \rightarrow 2H_2O$ is balanced.. **Teacher:** Referring to activity and the following reaction, discuss what a combination reaction is.	



Learners' answer: Combination reactions are those reactions in which a single product is produced from two or more reactants.

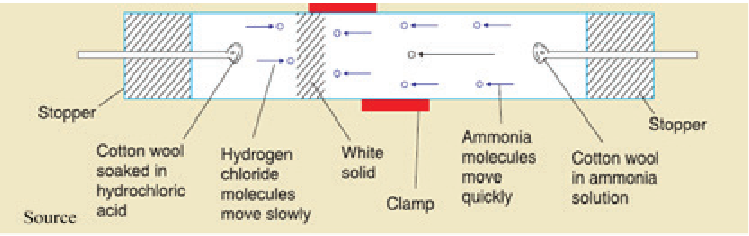
Teacher: What are the natures of reagents and products in a combination reaction as described below?

Learners 'answer: The reactants X and Y can be elements or compounds, or a compound and an element. The product XY is always a compound.

Teacher: Combination reactions may involve:

- The combination of two elements to form a compound.
- The combination of a compound and an element to form a new compound.
- The combination of two compounds to form a new compound.

	Examples of combination reactions: By referring to the reaction type below, write an example of a balanced combination reaction between calcium and chlorine. **Element + Element $\longrightarrow$ Compound** **Learner's answer:** $Ca_{(s)} + Cl_{2(g)} \longrightarrow CaCl_{2(s)}$ By referring to the reaction type below, write a balanced combination reaction between calcium oxide and carbon dioxide. **Compound + Compound $\longrightarrow$ Compound** **Learners' answer:** $CaO_{(s)} + CO_{2(g)} \longrightarrow CaCO_{3(s)}$ **Application activity:** Work in groups of four learners and perform the following activity: Combination of ammonia and hydrogen chloride. **Materials Required**: Ammonia solution, hydrochloric acid, two glass rods, cotton buds, long glass tube, two stoppers and clamp.	

	Safety. • Do not soak the cotton buds into chemicals with your hand. • Make sure that the glass tube is clamped properly. **Procedures** – Fix a cotton bud on two glass rods. – Mark the glass rods as A and B. – Dip rod A into concentrated ammonia solution and rod B into concentrated hydrochloric acid. **Note**: Insert the two stoppers at the end of glass tube (see diagram) a) Observe the glass tube for a few minutes and interpret your observations. b) Write the balanced chemical equation for this reaction. Arrange all apparatuses as shown in the diagram below. Teacher:  Source Comprehensive Chemistry for Rwanda Schools, Student's Book, Secondary 2,P.97.	

	In the experiment, you have observed that when ammonia reacts with hydrochloric acid, a white solid appears inside the glass tube. This solid is ammonium chloride (NH_4Cl). Here, two reactants react (or combine) to give one product. So this is a combination reaction. A combination reaction is a reaction where two or more elements or compounds combine to form a single compound. Such reaction is represented by equation of the following form: $x + y \rightarrow xy$. A combination reaction can be also defined as a reaction where two or more reactants are combined into one product. **Examples :** 1) $H_2(g) + I_2(g) \rightarrow 2HI(g)$ 2) $NH_3(g) + HCl(g) \rightarrow NH4Cl(s)$	
Assessment **(5 min)**	**Teacher:** Now I want to give you an assignment so that you try to apply some of what we have learned today on your own. Perform the following questions 1) Is the formation of water molecule from hydrogen and oxygen molecules a combination reaction? a) Yes b) No	– Assess learners basing on the key questions to verify the achievement of learning objectives. – Teacher has to appreciate learners' responses.

	2) Which of the following is/are characteristics of chemical reactions? A. Change in colour B .Evolution of gas C. Formation of precipitate. D. All of these 3) When a single product is produced from two or more reactants, the reaction is: a. Metathesis reaction b. Decomposition reaction c. Combination reaction d. Displacement reaction 4) Combination reactions may involve: a) Combination of two elements b) Combination of two compounds c) Combination of one element and one compound d) All of the above	In each group with different working steps, choose one group member to present their findings. Learners write the correct answers in their notebooks. Learners provide the answers and explain the reasoning behind each answer.

Lesson summary and conclusion **(5 min)**	**Teacher:** As we conclude, let us together review some of the key points that we learned. Facilitator helps learners to conclude on: 1) A combination reaction 2) Characteristics of chemical reactions (change in color, apparition of new products, evolution of a gas, ……) 3) Balancing chemical equations. A complete chemical equation represents the reactants, products and their physical states symbolically. In a combination reaction two or more substances combine to form a new single substance. **Homework** Now I want to give you an assignment so that you try to apply some of what we have learned today on your own. Assignment questions: By using S2 chemistry book describe the meaning of the following terms: 1) Precipitation reaction 2) Neutralisation reaction 3) Double displacement reaction and give an example for each type of reaction.	– Use different questions to help students recall key concepts of the lesson, and ensure that the summary is written down by all students. – Summarize the ideas of learners by clarifying some of the key points that they learned.

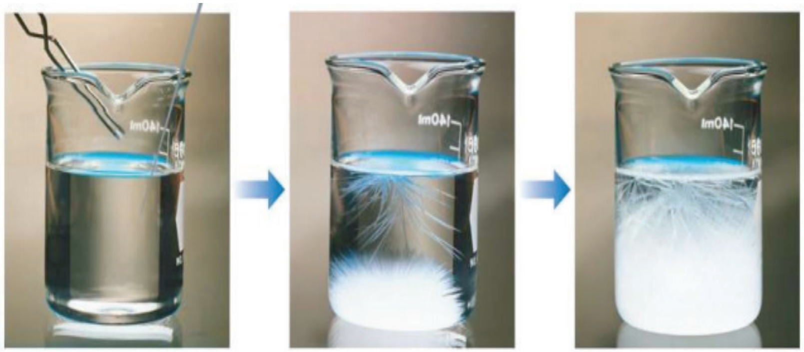
Scripted lesson from Unit 6

SUBJECT: Chemistry	**GRADE:** S2	**UNIT 6:** Arrangement of elements in the periodic table

Lesson title: Saturated and unsaturated solutions **Duration:** 80 min

Teaching & learning materials: Flipcharts, chalkboard, sugar, water , textbook, beakers, plastic wash bottle

Section	Step –by- step instructions and content	Notice to the teacher
Student readiness **(2 minutes)**	**Objectives:** By the end of the lesson you should be able to: – Define solubility, saturated, unsaturated and supersaturated solution – Identify dilute and concentrated solution.	Welcoming learners, gain learners' attention, communicate learning objectives and identify learners with special education needs.
Introduction **(18minutes)**	**Teacher:** Observe the pictures below and raise any two related questions.	Tell students to perform introductory activity and give them the opportunity to ask questions in order to deduce key question.

	 A B C Photo: 6.1 Unsaturated,saturated and supersaturated solution https://www.unf.edu/~michael.lufaso/chem2046/2046chapter13.pdf **Guiding questions:** a) What is the name of the mixture formed when water mixed with sugar? b) What do you observe among the three glasses? c) Is there any difference among the three glasses? **Key question:** How are unsaturated, saturated and supersaturated solutions differentiated?	– Pause to allow learners to get their materials before moving on. Learners write their findings. Analyzed by the teacher and peers to provide relevant feedback.

Lesson Development **(40 minutes)**	**Title of the lesson:** Preparation of saturated, unsaturated and supersaturated solutions **Teacher:** Perform the following experiment in 10 min (form groups of 5learners, each group will present the findings): **Materials Required:** Three hard glass beakers (100 ml), copper (II) sulphate salt (CuSO4), water and spoons. **Procedure:** – Label them A, B and C – Pour in all the beakers with an equal amount of water (50ml). – i) Add one teaspoon salt in beaker A, ii) Two teaspoons of the salt beaker B, iii) Three teaspoons in beaker C. Stir with the spoon. Note your observations in beakers A, B and C. **Teacher:** Referring to the above experiment and image below, describe the difference between picture A, B and C.	Learners are given time to think and note down their findings. Emphasize on new concepts in bold.

<table>
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A After stirring. 1 tea spoon | B After stirring. 2 teaspoons | C After stirring. 1 more teaspoon

https://www.qsstudy.com/chemistry/experiment-make-saturated-unsaturated-solutions

Learners'answer:

- In test tube A, the solute dissolves very fast, more solute can be added and dissolved: *Unsaturated solution*.
- In test tube B,excess solute starts to crystallize from the solution. Meaning solute added doesn't dissolve: *Saturated solution.*
- In test tube C, the solute added will no longer dissolve any more solute added, excess solute has crystallized. *Supersaturated solution*.

Activity

- What do you understand by the terms: saturated, unsaturated and supersaturated.
</td>
<td>
Make sure you have mixed boys and girls in different groups.

Learners must be given time to think and note down their answers which will Allow some groups to present their findings.
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</table>

	– When a solute is excessively added progressively to the solute, it will reach the point at which more of the solute no longer dissolves. Explain why? **Learners' answer** **Solubility:** When a substance dissolves in water or in other liquids (solvent), it is said to be soluble in it. The phenomenon of a substance by which it tends to dissolve in water (or any other solvent) is called its "solubility". **Unsaturated solution:** A solution that contains an amount of solute that can dissolve at a given temperature is an unsaturated solution. A saturated solution at a particular temperature contains the maximum amount of solute that can dissolve at that temperature. At that temperature, the solvent and solute are in equilibrium state. This state of equilibrium or saturation can only be changed by adding more water (solvent) to it or by increasing the temperature of solution. **Application activity**: Perform the following experiment in groups of 5 each and present your findings. – Prepare an unsaturated, saturated and a supersaturated solution of sugar separately in three beakers.	At each step, make a pause for learners to think and write their ideas. Learners ask questions for clarification while discussing in groups. Learners answer questions by using relevant key words. Learners record the correct answers in their notebooks.

	– Pour 20ml of distilled water in all beakers. In beaker 1 add two teaspoon, beaker 2 add eight teaspoons and in beaker 3 add twenty teaspoons of sugar. Stir well each of the solutions and record your observations. **Learners' answer** – If it dissolves and the concentration of the solution increases, it is unsaturated. – If it does not dissolve even on vigorous stirring and the concentration of the solution remains the same, it is saturated. – Then supersaturated solution is one which has more of the solute than a saturated solution requires.	
Assessment **(10 min)**	**Teacher:** Answer the following questions: 1. A solution that can dissolve more solute at a given temperature is called ☐ Unsaturated ☐ Unsaturated ☐ Supersaturated ☐ None of these 2. Choose the correct answer: A. With increase in temperature the saturated solution becomes unsaturated	Teacher has to move around to help learners in various groups.

	B. The quantity of solute dissolved in a certain quantity of solvent denotes the concentration of solution C. Both a and b D. None of these 3. A solution which can dissolve more solute at a given temperature is called unsaturated. A True B False) 4. In your own words, define "saturated solution"5. An unsaturated solution contains ______________ solute than it can dissolve at that temperature. 5. How can the state of equilibrium be changed? **Learners'answers:** 1) Unsaturated (B) 2) B 3) B 4) A solution which is unable to dissolve anymore of the solute at a particular temperature is called a saturated solution at that temperature 5) An unsaturated solution contains less solute than it can dissolve at that temperature. 6) The state of equilibrium (or saturation) can be changed either by adding more water (solvent) to it or by increasing the temperature of solution.	Conclude the lesson by highlighting the main points. Check learners in writing summary

<table>
<tr>
<td>Lesson summary and conclusion

(10 min)</td>
<td>A solution which is unable to dissolve any more of the solute at a particular temperature is called a “saturated

Solution at that temperature”.

• A solution which can dissolve more solute at a given temperature is called an unsaturated.
• A solution containing relatively small amount of solute in a fixed amount of solvent or compared to that of the solvent is a dilute solution.
• Solution containing relatively more quantity or large amount of solute in the fixed amount of solvent is a Concentrated solution.

We are at the end of the lesson. You are given an assignment to perform on your own .

Assignment questions:

1) Describe the differences between saturated and unsaturated solutions.
2) State and explain the factors that affect solubility of different salts.

Thank you for your participation in this lesson.</td>
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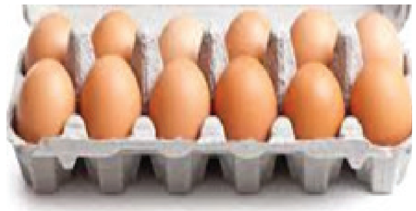
Scripted lesson from Unit 7

SUBJECT: Chemistry	GRADE: S2	UNIT 7: The mole concept and gas laws.
Lesson title: Avogadro number and mole concept **Teaching & learning materials:** Pieces of chalk, manila paper, marker, pencils, pens, erasers, shoes, eggs		**Duration:** 40 min
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Lesson (readiness) **(2 minutes)**	**Lesson Objectives:** By the end of this lesson, you should be able to: – Define the mole – Describe the mole concept – Relate the Avogadro's number with atomic number, mass number and molecular mass.	Welcoming students, gain students' attention, and identify students with special needs. Organize each of the items listed logically and communicate learning objectives.
Introduction **(18minutes)**	**Teacher:** In groups of 5 students each, get a glass of water and answer the following questions: Can you count the number of molecules of water present in the glass?	Organize each of the items listed logically and communicate learning objectives.

	a) If the answer is "yes", why? b) If the answer is" no" , why? **Answers:** a) No, b) Molecules are very tiny particles. **Teacher:** You are right. In pairs, students raise questions related to their answers. Each pair shares one question which they would like to answer. Based on the questions from students try to come to the key question of the lesson. **Key question:** How do you determine the amounts of reactants and products?	Allow learners to ask questions related to the topic of the day. Refer to their questions to communicate the key questions. Indicate the title of the lesson
Lesson Development **(20 minutes)**	Today's concern is to determine the amounts of products formed when a given amount of reactant reacts or vice-versa. This quantitative determination of reactants and products involves application of the mole concept. **Lesson title: Avogadro number and mole concept** The teacher groups Students boys and girls together and gives them instructions to explain "mole concept". **Teacher:** Express the quantity in a given substance.	

	The following pictures show the quantities of items in each and answer the related questions.  a  b  c **Questions:** a) Count items in the pictures. b) What specific term used to identify objects as single entity in picture b and c. c) Assume picture a is table salt (NaCl), what specific term can be used to specify the quantity of substance in term of measuring reference unit of weight a?	Tell students the materials needed and give them a small time to take them. Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback.

	d) What specific term can be used to specify the quantity of substance d? **Students' answer** Mole is the amount of substance which contains as many elementary particles as there are carbon atoms in 12g of the carbon-12 or A MOLE is a unit just like a Dozen that is used by Chemists to describe a certain number of elementary particles such as atoms, molecules, ions and electrons that are involved in chemical reactions. Avogadro's number; its value is equal to 6.022×10^{23} particles (ions, atoms, molecules, protons, and electrons) in one mole of a substance. Amount of matter that contains each of these particles is referred to as a "mole". Avogadro's number is the constant number of particles that contains one mole. **Questions:** – How many particles are in one mole of carbon? – How many particles are in two moles of sodium?	Students are given time to write the summary in their notebooks with teacher's supervision. Keep guiding students in every step and consider individual differences of learners.

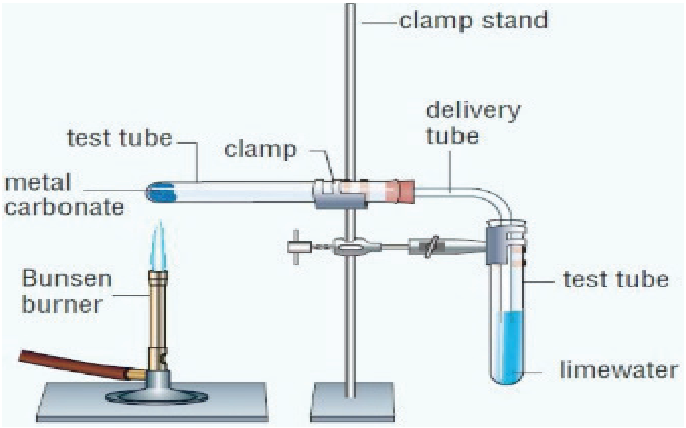
	 sodium  carbon **Students'answer:** This is very similar to the unit 'dozen', which is a common analogy used to explain the concept of mole, a dozen is always equal to 12 irrespective of the object referred to. For instance, in one mole of carbon there are 6.023×10^{23} particles. Because substances are composed of small particles, one way to measure the amount of a substance is to count the number of particles but for atoms, molecules and ions counting is not convenient. For 2 moles of Na ,we have $6.023 \times 10^{23} \times 2 = 12.046 \times 10^{23}$ particles	Students are given time to write notes and ask questions for clarifications. Guide students to find answers and ask to observe and record their findings. Provide opportunities to ask some questions and give positive feedback to Students. Appreciate students' correct answers.

Assessment **(10 min)**	**Application activity:** 1) The molecular mass of Oxygen is 32gr. Calculate the number of oxygen molecules in 1 gr of oxygen. **Learners' answer:** Number of oxygen molecules in 32g = 6.023 x 10^{23} molecules = 1) Number of oxygen molecules 6.023 x 10^{23} in 1g = (6.023 x 10^{23}) : 32 = 0.188 x 6.023 x 10^{23} = 2) How many particles are in one mole of carbon? **Learners' answer:** One mole of carbon contains 6.022x10^{23} particles.	Give time to students to write the summary in their notebooks. Conclude the lesson by highlighting the main points.
Lesson summary and conclusion **(5minutes)**	Mole is the amount of substance which contains as many elementary particles as there are carbon atoms in 12g of the carbon-12 or A MOLE is a unit just like a Dozen that is used by Chemists to describe a certain number of elementary particles such as atoms, molecules, ions and electrons that are involved in chemical reactions. Avogadro's number; its value is equal to 6.022x10^{23} particles (ions, atoms, molecules, protons, and electrons) in one mole of a substance. Amount of matter that contains each of these particles is referred to as a "mole". Avogadro's number is the constant number of particles that contains one mole. *Thanks for your active participation*	

Scripted lesson from Unit 8

SUBJECT: Chemistry	GRADE: S2	UNIT 8: Preparation and classification of oxides
Lesson title: Preparation of oxides		**Duration:** 40 min
Teaching & learning materials: Charts, manila papers, chalk board, periodic table, pair of tongs, deflagrating spoon, bunsen burner, gas jar, magnesium ribbon, sulphur powder, distilled water, calcium carbonate, lime water, litmus paper, retort stand with boss and clamp.		

Section	Step –by- step instructions and content	Notice to the teacher
Student readiness **(2 min)**	**Objectives:** By the end of this lesson, learners will be able to: – Explain the direct combination of an element with oxygen. – Explain the thermal decomposition of hydroxides, carbonates and nitrates.	Welcoming the students and introduce the lesson objectives Gain the students attention Identify the students with special educational needs
Introduction **(8 min)**	**Teacher:** In unit 2, S2, we have seen that elements (metals and non-metals) react with oxygen to form Oxides. In unit12, S1, we have also seen that carbonate and nitrate salts decompose on heat to give oxides.	

	Dear students, look at the reaction below of the decomposition of calcium carbonate using a Bunsen burner and raise questions related to the reaction:  https://images.app.goo.gl/YwwdC9hXxXXL9dW56 **Teacher:** Based on the questions from learners, the teacher tries to come to the key question of the lesson. **Key question:** How are oxides prepared?	Tell students the materials needed and give them a small time to take them.

<table>
<tr>
<td>Lesson Development

(20 min)</td>
<td>The teacher: The teacher gives instructions; materials and chemicals needed, and then assigns tasks in groups of 2 learners. The teacher takes learners through steps of preparing oxides.

Teacher: Preparation of oxides by direct combination

1. In group of 2 take a sample of magnesium and sulphur and burn it using a Bunsen burner till it catches fire.

Procedure:

i) Using a pair of tongs, ignite the piece of magnesium in a Bunsen burner flame.
ii) Lower the burning magnesium into the gas jar of oxygen
iii) When the reaction is over, observe the colour of the product, and then add some distilled water to the product.
iv) Shake the mixture and test the solution with the strips of both red and blue litmus papers.
v) Note the observations

2. In a similar way:

i) Heat a powder of sulphur in a deflagrating spoon until it glows.</td>
<td>Give instructions, materials and chemicals required.

Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback.</td>
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</table>

ii) Lower the burning powder in a jar of oxygen.

iii) Test the gas evolved with moist blue and red litmus papers

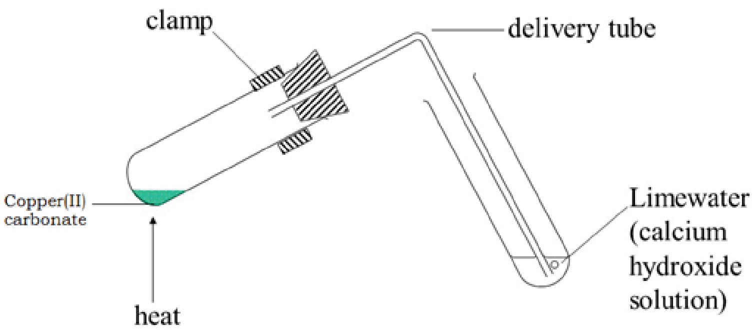
iv) Note the observations

3. In a similar way

i) Burn a little amount of copper carbonate in a boiling test tube.

ii) Collect the evolved gas in lime water

iii) Arrange all apparatuses as shown in the following figure.



iv) Note the observations

Combination of Metals with Oxygen

Teacher: Refer to the activity 8.1.1 write down the reaction of metals (Mg) with oxygen.

	Student's answer: Metals react with oxygen to produce metal oxide. Metal oxides are generally basic in nature. Metal+oxygen $\longrightarrow$ Metal oxide Some elements react with oxygen at room temperature, some react on heating whereas others react only on strong heating. The reaction of oxygen with some elements is given below: Magnesium combines with oxygen on heating with a bright white flame to form magnesium oxide. Magnesium oxide dissolves in water to form a basic solution. $2Mg(s) + O_2(s \longrightarrow 2\ MgO(s)$ **Combination of a non-metal with Oxygen** **Teacher:** write down the reaction of non-metals (Sulphur) with oxygen. **Student's answer:** Non metals react with oxygen to produce non metal oxides. Non metal oxides are generally *acidic* in nature. Non metal + Oxygen $\longrightarrow$ Non metal oxide	Emphasize new concepts. At each step, provide a pause time for students to think and say or write their ideas.

	Sulphur (yellow powder) burns in oxygen with a blue flame to form a colourless gas that turns moist blue litmus paper red. That gas is sulphur dioxide and dissolves in water to form an acidic solution. $S(s) + O_2(g) \rightarrow SO_2(g)$ **Teacher:** refer to the experiment above, complete the following reactions and explain whether the resulting oxides are acidic or basic. a) $S(s) + O_2(g) \rightarrow$ b) $C(s) + O_2(g) \rightarrow$ c) $Fe(s) + O_2(g) \rightarrow$ **Student's answer:** a) $S(s) + O_2(g) \rightarrow SO_2(g)$,acidic b) $C(s) + O_2(g) \rightarrow CO_2(g)$,acidic c) $2Fe(s) + O_2(g) \rightarrow 2FeO(s)$,basic Thermal Decomposition of Hydroxide, Carbonates and Nitrate **Teacher:** refer to the experiment and complete the following reactions: a) $Zn(OH)_2(s) \rightarrow$	Use different questions to probe students to understand the content/ Questions/ answers method The teacher requests again learners to be ready and follow carefully instructions note key points.

b) $MgCO_3(s) \rightarrow$

c) $PbCO_3(s) \rightarrow$

Student's answer:

a) $Zn(OH)_2(s) \rightarrow ZnO(s) + H_2O(l)$

b) $MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

c) $Pb(NO_3)_2(s) \rightarrow PbO(s) + CO_2(g)$

When a decomposition reaction is carried out by heating, it is called thermal decomposition. Thermal means related to heat.

In the following sections, we will study the formation of oxide by thermal decomposition.

Thermal Decomposition of Hydroxide

Teacher: refer to the experiment write the reactions for thermal decomposition of magnesium hydroxide.

Student's answer: Metal hydroxide decomposes to form metal oxide and water. For example,

i) Magnesium hydroxide on heating at a high temperature decomposes into magnesium oxide and water.

$$Mg(OH)_2(s) \xrightarrow{heat} MgO(s) + H_2O(l)$$

	Thermal Decomposition of Carbonates **Teacher:** refer to the experiment 8.1.1,write the reaction for thermal decomposition of calcium carbonate. **Student's answer:** All the metal carbonates undergo thermal decomposition to give metal oxide and carbon dioxide. For example when calcium carbonate is heated, it decomposes (breaks) to give calcium oxide and carbon dioxide. $CaCO_3(s) \xrightarrow{heat} CaO(s)+CO_2(g)$ **Thermal Decomposition of Nitrates** **Teacher:** refer to the experiment 8.1.1,write the reaction for thermal decomposition of copper nitrate. **Student's answer:** Most metal nitrates decompose on heating to give the metal oxide, brown fumes of nitrogen dioxide and oxygen. Group I nitrates except LiNO3 decompose to give metal nitrates and oxygen. Copper nitrate decomposes on gentle heating to give copper oxide, nitrogen dioxide and oxygen.	Provide review Opportunities for students.

$$2Cu(NO_3)_2(s) \xrightarrow{heat} 2CuO(s) + 4NO_2(g) + O_2(g)$$

Teacher: ***Note:*** All nitrates of group 1 (from sodium to caesium) decompose to give metal nitrites and oxygen. As you go down the group you have to use higher temperatures.

Activity for application:

The teacher questions the students so that they can apply the learned knowledge in new situations.

In pairs, perform the following experiments and answer the questions given:

Activity 1:

Teacher:

i) Using a pair of tongs, ignite the piece of sodium in the Bunsen burner flame.

ii) Then, lower the burning sodium into the gas jar of oxygen

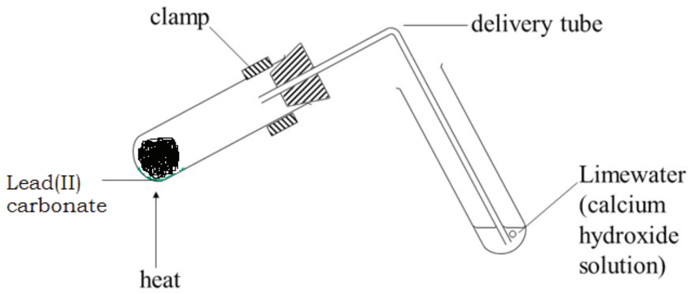
iii) When the reaction is over, observe the colour of the product then add some distilled water to the product.

	Questions – What is the colour of the flame when sodium burns in oxygen? – What is the colour of the product when sodium burns in oxygen? Name the product formed. – Write the balanced chemical equation when sodium burns in oxygen. – The product is added to water, then the mixture tested with litmus paper. Describe the observable change on litmus paper. **Student's answer:** – Sodium burns in oxygen with a yellow flame. – The colour of the product is white. This is the sodium oxide. – The balanced chemical equation: $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$ – The mixture of Na_2O and water turns red litmus paper blue and blue litmus remains blue because sodium oxide dissolves in water to form alkaline solution.	

Activity2

Teacher: in pairs,

i) Set the apparatus as shown below:



ii) Start by heating the carbonate carbonate given

iii) Test any gas evolved using lime water and when the reaction is over, observe the colour of the residue.

Questions:

- What is the colour of the residue after reaction?
- Name the products formed when lead(II) carbonate is heated.
- Write a balanced chemical equation for the reaction taking place while heating the tube.
- What happens to the lime water? Explain using a chemical equation.

	Student's answer: – When hot, the residue is orange and when cold the residue becomes yellow. – The products formed are: Lead(II) oxide and carbon dioxide. $PbCO_3(s) \rightarrow PbO(s) + CO_2(g)$ – Lime water turns milky due to the formation of a white precipitate (Calcium carbonate). – The reaction that leads to the formation of calcium carbonate: $CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$	
Assessment **(5 min)**	Oxides can be prepared by direct combination between an element and oxygen. They can also be prepared through thermal decomposition of metallic hydroxides, nitrates and carbonates. a) Write the balanced chemical equation when the following elements burn in oxygen: i) Potassium ii) Magnesium iii) Phosphorus b) Give the names of the products in a) above.	

	Name all the products formed when the following compounds are decomposed by heat: a) Aluminium hydroxide b) Calcium nitrate c) Zinc carbonate Complete and balance the reactions when the following compounds are heated: a) $Pb(NO_3)_2(s) \rightarrow$ b) $CaCO_3(s) \rightarrow$ c) $Mg(OH)_2(s) \rightarrow$	Provide opportunities to ask some questions and give positive feedback to Students.
Lesson Summary and Conclusion **(5 min)**	We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on the different methods used to prepare oxides: – Preparation of oxides by direct combination of elements (metal and non-metal) with oxygen. – Preparation of oxides by thermal decomposition of carbonates, hydroxides and nitrates. – Oxides are compounds of oxygen with another element. – Metals combine with oxygen to give basic oxides or amphoteric oxides.	

	Non-metals combine with oxygen to form acidic oxides or neutral oxides. Oxides can be prepared by thermal decomposition of carbonates, hydroxides and nitrates or by direct combination of an element with oxygen. Now I want to give you a homework assignment so that you try to apply some of what we have learned today. **Homework** 1. Oxides are prepared by: a. direct combination reaction of an element with oxygen b. thermal decomposition reaction of hydroxides,carbonates and nitrates c. both a and b 2. Which of these is/are not an example of non metal oxides? (a) CO_2 (b) H_2O (c) SO_3 (d) none of these 3. Oxides of sulphur and nitrogen react with water to form acids. a. false b. true *Thank you for your participation in this lesson.*	Appreciate students' correct answers. Give time to students to write the summary in their notebooks. Conclude the lesson by highlighting the main points. Check learners in writing summary

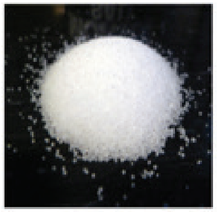
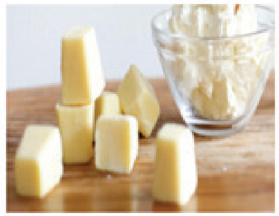
Scripted lesson from Unit 9

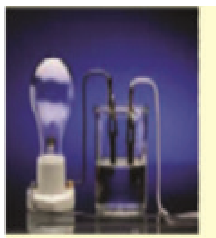
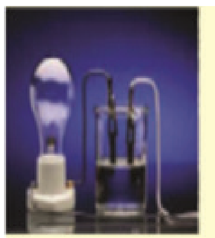
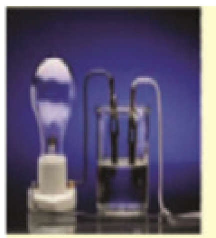
SUBJECT: Chemistry	**GRADE:** S2	**UNIT 9:** Electrolytes and non-electrolytes

Lesson title: Electrolyte and non-electrolyte **Duration:** 40 min

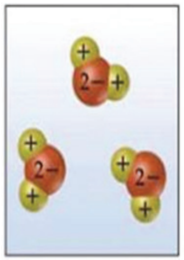
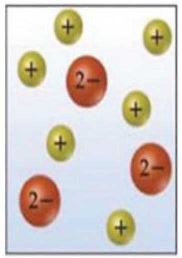
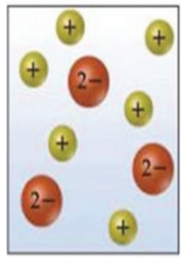
Teaching & learning materials: Charts, manila papers, chalk board, periodic table, table salt (NaCl) pure water, butter, salt (NaCl) solution, sugar solution, pure water, 3 nine-volt cells,6 carbon electrodes, 3 bulbs, 3 beakers and wires.

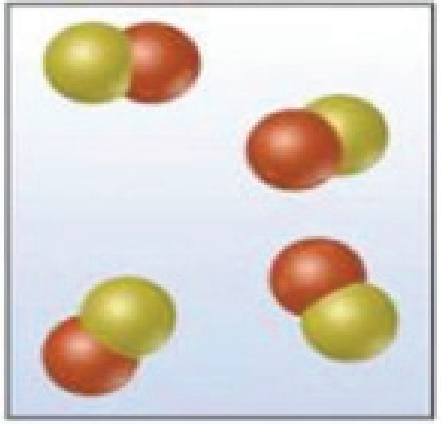
Section	Step –by- step instructions and content	Notice to the teacher
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to: – define an electrolyte and a non-electrolyte. – give examples of electrolytes and Non-electrolytes – carry out experiment to distinguish between electrolytes and non-electrolytes.	Welcoming the students and introduce the lesson objectives Gain the students attention Identify the students with special educational needs Tell students the materials needed and give them a small time to take them.

Introduction **(8 min)**	**Teacher:** In Unit 1, S2, we have seen that, the ionic compounds conduct electricity when melted or when dissolved in water, while covalent compounds do not. Now, observe the images below and predict what is happening when salt and butter are mixed with water.  Figure A  Figure B  Figure C **Learner's answers:** Salt dissolves in water to give salt solution while butter does not. **Teacher:** Based on the predictions from learners, the teacher try to come to the key question of the lesson. **Key question:** How do we differentiate compounds that dissociate in water from those which do not dissociate in water?	Give instructions, materials and chemicals required.

Lesson development **(20 min)**	**Lesson title: Electrolyte and non-electrolyte** The teacher gives instructions; materials and chemicals needed, and then assigns tasks (activity 9.1 student book page 229) in groups of 5 learners. The teacher takes learners through steps of differentiating electrolytes and non-electrolytes. The teacher provides the following materials to the students: Salt (NaCl) solution, sugar solution, pure water, 3 nine-volt cells, 6 carbon electrodes, 3 bulbs, 3 beakers and wires. Students perform the activity 9.1 from student book page 229. **Procedure:** – Take 3 beakers, label them A, B and C – Half-fill the beaker A with pure water, half-fill beaker B with sugar solution, half-filled the beaker C with salt solution. – Set all apparatuses as shown in figures below:  Figure: 9.1.3 A  Figure: 9.1.3 B  Figure: 9.1.3 C	Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback. Emphasize new concepts.

	Teacher: In group of 2: – Dip the two carbon electrodes in each beaker, then connect them to the battery by using provided wires. – Perform the experiment, see what will happen for each beaker and note your observations with. **Learner's answer:** Only in 9.1.3C, there is free movement of ions since there is an electrolyte, therefore, the bulb glows. Other two beakers contain non – electrolytes. **Teacher:** From your observations, explain why the bulb glows only in the sodium chloride solution (beaker C).  Figure: 9.1.4 A  Figure: 9.1.4 B  Figure:9.1.4 C **Student's answer:** Only in 9.1.4C, there is electrolyte ($NaCl$). The bulb produces light due to the presence of ions ($Na+$ and $Cl-$) in the salt solution. These ions allow the conduction of electricity.	At each step, provide a pause time for students to think and say or write their ideas. Use different questions to probe students to understand the content/ Questions/ answers method

	Teacher: In pairs, refer to the images below and from your observation on experiment 9.1.4C, explain what is electrolyte. **Student's answer:** **Electrolytes:** are compounds whose aqueous solution contains ions. In other words, substances that dissociate into ions when they are dissolved in water. For example, sodium chloride, magnesium chloride solutions conduct electricity. This is because these solutions contain ions. Compounds in Fig. A, B and C represent electrolytes.  Figure:9.1.5 A  Figure:9.1.5 B  Figure:9.1.5 C **Teacher:** In pairs ,refer to the images below and from your observation on experiment 9.1.4B, explain what is a non-electrolyte.	The teacher request again learners to be ready and follow carefully instructions note key points.

	 Figure:9.1.6 **Student's answer:** **Non-electrolytes:** are covalent compounds that do not dissociate into ions when they are dissolved in water. They dissolve in water as molecules. Sugar and urea are good examples of non-electrolytes. **Teacher:** In pairs, refer to the images below and from your observation on experiment 9.1.6 C and the equation below, explain what strong electrolyte is. $NaCl(s) \longrightarrow Na^{+}(aq) + Cl^{-}(aq)$	Provide review Opportunities for students.

Student's answer:

Strong electrolyte: An electrolyte which is completely ionized in water and thus produces a large amount of ions is called strong electrolyte. For example, hydrochloric acid, nitric acid and sulphuric acid, sodium hydroxide, potassium hydroxide and Sodium chloride.

Teacher: In pairs, refer to the images above and from your observation on experiment 9.1.6 C and the equation below, explain what weak electrolyte is.

$$CH_3COOH(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

Student's answer:

Weak electrolyte: an electrolyte compound which is partially ionized in water and thus produces a small amount of ions is called weak electrolyte. For example, acetic acid, carbonic acid, sulphurous acid, organic acid and ammonium hydroxide.

Activity 9.1.2: Application

The teacher questions the students so that they can apply the learned knowledge in new situation.

1. Which of the following schematic drawings best describes a solution of Li_2SO_4 in water (water molecules not shown for simplicity)?

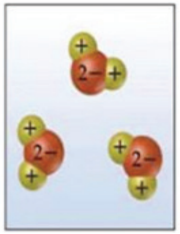


Figure:9.1.6 A

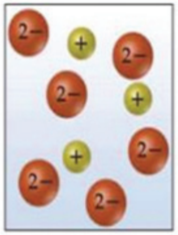


Figure:9.1.6 B

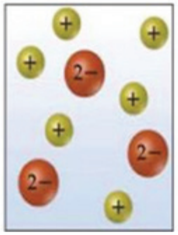
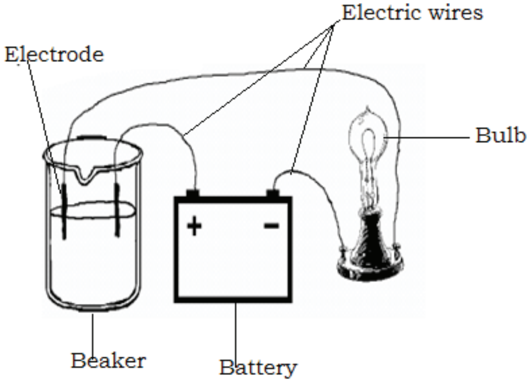


Figure:9.1.6 C

Student's answer:

2. A student misplaced labels on bottles containing electrolytes and non-electrolytes. He carried out an electrical conductivity tests on each solution using the electric circuit given below:



	The results that he obtained are as shown in the table below: Bottle / Brightness of the bulb / Conductivity / Correct label A / Very bright / Does conduct / B / Off (no light) / Does not conduct / C / Dim light / Does conduct / D / Off (no light) / Does not conduct /	

The results that he obtained are as shown in the table below:

Bottle	Brightness of the bulb	Conductivity	Correct label
A	Very bright	Does conduct	
B	Off (no light)	Does not conduct	
C	Dim light	Does conduct	
D	Off (no light)	Does not conduct	

Complete the table by filling the correct label of bottle A, B, C and D. Justify your answer.

Student's answer:

Bottle	Brightness of the bulb	Conductivity	Correct label
A	Very bright	Does conduct	Electrolyte
B	Off	Does not conduct	Non-electrolyte
C	Dim light	Does conduct	Electrolyte
D	Off	Does not conduct	Non-electrolyte

Explanation:

The correct label of B and D is Non-electrolyte because solution in bottle of B and D do not allow the electric current

Provide opportunities to ask some questions and give positive feedback to Students.

Appreciate students' correct answers.

	to pass through, due to absence of ions. The reason why no light on the bulb. The correct label of A and C is electrolyte because solution in A and C allow the electric current to pass through due to presence of ions. The reason why bulb produces light.	
Assessment **(5 min)**	1. Sodium chloride in molten state conducts electricity while sodium chloride in solid state does not conduct electricity. a. Sodium chloride in molten state does conduct electricity because of: i) ions are free to move ii) electrons are free to move iii) ions are fixed b. Sodium chloride in solid state does not conduct electricity because of: i) ions are free to move ii) ions are fixed iii) electrons are free to move 2. Sugar is an example of: a. an electrolyte b. Non electrolyte	

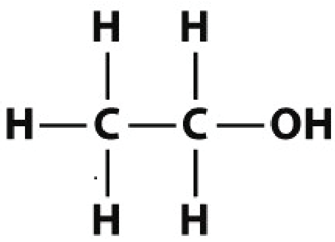
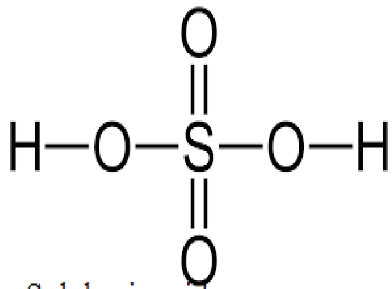
	c. a and b are correct answers d. non correct answer 3. Sodium chloride solution is: a. a strong electrolyte b. a weak electrolyte c. both a and b are correct. d. non correct answer 4. Pure water is: a. a strong electrolyte b. a weak electrolyte c. a and b are correct d. none of these **Student's answer:** **1. a. i) 1. b. ii) , 2.b, 3.a, 4.d**	Give time to students to write the summary in their notebooks. Conclude the lesson by highlighting the main points. Check learners in writing summary

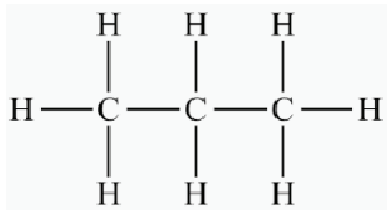
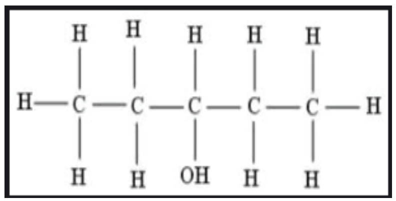
Lesson Summary and Conclusion **(5 min)**	**Teacher:** we are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: – The meaning of electrolyte and non- electrolyte – The particles responsible to conduct electric current in electrolytes – The examples of weak and strong electrolytes and non-electrolytes – Non-electrolytes are covalent compounds that do not dissociate into ions when they are dissolved in water. They dissolve in water as molecules. Sugar and water are good examples of non-electrolytes. This is the reason why they do no conduct electricity. – Electrolytes are compounds whose aqueous solutions contain ions. – Electrolytes are grouped into: strong electrolytes and weak electrolytes. – An electrolyte which is ionized completely in water is called strong electrolyte. For example, H_2SO_4, HCl and HNO_3. – An electrolyte which is ionized partially in water is called weak electrolyte. For example, CH_3COOH.	

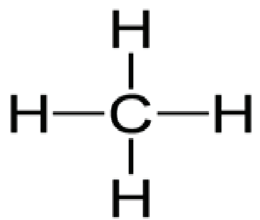
	Homework: Now I want to give you a homework assignment so that you try to apply some of what we have learned today. Give the difference between electrolyte and non-electrolyte. a) Draw a well labeled diagram showing how you can compare electrical conductivity of ethanol (type of alcohol) and dilute hydrochloric acid. b) State the observations that would be made in the experiments. Give two examples of electrolytes and two examples of non-electrolytes. *Thank you for your participation in this lesson.*	

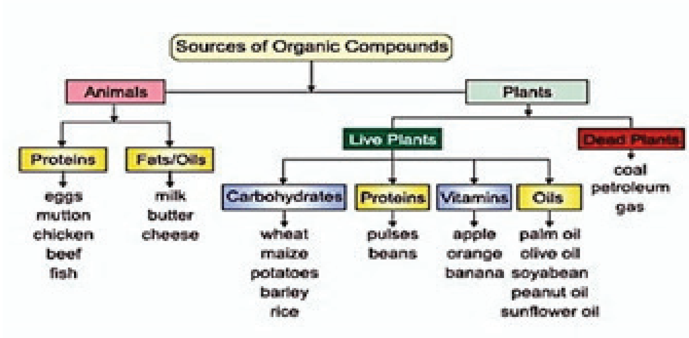
Scripted lesson from Unit 10

SUBJECT: Chemistry	**GRADE:** S2	**UNIT 10:** Properties of organic compounds and uses of Alkanes
Lesson title: Definition of organic chemistry		**Duration:** 40 min
Teaching & learning materials: Charts, manila papers, chalk board, periodic table, Bunsen burner		
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to: – Define organic chemistry – Identify organic compounds and their origin – Use simple experiments to classify compounds into organic and inorganic.	Welcoming students and introduce the objectives of the lesson Gain the students attention Identify the students with special educational needs Give learners the opportunity to reflect on the introductory questions.

Introduction **(8 min)**	**Organic compounds Vs Inorganic compounds** The teacher shows the test of flammability of the following compounds:  Ethanol(type of alcohol)  Sulphuric acid **Procedure:** **The teacher;** – Light a Bunsen burner – Dip the glass rod into alcohol and another glass rod into sulphuric acid. – Hold the glass rod with liquids droplets into a non-luminous flame. – Each group shares one question they would like to get an answer to from the 3questions.	Allow learners to ask question about the topic of the day. The learners observe what the teacher is doing. In groups of 5, learners raise any three questions related to their observations. They write down the questions related to their observation Build on their questions and communicate the key questions Tell students the materials needed and give them a small time to take them.

	Teacher: The teacher helps with correct formulation and records them. **The students:** Students correct the formulation of their question. **Teacher:** Based on the questions from learners, the teacher try to come to the key question of the lesson. **Key question:** What are the similarities and differences between organic and inorganic compounds?	Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback.
Lesson Development **(20 min)**	H-Cl A  B Cl-Mg-Cl C  D	Emphasize new concepts. At each step, provide a pause time for students to think and say or write their ideas.

	B: is an organic compound because it is made of bond between Carbon and Hydrogen. B and D: are organic compounds since they contain bonds between Carbon and Hydrogen. A and C are all inorganic compounds since they do not contain bonds between carbon and hydrogen. State whether the following structure is for organic compound or not. Explain your answer.  **Answer:** The compound given above is an organic compound because, an organic compounds are those compounds which have carbon and Hydrogen bonds (C-H). Except oxides of carbon, hydrogen carbonate, Carbonates, carbides and cyanides. All living things, plants and animals are composed of organic compounds.	Use different questions to probe students to understand the content/ Questions/ answers method

	Definition of organic chemistry Organic chemistry is a discipline of chemistry that is concerned with the study of organic compounds.  **Distinction between organic and inorganic compound** **Test of solubility for organic and inorganic compounds** **Procedure:** Pour about $5cm^3$ of water in test tubes. Add small portions of the following substances into each test-tube as shown below: Test tube 1: piece of bread Test tube 2: paraffin Test tube 3: dilute HCl	The teacher requests again learners to be ready and follow carefully instructions note key points.

	Test tube 4: common salt Test tube 5: piece of a candle wax Test tube 6: magnesium ribbon Test tube 7: sand Test tube 8: cooking oil Test tube 9: ash Observe the solubility of each substance in water and record your observation in the table 10.1. **Test of volatility for organic and inorganic compounds** **Procedure:** – Pour about $2cm^3$ of liquids under test into clean test tubes (HCl, water, paraffin, cooking oil). Place the test tubes in a rack – Place small pieces of paper on the open end of the test tubes. – Wait for 10 minutes. Remove the pieces of paper and observe if there is any dampness. Is there any smell while pouring them?	

	Questions Why are some papers damp? Explain Why are some papers dry? Explain. Record your observation in the table 10.1. (If there is dampness indicate as volatile. If there is no dampness on paper indicate as non-volatile. **Test of flammability of organic and inorganic compounds** **Procedure:** **For solid substances:** – Light a source of heat – Cut small pieces of (about 2cm) of candle and magnesium. – Hold the solids using a pair of tongs in a non-luminous flame. **For liquid substances:** – Dip the glass rod into these liquids – Hold the glass rod with liquid droplets into a non-luminous flame. **For powders and granules:** – Put a half spatula of substances and heat cautiously in a flame.	Provide review opportunities for students.

	– Observe and record what happens in the table given below and explain. Dear students after performing the three activities given above, record your observations in the table 10.1. **Table 10.1**	Provide opportunities for corrective feedback or positive feedback to students.

Substance	Solubility in water	Volatility	Flammability
Piece of bread			
Candle			
Paraffin			
Dilute HCl			
Common salt			
Magnesium ribbon			
Water			
Sand			
Cooking oil			
Ash			

Refers to the activities done above, complete the table by giving characteristics of organic compounds

	Inorganic compounds	Organic compounds
1	They contain all known elements	
2	They are found in non-living things	
3	They are generally soluble in water and non-soluble in organic solvents	
4	They are non-inflammable	
5	In aqueous solution inorganic compounds are known as good conductors of heat and electricity.	
6	They have high melting and boiling points compared to organic compounds	

Answer:

	Inorganic compounds	Organic compounds
1	They contain all known elements	They usually contain carbon, hydrogen and oxygen
2	They are found in non-living things	Organic compounds are mainly found in most of the living things
3	They are generally soluble in water and non soluble in organic solvents	They are generally insoluble in water but soluble in organic solvents
4	They are non inflammable	They are highly flammable
5	In aqueous solution inorganic compounds are known as good conductors of heat and electricity.	In most of the aqueous solutions, organic compounds are poor conductors of heat and electricity
6	They have high melting and boiling points compared to organic compounds	They have low melting and boiling points compared to inorganic compounds.

Occurrence of organic compounds

After observing the images given below, summarise the occurrence of organic compounds:




Answer:

Simplest organic compounds occur naturally in crude oil and natural gas. Crude oil and natural gas are usually found together, formed by the same gradual decay of marine animals and plants.

The alkanes are heavily exploited as fuels. Alkanes are obtained from crude oil by fractional distillation.

Fractional distillation separates crude oil into different fractions, that is, the various hydrocarbons.

Hydrocarbons are organic compounds made of hydrogen and carbon only.

Activity for application:

Distinguish between organic and inorganic chemistry.

Compare and contrast the physical properties of organic and inorganic compounds.

Answer:

Organic chemistry	Inorganic chemistry
Organic chemistry focuses on all compounds that contain the element carbon, usually in the form of carbon and hydrogen bond.	Inorganic chemistry deals with the compounds that do not have carbon, though they are some exception.
Many of the organic compounds are classified as hydrocarbon	Many of the inorganic compounds are classified as salts.
Example: methane, ethane, acetic acid and ethyl alcohol	Example: sodium bicarbonate, sodium carbonate, water.

Assessment **(5 min)**	1. Choose an organic compound from the following compounds: A. Na_2SO_4 B.CO_2 C. CH_4 D. $KHCO_3$ **Answer: C** Organic compound is compound which contain mainly --------- and --------- A. Carbon and Hydrogen B. Carbon and Oxygen C. Both A and B D. All of them **Answer: A** 2. Define the term organic chemistry. 3. Give two examples of organic compounds and two examples of inorganic compounds.	

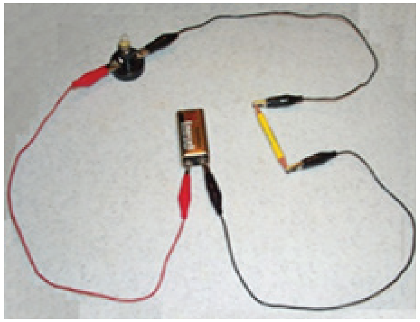
Lesson Summary and Conclusion **(5 min)**	We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: – The meaning of organic chemistry – The difference between organic compounds and inorganic compounds. Organic compounds are those compounds which have carbon and Hydrogen bonds (C-H). Except oxides of carbon, hydrogen carbonate, carbides and cyanides. Organic chemistry is a discipline of chemistry that is concerned with the study of organic compounds. Simplest organic compounds occur naturally in crude oil and natural gas. **Hydrocarbons:** Are organic compounds made of hydrogen and carbon only.	

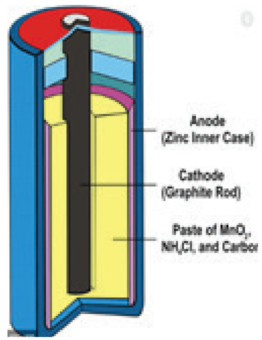
SCRIPTED LESSONS FOR SENIOR THREE

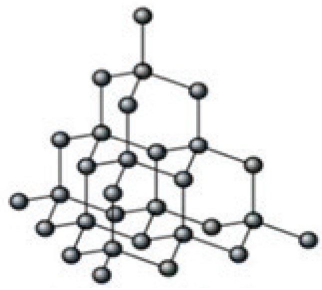
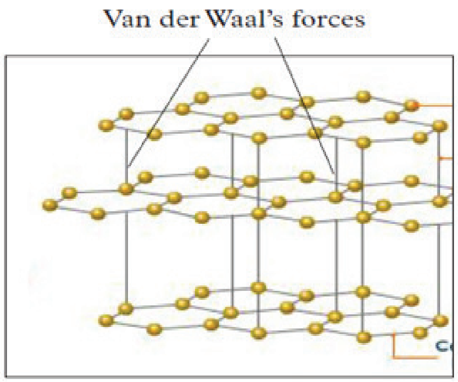
Scripted lesson from Unit 1

SUBJECT: Chemistry	**SENIOR:** S3	**UNIT 1:** Carbon and its inorganic compounds
LESSON TITTLE: Allotropic forms of carbon their physical properties and uses		**Duration:** 80 min
Teaching & learning materials: Charts, manila papers, pencil, wood charcoal, chalk board, periodic table, cell rod.		

Section	Step- by- step instruction and content	Notice to the teacher
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to:: – Define the term allotropy – Discover the various allotropes of carbon and uses.	– Welcoming students and gain their attention. – Identify students with special needs to be helped and communicate objectives of the lesson. – Tell students the materials needed and give them a small time to take them.

Introduction **(8 min)**	**Teacher:** Observe the figure below. What does it represent? **Student:** This figure represents electric circuit. **Teacher:** Name the components of the circuit. **Student:** The components of the circuit are electric wires, a battery, a light bub and pencil **Teacher:** What is in place of switch in this circuit? **Student:** Pencil lead  **Teacher:** Does the pencil lead conduct electricity? Explain your answer. **Student:** It conducts electricity because the bulb lights up..	Ask questions helping the learners to recall what they have seen in senior two Emphasize new concepts. At each step, provide a pause time for students to think and say or write their ideas.

	Teacher: Observe the following figure. Which element is in common for those substances? For cells consider the inner black cell rod.    **Student:** It is carbon. **Teacher:** In Senior 2 under covalent bonding, you learnt about giant covalent structures, their properties and uses. Now I want you to answer the following questions related to the previous lessons: **Teacher:** State two examples of giant covalent structure. **Student:** Diamond and Graphite **Teacher:** Give the structures of giant covalent structures in (1).	Write the title of the lesson Use different questions to probe students to understand the content/ Questions/ answers method Ask learners to present their findings from the research. Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback.

	Student: Diamond  Graphite  	Provide opportunities for corrective feedback or positive feedback to students.
	Teacher: What is the common element in those giant covalent structures? **Student:** It is carbon	Use different questions to probe students to understand the content/ Questions/ answers method

Lesson Development **(60 min)**	**Teacher:** Today we are starting with giant covalent structures of carbon element a lesson learnt in senior two in Chemical bonding. It will be easy for you as you have the prerequisites needed electronic configuration of carbon and its giant covalent structures. **Lesson title: Allotropic forms of carbon and their uses.** **Teacher:** How wood charcoals are formed? **Student:** They are formed by destructive distillation of wood, wood are burned in a limited supply of air (incomplete combustion). **Teacher:** Allotropes are different forms of an element which have the same chemical properties but different physical properties. Charcoal, diamond and graphite are allotropes of carbon atom. Allotropes of carbon exist in two main forms known as crystalline and amorphous. Classify soot, graphite, charcoals and diamond into crystalline and amorphous.	Guide the learners to give the correct answers

<table>
<tr>
<td>Assessment

(5 min)</td>
<td>
Student:
– Crystalline: Graphite and Diamond
– Amorphous (non-crystalline): Charcoal and soot

A. Crystalline form

Teacher: Each group is going to present the findings from the research that you have done differentiating diamond and graphite in terms of their physical properties.

Student:
<table>
<tr><th>Diamond</th><th>Graphite</th></tr>
<tr>
<td>• It is the hardest known naturally occurring substance. This is because of the strong covalent bonds that hold the atoms of carbon together.

• When carefully and specially cut, it is colourless crystalline and transparent with a dazzling brilliant lustre. The lustre is caused by its high refractive index.</td>
<td>• Graphite is a soft, black and shiny material with a greasy feel.

• Graphite easily flakes off.

• Has relatively high melting and boiling points due to the strong covalent bonds joining its atoms together.

• It has a density of 2.25g/cm^3.</td>
</tr>
</table>
</td>
<td>Provide review

Opportunities for students and guide their ideas

Give application activities to the learners individually.</td>
</tr>
</table>

	• Diamond has a higher density of 3.5g/cm^3 compared to that of graphite (2.25g/cm^3). This is because the arrangement of atoms in a diamond crystal allows for more atoms to be packed per given space compared to graphite. • It has a high melting and boiling points. It melts at 4200°C.This is because all the carbon atoms are bonded by very strong covalent bonds that require a lot of heat energy to break. • Diamond does not conduct electricity. This is because it has no delocalized electrons.	• Graphite is a good conductor of electricity due to the presence of delocalised electrons in its structure. • It is opaque. Numerous parallel layers arranged on top of one another blocks light from penetrating through.	

• Diamond is a good conductor of heat because of its strong covalent bonding	

Uses of graphite

The properties of graphite determine its uses. Some uses of graphite include:

- It is used as electrodes in dry cells and fuel cells. This is because it is a good conductor of electricity.
- Graphite is used as a carbon raiser in the production of steel. It gives steel its strengthening characteristics.
- It is used in advanced high-friction applications such as car brakes and clutches because of its high thermal and electrical conductivity.
- -It is used to make pencil ‘leads’ when mixed with clay. This is due to the sliding of its layers which enable it to slide on paper when writing.

Uses of diamond

- Because of its hardness, it is used for making drill tips used when drilling or cutting metals.

	– It is also used to make glass cutters. – It is used in making jewelry due to its beautiful sparkling radiance and lustre. **B. Amorphous form** **1.Charcoal** **Teacher:** What are the physical properties of charcoal? **Student:** – It is a black, porous and brittle solid – It is soft and has low density. – It is bad conductor of electricity. – It can adsorb large volume of gases and solids. There are three common types of charcoal: wood charcoal, animal charcoal and sugar charcoal. **a) Wood charcoal** **Teacher:** How wood charcoal is formed? **Student:** Wood charcoal is obtained when wood is strongly heated in absence of air. This process is called destructive distillation of wood.	

	Teacher: What are the uses of wood charcoal? **Student:** – Household fuel for cooking. – Reducing agent in extraction of metals constituent of gun powder (explosives in guns and rifles) **b) Animal charcoal (bone charcoal)** **Teacher:** How animal charcoal is formed? **Student:** Animal charcoal is formed when bones are subjected to destructive distillation **Teacher:** What are other compounds found in animal charcoal? **Student:** Animal charcoal is only about ten percent carbon with the rest being mainly calcium phosphate. **Teacher:** What are the uses of animal charcoal? **Student:** – Depollution of water by removal of fluoride ions. – Filter aquarium water – Decolorizing agent in sugar refining industry.	

	It removes brown colour from sugar syrup before crystallizing. – Source of black pigment for artistic paint. **c) Sugar charcoal** **Teacher:** Describe the way by which sugar charcoal can be formed **Student:** Sugar charcoal is obtained by dehydrating sugar using concentrated sulphuric acid. This can also be formed by heating sugar in limited supply of air. **Teacher:** What are the uses of sugar charcoal? Student: – Reducing agent in extraction of metals such as iron and zinc from their oxides – Decolourises coloured solutions – Manufacture artificial diamond **Teacher:** what do you understand by activated charcoal? **Student:** Activated charcoal (charcoal that is finely powdered) is used to remove smelly gases in slaughter houses, gas manufacturing plants, large air conditioning systems and airports. This is because activated charcoal has a large surface area and hence can adsorb large volumes of gases.	

d) Lampblack/soot

Teacher: Why the inside of your school chimney is black?

Student: The inside of chimney is coated with a very fine black powder of carbon known as soot.

Teacher: What are the uses of soot?

Student: Making black shoe polish, black ink, black paints and carbon paper

As an ingredient in the rubber tyres (For hardening of rubber).

e) Coke

Teacher: What is coke and how it is prepared?

Student: It is a solid made by heating coal in the absence of air in the process known as destructive distillation of coal.

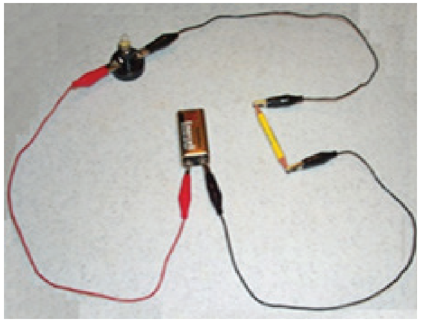
Teacher: What are the uses of coke

Student:

- Reducing agent in extraction of metals like iron and zinc from their oxides
- Manufacture of gaseous fuels, water gas and producer gas.

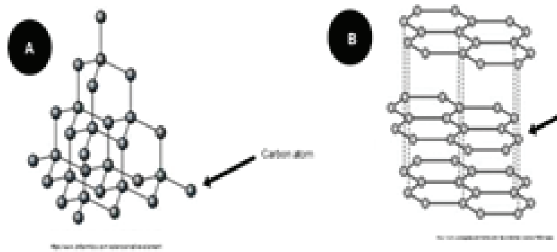
Teacher: In combined state carbon occurs in living things in form of carbohydrates, proteins and vitamins while in nonliving things it occurs mainly in form of carbonates, coal, crude oil and natural gases.

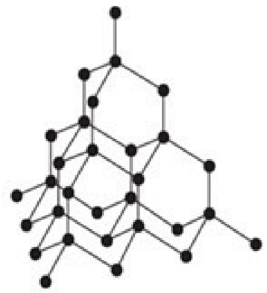
Teacher: Observe the following circuit and answer the following questions.



- Replace pencil lead by diamond, record the observation. What will happen if pencil lead is replaced by diamond? Explain why.

Student: a) The bulb does not light; Diamond does not conduct electricity due to the absence of delocalized electrons. Graphite conducts electricity due to the presence of delocalized electrons.

Assessment **(5 min)**	**Teacher:** Workout in groups of 2 students the questions that follow: 1. Carbon is an element in group 14 (4A) of the periodic table of elements. Considering the structure of graphite and diamond below:  Fig 1.5. a) Which among structures A and B is graphite? b) How many covalent bonds are formed by each carbon atom in: (i) diamond (ii) graphite? c) State which structure between diamond and graphite contains delocalized electrons. Briefly explain. d) Why wood charcoal are added in cooked carbonized rice? 2. Differentiate allotropes from allotropy 3. Choose the element of Period 2 corresponding to the below structure	

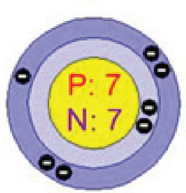
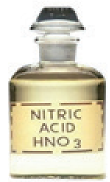
	 Lithium, Boron, Carbon, Oxygen 4. Choose the correct statement a) Graphite is exclusively made of carbon and hydrogen only. b) Graphite has delocalized electrons c) Graphite is highly ductile d) Graphite is soft therefore it is used as a lubricant 5. Which of the following are not the crystalline forms of carbon? a) Coke b) Diamond c) Animal charcoal d) Graphite	Give time to students to write the summary in their notebooks. Conclude the lesson by highlighting the main points. Check learners in writing summary

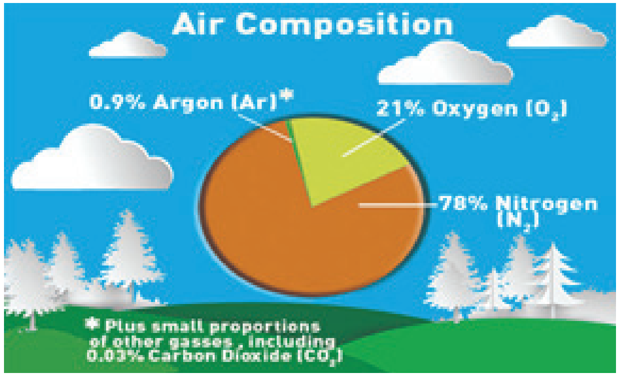
	A. 2 only B. 1 and 3 C. 4 and 3 D. 1, 2 and 3 **Learners' answers:** a) It is B b) (i) In diamond: four covalent bonds (ii) In graphite: three covalent bonds c) Graphite contains delocalized electrons; this is because during bonds formation each carbon atom use 3 valence electrons and one electron remains free. d) It absorbs bad smell from carbonized 2. Allotropy is the existence of an element in more than one form in the same physical state while Allotropes are different forms of an element that exist in the same physical state. 3. c 4. b and d 5. a and c	

Lesson Summary and Conclusion **(5 min)**	**Teacher:** Carbon exists in different forms called allotropes of carbon. Allotropes are different forms of an element which have the same chemical properties but different physical properties. Allotropy is therefore the existence of an element in two or more forms. Other elements show allotropes are sulphur and phosphorus. Carbon exists in two forms (Crystalline and amorphous) **Amorphous:** Non-crystalline are forms of carbon are formed by decomposing other substances like wood using heat. Charcoal and soot are examples of amorphous carbon. Soot, charcoal, lampblack are examples **Crystalline:** Are allotropes of carbon with definite structures. Diamond and graphite are examples. Physical properties of graphite differ from that of diamond due to the presence of delocalized electron in graphite but absent in diamond.	

	Homework: 1. What is allotropy? 2. Name two elements that exhibit allotropy. 3. Name the allotropes of elements named in question 2 above. 4. ____________ is the allotrope of carbon used in dry cells. 5. Soot and charcoal are formed when _________________. 6. What is the role of the rod in a dry cell? *Thank you for your participation in this lesson.*	

Scripted lesson from Unit 2

SUBJECT: Chemistry	**Grade:** S3	**UNIT 2:** Nitrogen and its inorganic compounds
LESSON TITTLE: Industrial isolation of nitrogen **Teaching & learning materials:** Charts, chalk board, periodic table, Video		**Duration:** 80 min
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(4min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to describe the industrial isolation of nitrogen	Welcoming students and gain students' attention.
Introduction **(10min)**	**Teacher:** Observe the following figure and answer related questions  Figure A  Figure B  Figure C	Identify students with special needs to be helped and communicate objectives of the lesson

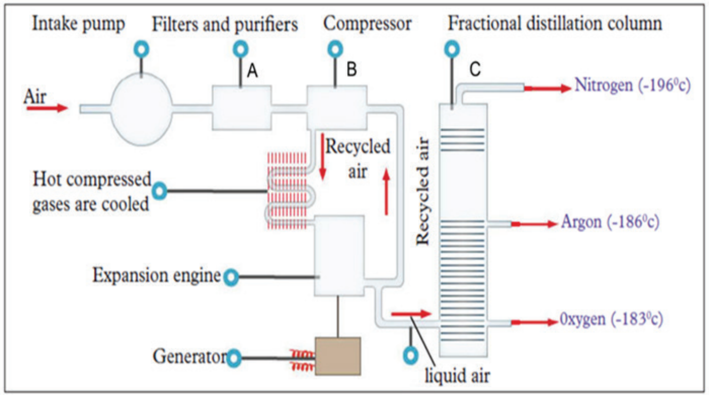
	What is the common element for the compounds in figure B and C? **Students:** It is nitrogen **Teacher:** Observe the picture below  **Teacher:** State the compositions of air. **Student:** Oxygen, nitrogen, carbon dioxide and noble gases. **Teacher:** What is the gas that has high percentage composition in air? **Student:** Nitrogen **Teacher:** Which method is used to separate oxygen, hydrogen and nitrogen?	Ask questions that will help learners to recall the composition of air.

	Student: Nitrogen can be isolated from the air using fractional distillation of liquid air. This process involves eliminating other components of the air hence remaining with oxygen.	
Lesson development **(50 min)**	Today we are starting with composition of air, the lesson you learnt in senior one. It will be easy for you as you have the prerequisites needed which are nitrogen, oxygen and carbon dioxide as composition of air. We are going to see how nitrogen is isolated from air in industry. **Lesson title: Industrial isolation of nitrogen** **Teacher:** In senior one, you studied nitrogen as one of the components of air. Is air a mixture or a compound? **Student:** Air is a mixture **Teacher:** Components of a mixture can be separated by physical means. Do you agree? **Student:** Yes **Teacher:** What is the percentage composition of nitrogen in air? **Student:** 78%	Write the title of the lesson.

Teacher: What method is used to separate components of the mixture which have different boing point

Student: Fractional distillation method.

Teacher: Nitrogen can be isolated from air by fractional distillation of liquid air. This process involves eliminating other components of air hence remaining with nitrogen. It is a four-step process as discussed below:



Filtration of air

Air passes through filters to remove dust particles, then the dust-free air is passed through driers or absorber to remove water vapor and final is passed through solution of concentrated sodium hydroxide which later absorbs carbon dioxide from the air.

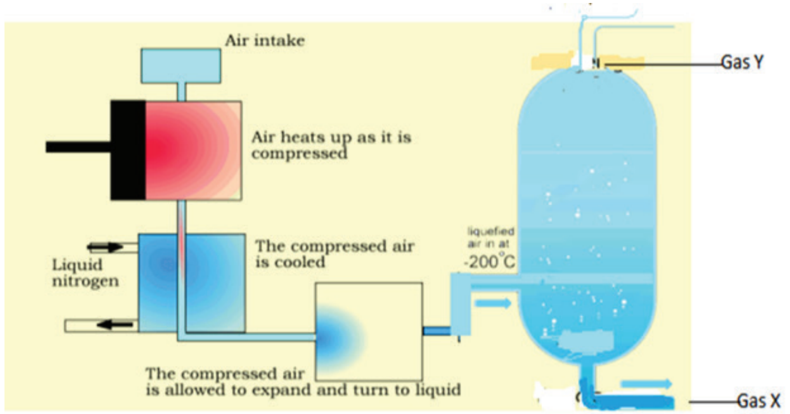
Emphasize new concepts.

At each step, provide a pause time for students to think and say or write their ideas.

	Compression of air This is the second stage whereby the remaining gas (mainly mixture of nitrogen, oxygen and noble gases) are compressed at very high pressures (200 atmospheres). The compressed gases are immediately cooled by passing them through cooling coils in a tank and then returned to the compressor several times to liquefy air into a pale blue liquid -2000C. Neon and helium do not liquefy at this temperature and are hence removed at this stage. **Fractional distillation** It is based on the boiling point of the component of the air. The liquid air obtained is a mixture of colourless nitrogen (boiling point = -196°C), pale-blue oxygen (boiling point = -183°C) and argon (boiling point = -186°C). The liquefied air is passed into the bottom of fractionating column this is a warmer at the bottom than it is at the top. Nitrogen boils at -196°C and so distills first and is collected at the top of the fractionating column. Argon with a boiling point of -186°C and oxygen with a boiling point of -183 °C distills later and are collected from the lower part of the column in that order.	Use different questions to probe students to understand the content/ Questions/ answers method

	Storage of nitrogen At the correct low temperature, the nitrogen becomes liquid, and then can be extracted and harvested for industrial processes. Once in its liquid form the gas can be transported in tanks and stored cylinders under pressure. The nitrogen obtained by this method is pure. **Teacher:** Fractional distillation applied also when separating liquid ethanol from a mixture of water and ethanol. It is also applied when separating components crude oil (petroleum).	
Assessment **(6 min)**	1. State and describe steps involved in industrial isolation of nitrogen. 2. Liquid air has three components X,Y and Z whose boiling points are -186°C, -183°C and -196°C respectively. When the liquid air is fed into a tall fractional distillation column and near its bottom warmed up slowly: a) Which component will be collected from near the bottom of the fractional distillation column? Why? b) Which component will be collected from the top of the fractional distillation column? Why? c) Which component will be collected from the middle part of the fractional distillation column? Why?	Provide opportunities for corrective feedback or positive feedback to students.

	d) What could the components X,Y and Z be in real situation? 3. What is the importance of the following during isolation of nitrogen from air: • Passing air through filters and concentrated sodium hydroxide solution? • Compression and expansion of air? • Fractional distillation of liquid air? 4. In your study groups, discuss the industrial isolation of nitrogen gas from air and make a presentation to the rest of class. 5. Air contains mainly ______________ gas with about ____________%. The main components of air are mainly separated by ________________ process. *Thank you for your participation in this lesson.*	

Lesson Summary and Conclusion **(10 min)**	We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: Four-step process required in industrial isolation of nitrogen. – Purification of air – Compression of air – Fractional distillation – Storage of nitrogen **Homework:** Interpretation of the chart explaining the industrial isolation of nitrogen **Teacher:** Observe the figure below work in pairs and answer the following questions 	

	a) Give the name of the figure above b) Examine what are the substance X and Y and justify your answer c) State the temperature required to collect the substances X and Y **Answers from learners:** a) Set up for fractional distillation of liquid air b) X is oxygen gas Y is nitrogen gas, this is because nitrogen has low boiling point than oxygen c) X:-183^{0}C, Y: -198^{0}C *Thank you for you for your participation*	

Scripted lesson from Unit 3

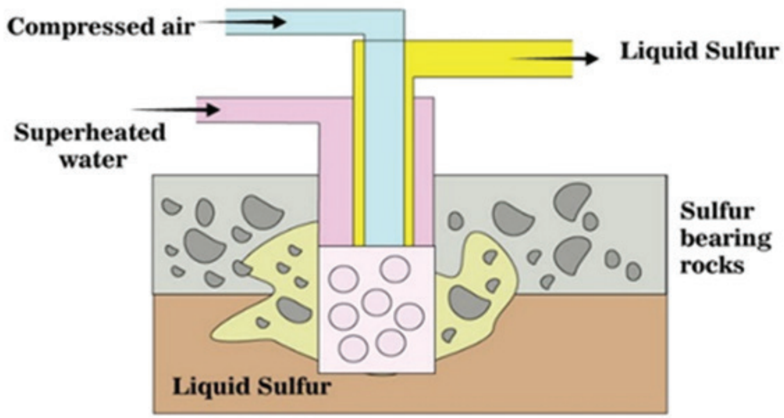
SUBJECT: CHEMISTRY	**GRADE:** S3	**UNIT 3:** Sulphur and its inorganic compounds
LESSON TITTLE: Occurrence and extraction of Sulphur **Teaching & learning materials:** Charts, Rotten eggs, onions, chalk board, periodic table		**Duration:** 80 min
Section	**Step -by- step instructions and content**	**Notice to the teacher**
Student readiness **(4min)**	**Lesson Objectives:** By the end of this lesson, learners will be able to describe occurrence and the process of extraction of sulphur in nature.	– Welcoming students and gain students' attention. – Identify students with special needs to be helped. – Communicate objective of the lesson
Introduction **(10min)**	**Teacher:** Describe the image below. 	Ask learners to observe and describe the image

	Students: The image shows fireworks, showing different colours. They are produced by sulphur **Teacher:** Observe carefully the figure below  **Teacher:** What is this? **Student:** Yellow stones, yellow soil. **Teacher:** What element of the periodic table that has this colour? **Student:** Sulphur **Teacher:** Do you think sulphur is obtained in atmosphere or earth's crust? **Student:** It is found in earth's crust. **Teacher:** How sulphur is extracted? **Student:** Sulphur is extracted from its underground deposits by Frasch process.	Form groups of 5 students and give tasks to the students. Provide time for learners to think and answer the questions. Write the title of the lesson Ask the learners to read the following paragraphs and observe the following figures.

Lesson Development **(50 min)**	**Teacher:** Today we are going to see where sulphur occurs and how it is extracted. **Lesson title: Occurrence and extraction of Sulphur** **Teacher:** Give two compounds which contain sulphur **Student:** H_2S, H_2SO_4, natural gases, ZnS, SO_3, ... **Teacher:** Reads the following passages Sulfur is widely distributed in nature. It is found in many minerals and ores, such as iron pyrites, galena, cinnabar, zinc blende, gypsum, barite, and epsom salts and in mineral springs and other waters. It is found uncombined in some volcanic regions and in large underground deposit. Sulfur often occurs with coal, petroleum, and natural gas. Sulfur is found in meteorites. Sulfur is a component of all living cells. The amino acids cysteine, methionine, homocysteine, and taurine contain sulfur as do some common enzymes; it is a component of most proteins.	Emphasizes new concepts. Use different questions to probe students to understand the content/ Questions/ answers method

	Some forms of bacteria use hydrogen sulfide (H_2S) in place of water in a rudimentary photosynthesis like process. Sulfur is absorbed by plants from soil as sulfate ions.   **Teacher:** Where can we find sulphur? **Student:** It is found in volcanic region. **Teacher:** Use the dictionary and check the meaning of meteorite.	The teacher request again learners to be ready and follow carefully instructions note key points.

	Teacher: Yes, Sulphur occurs in minerals and ores, mineral springs and other waters, in some volcanic regions and in large underground deposits, coal, petroleum, natural gas and in all living cells mostly as proteins. A meteor is an asteroid or other object that burns and vaporizes upon entry into the Earth's atmosphere. Meteors are commonly known as "shooting stars." If a meteor survives the plunge through the atmosphere and lands on the surface, it's known as a meteorite. Sulphur occurs naturally in volcanic regions or regions where volcanoes were formerly active. As a free element sulphur is found occurring about 150 m underground in Texas and Louisiana in USA and Sicily in Italy. Sulphur also occurs as underground deposits in Japan. Sulphur can occur as a "free" element or combined in compounds such as: • Hydrogen sulphide found in petroleum, coal gas and natural gas. • Metal sulphides, for example, zinc blende (ZnS), iron pyrites (FeS_2), copper pyrites ($CuFeS_2$), etc. • Metal sulphates, for example gypsum ($CaSO_4$ $2H_2O$).	Provide opportunities for corrective feedback or positive feedback to students. Distributes sheets of paper in groups

	Teacher: Observe the following chart. The chart tells us about what?  **Student:** It tells us about how sulphur is obtained **Teacher:** a) Explain why: i) Superheated water is pumped into sulphur bed ii) Compressed air is used in the above process b) How is the mixture and water superheated? Suggest a property that allow them to be separated.	

	Leaners' answers: a) i) to melt sulphur ii) to force the mixture of sulphur and water to push out b) By cooling, the property is solubility, water and sulphur are immiscible/ are not soluble in each other. **Teacher:** Sulphur is normally extracted from its underground deposits by **Frasch process**, developed by American Herman Frasch. The sulphur deposits usually occur at about 150 meters below the ground level in beds of about 30 meters diameter. The basic principle behind Frasch process is melting the underground sulphur and then pumping it to the earth's surface. T**hree concentric pipes of different diameters** are drilled through into sulphur beds. Super-heated water at 170°C and a pressure of 10 atmospheres is pumped down the outermost pipe to melt the sulphur deposits. The melting point of sulphur is 113°C. Hot compressed air at pressure of 15 atmospheres is pumped down the innermost pipe. This changes the molten sulphur into a froth which is then forced up through the middle pipe and collects in large containers where it solidifies to yellow solid Sulphur. The sulphur obtained this way is usually over 99.8% pure.	

Activity in groups.

Read carefully the passage below explaining the ways from which sulphur can be made. Write all chemical equations in process 1 and 2.

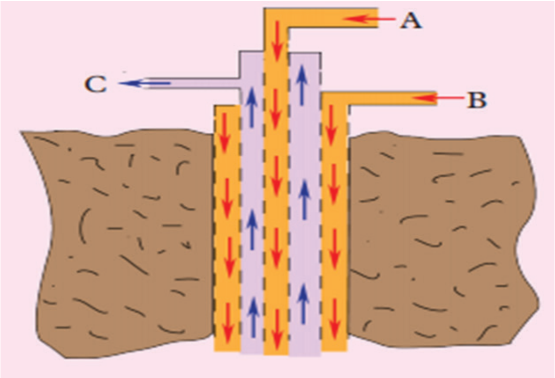
1. Sulphur can be extracted from crude oil gases. Crude oil gases include hydrogen sulphide (H_2S), carbon dioxide (CO_2) and methane (CH_4).

This gaseous mixture is passed through an alkaline solution

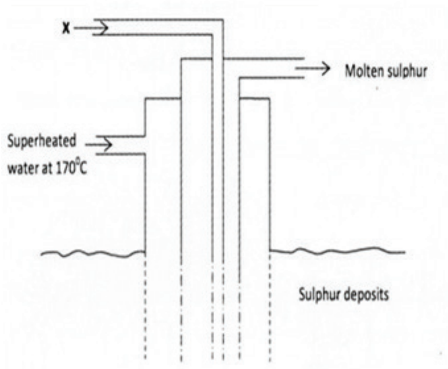
Since hydrogen sulphide and carbon dioxide are acidic gases, they are absorbed by the alkaline solution and can be regenerated by heating the solution.

The hydrogen sulphide is oxidised to sulphur by air in the presence of aluminium oxide catalyst to produce sulphur and water vapor in method called the **Claus process**.

2. Sulphur can also be produced during the extraction of metals from metal sulphide like zinc sulphide. When the ore is roasted in air (oxygen) it forms zinc oxide and sulphur dioxide. The sulphur dioxide obtained is reduced by reacting it with hydrogen sulphide to give sulphur and water vapors.

	1. $2H_2S(g) + O_2(g) \xrightarrow{Al_2O_3} 2S(s) + 2H_2O(g)$ 2. $2ZnS(s) + 3O_2(g) \longrightarrow 2ZnO(s) + 2SO_2(g)$ 3. $SO_2(g) + 2H_2S(g) \longrightarrow 3S(s) + 2H_2O(g)$ **Application activities:** 1. Where in nature is sulphur found? 2. The figure below shows process used to extract sulphur.  a) What is the name of the process? b) Name the substance that passes through pipes A, B and C. c) What is the role of the substances that pass though pipes A and B?	Give application activities to the learners in groups.

	d) What is the physical substance of sulphur that makes it to be extracted by this method? **Leaners' answers:** 1. Volcanic regions and underground deposits 2. a) **Frasch process**. b) A: Compressed air, B: Superheated water, C: Liquid sulphur c) **Hot Compressed air**: changes the molten sulphur into a froth which is then forced up through the middle pipe and collects in large containers where it solidifies to yellow solid Sulphur. **Superheated water:** is pumped down the outermost pipe to melt the sulphur deposits. d) Low melting point, solid state and insolubility in water.	

Assessment **(6 min)**	1. Sulphur can be found in all the listed source except a. Volcanoes b. India ocean c. Ores d. Timbers 2. Sulphur is normally extracted by the process called a. Haber process b. Frasch process c. Bosch process d. Contact process 3. The diagram below shows the process used for extraction of sulphur. Use it to answer the questions that follow.  	

	a) Name X. b) Why is it necessary to use superheated water in this process? c) State two physical properties of sulphur that makes it possible for it to be extracted by this method? **Learners' answers:** 1. d 2. b 3. a) X is hot compressed air b) To melt sulphur	Ask questions to help learners to develop summary and conclusion
Lesson Summary and Conclusion **(10 min)**	**Teacher:** What we have seen in this lesson? **Students:** We have seen where sulphur occurs and how it can be extracted. Sulphur occur naturally in volcanic regions, deposits usually occur at 150m below the ground, it is mainly found in combined form and it is extracted by **using Frasch process or Claus process**. In Frasch process three concentric pipes of different diameters are drilled through into sulphur beds. Super-heated water and hot compressed air are used to melt and forced up through the middle pipe and collects in large containers where it solidifies to yellow solid Sulphur. Sulphur can also be produced during the extraction of metals from metal sulphides like zinc blende. *Thank you for your participation in this lesson.*	

Scripted lesson from Unit 4

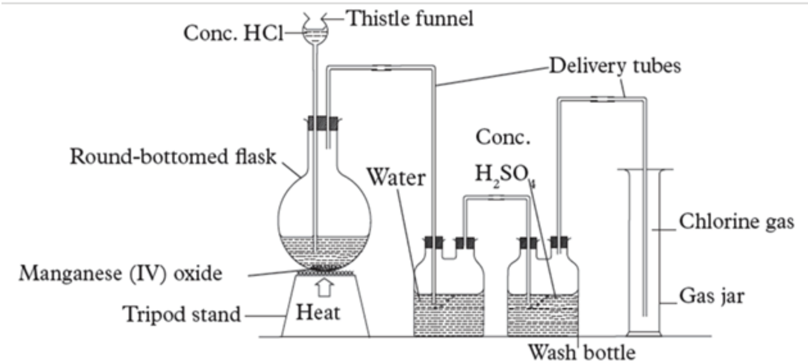
SUBJECT: Chemistry **GRADE:** S3 **UNIT 4:** Chlorine and its inorganic compounds

Lesson title: Preparation and test of chlorine **Duration:** 80 min

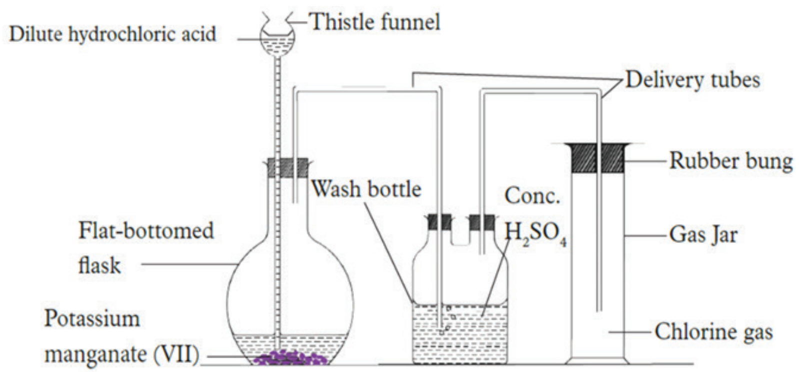
Teaching & learning materials: Charts on the preparation and test for chlorine, manila papers, chalk board, Reagents and apparatus. periodic table

Section	Step –by- step instructions and content	Notice to the teacher
Student readiness **(4min)**	**Lesson Objectives:** By the end of the lesson, learners will be able to prepare and test for chlorine.	Welcoming students and gain students' attention.
Introduction **(16 min)**	**Teacher:** What is the element do you see on the labels of the substance below?   	Identify students with special needs to be helped. Communicate objective of the lesson Ask questions

	Student: It is chlorine. **Teacher:** Which chemical substances are used in disinfection of water in water treatment plants? **Student:** Chlorine water, $Cl_2(aq)$ **Teacher:** From which compound can chlorine be prepared in the laboratory? **Student:** It can be prepared from NaCl, HCl, $MgCl_2$, $KMnO_4$, … **Teacher:** Chlorine is mainly prepared in the laboratory using $KMnO_4$ or MnO_2 and HCl.	Students must be given time to think and note down their answers which will be analyzed by the teachers and peers in order to give constructive feedback.
Lesson Development **(50 min)**	**Teacher:** Today we are going to study how chlorine is prepared and tested **Lesson Title: Preparation and test of chlorine** **Students:** Move in their respective groups. **Teacher:** Construct the set up below but do not add HCl. **Apparatus:** Round bottomed flask, conical flask, gas jars, source of heat, two wash bottles, delivery tubes, dropping funnel, retort stand, blue and red litmus papers. **Reagents:** Manganese(IV) dioxide, water, concentrated hydrochloric acid.	Distribute apparatus and chemicals for each group. Then he/she gives clear instructions.

	Caution: Chlorine gas is poisonous and should be prepared in a fume chamber or in open air. ***Procedure:*** – Put manganese dioxide in a round bottomed flask and arrange the apparatus as shown below: Laboratory set up for Chlorine gas preparation  **Source:** *Chemistry, Student's Book /Senior 3* P.(127) – Add concentrated hydrochloric acid into the flask from the thistle funnel as shown and heat the mixture. – Write down your observations of what is taking place in the gas jar and in the flask as the reaction proceeds. – Test the gas collected with moist blue and red litmus papers. Observe the changes.	Write title of the lesson Teacher forms groups of 5 students Tell students the materials needed and give them a small time to take them.

	Teacher: Helps the students to construct the apparatus set up. Control whether all groups have finished to construct the apparatus set up and allow them to start by adding HCl. **Student:** Add concentrated (2M) HCl in flat bottomed flask, record the observation *Write the equation of reaction* $MnO_2(s) + 2HCl(l) \longrightarrow MnCl(aq) + 2H_2O(l) + Cl_2(g)$ Hydrochloric acid reacts with manganese (IV) oxide to form manganese (II) chloride, water and chlorine gas. **Teacher:** What is the role of water and sulphuric acid in the apparatus set up of preparation of chlorine above? **Students:** Water in the wash bottle absorbs hydrogen chloride fumes. The gas evolved is dried by passing it through concentrated sulphuric acid. Chlorine gas can also be dried by passing it through anhydrous calcium chloride. It is collected by downward delivery since it is denser than air. **Teacher:** Chlorine gas can also be prepared using potassium permanganate instead of manganese dioxide as shown in the diagram below.	Asks the learners to write the chemical equations.



$$2KMnO_4(s) + 16HCl(aq) \longrightarrow 2KCl(aq) + 2MnCl_2(aq) + 8H_2O(l) + 5Cl_2(g)$$

Water in the wash bottle absorbs hydrogen chloride fumes. The gas evolved is dried by passing it through concentrated sulphuric acid. Chlorine gas can also be dried by passing it through anhydrous calcium chloride. It is collected by downward delivery since it is denser than air. Chlorine gas can also be prepared using potassium permanganate instead of manganese dioxide as shown by the following equation.

$$2KMnO_4(s) + 16HCl(aq) \longrightarrow 2KCl(aq) + 2MnCl_2(aq) + 8H_2O(l) + 5Cl_2(g)$$

In this method, no heating is required since potassium permanganate is a stronger oxidizing agent than manganese dioxide.

Emphasize new concepts.

At each step, provide a pause time for students to think and say or write their ideas.

	Chlorine also can be prepared by heating a mixture of manganese (IV) oxide and sodium chloride with concentrated sulphuric acid. In this reaction, sulphuric acid first reacts with sodium chloride to form hydrochloric acid. The hydrochloric acid then reacts with manganese (IV) oxide to form chlorine gas. *Write equations of the reaction:* **Students:** Write the equations $H_2SO_4(l) + NaCl(s) \longrightarrow HCl(g) + NaHSO_4(aq)$ $MnO_2(s) + 4HCl(aq) \longrightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$ **Test for chlorine gas** Moist blue litmus paper placed in chlorine gas immediately turns red and then it is bleached.  Before test  After test (Observation: Immediately, the wet blue litmus paper first turns red, and then quickly turns white.	Use different questions to probe students to understand the content/ Questions/ answers method. The teacher requests again learners to be ready and follow carefully instructions note key points.

Assessment **(5 min)**	**Teacher:** Workout in groups of 4 students and answer the questions that follow: Uwimbabazi and members of her study group wanted to prepare chlorine gas in the laboratory. Describe the method you would advise them to use. What precautions would you advise them to take? Gatete found a green-yellow gas in a gas jar. He wanted to confirm whether the gas was chlorine. Describe a method you would advise him to use. What is the name of the group that contains the element chlorine in the periodic table? Chlorine can be prepared by heating a mixture of manganese (IV) oxide and sodium chloride with concentrated sulphuric acid. Write a balanced chemical equation for the reaction that takes place. **Learners' answers:** a. They can prepare using: Concentrated hydrochloric acid + manganese dioxide Dilute hydrochloric acid + Potassium manganate (VII) b. Prepare the gas in the fume chamber because it is poisonous.	Teacher shows the results of test of chlorine

	Place a moist blue litmus paper into the gas, if it turns red immediately then gets bleached. This is a confirmatory test for chlorine gas. They are called halogens $MnO_2(s) + HCl(aq) \longrightarrow MnCl_2(aq) + Cl_2(g) + H_2O(l)$	Provide review Opportunities for students.
Lesson summary and conclusion **(5 min)**	We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: **The preparation of chlorine.** Chlorine is prepared by the oxidation of concentrated hydrochloric acid using a strong oxidizing agent like manganese (IV)oxide or potassium permanganate ($KMnO_4$). **Test of chlorine** Chlorine is tested with wet (moist) blue litmus paper that is being placed in a gas jar containing chlorine gas. **Observation:** Immediately, the wet blue litmus paper first turns red, and then quickly turns white. **Homework:** Now I want to give you a homework assignment so that you try to apply some of what we have learned today.	Provide opportunities for corrective feedback or positive feedback to students.

	1. How many electrons are found in the outermost energy level of chlorine atom. 2. Chlorine gas is prepared in the laboratory through the reaction between concentrated hydrochloric acid and potassium permanganate. Write a balanced chemical equation for the reaction that takes place. Which of the following best describes chlorine? a) A solid that readily combines with other elements. b) A halogen. c) A noble gas. d) A mixture of carbon dioxide and ammonia. *Thank you for your participation in this lesson.*	

Scripted lesson from Unit 5

SUBJECT: Chemistry	GRADE: S3	UNIT 5: Arrangement of elements in the periodic table
Lesson title: Definition of rate of reaction and description of reaction kinetics		**Duration:** 40 min
Teaching & learning materials: Magnesium ribbon, a pair of tongs, Bunsen burner, charcoal and pictures showing burning of some substances		
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(2 minutes)**	**Lesson Objectives:** by the end of this lesson, learners will be able to: – Define reaction rate – Identify fast and slow reaction	Begin by welcoming, gaining students' attention and communicating objectives of the lesson. Take into account the learners with special educational needs
Introduction **(8minutes)**	**Teacher:** In senior 2, we learnt categories of reaction. before starting our lesson of today, I want you to answer the following questions Q1. What is chemical reaction?	Ask questions (Q1 and Q2) about previous lesson Make groups of 3 learners each and Guide learners to answer the questions and give them enough time for discussion

	Learner's answers: Chemical reaction is the chemical change by which two or more atoms combine together to form one or more new substances (products) **Q2.** State any three characteristics of chemical reaction **Learner's answer:** Three characteristics of chemical reaction are: Formation of precipitate, Change in color Evolution of gases etc. **Teacher:** **Activity 1.** Look at the following images and answer the following questions **A**  **B**  Are the processes shown in image A and B physical or chemical change? What are the differences between the processes shown in image A and B?	– Pause to allow learners to get their materials before moving on. If magnesium is not available, you can burn a paper instead. If no Bunsen burner available use another source of heat like a splint lamp, gas cooker, candle Let learners discuss and give different examples thereafter display the examples of slow and fast reaction. Guide them and explain why a given example is a fast or slow reaction. Help learners to summarize the lesson

	Learners answers: a) All are chemical changes since they are irreversible b) Process in A supplies flame and takes a short time while the process in B occurs slowly and do not require supply of external energy **Teacher:** very good. You can see that A is faster than B , it means that their speed or their rate are different.	Assess learners basing on the key questions to verify the achievement of learning objectives. Explain why the given answer is correct. Provide constructive feedback Give homework and thank learners to their participation
Lesson Development **(20min)**	**Teacher:** According to the observation above, what is rate of reaction? **Learner's answer:** Rate of reaction is a measure of how fast or slow a reaction takes place. To be able to know how fast a reaction is, we measure the rate at which a reactant is consumed or a product is formed at a given time. **Rate of reaction** or **Reaction rate** is also called speed of reaction. Different reactions have different reaction rates some are fast, and others slow or very slow	

	Activity 2. Differentiate fast and slow reaction based on the following experiment **Experiment:** ***Apparatus and reagents:*** Magnesium ribbon, a pair of tongs, Bunsen burner, and charcoal. **Procedure:** – Using a pair of tongs place magnesium ribbon on a lit Bunsen burner. – Burn the charcoal and record the time it takes to burn completely. – Burn the magnesium ribbon and record the time it takes to burn completely – Note your observations and Discuss with other group members. **Interpretation of the experiment results** Magnesium burns quickly to form white powder i.e. the reaction is faster Charcoal take a longtime to lit and it burns slowly i.e. the reaction is slow Charcoal burns with emission of gases and reduce into ash	

	Activity 3. What are other examples of fast and slow reactions? **Examples of slow reactions** Fermentation of banana juice weathering of rocks, Ripening of fruits, etc. **Examples of fast reactions** Neutralization reactions, Reaction of baking powder and vinegar, Precipitation reactions, Explosion reactions (eg: reaction of potassium and water)	
Assessment **(5min)**	1. Write equation for the reaction that occurs when: a) magnesium burns in air b) charcoal burns in air 2. Given the following reactions, order them from the fastest to the slowest **Reactions:** fermentation of banana juice, burning charcoal, burning fire woods, explosion of gun powder, weathering or sedimentary rocks. **Answers** 1. a) $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$ b) $C(s) + O_2(g) \longrightarrow CO_2(g)$	

	2. Explosion of gun powder, burning fire woods, burning charcoal, fermentation of banana juice, weathering or sedimentary rocks 3. Study of rate of chemical reactions is called.............. a) reaction rate b) reaction kinetics c) reaction speed d) reaction power 4. Rate of reaction is change in amount of reactants or products in specific a) time b) density c) volume d) area **Answers:** 3. B 4. A	

<table>
<tr>
<td>Lesson summary and conclusion

(5min)</td>
<td>Teacher: We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned about:

Rate of reaction is a measure of how fast or slow a reaction takes place.

To be able to know how fast a reaction is, we measure the rate at which a reactant is consumed or a product is formed at a given time. Rate of reaction or Reaction rate is also called speed of reaction

The rate of reaction is inversely proportional to time taken.

Slow reaction is a reaction that takes long time. A reaction that occurs quickly has a high reaction rate and is called fast reaction.

<u>Homework</u>

Make a research and explain briefly how the following factors affect rate of reaction. Use suitable example in each case.

– Pressure
– Size of particles
– Light
– Concentration

Thank you for your participation in this lesson.</td>
<td>Ask questions to help learners to develop summary and conclusion</td>
</tr>
</table>

Scripted lesson from Unit 6

SUBJECT: Chemistry	**GRADE:** S3	**UNIT 6:** Chemical properties of acids and bases

Lesson title: Preparation of acids and bases **Duration:** 80 min

Teaching & learning materials: Sodium oxide, distilled water, beaker, conical flask, Sodium metal, trough, splint, Bunsen burner, boiling tube, aluminium foil, knife, universal indicator, a pair of tongs and pictures related to the lessons

Section	Step –by- step instructions and content	Script section and instructions
Student readiness **(5min)**	**Lesson Objectives:** At the end of this lesson, learners will be able to prepare acids and bases	Begin by welcoming, gaining students' attention and communicating objectives of the lesson. Take into account the learners with special educational needs
Introduction **(15minutes)**	**Teacher:** Today we are going to study the new lesson, but before we start let us do the following review questions. **Q1.** Acids and bases are two important, but opposite classes of compounds. What is meant by: i) acid? ii) base?	

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Give three examples; each of acids and bases. Give their names and formula

Learners’ answers:

a) i) an acid is a substance that ionizes in water to produce hydrogen ion(H^+) as the only cation base is a substance that ionizes in water to produce hydroxyl(OH^-)ions as the only anion.

b)
<table>
<tr><th>Name of acid and formula</th><th>Name of base and formula</th></tr>
<tr><td>Hydrochloric acid (HCl)</td><td>sodium hydroxide(NaOH)</td></tr>
<tr><td>Nitric acid(HNO_3)</td><td>potassium hydroxide (KOH)</td></tr>
<tr><td>Sulphuric acid(H_2SO_4)</td><td>Calcium hydroxide ($Ca(OH)_2$)</td></tr>
</table>

Q2. State any three properties that distinguish between acids and bases

Learner’s answers:
<table>
<tr><th>Properties of the acids</th><th>Properties of the bases</th></tr>
<tr><td>Have sour taste</td><td>Have bitter taste</td></tr>
<tr><td>Are corrosive</td><td>Have corrosive effect</td></tr>
<tr><td>Have PH of less than 7</td><td>Have PH greater than 7</td></tr>
</table>
</td>
<td>Ask review questions</td>
</tr>
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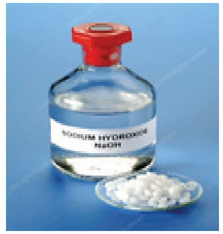
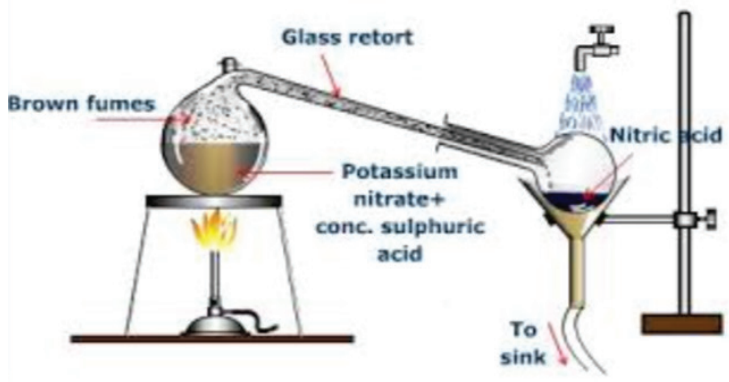
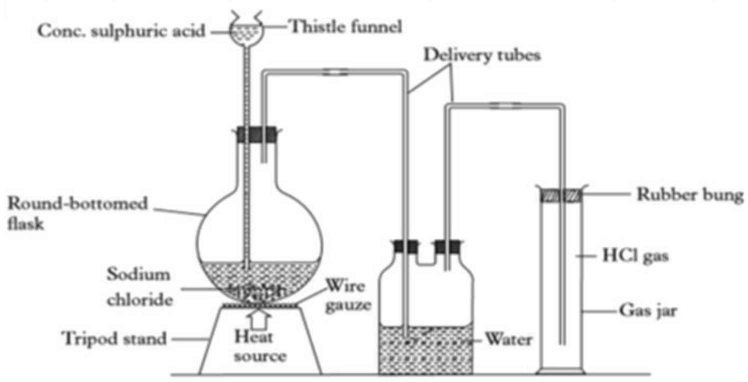
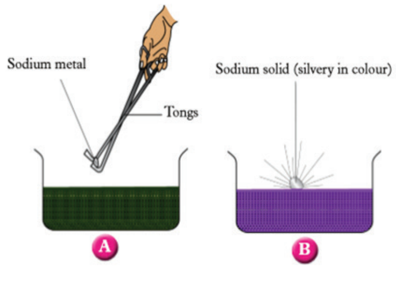
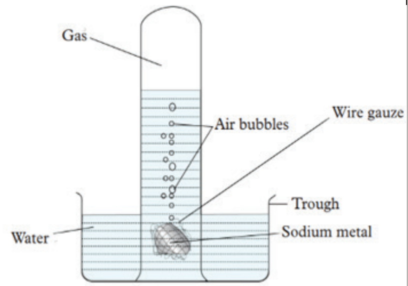
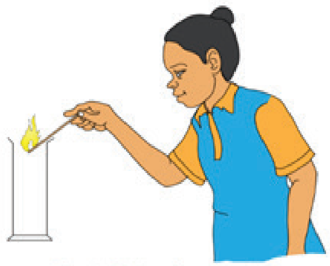
	Activity 1: Now students; Observe the images below and answer the questions that follow  A  B  C **Q1.** What are the chemical contained in the bottles A? **Learner's answer:** the chemical contained in the bottle is hydrochloric acid **Q2.** what is the nature of the liquid inside the car battery? **Learner's answer:** the liquid in the battery is sulphuric acid **Q3.** What is the substance contained in the bottle C? **Learner's answer:** the substance in C is sodium hydroxide **Q4.** Classify the substances contained in A, B and C as either acid or base **Learner's answer:** A and C are acids while B is Base How can acids and bases can be prepared? This is the lesson of today	Provide enough time for observation.

Lesson Development **(45min)**	**Preparation of acids** **Activity 1:** the following set up shows Laboratory Preparation of Nitric acid. observe it carefully and answer the questions that follow.  **Teacher:** What are the raw materials for laboratory preparation of nitric acid? **Learner's answer:** Potassium nitrate and concentrated sulphuric acid **Teacher:** Write a balanced chemical equation for the reaction between concentrated sulphuric acid and potassium nitrate. **Learner's answer:** $KNO_3(s) + H_2SO_4(l) \longrightarrow KHSO_4(s) + HNO_3(l)$	Ask learners to write what they are observing in that preparation. Emphasize that the product being prepared is an acid Guide learners during concept clarification activities Guide learners when writing the reaction. Make sure the written reaction contains the state symbols Helps learners to get enough clarification to the preparation of nitric acid

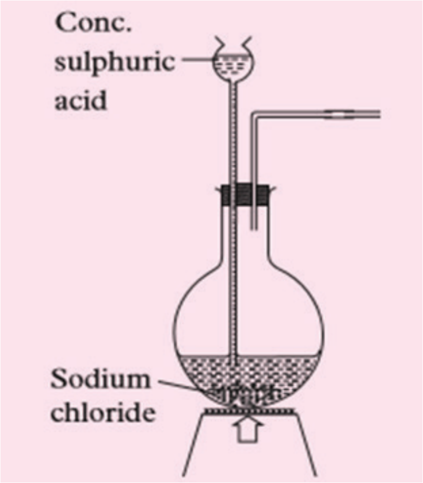
	Teacher: What is the importance of tap water? **Learner's answer:** water helps in condensation of nitric acid as it is more volatile Nitric acid is produced by reacting concentrated sulphuric acid with either sodium nitrate or potassium nitrate. The mixture is heated to speed up the reaction. Nitric acid is more volatile than concentrated sulphuric acid and hence it vaporizes. These vapors condense to form nitric acid (a yellow liquid) **Activity 2.** The following set up represent laboratory preparation of hydrochloric acid. Write down the chemical equation for the reaction occurring in the flask containing NaCl  	Helps learners to get enough clarification to the preparation of nitric acid Respect the experimental procedure Take care since this reaction is explosive

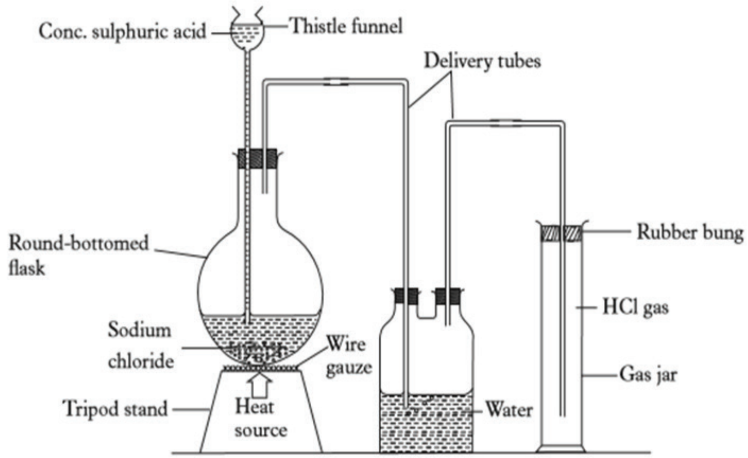
	$NaCl(s) + H_2SO_4(l) \longrightarrow NaHSO_4(s) + HCl(g)$ Concentrated sulphuric acid is less volatile than hydrochloric acid therefore it displaces it from sodium chloride The gas is then dissolved in water. the gas is highly soluble in water therefore an inverted funnel is used to increase the surface area for absorption. $HCl(l)$ water $\longrightarrow HCl(aq)$ **Preparation of a base**	
	i. By addition of water to soluble metal oxide Preparation of NaOH by adding water to sodium oxide **Activity 3:** follow the procedures and perform this experiment below *Apparatus and reagents:* Sodium oxide, distilled water, beaker, conical flask or beaker. **Procedure:** 1. Place some sodium oxide in a conical flask. 2. Add distilled water to the sodium oxide and stir the mixture. What do you observe? 3. Test the resulting solution using blue and red litmus paper. What do you observe? Write the chemical equation for the above preparation, and make interpretation	Make sure you use small grain of sodium in enough water. Take great care when testing hydrogen gas in pair allow learners to discuss on the activityquestions related to the reaction of water and sodium.

	$$Na_2O(S) + H_2O(l) \longrightarrow 2NaOH(aq)$$ Sodium oxide is a white solid formed when sodium metal burns in air. On addition of water, the sodium oxide dissolves forming a colorless solution. The solution turns red litmus paper blue showing it is an alkali **ii. By Reaction between water and metals** **Activity 4:** follow the procedures and perform this experiment below *Apparatus and reagents:* Sodium metal, trough, water, splint, Bunsen burner, boiling tube, aluminium foil, knife, universal indicator, a pair of tongs. **Procedure** 1. Place water in a trough up to half its volume. 2. Add three drops of universal indicator solution to the water. 3. Cut a small piece of sodium (size of rice grain) and drop into the water in the trough.	The two pairs share their findings Potassium react similarly to sodium but the reaction is highly explosive, never attempt this reaction in laboratory

	Record all the observations.  *Fig 6.4: Reaction of sodium with water*  *Fig 6.5: Collecting produced gas*  *Fig 6.6: Testing for collected gas* 4. Wrap another piece of sodium in wire gauze. Place it in a trough of water and insert on it a test tube full of water as shown. Collect the gas in the test tube as shown in figure **Activity questions** 1. What observation are made when sodium metal is dropped in water?	Give time to students to write the summary in their notebooks. Conclude the lesson by highlighting the main points.

	2. Write the equation for the reaction between sodium metal and water. 3. What happen to the burning splint inserted in test tube containing the gas collected? **Learners' answers** A colorless gas is given out, universal indicator turns blue and sodium darts floats on water $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$ The hydrogen gives pop sound when burning splint is inserted in test tube. **Activity for application:** A small piece of potassium metal was dropped in a trough of water. a) Write the equation for the reaction that occurs. b) What happens when the blue litmus paper is dump in the resultant solution? c) Write the equation for the reaction between sulphuric acid and sodium nitrate **Learners' answers** a) H_2SO_4 (aq) + $NaNO_3$(aq) $\longrightarrow$ KOH(aq) b) it turns red c) $NaNO_3(s) + H_2SO_4(l) \longrightarrow NaHSO_4(aq) + HNO_3(aq)$	

Assessment **(5 min)**	1. Name the method used to prepare hydrochloric acid in the laboratory 2. The following diagram gives an incomplete set up of the apparatus that can be used to prepare a sample of hydrochloric acid in the laboratory. Study it and answer the questions that follow.  i) Complete the diagram to show how a sample of hydrochloric acid may be collected. ii) Write an equation for the reaction that occurs. iii) Name another substance which can be used in place of sodium chloride	Assess learners basing on the key questions to verify the achievement of learning objectives. Explain why the given answer is correct. Provide constructive feedback

	Answers: Displacing a volatile acid by a less volatile one i)  *Fig 6.2: Laboratory preparation of hydrogen chloride gas* ii) $NaCl(s) + H_2SO_4(l) \longrightarrow NaHSO_4(s) + HCl(g)$ Sodium chloride	

Lesson summary and conclusion **(10min)**	**Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned about: Acids are substances which dissolve in water producing H^+ ions as the positive ions and turn blue litmus paper red. Acids can be prepared by displacement methods and addition of water to the acidic oxides Bases are substances which dissolve in water producing OH^- ions as the only negative ions and turn red litmus paper blue. The methods for preparation of base include addition of water to soluble metal oxides or reaction between water and metal. **Teacher:** Now I want to give you a homework assignment so that you try to apply some of what we have learned today. **<u>Homework</u>** a) name the products formed when water is added to a potassium oxide b) write a balanced chemical equation for the reaction that took place 2. complete the following equation to show how nitric acid is prepared in the laboratory. $NaNO_3(s) + H_2SO_4(aq) \longrightarrow$ *Thanks for your active participation*	Ask learners to questions to summarize the lesson

Scripted lesson from Unit 7

SUBJECT: Chemistry	GRADE: S3	UNIT 7: Concentration of solutions
Lesson title: Determination of the concentration of the solutions **Teaching & learning materials:** Super Dip packets, Sugar, teaspoons, 3 cups, water.		**Duration:** 40 min
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, leaners will be able to determine the concentration of the solutions.	– Welcoming students. – Begin by gaining students' attention, revisiting pertinent skills and knowledge previously taught and communicate objective of the lesson. – Identify all students with special education needs to be helped.

Introduction **(8 min)**	**Teacher:** What do you observe on the picture? **Student:** The following picture is showing packets of Super dip powder  **Teacher:** *"As you remember at primary level kids like Super Dip so much. It is said on the packet that it should be dissolved into at least 2 liters of water. Yet kids once they buy the packet of Super Dip, they start licking it without mixing it with water. And those who attempt to put water, they use to little amount, for instance a cup of water".*	– Start the lesson with a context that will be followed by questioning. Before you start this context show to learners a packet of Super Dip powder. Give learners opportunity to reflect on the introductory questions. Allow learners to ask question about the topic of the day. Build on their questions and communicate the key questions.

	Questioning sequence: On your behalf, how did you drink the super dip when you were at primary? **Student:** I took 1 jar of water and add the super dip after mixing then I drank it. **Teacher:** Once you put 2 liters of water and add 1 packet how does it taste? **Student:** Um! It is not too sweeter. **Teacher:** How does it taste if we put only 500 mL? **Student:** A little sweet. **Teacher:** Then how about dissolving 1 packet into 5 liter of water? **Student:** Oh no! that very nasty, it tastes like water. And those kids who licks it, how is the taste That is very sweet. **Teacher:** Between water and the powder in the packet which one is the solute? **Student:** The solute is the powder.	Distribute the procedure and materials needed to all the groups After hearing from the student's findings and observations. The teacher can also ask a couple of questions.

	Teacher: In those different cases, how much is the solute in those cases of solutions? **Student:** They are different. The one with few water has large amount of solute compared to the others.	
Lesson Development **(20 min)**	**Teacher:** Let's look at the Concept of Concentrations. The knowledge got from UNIT 5/Senior 1 Atoms, Elements and Compounds will help to understand well the Stability of Atoms. **Lesson title: Determination of the concentration of the solutions** **Teacher:** Suppose you have sugar, teaspoons, 3 cups and water. You put equal amounts of water in each of the three cups and label them A, B and C and add sugar as follow: In cup A, add half teaspoonful of sugar. In cup B, add one spoonful of sugar. In cup C, add two spoon full of sugar. Stir and taste each sugar solutions prepared in each cup. **Study Questions:** Identify the substance used as solute and one used as solvent? **Student:** the solute is sugar and the solvent is water. **Teacher:** In which cup was the solution sweetest? **Student:** Cup C had the sweetest taste because it contained most sugar particles.	– Communicate the new lesson and write its title on the chalkboard. Emphasize new concepts. At each step, provide a pause time for students to think and say or write their ideas. Provide reviewed summary to the students and give them opportunities to answer and ask for clarifications.

	Teacher: How can we decrease the taste of sugar in each cup and how the process is called? **Student:** By adding more water; that is diluting the solution (dilution), we reduce the taste of sugar. **Concept clarification:** The term concentration refers to the amount of solute dissolved in a specific volume of solvent. In a given amount of water, the more solute dissolved, the more concentrated the solution. If the solution contains large amount of solute, the solution becomes more concentrated. We normally think of a solute as a solid that is added to a solvent. (e.g.: adding table salt to water). Concentration may be expressed in different ways: percent composition by mass, volume percent, mole fraction, mass concentration and molar concentration or molarity. Hence in our case, the concentration we have is called *Mass Concentrations* and it is defined as: ***Mass Concentration:*** is the amount of solute in grams present in 1 liter of solution. Formula: $X = \frac{\text{mass of solute (in gr)}}{\text{volume of solution (in dm}^3\text{ or L)}}$	Guide learners how to calculate the percentage composition by mass and work out to the exercise given. Help learners to relate what they have learnt to real life experience by discussing the given case study. Facilitate learners during presentation of their findings.

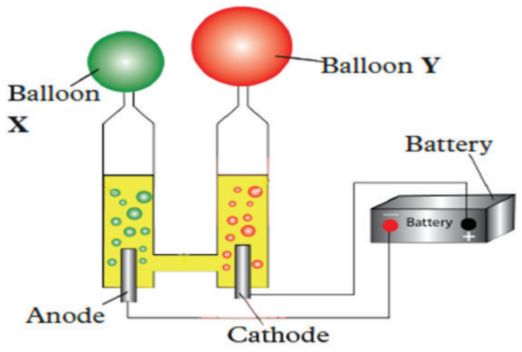
	Where X is mass concentration. **Concept Summary:** Concentration is the amount of solute per unit volume of solution. It can be expressed in term of mass, mole, volume and percentage. Mass concentration is the mass of solute per unit volume.	Use different questions to probe students to understand the content/ Questions/ answers method
Assessment **(5 min)**	**Teacher:** In pairs of two try to do this example, you can use you exercises books: 1. What is the mass concentration of a solution made when water is added to 11g calcium chloride($CaCl_2$) to make 100 ml of solution? **Expected answer:** Data: Mass = 11g of $CaCl_2$ Volume = 10mL = 0.1L Formula: $X = \frac{\text{mass of solute (in gr)}}{\text{volume of solution (in dm}^3\text{ or L)}}$ Hence: $X = \frac{11g}{0.1L} = 110\ g/\ell$	Use the ideas given by learners during assessment, enrich their feedback to summarize the lesson.

	2.500 cm^3 of solution of NaOH contains a mass of 5g of solid NaOH. Calculate the concentration of the solution in g/dm^3. **Expected answer:** Volume of solution = 500 cm^3 = 0.5 dm^3 Mass of NaOH = 5g Mass concentration : $X = \frac{5g}{0.5dm^3} = 10\ g/dm^3$ 3. Calculate the mass NaCl to be dissolved in 2l of the solution to prepare 20g / L **Answer:** Mass = 20g x 2 = 40g 4. What is the mass concentration of a solution made when water is added to 12 g sodium hydroxide (NaOH) to make 200ml of solution? **Answer:** Mass concentration= (12 x 1000): 200 = 60g/ L	

Lesson Summary and Conclusion **(5 min)**	**Teacher:** We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: **Summary questions:** Who can remind us what Concentration is? Explain the term Mass Concentration How can you calculate Mass Concentration? Okay then, let me give you a homework so that you try to apply some of what we discussed on today. **<u>Homework:</u>** 1. __________ is the name given to the mixture formed when a solute is dissolved in a solvent. A chemistry teacher gave the concentration of a solution of NaOH as: 10g/liter 0.025moles/liter 2. Which concentration is given as mass concentration? ***Thank you for your participation in this lesson.***	

Scripted lesson from Unit 8

SUBJECT: Chemistry	**GRADE:** S3	**UNIT 8:** Electrolysis and its applications.
Lesson title: Introduction to oxidation and reduction reaction.		**Duration:** 40 min
Teaching & learning materials: Charts, manila paper; shark board; rusted hoe (rusted tool)		
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be to: – Identify oxidation and redaction reaction based on classical concept. – Define the term: oxidation; reduction; reducing agent; oxidizing agent	– Welcoming students. – Begin by gaining students' attention, revisiting pertinent skills and knowledge previously taught and communicate objective of the lesson. – Identify all students with special education needs to be helped.

Introduction **(5 min)**	**Teacher:** in S2, unit 9, you learned electrolysis and electrolytes. What is the figure below showing? **Student:** it shows electrolysis process.  **Teacher:** what are the names do you give to the cathode and anode from this diagram? **Students:** The names given to cathode and anode are called electrodes. **Teacher:** can you define electrolysis? student: electrolysis is a decomposition of substances by using electric current. **Teacher:** in senior 2, unit 1 lesson 1 you learned the formation of ions from an atom. Now I want you to answer the following question that are related to previous lessons.	Tell learners to observe the given diagram and answer the given questions. Tell learners students the materials needed a give them a small time to take them. Learners must be given time to think and note down their answers which will be analyzed by the teacher and peers to give constrictive feed back.

	Teacher: what is ion? **Student:** ion is an atom which is charged,either positively or negatively. **Teacher:** which name do you give to an atom: i) positively charged, what does it meant? ii) negatively charged, what does it meant? **Student:** 2.i. cation: loses electrons ii. Anion: gains electrons **Teacher:** The number of electrons are equal to the number of protons for an atom while for cation and anion are not equal. Explain why? **Students:** Protons in nucleus of atom are constant. **Teacher:** in senior two unit 2 chemical bonding, you learned ionic bonding: How electrons are transferred from atom to another?	Teacher focuses on new concepts. Oxidation and reduction reaction Facilitate learners to understand loosing and gaining electrons. Give a time to pause for learners to think and write

	Student: electron(s) is or are transferred from metal atom to non-metal. Metal loses its valence electron(s) non- metals gain electron from a metal ones to become stable.	Guide or facilitate students how to find oxidation number of an element in given compound or ion by using rules of determining oxidation number
Lesson Development **(20 min)**	**Teacher:** Today we are starting with the introduction to oxidation and reduction reaction, the lesson of unit 8 which is electrolysis and its applications. It will be easy for you as you have the basic (prerequisites) needs which are transfer of electrons. **Lesson title: Introduction to oxidation and reduction reaction.** • **Oxidation and reduction in terms of electron transfer.** **Teacher:** Consider the following equation: $Cu(s)+Cl_2 \rightarrow CuCl_2(s)$ **Teacher:** a) Which element increases in charge during chemical equation? b) which element deceases in charge during chemical equation **Student:** a) Cu, forms Cu^{2+} b) Cl, forms Cl^-	Use the different ways of questioning to help learners to understand the content. Question and answer method Teacher tells students to use the rules of determining oxidation number. Ask students to write new concept in their note books. Help learners to obtain an easy convenient acronym Teacher helps learners to understand the new concepts (Oxidizing agent and reducing agent)

	Teacher: an element or an atom which increases in its charge does oxidation reaction while an atom or element which decreases in its charge does reduction reaction. So, **Oxidation** is a loss of electron(s). **Reduction** is a gain of electron(s) **Students:** **Acronym:** O I L (oxidation is loss), R I G (Reduction is gain) **Oxidation number.** **Teacher:** Consider the equation below and answer the following questions: a) $Al(s) \rightarrow Al(aq)^{3+} + 3e^{-}$ b) $Cl_2(g) + 2e^{-} \rightarrow 2Cl^{-}(aq)$ What happens? **Students:** For equation a. Al changes from Al to Al^{3+} means increased in charge. For equation b) equation, Cl changes to Cl^{-} means decrease in charge. **Teacher:** From the answer above, a reaction where there is increase in charge is oxidation reaction while a reaction where there is decreasing in charge is reduction reaction.	Give opportunities to think and for giving feed back. Teacher facilitate students in their groups in order to known the participation of each students. Teacher Guide student how to determine the oxidation number of an element in compound or in ion. Ask students to note those rules in their note books. Teacher helps students to conclude on the key points of the lesson.

	Teacher: the charges in which elements is charged is its oxidation number (or oxidation state). **Note:** Rules of determining oxidation state of an element in a given compound: – At elementary state the oxidation number of element or an atom is equal to zero. – In a molecule to find the oxidation number (oxidation state) you calculate by using known valence then = 0. – When we find an oxidation state of an element or ion or complex ions we equalise with the charge of that ion. **Teacher:** determine the oxidation number of each element in: a) CO_2, b. MgO. c. H_2. d. ClO^{3-} Student: Let x be the oxidation number of carbon, and y be the oxidation number of oxygen then ; X+ (-2)2 =0 hence x= +4 +4+2y=0, 2y=-4 hence y=-4/2 so y=-2 Therefore, the oxidation number of C is +4 while the oxidation number of O is -2. Let **m** be the oxidation number of Mg and **n** be the oxidation number of O.	

	M + (-2) =O m=+2. The oxidation number of Mg is +2. +2+n=0; n=-2. The oxidation number of O is -2. c) Oxidation state of H at elementary state is 0. Teacher helps and guides learns to determine the oxidation number (or oxidation state)	Teacher give student opportunities to contribute in summarizing a lesson.
	➢ **Oxidation and reduction in terms of Oxygen transfer.** **Teacher:** Consider the following equation and answer the question that bellow: $2Fe_2O_3 + C \longrightarrow 4\ Fe + 3CO_2$. What is the oxidation number of Fe in Fe_2O, and the oxidation number of C in CO_2. Student; let **x** be the oxidation number of Fe in Fe_2O_3, and D be the oxidation state of C in CO_2. 2x + (-2)3=0; 2x-6=0 hence x=+6/2=> x= +3. So the oxidation number of Fe is +3. D+ (-2)2=0=> d-4=0=> D=+4.Hence the oxidation state of C is =+4. **Teacher:** From the above equation which species removes oxygen to another species, and which one gives oxygen to another?	Teacher asks the learners to answer by voting trough raising hands. Ask a few to give their arguments for their answer. End each by giving question with answer. Appreciate learners for their contribution in the lesson.

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Student: C gains oxygen from Fe_2O_3; Fe gives oxygen to carbon.

Teacher: Based on answers of student:

- Oxidation is the gain of oxygen.
- Reduction is the loss of Oxygen.

+2 oxidation +4

$$Fe_2O_3 + CO \longrightarrow Fe + CO_2$$

+3 0

Because both reduction and oxidation occur simultaneously in the reaction. This reaction is called **redox reaction**.

Teacher: From the above reaction which substance increases the oxidation state of another, and which one decreases the oxidation of state of another?

Student: Substance which increase the oxidation state of another is **iron(III) oxide**; a substance which decrease the oxidation state of another is **carbon monoxide**.

From the above reaction: Iron (III) oxide is an oxidising agent: a substance which increases the oxidation state of another during a reaction.

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	Carbon monoxide: is a reducing agent: a substance which decreases the oxidation state of another during a reaction. – **Oxidising agent:** is a substance which increase the oxidation state of an other during a reaction. – **Reducing agent:** is a substance which decreases the oxidation state of an other during a chemical reaction. ➢ **Oxidation and reduction in term of hydrogen transfer** **Teacher:** Find the oxidation state of carbon in reactant and in product, state whether there is decreasing or increasing in oxidation state in the question that below: $CH_3CH_2OH \longrightarrow CH_3CHO$ **Student:** let x be the oxidation state of C in reactant:2x +(+1) 6 +(-2)=0 => 2x+6-2=0=>2x=-4, x=-4'/2=> x=-2 . in product let b be the oxidation state of carbon 2b +(+1)4 + (-2) =0 => 2b +2=0, 2b =-2. b=-2/2=> b=-1 So carbon change the oxidation number from -4 to -1 it means increase in oxidation number. Teacher from the answer of learner: there is oxidation by loosing hydrogen. Oxidising agent remove hydrogen from another substance during a reaction.	

	Reducing agent add hydrogen to another substance during a reaction. **Teacher:** in groups of 4 students : 1. consider the following equation for reaction and answer the following questions: $2\ CuO(s) + C(s) \longrightarrow 2\ Cu(s) + CO_2\ (g)$. a) Which species i) gain electrons ii) increased. Iii) oxidised, reducing agent. b) For which atom the oxidation number has : i) decreased. ii)increased c) Write the half reaction for i) oxidation reaction. ii) reduction reaction. **Students:** 1. a) i) Is Cu. ii.is C. iii. Is C. b) i) Cu. ii) C. c) $Cu^{2+} + 2e^{-} \rightarrow Cu(s)$ Reduction reaction $C(s) - 4e^{-} \rightarrow C^{4+}$ Oxidation reaction.	Provide opportunities for corrective feedback or positive feedback to students.

Assessment. **(8min)**	**Teacher:** answer the following questions 1. Define the following terms, a) Oxidation b) Reduction c) Reducing agent, d) oxidizing agent 2. Determine the oxidation number of each element in a) CO_2 b) CaO c) SO_4^{2-} **Students:** 1. Oxidation is a loss of electrons. Means there is increasing in oxidation in oxidation state. Reduction is a gain of a electrons which means decreasing in oxidation state. 2. Oxidation number of C in CO2 is +4. a) The oxidation number of O in CO_2 is -2. b) Oxidation number of Ca in CaO is +2 , The oxidation number of O in CaO is -2. c) The oxidation number of S in SO_4^{2-} is +6, the oxidation number of O in SO_4^{2-} is -2.	

Lesson summary and Conclusion **(5min)**	**Teacher:** We are coming to the end of our lesson. As we conclude, let' review some of the key points that we learned. **1. Oxidation** is the loss of electron(s) during a reaction by an atom, ion or a molecule. **2. Reduction** is the gaining of electrons during a reaction by an atom, ion or a molecule. **3. Oxidising agent** is a substance that that tend to bring about oxidation by being reduced (reduction reaction). **4. Reducing agent** is a substance which bring about reduction by being oxidize and loosing electron(s) (there is oxidation reaction). Reducing agent=> oxidation reaction. Oxidizing agent=> reduction reaction. **<u>Homework</u>** Now I want to give you a homework assignment so that you apply what we learned to day. 1. Cation are formed by .... (loosing/gain)of electrons and anion are formed by ....(loosing/gaining) of electrons. 2. Explain why electrolysis is an example of Redox-reaction?	Use different questions to help students recall key concepts of the lesson and ensure that the summary is written down by all students. During harmonization/ making a general summary, provide time students to ask questions on what they do not understand well.

	Which of the following statements concerning electrolysis in incorrect? During electrolysis chemical energy is converted into electric energy. Electrolysis involves the decomposition of electrolytes. An energy supply is required for electrolysis Graphite is commonly used as an inert electrode in electrolysis. ***Thank you for your participation in this lesson***	

Scripted lesson from Unit 9

SUBJECT: Chemistry	GRADE: S3	UNIT 9: Structure and properties of alkenes and alcohols
Lesson title: Nomenclature of alkenes and their structures.		**Duration:** 40 min
Teaching & learning materials: Chart of Alkenes (ethene, chalk board; manila paper, plastic materials (plastic cup; basin;)……….		
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(3 min)**	**Lesson Objectives:** By the end of this lesson; learners will be able to: – Describe the structure of alkenes. – Name alkenes using the I U P A C system of naming up to C5. – Describe the uses and misuse of alkenes	– Welcome students and identify students with special education needs in order to facilitate them. – Communicate students about learning objectives. – Ask the students to observe the chart A and B attentively in order to answer the asked questions.

Introduction **(8 min)**	 B. $CH_2 = CH_2$ A. $CH_3 - CH_3$ **Teacher:** consider the above structures and answer the following questions, 1. What are the similarities having by structure A and structure B. 2. What is the difference between A and B. 3. Among the two structure above one is saturated while another is not, which one is not saturated. **Student,** 1. They both have carbon and hydrogen atoms. 2. A is saturated because it contain single bond while B is unsaturated because it has **double bond**,	– Ask students to study the structure and answer the questions that follow. – Tell students to study the structures A and B, to answer the given questions – Tell students the way used to name compounds contain double bond. – Students must be given time to think and note down their ideas ----- – Emphasize new concepts in bold.

	3. B is not saturated because it has double bond, **Teacher:** In senior two for unit 10 you learned properties of organic compounds and the uses of alkanes. So I want you to answer the following questions of 3. a. Alkanes contain only ……………and ………bonds. b. The first fifteen members of alkenes are gases. (true or false). **Student:** a) H and C and simple b) true **Teacher:** Using cards, choose the correct answers: Alkanes have A. c=c double bond B. C-C single bond. C.C==C bond **Student:** correct card is B.; Alkanes contain single bond.	Help students to understand the new concept (The suffix ane in alkanes is replaced by the suffix ene in alkenes) Help students focused on a new concept (no alkene formula when n=1.(due to its C=C double bond).
Lesson Development **(20 min)**	**Teacher:** Today we are starting with the nomenclature of alkenes and their structures; the lesson of the unit 9 which is the structure and properties of alkenes and alcohols. It will be easy for you as you have some knowledge and skills about hydrocarbons.	At each step, make a pause for students to think and say or write their ideas. Give students a small break and allow them to think carefully.

	Lesson title: Nomenclature of alkenes and their structures. **Teacher:** In unit 9 senior 2; you learned about nomenclature and structure of alkanes. This will help you to understanding the new lesson. **Teacher:** what is the valence carbon? **Student:** carbon has valence 4. **Teacher:** In your activity you say that alkane contain only single bond. C-C single bond. So, now due to the structure of B, what do you notice about alkenes?). (think in pair and share your answer). **Students:** Alkenes contain C = C double bond. **Teacher:** in pair; after understanding that alkenes has C=C double bond; what conclusion could you take about the smallest member of alkenes base on valance of carbon. Ask learner to share their findings. **Students' answer:** the smallest member of alkene is C2H4. Teacher show students a chart that contain an example of alkene (ethene). C_2H_4. $CH_2 = CH_2$.	Give students a small break and allow them to think carefully. Help students to understand the new concept(rules for naming structure of alkenes). Provide time to collaborate and sharing their findings answers. Help learners to understand the rules used in naming compound contain double bond.

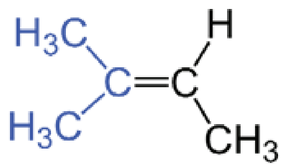
	Teacher: from the above information about alkenes in group of 4; try out to write the names of the following compounds: a) C_3H_6, b) C_4H_8 c) C_5H_{10} d) C_6H_{12} From your working which conclusion do you make about that number of carbon and hydrogen? **Student answer:** a) propene. b) butene, c) pentene) hexene. Teacher helps students for b) But 1- ene. c) pent1-ene. d) hex1-ene. Students note new idea from their teacher. **Student:** from working the number of hydrogen is twice to the number of carbons.	
	Teacher: construct from answer of students so; the general formula of alkenes is CnH2n. where n is the number of carbons. **Students:** Students write general formula of alkanes in their note books. **Teacher:** in group of 3 give any 3 rules that you were following during naming alkanes in S2. **Students 'answer:** 1. Determine the longest chain of carbon atom.	Teacher provide a time for learners in order to do the given questions, Show students a chart that contain an example of alkene (ethene). Tell students to use the rules of naming alkenes, focused on double bond.

	2. account the number of carbons and chose the short way in order to reach braches. **Teacher:** construct from student answers 'tell them Rules for naming alkenes. 1. Dermine the longest continuous chain of carbon atoms that has a double bond between two carbon-atoms. This will give us the parent or ending name. 2. Number the carbon atoms in the chain so that the double bond is between the two carbon atoms assigned the possible lowest number. This means that you have to decide whether to number to start on the right or on the left end of the longest identified chain. 3. Identify the various branching groups or substituent groups attached to this continuous chain of carbon atoms. 4. If more than one member of substituents groups is attached to the same carbon atom; We write the position number to the number of times substituent group appears separated by comma then a hyphen then suffix denoting the number of times the group is attached such di, tri, etc followed by the substituents group name of the parent alkene. Eg: 3,3-dimethylbutene.	Teacher allow students to contribute in summarizing a lesson to evaluate on which level they still on. Teacher using voting by raising hands and ask a few to give their arguments.

5. Write the lowest number of carbon atoms bearing the double bond.

Students write the new concepts in their note book.

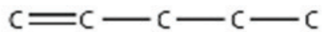
Teacher: give the name of this compound.



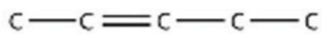
Students' answer: 2-methylbutene-2.

Teacher: due to what you learned about isomerism give an example for each type of isomerism.

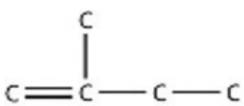
Students: Chain isomerism.



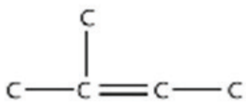
1-pentene



2-pentene



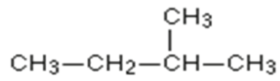
2-methyl-1-butene

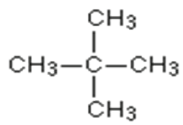


2-methyl-2-butene

2. Position isomerism.

$CH_3-CH_2-CH_2-CH_2-CH_3$

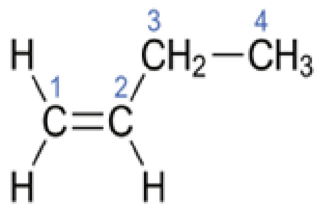


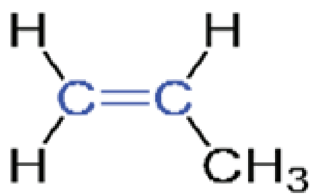


Application Activities: In group of two: do the following tasks.

Teacher: Name the following alkenes:

1)

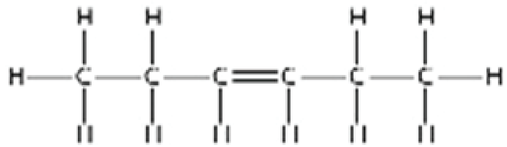
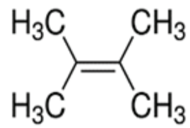
a) 

b) 

2) Write the structural formula of

a) hex-3-ene. b) 2,3-dimethylbut-2-ene.
2 b)

Students' answers: 1. a) n-but -1-ene. b) propene

	2. a)  b) 	
Assessment **(4min)**	**Teacher:** Answer the following questions. 1. Define the term hydrocarbons. **Student:** 1. Hydrocarbons are compounds composed by Hydrogen and Carbons. 2. What is the main feature in the bonding of an alkene ? 3. What is the difference between saturated and unsaturated hydrocarbons?	

Lesson summary and conclusion. **(5min)**	We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned about: Alkenes are hydrocarbon which contain C=C double bond in their structures… For naming alkenes you focus on the position of double bond. You end with a suffix "ene"… The C=C double bond is called the functional group of alkenes. Like in alkanes also alkenes have chain isomerism and structural isomerism. As you see a cup made in plastics alkenes are used to make materials in plastics, polyethene tanks. The first member of alkenes is note methene, because the presence of double bond. The double bond of alkenes is functional group.	

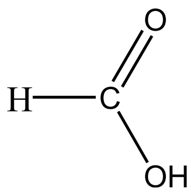
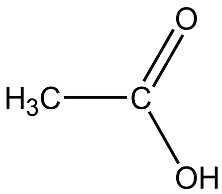
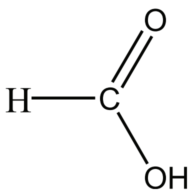
Scripted lesson from unit 10

SUBJECT: Chemistry	**GRADE:** S3	**UNIT 10:** Carboxylic acids.
Lesson title: General formula and nomenclature of carboxylic acids.		**Duration:** 40 min
Teaching & learning materials: Charts, manila papers, chalk board, Bottle of vinegar.		
Section	**Step –by- step instructions and content**	**Notice to the teacher**
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, learners will be to: – Define carboxylic acid. – Name and write the structure of some carboxylic acids up to C5. – Understand of some uses of carboxylic acid	Welcome students, Identifying the students with special education needs and with special need education in order to help them Communicate students about learning objectives.

Introduction **(7 min)**	 **Teacher:** Observe the above pictures and answer the questions that follow: – What do you observe in bottle 1,2? – What contained in the third and fourth bottles? – What conclusion do you take from above pictures? **Student:** – We observe acetic acid 0.6%, second we observe Benzoic acid. – In third and fourth bottles there are vinegar.	Ask the students to observe attentively the given picture in order to answer the given questions. Provide a time to learners for thinking and responding to the given answer. Help students to remember what they have learned in previous lesson by guiding them,

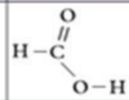
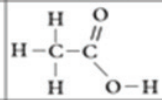
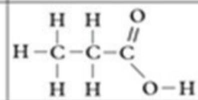
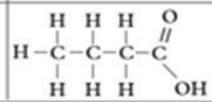
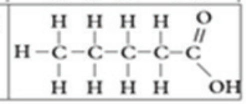
	– Acetic acid and benzoic acids are used in manufacturing of vinegar. **Teacher:** in senior 2, unit 10 you learned homologous series; general names and name of alkanes up to C5; Now I want you to answer the following questions that are related to previous lessons. 1. What is homologous series means? **Students:** Homologous series are compound having same general formula and same functional group. 2. Give general formula and functional group for alkanes. The general formula of alkanes is C_nH_{2n+2}. **Teacher:** In last lesson S3 unit 9; you learned alkenes; now answer the following questions: Give the name and formula of alkenes from C1 to C5 give a general formula for alkenes **Students' answer:** first member of this series is ethene from its general formula. C2: Ethene (C_2H_4) C3: C_3H_6: Propene. C4: C_4H_8 (Butene) C5:C_5H_{10} (Pentene) General formula of alkenes is C_nH_{2n}.	

Lesson Development **(23 min)**	**Teacher:** Today we are starting general formula and nomenclature of carboxylic acids, the lesson of unit 10 which is Carboxylic acids. **Lesson title: General structure and nomenclature of carboxylic acids.** **Teacher:** observe the following structures and class them into homologous series: CH_3COOH, $CH_3CH_2{=}CH_2$, $CH_3CH_2CH_2CH_3$, $CH_3CH{=}CHCH_3$, $CH_3CH_2CH_2CH_2CH_3$, $CH_3CH_2CH_2COOH$ **Student:** – 1^{st} series: CH_3COOH, $CH_3CH_2CH_2COOH$; – 2^{nd} series: $CH_3CH_2CH_2CH_3$, $CH_3CH_2CH_2CH_2CH_3$; – 3^{rd} series: $CH_3CH_2{=}CH_2$, $CH_3CH{=}CHCH_3$ **Teacher:** What is the function of the first series **Student:** COOH **Teacher:** This is the series of organic compounds named carboxylic acids Their general formula is **$R\text{-}CH_2 - COOH$** **Teacher:** Give 3 examples of carboxylic acids:	

	Student:   , CH_3-CH_2-COOH **Teacher:** The suffix in carboxylic acid OIC Ex:  : methanoic acid	– Teacher facilitate student to have the common sense for carboxylic acid. Teacher facilitate students: -COOH is functional group of carboxylic acids. Also called alkanoic acid because of –COOH. (carboxyl group). acids(suffix e in alkane is replaced by oic acid Teacher helps the students to understand new concept
Assessments **(4min)**	1. Name the following carboxylic acids: a. CH_3CH_2COOH, b. $CH_3CH_2CH_2COOH$ c. $CH_3C(CH_3)_2COOH$. **Students:** a. Propanoic acid. b. Butanoic acid. c. 2,2-dimethylpropanoic acid. 2. The general formula of carboxylic acid is: a) CnH2n+2 b) CnH2n+1 c) CnH2n+1COOH d) None of all. **Answer**: c)	Also using questioning emphasize for new lesson.

Lesson Summary and Conclusion **(4 min)**	We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: 1. Carboxyliic acids form homologous series in which compounds contain functional group called Carboxyl group (-COOH). 2. Carboxyl compounds have similar chemical properties. This is because they have same functional group 3. Carboxylic acids are used in making vinegar 4. – They have general formula: C_nH_{2n}+1COOH. Where n is the number of carbon atoms. – They differ from the next by –CH2-, except for fist member where R is represented by H, (HCCOH). – As they have same functional group having similar chemical properties, but as the number of carbon atoms are not equal they change in physical properties.	Facilitate students by telling them to apply the rules of naming carboxylic acids. Teacher tell learners to use rules of naming carboxylic acids. Teacher helps students to contribute in summarizing and conclusion for a lesson.

Names of first five carboxylic acids

Carboxylic acid	Number of carbon atoms	Molecular formula	Structural formula
Methanoic acid	1	$HCOOH$	
Ethanoic acid	2	CH_3COOH	
Propanoic acid	3	CH_3CH_2COOH	
Butanoic acid	4	$CH_3CH_2CH_2COOH$	
Pentanoic acid	5	$CH_3CH_2CH_2CH_2COOH$	

Home work:

1. Give the structure of the following compounds:

   a) 2-dimethy butanoic acid. b) 3-methylhexanoic acids.

2. Explain carbonic acids are called some times alkanoic acids.
3. Carboxylic acids have the same chemical properties but having different physical properties .(True or false). Give an evidence for your answer.
4. State to uses of carboxylic acids in our daily life.

Thank you for your participation in the lesson

Provide a time for leaners to think and to give feed back,

Appreciate the students for their contribution in the lesson.

Scripted lesson from Unit 11

SUBJECT: Chemistry	GRADE: S3	UNIT 11: Petroleum products and polymerization
Lesson title: Origin of crude oil. **Teaching & learning materials:** Charts, manila papers, chalk board, Bottle containing petrol or kerosene;		**Duration:** 40 min

Section	Step –by- step instructions and content	Notice to the teacher
Student readiness **(2 min)**	**Lesson Objectives:** By the end of this lesson, you learners will be able to; – State the origin of crude oil. – Explain why crude oil is renewable energy source. – Explain the important of crude oil in our daily life. – Explain negative effects of crude oil to environment.	Welcoming Students. Identify students with special education needs, and those with special needs education in order to help them during a lesson. communicate students about learning objectives.

Introduction **(8 min)**	A  B  **Teacher:** What are the difference between a picture A and a picture B. **Student:** In picture A fishes are still living while in a picture B fish are died. **Teacher:** What the name given to compound composed by hydrogen and carbon? **Student:** They are called Hydrocarbons. **Teacher:** Give any 2 element abundant in living things.. **Students:** Carbon; nitrogen.. **Teacher:** Where do you think died animals like those you look on the picture B are deposited? **Students:** They are deposited in underground surface. **Teacher:** In S3 Unit 1 lesson 9 you learned carbon cycle. Now in group of two answer the following questions:	Ask student to observe the picture carefully in order to answer the related questions. Guide students by focusing on new concept. Help student to understand the formation of sediments at the bottom of sea from died animals and remains of plants.(guide them toward to the topic). Teacher guide students(the solids are in form of sediments in sedimentary rock layer). Emphasizing a new topic. Students must be given time to think f and note down their answers which will be analyzed by a teacher and peers. Teacher facilitate students focused on new concept (origin of crude oil) (takes millions of years ago) Teacher facilitate student to understand new lesson trough different ways of questioning.

	Teacher: 1. By which process decay organisms release carbon dioxide? **Students' answer:** during burning or combustion of them.	
Lesson Development **(22 min)**	Today we are starting with the origin of Crude oil; the lesson of the unit 11, which is Petroleum products and polymerisation. **Lesson title: Origin of crude oil.** **Teacher:** Where you do think petrol or kerosene or natural gas we use are coming from? **Students:** There are coming from the underground surface. **Teacher:** Where died animals and remains of plants are deposited? How many years those remain there?. **Students:** The remains of plants and animals are deposited in underground surface. The take many years. **Teacher:** from your answer what is the origin of crude oil? **Students:** Crude oil is formed from the remains of plants and animals lived millions of years ago. **Teacher:** Name the main elements found in organisms **Students:** Carbon and nitrogen.	Help students to understand that remaining of plants and animals are decayed without oxygen. Teacher guide students crude fuels are non-renewable energy because is formed from organisms, Teacher help student: when fossil fuels are burned carbon return in environment in form of CO_2 Teacher helps students to understanding questions focused on the new lesson, At giving answer. teacher using voting by using raising hands and allow a few to give their arguments.

	Teacher: from your answer what is crude oil? **Students:** Crude oil is a mixture of many hydrocarbons. **Teacher:** at your home when there is no electricity you need to use lamp, which allow the lamp to grow a light? **Students:** Petrol or kerosene . **Teacher:** Give the names of 5 sources of energy you know. **Students:** Sun; fuel, kerosene; petrol, gas. **Teacher:** What do you think about burning fossil fuels that we use as source of energy? **Students:** This will produce gases in atmosphere (Carbon dioxide), **Teacher:** Where the fossil fuels we use are formed from? **Students:** They are formed from the remains of organisms, **Application activities:** In group of 2: What is the difference between energy from the sun and energy from the crude oil? Share your findings. In group of 4 discuss the negative effects of crude oil to environment.	Teacher appreciate the students for their participation.

	Students: 1. The energy from the sun cannot terminate while the energy from crude oil can, Crude oil fuels are non- renewable energy because they are formed from organisms. 2. Crude oil has negative effect to environment: when vehicles use kerosene they liberate carbon dioxide which can pollute atmosphere. Also when industries use petrol and gas they liberate fumes which can pollute air ,this pollute environment.	
Assessment **(4 min)**	1. Explain why fuels from crude oil are non-renewable. 2. a) What is a crude oil? b) How crude oil is formed? 3. What is the natural gas that found in lake Kivu? 4. Give the names of 4 fuels coming from crude oil 5. What is the negative effect of fossil fuel on environment? **Students:** 1. Fossils from crude oil are non-renewable energy because they are formed from organisms (From remains of plants and animals) 2. a) Crude oil is a mixture of many hydrocarbons. These hydrocarbons have important such fuels, gases and others. b) Crude oil is formed from the remains of plants and animals which lived millions of years ago.	

	3. Methane gas. 4. Methane gas, petrol, kerosene, fossil fuels. 5. When fossil fuels are burned Carbon returns in environment in form of carbon dioxide which result to global warming.	
Lesson summary and conclusion **(4min)**	We are coming to the end of our lesson. As we conclude, let's review some of the key points that we learned. The teacher helps students to conclude on: 1. Crude oil is a mixture of may hydrocarbons. These hydrocarbons; in crude oil, Have important uses such as fuels, petrol; kerosene; methane gas and other among those. 2. Crude oil is formed from the remains of plant and animal that lived millions of years ago. 3. The remains form sediments at the bottom of sea and become buried under sedimentary rock. 4. The remains decay without oxygen under action of heat and pressure to form Crude oil. 5. Crude oil fuels are non- renewable because it is formed from living organisms. 6. When fossil fuels are burned the carbon;in form of carbon dioxide return to environment; which can result to global warming.	

	Homework: 1. State the origin of crude oil 2. Do you think that crude oil has any impact to economy of countries? Give evidences for your answer. 3. Briefly describe the negative effects of fossil fuels to environment. 4. Name any 4 compounds which formed from crude oil, and state their uses in our daily life. ***Thank for your kind attention in this lesson.***	

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