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(MMU)

SCHOOL OF EDUCATION

BACHELOR OF EDUCATION PROGRAMME

Module

CIM 323: PHYSICS TEACHIING METHODS

MAERA JOHN

© 2016 Third Edition

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Narok-Kenya

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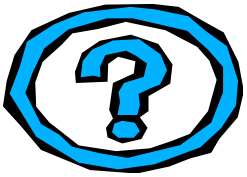
Symbols used

Take Note

Further Reading

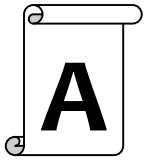
Question



A question: This symbol indicates that there is a …?...

Written Exercises

Activity

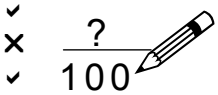


Summary

Congratulations

Definitions of Key Words

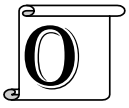
Self-Diagnosis Test



Written Assignment

My score

Objectives



General Introduction

The chapters in this module are called units. Each unit contains a self - diagnosis, a list of specific objectives, an introduction, the unit text, an overview, questions, and notes, activities written exercises, written assignment and suggestions for further readings. The objectives inform you very specifically about what you should be able to do at the end of the unit. Written exercises and answers to written exercises inform you of the progress you are making towards mastering the content of the unit.

Throughout these units you will find activities. These activities are designed to help you study more effectively. Do not skip the activities. Do all of them. You may do the activities in your head or respond in writing.

We would recommend that you use the following general study plan:

1. Do the self-diagnosis test.
2. Read the instruction.
3. Examine carefully the unit objectives. Find out what you are expected to do upon completion of the unit.
4. Read through the, from time to time to see how well you are mastering the objectives. Review what you do not understand. Try the written exercises and activities.
5. Read some of the suggested reading.
6. Do the written assignment. Assignments should be submitted to the Head, Department of curriculum and instruction (MMU). They will be evaluated by your unit lecturer and returned to you.
7. Discuss any problems by e-mail or telephone or present your problems to your lecturer during face – to - face residential sessions.
8. Expect to spend a minimum of three months to complete the module.
9. To earn credit in a course, you must complete all required assignments, two continuous assessment tests and pass an end of semester examination to demonstrate your mastery of the course content.
10. You have three months from the date of registration for a course to complete the module. Renewals of one semester are permitted.

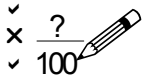
Enjoy the module

TABLE OF CONTENTS

UNIT ONE: HISTORICAL DEVELOPMENT OF PHYSICS AND CONTRIBUTION TO SOCIETY

Self-diagnostic Test

Answer all questions

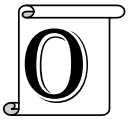


1. When did Physics as a proper Science start?
2. Explain what you understand term physics.
3. Differentiate between the roles played by the teacher and the learner during physics concept formation.

Introduction

This unit deals with the history of physics which focuses on its origin, and its spread to other parts of the world. The unit then goes on to discuss the nature of physics and then finally examines the main contributions of physics to society.

Specific Objectives



After studying this unit, you should be able to:

1. Explain the early activities that formed the basis for modern physics.
2. Apply the lessons learned from the history of physics to classroom situations.
3. Explain the contributions of physics to society.
4. Explain what is meant by nature of physics.
5. Discuss the factors that retarded the development of Physics.
6. Identify the various skills that a physics learner acquires in the process of learning physics.

Content

Historical Development of Physics

Earliest forms of Physics started about 2000 BC in the Middle East and this is in accordance with the available documents. The Middle East region comprised such places as Egypt, Greece, Italy (Rome), Iran (Persia) and Iraq (Mesopotamia).

The Nature of Physics

Physics, a major science deals with the fundamental constituents of the universe, the forces they exert on one another and the results produced by these forces.

To describe physics as the study of motion, energy, heat, waves, sound, light, electricity, magnetism, matter, atoms, molecules, and nuclei. This description, aside from sounding like the table of contents of a high school physics textbook, does not really specify the nature of physics

What is Physics?

It is a part of science that deals with the interaction of matter with energy. This can be through collisions, motion through electric, magnetic or gravitational fields etc

Rationale for offering physics

Physics is not just the study of the natural phenomena listed above but it is also a process; a process which has two distinguishable aspects.

(i) The first of these is simply the *acquisition of knowledge* of our physical environment.

(ii) The second, and perhaps more interesting, is the creation of a *world view* which provides a framework for understanding the significance of this information.

These two activities are by no means independent of each other. One requires a world-view to acquire new knowledge and vice versa one needs knowledge with which to create a world view. But how does this process begin?

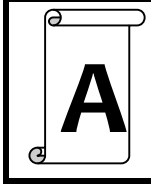
Which comes first, the knowledge or the world-view? These two processes arise together, each creating the other. This is analogous to a present day theory concerning the existence of elementary particles. According to the bootstrap theory, the so-called elementary particles such as protons, neutrons, and mesons are actually not elementary at all but rather they are composites of each other which create each other.

The study of physics is generally recognized to be quite old but there are differences of opinion as to how old. Some would argue that physics began in Western Europe during the Renaissance with the work of Copernicus, Galileo, Kepler, and Newton. Others would trace the beginnings back to the early Greeks and credit he Ionian Thales with being the world's first physicist. For me, physics is much older having begun with man himself. Man became a scientist for the sake of his own survival. The very first tool-makers were scientists. They discovered that certain objects in their physical environment were useful for performing certain tasks. Having learned this they went on to improve on these found objects first by selecting objects more suitable for the task involved and later actually altering the materials they found to produce manufactured tools. The type of reasoning involved in this process is typical of the scientific method in which an observation of nature is made. For early man, the generalization made was not a theoretically but rather a useful tool.

Examples of this form are found in the mythology of ancient Egypt, Greece, India, Babylonia, Polynesia and North America. The other classes of myths include creation by an earth diver, creation from a cosmic egg, creation from chaos, and creation from nothing. In the earth diver myths an animal or god dives into a body of water to retrieve a tiny particle of earth which then expands to become the world. The cosmic egg myths tell of an egg, usually golden, which appears at the first moment of the universe. The egg breaks open and the events of the universe unfold. In one version the upper part of the egg shell becomes the heavens and the lower part, the earth. At the beginning of the creation from chaos myths there is disorder or chaos sometimes depicted as water from which a creator creates the universe. Finally, in the creation from nothing myths, which are closely related to the chaos myths, the original starting point of the universe is a void. The best known example of this group to Western readers, of course, is Genesis, where we read

"*In the beginning, God created the heavens and the earth. The earth was without form and void and darkness was upon the face of the deep*".

Activity 1



1. Explain the meanings of the following terms: charge, intensity, pion, momentum, inertia.
2. Using each term in (1) above , write at least three physics words and explain their meaning

Main Lessons from history of physics

(i) **Progressive nature of Physics**

Physics is ever developing /growing. This has led to new knowledge /conventions/names and new units. At the present, it is the S.I units that are used. S.I units stand for -***Scientae Internationale Unitase*** (International Science Units) expressed in French as ***Système International d'unités***

Table1.3: Some SI units for Some Quantities

Quantity	Unit	Symbol
Length	Metre	m
Mass	Kilogram	kg
Absolute temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous intensity	Candela	Candela
Time	Second	s
Electric current	Ampere	A
Plane angle	Radian	rad
Solid angle	Steradian	sr

To teach in a progressive way a teacher has to do the following:

- Use the new edition of textbooks.
- Attend a number of seminars organized for teachers because they help one to acquire the current skills on teaching approaches and knowledge
- Read journals –They have the most current information because they deal with research which brings with it new knowledge.
- Internet use

(ii) **Multi-cultural nature of physics**

The main known contributions came from the following: Romans, Greeks, Egyptians, Russians, British, French, Germans and Americans.

(iii) **Humanistic side of Physics (scientists)**

What comes out of this study is that early physicists worked for long hours under selfless conditions. Most discoveries were made after long periods of experimentation and frustrations. Physicists are expected to be patient and tolerant people.

(iv) **Practical orientation of Physics**

Physics was practically oriented and most of the activities were done in a practical way. It was about finding out and this meant use of a number of skills before arriving at the best possible results. Developed skills led to improved products hence emphasis on practical in physics. It is actually the skills that

determine the quality of the products. Most countries where the standard of life is good, the people have high-level skills, which have improved their lives due to high quality products.

Factors that led to accelerated development in Physics

(i) **Development of Mathematical skills.** These helped in refining instruments for accurate measurements and observations.

(ii) **Communication.** The ability to hold seminars and write journals led to sharing of knowledge with other people and also development of common language.

(iii) **Sponsorship.** This helped those who had knowledge and talents but lacked the funds needed to exercise them. A number of companies and bodies among them Oxford, Rockefeller, World Bank, Ford Foundation and recently JIKA have been significant in sponsoring science activities. In Kenya there is the Academy of Sciences, which mainly sponsors scientific activities.

Terminologies in Physics

The following are the terminologies in physics.

a) Facts: This is something that is true and cannot be disputed such as states of matter, strength of materials, boiling point, melting point etc.

b) Concepts: Refers to classification of ideas, objects or events into a set of common essential features/attributes that define that set. For example consider an atom whose defining ideas are: nucleus, protons, neutrons and electrons as a concept

c) Principles/Laws: These are rules or laws that are stated and which predict interrelationships among concepts. Principles relate two or more variables and therefore can be used for prediction (on reacting gases, temperature and pressure). Boyle's law on variation of volume with pressure expressed as $P \alpha V$ or $P = kV$, the universal law of gravitation, Kepler's laws, Hooke's law, Ohm's law just to mention a few.

d) Theory: This refers to logical thinking which explains the nature of the physical world. Thus a theory cannot be verified in a practical way, an example is the kinetic theory which deals with the behavior of particles under different conditions.

Written exercise 1.1

1. What factors led to the slow development of physics prior to 1500AD? (3marks)
2. Physics as an activity involves many activities such as experimentation. Explain what experimentation does in physics. (2marks)
3. What are the main lessons that one learns from the history of physics? (15marks)

The answers are on page **54** and **my score section** on page **60**

What skills are enhanced by the study of physics?

The contribution of physics to society

- The computer, the laser, the transistor, the World Wide web, all of these are contributions of Physics
- Physics is a central part of our culture and will continue to inspire many people. Physics reveals important universal truths notwithstanding certain strands of postmodern thought.
- Physics will continue to underpin all science and technology for the foreseeable future.
- Physics is and will continue to be essential for analyzing and solving urgent environmental and energy problems.
- Physics plays a unique educational role:

  - ✓ Secondary school: It is recognized that other scientific disciplines more and more require knowledge of physics.
  - ✓ Undergraduate level: Physics is becoming recognized as providing education of great value for many careers outside physics such as commerce, banking and medicine.
- Physics is global and constitutes our best 'anti-Babel'. Generations of physicists of the most diverse political and cultural backgrounds have collaborated on the basis of shared understanding and shared ideals.
- Physics sets standards of rational thought in the face of irrationality; it upholds the primacy of observation.

Skills in learning Physics

The study of Physics helps to develop certain abilities and skills in the learners such as:

Communication skills: They involve acquisition of physical language

Social skills: These involve being able to get along with other people, respect for others, and working effectively in groups etc.

Mathematical skills: They include computation, graphing and arranging among others.

Aesthetic skills: They involve artistic sensitivity and the ability to prepare charts, models etc.

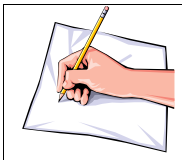
Safety skills: A person keen on scientific processes must be quick to execute correct and timely First Aid measures so as to minimize the probable loses due to accidents.

Laboratory skills: These are further classified into manipulative skills and process skills as illustrated below and deserve special mention.

Manipulative Skills/Handling /Psychomotor: Handling skills that are well used lead to accurate results that bring about meaningful (useful) conclusion. Processes such as titration and electrolysis among others need high level handling skills. Improvisation of apparatus is an additional skill acquired.

Process Skills: They assist in investigations or experiments. These are skills needed at every stage/ level of an investigation. For example observation of colour changes during an investigation on effect of heat on substances. Ability to plan good experiments is an important skill that is usually expected of physicists.

Written Exercise 1.2



1. Using appropriate examples, explain the main contributions of physics to a learner. (20marks)

The answers are on page **54** and **my score section** on page **60**

Written Assignments
CIM 323/2

Do the following assignment and post it to:

The Head
Department of curriculum Development
Maasai Mara University
P.O. Box 861-20500,
Narok- Kenya

Q1. Briefly explain the factors that have led to accelerated development in physics? (5marks)

Q2. Using an atom as your concept, explain what you understand by concept map (Concept Mapping). (15 marks)

Suggestions for Further Readings

Levinson, R. (Ed) (1994). *Teaching science*. Open University Routledge: London.

Partington, J.R. (1965): *A short History of Physics*: Macmillan and Co. Ltd.: London.

Hartley H. (sir) (1971): *Studies in the History of Physics*: Clarendon Press: Oxford

Stove, J. D. & Phillips, K.A. (1971). *A modern approach to Physics*. Heinemann: London.

Twoli, W.N. (2006). *Teaching secondary school physics. A textbook for teachers in developing countries.* Nehema publishers: Kenya.

Watts, M. (1991). *The science of problem solving. A practical guide for science teachers.* Heinemann: Portsmouth.

White, B. (1991). *Studying for science. A guide to information, communication and study techniques.* E. A. F. N. SPON: Melbourne.

UNIT TWO: AIMS OF TEACHING AND INSTRUCTION IN PHYSICS

Self-diagnostic Test

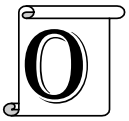
Answer all questions

1. What are the *four* main aims of teaching physics?
2. What do you understand by an instructional objective?
3. Differentiate between the lower and higher levels of bloom's taxonomy.
4. Suppose you were to perform a Teacher-Demonstration in a laboratory:
   (a) Outline the main activities of the teacher during preparation, performing and discussion stages.
   (b) Outline any three conditions that will compel the teacher to arrange for a teacher demonstration rather than a student practical.
5. Outline some **ten** conditions that affect instructions in schools
6. What is the role of a teacher as an advisor/ counselor?

Introduction

This unit deals with the aims of teaching physics at different levels and in various institutions. The unit discusses the writing of instructional objectives with the right type of action verbs derived from different domains such as: cognitive, psychomotor and affective. The unit further addresses the question of how to select suitable instructional methods and the factors considered.

Specific Objectives



After studying this unit, you should be able to:

1. Write acceptable instructional objectives.
2. Classify action verbs based on the different levels of the various domains.
3. Identify factors that are considered when choosing a method of instruction.
4. Describe different methods of instruction.

Content

Aims of teaching physics in secondary schools

It is important to note that for any subject to be in the curriculum it must be very useful to the society. For physics, these aims which evolve from the Societal Needs are:

- To acquire a systematic body of physical knowledge and develop an understanding of the concepts, principles and applications of physics. In understanding the concepts & principles, then one can further education in physics.
- To develop a scientific attitude by looking at issues systematically and applying systematic methods of analysis (clear steps or procedures).
- To develop a range of skills important for scientific investigation and everyday life-this is where the practical papers in school test the skills acquired by the learner.

  Skills are important:-
  - ✓ For investigation e.g. practical research
  - ✓ In services e.g. medical doctors, engineers
  - ✓ In industrial production (quality and mechanical strength of products)

- To stimulate curiosity, interest and enjoyment of physics through methods of inquiry and care for the environment. This will help in motivating the students because it is only a motivated person that spends more time on a subject and achieves more as a result. In science the best method of inquiry is the practical approach.
- To develop an understanding on the consequences of physics on man and his environment such as communication, transport.

For aims to be complete they must emphasize all the 4 domains of knowledge which include: **Cognitive domain, - Psychomotor domain, - Affective domain and - Social domain** (interaction with humans and environment).
It is mostly the cognitive and the psychomotor domains that are emphasized and examined in schools. It is worth noting that aims guide us in planning.
In the classroom, aims have to be translated into applicable instructional units (statements) which are objectives (Instructional).
(Aims → General Objectives → Instructional Objectives)

General Objectives

These are objectives which are long term and more specific than aims. A set of such general objectives can be used to determine or describe what is to be covered in the long term e.g. at the end of the term, end of the year or end of the course.

Below is an example of a set of General objectives for the Kenya 8-4-4 physics syllabus (2010)
By the end of the course the learner should be able to:

1. Select and use appropriate instruments to carry out measurements in the physical environment
2. To use acquired knowledge to discover and explain the order of the physical environment.
3. To acquire positive attitude towards physics.

Instructional Objectives

These are written statements of specific behavior to be exhibited by the learners. They are stated in behavioral terms and, as such, they are statements predicting behavioral outcomes. To understand the importance of objectives in lesson plans, two basic questions must be answered:

1. *'In what ways do you as a teacher, want this lesson to change your students?'*
2. *'What will they be able to do as a result of the lesson?'*

In selecting the lesson objectives, the teacher should keep the following points in mind.

i) The objective may be a concept, skill, attitude, ideal and appreciation or any combination of these things.
ii) Each objective should be a worthwhile learning element related to the course. One should always have a specific answer for a student who asks, 'Why do we have to study this?'
iii) The teacher should have each learning product clearly defined in his/her own mind.
iv) Some objectives should be stated in such away that they allow students to express their own opinions or skills.
v) Some objectives should provide students with an opportunity to explore or create dimensions in their learning.
vi) The objectives must be attainable. To try to teach something that is too difficult or something that cannot be completed in the time allotted is pointless.

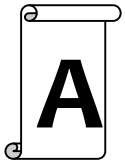
vii) The objectives should allow for differences in individuals. All students cannot learn the same things in any class at the same time. Therefore, one's objectives should allow students to achieve them to a greater or lesser degree and in different ways.

Facts on instructional objectives:

- The stem of writing an instructional objective should be At/By therefore:
- Every instructional objectives must have a **key verb** e.g. list, compare. The key verb must be an **action verb.**
- An action verb describes what the learner is going to do. Avoid using two or more action verbs.
- The instructional objectives also indicate the **performance level.** For example, give (at least three) uses of a magnet. *At least three* is the performance level; At the end of the practical, the learner should be able to identify at least one magnetic and one non-magnetic substance. In this objective, the level of performance is **'at least one** magnetic **and one** non-magnetic substance
- Instructional objectives also give **conditions** of how things are to be performed e.g. at the end of the lesson, the learner should be able to classify quantities into scalars and vectors using a list of physical quantities. In this objective the condition is **'using a list of physical quantities'**
- Consider the domains when preparing the instructional objectives.
- Instructional objectives have Taxonomy (Level of difficulty) from simple to complex.

The **performance level** and the **conditions** are not always part of the objective but are applied where necessary as illustrated above. The objectives should have the domain and the action verb.

Activity 2.1



Write appropriate instructional objectives given the following verbs: Convert, Weigh, Distinguish, Explain and Relate

Classification of instructional objectives

To enable teachers to prepare meaningful instructional objectives which focus on what it is that students are to be able to do as a result of the instruction; objectives have been categorized into three domains. These domains are the cognitive, effective and psychomotor. The sections on different taxonomies of these domains are intended to clarify further the dynamics of each of these three objective domains. In this work, Bloom, Krathwohl and Masia arranged the categories of behavioral objectives according to the degree of internalization they represent, as illustrated below:

Bloom's Taxonomy of the Cognitive Domain

i) **Knowledge:** Knowledge is (here) defined as the remembering (recalling) of appropriate, previously learned information. **Skills Demonstrated here include:** observation and recall of information, knowledge of dates, events, places knowledge of major ideas and mastery of subject matter. **Question Cues or outcome-illustrating verbs include;** list, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.

ii) **Comprehension:** Grasping (understanding) the meaning of informational materials. **Skills Demonstrated here include:** Understanding information, grasp meaning, translate knowledge into new context, interpret facts, compare, contrast, order,

group, infer causes, predict consequences. **Question Cues or outcome-illustrating verbs:** summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend, etc.

iii) **Application.** The use of previously learned information in new and concrete situations to solve problems that have single or best answers. **Skills Demonstrated here include:** use information, use methods, concepts, theories in new situations, solve problems using required skills or knowledge. **Questions Cues or outcome-illustrating verbs:** apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover, etc.

iv) **Analysis.** The breaking down of informational materials into their component parts, examining (and trying to understand the organizational structure of) such information to develop divergent conclusions by identifying motives or causes, making inferences, and/or finding evidence to support generalizations, etc. **Skills Demonstrated here include:** seeing patterns, organization of parts, recognition of hidden meanings and identification of components. **Question Cues or outcome-illustrating verbs:** analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer etc.

v) **Synthesis.** Creatively or divergently applying prior knowledge and skills to produce a new or original whole. **Skills Demonstrated here include:** use old ideas to create new ones, generalize from given facts, relate knowledge from several areas, predict and draw conclusions. **Question Cues or outcome-illustrating verbs:** combine, integrate, modify, rearrange, substitute, plan, create, design, invent, what if?, compose, formulate, prepare, generalize, rewrite, etc.

vi) **Evaluation.** Judging the value of material based on personal values/opinions, resulting in an end product, with a given purpose, without real right or wrong answers. **Skills Demonstrated here include:** compare and discriminate between ideas, assess value of theories, presentations, make choices based on reasoned argument, verify value of evidence, recognize subjectivity. **Question Cues or outcome-illustrating verbs:** assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize, etc.

Table 2.1: Taxonomy of the Affective Domain

Description of Major categories	Illustrative behavioral terms of learning outcomes.
1. Receiving- willingness to receive or attend to particular phenomena (class activities etc)	Acknowledge, ask, attend, be aware, choose, listen, locate, name, show alertness, watch, tolerate
2. Responding- refers to active participation on the part of the student	agree (to), answer, ask, assist, contribute, cooperate, discuss, follow-up, inquire, question, react, participate volunteer
3. Valuing- student sees value or worth in the subject, activity, assignment	Desire, approve, commit, endorse
4. Organization- bringing together complex values-building an internally consistent value system.	Adopt, adhere, alter, arrange, defend, rate, group, categorize, classify
5. Characterization by a value: Internalization of values, have a place in the individuals value hierarchy.	Act, advocate, behave, characterize, conform, defend, devote, uphold, support, use.

Table 2.2: Taxonomy of the Psychomotor Domain

Description of major categories	Illustrative verbs
1.Imitation-early stages in learning a complex skill	Assemble, attempt, calibrate, construct, dissect, repeat, sketch, and try.
2.Manipulation-individual continues to practice a given skill	Same as above- add acquire, complete, conduct, execute, operate, perform, manipulate
3.Precision- skill has been attained	Conduct, execute, operate, refine
4. Articulation-Involve a higher level of precision. Skills are well developed	Adapt, alter, revise, re-arrange
5. Naturalization- response is automatic. Individual begins to experiment, creating new ways of manipulating material.	Arrange, combine, construct, create design, refine

Written Exercise 2.1

1. What are the main components of a properly written instructional objective? 3 marks
2. (a) Outline the main procedure you would use to plan for the trip.
   (b) How would you treat the information from the trip when you get back to school? 15 marks

The answers are on page **54** and **my score section** on page **60**

Methods of instruction in physics

There is a range of methods to use and one has to make a choice of the appropriate method based on some factors.

Factors to consider when choosing a method of instruction

- **Effective Method**
  A teaching method which seems most effective is one that is learner-centered (heuristic or discovery-learning method). Expository or teacher-centered are not so effective and are not encouraged. Teachers should strive to use methods that facilitate the learners' understanding. This method is intended to involve students in intensive learning activities. What students need to succeed in achieving their learning objectives is to ask questions. For this reason, questioning skills are heavily used in this method. Learners should be encouraged to ask questions.
- **Objective of the lesson**
  From the instructional objective, the teacher can determine which method to use for teaching e.g. to prepare determine the elastic constant of a material, the learner need to perform laboratory practical session.
- **Class Size**
  Consider the number of students within the class. A teacher handling a large class will most likely arrange for demonstration rather than class experiments or many group discussions.
- **Resource availability**
  This can lead to either the teacher demonstration or class experiment. Lack of resources has led to either no practical or demonstrations by teachers. Availability of apparatus encourages class experiments.
- **Entry behavior of learners**

This is to check on the ability of learners. Normally proper teaching requires that the teacher builds on what the learners have. When the entry behavior is low then the teacher must start off with demonstration then later introduce learners to class experiments after they acquire the necessary skills.

- **Teacher preferences /styles**
  The teacher chooses a method which she/he feels comfortable to use. The reasons are rather personal.

Teaching approaches commonly used in physics

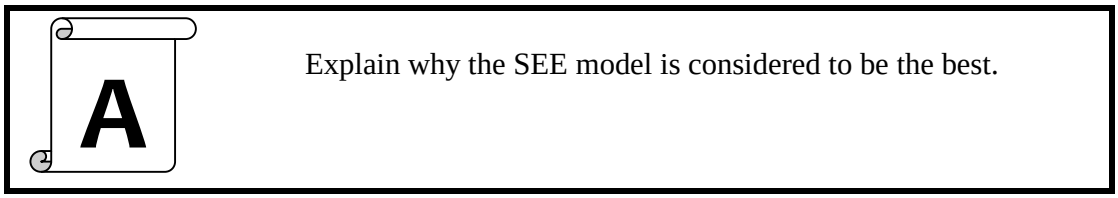
Sevaral teaching approaches are available for the teaching of physics in secondary school. The common ones are:

Lecture Method

It is teacher centered thus not so useful in terms of learning practicals skills. In physics there are some topics which do not have practical lessons therefore the lecture method is applicable. Atomic structure, quantum mechanics, introduction to nuclear physics requires the use of lecture method. Lecture method used should not be the **straight jacket lecture** - this is the kind of lecture, which is used at the university level; where the student listens quietly and sometimes takes notes. At school level, **integrated lecture** method should be used. It is integrated by using questions, examples, resources, and class activities so that it is not so much of an expository method. This method is improved by using the following model:

TEB → SEB → SEE (technique has been used for lecture method)
TEB → **T**eacher, **E**xample on the **B**oard
SEB → **S**tudent, **E**xample on the **B**oard
SEE → **S**tudent, **E**xamples in the **E**xercise books.

Activity 2.2



Teacher Demonstration

It is a popular method in most of the schools. This method is preferred under the following circumstances:

a) When the resources are limited.
b) When safety is a major problem
c) When experiments involve sophisticated or very expensive apparatus.
d) When there is limited time.
e) When the experiment requires a specific skill, which has not been acquired by the students.

Although demonstration is very useful, it has got **limitations** such as: -

i. Restricting learners from practicing skills especially handling skills.
ii. Being more of teacher dominated (centered) leaving the learners passive most of the time. The passiveness of the students can be reduced by using questions. Ask them to participate in readings, observation etc so as to avoid **dead times** (when there is lack of communication between the teacher and the learners) which make learners switch off from the main activities.

Procedure for carrying out Teacher Demonstration

(i). Rehearsing Stage

Trying out of or previewing the experiment to be done. This helps to check on the availability of resources and their working conditions.

Rehearsing helps in adjusting certain concentrations and other conditions to give the required outcomes. For new and inexperienced teachers it is a must. It can save one a lot of embarrassment in front of one's class.

(ii). Performance Stage

This is when the actual demonstration is carried out. The essence of demonstration is that learners should be able to see what is happening without straining. The learners should stand in semi-circular that is round the teacher demonstration table. During performance use the materials and apparatus used during rehearsal. It is instructive to put a clearly written procedure on the blackboard or give manuals (worksheets). The teacher must arrange students in an orderly pattern such that all learners are able to see what is happening in class.

(iii). Discussion Stage

The discussion should focus on the following:

- Experimental set up, apparatus, materials and possible alternatives
- Accuracy of the results and likely sources of error
- Underlying concepts or principles
- Extensions of the concepts and principle.
- Patterns and generalizations. These are useful in drawing conclusions.

Student Practical Work

In this approach students carry out the important manipulations and other processes under the supervision of the teacher. The teacher facilitates during the learning process especially where the learner intellectually engages in rigorous thinking. It is a heuristic method of teaching which gives an opportunity to the learner to learn and practice skills (handling skills and process skills). It motivates the learner in the given content being learnt. There is a high degree of retention of the lesson content as compared to lecture and teacher demonstration.

Design of Students Practical Work

There are normally **three designs** of student practical work/experiments

(i). The learners are doing the same experiment in groups.

(ii). The learners do different experiments of the same concept for example when heating

(iii). When learners have different experiments of the same concept and the learners do it in a rotational manner as illustrated in the table below.

Table 2.3: Different experiments of the same concept: Elastic constant

Group 1 : iron spring	**Group 3:** Copper spring
Group 2: Rubber band	**Group 4:** Brass spring

(iv). Is the easiest to plan for and economical in time

(v). Is time consuming, students can easily dodge the experiments and use other group's results.

Planning For Practical Work

a) Preview/Preparation

- ❖ Ensure that the resources to be used are available and in sufficient quantities
- ❖ Preview /rehearse or try out the experiment.
- ❖ Prepare a work sheet (instructions) for the students to follow during experiments.

OR

- ❖ Write instructions on the writing board.
- ❖ Dictate instructions to the learners.
- ❖ Use a chart.

It is very important to write instructions after previewing the experiments and confirming the working condition of the instruments. Equally important is the decision on which method to be used. This is normally taken after previewing.

b) Performing Student Practical Work

- ➢ Students to go into groups which should have a secretary who gives the report and chairperson who ensures that the practical work is done as expected.
- ➢ Provide the learners with the resources.
- ➢ Give the learners the worksheet.
- ➢ The learners start to do the practical as the chairperson ensures that the practical is done and the learners record the observations.
- ➢ The teacher goes around checking on the progress of the practical and assists where necessary and encourages them to move first and finish the experiment.

c) Discussion

- ➢ Pool (get together) all the results.
- ➢ Look for patterns (certain common behaviors).
- ➢ Make conclusions

Project Work in Physics

It comes at the end of every main topic. This should be arranged for the learners by the teacher who has an added responsibility of sampling and involving students in as many projects as possible. Projects are recommended and encouraged by many physics syllabuses the world over.

Advantages

- ➢ They relate the learnt physics to the outside world.
- ➢ Stimulate the interest of the students.
- ➢ Expose students to a wider range of skills and instruments.
- ➢ Train students in practical design and problem solving.
- ➢ Improve on communication skills.
- ➢ Group work and its appreciation is encouraged.
- ➢ Promote interdisciplinary activities.

Disadvantages

- ➢ Time consuming.
- ➢ Lack of required resources.
- ➢ They are not directly examinable.
- ➢ Most teachers feel incompetent to supervise projects.
- ➢ Lack of reward (motivation) for the teachers.

Written Exercise 2.2

1. Outline any **four** roles of a teacher during a class experiment? (2marks)
2. Any meaningful learning cycle consists of three phases which are: Exploration, Elaboration and Application. Explain what each term means. (3marks)
3. Physics is said to be arranged in 'patterns'
   (a) Explain the **three** advantages of patterns in Physics content.
   (b) Give **two** examples of patterns in linear motion and two in angular motion in Physics. (15 marks).

The answers are on page **54** and **my score section** on page **60**

How does a given method of teaching affect discipline in class?

Types of Projects

1. **Experimental**- This involves work in the laboratory, an experiment or a series of experiments are carried out to investigate some problem. A typical example is the construction of simple radio receiver.
2. **Observational**-This is done mainly through observation, collection and analysis of data which already exists in some form.
3. **Survey**-This type is to do with finding out through use of questionnaires or interviews or both. This type of project deals mainly with socio-scientific issues. Conclusions are normally drawn from the analyzed and compiled results. The physics syllabus suggests a number of these.

TEACHER ROLES IN MOTIVATING THE LEARNERS

Introduction

Motivation is a vital factor in the teacher's management of learning and behaviour in the classroom. Motivation signifies the causes or 'why' of behaviour; it is concerned with questions of the energising of behaviour and the direction given to behaviour. In the classroom, motivation is observed as students show interest and enthusiasm, and give attention and concentration to learning tasks. Conversely, low levels of motivation are observed in student apathy and misbehaviour.

Motivation is closely related to self-concept and to personal needs. Maslow (1970) has described a hierarchy of needs extending in pyramid fashion from basic physiological and safety needs to needs for belongingness and love, to self-esteem needs, and to the highest level need for self-actualisation. Self-actualisation involves striving for the full realisation of a person's potential.

The motivating role of teachers encompasses attempts to create conditions within a classroom which will energise, direct and sustain students' performance. This role is important for promoting morale and climate, and involves the sustaining of enthusiasm and positive attitudes towards school goals and learning tasks, both those assigned and those self-generated by the students.

Aims of motivation

As mentioned previously, the motivating role is primarily concerned with energising behaviour by tapping internal forces which will initiate and sustain the work of students for whom classroom teachers are responsible. Classroom teachers will seek to achieve the following:

- Ensure commitment of all students to the school's mission.
- Create conditions which will energise and direct the efforts of students towards achieving learning goals.
- Sustain levels of motivation which will keep the students persevering with their assigned tasks.
- Provide an appropriate model of enthusiasm and diligence, displaying warmth and a high level of effective interpersonal relationships and communication.
- Foster classroom climate through a proper sense of student achievement which comes from felt success in achieving school and personal goals.

Categories of Motivation

There are two broad categories of motivation - intrinsic and extrinsic.

Intrinsic motivation is a response to needs within the student, such as curiosity, the need to know, or feelings of competence and growth. Internal satisfaction a student feels about a particular task is another aspect of intrinsic motivation. For example, some students might find activities involving movement to be intrinsically satisfying.

Extrinsic motivation is motivation from outside the learner and has to do with external rewards for completion of a task. Words of praise from the teacher, a higher grade, or a privilege are examples. The reinforcement of extrinsic motivation can be effective; but be aware that excessive use of rewards may be decreasingly successful in new situations, foster dependence on the teacher, and undermine intrinsic motivation.

A number of educators have proposed strategies to motivate students to learn. Keller (1983), for example, suggests that teachers consider four dimensions of motivation: (a) interest, the extent to which the learner's curiosity is aroused and sustained over time; (b) relevance, the learner's perception that instruction is related to personal needs or goals; (c) expectancy, the learner's perceived likelihood of success through personal control; and (d) satisfaction, the learner's intrinsic motivations and responses to extrinsic rewards. A summary of the six categories of actions has been included below.

Six strategies for motivating students to learn:

1. Capture Student Interest in the Subject Matter.

- Take student interest into account
- Capitalise on the arousal value of suspense, discovery, curiosity, exploration, and fantasy.
- Try to make study of the subject matter as active, investigative, adventurous, and social as possible.
- Use questions and activities to capture student interest in the subject matter.
- Use games, simulations, or other fun features.

2. Highlight the Relevance of the Subject Matter.

- Select meaningful learning objectives and activities.
- Relate the subject matter to students' everyday experiences and backgrounds.

- Call attention to the usefulness of the subject matter.
- Have students use what they previously learned.

3. Help Students Maintain Expectations for Success.

- Have students set short-term goals.
- Help students assess their progress toward their goals.
- Allow students a degree of control over their learning.
- Draw attention to the successes students have achieved.

4. Design the Lesson to Maintain Interest and Promote Student Success

- State learning objectives and expectations, and provide advance organisers.
- Vary instructional approaches and present the subject matter in interesting, novel ways.
- Plan active student involvement.
- Select stimulating, appropriate tasks.
- Occasionally do the unexpected.
- Use familiar material for initial examples, but provide unique and unexpected contexts when applying concepts and principles.
- Design activities that lead to student success.
- Provide an appropriate level of challenge and support.
- Plan for individual, cooperative, and competitive activities.
- Adapt tasks to match motivational needs.
- Promote feelings of control by giving students a voice in decision making.
- Communicate desirable expectations and attributes.
- Minimise performance anxiety.
- Establish a supportive environment.

5. Express Interest in the Content and Project Enthusiasm.

- Model interest in learning and motivation to learn.
- Model task-related thinking and problem solving.
- Project enthusiasm.

6. Provide Feedback and Rewards for Performance.

- Provide frequent opportunities for students to respond and to receive feedback about their academic work.
- Offer rewards as incentives.
- Give some rewards early in the learning experiences.
- Help students attribute achievement to effort.
- Help students recognise that knowledge and skill development are incremental.
- Provide remedial socialisation for discouraged students.

The six strategies for motivating students to learn was adapted from 'Burden. P. R., 1995, Classroom Management and Discipline, Longman, New York.

When Planning a Lesson

As you plan a lesson, also plan for motivation, and plan that each time phase of the learning sequence includes positive motivational influences. There are three critical periods in a learning event during which particular motivational strategies will have a maximum impact on motivation. These are:

1. Beginning a lesson - when the student enters and begins the learning process.

2. During a lesson - when the student is involved in the body or main content of the learning process.
3. Ending a lesson - when the student is completing the learning process.

Beginning a Lesson

At the beginning of a learning activity, you need to consider two motivational factors when selecting motivational strategies: attitude and needs. Attitude deals with the student's view of the subject matter, the general learning environment, and other factors. Needs deal with the students' basic needs at the time of learning. As you plan for the beginning of a learning event, ask yourself two questions:

- What can I do to establish a positive learning attitude for this learning sequence?
- How do I best meet the needs of my learners through this learning sequence?

Attitude is the student's stance toward the learning environment, teacher, subject matter, and self. When planning to incorporate motivational factors at the beginning of a lesson, you need to select strategies that positively affect the student's attitude about themselves, yourself as the teacher, the subject, and the learning situation, while also establishing learner expectations for success. To positively affect attitude about yourself as a teacher, you might plan to establish a relationship with the students by sharing something of value with them. Listening to them with empathy, treating them with warmth and acceptance, and using class or individual meetings to establish relationships. To positively affect attitude toward the subject and learning situation, plan to make conditions surrounding the subject positive, model enthusiasm for the subject, associate the student with other students who are enthusiastic about the subject, positively confront the student about erroneous beliefs, and make the first experience with the subject matter as positive as possible.

You can positively affect the students' attitude toward themselves by promoting success, giving encouragement, emphasizing students' personal causation in their learning, and using group process methods to enhance a positive self-concept. Finally, when trying to establish learner expectancy for success, you could interview students and help them set goals or contracts for their learning.

A need is a condition experienced by the individual as a force that leads the person to move in the direction of a goal. Maslow's hierarchy of needs provides a framework to examine strategies that teachers could select in addressing students' needs at the beginning of a lesson. When planning for meeting psychological needs, you could select content, examples, and projects that relate to students' psychological needs, and could be alert to restlessness so you can relieve the causes producing it. For example, students may not be physically comfortable after sitting for long periods of time, or after being asked to do one task for a long time. Instead, have a change of activities or break the tasks up into shorter segments.

During a Lesson

During a learning activity, two motivational factors need to be considered stimulation and affect. Stimulation deals with attention and involvement during the learning process. Affect deals with the affective or emotional experience of the student while learning. As you plan for this part of the learning activity, ask yourself two questions:

- What about this learning sequence will continuously stimulate my learners?
- In what way is the affective experience and emotional climate for this sequence positive for learners?

Stimulation has to do with holding attention and building involvement. When you introduce or connect learning activities, draw attention to the new learning activity or topic. Use movement, voice, body language, and props to vitalize and accentuate classroom presentations. To promote interest and involvement, relate learning to student interest, and use humor, examples, analogies, stories, and questions. When asking questions, limit informational questions and selectively increase questions that require comprehension, application, analysis, synthesis, and evaluation. To create disequilibrium, introduce contrasting information, play the devil's advocate, and be unpredictable to the degree that students enjoy the spontaneity. To be unpredictable, for example, you could alter your conduct of each review session before a test.

Affect pertains to the feelings, concerns, values, and passions of the students while learning. When planning lessons, try to encourage and integrate learner emotions, and maintain an optimal climate within the learning group. Feelings are the emotions that accompany the how and what a student is learning. Awareness and communication allow feelings to become a vital influential aspect of motivation. Integrate what is being taught with how the student feels now about the content and then establish a relationship between this content and the student's life. You can also take steps to establish a climate that promotes a positive interrelationship among class members.

Ending a Lesson

At the end of a learning activity, two motivational factors are considered: competence and reinforcement. Competence deals with the degree of progress the students feel they have made. Reinforcement deals with feedback on their progress. When you plan for the ending of a learning activity, ask yourself two questions; 'How does this learning sequence increase or affirm the learner's feelings of competence?' and 'What reinforcement does this learning sequence provide?'

Competence refers to the sense of growth and content mastery that a person recognizes. As you plan for the end of a learning activity, take into account at least two aspects of competence. First, make sure students have opportunities to become aware of their progress and mastery. You can do this by providing feedback on mastery of learning, offering constructive criticism, and facilitating successful completion of the learning task. Second, students need to be aware at the end of the activity that theory 'personally caused' their own learning. This can be done by acknowledging and affirming the student's responsibility in completing the task, using a competence checklist for students self-rating, and acknowledging the risk taking and challenge involved in the learning accomplishment.

Reinforcement is an event of a state of affairs that changes subsequent behavior. For example, a student who is given praise for efforts made in studying for a test will tend to continue these efforts after the praise is given. Reinforcement can be in the form of artificial reinforcers such as tangible or concrete materials, or extrinsic symbols for learning behavior.

Gold stars, prizes, trinkets, certificates, and points are examples. When natural consequences (e.g., reading can produce new insights and expand awareness) of student learning are evident, emphasis the result of the learning behavior. and highlight it as a part of the learning process. You can take steps to enhance the intrinsic value of traditional grading and limit its negative

intrinsic value. Provide alternative forms of feedback to students about their performance, clearly explaining the grading policy to students, and perhaps using student self-evaluation.

Written Assignments
CIM 323/2
Do the following assignment and post it to:

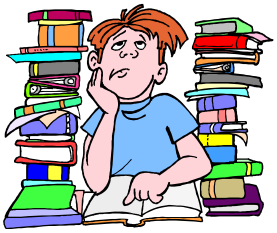
The Head
Department of curriculum Development
Maasai Mara University
P.O. Box 861-20500,
Narok- Kenya

Q1. Differentiate between aims and objectives as used in the teaching of physics. 5 marks

Q2. Describe the major categories of the following affective and Psychomotor Domains. 15 marks.

Q3. Critizice any five strategies for motivating students to learn physics. 10 marks

Suggestions for Further Readings



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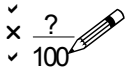
UNIT THREE: TEACHING RESOURCES

Self diagnostic Test

Answer all questions

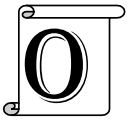


1. What are teaching Aids?
2. What are the points to consider when selecting physics textbooks to buy or purchase for students?
3. What characteristics must a teacher-made chart have if it is to be effective for instructional purposes?
4. How does one plan for a guest speaker in physics?
5. List **five** other internet search engines apart from google.com or google.co.ke

Introduction

This unit is concerned with resources used in the teaching of physics. The physics Laboratory is discussed in detail in terms of its essential features and their uses. Storage of apparatus is also discussed with the view to ensuring that all apparatus are safely stored. The Unit further addresses the question of common incidents and accidents in the laboratory and the expected First Aid measures. The unit also looks at other types of resources useful to a physicist and finally concludes with the relevance of computers in the teaching of physics.

Specific Objectives



After studying this unit, you should be able to:

1. Explain the meaning of a teaching Aid.
2. State the advantages of using teaching Aids
3. Differentiate between the two common bench arrangements found in the Physics laboratory
4. Identify the key parts of a physics laboratory
5. Explain the safe storage of Apparatus in the laboratory
6. Describe the common incidents in a physics laboratory
7. Improvise teaching Aids
8. Explain the use of Computers in the teaching of Physics.

Content

Resources: These are non-printed materials used to facilitate learning. They make explanation and description more real, lively and interesting for the class. Examples include pictures, real objects/specimen, charts, and physics laboratory and resource persons.

Physics Laboratory as a Teaching Resource

Laboratory in schools.

The idea of a laboratory means different things to different schools. Schools that have financial means have been known to have separate laboratories for each of the three main science subjects which are: Biology, Physics and physics. Middle level schools have two science laboratories- one for biological Sciences and another one for physical

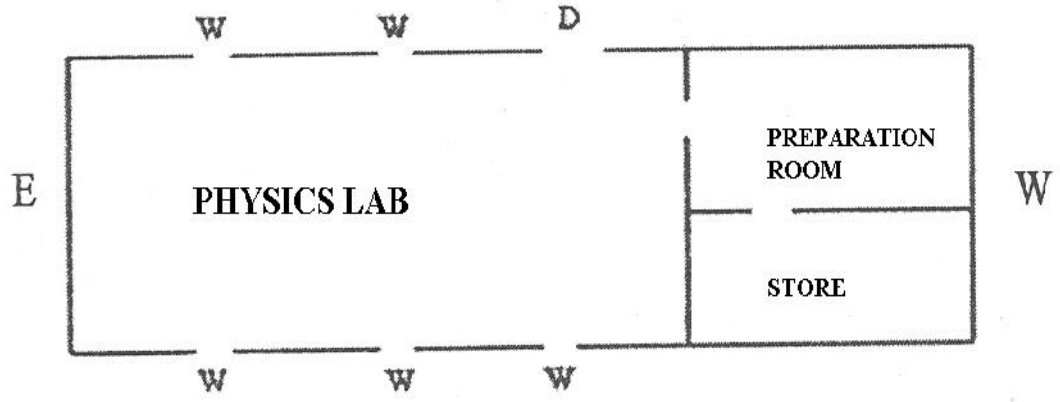
Sciences (physics and Chemistry). Smaller schools have what are referred to as **'science rooms'**- these are improvised rooms of some sorts.

Location and Design

Location - It should be removed from other buildings. It should be a quiet working place with minimum or no disruptions at all.

Size and Orientation - It should be East-West so as to avoid direct sunshine into the laboratory (through the window).This can interfere with the experiments such as timings in harmonic oscillations.

Figure 3.1: Orientation of a physics laboratory



Sunlight forms **glare/reflection**, which affects view during the observation, clear vision reduces incidents/accidents within the laboratory.

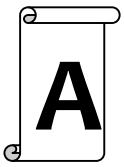
Enough room- It should have at least three rooms. These three rooms are:

(a) *Main Laboratory*- this is meant for practical i.e. teacher demonstrations, student practical. It can also be used as a classroom.

(b) *Prep room*- the main work of this room is for preview of experiments, marking etc.

(c) *Store room*- This is for storage of apparatus. The laboratory should be able to accommodate between 40 and 50 students.

Activity 3.1



Explain how different laboratory designs affect the methodology used by the physics teacher.

Important Basic Requirements in the Laboratory

1. **Gas Room-** Gas is needed in the laboratories for heating during experiments. The gas room is located outside the main laboratory because gas is flammable and this would pose great danger if the gas were to find its way into the main laboratory. The doors of the gas room should be either perforated or meshed, so that incase of gas leak the circulation of the air dilutes the gas concentration to below the ignition point. The gas has to be piped into the laboratory and onto the benches.
2. **Master Tap**-The master tap is sometimes referred to as the main tap. When the laboratory is not in use for a long time, the master tap has to be switched off to reduce

loss due to leaks along the joints. It can be used when teaching to stop the learners from working by switching it off.

3. **Piping of Gas-**The materials used for piping the gases should be those that cannot be corroded by reactions of the gases. The materials used should be made out of copper and silver metals.

Copper is used because:

- It is resistant to corrosion,
- It is malleable e.g. can bend very easily; threads can be very fine leading to firm joints thus reducing the rate of leaks, reducing risks.
- It is resistant to oxidation

4. **Board**

Fig 3.2: Design of teaching boerd

This consists of three parts two soft boards and one writing board. One soft board can be used for pinning the teaching aids and the other soft board can be used for putting the assignments, special dates and general laboratory information.

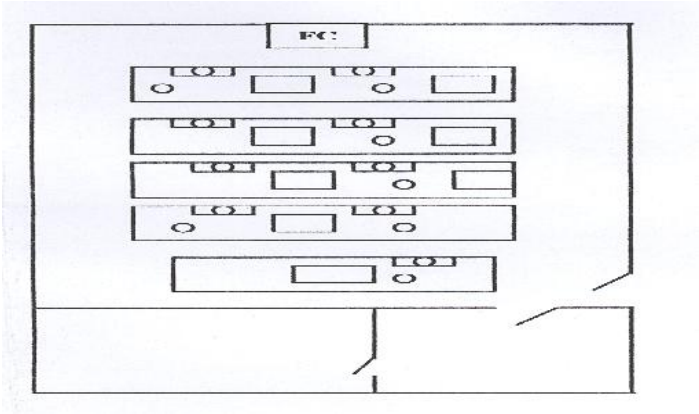
5. **Floor and Ceiling**

The floor should be rough (concrete) or a firm grip so that one cannot easily slip. Alternatively one could use rubber pads. Low roof ceiling reduces air circulation leading to pollution thus high roof ceiling is recommended.

6. **Special Fittings:**

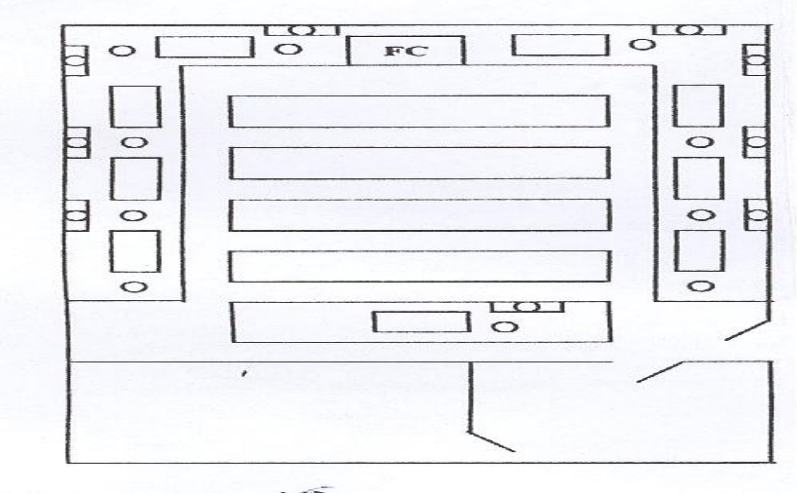
Benches: These are very useful in physics laboratory. Giving it a broad consideration, these are two main arrangements of benches (or tables) in a physics laboratory. The first type of arrangements is what may be referred to as **fixed bench design**. In this arrangement the benches are in a fixed position. On the benches there are the usual facilities such as water, gas taps and electricity points. The second type of arrangements is the movable **bench design**. In this type the student benches are not fixed. Only the teacher's demonstration bench is fixed. This is the type you would expect in newly built laboratories in schools. The two types are shown below. Main facilities on the fixed central tables (benches) include: Gas, Electricity

Figure 3.3: Bench arrangement for the fixed bench physics Laboratory design.



Main facilities are arranged around the laboratory with central movable tables (Benches).

Figure 3.4: Bench arrangement and the main facilities in the movable bench physics laboratory design.



Written Exercise 3.1

1. List four advantages of using teaching aids. 2 marks
2. Explain two advantages and one disadvantages of improvisation of teaching resources? (3 marks).
3. Using a sketch diagram of a modern physics laboratory design, explain how this design facilitates:
   (a) a student experiment,
   (b) a teacher demonstration experiment. (15 marks).

The answers are on page **54** and **my score section** on page **60**

Storage and use of Apparatus in a School Laboratory

Why emphasize on proper storage?

i. It helps to limit contamination.
ii. It limits risks (dangers) e.g. fires, poisoning, burns etc.
iii. It helps to quickly locate apparatus needed for a given experiment

Every laboratory is supposed to have apparatus stored in specific places within the laboratory.

Radioactive Apparatus

These are mutagenic to the body system. They should be kept in places where the radiations from the elements are effectively cut out. Lead casing/block surrounds a radioactive element such as Uranium and is in turn surrounded by a concrete block.

Quantity Apparatus

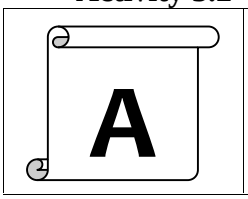
Some schools prefer buying apparatus in large quantities others in small quantities. Quantity is likely to determine where it is kept. Heavy apparatus are kept at the base whereas light apparatus are kept in the upper shelves as shown below. This is to avoid risk of weighing down the shelves and also ease of removing and handling.

Figure 3.5: Apparatus arranged according to quantity

L	L	L
L	L	L
L	L	L
L	L	L
H	H	H

FLOOR

Activity 3.2



What are the factors to consider when deciding on the quantity of apparatus to buy in the physics laboratory?

Explain in your view why learning became less and less lively and active as you moved from primary to secondary and finally to post-secondary education.

Safety in physics laboratory

Introduction.

The laboratory should be a safe place to work in.

Safety in the laboratory is emphasized because it motivates teachers, learners and laboratory technicians to arrange and perform more practical in the laboratory. This in turn enables learners to get an opportunity to practice more skills. In developed countries there are proper rules put in place about the use of the laboratory. Regulations regarding safety in school laboratories are still “loose” in developing countries.

Laboratory Rules

These are necessary in minimizing incidents and accidents in a physics laboratory. The most important point to note about these rules is that they are a must and every school must arrange to make them readily accessible to all those who need them. A clear set of these rules must be posted on the notice board in the laboratory.

- No student may enter the lab unless prior permission has been given by the teacher (Students should not be allowed in the lab alone)
- Always walk in the lab looking where you are going
- No apparatus or material may be removed from the lab.
- All apparatus must be cleaned after use and returned to their correct places

- All laboratory procedures to be carried out accurately in accordance with the instructions
- Any breakages or damage to apparatus to be reported immediately to whoever is in charge
- Any injury to be reported at once to the teacher or technician in charge. The list of these rules is fairly long and what is most important is the fact that different situations require different rules and that these must be borne in mind at all times when in the laboratory.

Safety Equipments commonly found in physics laboratory.

First aid box.

This is a clearly labeled box with a cross or crescent. It is usually kept in the preparation room, out of reach of learners. This box contains the following First -Aid items:

- Bandages (rolled bandages and triangular bandages)
- Safety pins
- Cotton wool
- Pair of Scissors
- Elastoplasts (any appropriate adhesive plaster)
- A pair of forceps
- Eye lotion
- Burns lotion
- Antiseptic liquid (e.g. Dettol)

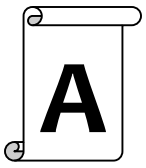
In conjunction with the First Aid Box is the First Aid Chart (or Treatment Chart). This Chart gives the symptoms of certain incidents and advices on the right measures to be taken.

Protective wears

Every laboratory should have some protective wears. These are meant to reduce the direct contact of apparatus and apparatus with our bodies. These include among others the following:

- White lab coats
- Goggles (masks)
- Gloves-for corrosive liquids

Activity 3.3



1. List some of the dangerous substances found in your physics laboratory
2. List 3 common accidents found in physics laboratory.

Fire and Fire Fighting equipment

For fire to break out, three essential factors must be present. These are:
Fuel, Oxygen (air) and source of Heat

Most fire fighting-equipment have been devised on the basis of which factor is the easier and faster to eliminate. It is easier and cheaper to cut out air and this is the reason why all fire-fighting equipment are based on cutting out air. Some of these equipment include the following:

- Sand in a bucket plus a scoop- this is for small isolated fires where the sand cuts off air (oxygen) and stops the burning.

- Fire blanket (fiberglass)-can use ordinary blanket if fire is not a lot. It is useful for a fire, which is burning a person. One has to be quick otherwise the blanket catches fire and makes matters worse.
- Fire extinguisher.-this is not only very efficient but also very fast. There are 3 types:

  -water type; -Powder type; -Gas type (CO_2)

For a physics laboratory in a school, the gas type (CO_2) is recommended. It is very useful to ensure that all the fire extinguishers are inspected by experts to make sure that they are in good working conditions at all times.

How to deal with electric shock

1) Immediately switch off the circuit. If this cannot be done remove the student from contact with it by grasping his clothing or using a piece of dry wood. DO NOT touch his body before he or she is clear of the live circuit. Try to stand on dry wood, rubber or thick paper.
2) If breathing has stopped apply artificial respiration.
3) Treat for shock
4) Treat any burns on the skin.

Other Resources for Teaching Physics in secondary Schools.

- Practicals (skills): Laboratory is the major resource
- Charts
- Models
- Computers
- Guest speakers

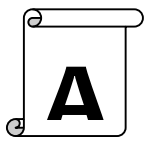
(b) Charts

A chart is used to display large diagrams. It should be simple and cheap. It can be teacher made or commercially made.

Characteristics of a good chart

- It should be large enough to be seen by all learners.
- It should not be overcrowded by so many features but should emphasize the important features only.
- It should have a relevant title (one that relates well to the content).
- It should be well labeled. Avoid writing in the object and even more importantly avoid use of arrows for labeling because arrows have a special meaning in physics.
- It should have good color scheme that brings out various parts in the chart.
- The charts should be labeled and stored.

Activity 3.4

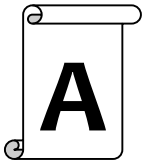


1. Identify some topics in the physics syllabus that are suitable for charts

(c)Models

These are visual aids that play an important role in the teaching of physics. A model is viewed as an improvement on the chart. A model being three-dimensional gives a better representation than the chart.

Activity 3.5



Identify some models that may be used in teaching in the secondary school physics and the sub-topic that are relevant.

Factors to Consider when choosing models

The most important factor to consider when choosing a model is the level to be taught. Models have international interests thus they are given certain consideration.

Materials needed to make Models:

Clay	Wood
Plasticine	Cork
Paper	Nails
Polystyrene	Wires

Main qualities of a good model

- It should have international colour codes of atoms properly used.
- It should be large enough for all learners to see without straining.
- It should show proper proportion in terms of sizes of spheres and bonds
- It should be strong enough to be used for a long time thus cutting down on time and energy needed in preparing them from time to time.

Written Exercise 3.2

1. Outline some limitations of textbooks. 3 marks
2. Proper storage of apparatus in a physics laboratory is important.
   (a) Outline the main advantages of proper storage of apparatus.
   (b) Give the order or pattern which is used to arrange apparatus in a physics laboratory storeroom. 15 marks
3. Outline four advantages of using minilabs as compared to conventional laboratories. 2 marks

The answers are on page **54** and **my score section** on page **60**

Computers in Physics

Computer Aided Physics

"Computer aided physics" includes all the ways computers help a physicist, both for calculations and visualization. Computers help in the learning of physics in so many ways. Some of these ways are as listed below:

- Teacher preparation of notes, setting of examinations etc
- Downloading of notes from the search engines such as goggle.
- Tele-conferencing.
- Interfacing of instruments with computers in physics.

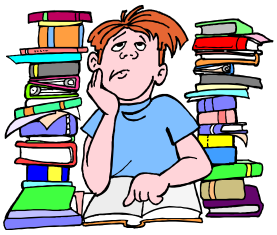
- LCD projectors for real teaching in class.
- Use of softwares such as *electronic workbench* for drawing of physics diagrams which facilitates teaching and examination preparation. Besides, there many other highly specialized softwares that perform many complicated tasks in physics.

Written Assignments
CIM 323/3

Do the following assignment and post it to:

The Head
Department of curriculum Development
Maasai Mara University
P.O. Box 861-20500,
Narok- Kenya

Q1. What is expected of a teacher as a human resource in the teaching of physics by his or her learners? (5 marks).
Q2. What are the key points to consider when selecting physics textbooks to buy or purchase for the learners/students? (15 marks)



Suggestions for Further Readings

Archenhold, W.F., Jenkins, E.W. & Wood-Robinson, C. (1978). *School science laboratories. A handbook of design, management and organization.* John Murray: London.

Archenhold, W.F., Jenkins, E.W. & Wood-Robinson, C. (1978): school science laboratories. *A handbook of design, management and organization.* John Murray: London.

Everett, K. and Jenkins, E.W. (1991). *A safety Handbook for science teachers. Murray:* London.

Monk, M. & Osborne, J. (2002): *Good practice in science teaching*. Open University. Buckingham.

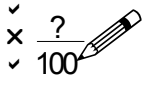
UNESCO, (1990). UNESCO handbook for science teachers. UNESCO: Paris.

Waddington, J.D. (1989). *Teaching school physics. C (1978): School science laboratories. A handbook of design, management and organization*. John Murray: London.

UNIT FOUR: PLANNING TO TEACH PHYSICS

Self-diagnostic Test

Answer all questions

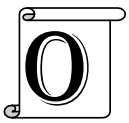


1. Outline the factors that are necessary in planning for successful teaching.
2. Explain the importance of carrying out a proper lesson plan preparation.
3. Discuss three pros and two cons of microteaching.
4. What are the three major purposes that introduction of a lesson serves?
4. Why are multiple-choice questions not recommended in physics?
5. What are the common methods used in presenting introduction of a given theory lesson in physics?

Introduction

This unit deals with preparation and use of teaching documents such as schemes of work and lesson plans. The unit further looks at questions, question types and ways of formulating them. It addresses the question of qualities of a good question. This section also looks at the factors to consider when setting questions. These include among others such factors as: table of test specifications, marking scheme preparation, grading process and treatment of examination outcomes.

Specific Objectives



After studying this unit, you should be able to:

1. List the important components of a scheme of work.
2. Discuss the importance of each of the components in a scheme of work
3. Prepare an acceptable scheme of work
4. Define a daily lesson plan and describe its importance.
5. List the important parts of a daily lesson plan.
6. Describe the process involved in the preparation of daily lesson plans.
7. Describe the dynamics of lesson-plan evaluation.
8. Formulate proper and acceptable questions in physics examinations
9. Discuss the advantages of microteaching.

Content

Scheme of Work and Lesson Plan

For effective and proper teaching, the teacher is expected to understand how to plan his/her work. This is usually done through two very important documents which are the scheme of work and lesson plan.

Scheme of Work:

The physics scheme of work is a document which contains the pattern that the teacher is to follow when teaching. It is a detailed plan for the subject matter that is to be covered**.** Schemes of work are written for a period of a few weeks, a term or an academic year.

Importance of Scheme of Work

- Guides in writing of a lesson plan
- Assists in planning for resources in good time.
- Ensures continuity

Requirements for Scheme of work- the teacher preparing to write a scheme of work should consider the following:

- **The Physics syllabus**- this is the source of the content (topics) and their related objectives to be achieved for each topic. The teacher should make an effort to cover the syllabus in a logical order. The arrangement of the topics in the syllabus or in the textbook is not always the best. The teacher is thus expected to organize the content so that concepts follow each other logically. Teachers in other departments should be consulted for integrated teaching. Some concepts are best handled by the integrated approach of teaching.
- **Text book**-this gives a detailed treatment of the topics and a wide variety of activities from which the teacher should either find or develop suitable experiments for every theoretical section of the syllabus. The teacher should be careful not to use textbooks which contain errors or erroneous information.
- **School timetable**-this guides one on the number of lessons/periods in terms of their distribution & duration per week (i.e. in terms of whether the periods are single or double). This further helps in determining whether a given lesson should be for theory or practical.
- **Resources**- the main resources for the teaching of physics include among others the following: laboratory (apparatus, equipment, space etc), Charts and Models.

Components of a scheme of work.

There are a variety of formats of schemes of work used in institutions. There is no standard format of a scheme of work. What is expected is that the teacher does proper interpretation of whatever format his/her institute prefers.

Most schemes of work have the following parts:

- administrative details
- term objectives
- a week as a unit of time
- a lesson/period as a unit of time
- contents/topics/subtopics
- objectives to be achieved
- learning activities
- resources
- references
- Remarks

The Maasai Mara University uses the format below.

Scheme of Work

NAME……	REG.NO…….
SCHOOL……...	FORM……
DEPARTMENT…….	SUBJECT……..
YEAR…….	TERM……

week	Date	Lesson	Topic /subtopic	Specific Objectives	Learner activities	Teaching /learning resources	Assessment methods	Remarks

Table 4.1: Scheme of work format

It is important to note that a scheme of work is usually flexible and this is due to interruptions/disruptions. It is not so easy to follow a scheme of work so strictly at all times. What matters most is the realization on the part of the teacher that time must be created somehow to ensure all the topics in the scheme of work are covered by the time the stipulated time expires.

Remarks column: This one is for self-evaluation e.g.

- ✓ Were the objectives attained (when students answered questions correctly)
- ✓ Were some objectives not attained and are thus emphasized in the next lesson?
- ✓ Was the lesson not taught due to some unavoidable reasons and when will it be taught?

Lesson Plan

This is a detailed plan of activities that will take place during the lesson (single or double). It may be seen as a teaching outline of the important points of a lesson arranged in order in which they are to be presented.

The lesson plan has the following parts:

1. **Administrative** details which include:

NAME…… REG.NO……
SCHOOL…… FORM……
DATE…… SUBJECT……..
TOPIC…...…… TIME……

2. **Objectives** of the lesson. Objectives ought to:
   - o Be written in behavioral terms,
   - o Give various performance levels and
   - o Represent various domains of learning.

Common verbs used in writing instructional objectives

Verbs one can use *Verbs to avoid*

List	Know
Describe	Understand
Label	Appreciate
State	Believe
Evaluate	Enjoy
Explain	Be familiar
Identify	Become acquainted
Distinguish	Have a goo grasp
Construct	Obtain a working knowledge
Solve	Be aware of
Classify	Have information about
Sketch	

3. **Resource material.** This section outlines the materials that you will use to facilitate your teaching and enhance learning by the learners.

Resource materials include key references or textbooks, charts, models, apparatus etc. The position for this part is not fixed for all institutions. For the Maasai Mara University, it is at the top of the lesson plan whereas for other institutions it forms the last column of the lesson plan.

The lesson plan itself consists of the following columns:

(i) Timing of the coverage of the content. This shows the number of minutes needed to cover a given content in the lesson.

(ii) The content; this details what is to be covered. This section is usually broken down into **steps/stages** that consist of the following parts; introduction, body and conclusion.

(iii) The learning activities. These are activities that the learners will be involved in such as: answering questions, performing an experiment and discussing among themselves etc.

Lesson evaluation: This is actually optional for some lesson plan formats. It is meant for self –evaluation at the end of the lesson. Its proper place is at the bottom of the lesson plan.

The Maasai Mara University format is as follows:

Lesson Plan

NAME……	REG. No……
SCHOOL……	FORM……
DATE……	SUBJECT……..
TOPIC…..……	TIME……

OBJECTIVES……

RESOURCE MATERIALS…….

Time	Lesson	Teaching/Learning Activities
x minutes	Introduction	
y minutes	Body/Lesson Development	
z minutes	Conclusion	

Table4.2: Lesson plan format

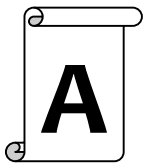
NB: x minutes for introduction, **y** minutes for the body and **z** minutes for conclusion. Most of the time is spent on the body. For a 40 minute single lesson is normally
x= 5, y= 30 and z = 5.
Another common format from is given below

Lesson Plan

Name…… Reg. No.: (For TP student)……
School…… Form……
Topic…….. Subject……..
Date...……Week……Lesson No….. Time……
Objective(s)……

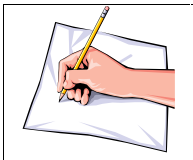
Time	Content	Learning activities	Resource materials

Activity 4.1



1. Given the topic 'determination of period of oscillation', identify and list the appropriate behavioral verbs that would be associated with the effective handling of this topic

Written Exercise 4.1



1. What are the key questions that a teacher should try to answer when planning the introduction of a lesson? (4marks).
2. Prepare a 40- minute lesson plan for a CAT. (10 marks).
3. Knowledge generation in Physics (Science) is achieved through: Observation, Experimentation, Speculation, Imagery and Intuition, explain any four of these terms. (4marks).
4. Outline any two methods that may be used to introduce a practical lesson. (2 marks).

The answers are on page **54** and **my score section** on page **60**

MICRO-TEACHING

- **Introduction**

You know that the economic prosperity and good quality of any nation depends upon the development of human resources of that nation. The significant fact in the development of manpower resource refers to the competencies and the level on which these competencies are imparted. You also know that it largely depends on those who develop these competencies. Therefore, for this purpose we need highly competent teachers for imparting these competencies. It is essential that teachers imparting these competencies should have the capability to perform their task efficiently. For this, they need to acquire requisite competencies themselves.

In the present Unit we will attempt to understand as to what competencies are essential for becoming better teacher and how these competencies can be imparted.

Teaching: Definition

"Teaching means many different things, that teaching act varies from person to person and from situation to situation. " (Bar, 1961)

"The behaviour or activities of persons as they go about doing whatever is required of teachers, particularly those activities which are concerned with the guidance or direction of learning of others." (Ryan, 1965)

"Teaching is the arrangement of contingencies of reinforcement under which students learn. They learn without teaching in their natural environment, but teachers arrange special contingencies which expedite learning and hastening the appearance of behaviour which would otherwise be acquired slowly or making scene of the appearance of behaviour which might otherwise never occur." (B.F. Skinner. 1968)

"Teaching as an act of interpersonal influence aimed at changing the ways in which other persons can or will behave." (N.L. Gage, 1963)

What is a teaching skill?

Definition of teaching skill might be one of the following :

* A teaching skill is that behaviour of the teacher which facilitates students' learning directly or indirectly.

* A teaching skill includes all arts and behaviour of the teacher which maximizes students' learning.

*A teaching skill is that art of the teacher which makes communication between the teacher and students sufficiently.

Attempts have been made to list teaching skills. Allen and Ryan listed the following teaching skills at Stanford University in the U.S.A.

1. Stimulus Variation
2. Set induction

3. Closure
4. Teacher silence and non-verbal cues
5. Reinforcing student participation
6. Fluency in questioning
7. Probing questioning
8. Use of higher questions
9. Divergent questions
10. Recognizing and attending behaviour
11. Illustrating and use of examples
12. Lecturing
13. Planned repetition
14. Completeness of communication

B.K. Passi has given the following list of Teaching Skills in his book "Becoming Better Teacher; Micro-teaching Approach" :
1. Writing instructional objectives
2. Introducing a lesson
3. Fluency in questioning
4. Probing questioning
5. Explaining
6. Illustrating with examples
7. Stimulus variation
8. Silence and non-verbal cues
9. Reinforcement
10. Increasing student participation
11. Using black board
12. Achieving Closure
13. Recognizing attending behavior

NCERT (National Council of Educational Research and Training) in its publication ***Core Teaching Skills*** (1982) has laid stress on the following teaching skills…
• writing instructional objectives
• Organizing the content
• Creating set for introducing the lesson
• introducing a lesson
• Structuring classroom questions
• Question delivery and its distribution
• Response management
• explaining
• illustrating with examples
• Using teaching aids
• Stimulus variation
• Pacing of the lesson

• Promoting student participation
• Use of blackboard
• Achieving closure of the lesson
• Giving assignments
• Evaluating the student's progress
• Diagnosing student learning difficulties and taking remedial measures
• Management of the class

Core Teaching Skills

It is not possible to train all the student teachers in all these skills in any training programme because of the constraints of time and funds. Therefore a set of teaching skills which cuts across the subject areas has been identified. They have been found very useful for every teacher. The set of these skills are known as CORE TEACHING SKILLS

Core Teaching Skills are:

1. Skill of Probing Questions
2. Skill of Explaining
3. Skill of Illustrating With Examples
4. Skill of Stimulus Variation
5. Skill of Reinforcement
6. Skill of Classroom Management
7. Skill of Using Blackboard
8. Skill of Introducing a lesson

Core Teaching Skills and their Components

1. Probing Questions

Components : Prompting, seeking further information, redirection, focusing, increasing critical awareness.

2. Explaining

Components : Clarity, continuity, relevance to content using beginning and concluding statements, covering essential points.

3. Illustrating with examples

Components : Simple, relevant and interesting examples appropriate media, use of inducts, deductive approach.

4. Stimulus variation

Components : Body movements, gestures, change in speech pattern, change in interaction style, pausing, focusing, oral-visual switching.

5. Reinforcement

Components : Use of praise words and statements, accepting and using students' idea, repeating and rephrasing, extra vertical cues, use of pleasant and approving gestures and expressions, writing students' answer on the black board.

6. Classroom Management

Components : Call students bynames, Makenorms of classroom behaviour, attending

behaviour reinforced, clarity of direction, check non-attending behaviour, keep students in Eye Span, check inappropriate behaviour immediately.

7. Use of blackboard

Components : Legible, neat and adequate with reference to content covered.

Concept of Micro-teaching

Micro-teaching is a teacher training technique which helps the teacher trainee to master the teaching skills. It requires the teacher trainee

1. to teach a single concept of content
2. using a specified teaching skill
3. for a short time
4. to a very small member of students

In this way the teacher trainee practices the teaching skill in terms of definable, observable, measurable and controllable form with repeated cycles till he attains mastery in the use of skill.

Meaning and Definition of Micro-Teaching

Meaning

Micro teaching is a procedure in which a student teacher practices teaching with a reduce number of students in a reduced period of time with emphasis on a narrow and specific teaching skill.

Definition

• "Microteaching is a scaled down teaching encounter in class size and time
- D.W.Allen(1966)

• "Microteaching is defined as a system of controlled practice that makes it possible to concentrate on specified teaching behaviour and to practice teaching under controlled conditions."
- D.W. Allen & A.W.Eve (1968)

• "Microteaching is a scaled down teaching encounter in which a teacher teaches a small unit to a group of five students for a small period of 5 to 20 minutes"
- L.C. Singh (1977)

Objectives of Microteaching

• To enable teacher trainees to learn and assimilate new teaching skills under controlled conditions.
• To enable teacher trainees to master a number of teaching skills.
• To enable teacher trainees to gain confidence in teaching.

- **Characteristic of Microteaching**

• Microteaching is a highly individualized training device
• Microteaching is an experiment in the field of teacher education which has been incorporated in the practice teaching schedule
• It is a student teaching skill training technique and not a teaching technique or method
• Microteaching is micro in the sense that it scale down the complexities of real teaching
• Practicing one skill at a time
• Reducing the class size to 5 – 10 student
• Reducing the duration of lesson to 5 – 10 minutes
• Limiting the content to a single concept
• immediate feedback helps in improving, fixing and motivating learning
• The student are providing immediate feedback in terms of peer group feedback, tape recorded/CCTV
• Microteaching advocates the choice and practice of one skill at a time

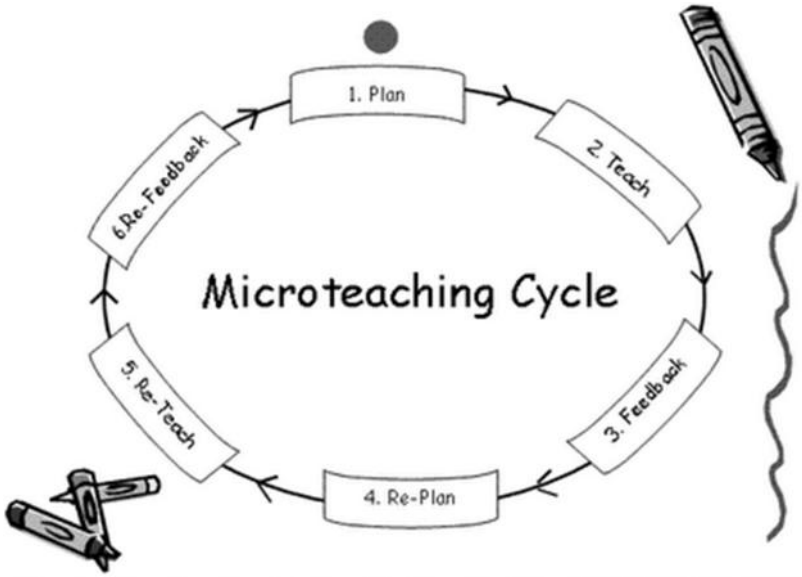
Steps of Micro-teaching

The Micro-teaching programme involves the following steps:
Step I Particular skill to be practiced is explained to the teacher trainees in terms of the purpose and components of the skill with suitable examples.
Step II The teacher trainer gives the demonstration of the skill in Micro-teaching in simulated conditions to the teacher trainees.
Step III The teacher trainee plans a short lesson plan on the basis of the demonstrated skill for his/her practice.
Step IV The teacher trainee teaches the lesson to a small group of students. His lesson is supervised by the supervisor and peers.
Step V On the basis of the observation of a lesson, the supervisor gives feedback to the teacher trainee. The supervisor reinforces the instances of effective use of the skill and draws attention of the teacher trainee to the points where he could not do well.
Step VI In the light of the feed-back given by the supervisor, the teacher trainee replans the lesson plan in order to use the skill in more effective manner in the second trial.
Step VII The revised lesson is taught to another comparable group of students.
Step VIII The supervisor observes the re-teach lesson and gives re-feed back to the teacher trainee with convincing arguments and reasons.
Step IX The 'teach – re-teach' cycle may be repeated several times till adequate mastery level is achieved.

Micro-teaching Cycle

The six steps generally involved in micro-teaching cycle are Plan , Teach , Feedback Replan , Reteach , Refeedback. There can be variations as per requirement of the objective of practice session. These steps are diagrammatically represented in the

following figure :



- **Diagramatic representation of a Micro-teaching Cycle**

Plan : This involves the selection of the topic and related content of such a nature in which the use of components of the skill under practice may be made easily and conveniently. The topic is analyzed into different activities of the teacher and the students. The activities are planned in such a logical sequence where maximum application of the components of a skill is possible.

Teach : This involves the attempts of the teacher trainee to use the components of the skill in suitable situations coming up in the process of teaching-learning as per his/her planning of activitieó. If the situation is different and not as visualized (in the planning of tTe activities, the teacher should modify his/her behaviour ás per the demand of the situation in the Wlass. He should have the courage and confidence to handle the situation arising in the class effectively.

Feedback : This term refers to giving information to the teacher trainee about his performance. The information includes the points of strength as well as weakness relating to his/her performance. This helps the teacher trainee to improve upon his/her performance in the desired direction.

Re-plan : The teacher trainee replans his lesson incorporating the points of strength and removing the points not skillfully handled during teaching in the previous attempt either on the same topic or on another topic suiting to the teacher trainee for improvement.

Re-teach : This involves teaching to the same group of students if the topic is changed or to a different group of students if the topic is the same. This is done to remove boredom or monotony of the student. The teacher trainee teaches the class with renewed courage and confidence to perform better than the previous attempt.

Re-feedback : This is the most important component of Micro-teaching for behaviour modification of teacher trainee in the desired direction in each and every skill practice.

Time duration for the microteaching is;

o Teach : 6 Minutes.
o Feedback : 6 Minutes.
o Re-Plan :12 Minutes.
o Re-Teach : 6 Minutes.
o Re-Feedback : 6 Minutes.

Phases of Micro-teaching

There are three phases of the Micro-teaching procedure which you have studied in the previous section of this Unit. They are:

1. Knowledge Acquisition Phase.
2. Skill Acquisition Phase.
3. Transfer Phase of Micro-teaching.

1. Knowledge Acquisition Phase (Pre-Active Phase)

It includes the activities such as;

Ø Provide knowledge about teaching skills.
Ø Observe the demonstration of teaching skill.
Ø Analyze and discuss the demonstration of the teaching skill.

2. Skill Acquisition Phase (Inter-active Phase)

It includes the activities such as;

Ø Planning and preparation of micro lesson for a skill.
Ø Practicing the skill.
Ø Evaluation of the practiced skill (Feedback).
Ø Re-plan , Re-teach and re-feedback till the desired level of skill is achieved.

3. ***Transfer Phase (Post –Active Phase)***

Ø Giving opportunity to use the mastered skill in normal class room teaching.
Ø Integrate the different skill practiced

Link Practice (Integration of Teaching Skills)

When mastery has been attained in various skills ,the teacher trainee is allowed to teach the skills together. This separate training programme to integrate various isolated skills is known as ‘Link Practice’

It helps the trainee to transfer effectively all the skills learnt in the micro teaching sessions.

ü It helps to bridge the gap between training in isolated teaching skills and the real teaching situation faced by a student teacher.
ü Desirable Number of Students :15-20

ü Preferable Duration :20minutes.
ü Desirable Number of Skills :3-4 Skills
• Link practice or integration of skills can be done in two ways;

Integration in parts

3 or 4 teaching skills are integrated and transferred them into a lesson of 15-20 minutes duration. And again 3 or 4 skills are integrated and are transferred all the skills to one lesson.

Integration as a whole

Student teacher integrates all the individual teaching skills by taking them as a whole and transferred them into a real teaching situation.

Merits of Microteaching

• It helps to develop and master important teaching skills.
• It helps to accomplish specific teacher competencies.
• It caters the need of individual differences in the teacher training.
• It is more effective in modifying teacher behaviour.
• It is an individualized training technique.
• It employs real teaching situation for developing skills.
• It reduces the complexity of teaching process as it is a scaled down teaching.
• It helps to get deeper knowledge regarding the art of teaching.

Limitations of Microteaching

• It is skill oriented; Content not emphasized.
• A large number of trainees cannot be given the opportunity for re-teaching and re-planning.
• It is very time consuming technique.
• It requires special classroom setting.
• It covers only a few specific skills.
• It deviates from normal classroom teaching.
• It may raise administrative problem while arranging micro lessons

Microteaching Vs Traditional Classroom teaching

Microteaching teaching versus *Traditional Class room

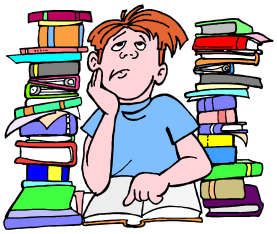
· Teaching is Relatively Simple * Teaching is Complex Activity
· Carried out in controlled situation * Carried out in uncontrolled Situation
· The Class Consist of a small of no.* Classroom consist of large no ie 35 to 40 students
· takes up one skill at a time * Teacher practices several skill at a time
· Teaching time is 5 to 10 mins. * Teaching time is 40 to 50 mins
· Student teacher provided immediate feedback * No immediate feedback
· Provision for reteaching * No provision for reteaching
· Students gains confidence in teaching * Students usually tensed and before actual scared

Origin and Development of Micro-teaching

The idea of micro-teaching originated for the first time at Stanford University in USA, when an Experimental Project on the identification of teaching skills was in progress under the guidance and supervision of the faculty members (Bush, Allen, McDonald Acheson and many others). This project was aided by Ford Foundation and Kettering Foundation. The team of experts was assigned the development of testing and evaluation tools to measure the attainment of teaching skills. At this juncture Keath Acheson, a research worker was investigating the utility of video tape recorder in the development of technical teaching skills. This instrument could be used for recording the class interaction and the behaviours of the trainee vividly and accurately. This lead to the development of a systematic and accurate method of giving feedback to the teacher trainee. All the steps of micro-teaching technique :

Teach → Feedback → Replan → Reteach → Refeedback were formulated. Thus the name of micro-teaching was coined for this method of developing teaching skills in 1963. Since then this technique of teacher training has been widely used in almost all Colleges and Universities of Europe, Africa and Asia. In Kenya , it is being used with great emphasis in all the teacher training programmes of developing teaching skills and competencies among teacher trainees.

Suggestions for Further Readings



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2. GREWAL, J.S., R. P. SINGH. “A Comparative Study of the Effects of Standard MT With Varied Set of Skills Upon General Teaching Competence and Attitudes of Pre-service Secondary School Teachers.” In R.C. DAS, et.al. Differential Effectiveness of MT Components, New Delhi, NCERT, 1979.
3. PASSI, B.K., Becoming Better Teachers. Baroda : Centre for Advanced Study in Education, M. S. University of Baroda, 1976.
4. SINGH, L. C. et.al. Micro-teaching – Theory and Practice, Agra : Psychological Corporation, 1987.
5. SHAH, G. B. Micro-teaching – Without Television, Nutan Shikshan, 1970.
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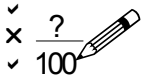
UNIT FIVE: ASSESSMENT IN PHYSICS

Self diagnostic Test

Answer all questions



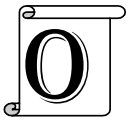
1. Why do we assess learners?
2. Explain the different methods used to assess learners.
3. Why is multiple choice questions not recommended in physics assessment?

Introduction

Assessment is the process by which the quantity of an individual's performance is judged. Assessment is an important component of any educational program. Through assessment we determine whether a range of our objectives have been realized. Quality assessment will depend on quality questions that form a question paper.

This unit deals with assessment in physics. Discussion of questions and their formulation. It addresses the issue of qualities of a good question. This section also focuses on factors to consider when setting questions. This include among others: table of test specifications, marking scheme preparation, grading process and treatment of examination outcomes.

Specific Objectives



After studying this unit, you should be able to:

1. Formulate proper and acceptable questions.
1. Explain the qualities of a good examination
2. Prepare and use a table of test specifications
3. Prepare a good marking scheme
4. Objectively mark and grade an examination.

 **Note**: The main objectives of teaching physics fall into two main categories. These are: understanding of concepts, and acquisition of range of manipulative skills and process skills. It is important that any serious assessment in physics (theory and practical) recognizes these two areas.

Physics can be assessed through:

- Theory - Continous assessment tests
- Final exams
- Practical work – Experiments
- Projects

Generally the purpose of any examination is to:

- Assess mastery of material taught
- Motivate students
- Grade and classify students
- To show the pupils where they have gone wrong.
- To keep a check on the progress of the pupils.

It is through assessment that we can determine whether or not our objectives have been achieved. In physics there are two main types of questions used to assess learners. These two types are the:–

(a) **Fixed response** or closed type. These are true-false, multiple choices, matching pairs and multiple completions.

(b) **Free response** or open type. These include short-answer, structured and essay questions.

Quality assessment will depend on quality questions that form a question paper.

Qualities of a Good Examination

Validity: Requires an examination to measure what is supposed to measure.

Reliability: Requires the examination to measure accurately and consistently what it is supposed to measure. Factors affecting reliability**:** Duration, simplicity of instructions, ambiguity, emotional and physical readiness of a student.

Objectivity: Requires that the examination is fair to all students so that everyone has equal opportunity to reveal what they have learnt

Discrimination: A good examination reveals progress each student has made towards achieving the objectives.

Comprehensiveness: an examination should sample all objectives specified in the test plan and do so in a well balanced manner and with the right emphasis. This is judged by the thoroughness with which the student performance objectives are represented by the test items

A good question paper in physics should take into consideration the above qualities of a good examination especially high **reliability** and **validity** and must also emphasize two areas-**theory** (emphasis on understanding of concepts and how to apply them) and **practical** (emphasis on manipulative and process skills).

Usually the assessment comes at the end of the course (e.g. Form Four).

THEORY PAPER

In Kenya the theory paper consists of three papers:-

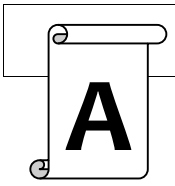
(a) Paper 1
(b) Paper II
(c) Paper III

a) PAPER 1

- **Questions from selected topics.** These topics in Kenya certificate of secondary school education are:
  - **Heat-** quantity, thermal expansion, kinetic theory, gas laws, thermometry, phase changes
  - **Mechanics-** Measurements, linear motion, horizontally and vertically projected motion, circular motion and Newton's laws of motion, Forces, fluid at rest and in motion.

The paper consists of questions to which the student responds in a word, phrase, or at most, one or two sentences, applies a formula and obtains a numerical solution, plots a graph and interprets the trend or describes an experimental set up e.g.

Activity 5.1



1 Identify the processes where the **four** states of matter are converted from one form to the other.

2	Write units for each of the following measurements: power, force, viscosity, magnetic field, electric flux intensity

Guidelines for writing examination questions items

- Try to phrase items so that there is only one possible correct response.
- Phrase items so that the student is clear on what type of response is demanded
- Avoid statements taken directly from the text.

b) **PAPER II**

Paper II consists of questions from the following topics.

- Electricity and Magnetism- Electrostatics, electric current, resistance, dc currents, magnetic materials magnetization and demagnetization, ac currents , electromagnetic induction, applications of electromagnetism.
- Optics- Rectilinear propagation, image formation of plane and curved reflectors, refraction, thin lenses and applications, application in communication and correction of vision.
- Modern physics- atomic theory, x-rays, photoelectric effect, radioactivity, electronics

Consists of questions to which the student responds in a word, phrase, or at most, one or two sentences, applies a formula and obtains a numerical solution, plots a graph and interprets the trend or describes an experimental set up e.g.

c) **PAPER III**

Paper III consists of practical paper. This is where a student sets up an experiment with apparatus provided, follows some given instructions, collects data and uses the data to plot graphs and interpret the findings. Some more questions may be asked for the student to extrapolate the findings to similar unfamiliar situations.

Characteristics of Structured Questions:

Parts of questions require short answers to be entered in spaces provided on the paper. Longer structured questions consist of a series of questions on the same topic. The central source of the question is a table or diagram. This central part is the source of sub-questions. These questions are hierarchical-The first sub-questions are simple but the subsequent questions get more difficult as one moves on. When information is in a table or on a graph it is referred to as non- linear information.

ESSAY QUESTIONS

These types of questions are more condensed and thus, very brief. They require a candidate to describe a manufacture process, or an experiment. These give an opportunity to a candidate to self-expression and also to organize the answer or response to the best of his ability.

An essay type question consists of a statement that sets the problem. They are the best examinations for synthesis and evaluation. In an essay type question one is expected to read the question carefully and understand precisely what it asks. Certain key words indicate the method you are to use in presenting the information. Many students either fail to isolate these key words or do not understand precisely what is meant by them. Below is a comprehensive list of the key words used in essay type questions. This is meant to help both teachers and students as they prepare for essay questions.

Compare: When you are asked to compare, you should examine qualities or characteristics, in order to discover resemblances. The term "compare" is usually stated as "compare with" and it implies that you are to emphasize similarities, although differences may be mentioned.

Contrast: When you are instructed to contrast, the dissimilarities, differences, or unlikeness of associated things, qualities, events, or problems should be stressed.

Criticize: In a criticism, you should express your judgment of the correctness or merit of the factors under consideration. You are expected to give the results of your own analysis and to discuss the limitations or good points of contributions of the plan or work in question.

Define: Definitions call for concise, clear, authoritative meanings. In such statements, details are not required, but boundaries or limitations of the definition should be briefly cited. You must keep in mind the class to which a thing belongs and what differentiates it from all other objects in the same class.

Describe: In a descriptive answer, you should recount, characterize, sketch, or relate in narrative form.

Diagram: For a question that specifies a diagram, you should present a drawing, chart, plan, or graphic representation in your answer. Generally, the student is expected to label the diagram and, in some cases, to add a brief explanation or description.

Discuss: The term "discuss" directs you to examine, analyze carefully, and present considerations pro and con the problems of items involved. This type of question calls for a complete and detailed answer.

Enumerate: The word "enumerate" specifies a list or outline form of reply. In such questions you should recount concisely, one by one, the points required.

Evaluate: In an evaluation question, you are expected to present a careful appraisal of the problem, stressing both advantages and limitations. Evaluation implies authoritative and, to a lesser degree, personal appraisal of both contributions and limitations.

Explain: In explanatory answers, it is imperative that you clarify, elucidate, and interpret the material you present. In such an answer, it is best to state the "how" or "why", reconcile any differences in opinion or experimental results, and, where possible, state causes. The aim is to make plain the conditions that give rise to whatever you are examining.

Illustrate: A question that asks you to illustrate usually requires a figure, picture, diagram, or concrete example to explain or clarify your answer to the problem.

Interpret: An interpretation question is similar to one requiring explanation. You are expected to translate, exemplify, solve, or comment upon the subject and, usually, to give your judgment or reaction.

Justify: When you are instructed to justify your answer, you must prove or show grounds for decisions. Evidence should be presented in convincing form.

List: Listing is similar to enumeration. You are expected in such questions to present an itemized series or tabulation. Such answers should always be given in concise form.

Outline: An outline answer is organized description. You should give main points and essential supplementary materials, omitting minor details, and present the information in a systematic arrangement or classification.

Prove: A question that requires proof is one that demands confirmation or verification. In such discussions, you should establish something by evaluation and citing experimental evidence or by logical reasoning.

Relate: In a question that asks you to show the relationship or to relate, your answer should emphasize connections and associations in descriptive form.

Review: A review specifies a critical examination. You should analyze and comment briefly in organized sequence upon the major points of the problem.

State:In questions that directs you to specify, give, state, or present, you are called upon to express the high points in brief, clear narrative form. Details, and usually illustrations or examples, may be omitted.

Summarize: When you are asked to summarize or present a summarization, you should give in condensed form the main points or facts. All details, illustrations, and elaboration are to be omitted.

Trace: When a question asks you to trace a course of events, you are to give a description of progress, historical sequence, or development from the point of origin. Such narratives may call for probing or for deductions.

In the type of examination that involves writing an essay, you must be able to recall pertinent information and organize it in a logical manner. The result should be clearly stated in good English, using suitable **terminology**. You must therefore decide which points you want to emphasize and how best to support the statements you make. Try to include related material form lessons, texts, and other sources. Before actually beginning to write the examination, take time to outline your answer, to jot down the points you wish to include, and to organize your presentation.

Requirements of a good essay

The requirements of a good essay which are:

i. Factual accuracy
ii. Clarity
iii. Neatness
iv. Relevance to the question that has been asked
v. Good organization
vi. Logically developed arguments
vii. Good English
viii. Evidence of thorough information
ix. Ability to relate this course to others
x. Completeness of response

Make an attempt to answer all questions. After you have completed each question, leave a **space**, so that you may, if necessary, add more material to your answer later on. When you have finished your examination, **reread** the paper, checking grammar, spelling, and content. If diagrams or charts have been included, examine the labeling for completeness and accuracy.

Advantages of essay questions

An essay question tests the following; organizational skills, evaluation, summarization, and comprehension.

- It is easy to construct this type of question.
- It requires a student to compose his/her own answer.
- It tests ability to make judgment from certain conditions and known facts.

Disadvantages:

- Scoring is time consuming.
- Problems are not always clearly defined.
- Irrelevant variables e.g. speed, writing style.
- Few questions included in the exam, i.e. covers only a few areas.

Tips on Setting Essay Questions:

Limit the problem the question poses. Use key words like; explain how, give the reasons for, compare and contrast, and present the arguments for or against. Additionally, prepare questions which require considerable thought but which can be answered in relatively few words. Use questions that have clearly acceptable correct answers rather than ones that require opinions or attitudes. Write questions about materials immediately after teaching each topic and study past questions to determine how students performed.

PRACTICAL PAPERS

A practical paper is normally set alongside a theory paper at the end of a course. The end of course depends on the curriculum of a given country. In Kenya it is usually at the end of four years in form four and in other countries there are physics examinations.
The practical skills emphasized are the usual two types which are manipulative (handling) skills and process skills. It is one paper with mainly three questions.

Written Exercise 5.2

1. An examination is usually described as either a means to an end or as an end in itself. Explain. (2 marks)
2. List the factors to consider when writing essay examinations. (3 marks)
3. What are the requirements before starting to set an examination? (15 marks)

The answers are on page **54** and **my score section** on page **60**

Constructing a Test:
Plan the test in terms of:

- Type of questions to be used
- The content and skills to be assessed
- Table of test specifications (Blue Print)
- The Marking scheme.

Table of Test Specifications

Rather than just making up test questions immediately, a teacher should formulate **a test plan** first. This is also known as **a blue print**. This test plan is represented by a table of test Specifications.

Table 4.3: Table of Test Specifications

S/N	TOPIC	SUB-TOPIC	SKILLS TO BE TESTED NUMBER OF QUESTIONS							
			KNOWLEDGE	Comprehension	APPLICATION	ANALYSIS	SYNTHESIS	EVALUATION	Total questions	Percentage weight per topic/subtopic
1.	MOTION	Linear motion	01		01				02	3.8
		Projected motion		01	01	01			03	5.8
		Circular motion	01			01			02	3.8
		Equation of motion	01	01		01			03	5.8
		Restrictive motion		01	01				02	3.8
2	QUANTITY OF HEAT									
3	GAS LAWS									
4	NEWTONS LAWS									
5	THERMAL EXPANSION									
NUMBER OF QUESTIONS										
PERCENTAGE WEIGHT PER SKILL										100

The test plan describes both the content which the test should cover and the behaviors expected of the student for that content. It also serves as a basis for setting the number of test items and for ensuring that the test will have the desired emphasis and balance. Usually the table **is** composed of the topics the test will cover on the left and the major classifications of the Bloom et al. taxonomy of cognitive educational objectives. There is an increasing complexity from left to right in the types of behavior implied by the column headings. Behaviors which demonstrate knowledge or comprehension, for example, are lower-level cognitive performances, while those behaviors reflecting the ability to

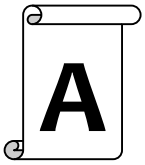
synthesize or evaluate are higher level cognitive performances. The body of the blueprint lists the specific objectives to test (e.g. observe). The objectives are thus doubly classified by both a content topic and a level of complexity of the taxonomic category.

Note: It is difficult to classify objectives and items into the categories of the Bloom et al. taxonomy. This does not render this approach to test planning useless, however. The purpose of formally laying out this two-way grid is not to promote exact or rigorous classification. Rather it is to aid the teacher in recalling that there are higher-order cognitive skills which need to be systematically taught and evaluated in the classroom. The numbers in the blueprint describe the emphasis of the test, both in terms of percentage of the total number of items and in terms of the percentage of items within each row or content category. The decision on how many questions to include on a test is based on the importance of the objectives, the type of questions, the subject matter, and the amount of time available for testing.

Weighting or emphasis of a test is based on the number of items in a particular category, not the number of objectives, reflecting the fact that some objectives are more important for a student evaluation than others. Students will expect the various numbers of questions on a test to correspond to the amount of time devoted to the objectives in class and to the emphasis which they perceived the teacher has placed on the objectives. If the test you are planning does not meet this expectation, it seems fair to notify the students of this fact well in advance of the test.
This advanced planning for developing a classroom test allows a teacher to view the test as a whole. In this way, a teacher can maintain whatever balance or emphasis of content coverage and whatever complexity of performance necessary and the test need be neither too easy nor too hard for the students.

Compare and contrast the norm and criterion referenced tests.

Activity 5.3



1. Prepare a five-topic table of specifications for a test you intend to use to determine the number of learners that are to proceed to form four.
2. Use the Kenya Secondary School Physics Syllabus to identify the appropriate topics to be used in this exercise.

Marking Scheme:

It is instructive to know how to make a marking scheme that is able to serve the intended purpose. A marking scheme consists of two parts; the answers or solutions to the question and the mark or points distribution against the specific answers to the question.

A marking scheme helps a physics teacher to be consistent when marking. A teacher should strive to write a marking scheme before marking the test/examination.

Points to consider when writing a marking scheme:

- Write it when setting the paper
- Allocate marks according to the difficulty of the concepts involved
- Marking scheme should allow for some little flexibility.

- Mark one question through for all candidates. This approach brings consistency and makes one mark faster.

Sum carefully the marks to ensure fairness to all students. At the end of it all the individual scores are supposed to give you a picture of the performance. To see this picture properly, one must apply statistical tools such as the **mean.** Work out the mean mark for each question in order to determine the "*difficulty level*" of each question. For example in a test consisting of five questions all marked out of ten marks, the mean score for each question is as indicated in the table below:

Question	Q1	Q2	Q3	Q4	Q5
Mean Score	7	9	3	6	8

The mean scores obviously indicate that question **three** had a problem. The teacher must take time to find out the source of this problem. Either the question was too difficult or it was poorly set.

Examination Outcomes

Examination outcomes should conform to the normal distribution curve shown below in figure 4.2 (B) if it is to show the expected necessary discrimination among the examinees.

The Normal Distribution Curve

A normal curve represents the normal distribution which in turn is the data curve which results from plotting the measurements of most events and closely resembles bell-shaped curves.

Measurements of natural phenomena such as weights and heights of persons or scores on achievement tests are normally distributed as illustrated by figure 4.2 (B).

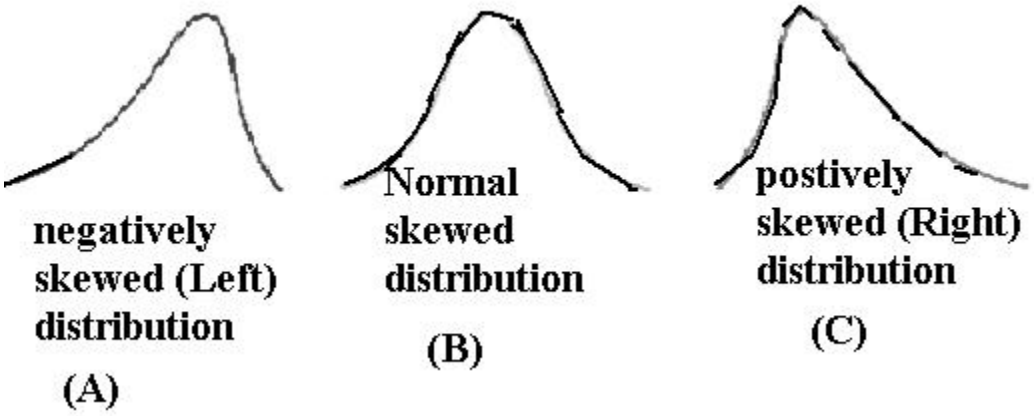
Negative Skew

The skew is the tail. If the tail (skew) is on the left (negative side), we have a negatively skewed distribution. That means that more of the students scored on the high end (because most of the people are not in the tail where the low scores are). This is usually the case when the test is too easy and the majority of the scores are high. This shape means that many high scores are massed at the right and few low scores are spread gradually towards the left end of the scale to give the shape shown in figure 4.2 (A).

Positive Skew

If the skew (tail) is on the right (positive side), we have a positive skew. That means more people scored low (because most of the people are not in the tail where the high scores are). This is what is expected when the test is too difficult and the majority of scores are low and produce a shape/ figure in which the curve slants to the right. This means that few high scores are spread gradually towards the right end of the scale while many low scores are massed at the left end of the scale. Thus in a positive skew, the excess tail points to the left as shown in figure 4.2 (C).

Figure 5.2: Examination Outcomes Distribution Curves



Two other terms associated with examination outcomes/scores/results are to do with skewedness i.e. negatively and positively skewed results.

Written Assignments
CIM 323/5

Do the following assignment and post it to:

The Head
Department of curriculum Development
Maasai Mara University
P.O. Box 861-20500,
Narok- Kenya

Q1. Explain the procedure for making an objective examination paper. (15 marks)
Q2. What considerations does one make when asking questions during his/her teaching in class? (5 marks)

Suggestions for Further Readings

Monk, M. & Osborne J. (2002). *Good practice in science teaching*. Open University: Buckingham.

UNESCO (1980): UNESCO handbook for science teachers. UNESCO: Paris.

Waddington, D.J. (1989) (Ed). Teaching school physics. Sterling/ UNESCO, New Delhi.

Ornstein, A.C. (1995). *Strategies for effective teaching*. Brown and Benchmark Dubuque: USA

UNESCO (1980). *UNESCO handbook for science teachers*. UNESCO: Paris.

Answers to Written Exercises

Written Exercise 1.1

1. The slow development of Physics prior to 1500AD was due to:-
   -Communication problems- no mass media language.
   -Lack of funds (Scientists were from the rich families, pastors etc)
   -Low standard of technology
   -Low motivation- Noble prize, honorary degrees
   -units and no standard units to enable quick communication
   -time between discoveries used to take a very long time leading to delay of information meant to reach many people. This was mainly due to conservatism.

   Any 3 points, 1 mark each **(3 marks)**

2. Physics as an activity involves many activities such as experimentation and experimentation does the following:
   - proving theories
   - Deriving new relationships between quantities
   - Inventing new ideas

   Any 2 points, 1 mark each

3. The main lessons learned from the history of Physics are:
   (a) Progressive nature of Physics: Physics is ever developing/growing. This has led to: new knowledge /conventions and new units. At the present it is the S.I units that are used.
   (b) Multi-cultural nature of physics: The main known contributions came from the following:
   -Romans, Greeks, Egyptians, Russians, British, French, Germans, and Americans.
   (c) Humanistic side of Physics (scientists): What comes out of this study is that early physicists worked for long hours under selfless conditions. Most discoveries were made after long periods of experimentation and frustrations. Physicists are expected to be patient and tolerant people.
   (d) Practically orientation of Physics: Physics was practically oriented and most of the activities were done in a practical way. It was about finding out and this meant use of a number of skills before arriving at the best possible results. Developed skills led to improved products hence emphasis on practical in physics.
   It is actually the skills that determine the quality of the products. Most countries where the standard of life is good, the people have high-level skills, which have improved their lives due to high quality products. **(15 marks)**

Written Exercise 1.2

1**. What are the Main Contributions of Physics to a learner? (8marks)**

2. The study of Physics helps to develop certain abilities and skills in students such as: -
Communication skills i.e. acquisition of physical language
Social skills i.e. able to get along with other people, respect for others, working effectively in groups etc.
Mathematical skills: computation, graphing, arranging etc.

Aesthetic skills: artistic sensitivity and the ability to prepare charts, models etc.
Safety skills: a person keen on scientific processes must be quick to execute correct and timely First Aid measures so as to minimize the probable loses due to accidents
Laboratory skills: these are further classified into manipulative skills and process skills as illustrated below and deserve special mention.
Manipulative Skills/Handling /Psychomotor
Handling skills that are well used lead to accurate results that bring about meaningful (useful) conclusion. Improvisation of apparatus is an additional skill acquired.
Process Skills: They assist in investigations or experiments. These are skills needed at every stage/ level of an investigation. Ability to plan good experiments is an important skill that is usually expected of physicists.
Any 6 points, 2 marks each

Written Exercise 2.1

1. An instructional objective is written in a standard format, which has the following main components:-
   -To be written in behavioral terms
   -To indicate the situation or condition
   -To indicate the acceptance level to be attained by the learner. 3**Marks**

2.(a) Procedure for a trip to a institution
- Write to the institution for permission
- If yes preview the trip (visit the institution as the teacher in charge)
- Write a program for the trip
- Write a worksheet.

(b) Treatment of information from the trip
- Discuss the information in groups
- Can display information for general (class) discussion or
- Can give the teacher for assessment and feedback

(15 marks)

Written Exercise 2.2

1. The roles of a teacher during a class experiment are:-
In all of the above experiments, the teacher:
- Must know the experiment very well, {Rehearse it} check that it works well with the equipment/apparatus learners are using.
- Demonstrate to learners how to use the apparatus.
- Show how much apparatus to take if they are not to be measured
- Give safety rules and discuss them
- Give instructions usually before the start of the experiment
- Supervise the experiment walking around the class
- Ensure there is time after the experiment for clean up
- Asks for the observations made and results
- Give summary of the experiment and where applicable discussion to follow when the experiment is still fresh in learners minds

Any four points with 0.5marks each

2. Meaningful learning cycle consists of three phases: -
(A) **Exploration**- The process of finding out about nature and the physical behavior of substances
(B) **Elaboration**- The process or act of clarifying the meaning of new terms, ideas, patterns or results from exploration. Explaining why or how some events occur.

(C) **Application**- The act of using knowledge or skill to solve a problem or to interpret a new situation.

1 mark each, (3marks)

(a) Advantages of patterns in content:

(i) Facilitates conceptualization – as knowledge can be easily be transferred
(ii) Facilitate planning e.g. for resources as such contents use similar resources
(iii) Assessment is simplified, as can test within the pattern but using different examples

Written Exercise 3.1

1. Advantages of using teaching aids
   b. Allows ease and repeated reproduction of events or procedure
   c. Provide visual access to a process or technique.
   d. Promote an illusion of reality
   e. Gain and hold the attention of the learner
   f. Save time, avoid wordy explanations
   g. Facilitate understanding of abstract concepts
   h. Illustrate and clarify theoretical matter.

   Any 4 points, each 0.5 marks **(2marks)**

2. Improvisation of teaching resources

   Advantages:

   - Useful in bringing about meaningful learning of physics.
   - Its use compels the teacher in revision and delivery of key concepts
   - Saves foreign exchange of a developing country.

   Any 2 points **(2marks)**

   Disadvantages/limitations:

   - It takes time and considering that most physics teachers carry a heavy teaching load, this can be quite over taxing to a teacher.
   - One handles a variety of materials, and there is a likelihood of being exposed to dangers such as poisoning, cuts and scratches.

   Any 1 point **(1mark)**

3. A modern physics laboratory design shown below facilitates both student and teacher demonstration as follows:

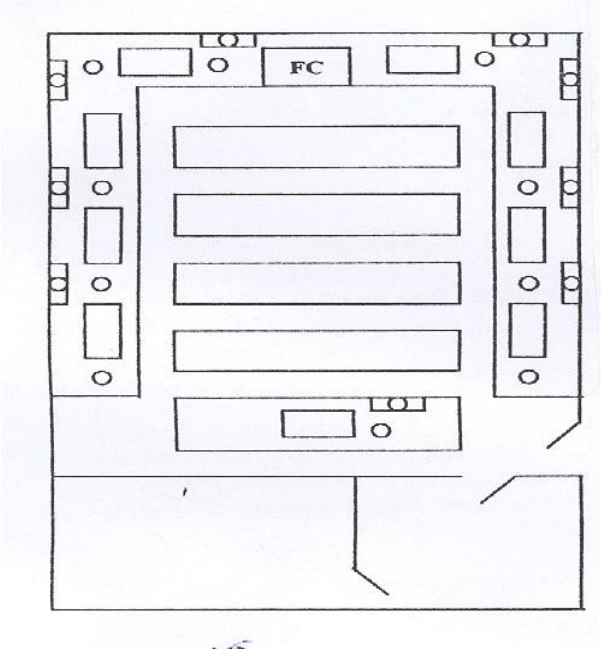
   (a) Facilitation of student experiment

   (i) During introduction- students are on the middle tables.
   (ii) During experiments: they move to the side tables.
   (iii) During discussion: students come back to the clean middle tables.

   (b) Facilitation of Teacher Demonstration experiment:

   The middle movable tables are moved back (if experiment is on the Teacher Demonstration) or Pushed forward (if experiment is in the FC) to give enough space for learners to stand (or sit) to view clearly the demonstration.

Bench arrangement and the main facilities in the movable bench physics laboratory design (modern laboratory design).



Main facilities arranged around the laboratory with central movable tables (benches).

Key

Sink Gas Electricity

(15 marks)

Written Exercise 3.2

1. Limitations of text books

- some text books are quite expensive
- Some texts get out of date quickly
- some texts do not offer to the reader the alternative techniques of carrying out various Experimental investigations **3marks**

2. (a) Advantages of proper storage

- prevents contamination of apparatus
- Prevents incidents e.g. fire etc.
- Facilitates access to a apparatus.

(b) The order in the storeroom

- Each section is arranged alphabetically
-Light apparatus on the shelves and heavy ones on the basement.
-Poisonous apparatus in a locked cupboard.

(15marks)

3. Advantages of minilabs compared to conventional laboratories:

a) Minilabs use small quantities of reagents as compared to laboratories. This has three major effects:

- It reduces the cost of apparatus, thus a huge saving of funds.
- Using large quantities of apparatus the way it is used in laboratories has a greater polluting effect on the environment. When using minilabs only, small amounts of residues are disposed, hence saving the environment.
- Using small quantities means using less energy to heat, thus a saving on energy.

b) Minilabs are easy to assemble and re-assemble, thus saves time and complete experiments faster than those in laboratories. Minilabs have been estimated to be 30-50% faster compared to standard laboratory methods.

c) Minilabs have the distinct advantage of being considerably safer than the traditional laboratory techniques and equipment. This is mainly so because of:
- Small amount of apparatus that reduce the risk of accidents.
- The miniaturized glass components that is usually more resistant to breaking.
- The precise instructions that come with minilabs making the operating procedure to be fault free.
- The storage is in well-designed boxes with all the materials intact.

d) Minilabs are generally cheaper to buy and maintain as compared to the traditional laboratories. In case of any breakage, only the broken part is replaced.

e) Minilabs have a flexible design, which makes it possible to arrange for many standard experiments plus other innovative ones.

f) Minilabs are well packaged with clear instructions. This makes it ideal for individualized physics learning, allowing students to conduct their own experiments and to a large extent being responsible for designing and setting up experiments on their own. Individualized modes of instruction have been found to be gender friendly.

Any 4points, each 0.5 marks (2marks)

Written Exercise 4.1

1. In planning an introduction, one should attempt to answer the following questions:
- How shall I arouse the interest of my learners?
- Can I introduce this topic by placing students in a situation in which they will feel the need for new additional information?
- What material taught in previous lessons is necessary for the understanding of the material that is to be presented?
- In what ways can I link this topic with topics taught earlier.
- How best can I lead to the purpose of the lesson?

Any 4 points, 1 mark each (4marks)

2. **Lesson plan for a CAT**

Time	content	CAT related activities	Resources
5 minutes	**Introduction** -caution on the time for the CAT(30 minutes) -use of large diagrams -distribution of papers -correction of errors in papers	-listen -ask questions - correct errors	-WB (BB) -Q papers -answer papers
30 minutes	**The CAT**	-Answering	-WB

	-Supervision of the CAT. -Announcement of time after every 10 minutes	questions	-Q papers -A Papers (foolscaps)
5 minutes	**Conclusion** -collect papers -relevant announcements (or comments)	-Hand in answer papers -Note announcements	-WB (BB)

(10marks)

3. Knowledge generation in Physics (Science) this is achieved through:

-Observation - It is the disciplined use of the five senses (sight, smell, taste, touch and hearing) to record information about events in nature.

-Experimentation -Deliberate effort to gather systematic data to test the truth or validity of a hypothesis. The goal is to explain natural phenomena by exploring a relationship between an independent and dependent variable.

-Speculation - A deliberate process of going beyond available data and postulating the mechanism that might or may underlie the behavior of a thing in nature.

-Imagery -A mental process of forming abstract mental pictures/models that represent reality.

-Intuition - The faculty that provides the legitimate knowledge that cannot be explained. It is knowledge that is consistent with reality in nature but cannot be given rational explanation (being convinced that something is correct without having a reason as to why it is correct).

Any 4 points, each 1 mark (4marks)

4. In practical lessons, several methods that may be used to introduce the lesson are:

- Explanation: Clear step-by-step explanation of the process to be carried out by the students in the experiments may be verbal or put down in the worksheet.
- Question/Answer method- (same as theory)
- Demonstration-useful-incase where a new process is to be taught.

Any 2 points, 1 mark each (2marks)

Written Exercise 4.2

1 Examinations are a means and an end. As an end, they measure learning and as a means they are a learning experience. In the preparation for exams, you review past work; this promotes learning and is in itself a type of learning. In the actual writing of the examination, you learn to organize and evaluate information under the pressure of time. Your test performance is an indication of the extent of your knowledge and the ability to prove it under pressure.

(2marks)

2. Writing essay examinations requires:

- Noting the key words in the question
- Outlining your answer
- Observing the rules of good essay
- Proof reading.

Any 3 points, each 1mark (3marks)

3. Prerequisites for assessment/setting an examination are:

A.

(a) content of the syllabus
(b) Examination syllabus

This ensures that one stays within the scope of the syllabus and focuses on relevant abilities to test.

Schemes of work- these provide a detailed analysis of what students are expected to be able to do by the end of each topic

- This must be checked by assessment.
- Past Examination Analysis:
- Gives the structure and topic loading.
- Guides the frequency of topic areas and scope of paper.
- Gives rubric and standard of testing.

B. Team setting and moderation ensures balance in quality, skill and focus.

C. Marking scheme and moderation- ensures accuracy in mark loading and check conformity to national standards.

D. **Comparative papers-** ensure weaknesses are reduced through borrowing. Also widens the scope of question bank.

E. **Marking and grading systems**

It is advisable for the teacher to train as a national examination marker to gain the insight of how the final examination is marked and graded. This helps you to; **train learners** how to answer questions better. **(15marks)**

My score

20	A	Outstanding
18-19	A-	Excellent
16-17	B+	Very good
14-15	B	Good
13	B-	Well above average
11-12	C+	Above average
9-10	C	Average
7-8	C-	Below average
5-6	D+	Well below average
3-4	D	Poor
1-2	D-	Very poor
0	E	Extremely poor

Congratulations

APPENDICES

THE 8-4-4- SYLLABUS

INTRODUCTION

The Physics Syllabus is designed to offer varied experiences to the learner. The experiences are meant to lead to an all round mental, social and moral development of the learner. This syllabus presents Physics as a body of knowledge about the physical environment. It employs a systematic scientific methodology of study to arouse learners' way of reasoning and create positive attitude. To this end the use of teacher/learner discussion, teacher demonstration and group/class experiments as methods of instruction is encouraged. It emphasizes not only the understanding of the fundamental scientific concept and principles, but also the experimental approach of investigation. The experimental approach should prepare the learner to present scientific concepts and ideas in the modern technology. Teachers are encouraged to expand upon suggested projects and teaching methodologies for effective implementation of this syllabus. These projects are designed to enrich the experiments carried out in the laboratory and enhance creativity. The project work approach provides a learner with opportunities in undertaking investigations for purposes of finding solutions to problems. It also helps in the transfer and application of the required scientific knowledge to solving problems encountered in day-to-day experiences. Field visits to resource centre/institutions of higher learning and industries are encouraged to enrich and modernize the teaching/learning process.

The general and specific objectives have been carefully articulated to ensure clarity of the intended learning outcomes. The time allocated for each topic is adequate and will enable the average learner not only acquire knowledge but also discover more about the world around him/her and as such develop interest in the subject.

The syllabus also aims at inculcating in the learner virtues such as diligence and high integrity. Care has also been taken to sensitize the learner on aspects of health and environmental concerns. The syllabus ensures appropriate balance in the development of cognitive, psychomotor and affective skills

The teacher of Physics is therefore challenged to make the subject more appealing through experimental approach and proper planning.

GENERAL OBJECTIVES OF KCSE PHYSICS

By the end of the course, the leaner should be able to:

1. select and use appropriate instruments to carry out measurements in the physical environment
2. use the knowledge acquired to discover and explain the order of the physical environment
3. use the acquired knowledge in the conservation and management of the environment
4. apply the principles of Physics and acquired skills to construct appropriate scientific devices from the available resources
5. develop capacity for critical thinking in solving problems in any situation
6. contribute to the technological and industrial development of the nation
7. appreciate and explain the role of Physics in promoting health in society
8. observe general safety precautions in all aspects of life
9. acquire and demonstrate a sense of honesty and high integrity in all aspects of Physics and life in general
10. acquire positive attitude towards Physics

11. Acquire adequate knowledge in Physics for further education and/or training.

FORM ONE CONTENT

1.0.0 INTRODUCTION TO PHYSICS (4 Lessons)

1.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

(a) explain what the study of physics involves
(b) relate physics to other subjects and to technology
(c) identify career opportunities related to physics
(d) State and explain basic laboratory safety rules.

1.2.0 Content

1.2.1 Physics as a Science(reference to Primary Science Syllabus)
1.2.2 Meaning of Physics
1.2.3 Branches of Physics
1.2.4 Relation between Physics, other subjects and technology
1.2.5 Career opportunities in Physics
1.2.6 Basic laboratory safety rules

2.0.0 MEASUREMENTS 1 (12 Lessons)

2.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define length, area, volume, mass, density, time and state the corresponding symbols and SI units
b) convert other metric units to SI units
c) estimate length, mass and time
d) use accurately the following measuring instruments; metre rule, tape measure, beam balance, stop clock/watch, measuring cylinder, pipette and burette
e) determine experimentally the densities of substances
f) solve numerical problems on density.

2.2.0 Content

2.2.1 Definition of length, area, volume, mass, density and time
2.2.2 SI units and symbols
2.2.3 Estimation of quantities
2.2.4 Conversion of units
2.2.5 Measuring instruments
2.2.6 Experiments on density
2.2.7 Problems on density

3.0.0 FORCE (16 Lessons)

3.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define force and state its SI unit
b) describe types of forces
c) describe experiments to illustrate cohesion, adhesion and surface tension
d) state the effects of force
e) state the difference between mass and weight
f) state the relation between mass and weight, W = mg
g) define scalar and vector quantities
h) solve numerical problems involving W = mg.

3.2.0 Content

3.2.1 Definition of force
3.2.2 Types of forces (including cohesive, adhesive and surface tension)
3.2.3 Experiments to demonstrate cohesion, adhesion and surface tension.
3.2.4 Effects of force
3.2.5 Mass, weight and their relationship
3.2.6 Scalar and vector quantities
3.2.7 Problem involving W = mg (take g =10N/kg)

4.0.0 PRESSURE (24 Lessons)

4.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define pressure and state its units
b) determine pressure exerted by solids
c) describe experiments to investigate factors affecting pressure in fluids;
d) derive the formula P = pgh
e) state the principle of transmission of pressure in fluids (Pascal's principle)
f) explain atmospheric pressure and its effect
g) state and explain the applications of pressure
h) solve numerical problems involving pressure.

4.2.0 Content

4.2.1 Definition of pressure
4.2.2 Pressure in solids
4.2.3 Factors affecting pressure in fluid (Experimental treatment required)
4.2.4 Derivation of P = pgh
4.2.5 Atmospheric pressure
4.2.6 Simple mercury barometer, manometers
4.2.7 Applications of pressure: drinking straw, syringe, siphon, hydraulic press, hydraulic brakes, bicycle pump, force pump, lift pump
4.2.8 Problems on pressure

4.3.0 Project Work

4.3.1 Construct a hydraulic press model.

5.0.0 PARTICULATE NATURE OF MATTER (12 Lessons)

5.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

(a) show that matter is made up of tiny particles
b) describe experiments to show that particles of matter are at constant random motion
c) explain the states of matter in terms of particles
d) explain diffusion

5.2.0 Content

5.2.1 Experiments to show that matter is made up of tiny particles (e.g. cutting papers into small pieces), dilution experiments
5.2.2 Brownian motion
5.2.3 States of matter
5.2.4 Diffusion (Graham's law not required)

6.0.0 THERMAL EXPANSION (12 Lessons)

6.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define temperature
b) describe the functioning of various thermometers

c) describe thermal expansion in solids, liquids and gases
d) explain expansion in terms of particle behaviour
e) describe the unusual expansion of water and its effects
f) explain the effects and applications of thermal expansion.

6.2.0 Content
6.2.1 Temperature
6.2.2 Thermometers:
- liquid - in - glass,
- clinical,
- six's maximum and minimum

6.2.3 Expansion of solids, liquids and gases
6.2.4 Effects of expansion and contraction
6.2.5 Unusual expansion of water (Anomalous expansion)
6.2.5 Applications of thermal expansion, include Bimetallic strip

7.0.0 HEAT TRANSFER (12 Lessons)

7.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define heat
b) state the difference between temperature and heat
c) state and explain the modes of heat transfer
d) describe experiments to illustrate factors affecting heat transfer
e) explain applications of heat transfer.

7.2.0 Content
7.2.1 Heat and temperature
7.2.2 Modes of heat transfer
7.2.3 Factors affecting heat transfer (Experimental treatment required)
7.2.4 Applications of heat transfer on:
- Vacuum flask,
- Domestic hot - water system,
- Solar concentrators

8.0.0 RECTILINEAR PROPAGATION OF LIGHT AND REFLECTION AT PLANE SURFACE (16 Lessons)

8.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) perform and describe experiments to show that light travels in a straight line
b) describe the formation of shadows and eclipses
c) explain the functioning of a pin-hole camera
d) state the laws of reflection
e) verify experimentally the laws of reflection
f) state the characteristics of images formed by plane mirrors
g) explain the applications of reflection at plane surfaces
h) solve numerical problems involving pin-hole camera and mirrors inclined at an angle.

8.2.0 Content
8.2.1 Rectilinear propagation of light (experimental treatment required)
8.2.2 Formation of shadows and eclipses (umbra and penumbra)
8.2.3 Pin-hole camera image formation and magnification
8.2.4 Laws of reflection
8.2.5 Images formed by plane mirrors, ray diagrams, parallel and inclined mirrors
8.2.6 Devices based on reflection: periscope, kaleidoscope
8.2.7 Problems on pin-hole camera and mirrors inclined at an angle

8.3.0 Project Work

8.3.1 Construct Pin-hole Camera,
Periscope and Kaleidoscope.

9.0.0 ELECTROSTATICS I (12 Lessons)

9.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) describe electrostatic charging of objects by rubbing
b) explain the source of electrostatic charges
c) state the two types of charges
d) state the basic law of charges
e) state the unit of charge
f) construct a simple leaf electroscope
g) explain the charging of a leaf electroscope
h) Use a charged leaf electroscope to identify conductors, insulators and types of charges.

9.2.0 Content

9.2.1 Electrostatic charging of objects by rubbing (experimental treatment required)
9.2.2 Types of charges and law of charges
9.2.3 The source of charge
9.2.4 The coulomb
9.2.5 Leaf electroscope: features, charging and discharging
9.2.6 Charging by contact and by induction
9.2.7 Identification of charge
9.2.8 Conductors and insulators

10.0.0 CELLS AND SIMPLE CIRCUITS (12 Lessons)

10.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) Draw and set-up simple electric circuits
b) Identify circuit symbols
c) define electric current
d) explain the working of primary and secondary cells
e) Explain the care and maintenance of secondary cells.

10.2.0 Content

10.2.1 Simple electric circuits: cell, ammeter, voltmeter, variable resistor, connecting wires, bulb and switches
10.2.2 Circuit symbols
10.2.3 Electric current and its units
10.2.4 Primary and secondary cells (simple cell, dry Leclanche' cell, Lead acid cell)
10.2.5 Care and maintenance of secondary cells

10.3.0 Project Work

10.3.1 Making a simple cell from locally available materials.

FORM TWO CONTENT

11.0.0 MAGNETISM (12 Lessons)

11.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) Describe the properties and uses of magnets
b) identify magnetic and non magnetic materials
c) state the basic law of magnetism
d) describe patterns of magnetic field
e) describe methods of magnetization and demagnetization

f) explain magnetization and demagnetization using the domain theory
g) construct a simple compass.

11.2.0 **Content**

11.2.1 Magnets: properties and uses
11.2.2 Magnetic and non-magnetic materials
11.2.3 Basic law of magnetism
11.2.4 Magnetic field patterns
11.2.5 Magnetization and demagnetization
11.2.6 Domain theory of magnetism
11.2.7 Care of magnets
11.2.8 Construction of a simple compass

12.0.0 MEASUREMENT II (16 Lessons)

Specific Objectives

By the end of this topic, the learner should be able to:

a) measure length using vernier calipers and micrometer screw gauge
b) express quantities in correct number of decimal places and correct number of significant figures
c) express measurements in standard form
d) estimate the diameter of a molecule of oil
e) solve numerical problems in measurement.

12.2.0 Content

12.2.1 Measurement of length using Vernier calipers and micrometer screw gauge
12.2.2 Decimal places, significant figures and standard form
12.2.3 Estimation of the diameter of the molecule of oil (relate to the size of the HIV virus, mention effects of oil spills on health and environment)
12.2.4 Problems in measurements

12.3.0 Project Work

12.3.1 Construct Vernier Caliper.

13.0.0 TURNING EFFECT OF A FORCE (10 Lessons)

13.3.1 Specific Objectives

By the end of this topic, the learner should be able to:

a) define moment of a force about a point and state its SI unit
b) state and verify the principle of moments
c) solve problems involving the principle of moments.

13.2.0 Content

13.2.1 Moment of a force, unit of moment of a force
13.2.2 Principle of moments Problems on principle of moments (consider single pivot only)

14.0.0 EQUILIBRIUM AND CENTRE OF GRAVITY (12 Lessons)

14.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define centre of gravity
b) determine experimentally the centre of gravity of lamina objects
c) identify and explain the states of equilibrium

d) state and explain factors affecting stability of an object
e) explain the applications of stability
f) solve numerical problems involving centre of gravity and moments of a force.

14.2.0 Content

14.2.1 Centre of gravity (Experimental treatment required)
14.2.2 States of equilibrium
14.2.3 Factors affecting stability
14.2.4 Applications of stability
14.2.5 Problems on centre of gravity and moments of a force (consider single pivot only)

15.0.0 REFLECTION AT CURVED SURFACES (16 Lessons)

15.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) describe concave, convex and parabolic reflectors
b) describe using ray diagram the principal axis, principal focus centre of curvature and related terms
c) locate images formed by curved mirrors by construction
d) determine experimentally the characteristics of images formed by a concave mirror
e) Define magnification 0 explain the applications of curved reflecting surfaces.

15.2.0 **Content**

15.2.1 Concave and convex parabolic reflectors
15.2.2 Principal axis, principal focus, centre of curvature and related terms
15.2.3 Location of Images formed by curved mirrors by construction method (Experiment on concave mirrors required)
15.2.4 Magnification formula
15.2.5 Applications of curved reflectors

16.0.0 MAGNETIC EFFECT OF ELECTRIC CURRENT (18 Lessons)

16.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) perform and describe experiments to determine the direction of the magnetic field round a current carrying conductor
b) construct a simple electromagnet
c) state the factors affecting the strength of an electromagnet
d) determine experimentally the direction of a force on a conductor carrying current in a magnetic field (motor effect)
e) state the factors affecting force on a current carrying conductor or in a magnetic field
f) Explain the working of simple electric motor and electric bell.

16.2.0 Content

16.2.1 Magnetic field due to a current
16.2.2 Oersted's experiment
16.2.3 Magnetic field patterns on straight conductors and solenoid (right hand grip rule)
16.2.4 Simple electromagnets
16.2.5 Factors affecting strength of an electromagnet
16.2.6 Motor effect (Fleming's left hand rule)
16.2.7 Factors affecting force on a current carrying conductor in a magnetic field (Qualitative treatment only)
16.2.8 Applications: - electric bell, - simple electric motor

16.3.0 Project Work

16.3.1 Construct an electromagnet and at least one of the following:
- loudspeaker
- telephone receiver
- electric bell
- electric motor

17.0.0 HOOKE'S LAW (8 Lessons)

17.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) state and verify experimentally Hooke's law
b) determine the spring constant
c) construct and calibrate a spring balance
d) solve numerical problems involving Hooke's law.

17.2.0 Content
17.2.1 Hooke's law
17.2.2 Spring constant
17.2.3 Spring balance
17.2.4 Problems on Hooke's Law

18.0.0 WAVES I (14 Lessons)

18.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

(a) describe the formation of pulses and waves
b) describe transverse and longitudinal waves
c) define amplitude(a),wavelength (λ,),frequency (f) and periodic time(T) of a wave
d) Derive the relation v = fλ,
e) Solve numerical problems involving v = fλ.

18.2.0 Content

18.2.1 Pulses and waves
18.2.2 Transverse and longitudinal waves
18.2.3 Amplitude (a), Wavelength *(k)*,
18.2.4 Frequency (f), periodic time (T)
18.2.5 v= fλ
18.2.6 Problems involving v = fλ.

19.0.0 SOUND (12 Lessons)

19.1.0 Specific Objectives

By the end of this topic the learner should be able to:

a) perform and describe simple experiments to show that sound is produced by vibrating bodies
b) perform and describe an experiment to show that sound requires a material medium for propagation
c) explain the nature of sound waves
d) Determine the speed of sound/ in air by the echo method
e) state the factors affecting the speed of sound
f) solve numerical problems involving velocity of sound.

19.2.0 Content

19.2.1 Sound: nature and sources(experimental treatment required)
19.2.2 Propagation of sound: compressions and rarefactions
19.2.3 Speed of sound by echo method
19.2.4 Factors affecting speed of sound
19.2.5 Problems on velocity of sound

20.0.0 FLUID FLOW (14 Lessons)

20.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) describe streamline flow and turbulent flow
b) derive the equation of continuity
c) describe experiments to illustrate Bernoulli's effects
d) explain the Bernoulli's effect
e) describe the applications of Bernoulli's effect
f) solve numerical problems involving the equation of continuity.

20.2.0 Content

20.2.1 Streamline and turbulent flow Equation of continuity
20.2.2 Bernoulli's effect (Experimental treatment required)
20.2.3 Applications of Bernoulli's effect: Bunsen burner, spray gun, carburetor aerofoil, spinning ball
20.2.4 Problems on equation of continuity

FORM THREE CONTENT

21.0.0 LINEAR MOTION (20 Lessons)

21.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define distance, displacement, speed, velocity and acceleration
b) describe experiments to determine velocity and acceleration
c) determine acceleration due to gravity
d) plot and explain motion - time graphs
e) applying the equations of uniformly accelerated motion
f) solve numerical problems.

21.2.0 Content

2.1.2.1 Distance, displacement, speed, velocity, acceleration (Experimental treatment required)
21.2.2 Acceleration due to gravity:
- free-fall,
- simple pendulum method (experimental treatment required)

21.2.3 Motion-time graphs:
- Displacement - time graphs,
- Velocity - time graphs (Experimental treatment required)

21.2.4 Equations of uniformly accelerated motion
21.2.5 Problems on uniformly accelerated motion

22.0.0 REFRACTION OF LIGHT (20 Lessons)

22.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) describe simple experiments to illustrate refraction of light
b) state the laws of refraction of light
c) verify Snell's law
d) define refractive index
e) determine experimentally the refractive index
f) describe experiments to illustrate dispersion of white light
g) explain total internal reflection and its effects
h) state the applications of total internal reflection
i) Solve numerical problems involving refractive index and critical angle.

22.2.0 **Content**

22.2.1 Refraction of light - laws of refraction (Experimental treatment required)

22.2.2 Determination of refractive index:

- Snell's law,
  real/apparent depth,
- critical angle

22.2.3 Dispersion of white light Experimental treatment required

22.2.4 Total internal reflection and its effects: critical angle

22.2.5 Applications of total internal reflection:

- Prism periscope,
- Optical fiber

22.2.6 Problems on refractive index and critical angle

23.0.0 NEWTON'S LAWS OF MOTION (15 Lessons)

23.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) state Newton's laws of motion describe simple experiments to illustrate inertia
b) state the law of conservation of linear momentum
c) define elastic collision, inelastic collision and impulse
d) derive the equation F = ma
e) describe the application of frictional force
f) define viscosity
h) Explain terminal velocity) solve numerical problems involving Newton's laws and the law of conservation of linear momentum.

23.2.0 Content

23.2.1 Newton's laws of motion(Experimental treatment on inertia required)

23.2.2 Conservation of linear momentum: elastic collisions, inelastic collisions, recoil velocity, impulse (oblique collisions not required).

23.2.3 F = ma.

23.2.4 Frictional forces:
Static and dynamic friction
- advantages and disadvantages,
- viscosity,
- Terminal velocity (qualitative treatment).

23.2.5 Problems on Newton's Laws and law of conservation of linear momentum (exclude problems on elastic collisions)

24.0.0 WORK, ENERGY, POWER AND MACHINES (20 Lessons)

24.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) Describe energy transformations
c) state the law of conservation of energy
d) define work, energy, power and state their SI units
e) Define mechanical advantage, velocity ratio an efficiency of machines
f) Solve numerical problems involving work, energy,
- Power and machines.

24.20 Content

24.2.1 Forms of energy and energy transformations

24.2.2 Sources of energy:

- renewable,
- non-renewable

24.2.3 Law of conservation of energy

24.2.4 Work, energy and power (work done by resolved force not required)

24.2.5 Kinetic and potential energy
24.2.6 Simple machines
24.2.7 Problems on work, energy, power and machines
24.3.0 Project Work
24.3.1 Construct an energy saving jiko and a solar heater

25.0.0 CURRENT ELECTRICITY (20 Lessons)

25.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define potential difference and state its units
b) measure potential difference and current in a circuit
c) verify Ohm's law
d) define resistance and state its unit
e) determine experimentally the voltage - current relationships for various conductors
f) define emf and explain internal resistance of a cell
g) derive the formulae for effective resistance of resistors in series and in parallel
j) solve numerical problems involving ohm's law, resistors in series and in parallel.

25.2.0 Content

25.2.1 Scale reading: Ammeter, Voltmeter
25.2.2 Electric circuits: current, potential difference
25.2.3 Ohm's law (experimental treatment required)
25.2.4 Resistance: types of resistors, measurements of resistance and units.
25.2.5 Electromotive force (emf) and internal résistance of a cell (E = V + Ir)
25.2.6 Resistors in series and in parallel
25.2.7 Galvanometers: Conversion to ammeters and voltmeters
25.2.9 Problems on Ohm's law, resistors in series and in parallel

26.0.0 WAVES II (10 Lessons)

26.1.0 Specific Objectives

By the end of this topic the learner should be able to:

a) describe experiments to illustrate the properties of waves
b) sketch wave fronts to illustrate the properties of waves
c) explain constructive interference and destructive interference
d) Describe experiments to illustrate stationary waves.

26.2.0 Content
26.2.1 Properties of waves including sound waves: reflection, refraction, diffraction, interference (Experimental treatment required)
26.2.2 Constructive interference and destructive interference(qualitative treatment only)
26.2.3 Stationary waves (qualitative and experimental treatment required)

27.0.0 ELECTROSTATICS II (15 Lessons)

27.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) sketch electric field patterns around charged bodies
b) describe charge distribution on conductors of various shapes
c) define capacitance and state its SI unit
d) describe charging and discharging of a capacitor(calculation involving curves not required)
e) state the factors affecting the capacitance of a parallel plate capacitor
f) state the applications of capacitors
h) solve numerical problems involving capacitors.

27.2.0 Content

27.2.1 Electric field patterns

27.2.2 Charge distribution on conductors: spherical and pear shaped conductors
27.2.3 Action at points: lightning arresters
27.2.4 Capacitance, unit of capacitance(farad, microfarad), factors affecting capacitance
27.2.5 Applications of capacitors
27.2.6 Problems on capacitors
{using $Q=CV$, $C_T=C1+C_2$, $1/C_T= 1/C_1+1/C_2$}

28.0.0 HEATING EFFECT OF AN ELECTRIC CURRENT (10 Lessons)

28.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

(a) Perform and describe experiments to illustrate heating effect of an electric current
(b) state the factors affecting heating by electric current
(c) derive the equations for electrical energy and electrical power
(d) identify devices in which heating effect of an electric current is applied
(e) solve numerical problems involving electrical energy and electrical power.

28.2.0 Content

28.2.1 Simple experiments on heating effect
28.2.2 Factors affecting electrical energy = Vlt, P =VI
28.2.3 Heating devices:- electric kettle, electric iron, bulb filament, electric heater
28.2.4 Problems on electrical energy and electrical power

29.0.0 QUANTITY OF HEAT (20 Lessons)

29.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define heat capacity and specific heat capacity
b) determine experimentally specific heat capacity of solids and liquids
c) define specific latent heat fusion and specific latent heat of vaporization
d) determine experimentally the specific latent heat of fusion of ice and the specific latent
heat of vaporization of steam
e) state the factors affecting melting point and boiling point
f) explain the functioning of a pressure cooker and a refrigerator
g) Solve problems involving quantity of heat.

29.2.0 Content

29.2.1 Heat capacity, specific heat capacity, units (Experimental treatment required)
29.2.2 Latent heat effusion, latent heat of vaporization, units (Experimental treatment necessary)
29.2.3 Boiling and melting
29.2.4 Pressure cooker, refrigerator
29.2.5 Problem on quantity of heat ($Q = Mc\Delta\theta$, $Q = Ml$)

29.3.0 Project Work

29.3.1 Construct a charcoal refrigerator (cooler)

30.0.0 GAS LAWS (15 Lessons)

30.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) state the gas laws for an ideal gas
b) verify experimentally the gas laws
c) explain how the absolute zero temperature may be obtained from the pressure - temperature and volume -temperature graphs
d) convert Celsius scale to Kelvin of temperature

f) state the basic assumptions of the kinetic theory of gases
g) explain the gas laws using the kinetic theory of gases
h) solve numerical problems involving gas laws.

30.2.0 **Content**
30.2.1 Boyle's law, Charles' law, pressure law, absolute zero
30.2.2 Kelvin scale of temperature

30.2.3 Gas laws and kinetic theory of gases $P = 1/3\rho\dot{c}^2$ not required)

30.2.4 Problems on gas laws [including $\frac{PV}{T} = \text{constant}$]

FORM FOUR CONTENT

31.0.0 THIN LENSES (20 Lessons)

31.1.0 Specific objectives

By the end of this topic, the learner should be able to:

a) describe converging lenses and diverging lenses
b) describe using ray diagrams the principal focus, the optical centre and the focal length of thin lens
c) determine experimentally the focal length of a converging lens
d) locate images formed by thin lenses using ray construction method
e) describe the characteristics of images formed by thin lenses
f) explain image formation in the human eye
g) describe the defects of vision in the human eye and how they can be corrected
h) describe the use of lenses in various optical devices
i) solve numerical problems involving the lens formula and the magnification formula.

31.2.0 Content

31.2.1 Types of lenses
31.2.2 Ray diagrams and terms used
31.2.3 Images formed
- ray construction,
- characteristics,
- Magnification.

31.2.4 Determination of Focal length :(Experimental treatment required)
- estimation method,
- lens formula,
- lens-mirror method

31.2.5 Human eye, defects (shortsightedness and long sightedness only)
31.2.6 Optical devices:
- simple microscope,
- compound microscope,
- the camera

31.2.7 Problems involving the lens formula and the magnification formula

31.3.0 Project work

31.3.1 Construct a telescope.

32.0.0 UNIFORM CIRCULAR MOTION (10 Lessons)

32.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) Define angular displacement and angular velocity

b) Describe simple experiments to illustrate centripetal force
c) explain the applications of uniform circular motion
d) Solve numerical problems involving uniform circular motion.

32.2.0 **Content**

32.2. 1 Tthe radian, angular displacement, angular velocity

32.2.2 Centripetal force; $F = \frac{mv^2}{r}$ and $F = m\omega^2$ (derivation of formulae not required)

(Experimental treatment is necessary)

32.2.3 Applications of uniform circular motion

32.2.4 Centrifuge, vertical, horizontal circles banked tracks (calculations on banked tracks and Conical pendulum not required)

32.2.5 Problem solving apply $F = \frac{mv^2}{r}$ and $F = m\omega^2$

33.0.0 FLOATING AND SINKING (15 Lessons)

33.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) state Archimedes' principle
b) verify Archimedes's principle
c) state the law of flotation
d) define relative density
e) describe the applications of Archimedes' principle and relative density
f) Solve numerical problems solving Archimedes 'principle.

33.2.0 Content

33.2.1 Archimedes's principle, Law of flotation (experimental treatment)
33.2.2 Relative density
33.2.3 Applications of Archimedes 'principle and relative density
33.2.4 Problems on Archimedes 'principle

33.3.0 Project Work
33.3.1 Construct a hydrometer.

34.0.0 ELECTROMAGNETIC SPECTRUM (15 Lessons)

34.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) describe the complete electromagnetic spectrum
b) state the properties of electromagnetic waves
c) describe the methods of detecting electromagnetic radiations
d) describe the applications of electromagnetic radiations
e) solve numerical problems involving c = fx.

34.2.0 Content

34.2.1 Electromagnetic spectrum
34.2.2 Properties of electromagnetic waves
34.2.3 Detection of electromagnetic(e.m.) radiations
34.2.4 Applications of e.m radiations (include greenhouse effect)
34.2.5 Problems involving $c = f\lambda$,

35.0.0 ELECTROMAGNETIC INDUCTION (20 Lessons)

35.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) perform and describe simple experiments to illustrate electromagnetic induction
b) state the factors affecting the magnitude and the direction of the induced emf
c) state the laws of electromagnetic induction
d) describe simple experiments to illustrate mutual induction
e) explain the working of an alternating current (a.c.)generator and a direct current (d.c.) generator
f) explain the working of a transformer
g) explain the applications of electromagnetic induction
h) solve numerical problems involving transformers.

35.2.0 **Content**

35.2.1 Simple experiments to illustrate electromagnetic induction
35.2.2 Induced emf:
- Faradays' law,
- Lenz's law

35.2.3 Mutual induction
35.2.4 Alternating current generator, direct current generator
35.2.5 Fleming's right hand-rule
35.2.6 Transformers
35.2.7 Applications of electromagnetic induction:
- induction coil,
- moving coil loudspeaker

35.2.8 Problems on transformers

35.3.0 **Project Work**

35.3.1 Construct a simple transformer.

36.0.0 MAINS ELECTRICITY (10 Lessons)

36.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) state the sources of mains electricity
b) describe the transmission of electric power from the generating station
c) explain the domestic wiring system
d) define the Kilowatt hour
e) determine the electrical energy consumption and cost
f) solve numerical problems involving mains electricity.

36.2.0 **Content**

36.2.1 Sources of mains electricity
36.2.2 Power transmission (include dangers of high voltage transmission)
36.2.3 Domestic wiring system
36.2.4 Kw-hr, consumption and cost of electrical energy
36.2.5 Problems on mains electricity

36.3.0 **Excursion**

36.3.1 Field trip to a power station is recommended.

37.0.0 **CATHODE RAYS AND CATHODE RAY TUBE (10 Lessons)**

37.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) describe the production of cathode rays
b) state the properties of cathode rays
c) explain the functioning of a Cathode Ray Oscilloscope(C.R.O.) and of a Television tube (T.V. tube)

d) explain the uses of a Cathode Ray Oscilloscope
e) solve problems involving Cathode Ray Oscilloscope.

37.2.0 **Content**
37.2.1 Production of cathode rays, cathode ray tube
37.2.2 Properties of cathode rays
37.2.3 C.R.O. and T.V. tubes
37.2.4 Uses of C.R.O.
37.2.5 Problems on C.R.O.

Note: Demonstration with a CRO is suggested.

38.0.0 X-RAYS (8 Lessons)

38.1.0 Specific Objectives
By the end of this topic, the learner should be able to:
a) explain the production of X-rays
b) state the properties of X-rays
c) state the dangers of X-rays
d) explain the uses of X-rays
e) solve numerical problems involving X-rays.

38.2.0 Content
38.2. 1 Production of X-rays, X-ray tube
38.2.2 Energy changes in an X-ray tube
38.2.3 Properties of X-rays, soft X-rays and hard X-rays
38.2.4 Dangers of X-rays and precautions
38.2.5 Uses of X-rays/Bragg's law not required)
38.2.6 Problems on X-rays

39.0.0 PHOTOELECTRIC EFFECT (15 Lessons)

39.1.0 Specific Objectives
By the end of this topic, the learner should be able to:
a) perform and describe simple experiments to lustrate the photoelectric effect
b) explain the factors affecting photoelectric emission
c) apply the equation E = hf to calculate the energy of photons
d) define threshold frequency, work function and the electron volt
e) explain photoelectric emission using Einstein equation
f) explain the applications of photoelectric effect
g) solve numerical problems involving photoelectric emissions.

39.2.0 Content
39.2. 1 Photoelectric effect, photons, threshold frequency; work function, Planck's constant, and electron-volt
39.2.2 Factors affecting photoelectric emission
39.2.3 Energy of Photons
39.2.4 Einstein's equation = $hf_0+1/2mv^2$
39.2.5 Applications of photoelectric effect:
- photo emissive,
- photo conductive,
- photovoltaic cells

39.2.6 Problems on photoelectric emissions

39.3.0 Project Work
39.3.1 Construct a burglar alarm.

40.0.0 RADIO ACTIVITY (15 Lessons)

40.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) define radioactive decay and half-life
b) describe the three types of radiations emitted in natural radioactivity
c) explain the detection of radioactive emissions
d) define nuclear fission and fusion
e) write balanced nuclear equations
f) explain the dangers of radioactive emissions
g) state the applications of radioactivity
h) solve numerical problems involving half-life.

40.2.0 Content

40.2.1 Radioactive decay
40.2.2 Half-life
40.2.3 Types of radiations, properties of radiations
40.2.4 Detectors of radiation,
40.2.5 Nuclear fission, nuclear fusion
40.2.6 Nuclear equations
40.2.7 Hazards of radioactivity, precautions
40.2.8 Applications
40.2.9 Problems on half-life (integration not required)

41.0.0 ELECTRONICS (10 Lessons)

41.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

a) state the differences between conductors and insulators
b) define intrinsic and extrinsic semi-conductors
c) Explain doping in semiconductors.
e) explain the working of a p-n junction diode
f) sketch current-voltage characteristics for a diode
g) Explain the application of diodes in rectification.

41.2.0 **Content**
41.2.1 Conductors, semi-conductors, insulators
41.2.2 Intrinsic and extrinsic semiconductors
41.2.3 Doping
41.2.4 p-n junction diode
41.2.5 Applications of diodes: half wave rectification and full-wave rectification

41.3.0 Project Work

41.3.1 Construct a simple radio receiver

SUGGESTED ASSESSMENT METHODS

1. Practical work.
2. Project work.
3. Field trips.
4. Oral questions.
5. Quizzes.
6. Written tests and examination.

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