COURSE GUIDE

SED313
IMPROVISATION IN INTEGRATED SCIENCE

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MAIN COURSE

CONTENTS

MODULE 1 GENERAL PRINCIPLES AND PHILOSOPHY OF IMPROVISATON IN INTEGRATED SCIENCE TEACHING

UNIT 1 MEANING AND PHILOSOPHY OF IMPROVISATION IN INTEGRATED SCIENCE

Unit Structure

1.1 Introduction

Congratulations on getting to this unit. Here we will discuss a very interesting concept in science teaching – improvisation of teaching/learning resources. You already know that in the teaching and learning of science concepts, it is necessary to use instructional materials/aids which are designed to make clearer the concepts being discussed. These materials appeal to different human senses. Sense of sight (visual aids; specimens, diagrams, etc.), sense of hearing (audio aids; radios, headsets, etc.) and sense of hearing and sight (audio-visual; televisions, computers, etc.).

In the course of teaching integrated science, you are expected to use different instructional materials as you deem appropriate to deliver your lesson content effectively. What then happens if the instructional

materials you wish to use are not available in the laboratory or store room? Or is not sufficient? Or is not adequate?

This unit will show you what to do when faced with any of the challenges listed above while preparing to teach Integrated Science effectively.

1.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- explain the meaning of improvisation
- give reasons why you should improvise teaching/learning resources in your teaching of Integrated Science
- explain the principles of improvisation of teaching/learning resources, and
- discuss the philosophical basis of improvisation of teaching/learning resources in Integrated Science.

1.3 Concept of Improvisation in Science

The teaching and learning of Integrated Science involve doing things – handling of materials and equipment. It is generally observed that it is quite difficult to find an institution of learning that has **all** the required teaching and learning materials. Most of the teaching and learning materials are supplemented from locally available or locally made materials.

1.3.1 Meaning of Improvisation

There are many definitions of improvisation. Some authors define improvisation as the act of substituting for the real thing that is not available. Some define it as an act of making a teaching aid from locally sourced, readily available materials. From the definitions of other authors above, we can say that improvisation is the act of originating a totally new tool, modifying existing equipment or substituting an instrument, material, device using locally sourced resources.

Self-Assessment Exercise 1

1.	What is improvisation?
2.	Why is improvisation important in the teaching of Integrated Science?
3.	What are the sources of improvised resources for Science Teaching?

1.3.2 The Principle of Improvisation in Integrated Science

The principle of improvisation in Integrated Science aims to show how teaching/learning resources produced from the school environment and community can be integrated into the teaching and learning of science. It reveals the way or manner improvised materials (non-standard materials) should be incorporated into the teaching of the subject. Incorporation means the inclusion of something as part of a whole. The use of an improvised material has to be done with care and tact. The lesson objectives should serve as a guide in preparing improvised resources for teaching. To incorporate an improvised instructional material, certain basic steps should be followed. These steps include:

- Preparation of instructional materials for lesson presentation by the teacher
- Preparation of instructional material by the learners as directed by the teacher.
- Actual presentation of the lesson by the teacher or the learner who has been appointed to carry out certain roles.
- Presentation of follow-up activities

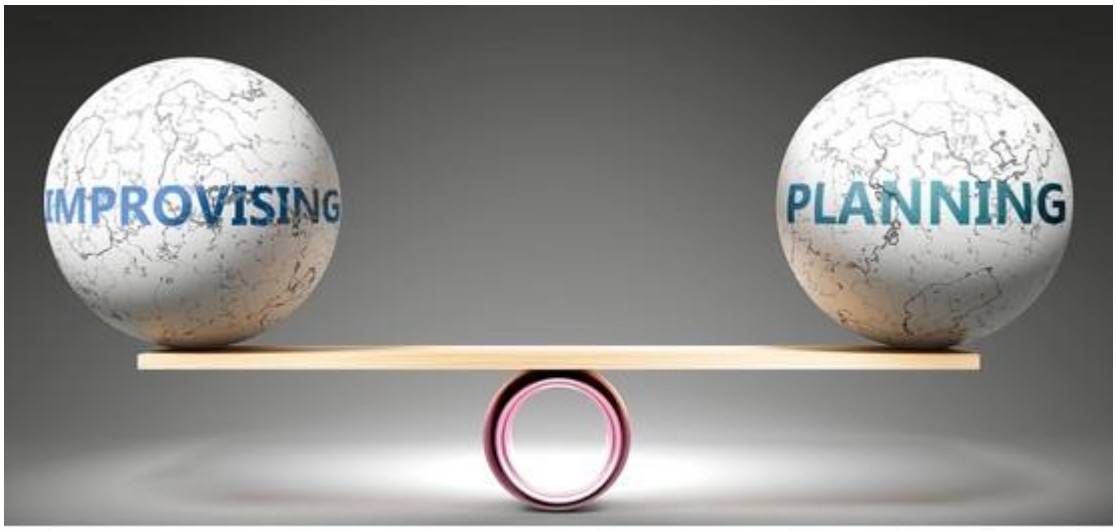


Fig. 11: Improvisation and Planning must be balanced

In teacher preparation, the objectives of the lesson should serve as a guide. This means that the teacher should make sure that the material to be improvised must serve its purpose. For example, to improvise a

sieve, you must get a material that is capable of allowing liquid to pass through it and at the same time preventing the undesired content from going through. The openings in the improvised sieve must not be too porous. Therefore, the teacher has to:

1. Produce and test-run the materials well ahead of time. This means that the teacher must produce the materials and test them before the lesson commences
2. Plan the integration in the lesson and follow it
3. Consider how the material can help in achieving the objectives

Preparation of Learners

1. Learners must be prepared psychologically with some explanations and reasons for the particular materials to be used
2. Clear directions must be given to learners on what they need to do during the lesson
3. Where necessary, new words associated with the material must be clearly defined.

Actual Presentation

The improvised materials must be appropriately applied at:

1. Introductory stage
2. Content presentation stage
3. Summary stage

The teacher should direct every stage, arousing the learners' interest and maintaining their attention. Learners should not be carried away at any stage whether or not they are directly involved in manipulation of the material(s). The whole lesson should be guided by the objectives.

In preparing the follow-up activities, the only way to evaluate the success or otherwise of an improvised instructional material is to obtain feedback from the learners. Therefore, the teacher must evaluate the integration and application of the material immediately. To achieve this, the teacher should:

- Ask questions that at every stage of the teaching. This is also known as formative assessment.
- Allow the learners to respond freely at every stage of the lesson. This will help the teacher to know when and where to re-teach. Misconceptions are also corrected when learners are allowed to ask and answer questions during a learning process.
- Evaluate the presentation using instructional materials already used in the lesson, based on the objectives of the lesson

Improvised materials can be damaged or destroyed due to learners' handling or repeated display, frequent retrieval or long period of storage. To preserve them from wear and tear, they may be laminated, mounted on harder materials like plywood or kept in boxes or special spaces created for them. Improvised instructional materials should be preserved so that they can be re-used.

Self-Assessment Exercise 2

Explain why learners need to be prepared for the use of improvised resources for science teaching

1.3.3 Philosophy of Improvisation in Integrated Science

The philosophy of improvisation in integrated science seeks to clarify the objectives of integration and application of improvised materials in the teaching of the subject. Improvisation requires a good imagination and a great ability to be creative. Improvisation is expected to help, though in varying degrees, the following aspects of learning:

1. Perception
2. Understanding
3. Transfer of training
4. Provide reinforcement
5. Retention (Adamu, 2003; Atadoga & Onaolapo, 2008).

There are two approaches to improvisation; one is concerned with the methods of teaching and the other with the equipment. However, the need for improvisation sums up the two approaches because they are interwoven.

Why do we improvise teaching/learning resources in science?

1. A way of providing unavailable or insufficient teaching aids
2. improvisation improves on curiosity and gives room for creativity
3. It may minimize the cost of purchasing brand new standard equipment
4. Science process skills are developed and nurtured in both teachers and learners.
5. When instructional materials are used in teaching, abstract concepts are concretized making it easier for the learners to remember concepts.

The need for improvisation in science teaching-learning process cannot be over-stressed. The place of practical activities in science lessons has

been described as very fundamental at all levels of education like Dewey (1968) who opined that experience is the source of all knowledge. Improvised materials when they are well designed and adequately presented can stimulate creative expressions in learners and encourage active participation in a lesson.

Improvisation involves several skills such as:

i. Observing
ii. Measurement skills
iii. Manipulative skills using various tools in cutting, bending, joining, impelling wood and/or metals into different shapes, etc

Generally speaking, improvisation can be derived either through substitution or construction. It is not always possible to find a suitable substitute for every piece of science equipment in the school. The construction is always done from the available materials. It is a more difficult form of improvisation in science than substitution. Construction form of improvisation requires innovation and creativity. An aquarium can be improvised by construction.

Self-Assessment Exercise 3

1.	As an integrated science teacher, give possible reasons why you may need to improvise an instructional material
2.	Name some skills involved in using improvised resources for teaching

1.4 Summary

- Improvisation is an act of constructing a totally new tool or substituting an unavailable or insufficient instructional material
- There are principles guiding improvisation
- The Philosophy of improvisation seeks to clarify how improvised integrated science teaching materials should be incorporated into the teaching of the subject.
- There are many reasons for improvising an integrated science instructional material some of which include making up for insufficient/unavailable instructional materials.

Improvisation helps an integrated science teacher to provide instructional materials to will help him/her effectively deliver the content of the lesson. Improvisation fosters creativity in both the teacher and the learner. It also improves the science process skills of all those involved. There are many reasons for improvising. The integrated science teacher must make sure that the material to be improvised serves

its purpose. An improvised instructional material must closely resemble the original standard equipment.

1.5 References/Further Readings/Web Resources

Adamu, A. I. (2003). *The Importance of Teaching Aids Towards the Enhancement of Teaching/Learning Progress*. Garkuwa Journal of Education, 1 (4), 98-104.

Alonge, E. I. (1983). *Improvisation in Integrated Science: A Practical Demonstration.* 24th Processing of STAN, Lagos. 171-177.

Atadoga, M. M. & Onaolapo, M. A. O. (2008). *A Handbook on Science Teaching Method.* (Vol. one). Zaria: Shola Press.

Dewey, J. (1968). *The Child and the Curriculum and the School and Society.* Chicago: University of Chicago Press.

Ogunniyi, M. B. (1986). *Teaching Science in Africa*. Ibadan: Salem.

Picture culled from https://www.google.com/search?q=improvisation&client=firefox-b-d&sxsrf=AOaemvKlIGxAfxYfUZCRMNsTNLOkj_iIyw:1636711325309&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjw4pPpyJL0AhVGyhoKHUTNDpgQ_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1#imgrc=gE2qsDrZ0rnDnM

1.6 Possible Answers to Self-Assessment Exercise(s)

Self-Assessment Exercise 1

1. What is improvisation?
   It is the provision of non-standard teaching learning resources from environment of learners when standard resources are insufficient or unavailable. It may be provided by the teacher or the learner or the laboratory personnel
2. Why is improvisation important? It is important because science teaching must continue to be fruitfully carried out whether the teaching / learning resources are adequately available or not.
3. Sources of improvised resources: The school premises, the learner's home, the local markets, Artisan's workshop, local river, school farm

Self-Assessment Exercise 2

1. Why do learners need to be prepared for use of improvised materials?

a) Learners need to know the sources of the improvised materials in their communities

b) They need to know that improvised materials may not be exactly as the original thing and the differences between the real material and the improvised one, such as functionality

c) Learners may be required to improvise the resources from their homes

Self-Assessment Exercise 3

1. As an Integrated Science teacher, give possible reasons for improvisation Some reasons for improvising resources for science teaching are: Scarcity of standard resources, High cost of standard resources, Unavailability of standard resources, acquisition of some skills by the teacher or the learners who is involved in improvising
2. Name some skills involved in improvising resources

a). Measurement skills, critical thinking skills, manipulative skills, observation skills, effective use of tools for constructing objects

UNIT 2 SOURCING A CATALOGUE OF SCIENCE TEACHING MATERIALS IN IMMEDIATE ENVIRONMENT

Unit Structure

2.1 Introduction

From the previous unit, you can remember that integrated science teaching requires the use of instructional materials. Most times these materials are not available in our school laboratories. This is why we discussed improvisation in the previous unit.

In this unit, we will discuss the meaning of teaching materials and ways we can source these instructional materials within our environment.

2.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- explain the meaning of teaching materials
- identify the sources of teaching materials from immediate environment of the learners
- explain the principles of improvisation in science teaching and learning

2.3 Meaning of Science Teaching Materials

Science teaching materials are also called instructional materials or resources for science teaching. These differences in terms have one thing in common and that is, they are the resources that are used in the teaching-learning process. They enhance effective and meaningful learning and encourage students' active participation in science lessons.

Science teaching materials as resources for teaching science can be broadly grouped into two: human and non-human resources. The human resources include science teachers, laboratory technologists, laboratory

assistants and artisans from outside the school such as markets, workshops, farms etc. The non-human resources include laboratory, textual materials, reagents, charts, models, natural environment and assorted laboratory equipment and other equipment that can be provided from the environment and the immediate school community.

In the context of this course, immediate environment includes school, the community and home environments. It is the environment we live in – the dwelling place(s) of the teacher and the students. Immediate environment also includes roadside artisanal workshops, tailor workshop, blacksmith workshop, local markets, shopping malls etc.

2.4 Sourcing for a Catalogue of Science Teaching Materials in Immediate Environment

Table 1 below shows where you can source/get some materials to construct or substitute science teaching materials

Table 1: Sourcing Science Instructional Materials from Immediate Environment

S/N	Instructional Material	Possible sources of materials
1.	Sand bucket, pictures, charts	Teacher can fill a bucket from the school with sand. Teacher can comfortably produce charts or ask the students to create some. The teacher can also enlist the expertise of artists. For pictures, the teacher can download and print them from the internet.
2.	Bottle top, stone, Fan, magnets of different shapes, dry cell and wet cell batteries, Electric Current regulators, electric bulbs, magnets of different shapes and sizes, gravel, grass, wood	School compound, shops, artisanal workshops, Radionics' workshops, Teachers and students can make posters, gravel and wood can be gotten from construction sites or carpenter sheds. Grasses can be uprooted from the school field.
3.	Posters on various science and social issues	Newspaper and books publishing industries
4	First Aid Box	Can be constructed by the local carpenter-based design by the teacher or the learners. Teacher or the learners can construct using wood from the environment
5	Assorted empty cans and tins	Can be collected from refuse dumps, recycling plants, from the home, markets

6	Lubricants, different metals and used motor oil, old car parts, etc.	Motor mechanic workshops, the home, the market
7.	Assorted fruits and seeds	School garden/farm, market, home,
8	Pictures, tapes, Audio records, videos and film strips, assorted tape-recorded materials	Home, markets, recording studios etc.

Self-Assessment Exercise 1

Make a short list of resources you can improvise from school premises for science instruction in your school.

2.5 Summary

- Instructional materials are also called resources for science teaching
- Since our laboratories are not always equipped with all the required materials for science teaching, it is necessary for the teacher to source for substitutes for these materials.
- Some of these materials can be constructed with the help of artisans too

Improvisation involves constructing or substituting resources for science teaching. These materials can be gotten from our immediate environment as you can see from the table above. Sourcing instructional materials fosters creativity among both teachers and students. This is why it is necessary for a teacher to involve the students in sourcing materials from the immediate environment.

2.6 References/Further Readings/Web Resources

NTI, (2010). *Basic Science and Technology Training Manual*. Kaduna: NTI Press.

UBE FCT (2009). *Manual on Capacity Building Workshop*. Abuja: UBE.

2.7 Possible Answers to Self-Assessment Exercise(s) within the Contents

1.	Charts/Pictures-the teacher can download and print them from the internet.
2.	Assorted fruits, seeds, Flowers, plants
3.	First Aid Box

UNIT 3 SOURCING FOR PRODUCING A CATALOGUE OF SCIENCE TEACHING MATERIALS FROM THE DISTANT ENVIRONMENT

Unit Structure

3.1 Introduction

The previous unit has shown us that science teaching materials can be sourced from our immediate environment. This immediate environment includes our homes, school compounds and even the roadside artisan workshops.

What would you do if the materials you need for teaching a particular integrated science topic cannot be seen just lying around your neighborhood?

This unit will show us what to do!

3.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- mention types of science teaching materials
- identify locations of science teaching materials.

3.3 Sourcing for Production of Science Teaching Materials from the Distant Environment

Distant environments mean places or even educational centers that are not within or around the school and the students and teachers' communities. It is called out door laboratory. This implies that all forms of environments have one type of science resource material or the other.

All the teacher and students need is to identify them and use them for knowledge and skills acquisition. Table 2 gives examples of science instructional materials and where they can be found.

Table 3.1: Sourcing Science Instructional Materials from Distant Environment

S/No	Instructional Materials	Where to Source for Materials
1	Fire extinguishers	Sourced commercially
2	Various types of ceramic and glass Products	Outdoor laboratory; ceramic/glass industries
3	Ammeter, galvanometer, voltmeter	Sourced commercially
4	Resonance kits, turning fork	Sourced commercially
5	Glass block, triangle prism	Sourced commercially
6	Models of hydraulic and hydraulic jack	Commercially bought and teacher made
7	Pressing iron, electric kettle, generators, cooker, refrigerator	Home economics laboratory, improvisation from an artisan
8	Engine scraps, levers, linkages, slides and slots, films containing use of levers	Teacher production educational centres
9	Bar magnet, iron filing, stop clock/watch	Commercially bought
10	Wild animals, e.g., lion, elephant	Zoo and game reserve – outdoor laboratory

Self-Assessment Exercise 1

Mention five (5) science teaching materials and the distant places you can find them.

3.4 Summary

This unit discussed instructional materials that could be used in the teaching of science and where to source for instructional materials for the teaching of the subject outside the students' and teachers' immediate environment.

Some teaching materials may require going out of the immediate environment to source. Sourcing for teaching materials can take teachers and students closer to nature. It is necessary that an integrated science teacher takes time to source these materials.

Some concepts may require taking the students to see live animals in zoos or a real-life production of a beverage or equipment. This may mean taking the students out of their immediate/school environment. It is therefore very necessary that you prepare ahead, find out the places you need to visit and make proper arrangements before the day.

3.5 References/Further Readings/Web Resources

Atadoga, M. M. & Onaolapo, M. A. O. (2008). *A Handbook on Science Method.* Zaria: Shola Press.

NTI, (2010). *Basic Science and Technology Training Manual*. Kaduna: NTI Press.

UBE FCT (2009). *Manual on Capacity Building Workshop*. ABUJA:

3.6 Possible Answers to Self-Assessment Exercise(s)

S/No	Instructional Materials	Where to Source for Materials
1	Fire extinguishers	Sourced commercially
2	Various types of ceramic and glass Products	Outdoor laboratory; ceramic/glass industries
3	Ammeter, galvanometer, voltmeter	Sourced commercially
4	Resonance kits, turning fork	Sourced commercially
5	Glass block, triangle prism	Sourced commercially
6	Models of hydraulic and hydraulic jack	Commercially bought and teacher made
7	Pressing iron, electric kettle, generators, cooker, refrigerator	Home economics laboratory, improvisation from an artisan
8	Engine scraps, levers, linkages, slides and slots, films containing use of levers	Teacher production educational centres
9	Bar magnet, iron filing, stop clock/watch	Commercially bought
10	Wild animals, e.g., lion, elephant	Zoo and game reserve – outdoor laboratory

UNIT 4 UTILISATION OF SCIENCE INSTRUCTIONAL MATERIALS

Unit Structure

4.1 Introduction

We have been discussing improvisation, teaching materials and how we can incorporate them into integrated science lessons. We have also discussed some distant places where you can get instructional materials. In this unit, we will discuss about utilization of Integrated Science improvised teaching resources, its meaning, types and the processes involved.

4.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- explain utilization
- identify the scientific thought process of utilization in a science lesson
- list and discuss any four human and physical facilities as resources for the teaching of science.

4.3 Meaning of Utilization

Have you ever bought a pair of shoes? Why did you buy the shoes? Just to admire them? I don't think so! You bought the shoes to wear them to an occasion. That is utilization!!

Utilization means putting what is available into use to achieve set goals. It can also be defined as an action that makes use of something for a purpose. Generally, all the definitions have action or the act of doing as a common factor. Therefore, acceptable definitions of utilization should contain words such as action, doing and purpose, goal or objective.

4.4 Science Process of Utilization in Science Lesson

In science, certain ordered steps or procedures are followed to arrive at a solution to a problem. These ordered steps are called scientific processes or process skills. The process skills are used by scientists in the course of investigation to find out more about objects, things, events, situations or natural phenomenon.

The scientific skills processes are many. The process skills include; observation, data collection, classification, measurement, communication, inference, prediction, making hypothesis, testing hypothesis, recording, manipulation, experimentation and questioning.

Observation: Students may look similar materials without knowing their differences. They have to be trained to look out for every detail for similarities and differences. They should be trained and encouraged to distinguish between rough surfaces and smooth ones; differences between and among colors. Plant a seed inside a room and another outside and observe how the two plants grow.

Data Collection: We are enveloped by information. Students should be trained on how to assess information in their environment, from the internet and from textual materials. In other words, they should be taught sources of information. The information we have or get will greatly influence the type of decisions we make.

Data Analysis: After students have generated the data they need, their understanding of them is important. They should be taught and trained on the use of calculator and computer: How to enter information into the computer and generate results.

Classification: To be able to classify and analyze correctly, we should be good observers. This is so because classification is based on ability to sort things according to certain characteristics, such as size, color, height, shape, to mention just a few. Students should be taught how to recognize similarities and differences.

Measurement: In measurement, different equipment, scale and units are used for different objects or things. Students should first be introduced to uncalibrated measuring activities; e.g., using feet, hands, fingers, etc., to measure the length and width of anything. Thereafter, move to graded scale measurement, e.g., volume in cubic centimetre, cubic meter, or liters, length, height in millimeters, centimeter, meter or hectares, temperature in degree centigrade, Kelvin; time in seconds, minutes or hours. Measuring is a skill and so it should be handled carefully.

Communication as Process Skill: Talking, writing, drawing and using gestures are vital communication process skill. All these can be grouped into three: Verbal (oral), non-verbal (written) and para-verbal (body movement). Science teachers must learn how to communicate effectively. The voice should be audible and clear. The teacher should learn to speak in simple and correct English. Writings on the blackboard should be bold, neat and legible. Students should be able to communicate their findings in simple correct writings; plotting of graphs and drawing of charts to illustrate their results.

Inference: This means to make deductions and translate them into conclusions. At sighting some objects or beings or people, you could presume their situations or state of minds and pass judgment at their conditions. From background information of theories, you form your opinion. Teach students how to judge or interpret appearance or situations. Train the students on how to obtain clues or evidences and think critically for solutions.

Prediction: Students should be taught basic principles, scientific ideas and logics. When sound background is laid based on scientific principles, theories and laws, students will be able to suspect or guess the outcome of events or action before investigations are made into such situations or events.

Making Hypothesis: Hypothesis can be seen as an intellectual guess which can either be retained or rejected, based on experimental result. It gives direction to stated problem. Statement from hypothesis before a study is carried out is tentative until data or information gathered on the problem or issue is subjected to statistical test using appropriate statistic(s). Hypothesis is a skill. Science students should be exposed to it because they need it.

Testing Hypothesis: When hypothesis is formulated, the next step is that it must be tested. How it is carried out depends on students' knowledge of computer and data analysis. Therefore, students should be carefully taught how this is done.

Recording: Observations are to be recorded correctly. Recording correctly is part of process skill. Wrong recording could lead to wrong report which will translate to wrong conclusion. To avoid this, students should be taught or trained to record results carefully and correctly. Wrong recording can be avoided when students learn to take repeated readings. Also, any observation made should be recorded immediately. The students should also be trained to concentrate on their work. They must learn to record their readings correctly.

Manipulating: Students should be given opportunity to handle equipment. Training should be given to them on how to operate equipment correctly without damaging the equipment or harming themselves. They should be provided with materials to manipulate, touch, push, pull and rub as the case may be. As they carry out these activities, they should be asked to explain or discuss their experiences.

Experimenting: Students are always faced with challenges. Challenges may come from what they observe in their environment, their teacher or books they read. The teacher should assist and guide them on how to tackle the problems by approaching them scientifically and also through trial and error. The students should be exposed to various methods or strategies of solving problems.

Questioning: Students are naturally inquisitive, curious and wanting to know everything and thereby asking questions about what they see. They ask questions such as; "What?", "Why?" and "How?" These kinds of questions are scientific and should be encouraged. Therefore, students should be given opportunities to ask questions. Teacher should train them on how to generate questions and ways to answer them correctly. When answers are not coming after several efforts, the teacher should give them a clue that leads to the answer.

Self-Assessment Exercise 1

List 5 (five) science process skills and mention ways you can teach integrated science to foster the acquisition of the sills you have listed.

4.5 Roles of Human and Physical Resources in Utilization

Humans are resource materials for utilization in teaching and learning of science at all levels of education. They include teachers, laboratory technologists, laboratory assistants, laboratory attendants, students and resource persons. Humans as resources for utilization must be knowledgeable in their subject areas, physically, mentally, socially and morally sound. They need to be familiar, firm and friendly for effective utilization in the teaching and learning of science. For effective utilization, the teacher must prepare before entering the class. The teacher must provide students with activities that will give them opportunities to think and work like scientists.

A resource person as part of human resources for utilization may come from within the school, from another department or unit or from the community or outside the community. A specialist in a field of study, skilled personnel outside or within the school may be invited to come and discuss a specific topic that will be of benefit to the students and even the teachers. Examples of resource persons for utilization in

science teaching include; medical doctors, mechanics, plumbers, goldsmith, carpenters, hair dressers, pilots, to mention a few.

Physical resources for utilization for science teaching refer to the entire school environment. The school environment comprises classrooms, furniture, building, laboratories, playground, school farm and botanic garden. The classrooms and laboratories should be well equipped with modern facilities and made conducive by the teacher and laboratory staff for effective science teaching and learning. The facilities should be well managed and organized. There should be routine check on the reagents; all laboratory materials should be correctly labelled. The students should be taught how to maintain clean environment and given guidelines and laboratory rules to ensure proper use of the facilities with little or no laboratory accidents.

4.6 Summary

In this unit, we learnt the meanings of utilization, science process skills, human and physical facilities and resources. Utilization and processes build up both the teacher and students to be creative and resourceful.

In this unit, you were also exposed to how you can utilize the components of both the human and physical facilities and resources for effective teaching of Integrated Science.

It is not enough to have real or improvised science instructional materials. Their beauty lies in their effective utilization. All materials and processes involved must be well incorporated into the Integrated Science lesson so that we can achieve desired goals we and objectives through proper utilization.

4.7 References/Further Readings/Web Resources

Ayoga, A.V. & Ozike, B. C. (1976). *Improvisation in Science Training*: A Book of Reading on Survival of Nigerian Education. Vol 17.

Nkom, A. A. (2006). *Supervising Core Subject in Primary Education:* A Manual. Zaria: Tamaza Publication.

Umudhe, S. E. (1998). *A Guide Book for Science Teacher in Nigeria*. Delta: Research Publishers.

4.8 Possible Answers to Self-Assessment Exercise(s)

1. **Questioning**: Teacher should train them on how to generate questions and ways to answer them correctly. When answers are not coming after several efforts, the teacher should give them a clue that leads to the answer.

2. **Experimenting**: The teacher should assist and guide them on how to tackle the problems by approaching them scientifically and also through trial and error. The students should be exposed to various methods or strategies of solving problems.

3. **Manipulating**: Students should be provided with materials to manipulate, touch, push, pull and rub as the case may be. As they carry out these activities, they should be asked to explain or discuss their experiences.

4. **Making Hypothesis**: Hypothesis can be seen as an intellectual guess which can either be retained or rejected, based on experimental result. Hypothesis is a skill. Science students should be exposed to it because they need it.

5. **Testing Hypothesis**: When hypothesis is formulated, the next step is that it must be tested. How it is carried out depends on students' knowledge of computer and data analysis. Therefore, students should be carefully taught how this is done.

6. **Recording**: Observations are to be recorded correctly. Recording correctly is part of process skill. Wrong recording can be avoided when students learn to take repeated readings. Also, any observation made should be recorded immediately. The students should also be trained to concentrate on their work. They must learn to record their readings correctly.

UNIT 5 SELECTION AND UTILISATION OF IMPROVISED MATERIALS

5.1 Introduction

For improvised teaching and learning materials to be used effectively, some basic principles or guidelines must be followed in their selections and utilization. If a teacher cannot effectively utilize an improvised material that will bring positive result in teaching-learning process, then the aim of the improvised material and also the lesson is defeated.

Therefore, this unit will expose you to guidelines for selecting and utilizing improvised materials. This unit will also show you the advantages and limitations of improvisation**.**

5.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- identify the principles guiding the selection and use of improvised materials
- select appropriate improvised materials in the teaching of Integrated Science
- identify the advantages and limitations of improvisation.

5.3 Guiding Principles in Selection and Use of Improvised Materials

For good success of anything or approach, there should be guiding principles to be followed. Selection is the process of choosing from among many things. In teaching-learning process, it is a careful choosing of instructional materials that will enable the teacher to effectively deliver his/her lesson contents within the stipulated period of time.

5.4 Guideline for Preparing Improvised Teaching Resources

Although improvised materials have several purposes for which they are selected, there are certain guidelines that must be followed for effective utilization. The guidelines for selection include the following:

1. Students' characteristics: Improvised materials should be appropriate for the age and level of the students. Characteristics of the students should be analyzed so that the improvised materials can be within their abilities and interest. The characteristics of the students include age, ability level, number in the class and physical impairment.

2. Behavioral objectives: The improvised material must meet the objectives of the lesson. Objectives of the lesson must agree with the improvised materials to be used. For instance, if the behavioral objective is to help students demonstrate static electricity, it is important to use ebonite rod or biro, small piece of paper and a piece of cloth or dry hair on the head.

3. The number of students in the class number of students should be considered as teacher selects and uses the materials. Some classes are very large while others are small. The teacher should bear in mind that whatever he/she selects should meet the desired purpose(s).

4. Time allotted for the lesson is another factor when selecting. There should be sufficient time and daily routine.

5. Cost: Improvised materials should not be more expensive than the standard equipment.

6. Sourcing: You must think of how to source the materials needed.

7. The improvised material must closely resemble the standard equipment effectiveness of the materials is also an issue in the selection. Improvised materials selected must be suitable and their design must meet the aesthetic value.

8. The safety, durability and visibility of the improvised materials must be considered during selection and usage.

5.4.1 Advantages of improvisation

Improvisation in integrated science teaching and learning has some advantages and limitations as. The advantages include:

1. If managed effectively and appropriately, it will increase the rate of learning and will allow the teacher to use more time on other useful activities

2. It encourages involvement of teachers in curriculum design and development

3. It allows for effective lesson planning from determining the objective to evaluation

4. It encourages students' participation in the process of learning

5. It makes room for individualizing education, as variety of resources are available at the student's choice
6. Learning becomes real and immediate because the use of improvised instructional materials emphasizes understanding and practical activities.

7. Utilization of Improvised instructional materials makes science easily accessible for all learners

8. Improvisation gives room for creativity

9. Improvisation helps to make abstract concepts easier to grasp and retain thereby aiding recall of learned content.

10. Improvisation leads to the acquisition of science process skills

11. An improvised material can present the students with a more authentic picture of the real object than the teacher can ever describe or explain.

12. The use of improvisation can also facilitate the repetition of an idea without becoming monotonous (Balogun, 1981).

5.4.2 Limitations of Improvised Teaching Resources

As important as improvised instructional materials are, they are not substitutes for the teaching rather, they depend on skillful employment by the teacher. There are challenges which can be broadly classified into two: non-human and human challenges. Non-human challenges can further be categorized into two:

i. Teaching challenges and
ii. Finance challenges.

iii. Science Teacher Factors

Teaching Challenges:

a. Shortage of equipment
b. Lack of time
c. The durability of the materials and its ability to be moved from place to place
d. Inability of the teacher to use the improvised materials effectively

i. **Finance challenges**: This is all about availability of funds for the purchase of raw materials and handy simple workshop tools for constructing improvised resources for science teaching. Although improvisation is expected to be made from cheap sources, there are basic tools and materials that require money in the school. Lack of such funds can frustrate the effort and interest of the science teacher.

iii. **Science Teacher factors:** Science teacher factors include the teachers' professional commitment, competence, creativity, mechanical skills, initiative and resourcefulness. Researchers and classroom experiences have shown that many classroom teachers are aware of the importance of improvisation but majority of them do not practice it. Some of the teachers exhibit negative attitude towards improvisation and claim that it is time consuming and fund depleting.

5.5 SUMMARY

In this unit, you have learnt guiding principles in selection and utilization of improvised materials. Advantages and limitations in the use of improvisation in teaching-learning process were highlighted in the unit. Improvisation cannot take the place of the teacher. The teacher uses it as an instructional material. Therefore, improvisation is an alternative to real object.

The value of improvisation is its ability to serve and achieve educational goal(s) or objective(s) it is meant for. But the goal may be far reaching if improvised materials are not carefully selected. Therefore, in their selection for effectiveness, certain principles must be followed. These principles include time factor, number of students in the class, lesson topic and objectives. Improvisation advantages outweigh its limitations. Therefore, integrated science teachers should be encouraged to practice improvisation.

Self-Assessment Exercise 1

1. Identify and discuss any five guiding principles in selection and use of improvised materials.

5.6 References/Further Readings/Web Resources

Adamu, A. I. (2003). *The Importance of Teaching Aids Towards the Enhancement of Teaching/Learning Process*. Garkuwa Journal of Education, 1 (4), 98-104.

Atadoga, M. M. & Onaolapo, M. A. O. (2008). *A Handbook on Science Method*. (vol. one). Zaria: Shola Press.

Balogun, T. A. (1981). *Principles and Practice of Education*. Lagos: Macmillan Ltd.

5.7 Possible Answers to Self-Assessment Exercise(s)

1. Students' characteristics: Improvised materials should be appropriate for the age and level of the students. Characteristics of the students should be analyzed so that the improvised materials can be within their abilities and interest. The characteristics of the students include age, ability level, number in the class and physical impairment.

2. Behavioral objectives: The improvised material must meet the objectives of the lesson. Objectives of the lesson must agree with the improvised materials to be used. For instance, if the behavioral objective is to help students demonstrate static electricity, it is important to use ebonite rod or biro, small piece of paper and a piece of cloth or dry hair on the head.

3. The number of students in the class number of students should be considered as teacher selects and uses the materials. Some classes are very large while others are small. The teacher should bear in mind that whatever he/she selects should meet the desired purpose(s).

4. Time allotted for the lesson is another factor when selecting. There should be sufficient time and daily routine.

5. Cost: Improvised materials should not be more expensive than the standard equipment.

6. Sourcing: You must think of how to source the materials needed.

MODULE 2 IMPROVISABLE EXPERIMENT IN THE INTEGRATED SCIENCE CURRICULUM

UNIT 1 IMPROVISED PLANE MIRROR EXPERIMENT

Unit Structure

1.1 Introduction

Improvisation is done when real and standard material is not available or not sufficient. These improvised materials are used for the same experiment meant for the use of real materials. In this unit, you will learn how improvised materials can be used to demonstrate characteristics of images formed by a plane mirror.

1.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- explain the meaning of improvisable experiment
- demonstrate how improvised mirror, straight pins and drawing board can be used to show characteristics of images formed by plane mirror
- investigate laws of reflection.

1.3 Meaning of Improvisable Experiment

In science, formulae, laws and theories are postulated or arrived at through series of tasks, exercises, trials-and-errors in laboratories. These

series of scientific activities/exercises are carried out by scientists using equipments and apparatuses that are factory-made to obtain results.

Experiments involve orderly procedures carried out with the goal of verifying, refuting, or establishing the validity of a hypothesis. When an experiment involves control, it provides insights into cause and effect by demonstrating what outcome occurs when a particular factor is manipulated. Natural experimental studies also exist.

Experiments carried out using improvised instructional materials are referred to as improvisable experiments. Perhaps, there could be some experiments in integrated science curriculum that might be possible with improvised materials.

Self-Assessment Exercise 1

What is an improvisable experiment?

1.3.1 Verification of Characteristics of Images Formed by a Plane Mirror

Image formed by plane mirror has certain characteristics which include the following:

i. It is the same size as the object
ii. It is as far behind the mirror as the object is in front
iii. It is virtual
iv. It is upright

An example of a plane mirror is the dressing mirror.

Required Improvisation Materials

- A discarded broken mirror can often be cut into a number of small rectangular plane mirrors
- Pieces of ceiling boards can be cut into a number of small rectangular drawing boards.
- Straight pins, popularly known as office pins can substitute for optical pins

Procedure

a. Finding the Image in a Plane Mirror

To locate the image of a pin, a plane mirror is placed with its reflecting surface vertical on the surface of a placed on a ceiling board. An office pin is placed a few centimeters in front of the mirror. If you look past

the office pin into the mirror, you will see an image of it. A second pin, called the search pin, or image pin, is now placed behind the mirror, so it appears to be in the same position as the image of the object pin.

When the image pin is correctly placed, the top of the image pin should remain exactly in line with the bottom of the image of the first pin as you move your head from side to side. If the pins do not move together, but move relative to one another, there is parallax between them.

The image pin has to be adjusted to another position until there is no relative movement as you move your head from side to side. There is then no parallax between the image pin and the image of the object pin. The position of the second pin is marked and a line is drawn from this position to that of the object pin. If measured, the angle between this line and the mirror will be found to be 90^0. It will also be found that object distance in front of the mirror equals the image distance behind the mirror.

Nature of the Image Formed by a Plane Mirror

You can repeat the experiment for finding the image in a plane mirror for nature of the image formed by a plane mirror but this time you draw a large capital **U** on a paper in front of the mirror to serve as the object. A pin is put at various points of **U**, such as at positions 1, 2, 3, 4 and 5 in turn, and each time the corresponding image is located by the method of no-parallax. The position of the image in each case is marked by a dot. In this way we plot the position of the image of the letter **U** as a set of dots, you observe that the **U** has been turned around, as shown in figure 1. From this, you will now say that the image in a plane mirror is laterally inverted. Because of lateral inversion, you will notice in placing your left palm in front of a plane mirror that its image appears in the mirror as a right palm.

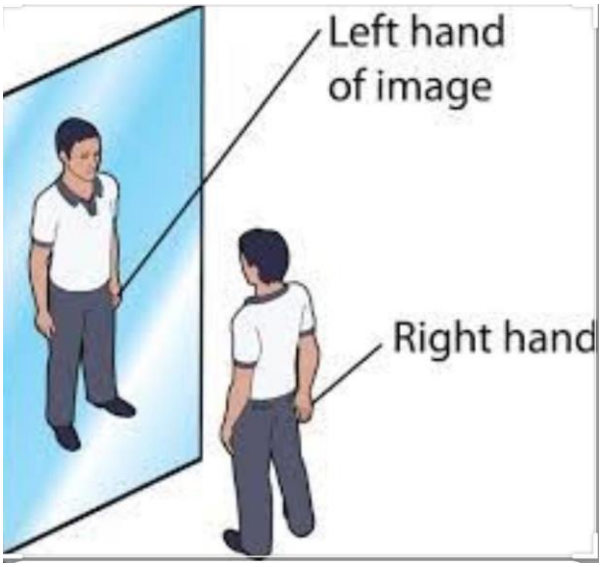


Fig. 1: Image formed by a plane mirror. The right hand appears to be the left hand in the mirror

Lateral inversion arises from the fact that an object is perpendicularly opposite its image behind the mirror.

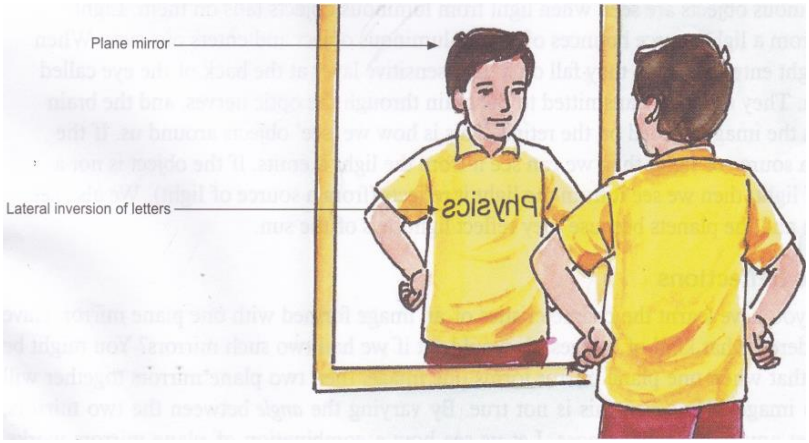


Fig. 2: Lateral inversion of the letters in the mirror

Practical Activity
Pick up your textbook. Place it in front of your mirror. Write down your observation.

1.3.2 Laws of Reflection

You can investigate the laws governing the regular reflection of light from a plane mirror. The laws known as laws of reflection states that:

i. The incident ray, the reflected ray and the normal at the point of incidence all lie on the same plane

ii. The angle of incidence is equal to the angle of reflection

The experiment can also be done using improvised mirror, straight (office) pin, instead of optical pin, plane sheet and ceiling board is used instead. Two pins are placed vertically at points P and Q along the incident ray. Two other pins R and S are placed to find the reflected ray by placing them in line with the images of P and Q as seen in the mirror.

The angles of incidence and reflection are measured as before. For each angle of incidence, it is found that the angle of incidence is equal to the angle of reflection.

Demonstrating the Laws of Reflection Using Pins
https://www.youtube.com/watch?v=hZ3miHIE-fg Click on this hyperlink to watch a live experiment on the laws of reflection

1.4 Summary

Improvisable experiments in Integrated Science are possible in the investigation of characteristics of image formed by plane mirror and laws of reflection using plane mirror instead of ray box. The exercise requires teacher's high level of commitment, resourcefulness and hard work. Improvised plane mirror, straight pins and ceiling board were used to investigate laws of reflection and characteristics of images formed by a plane mirror. The results gotten are the same with those gotten from real and standard equipment using real (factory-made or imported) materials or equipment. Therefore, a carefully selected and appropriate improvised material can adequately serve as good alternatives to real or imported science equipment on some topics.

Self-Assessment Exercises 2

1.	What are the characteristics of images formed by a plane mirror
2	a State the laws of reflection
b.	https://www.youtube.com/watch?v=hZ3miHIE-fg Click on this hyperlink to watch a live experiment on the laws of reflection. Write down your observations

1.5 References/Further Readings/Web Resources

Okeke, P. N. & Anyakoha, M. W. (2006). *Senior Secondary Physics*. (Revised Edition). Enugu: Macmillan.

National Primary Education Commission, (1998). Training Hand Book for Nigeria Primary School Teachers: Primary Science. Kaduna: Kazzy-Ana Printing and Publishing.

STAN (2011). Nigerian Basic Science Project: Pupils; Textbook Two (New Edition). Lagos: HEBN Publishers Plc.

https://www.youtube.com/watch?v=hZ3miHIE-fg

https://www.google.com/search?q=images+formed+by+a+plane+mirror&client=firefox-b-d&sxsrf=AOaemvLDgCXUhdC1_W8cV9RyOeNM4B0uVg:1636728737696&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjUxoPYiZP0AhVNB2MBHY23AVoQ_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1#imgrc=PkDnKJ25PVN4gM&imgdii=K9nXXpRVnif39M

1.6 Possible Answers to Self-Assessment Exercise(s)

SAE 1

Experiments carried out using improvised instructional materials are referred to as improvisable experiments.

SAEs 2

1.

i. It is the same size as the object
ii. It is as far behind the mirror as the object is in front
iii. It is virtual
iv. It is upright

2.

i. The laws known as laws of reflection states that:
ii. The incident ray, the reflected ray and the normal at the point of incidence all lie on the same plane
iii. The angle of incidence is equal to the angle of reflection

UNIT 2 USE OF LOCAL FRUITS IN TEACHING ACIDS AND BASES

Unit Structure

2.1 Introduction

Acids and Bases are important ingredients in the production of foods and other items in life. Some of the acids and bases could be produced locally using some local fruits and materials.

2.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- produce citric acid, lactic acid and ascorbic acid using locally available materials
- produce calcium hydroxide and potassium hydroxide using locally available materials.

2.3 Making some Acids and Bases using Local Fruits and Materials

Acid-base indicators are the substances which changes color with changes in pH. They are usually weak acids and bases and also known as neutralization indicators. You need acids and bases to teach some concepts in integrated science. In cases where these acids and/or bases are not available, you can improvise by extracting some of the acids found in food. Today various plants extracts are used as acid base indicators.

Natural Indicators

1. Turmeric

Turmeric is yellow in neutral solutions.

Turmeric is yellow acidic solutions.
Turmeric is red in basic solutions.

2. China Rose Petals
China rose indicator is pink in neutral solutions.
China rose indicator is dark pink in acidic solutions.
China rose is green in basic solutions.

3. Red Cabbage Juice
Red cabbage juice turns blue in a basic solution but it shows a distinct red colour in an acidic solution.

Synthetic Indicators:

1. **Phenolphthalein:** Its original colour is colourless. Phenolphthalein is colourless in acidic medium and pink in basic medium.
2. **Methyl Orange:** Its original colour is orange. Methyl orange is red in acidic medium and yellow in basic medium.

2.3.1 Extracting Acids and Bases from Natural Sources

i. Citric Acid

Materials: 10 lime fruits or oranges, beaker, funnel, cloth or wool

Procedure:

- Wash fruits with clean water
- Cut fruit into two and squeeze juice into beaker
- Filter the extracted juice using cloth or cotton wool and funnel

The extracted liquid juice is the citric acid that could be used for science activities.

ii. **Lactic Acid**

Material: Milk
Procedure: Open a tin of milk and leave it overnight. The milk would be covered with a liquid content in the form of lactic acid

iii. **Ascorbic Acid Materials**

- 10 big tomatoes
- Beaker
- Cloth or cotton wool
- Funnel

Procedure

- Wash fruits with clean water
- Cut tomatoes into two parts. Squeeze out the liquid into a beaker
- Pour the extracted liquid into beaker.
- Filter extracted juice using cotton wool or cloth
- Filtered liquid content is ascorbic acid that could be used in teaching acid and bases

iv. **Potassium Hydroxide**

Materials

- Dry cassava peels
- Dry Plantain peel
- Dry Cocoa peel
- Filter, Beaker, Water, Stirrer

Procedure

- Burn any of the above peels alone till it turns to ash
- Put ash into beaker
- Stir mixture very and add water
- Filter mixture using cloth or cotton wool through funnel
- The filtered liquid is potassium hydroxide which could be used for science activities

v. **Calcium Hydroxide**

Materials: Quick lime for white washing spoons and bottles

Procedures

- Put five spoonsful of powdered lime into bottle containing about 100ml of water
- Stir the mixture for some time
- Allow the mixture to settle
- Filter content
- Clear filtered liquid is calcium hydroxide.

Self-Assessment Exercise 1

Which improvised acids do the following materials produce?
a. Oranges
b. milk
c. Tomatoes

2.3.2 Using Local Fruits for Teaching Acids and Bases

Teaching of Acids and Bases require the use of indicators inform of blue or red litmus papers or PH strips for testing. The indicator can be made using red cabbage extract.

Materials/Procedure
Cut red Cabbage, blend it, Sieve the red liquid and add some water

The red liquid content could be used as indicator instead of red litmus paper.

Pour the red fluid into five beakers. Pour the following liquids and note the change of colour of the red liquid.

Observation
1) Vinegar
2) Base
3) Egg Yolk
4) 7up soft drink
5) Baking soda

Acids will turn the pigments in the indicator to a reddish color; bases will turn the pigments bluish or yellow-green.

2.3.3 How to Turn Water Into "wine" in the Integrated Science Classroom

Make ordinary water turn bright pink and then back to clear! This makes a great "magic trick" to impress your students – just be careful no one drinks it!

What You Need:
- Phenolphthalein solution
- Sodium carbonate
- Vinegar
- 5 glasses and a non-see-through pitcher of water

What You Do:

1. In the first glass put a little less than 1/8 teaspoon of sodium carbonate, in the second put 6 drops of phenolphthalein solution, and in the third put three droppers-full of vinegar.
2. Add a few drops of water to the first glass and stir to dissolve the sodium carbonate.
3. Fill all the glasses with water from the jug, and then pour all of them back in the jug except for the glass with vinegar.
4. Refill the remaining four glasses – the water will be red!
5. Now pour all five glasses back in the pitcher. Refill the glasses one last time—the liquid will be colorless again!

What Happened?

Phenolphthalein is a pH indicator, but it only turns colors in reaction to bases. When you poured the four glasses back into the pitcher, the phenolphthalein reacted to the sodium carbonate, a base, and turned the solution to bright pink "wine." To change it back to "water," all you had to do was add the acidic vinegar, which turned the phenolphthalein colorless again.

2.4 Summary

Locally and readily available fruits and vegetables could be used to produce indicators which are necessary in the teaching of acids and bases in integrated science. These fruits and vegetables include red cabbage, Oranges, Cassava peels, Quick lime, Tomatoes, etc. The local indicator changes colour for different materials added to it. Acids and bases are an integrated science concept that sounds abstract to many students. It is necessary for this concept to be taught using visible materials some of which may not be readily available. This is where improvisation comes into play. This unit has shown you different locally available materials that can be used to produce the acids and bases we need in the laboratory.

Self-Assessment Exercise 2

1. Click on this link to learn more about natural materials you can use as indicators https://scienceexplorers.com/teaching-children-about-acids-and-bases/
2. Click on this link to watch the video of turning water into "wine" experiment https://learning-center.homesciencetools.com/article/acid-base-reactions-ph-experiments/

2.5 References/Further Readings/Web Resources

Parker, J. (2011). Investigating the use of improvised Instructional Materials in Teaching Acids and Bases concepts among Diploma in Basic Education Students in Enchi College of Education.

https://scienceexplorers.com/teaching-children-about-acids-and-bases/
https://learning-center.homesciencetools.com/article/acid-base-reactions-ph-experiments/

2.6 Possible Answers to Self-Assessment Exercise(s)

Self-Assessment Exercise	
a.	Oranges……citric acid
b.	Milk……lactic acid
c.	Tomatoes ……..ascorbic acid

UNIT 3 EGG IN THE BOTTLE EXPERIMENT (DEMONSTRATION) ON PRESSURE

Unit Structure

3.1 Introduction

The previous unit discussed the different locally available fruits that we can extract acids and bases from. This unit will go further to discuss air pressure using the egg-in-the-bottle experiment.

3.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- demonstrate egg in the bottle experiment
- give some reasons behind your observations.

3.3 Demonstration of Egg in Bottle Experiment

Materials needed

- 3 peeled hard-boiled egg
- A glass bottle or flask with an opening slightly smaller than the diameter of the egg
- Paper and lighter/matches or very hot water or very cold liquid

Method 1

i. Set a piece of paper on fire and drop it into the bottle
ii. Set the egg on top of the bottle with the smaller side downward
iii. When the flame goes out the egg will be pushed or sucked into the bottle.

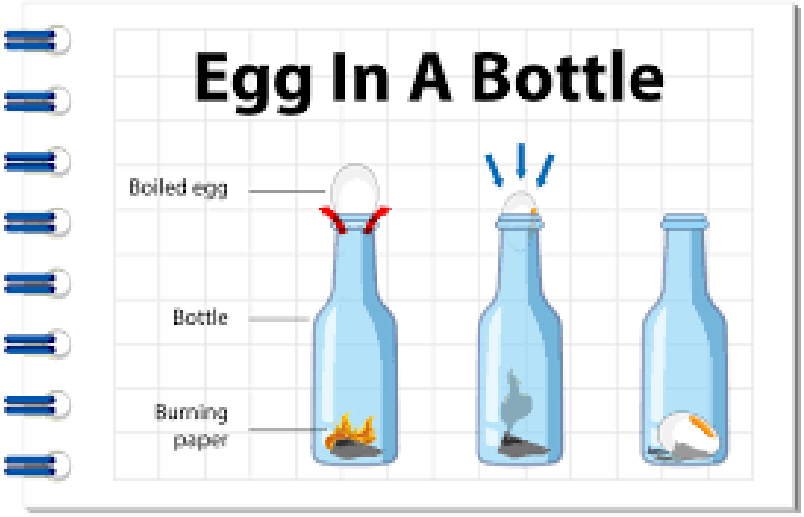


Fig. 1: Egg in a bottle experiment

Why does the egg get sucked into the bottle?

Method 2

- Set the egg on the bottle
- Run the bottle under very hot water
- Warmed air will escape around the egg
- Set the bottle on the counter
- As the bottle cools, the egg will be pushed into the bottle

Click on this link to watch a video on the egg in the bottle experiment https://www.youtube.com/watch?v=6R215vLf29w

Method 3

- Set egg on bottle
- Immerse the bottle in very cold water
- When the bottle is chilled, the egg is pushed into the bottle.

3.4 Summary

You have learnt about effect air pressure and some factors affecting air pressure. When you change the temperature of the air inside the bottle, you change the pressure of the air. If you cool the air, the pressure decreases. The change in pressure causes the sucking in/pulling or pushing of the egg. The change of temperature of air in or around air affects its pressure which makes it push or pull an item.

Self-Assessment Exercise 1

Explain a procedure for getting an egg into a bottle?

3.5 References/Further Readings/Web Resources

Chemistry.about.com

https://www.youtube.com/watch?v=6R215vLf29w

https://www.google.com/search?q=egg+in+the+bottle+experiment&client=firefox-b-d&tbm=isch&sxsrf=AOaemvK8pUsEvHtBMCT5iaqOKWJEdRjauQ:1636918259130&source=lnms&sa=X&ved=2ahUKEwjM-fHay5j0AhWTBGMBHegSCh4Q_AUoAnoECAEQBA&biw=1366&bih=643&dpr=1#imgrc=g0zo9Jo9V3mn_M

3.6 Possible Answers to Self-Assessment Exercise(s)

Method 1

i. Set a piece of paper on fire and drop it into the bottle
ii. Set the egg on top of the bottle with the smaller side downward
iii. When the flame goes out the egg will be pushed or sucked into the bottle.

UNIT 4 MATHEMATICS VALUE OF CONSTANT pi (∏)

Unit Structure

4.1 Introduction

In Mathematics and Sciences there a term that is used in formula for determination of area or volume of a circle or a sphere. This term is called pi (π). This unit will teach us how the value of Pi can be determined.

4.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- identify the process for calculating Pi (π) which is a constant used for finding the area of circle or sphere
- determine the value of pi (π) using available local resources.

4.3 Determination of Pi (∏) using available resources

Materials needed

- Five empty tins of different diameters
- Ruler
- Thread

Procedure

i. Measure the circumference and Diameter of the five different tin cans and record in the table below
ii. Divide the value of the circumference with value of the diameter(C/D)
iii. What do you observe about the calculated value of ratio of circumference to diameter of the tins?

Tin number	Circumference(C)	Diameter (D)	C/D	Remark
1				
2				
3				
4				
5				

4.4 Conclusion

The ratio of circumference to diameter of tins of various sizes is expected to be constant

4.5 Summary

The ratio of circumference to the diameter of tin cans gives a constant value equal to the value of pi. Pi is used in determination of circumference and area of circle and spheres.

Self-Assessment Exercise 1

What is the relationship between diameter and radius of a circle?

Determine the ratio of circumference and radius of the given tins and compare with ratio of circumference and diameter.

4.6 References/Further Readings/Web Resources

Wilson R. (2014). The History of pi, www.math.rutgers.edu (14/02/2015).

4.7 Possible Answers to Self-Assessment Exercise(s)

Self-Assessment Exercise

1. 2 x radius = diameter or
2. Diameter / 2 = radius

UNIT 5 FISH POND AND AQUARIUM – LESSON ON FISH

Unit Structure

5.1 Introduction

A science teacher should always be prepared to construct a piece of science equipment in the laboratory. The construction can be made from available local materials. When a teacher improvises a piece of science equipment by making an entirely new material from locally available resources or tries to modify an existing instrument to serve the same purpose, he/she is improvising through a construction process. In this unit, you are introduced to glass fish pond and aquarium which are improvised delivery of lesson content on aquatic animals e.g., fishes.

Fig. 1: Improvised aquariums

5.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- list materials required for the construction of a glass fish pond
- identify materials required for the construction of aquarium
- describe how glass fish pond and aquarium are constructed
- identify differences between glass fish pond and aquarium.

5.3 A Lesson on Fish I

Assuming you want to teach a lesson requiring the use of a glass fish pond but it is not available in your class, you may need to improvise. The materials you need for improvised glass fish pond include the following:

- Cellophane bag
- An empty sugar carton
- Water
- Fish fingerlings

Procedure
You can improvise glass fish pond from a cellophane bag well tucked into an empty sugar carton to hold water. Some life tadpoles can be caught and put in it. This will serve as a substitute for a glass fish pond. With this improvised fish pond, you can deliver lessons on can be used to teach lessons on fish; features, movement, types of fish, among others.

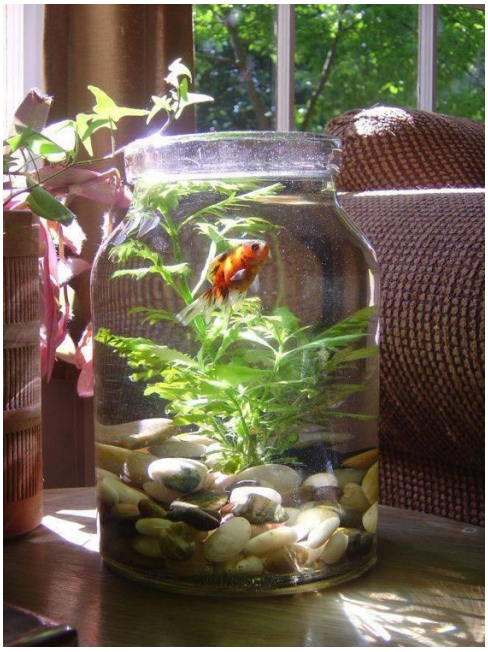


Fig. 2: A home-made fish tank

5.3.1 A Lesson on Fish II

Suppose you want to teach a lesson on fishes and you do not have an aquarium in your school and there is no nearby stream, you need to improvise an aquarium.

Materials required: Materials required for a construction of aquarium include the following:

i. A small or medium sized strong cardboard box
ii. A large transparent plastic bag or sheet of plastic bag enough to hold the box
iii. A razor blade or very sharp knife
iv. White board markers
v. Paper clips
vi. Masking tape

Procedure

1. The procedure to be followed in the construction is as follows:
2. With the top flaps of the box sticking out, mark and cut two windows in each short side
3. Fold the top flaps inside and cut off any bits that cross the windows you have cut.
4. Tape down the top flaps firmly inside the box
5. Place plastic bag or sheet in the box pressing it firmly right down into the corners, making neat folds.
6. Drape it over the top of the box and temporarily fasten it down with paper clip.
7. Put a layer of sand in the bottom making sure that the plastic is in contact with cardboard at all points, particularly in the corners.
8. Move box to its permanent home position since it cannot be moved once it is filled.
9. Fill carefully with water and adjust plastic as necessary.

Trim off the excess plastic and fasten it down with tape. The improvised aquarium is now completed and can be used to preserve some fishes. The preserved fishes can then be used for science lesson when the need arises.

5.3.2 How to Make a Bottle Aquarium in Pictures?

Step 1: Get a clean glass or plastic bottle with a lid

Step 2: Fill the bottle with pebbles

Step 3: Add a plant

Step 4: Add clean water

Step 5: Perforate the Lid

Step 6: Add the fingerlings

Step 7: The result

Self-Assessment Exercise 1

List at least five (5) materials required for the construction of an aquarium.

5.4 Summary

In this unit, you have learnt that:

1. Some experiments can be carried out using improvised materials. This means that improvisation is a very important technique concerned with substituting, replacing or modifying a science apparatus or requirement for a particular function.
2. The procedures for improvisation include substitution and construction
3. Science teachers are advised to encourage students' participation in the making of improvised materials so that they can get maximum educational benefits from them.

Construction of glass fish ponds and aquariums are possible. They can be used to teach aquatic life/fishes in an Integrated Science lesson. A teacher needs to be innovative and creative to try this form of improvisation (i.e., construction).

5.5 References/Further Readings/Web Resources

Ango, M. (1990). *Basic Science Laboratory*. Jos: Ehindero (Nig) Ltd.

National Primary Education Commission (1998). A Training Handbook for Nigeria Primary School Teachers: Primary Science. Kaduna: Kazzy-Ana Printing and Publishing.

Ministry of Education Jamaica (1981). Improvisation in Science: A Handbook for Teachers. Kingston: The Gleaner Co. Ltd.

https://www.google.com/search?q=homemade%20plastic%20bottle%20aquarium&tbm=isch&client=firefox-b-d&hl=en-GB&sa=X&ved=0CFsQrNwCKABqFwoTCOC-_cHOmPQCFQAAAAAdAAAAABAD&biw=1349&bih=643#imgrc=gAHOaM1FG5GZvM

https://getcraftideas.com/2018/06/22/how-to-make-bottle-aquarium/

5.6 Possible Answers to Self-Assessment Exercise(s)

Materials required: Materials required for a construction of aquarium include the following:

i. A small or medium sized strong cardboard box
ii. A large transparent plastic bag or sheet of plastic bag enough to hold the box
iii. A razor blade or very sharp knife
iv. White board markers
v. Paper clips
vi. Masking tape

MODULE 3 DEVELOPMENT OF IMPROVISED APPARATUS IN INTEGRATED SCIENCE

UNIT 1 DEVELOPMENT OF APPARATUS FOR BIOLOGY ASPECT OF INTEGRATED SCIENCE: RESPIRATORY SYSTEM (LUNGS)

Unit Structure

1.1 Introduction

Constructing a lung is a very good way to learn about the respiratory system and how the lung functions. This unit will teach you how. Teaching and learning of Integrated Science require the use of instructional materials standard teaching aids may not be available when needed this is why improvisation of the required teaching aid becomes necessary.

1.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- construct a model of a lung using local resources
- explain how the lung works.

1.3 Improvised Lungs

The lungs provide an avenue for gas exchange between air from the outside and gases in the blood. The lungs control breathing. To construct a lung model, the following materials are required:

Materials

1. Plastic bottle – 2 liters,
2. Rubber band
3. Plastic tubing,
4. Scissors
5. Y-shaped connector,
6. Electrical tape
7. Balloons (3 large ones)

Procedures

1. Fit the plastic tubing into one of the openings of the hose connector.
2. Make airtight seals around tubing and hose connector using electrical tape
3. Place a balloon around each of the remaining two (2) openings of the connectors
4. Wrap rubber tightly around balloons when the balloons and hose connector meet
5. Measure two inches from bottom of 2-liter bottle and cot bottom off.
6. Place the balloons and hose connector structure inside the bottle, threading the plastic tubing through the neck of bottle.
7. Use tape to seal the opening where the plastic tubing goes through the narrow opening of the bottle at the neck. The seal should be airtight.
8. Tie a knot at the end of the remaining balloon and cut the large part of the balloon in half horizontally.
9. Using the balloon half with knot, stretch the open end over the bottom of the bottle
10. Gently pull down the balloon from the knot. This should cause air to flow into the balloons within your long model
11. Release the balloon with the knot and watch as the air is expelled from your lung model.

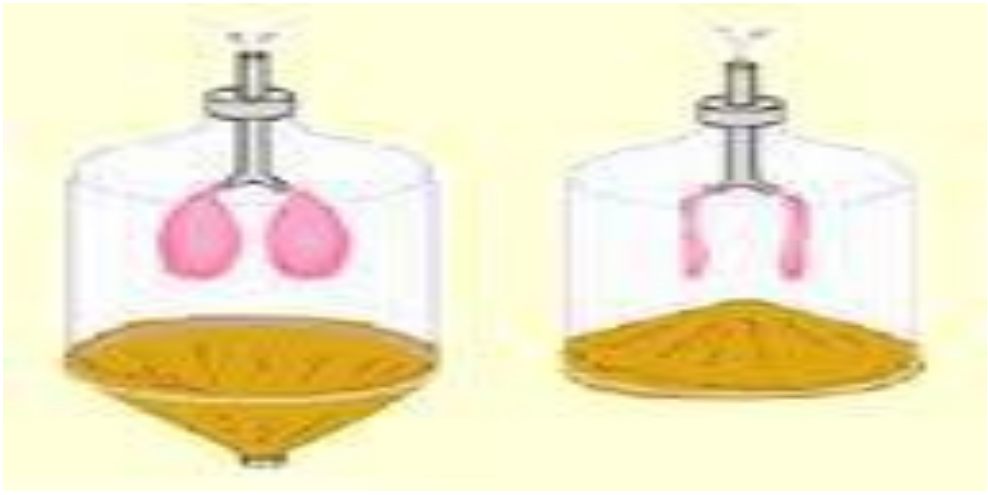


Fig. 1: Diagram of improvised lungs showing breathing in and out

Self-Assessment Exercise

Using the pictures below;
1. Identify the materials used in making these improvised lungs.
2. Explain how human lungs work.

Fig. 2: Improvised model of lungs

1.4 Summary

Lung is the main organ for respiration. Constructing it using local materials is an avenue for learning about the respiratory system. Lungs regulate breathing. They provide an avenue for the exchange of air from the outside environment and gases in the blood. To teach about this very important organ, it is necessary that the teacher uses some instructional

materials. This unit has taught you how to construct a typical set of human lungs.

1.5 References/Further Readings/Web Resources

Bailey, R. (2015). Improvised Lungs, biology.about.com

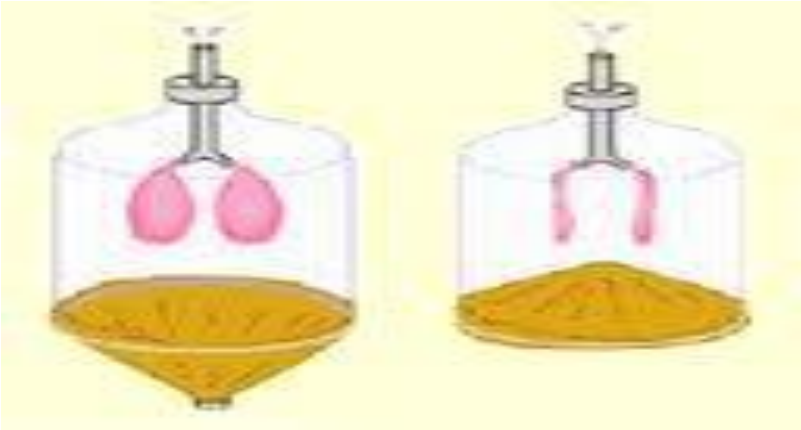
https://www.google.com/search?q=improvised+model+of+lungs&client=firefox-b-d&sxsrf=AOaemvIMlGmATDnhACOEH9Cv9LqZm3MVww:1636920303650&source=lnms&tbm=isch&sa=X&ved=2ahUKEwihuOWp05j0AhUN8xQKHRmlCLMQ_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1

1.6 Possible Answers to Self-Assessment Exercise(s)

Materials

1. Plastic bottle – 2 liters,
2. Rubber band
3. Plastic tubing,
4. Scissors
5. Y-shaped connector,
6. Electrical tape
7. Balloons (3 large ones)

2. How Human Lungs Work



UNIT 2 DEVELOPING OF APPARATUS FOR CHEMISTRY ASPECT OF INTEGRATED SCIENCE

Unit Structure

2.1 Introduction

A thermometer measures how hot or cold a substance is. This unit will teach us how to construct a thermometer.

2.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- identify local materials required for the construction of a thermometer
- construct thermometer using local materials.

2.3 Improvised Thermometer

Materials
The materials needed for construction of improvised thermometer are as follows:

1. Plastic Water bottle
2. Marker
3. Clean plastic straw
4. Food coloring
5. Water
6. Flash board
7. Clay or Plasticine

Procedure
i. Put a few drops of food coloring into water
ii. Fill water bottle with colored water
iii. Insert plastic straw into the bottle and mold the clay to seal the bottle air tight
iv. Use a marker to mark level of the water

v. Set the bottle in a bowl of boiling water, watch the level and mark
vi. Set the bottle in a bowl of ice water, watch the level and mark.
vii. Divide the separation between the marked level for hot boiling water and that for ice into one hundred bits
viii. Observe the freezing and boiling points for water several times to get better points
ix. Fix the labeled straw on a flash board

This thermometer could be used for observing change in temperature but not for measuring temperature accurately.

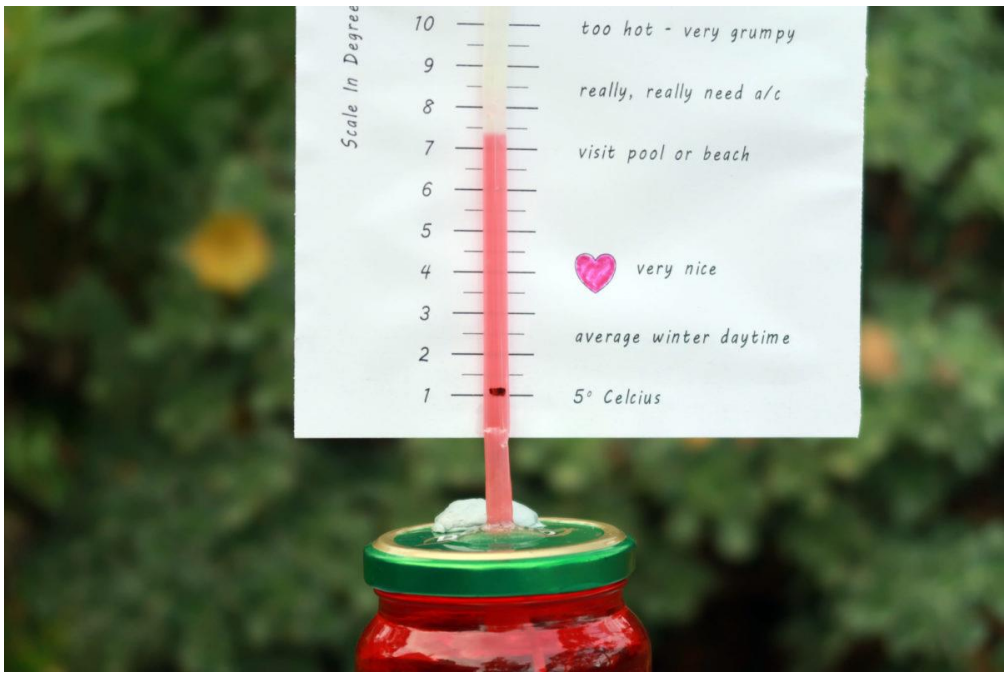


Fig. 1: How to make a thermometer

2.4 Summary

A thermometer measures temperature . It could be improvised for showing change in temperature using transparent straw, plastic bottle and colored water. This unit has shown you that you can construct a thermometer to supplement the little you may have in your laboratory. This way, every student will have a thermometer to work with.

Self-Assessment Exercises

List some materials needed for construction of improvised thermometer

2.5 References/Further Readings/Web Resources

Make thermometer (2014). Home Training Tools Ltd.

https://www.google.com/search?q=improvised+thermometer&client=firefox-b-d&sxsrf=AOaemvIAufQqo9WafossoLPgflsudCWyKw:1636920373227&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiKmPzK05j0AhVlDmMBHWvtDa0Q_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1#imgrc=LfIuygjuVJReQM&imgdii=LwIJob3-4v14oM

2.6 Possible Answers to Self-Assessment Exercise(s)

Materials

The materials needed for construction of improvised thermometer are as follows:

1. Plastic Water bottle
2. Marker
3. Clean plastic straw
4. Food coloring
5. Water
6. Flash board
7. Clay or Plasticine

UNIT 3 DEVELOPENT OF APPARATUS FOR PHYSICS ASPECT OF INTEGRATED SCIENCE

Unit Structure

3.1 Introduction

Electric energy can be converted into useful work or mechanical energy using simple machines called Electric Motor. This unit will show us how to construct an electric motor for effective teaching of the concept of electricity.

3.2 Intended Learning Outcomes

By the end of the unit, you will be able to:

- identify materials needed for the construction of electric motor
- construct a simple electric motor using local materials around.

3.3 Improvised Electric Motor

Electric motor works due to the interaction of current and magnetic fields. To construct electric motor, you need the following:

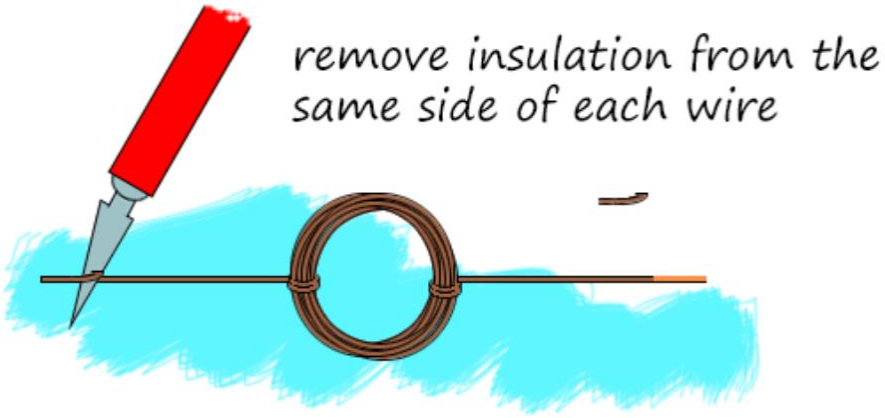
Materials

1. 2 long metal sewing needles
2. 1.5-volt battery
3. Electric tape
4. Small Circular Magnets
5. Plasticine or Molding clay
6. Knife
7. Marker

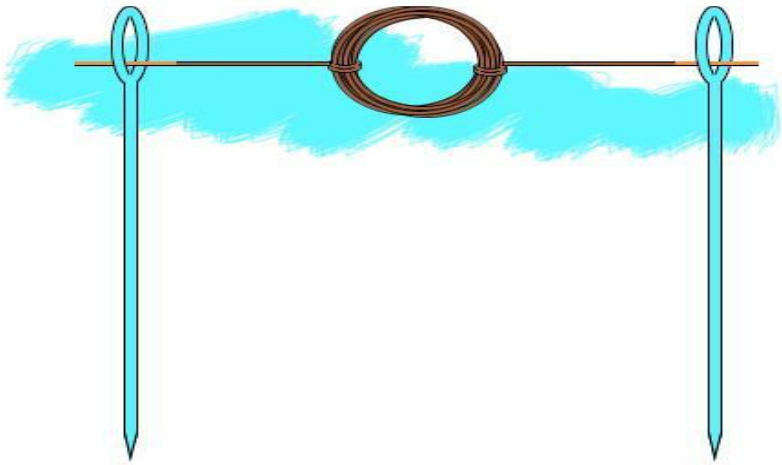
Procedure

i. Starting from center of the wire, wrap the wire tightly around the battery 30 times.
ii. Slide the coil off the battery
iii. Wrap each loose end of the wire round the coil a few times to hold it together, then point the wires away from the loop

iv. Remove top-half of the wire insulations on each of free end of coil



v. Thread each loose end of the wire through the large eye of the napkin safety pin keeping coil as straight as possible



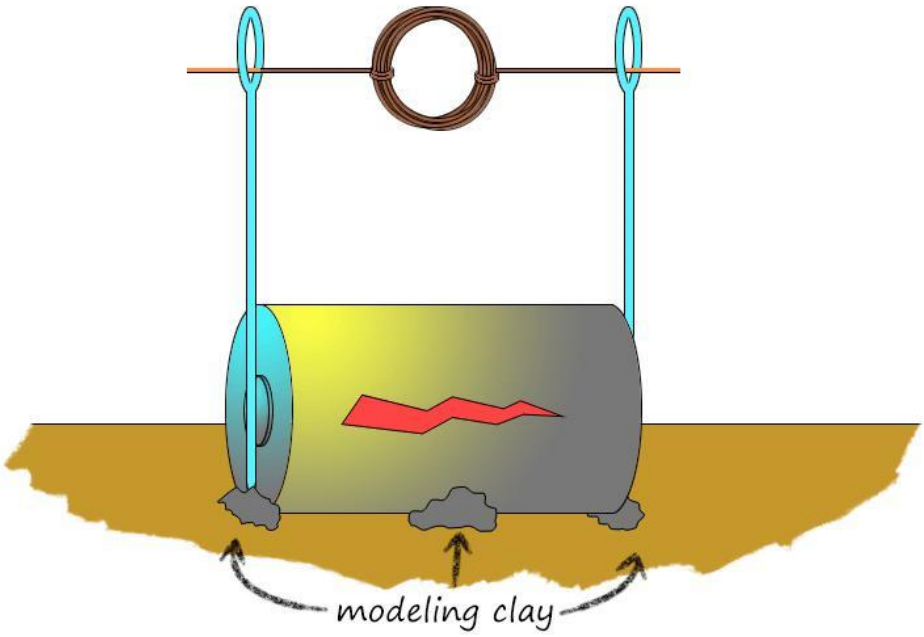
vi. Lay battery sideways on a flat surface

vii. Stick some clay/plasticine on either side of the battery to keep it from rolling away

viii. Place the safety pins upright next to the terminals of each side of the battery

ix. Use elastic tape to paste the needle to each end of the battery. Your coil should be hanging above the battery

x. Tape the small magnet to the side of the battery so that it is at the center underneath the coil



xi. Give the coil a spin, the spin is expected to spin round continuously in one direction

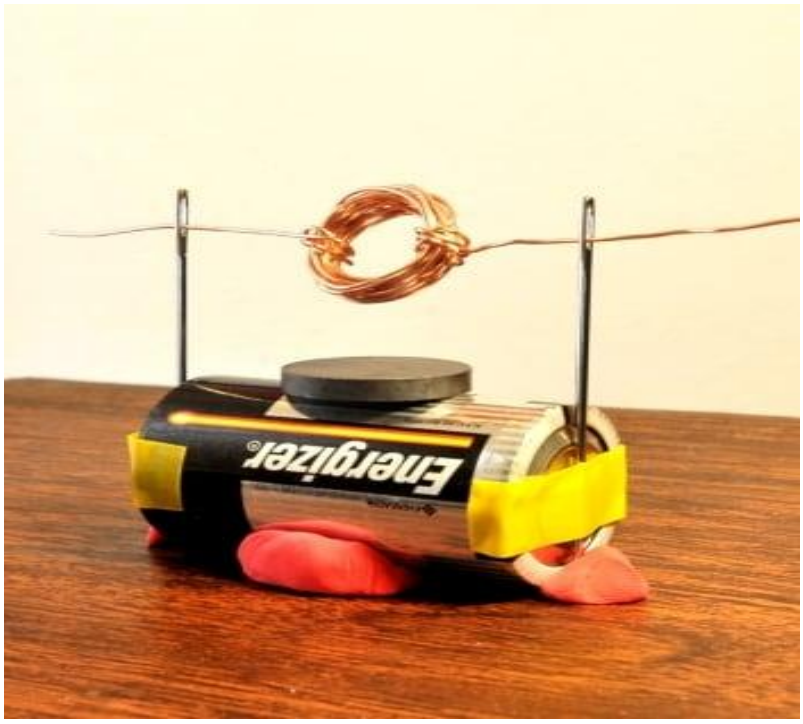


Fig. 1: An improvised electric motor

Self-Assessment Exercise 1

Draw diagram for the construction of improvised electric motor

3.4 Summary

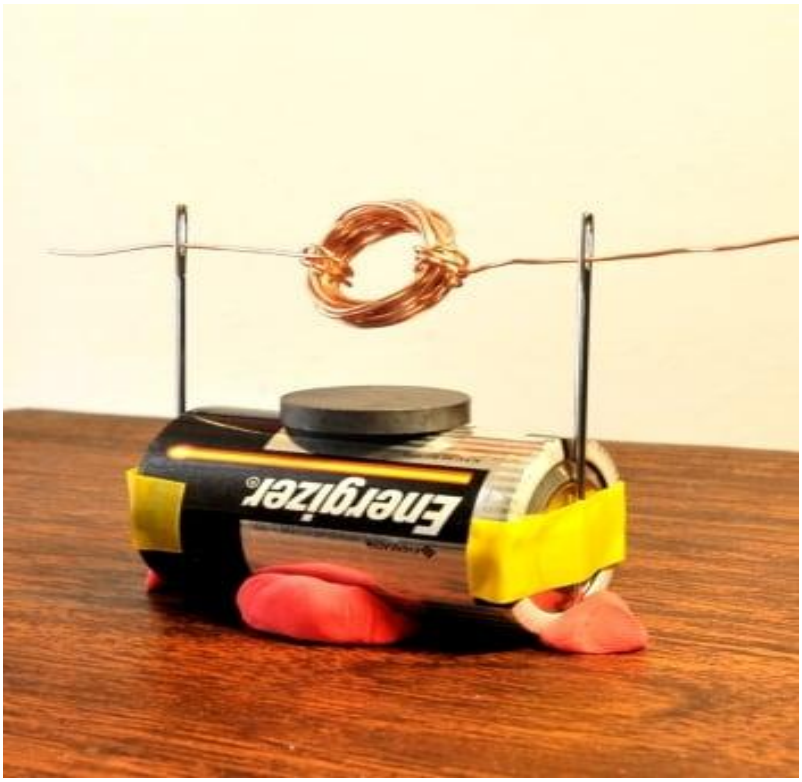
Electric motion is due to the interaction of electric current and magnetic field. Electric motor is one way of showing energy conversion from electrical to mechanical energy. Energy comes in different forms. Electric energy can be converted into mechanical energy by an electric motor.

- Identify the materials needed for construction of an improvised motor.

3.5 References/Further Readings/Web Resources

https://www.google.com/search?q=improvised+electric+motor&client=firefox-b-d&sxsrf=AOaemvL-OqMRM4z9zYX6p4SLfUaqk5qrXA:1636920743732&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjBhtL71Jj0AhXw1uAKHZRkDQEQ_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1#imgrc=wFM87uDVagJ3aM

3.6 Possible Answers to Self-Assessment Exercise(s)



SAE 2

Improvised Electric Motor

Electric motor works due to the interaction of current and magnetic fields. **Materials needed are:**

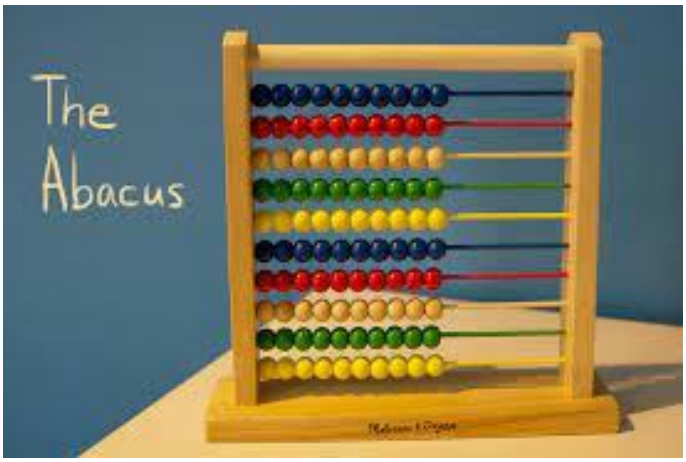
1. 2 long metal sewing needles
2. 1.5-volt battery
3. Electric tape
4. Small Circular Magnets
5 Plasticine or Molding clay
6. Knife
7. Marker

UNIT 4 DEVELOPMENT OF APPARATUS FOR MATHEMATICAL ASPECTS OF INTEGRATED SCIENCE

Unit Structure

4.1 Introduction

In teaching numbers which is needed in foundation science, abacus is one instrument commonly used. It is used in teaching values of numbers. Several forms of abacus have been developed and one cheaper and effective one is the square column paper abacus.



4.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- construct square column paper abacus
- describe how to use the paper abacus.

4.3 Square Column Paper Abacus

Numbers more than nine and less than hundred are represented by two-digit numerals. Numbers more than ninety-nine and less than thousand are represented by three-digit numbers and so on. The place values from

the right are respectively units, tens, hundreds, thousands, millions and so on.

An instrument for teaching the place value has been the abacus. There are wooden base, rods, beads and spikes abacuses. Every time ten objects are placed in a spike; they are removed and one object is placed in the spike to the immediate left to represent ten removed objects.

Square graph paper could now be used as the abacus. A column is assigned to place values and dots that could be used instead of the spikes or beads used in other forms of the abacus. It is cheaper and safer to use paper abacus than other forms.

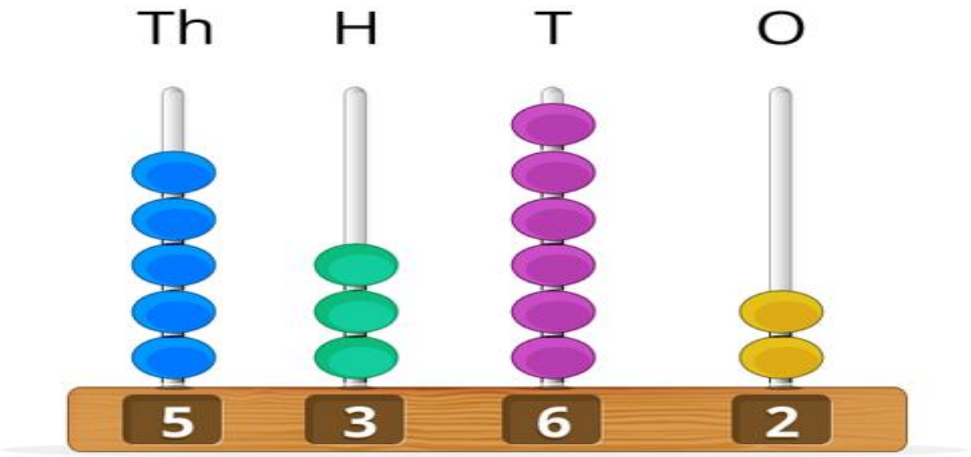


Fig.1: The Abacus

4.4 Summary

Abacus is used for teaching place values. Abacus can be made using a variety of materials. One of such materials is the square paper. The paper abacus is easy to make and can be done by the students in the class.

Self-Assessment Exercise

Sketch diagram of an abacus made of beads.

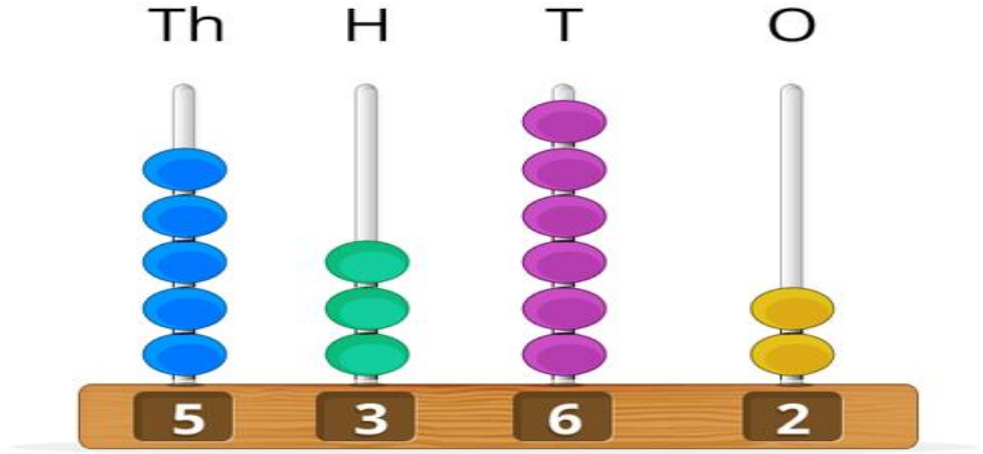
4.5 References/Further Readings/Web Resources

Srinivasan, S. P. K. (2014). Square Column Paper Abacus, Manual of Mathematics Teaching Aids for Primary School, National Council of Education Research and Training, New Delhi.

https://www.google.com/search?q=improvised+abacus&tbm=isch&ved=2ahUKEwiTwMHG1Zj0AhXNwYUKHeDSA-IQ2-

4.6 Possible Answers to Self-Assessment Exercise(s)

DIAGRAM OF ABACUS



UNIT 5 DEVELOPING OF ASPECTS OF INTEGRATED SCIENCE

Unit Structure

5.1 Introduction

Many instruments for teaching integrated science can be improvised using local materials. Procedure for improvising a rain gauge is described in this unit.

5.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- identify local materials that can be used to improve rain gauge
- improvise a simple rain gauge.

5.3 Improvised Rain Gauge

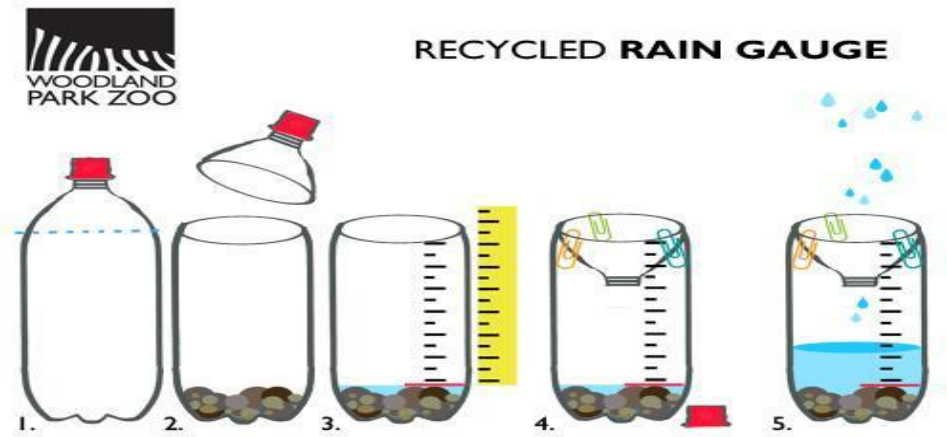


Fig.1: Procedure for construction of improvised rain gauge

Materials

- An empty big water bottle
- A knife
- Masking tape
- Ruler

- Permanent Marker

Procedure

i. Cut the bottle from top shoulder of the bottle.
ii. Place some gravel and little water to form zero base measurement of height
iii. Run a line of masking tape along the height of the bottle base
iv. Using marker and a ruler mark every centimeter and millimeter along the tape
v. Remove the cover and turn the top part of the bottle upside down into the base of the marked bottle. Stick with tape or pin if needed.
vi. Place the improvised gauge outside when it is raining to catch the rain.

Making a Rain Gauge in Pictures

There's no better way to learn about the weather than to observe it and experience it first-hand. Keep track of your local precipitation with a simple rain gauge made from a clear plastic bottle. If you calibrate it carefully, you can take quite accurate readings.

1. Cut the top section off a clear bottle as shown. Use a ruler to mark measuring increments starting about 2" from the bottom.

2. Place several small rocks in the bottom (for weight), then fill the bottle with water to the 0 mark. This will calibrate your gauge.

3. Invert the top of the bottle into to rain gauge to act as a funnel. Place gauge on a flat surface outside.

4. Wait for the next rain and observe and record rainfall amounts.

Self-Assessment Exercise

Discuss the materials and procedure that can be used to improvise rain gauge

5.4 Summary

Rain gauge is used for measuring the amount of rainfall per given time. Rain gauge could be locally improvised using a clean two-liter plastic bottle. When the bottle is cut into two, the base serves as the collector while the upper part serves as the funnel. Using the gauge will assist

students learn measurement, capacity, change in volume, rain, water cycle, weather, seasons and many other related concepts.

5.5 References/Further Readings/Web Resources

www.wikihow.com/Build-a-Rainguage Indian Weatherman.com
https://www.communityplaythings.com/resources/articles/2017/making-a-rain-gauge

5.6 Possible Answers to Self-Assessment Exercise(s)

Materials

- An empty big water bottle
- A knife
- Masking tape
- Ruler
- Permanent Marker

Procedure

i. Cut the bottle from top shoulder of the bottle.
ii. Place some gravel and little water to form zero base measurement of height
iii. Run a line of masking tape along the height of the bottle base
iv. Using marker and a ruler mark every centimeter and millimeter along the tape
vii. Remove the cover and turn the top part of the bottle upside down into the base of the marked bottle. Stick with tape or pin if needed.
viii. Place the improvised gauge outside when it is raining to catch the rain.

UNIT 6 DEVELOPING OF ASPECTS OF INTEGRATED SCIENCE

Unit Structure

6.1 Introduction

You always think of microscopes as very complicated equipment; right? Did you know that you can make a microscope using just three materials from around your house? This unit will teach you how!

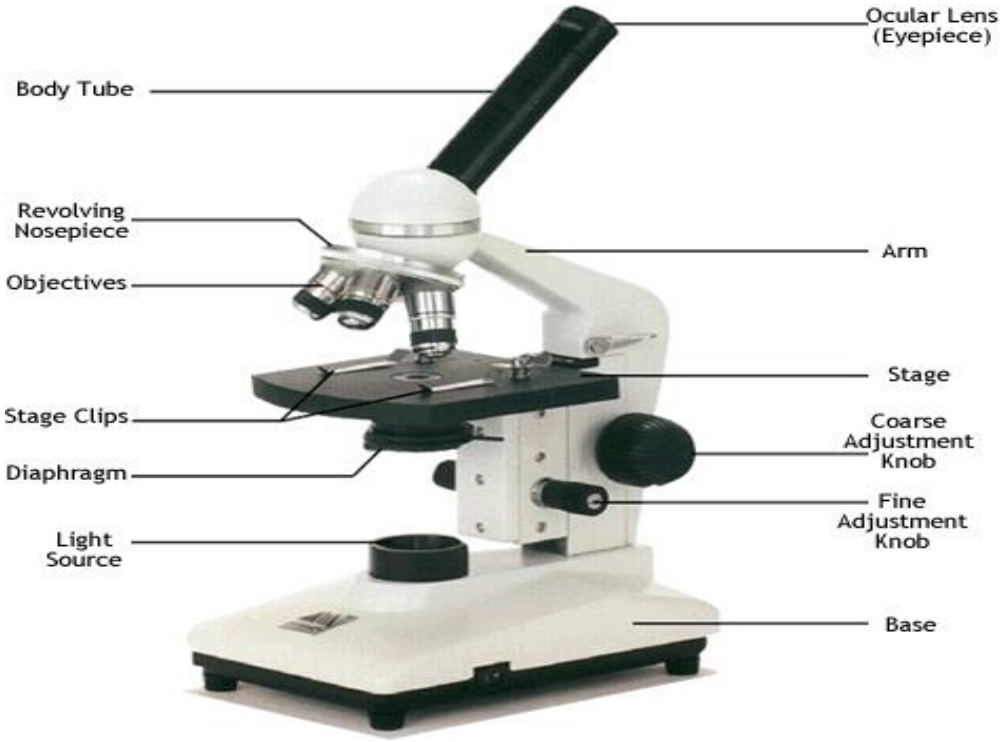


Fig. 2: A standard normal microscope

6.2 Intended Learning Outcomes

By the end of this unit, you will be able to:

- build your own microscope.

6.3 An improvised Microscope

Materials

- Clear tape
- 2 pencils
- Pipette
- Microscope slides (or you can use small objects from around the house)
- Water

Procedure

Step1: Set two pencils down facing each other. Make them about as far apart as the length of your slides to keep things easy.

Step 2: Stick a long piece of tape over the two pencils and to the table on either side of the pencils to hold the tape tightly between the two pencils like a bridge.

Don’t touch the sticky side of the tape or you will ruin the microscope.
Drop a small drop of water onto the top of the tape using the pipette.

Step 3: Make 3-4 lines of tape and add a different-sized drop to each one. This will help determine what size of water droplet produces the biggest magnification.

Slide a microscope slide under the pieces of tape and observe.

Step 4: Make 3-4 lines of tape and add a different-sized drop to each one. This will help determine what size of water droplet produces the biggest magnification. Slide a microscope slide under the pieces of tape and observe. The slide will be magnifying 4 times or more, depending on the size of your drop.

The slide will be magnifying 4 times or more, depending on the size of your drop.

How it actually works

A bead of water acts similarly to the lens of an eye. The droplet of water refracts the light and tricks your eyes into seeing the object larger than it actually is. We found that smaller drops of water were actually able to magnify the slides to a larger size than big drops of water.

6.4 Summary

A microscope is not as complicated as we think. We can make it for integrated science students. Although it may not give correct readings because it is not caliberated, it will surely make your integrated science class fun! This unit has shown us how to make a microscope using simple objects.

Self-Assessment Exercise

Discuss the working of an improvised microscope discussed in this unit

6.5 References/Further Readings/Web Resources

https://raisinglifelonglearners.com/easy-homemade-microscope/

https://www.wikihow.com/Make-a-Microscope

https://www.youtube.com/watch?v=83mrft-la70

6.6 Possible Answers to Self-Assessment Exercise(s)

How improvised microscope actually works

A bead of water acts similarly to the lens of an eye. The droplet of water refracts the light and tricks your eyes into seeing the object larger than it actually is. We found that smaller drops of water were actually able to magnify the slides to a larger size than big drops of water.