NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF EDUCATION

COURSE CODE: SED 713

COURSE TITLE:
LABORATORY DESIGN AND MANAGEMENT

COURSE GUIDE

SED 713
LABORATORY DESIGN AND MANAGEMENT

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CONTENT **PAGES**

INTRODUCTION

Science has changed over the past years and so laboratories must change! As a science teacher, you are used to having your students take part in laboratory activities. Have you noticed differences in design and organization as you move from one laboratory to another? Several teachers had found some of these laboratories to be inadequate in terms of design, space, technicians, apparatus materials chemicals and use of computer. But experimentation is very vital for the growth of science and it is impossible to teach science without practical works in a conducive atmosphere.

Who manages laboratory and the safety are also important issues that you must consider. So this course exposes you to the various designs, management and safety in the science laboratory. The course is a 3 credit unit course divided into four modules:-

i. Laboratory Organization, & Design
ii. Laboratory safety
iii. Hazards in the laboratory
iv. Laboratory management

Each of these modules contains 4-8 units. You will be expected to go through each of the units carefully attending to all built in exercise. You will also be expected to submit a tutor-marked assignment after each unit. Most of these assignments involves your use of the library since they are research oriented. This is to help you with your future research work and remember your assignments are as important as your examination as they carry equal weightings.

COURSE GUIDE

The Course Guide tells you briefly what the course is about, what course materials you will be using and how you can work your way through these materials. It suggests some general guidelines for the amount of time you are likely to spend on each unit of the course in order to complete it successfully. It also gives you some guidance on your tutor-marked assignments. Detailed information on tutor-marked assignments is found in the separate Assignment File, which will be available to you.

There should be some seminar classes arranged for this course where you can present your research reports. The locations are time for these seminars will be communicated to you.

WHAT YOU WILL LEARN IN THIS COURSE

As a post-graduate student in this course, it is assumed that you must have been exposed to working in a science laboratory. So the overall aim of SED 713 (Laboratory Design and Management) is to introduce you to some of the tradition laboratory design and organisation you are used to, the modern designed organization, and management procedures in the laboratory. Should you be in a position to propose a new science laboratory or improvement on an existing structure of science laboratory, this course comes handy.

COURSE AIMS

The aim of the course can be summarized as follows: This course aims to introduce you to various designs. Organisation and management of the science laboratory.

This will be achieved by aiming to:

- ❖ Introduce you to the laboratory organization and design,
- ❖ Outline the safety, First Aid & Design waste procedures that should be taken in the laboratory.
- ❖ Introduce you to the use of computers in the laboratory
- ❖ Give you an appreciation of the hazards in the laboratory
- ❖ Explain the role of the head of department, science teacher, laboratory technician and Assistant in laboratory management.
- ❖ Introduce you to the importance of storage in laboratory materials management
- ❖ Teach you how you can write and present research reports for seminar and conferences on laboratory design and management.

COURSE OBJECTIVES

To achieve the aims set above the course sets above the course sets overall objective. In addition, each unit has specific objectives included at the beginning of a unit. You may want to refer to them during your study of the unit to check on your progress. You should always look at each unit objectives after completing a unit to be sure you have done that was required of you in the unit.

Set out below is wider objectives of the course as a whole. By meeting these objectives you should have achieve the aims of the course as a whole.

On successfully completion of the course you should be able to

- Trace the historical background of science laboratory in schools.
- List factors to be considered in siting a laboratory

- Describe the various types of existing designs and organization of science laboratory
- Describe the design and organization of the prep. Room and store in the science laboratory
- State the use of the computers in laboratory organization
- Write research reports on laboratory design, safety and management
- Outline the safety, First Aid and waste disposal procedures in the science laboratory.
- Discuss the various hazards associated with the science laboratories
- Explain the roles of the human and material resources in the management of the science laboratory
- Read research reports from journal articles and make a summary
- Present research reports on laboratory design and management at conferences or seminars.

COURSE MATERIALS

Major components of the course are

- Course Guide
- Study units
- Journals and textbooks
- Assignments file
- Presentation schedule

STUDY UNITS

There are twenty-three units in this course as follows:

Module 1

Unit 1	-	Historical background and rationale for the laboratory
Unit 2	-	The laboratory in school
Unit 3	-	Existing traditional designs and organization of the Laboratory
Unit 4	-	Modern designs and organization of the preparation room
Unit 5	-	Design and organization of the store
Unit 6	-	The use of computers in laboratory organization and Design

Module 2

Unit 1	-	Research report in laboratory organisation and design
Unit 2	-	Safety in the laboratory
Unit 3	-	Laboratory rules and regulations
Unit 4	-	First Aid in the school laboratory
Unit 5	-	Disposal of waste materials in the laboratory

Module 3

Unit 1	-	Glass ware hazards in the laboratory
Unit 2	-	Chemical hazards in the laboratory
Unit 3	-	Electrical hazards in the laboratory
Unit 4	-	Hazards in the biology laboratory
Unit 5	-	Fire hazards in the laboratory

Module 4

Unit 1	-	Extinguishing fire in the laboratory
Unit 2	-	Research report on laboratory safety and hazards
Unit 3	-	The Head of Department in laboratory management
Unit 4	-	The science teacher in laboratory management
Unit 5	-	The laboratory technician and assistant in laboratory Management
Unit 6	-	Storage and material management in the laboratory

The first eight units constitute module one, which is on laboratory organization and design. The next 4 units constitute module 2, which is on laboratory safety. Next set of seven constitutes module three and this is on hazards in the laboratory. The last set of units is for module four, which has four units.

Each of these units is designed to take you for a minimum double period of two hours. Where you are expected to go to the library for your tutored marked assignment, you are likely to take more time. But as research students, you have to learn to do this within a stipulated time.

SET TEXTBOOKS AND JOURNAL

Any textbook on design, organization and management will be appropriate for this course. More importantly are recent journals of this topic.

COMPUTER SOFTWARE

In Unit VII, you were introduce to the use of computers in laboratory design and management you will need some software resource package – on CD ROM or Diskettes to help you with this. You could get this resource packages from computer shops.

ASSIGNMENT FILE

There are twenty-three assignments in this course. That is one assignment per unit. This is to be sure you really understood the unit. In this file, you will find all the details of the works you must submit to your tutor for marking. Remember your assignments are as important as the examinations as they carry equal weightings (50%). There are 23 assignments in this course. The 23 course assignments will cover:

PRESENTATION SCHEDULE

The Presentation Schedule included in your course materials gives you the important dates for this year for the completion of tutor-marked assignments and attending tutorials. Remember that you are required to submit all your assignments by the due date. You should guard against falling behind in your work.

ASSESSMENT

There are two aspects to the assessment of the course. First are the tutor-marked assignments; second, there is a written examination.

In tackling the assignments, you are expected to apply information, knowledge and techniques gathered during the course. The assignments must be submitted to your tutor for formal assessment in accordance with the deadlines stated in the Presentation Schedule and the Assignment File. The work you submit to your tutor for assessment will count for 50% of your total course mark.

At the end of the course you will need to sit for a final written examination of three hours' duration. This examination will also count for 50% of your total course mark.

FINAL EXAMINATION AND GRADING

The final examination for SED 713 will be of three hours' duration and have a value of 50% of the total course grade. The examination will consist of questions which reflect the types of self-testing, practice

exercises and tutor-marked problems you have previously encountered. All areas of the course will be assessed.

Use the time between finishing the last unit and sitting the examination to revise the entire course. You might find I useful to review your self tests, tutor-marked assignments and comments on them before the examination.

TUTOR-MARKED ASSIGNMENT (TMAS)

Assignment questions for the units in this course are contained in the Assignment File. You will be able to complete your assignments from the information and materials contained in your set books, reading, studying units and the internet. However, it is desirable in all post-graduate level education to demonstrate that you have read and researched more widely than the required minimum. Using other references will give you a broader viewpoint and may provide a deeper understanding of the subject.

When you have completed each assignment, send it, together with a TMA (tutor-marked assignment) form, to your tutor. Make sure that each assignment reaches your tutor on or before the deadline given in the Presentation Schedule and Assignment File. If, for any reason, you cannot complete your work on time, contact your tutor before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the due date unless there are exceptional circumstances.

There are twenty-three 923) tutor-marked assignment in this course. You only need to submit thirteen 913) out of the twenty-three. But assignment under units IV, VIII and XIX are compulsory as they are research reports and each of the three assignments carrying 10.00%. Other ten assignments carry 2.00% each making up your 50% continuous assessment.

The final examination covers information from all parts of the course.

COURSE MARKING SCHEME

The following table lays out how the actual course marked is broken down.

Assessment	Marks
Assignment 1 – 23	23 assignments, best ten out of 20
Final examination	50% of overall course marks

Total	100% of course marks

Table 1 Course marking scheme

COURSE OVERVIEW

This table brings together the units, the number of weeks you should take to complete them and the assignments that follows them.

UNIT	TITLE OF WORK	WEEKS	
	Assessment	**Activity**	**End of unit assignment**
1	Historical background		
2	The laboratory in school		
3	Existing traditional laboratory		
4	Modern designs and organization		
5	Design and organization of prep room		
6	Design and organization of the store		
7	The use of computers in the lab organization		
8	Research report on laboratory organization		
9	Safety in the laboratory		

10	Laboratory rules and regulations		
11	First Aid in the school laboratory		
12	Disposal of waste materials		
13	Glass ware hazards		
14	Chemical hazards in the laboratory		
15	Electrical hazards in the laboratory		
16	Hazards in the Biology laboratory		
17	Fire hazards in the laboratory		
18	Extinguishing fire in the laboratory		
19	Research report on laboratory safety		
20	The head of department in lab management		
21	The science teacher in lab management		
22	The lab Technician and Assist. in lab		
23	Storage and material management in the lab.		

HOW TO GET THE MOST FROM THIS COURSE

In distance learning the study units replace the university lecture. This is one of the great advantages of distance leaning,; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Think of it as a reading the lecture instead of listening to a lecture. In the same way that a lecturer might set you some reading to do, the study units tell you when to read your set books or other material, and when to undertake computing practical work. Just as a lecturer might give you an in-class exercise, your study units provide exercises for you to do at appropriate points.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. You should use these objectives to your study. When you have finished the unit you must go back and check whether you have achieved the objectives. If you make a habit of doing this you will significantly improve your chances of passing the course.

The main body of the unit guides you through the required reading from other sources. This will usually be either from your set books or from a reading section. Some units require you to undertake practical work on a computer. You will be directed when you need to use a computer and

guide through the tasks you must do. The purpose of the computing work is twofold. First, it will enhance your understanding of the material in the unit. Second, it will give you practical experience of using programs, which you could well encounter in your work outside your studies. In any event, most of the techniques you will study are applicable on computers in normal working practice, so it is important that you encounter them during your studies.

Self-tests are interspersed throughout the units, and answers are given at the end of units. Working through these tests will help you to achieve the objectives of the unit and prepare you for the assignments and the examination. You should do each self-test as you come to it in the study unit. There will also be numerous examples given in the study units; work through these when you come to them, too.

The following is a practical strategy for working through the course. If you run into any trouble, telephone your tutor or post the question to him. Remember that your tutor's job is to help you. When you need help, don't hesitate to call and ask your tutor to provide it.

READ THIS COURSE GUIDE THOROUGHLY

Organise a study schedule. Refer to the 'Course overview' for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester will be made available to you. You need to gather together all this information in one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working on each unit.

Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course work. If you get in difficulties with your schedule, please let your tutor know before it is too late for help.

1. Turn to Unit 1 and read the introduction and the objectives for the unit.

2. Assemble the study materials. Information about what you need for a unit is given in the 'Overview' at the beginning of each unit. You will almost always need both the study unit you are working on and one of your set books on your desk at the same time.

3. Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work

through the unit you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.

4. Keep an eye on the course information that will be continuously posted there.

5. Well before the relevant dates (about 4 weeks before due dates), take the Assignment File and your next required assignment. Keep in mind that you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore, will help you pass the exam. Submit all assignments not later than the due date.

6. Review the objectives for each study unit to confirm that you have achieve them. If you feel unsure about any of the objectives, review the study materials or consult your tutor.

   When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.

7. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also written on the assignment, consult your tutor as soon as possible if you have any question or problems.

8. After completing the last unit, review the course and prepare yourself for the examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this Course Guide).

TUTORS AND TUTORIALS

There are 20 hours of tutorials (ten 2-hour sessions) provided in support of this course. You will be notified of the dates, times and location of these tutorials, together with the name and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your tutor-marked assignments to your tutor will before the due date; at least two

working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact you tutor by telephone, e-mail, or discussion board if you need help. The following might be circumstances in which you would find help necessary. Contact your tutor if:

- You do not understand any part of the study units or the assigned readings
- You have difficulty with the self-tests or exercises
- You have a question or problem with an assignment, with our tutor's comments on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face-to-face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussions actively.

SUMMARY

SED713 intends to introduce you to Laboratory Design and Management. Upon completing the course, you will be equipped with basic knowledge laboratory design, management, organisation and safety procedures in the laboratory.

Among others, you will be able to answer these kinds of questions:

- What is the historical background of laboratories?
- Why are laboratories needed in schools?
- What is new about the modern laboratories?
- How can we improve the existing traditional laboratories in design and organisation?
- How can you use computer in the laboratory?
- How safe is the laboratory?
- What are the possible in the laboratory?
- What first aid procedures can e used in case of accident?
- What are the proper procedures for waste disposals in the laboratory?
- What are the possible hazards in the laboratory?
- What are the roles o the head of department, science teacher, laboratory technician and assistants in laboratory?
- How can you manage the material resources in the laboratory?

MAIN COURSE

CONTENTS **PAGE**

MODULE 1 LABORATORY ORGANISATION & DESIGN

INTRODUCTION

In this module you will be exposed to the various designs and organization of the laboratory which includes the preparatory room, store and the main laboratory in relation to others. The use of computers and recent research reports on laboratory organization and design are also considered. This module is divided into 8 units as follows:

Unit 1 Historical background and rationale for the laboratory
Unit 2 The laboratory in school
Unit 3 Existing traditional design and organization of the laboratory
Unit 4 Modern design and organization of the laboratory
Unit 5 Design and organization of the preparatory room
Unit 6 Design and organization of the store
Unit 7 The use of computers in laboratory organization
Unit 8 Research report on laboratory organization and design.

UNIT 1 HISTORICAL BACKGROUND AND RATIONAL FOR THE LABORATORY

CONTENTS

1.0 INTRODUCTION

Before going into the laboratory designs and organizations, it is necessary for you to know about the historical background of the laboratory, the rationale for the emphasis on science laboratory and the link between the school curriculum and the laboratory. These will be treated in this first unit.

2.0 OBJECTIVES

After reading this unit, you should be able to:

- trace the historical background of the school science laboratory.
- advance reasons for the continuous emphasis on school laboratories.
- list some science curriculum materials used in schools.
- outline how student's performances in the laboratory should be assessed.

3.0 MAIN CONTENTS

3.1 Historical Background

From your study of history years back, which do you think came first the laboratory or the equipments? Give a reason for your answer.

Before the advent of the 18th century, laboratories were not associated with science teaching. Science subjects such as Biology, Chemistry and Physics have become school subjects even before the instrument designed specifically for scientific purpose cam up. And as regards laboratories and equipment, Aliyu (1982) stated that most of the scientific equipment before 1600 were borrowed from practical crafts and craftsmen, whose tools were much better than those that the scientist had during the period. In fact, laboratory work became a permanent feature in science teaching at the high school in the nineteen century when the first student laboratory was built in Britain in the Royal Technical College in 1830 by Thomas Graham. Before this time, some eminent pioneer scientists such as Lavoisie (1743-1794) Pricsley (1776-1848) converted their homes into laboratories where regular demonstrations were held for youngsters who were interested in learning science (Lock 1988). So you can see how long ago the laboratory has been and continue to be an integral part of science learning activities.

3.2 Rationale for the Emphasis on Science Laboratories

Science Practical exercises in the laboratory in schools have been most exciting for some students. In fact some of them look forward to days when they have science practical and could display their skills.

Exercise 1.1

Why do you think some of your students prefer the science practical lessons?

This could because:

(a) of the complexity and abstract nature of the subject that some students find it difficult to understand and grasp the concepts without manipulations in the laboratories. In fact without these manipulations, students might end up memorizing the concepts without understanding. It explains why research report categorized most Nigerian science students as recallers than appliers (Shuaibu Ogunsola 1983, Ogunsola-Bandele 1993).

(b) Science should be activity and inquiry based. Students should be left to find out whatever they have been taught in the classrooms on t heir own.

(c) Students themselves are interested and enjoy practical work where they are able to work and interact in-groups with other students and get a lot of personal attention from their teachers.

3.3 The Laboratory and the School Curriculum

The laboratory has always been he most distinctive feature of science instruction. It has continued to occupy a central role in the new science curriculum science, which emphasizes student's involvement in science teaching through practical work.

Exercise 1.2

List two of the science curriculum materials you use in your school.

Some examples of Nigerian science projects which placed increased emphasis on laboratory work are Nigerian Integrated Science Project (NISP) developed by Science Teachers Association of Nigeria (STAN) and the Nigerian Secondary School Science Project (NSSSP) developed by Comparative Education Study and Adaptation Centre (CESAC (NERDC). These are widely adopted in our schools and they place much emphasis on laboratory work in line with the demand of science teaching which requires the development of certain skills and attitudes.

Assessment of student's laboratory work.

How do you usually assess your student's performance in laboratory?

In line with the curriculum, the assessment of student performance in the laboratory is usually based on the attainment measure of a list of behavioral objectives, which are:

a. Cognitive (knowledge)
b. Affective (attitude)
c. Psychomotor (Skills)

Exercise 1.3

With respect to these 3 main domains, how have you been assessing your students practical?

It has been observed hat in most schools, as soon as the students know what to do, set up the materials, perform the experiments and record the correct readings and measurements, the student is given a good assessment. But all these listed only emphasizes the knowledge and the skills with little or no emphasis on the attitude of the students towards the practical exercise. This has been the practice several decades ago that attitudinal aspect of the laboratory work is neglected (David 1976). So as a science teacher, you need to take note of this – for example, how careful are your students in handling the apparatus, do they take time to make sure apparatus & laboratory tables are cleaned before leaving the laboratory or do they rush to get out? etc.

4.0 CONCLUSION

This unit takes you through the historical background of the laboratory, the rationale for the emphasis on school laboratories and the link to the school curriculum. In the next unit you will be introduced to the laboratory in schools.

5.0 SUMMARY

In this unit you learnt that first school laboratory was built in Britain in 1830.

- Formerly, homes of scientists were used for regular demonstrations and served as laboratories.
- Science is abstract and complex and sometimes difficult to understand without manipulations in the laboratory.
- Science should be activity and inquiry based and so the need for the laboratory.
- That science laboratory occupies a central role in the new science curriculum.
- Assessment of your students' practical work should take into cognizance the three domains of behavioral objectives – cognitive, effective and psychomotor.

6.0 TUTOR-MARKED ASSIGNMENT

1. Write a page on the historical background of the school laboratory.

7.0 REFERENCES/FURTHER READING

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UNIT 2 THE LABORATORY IN SCHOOLS

CONTENTS

1.0 INTRODUCTION

In this unit you will learn about the laboratory in your school. What a laboratory is and its functions. Factors that you should consider in siting and choosing an appropriate shape for the laboratory are also considered. This unit will be most useful for you if your school is considering building a new school laboratory.

2.0 OBJECTIVES

After reading this unit you should be able to:

- define a laboratory
- list two functions of a laboratory
- differentiate between the indoor and outdoor laboratory
- advance reasons why schools opt for the indoor laboratory
- choose an appropriate shape in the design of the laboratory
- list some factors to be considered in the siting of the laboratory.

3.0 MAIN CONTENTS

3.1 The Laboratory Definition and Function

The laboratory which is a distinctive feature of science instruction has continued to occupy a central role in the new science curriculum.

Exercise 2.1

Do you have a laboratory in your school? How would you describe what a laboratory is to your students?

The school laboratory is an instructional facility used by the teacher to help students learn about science and how the scientists investigate the world around them. That is, it is that school building set aside for scientific discovery and inquiry. Students are brought in direct contact with materials, manipulating them through procedures that reflect scientific thinking. In fact there are various ways you could define a laboratory depending on the functions it performs.

3.2 Indoor and Outdoor Laboratories

Exercise 2.2

If the laboratory is where students learn what science is and investigate the world around them, then list two places where these activities take place and can be called laboratory.

There are many locations within and outside the school building that could serve as a means of helping pupils learn what science is. For example, the school garden, the riverside, the mechanic workshop etc. Since these also provide meaningful science learning experiences for the students, they could be called outdoor laboratories. Despite the usefulness of the outdoor.

Exercise 2.3

As a science teacher, since the outdoor laboratory would have been less expensive with lots of space for student teacher interaction, then why the emphasis on having a building?

Despite the usefulness and cost effectiveness that could be associated with the outdoor laboratory, there are many problems which necessitated the designing, planning and provision of an alternative within the closet range. Some of these problems include the weather, proximity and organization of outdoor activities, student's distraction and over crowdness of the school timetable (that may not allow sufficient time for students to move to designated locations).

Some of these problems therefore necessitated schools having indoor laboratory, design, built, equipped, organized and managed to help students learn what science is and how scientist work.

3.3 Siting of the Laboratory

Exercise 2.4

If your proposal for a new science laboratory is accepted, where would you want the laboratory sited?

The siting of laboratories is as important as the function they perform. You should therefore consider the following n making your decisions.

(a) The blocks of laboratories should be sited at the end wing of the college. This is to prevent other buildings from the hazard that could arise from the laboratories e.g. radiation, fire, explosion hazard. Also it is easier to expand the building when sited at the end wing of the school or college.

(b) It should be sited in block with other science laboratories to enhance:

i. Inter disciplinary works
ii. Reduce walking distance between other laboratories for staff, apparatus and students
iii. Share common facilities like science resource centre, workshops.
iv. Minimise the cost of installation of basic service facilities like water, electricity and gas.

(c) Environmental Consideration

The laboratory should be sited along E-W direction when the windows are made facing the N-S direction, a great illumination by the sunlight from the E-W direction if reduced. Also the E-W wind could be avoided.

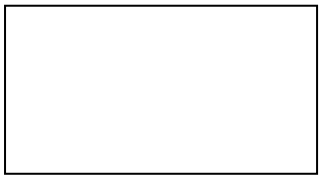
3.4 Various Shapes of the School Laboratory

Exercise 2.5

What is the shape of your laboratory?
Have you noticed any disadvantage associated with this shape?

There are many shapes a laboratory can take some of these are rectangular square, circular and T shapes.

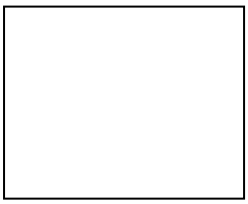
(a) **The Rectangular Shape**.



Sketch of the rectangular shape

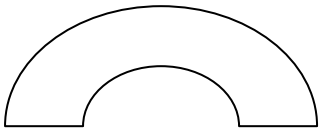
The rectangular shape has the disadvantages of having long distance between the teacher and the students at the back. Although this design is cheap, it makes teacher supervision difficult.

(b) The Square Shape



The square shape reduces the distance between the teacher and the students and enhances supervision. Since it is also cheap to design, most school opt for this.

(c) The Semi Circular Shape

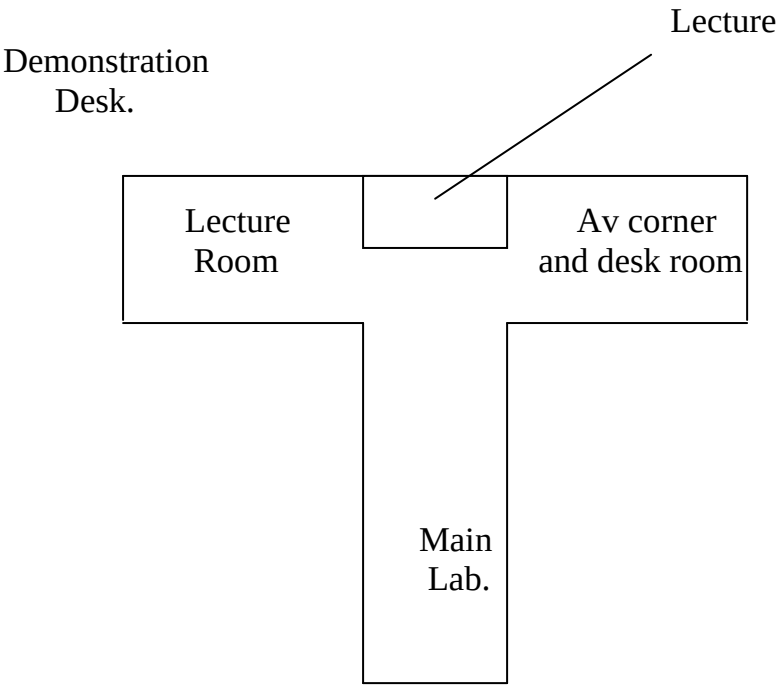


The semicircular shape brings all the students to about the same distance to the teacher and reduces the teacher – student distance to the bearest minimum. Also teacher supervision is enhanced. Although it has an advantage over the square and rectangular shape, it is quite expensive to design.

(d) The T Shape

T-Shape has provision for the experimental work demonstration and lectures for students as well as for audio-visual aid usage. However, because of the materials and human resources needed for this type of design, it will be very expensive. It has the advantages of saving time of

movement from the lecture class to the laboratory. All needed and available facilities could be used within the building. The T-shape laboratory is quite similar to the modern laboratories proposed in unit 4 in which the classroom and the laboratory are combined.



A Sketch of T-Shaped laboratory

2.6 Other Factors to be considered in Building a School Laboratory

After siting and choosing the shape for the laboratory, the following should also be considered.

a. **Purpose:-** What purpose will the laboratory serve? Will it be used for Biology, Physics, Chemistry, and Integrated Science or will it be used at the ordinary or advanced level? The purpose and level will determine the inner design, organization, materials management and maintenance.

b. **Local Condition:-** Most tropical countries experience very high humidity and temperature. Hence the laboratory must be designated to have good ventilation, heat installation and enough drought to prevent mound.

c. **Soil Conditions:** The drainage capacity of the land must be examined. Also, the type of soil sand, clay, loam or the humus content. It is also necessary to consider its orientation in terms of whether it is uphill, downhill, flat plan and water table level.

d. **Availability of Funds:-** Before embarking on building any laboratory it is necessary to consider how much fund is available. For building materials, science equipment and materials have become quite expensive with the going rate of inflation.

4.0 CONCLUSION

In this unit you have been introduced to your school laboratory and its functions. Factors that would help you in siting and choosing the shape of laboratories have also been considered. So should you be in a position to advice on building a new science laboratory, this unit will be handy.

5.0 SUMMARY

In this unit you learnt that:

- The school laboratory help students learn what science is all about and how the scientists investigate the world
- That there are some problems associated with the outdoor laboratories so the indoor is preferred.
- That laboratories should be sited at the end wing of the college to ease Expansion and prevent danger.
- That all science laboratories (Chemistry, Physics, Biology, Integrated Science etc) should be sited in a block to accommodate sharing of facilities services and human resources.
- That laboratories could be in different shapes depending on the purpose and cost.
- That other factors considered in building a laboratory include the purpose, local condition, soil condition and availability of funds.

6.0 TUTOR-MARKED ASSIGNMENT

1. The principal or provost of your college has just informed you about the need to site a new laboratory (Chemistry, Physics or Biology). Give a proposal.

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UNIT 3 THE EXISTING (TRADITIONAL) LABORATORY DESIGNS AND ORGANIZATIONS

CONTENTS

1.0 INTRODUCTION

Casting your mind back to your days in the secondary school, how are your laboratories internally designed and organized? Are you able to move your benches, cupboards and stools around? What is the seating arrangement vis-a-vis the teacher demonstration table (work station).

In most of the schools, teachers have been found to be demonstrating and teaching from the front of the classroom and the students especially those at the back struggling to see what the teacher is doing. For the inner arrangements there are basically two designs - The fixed and flexible design.

2.0 OBJECTIVES

After studying this unit, you should be able to:-

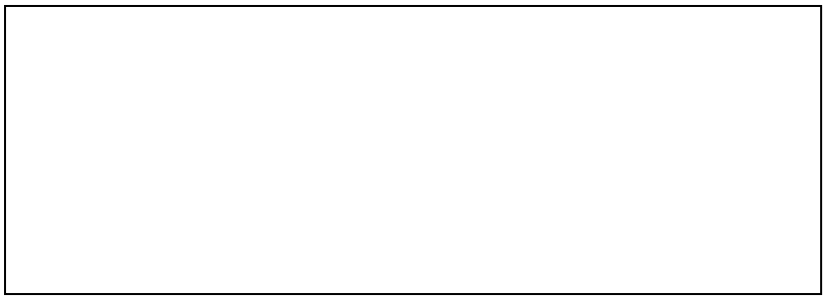
- describe the various types of existing designs and organization of the science laboratory.
- outline five shortfalls in each design
- list 4 service units in the existing laboratory
- advance one reason why students don't usually enjoy the teacher demonstration exercise.
- compare the laboratory space in the fixed and flexible design

- submit a report on the organization of your present school laboratory (Chemistry, Physics, Biology or Integrated Science).

3.2 The Fixed and Flexible Design

In this design all the benches, cupboards and services are rigidly fixed. Infact the benches are firmly attached to the floor and also to the walls. The advantage of this design is that it is able to accommodate many students for the specific room layout and it becomes extremely difficult to recognize the students into smaller groups for science discussions and activities.

The flexible design on the other hand allows the furniture and services to be free standing so that they can easily be moved.



A picture of Traditional laboratory

Exercise 3.1

Look at the picture, what are the advantages and disadvantages that this may have over the fixed design?

Well the present school, might opt for the fixed design because of the cost of replacement as the more flexible the benches, the more often the replacement because of the materials used. The flexibility in the inner arrangements is usually dictated by the various activities to be carried out. Two types of laboratory has been described above. When describes your school laboratory? What kind of services are available and how were they fixed.

3.3 The Laboratory Space

Exercise 3.2

Can you compare the laboratory space in the fixed design with the flexible design?

The fact that the students seats, benches and services are fixed makes movement restricted and does not allow much space for interaction. In fact in most cases students are identified with certain seats in the laboratory making team activities impossible. On the other hand, the fact that the students can move freely in groups in the flexible design also allows the teacher enough space for supervision. For sufficient distance should be allowed between the benches for the safe movement of people to avoid accident.

3.4 Surfaces and Furniture

In your school laboratory, what are he furniture and surfaces like? In some of the old laboratories, concrete workstations making it permanently fixed are observed. In some, the furniture are made of wood and still others having Formica surface for wood surfaces, teak has been a good choice but found to be quite expensive.

The concrete workstation which is also an old design has been found to be very uncomfortable for the students to work and other services attached. In fact the selection of laboratory good furniture is very important.

You must always consider suitable work tops, cupboards and other units. Bench tops should be impervious to water and resistant to disinfectants, acids, alkali organic solvents and moderate heat.

Exercise 3.3

What in your opinion then are the two main factors to be considered in the choice of a work top? These are the cost of the materials to be used and the nature of the laboratory work. For example, in the biology laboratory, it is important to be able to sterilize the surface easily and so the Formica surface is preferred.

3.5 Services

All laboratories require water gas lighting electricity as well as drainage system. Some even required more services, which include steam vacuum or compressed on, and the fund extractors. These extra services

if fixed make it difficult converting are laboratory to another. But some laboratories are equipped with movable service stations that are supplied via the floor but allowing for a considerable degree of flexibility. Since it is not an integral part of the furniture. Modern design as regards the flexible services will be discussed in unit 3.

3.6 Fume Cupboards

Exercise 3.4

Do you have a fume cupboard in your laboratory? Is it still functioning?

Most fume cupboards in the traditional laboratories are out of service even though in some they are not available at all. But it is important to have a fume cupboard in the laboratory especially the chemistry laboratory and those involved in radio active work. For any work involving noxious fumes must be carried out in a fume cupboard. The function of a fume cupboard is to protect laboratory personnel from dangerous fumes and to contain any minor fires or explosions which might occur. It must be designed to collect and disperse the fumes without the risk of them re-entering the laboratory through the windows or fresh air ducts. All the internal surfaces should be chemically resistant for maximum efficiency and economy. It should be located so that the exhaust duet can be vertical. Bends and horizontal runs should b e kept at absolute minimum. The satisfactory performance of the fume cupboard requires that contaminated air does not reach the breathing zone of the operator.

3.7 The Teacher Demonstration Desk (Work Station)

In each laboratory, the teacher is usually provided with the demonstration desk to carry out demonstration in front of the class. But have you ever noticed that the some student hardly see what the teacher is demonstrating why? This is because in some laboratories, the demonstrating desk is on the same level with the students and setting arrangement of the students does not help either. The teachers desk should rest on a raised platform so that the students seating at the back could share in the observation.

4.0 CONCLUSION

In this unit you have been reminded of the designs of the common laboratories you should be used to. This included the laboratory space, surface, furniture, service units and teachers demonstration desk. In the next unit, you will be able to compare all these with what should be in a modern laboratory.

5.0 SUMMARY

In this unit you learn that:

- There are two main types of laboratory inner design – the fixed and the flexible design.
- The flexible design allows the furniture benches and services to be free standing while in the fixed these are rigidly fixed.
- The flexible design might allow greater rate of furniture replacement because of the materials they are made with.
- The fixed design allows for less class interaction whereas the flexible encourages greater interaction among students.
- Surfaces Bench tops should be impervious to water resistant to disinfectant acids, alkali, organic solvent and moderate heat.

6.0 TUTOR-MARKED ASSIGNMENT

1. Compare the Fixed and the Flexible Design in a Science Laboratory.

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work among all levels, science education.

UNIT 4 THE MODERN DESIGN OF LABORATORY

CONTENTS

1.0 INTRODUCTION

Have you wondered how long ago your school laboratory was built? Most school laboratories were built some decades ago and lacked attractive up to date facilities to educate the growing student population. They were built when science was mainly didactic rather than the interactive hands on approach to science education. As a science teacher or head of science section in your school, you might not be able to change much as regards the building and design, except the organization within. But should you be in a school where there is a proposed new science laboratory, what you will learn in this unit will help you with your decision to make science laboratory what is should be.

2.0 OBJECTIVES

After studying this unit, you should be able to:

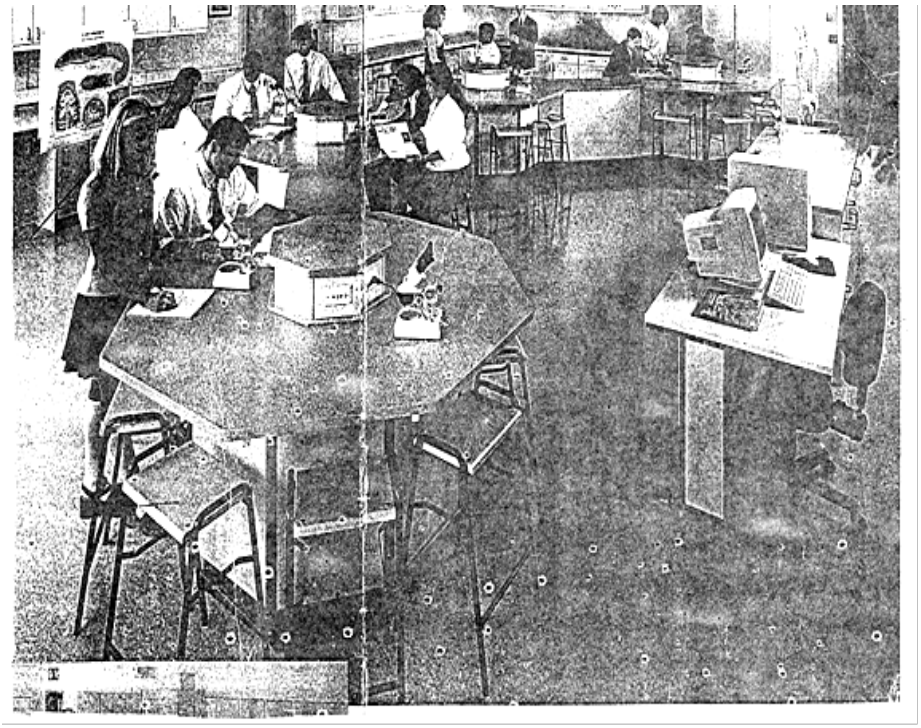
- describe what is modern about the power 8 (2001) laboratory
- compare the flexible design in unit III with the power lb 8 design as regards laboratory space.
- sketch the various configuration or arrangement in a modern laboratory with the present ones in schools
- list 4 service units that should be on each work station
- advance 2 reasons why the classroom and laboratory should be combined in certain instances

- compare the teachers work table in the existing with modern laboratory
- list 5 importance of a fume cupboard
- submit a report of not more the 4 papers on a proposed design of a new science laboratory.

3.0 MAIN CONTENTS

3.1 The Modern Laboratory

Power laboratory 8 (2001) is a complete science laboratory system, designated with both teachers and students in mind made adaptable to different approaches of science instruction. The new facilities provide safe, spacious work areas and convenient preparation rooms adaptable to different approaches of science instruction.



Picture taken from power lab 8 2001
Exercise 4.1

Look at the pictures above. How can you describe the design of the workstations (tables) and working environment?

Well the octagonal workstation encourage cooperative hands on learning while allowing the teacher to move freely about the room in order to observe groups students and assist them as needed. It lends itself to more formal instructional approaches for example, when instruction focuses on the whole class demonstration and lectures. There are

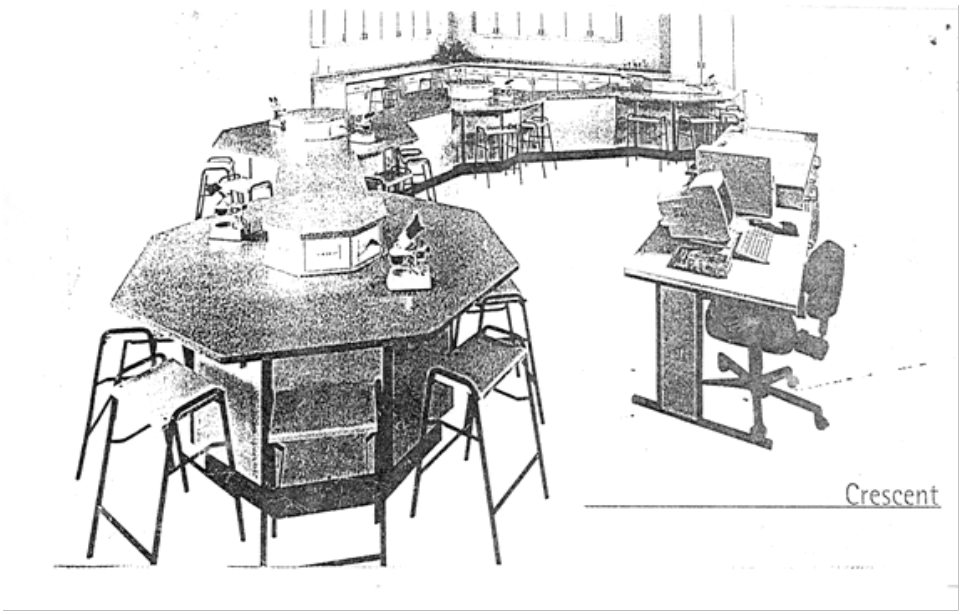
various types of configuration or arrangement you can have in the modern laboratory.

Exercise 4.2

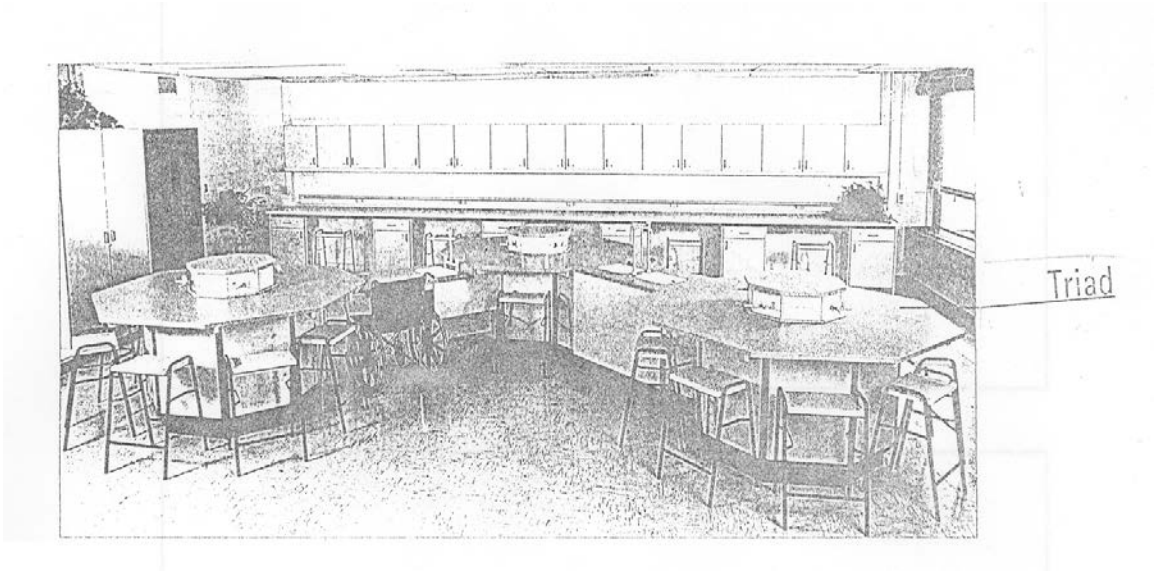
While having a practical demonstration, have you ever heard your students complaining of not being able to see the activities clearly?

Yes, in the past, teachers have been found to teach from the front of the laboratory. This usually makes it difficult for some students to see clearly from certain angles at the back seats, and for the teacher to give clear demonstrations and offer individual assistance to the students. With Power 8 design, the entire room becomes the teacher's domain and students are able to get personal attention through the various arrangements that can take place in the laboratory.

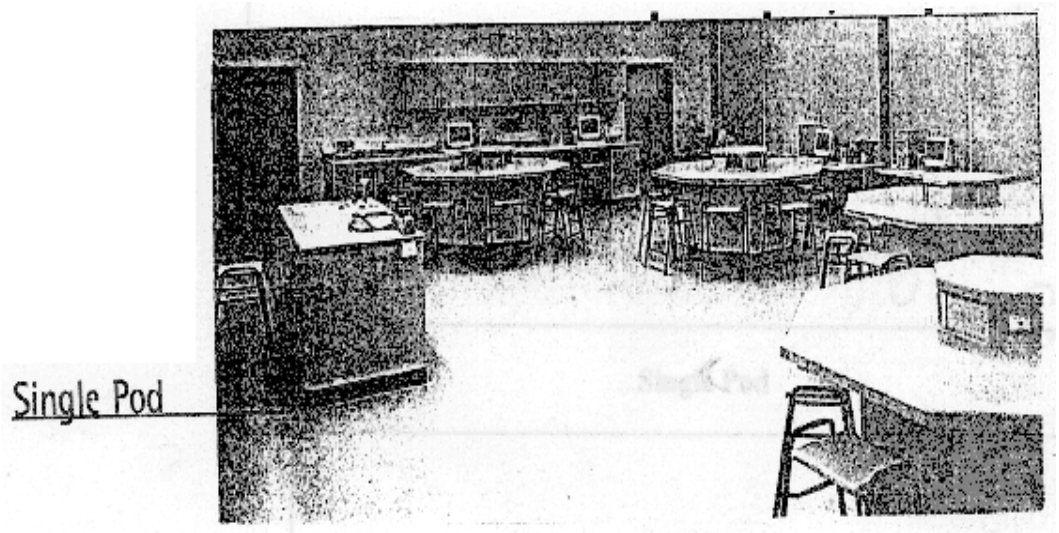
The workstation can be arranged in a crescent, triad, single pod and u-shape as shown in the pictures to accommodate any number of students according to the specific room layouts and space requirements.



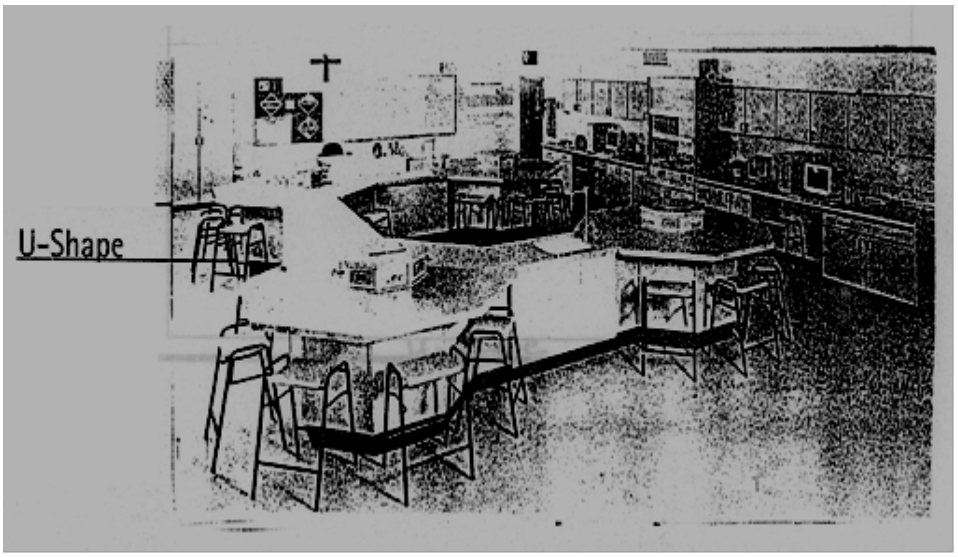
Crescent



Triad



Single Pod



U-Shape

3.1 The Laboratory Space

Exercise 4.3

Compare the flexible design with the power lab 8 design as regards the laboratory space.

Although both of them are flexible, the power lab 8 provides an attractive innovative appearance that can generate students enthusiasm for science. Students will enjoy working in a modern learning centered environment, where they have plenty of space to move around and can easily engage in team activities.

For according to the National Science Education Standards, “When carefully guided by teachers to ensure full participation by all, interactions among individuals and groups in the classroom can be vital in deepening the understanding of scientific concepts and the nature of scientific endeavours”.

Power lab 8 facilitates these types of interactions by having students sit where they can easily collaborate with their fellow students. This flexibility allows for the creation of an optimal laboratory configuration in which the teacher and students can work safely in an open and unclustered area. This spacious work surfaces encourage focused, hand-on experimentation and plenty of group interaction. The quality and durable components ensure that the laboratory look good and serve well for years.

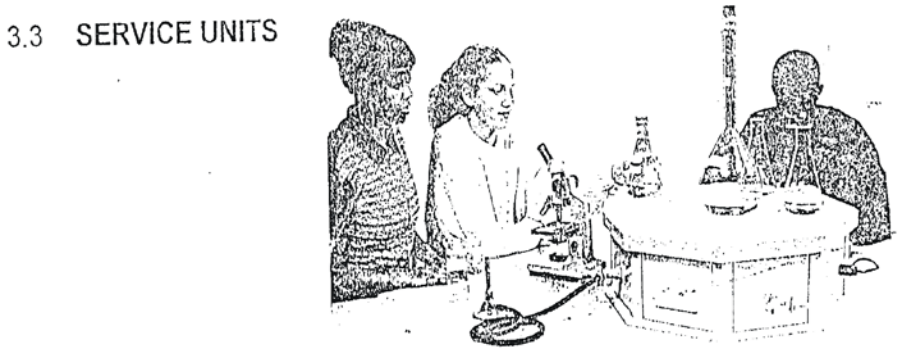
3.2 Surface and Furniture

Exercise 4.4

Having you ever attempted to clean spilled acid from the same wooden surfaces in your laboratory, what did you noticed?

The Power lab 8 has quality durable smooth surfaced furniture, which is ideal for chemistry, biology physics and other sciences classrooms. In addition to the traditional laminated tops in some laboratory, it offers corian work surfaces which are durable, hygienic and renewable. It is very easy to clean and wipe off spills that fall over. It has a seamless appearance and chemically resistance surfaces designed for easy maintenance and long life. And unlike many other science laboratory furniture, it is available in various colors that best suit the classroom environment.

3.3 Service Units



Picture taken from power lab 8 2001

From the picture, you can see that services are conveniently located at the centre of student octagons, making each easily accessible to all students.

Exercise 4.5

What are the service options available from the picture?
Well, available service options include electrical, gas, water, pneumatic and data communication. Also it has corian sinks which are bonded to the undesirable of the work surfaces to give it an overall seamless work surface appearance. This simplifies clean up by eliminating dirty traps.

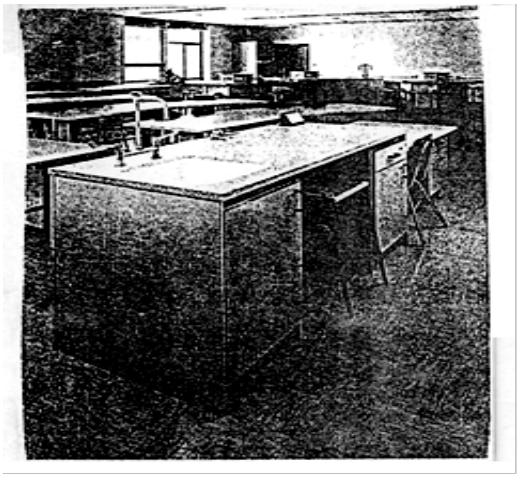
3.4 Classroom Laboratory Combination

Have you ever had your theory lessons in the practical class or try to do both in the same seating arrangement? This is very common in most schools but let's see what arrangement the power lab 8 has in the pictures.

Picture taken from power lab 8 2001

This arrangement provides a solution to having a separate lecture and laboratory areas. It combines one of the octagonal workstation with an attractive versatile classroom seating system. The flexible nature allows for a room layout that accommodate both lecture and laboratory areas and yet living room, open and inviting.

3.5 The Teacher Workstation



In performing demonstration, or lecturing, the teachers work table (station) unit must be convenient, spacious and long lasting. With the students seating arrangement, the teacher work-station is clearly visible to all students at whatever angle they are seating. For power lab 8, the teachers work surface is also made of corian which is easy to clean, durable and attractive. There is a sink

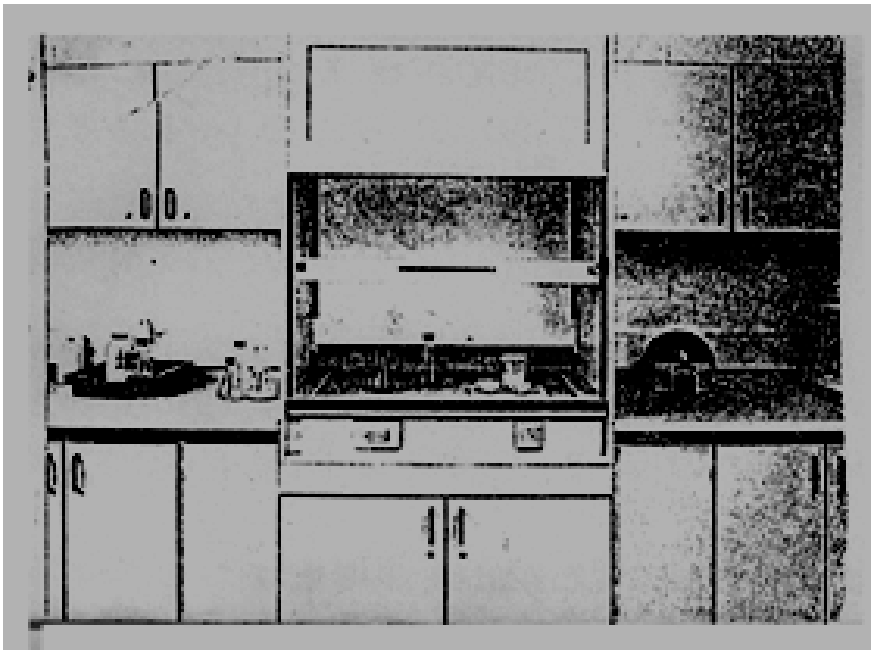
bonded to the under-side of the work surface to give an overall seamless work surface appearance.

This design eliminates dirt traps and helps keep maintenance to a minimum.

A sink service cupboard and a lockable three drawer storage unit are also located underneath the work surface. There is also a hot/cold water mixer, gas and electric outlets underneath the workstation.

3.6 Fume Cupboard

Fume cupboards are part of the necessary equipment available in chemistry laboratory in some schools. But in some they are not found and if available they are not in working conditions.



Picture taken from power lab 8 2001

Exercise 4.6

Do you have a fume cupboard in your school? Describe how it looks like.

The modern, ergonomic design of the fume hood and matching cupboards provides units that are easy to use and maintain. It is mounted on a storage unit, but can also be mounted onto an optional metal table frame. It is available with optional glass side viewing panels, which provides an unobstructed view of demonstration experience. Optional warning for air flow failure and incorrect sash height.

The front sash panel is made up of toughened glass with a fill-length handle for convenient work height adjustment. It provides fill counter balanced opening for safety and the work surface is made up of solid grade laminate. Inside the fume cupboard, there are cold water and gas outlets and an oval vulcatiene waste outlet. A switch for the overhead interior fluorescent light and a switched socket outlet are also supplied.

4.0 CONCLUSION

In this unit you have learnt about modern design of the science laboratory which includes the types of arrangements, the laboratory space surfaces, furniture service units, teachers table and the fume cupboards. In the next units V, you will be exposed to the design and organization of the preparation room.

5.0 SUMMARY

In this unit you learnt that

- The modern design has new design and facilities made adaptable to different approaches to science
- It provides a safe, spacious work areas for the students
- It encourages cooperative hands on learning
- It could be re-arranged in various shapes – U shape, triad, single pod and crescent according to the need
- The corian work surfaces are durable, hygienic and renewable. It is also easy to clean and wipe off.
- The service units are located on each octagon to make it accessible to all students.
- With a good student seating arrangement, the teacher demonstration table does not necessarily have to be on a higher platform
- The classroom and laboratory could be conveniently combined in the modern laboratory
- Surfaces bench tops should be impervious to water resistant to disinfectant acids, alkali, organic solvent and moderate heat.

6.0 TUTOR-MARKED ASSIGNMENT

1. As the head of science education in your college, you were required to propose a design of a new science laboratory.
2. Write this proposal of not more than 4 pages stating the advantages of the choice.

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UNIT 5 DESIGN AND ORGANIZATION OF THE PREPARATORY ROOM

CONTENTS

1.0 INTRODUCTION

In the previous unit you have been introduced to the various designs of the laboratory – its design, shapes, organization and the services required. In this unit you will learn about the adjacent rooms to the laboratory usually called the preparation room.

Exercise 5.1

Have you as a student ever wondered the use of importance of these rooms? And now as a science teacher, have you found the need and purpose to it?

2.0 OBJECTIVES

After studying this unit you should be able to:

- explain the need for a preparatory room
- list the essential components of a standard preparatory room
- state the need to control the access to the preparatory room
- explain the advantages of a well-planned laboratory exercise
- explain why your design f the preparatory room should depend on the type and function of the main laboratory.

3.0 MAIN CONTENTS

3.1 The Need for the Preparatory Room

Exercise 5.2

Have you as a science teacher ever tried going through a practical lesson with your student without previously preparing on your own for the practical?

This has led to failures of some practical lessons. The preparatory room should be ideally used for most of the preparation work of the experiments and demonstrations that would be later carried out in the laboratory. It could also be used as a convenient place to safely store a range of materials, equipments and apparatus which are not in continuous use. These are instances where a single room functions as the preparatory room and the store.

Some preparatory rooms have also been used in some schools where they are not enough office space. This is not ideal. Before any practical exercise therefore, the prep room helps you to get your materials together and try out such practical before the students practical class.

3.2 Access to the Preparatory Room

Usually in most cases, the preparatory room is designed in such a way that it serves other two adjacent laboratories as shown in the sketch below.

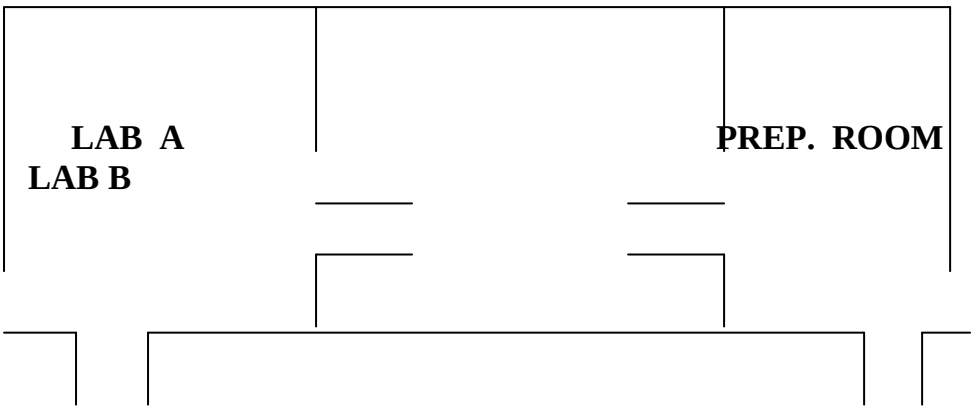

Fig. 51 – Typical relationship between the preparatory room and Laboratories.

Exercise 5.3

How do you access your room?

- From the corridor along
- From the corridor and laboratories
- From the laboratories alone.

Access to the preparatory room in most cases has been going through one of the laboratories. This is to restrict access to students since it is likely to contain expensive and dangerous materials and equipments.

In view of these, the doors are usually also fire proof.

3.3 The Design of the Preparatory Room

Casting your mind to your prep. room (the science teacher's prep. room); how was it designed and arranged?

There is no specific design for a preparatory room for its design and what it contains depends mainly on the type of main laboratory or laboratories it services. That is its size, type of design, location the kinds of equipment and apparatus it contains depend on the purpose and function of the main laboratory.

So before embarking on any design, it is necessary to consider the purpose. If for instance the purpose is to service laboratories used for general science then the usual activity will be preparation for experiments, like preparing solutions or media, assembling apparatus, and washing ups. Other activities might include the repair and construction of equipment apparatus (1G Nov 2001). So the requirements would include:

(1) Sufficient storage for daily use
(2) Services – gas outlets, electric points water supply for washing up.
(3) Access for heavy pieces of equipments and methods to transfer the goods
(4) Escape in case of fire (Ia Nov 2001)

But in general, each preparatory room should contain the following:

(a) A water distillation or de-ionizing plant
(b) A wet bench with running water and draining board
(c) A balance
(d) A large dry bench for dry work

(e) Small hard tools
(f) Adequate shelving and cupboards to be used for storage of apparatus equipment and chemicals
(g) An area for office work where the teacher or laboratory attendant could do paper work
(h) Adequate electrical outlet sockets
(i) Gas supply
(j) An efficient waste disposed system (I G Nov 2001)

Whatever your requirement which as mentioned earlier should be in line with your purpose, these requirements should be well arranged in the preparation room to make movement easy.

4.0 CONCLUSION

In this unit, you have learnt the importance of having a preparatory room, its function, access, design and organization with respect to the main laboratory. In the next unit, you will be introduced to the store which depending on available space could be combined with the preparatory room in some schools and colleges. It is always appropriate where necessary to have a separate storeroom.

5.0 SUMMARY

In this unit, you learnt that:

- You need the preparatory room to help with your experiments and demonstrations.
- The prep room could be used to store a range of your materials equipments and apparatus that are not frequently used.
- Access to the preparatory room should be restricted because it may contain some expensive and dangerous materials.
- The size type of design and, equipment materials of the preparatory room should depend on the purpose and function of the main laboratory.
- There are certain requirements for the preparatory room.

6.0 TUTOR-MARKED ASSIGNMENT

1. The preparatory room is convenient place to safety store laboratory materials and to set up experiments and demonstration. Discuss.

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UNIT 6 DESIGN AND ORGANISATION OF THE STORE

CONTENTS

1.0 INTRODUCTION

In some schools, a single room functions as the store and the preparatory room. Is this the situation in your school or you have the store room different from the preparatory room? To be more effective and service to the main laboratory, these rooms should be separated. In this unit, you will learn about the various types of stores, the requirement and appropriate design of a store.

2.0 OBJECTIVES

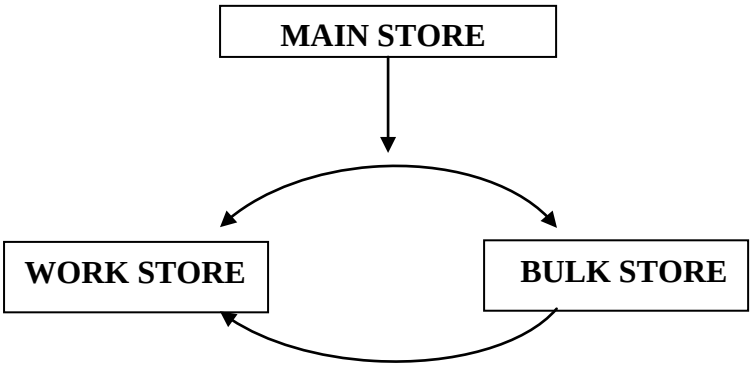
After studying this unit, you should be able to

- distinguish between the main store and the bulk store.
- trace the relationship between the three stores
- state the necessary requirement of a store
- explain why the flexible design is more appropriate for a store
- distinguish between the bulk store and the work store.

3.0 MAIN CONTENTS

3.1 The Various Stores and Materials

Depending on educational budget and the number of laboratory in the school, the volume of materials necessary to be stored may require having more than one store for easy flow of materials. See the diagram below.



Exercise 6.1

Study the diagram above. How are the materials distributed?

From the diagram, the main store distributes materials received and checked to the bulk store (those not for immediate use) or to the work store which is connected to the laboratory for the day to day use. The bulk store would continuously supply the work store with the required materials. These categories of stores are more applicable in higher institutions.

3.2 Requirements of a Store

Exercise 6.2

What do you actually need a store for in your laboratory?

A store is required to house materials and equipments. Some of these are on open shelves while others are kept under lockable storage. But many materials deteriorate if stored under wrong conditions such as extremes of temperature and dampness. So factors such as ventilation, temperature, lighting and humidity should be considered in storing materials.

Exercise 6.3

Let us take an example of acids in your school store. How do you usually store them?

Acids must be stored in cupboards having good ventilation to the outside air and non-corrosive shelving. That means that metal shelves should never be used. Also, because of the risk or danger involved, acids are not stored on high levels where lifting would be necessary. So a well organized store should:

- enable materials and equipments to be checked and serviced
- accessible to the science staff members and the laboratory
- house all equipment, poison, corrosive etc. materials with various precautionary measures.

3.3 The Design of the Store

In unit 3, you learnt about the fixed and the flexible designs of the inner part of the laboratory.

Exercise 6.4

List two advantages that the flexible design has over the fixed design.

You should see that the flexibility allows for creation of various seating arrangements which encourages cooperative hand on learning. This also allows the teacher to move freely about the room observing and assisting groups of students. For the store, as the factors change with different patterns of usage, the demand of the store will also change. The only way to accommodate these changes is to incorporate the flexible design in the store as much as possible.

Exercise 6.5

Take a look at the unit below. What can you say about it?

The storage unit Fig. 6.2 is free standing and not attached to walls and floors. This allows for easy repositioning of shelves. These shelves can be replaced by trays 3 shown in the tray units. All these modern units are constructed for easy cleaning and are designed to stand up for years of laboratory use. They can be filled with optional casters for extra mobility and locks for extra security.

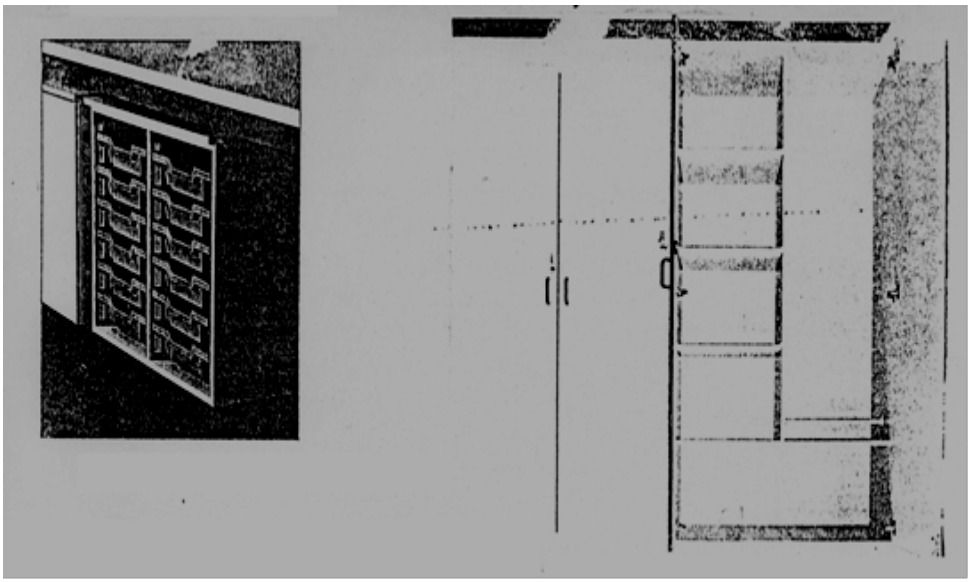


Fig. 6.2 from power 8 2001

4.0 CONCLUSION

In this unit, you have learnt that despite the fact that the preparation room and store are combined in some schools, it is more ideal to have them separated. The flow of materials within the stores has also been considered together with the various requirements necessary in the store. Since laboratories change, the need for you to have flexible design of the store was emphasized.

5.0 SUMMARY

In this unit you have learnt that

- The store should be a separate room from the prep room if possible.
- There are three main stores for easy flow of materials
- Materials and equipments in the store should be checked regularly and serviced
- The store should be accessible to staff members and the laboratory
- It should house all materials and equipments of necessary precautionary measures.
- The design of the store should be made flexible
- The units should be free storing and not attached to walls and floors.

6.0 TUTOR-MARKED ASSIGNMENT

1. Take another look at Fig. 6.1 then trace the relationship between the main store, the bulk store and the work store as regards the flow of materials.

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UNIT 7 THE USE OF COMPUTERS IN THE LABORATORY

CONTENTS

1.0 INTRODUCTION

Exercise 7.1

Do you have computers in your school? Have you ever used one? Most schools and colleges in Nigeria now have computers in the office for administrative use and a very few schools exposes their teachers and students to the use of computers. With the technology advancement in

the world, computers are gradually gaining access into the science laboratory to help the students with their practical and the staff with the organization and management of the laboratory which includes filing, record keeping, and their link with account.

You will realize therefore that computers are becoming a necessity in all spheres of life and there will hardly be a laboratory office or institution in future that will not use computer at some level for manipulating and organization of the laboratory. In this unit, the emphasis would be on your use of computers in the laboratory.

2.0 OBJECTIVES

After studying this unit you should be able to:

- state three advantages of using computer software's in the laboratory
- outline 2 disadvantages of emphasizing the use of the computer over hands in the laboratory.
- state three advantages of using the computer in interpreting and recording students practical and results.
- list three of the problems the school might have in the use of the computer in the laboratory.

3.0 MAIN CONTENTS

3.1 Integrating Computers Software into the Practical Exercises

Exercise 7.1

Have you had instances in your laboratory when you skipped a practical exercise because of lack of enough chemicals and apparatus to get round the students.

There are now various softwares in CDs and diskettes (computer simulations) that you can use to assist you to do this. For instance there are diskettes on Chemistry, Biology, Physics practicals which will take your student through their practicals on the computers e.g. if you want your student to titrate in Chemistry, the computers software helps the students to be able to set up the titration process, filling in the acid in the right apparatus, identifying the right indicator and actually seeing the experiment take place and recording their result. This is applicable to other practicals topics.

In Biology also are various CD's one of which for example can take your students through the whole human body which includes the skeletal, muscular, cardiovascular, reproductive system and more. It helps you to study and learn about the various internal system. The smart search also directs you to a part of the body even if you are not sure how to spell it. In fact, the detailed animation bring the intricate function of the body to life. These innovation make practicals real fun for your students and helps in situations where you have inadequate materials, apparatus or chemicals.

You need to emphasis to the school authority the need for a computer in your laboratory and get the necessary softwares.

3.2 Intergrating Computers into Recording & Interpreting Scientific Results

Although hands on experimentation is usually a main focus in any science laboratory. The importance of integrating the computers into recording and interpreting scientific results have been recognized. That is apart from the computer helping your students in their practical works, recording the results and interpreting is another aspect that your students might be finding difficult. Is this true of some of your students? How often do they interpret their recorded results wrongly?

With the computer integration, students can immediately interpret the results of their experiment by performing the hands on work and simultaneously entering the data into analytical software on a nearby computer. They can also perform an experiment using one set of variables and run a computer simulation using another set of variables. Integrating hands on experimentation with computer based activities in these and other ways can significantly enhance your students learning opportunities without taking up a lot of valuable class time or using costly laboratory resources.

So try and get your school to purchase these computers software and a computer expert can be invited to put you through. If you have never used a computer, try and get one and familiarize yourself with it.

3.3 Problems Regarding the Use of the Computers in Schools

Exercise 7.2

Can you envisage some of the problems your school might have in the use of computers? List some of them. Below are others.

- Irregular supply of electricity to most schools and the need for a stand by generator.
- The Science teachers have to be trained in the use of the computers.
- There is need to employ a computer experts
- The school has to beef up its security if computers are in the laboratory
- The school has to purchase some computers and softwares
- Instead of complimenting the hands on, some school; would supplement hands on for the use of computers.

4.0 CONCLUSION

In this unit you have learnt about the importance of using the computers to complement the hand – on experimentation in the laboratory, the emphasis was made on the use of various softwares into the practical exercises and recording/interpreting scientific results.

The need for the schools to have a stand-by generator, train science teachers in the use of computers employ computer experts among others were emphasized. Also the temptation not to supplement computer with hand on experimentation was mention.

5.0 SUMMARY

In this unit you learnt that

- Computers are not only to be administrative offices but in classrooms and laboratories.
- Teachers ad students would enjoy or could have fun in the laboratory using computers.
- Computers could be used for practical exercise
- Computers could be used in recording and interpreting practical results
- There are some problems that are associate with the use of computers in laboratories in Nigeria.

6.0 TUTORED-MARKED ASSIGNMENT

1. Discuss the problems the head of science or science teacher may have in the use of computers in the laboratory.

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UNIT 8 RESEARCH REPORT ON LABORATORY ORGANIZATION AND DESIGN

CONTENTS

1.0 INTRODUCTION

In this unit, you will use what you have learnt in your research method class and previous units in this module to write a research paper for the forth coming Science Teachers Association of Nigerian Conference on Laboratory Design and Organisation. You will be given some tips to guide you.

The four sub-themes are:

- Design and organization of the chemistry, biology integrated and physics laboratories.
- Design and organization of the preparatory room
- Design and organization of the store.
- The use of computers in laboratory organization.

2.0 OBJECTIVES

After studying this unit, you should be able to:

- choose appropriate topic for a research report
- consult related references appropriate to your topic
- scale down your topic to your area of specialization and locally collect data on your topic

- apply what you have learnt in your research method class to this course
- analyse your data
- make observation and recommendations.

3.0 MAIN CONTENTS

3.1 Choosing a Sub-Theme

You need to take a look at all the available sub-themes given and choose the one you feel you can write on. Your choice should be based on your interest, the materials available on it and if the materials are not readily avoidable, the time it might take to put things together.

3.2 Scaling Down to the Topic

It might be impossible within the framework of time you have to present a report covering too large a ground. So you need to narrow down the sub-themes to your area of specialization and your location. For instance, for sub-theme 2 your topic could be:

"Design and organization of the chemistry preparatory room in the Federal College of Education, Kontagora."

3.3 Getting into the Library

It is very important for you to get yourself acquainted to the library and its services. Since this paper is research oriented, you want to go into the library and look at how others have written research papers on related issues. So get into the library and go to the journal sections.

3.4 Choosing Appropriate Journals and References

Your topic should help you to choose the appropriate journal that can help you. For these sub-themes for instance, journals on science education, or science and technology will go a long way. Going through what others have done and how they have reported their research work should help you with the set out.

3.5 Data Collection

Depending on the sub-theme you have chosen, you need to get the necessary materials and data together. For instance, if you have chosen design and organization of the preparatory room, you have to find out.

- The need and purpose of the preparatory room
- The position of your preparatory room in relation to other rooms
- The design of the preparation room. (You could include some photographs)
- List the components you have in the preparation room and others.

3.6 Make a Comparison (Analysis)

Make a comparative analysis of other preparatory rooms (ones you read from the journal or your course guide) with the present data on the preparatory room you have. Are there differences or merits of one over the other as regards

- The design
- The list of essential components in a standard preparatory room
- The organization of the preparatory room and others.

3.7 Observation and Recommendations

Your observations and comparisons should be noted and reported. From the observations made, you may want to recommend to the school authority of the ways or means to improve for instance the preparatory room in schools.

3.8 Formal General Set-Up of a Research Work

You have been introduced to some tips on how to get your research report together. From your research method class, your will be given the formal setup which includes:

- Abstract
- Introduction

Review of Related Literature

- Methodology/Procedure
- Data collection
- Analysis/Results
- Conclusion
- Recommendation
- References

Any of the research report you have chosen from the library will help

4.0 CONCLUSION

This unit, which is the last one in this module, introduced you to writing research report on your chosen topic. As a graduate student, this will help you towards your postgraduate thesis and presentations at seminars and conferences.

5.0 SUMMARY

In this unit you learnt how to apply what you learnt in your research method class to this course.

- Choose appropriate topic for a research report.
- Scale down the topic to your area of specialization and locality
- Collect data on your topic using what you learnt in research method class
- Consult related reference to your topic
- Analyse your data
- Make observations and recommendations

6.0 TUTOR-MARKED ASSIGNMENT

1. Submit the research report you have written on laboratory organization and design (not more than ten pages)

7.0 REFERENCES/FURTHER READING

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MODULE 2 LABORATORY SAFETY

INTRODUCTION

In module one we have seen the challenges to the science teacher in designing, organizing and getting the students involved in scientific exploration. Although the curriculum is used to determine what activities the students engage in, but there is need to ensure safety of the student and staff.

Safety is a very important aspect of laboratory management and it should be presented to the students as a necessary aspect rather than a set of laws. Although many accidents occur on the playground, corridors, outside the school, a few of these accidents usually occur in the school laboratory causing damage to staff and students.

Module II introduces you to the safety and first aid procedures in the laboratory. It is divided into four units as follows:

UNIT 1 SAFETY IN THE LABORATORY

CONTENT

1.0 INTRODUCTION

In this unit you will be introduced to procedures to ensure safety in the laboratory. The causes of accidents in the laboratory and general

preventive measures towards those accidents have been discussed. Also our legal obligation in ensuring safety at all times in the laboratory has been emphasized.

2.0 OBJECTIVES

After studying this unit you should be able to

- list four reasons why accident occur in the laboratory
- state ways in which the institution or staff can be legally responsible for accidents in the laboratory
- list two preventive measures in ensuring safety in the laboratory
- list the obligation of the teachers and head of the institution towards safe working conditions in a laboratory.

3.0 MAIN CONTENTS

3.1 Obligation of the Science Teacher/Head of Department in Ensuring Safety in the Laboratory

As a science teacher or head of department, has it ever occurred to you that you have legal duties to ensure that the students under your care in the school laboratories are kept safe?

Many teachers are not aware of what the law requires as regards the protection of their students from accidents while in the laboratory and these needs to be emphasized.

Exercise 9.1

List 4 reasons why accidents occur in the laboratory.

3.2 Causes of Accidents in the Laboratory

Accidents occur in most instances due to:

- **Lack of Awareness:-** In some case, the students are not told or aware of certain hazards (implications) of their actions in the laboratory. So the need for the rules and regulations for the use of the laboratory.
- **Lack of Control:-** There are cases where the teacher finds it difficult to control the science practical class either due to the large number, students behaviours or seating arrangement. Thus making it difficult for the teacher to supervise.

- **Lack of Knowledge:-** With the inquiry and discovery nature of science, most students want to find out through experimentation without adequate knowledge of how to go about it. Also inexperienced science teachers and unqualified laboratory assistants may cause this.

- **Lack of the right attitude:-** Carelessness or insufficient care for instance can lead to injury of students and staff and also damage to equipment. For instance, using the mouth to pipette liquids which are toxic or corrosive. This is an example of undesirable students attitude. But over carefulness on the other hand could waste time, money and reduce the students experience. It can also deflect attention from real to imaginary hazards and produce undesirable attitude.

Although there is no law that is directly concerned with the legal liability for laboratory accidents in educational institutions; but in the event of any accident, the teacher, head of department, laboratory staff concerned would have to establish that reasonable steps have been taken and necessary care exercised to avoid such offence. If the student who is not a minor is found guilty of such an accident due to carelessness, he/she could be responsible for the acts performed and reprieved of compensation for injuries. If it is established that the institution is responsible then compensation is claimed by the student and the teacher or laboratory staff or department may face court action for negligence of duty.

It comes under the law of torts. Tort means an injury or damage for which monetary compensation could be claimed in a civil court action.

Exercise 9.2

State one thing you as the science teacher or head of department can do to avoid these accidents.

The head of department has a particular responsibility as the leader of the team of lecturers and technicians to encourage a positive attitude towards safety in the laboratory. Each student and staff in the department should be given safety rules in the laboratory. The rules should contain information on necessary procedure to prevent danger, how to contain it and medical procedures where necessary. To help you are the following measures:

3.3 General Preventive Measures

List 2 preventive measure you would take to ensure safety in the laboratory.

The following are the general preventive measures taken to prevent accident in the science laboratory:

- Your students should not have access to the laboratory except you or the technician is around
- You should always be the last person to leave the laboratory after each laboratory lesson. This is to make sure that your laboratory assistant turns of the gas, water, electricity and cleans up cleans up.
- In addition to having a suitable fire extinguisher, a fire cupboard for noxious or unpleasant gases, a sand bucket, a scoop with a long handle, a fire blanket etc. is necessary to curb all sort of accidents in the laboratory.
- The design of the laboratory should permit your free movement to supervise the students
- The students should not be too crowded in the laboratory so that you can control them.
- The fittings on the laboratory walls and floor should not stick out into the pathway in the laboratory.
- It should be possible for your students to open the laboratory windows without climbing the stools or worktables.
- In the design, the main control for the gas, electricity and water should be accessible to you and students to operate in case of emergency.
- To keep the laboratory clean and safe, design a daily routine of duties for the laboratory assistant.
- You should have the first aid kits available and accessible to your students, laboratory assistants and other teachers.

4.0 CONCLUSION

In this unit, you have been exposed to the obligations of the science teacher to ensure safety in the laboratory. The course of laboratory accidents and the general preventive measures were also discussed. The next unit, discusses the laboratory rules and regulations.

5.0 SUMMARY

In this unit, you learnt that:

- The science teacher/head of department has a legal duty to ensure that students are safe
- Accidents may occur in the laboratory due to lack of awareness
- Accident may occur in the laboratory due to lack of control
- Accident may occur due to lack of knowledge or right attitude
- Certain preventive measurers should be taken by the science teacher/head of department to ensure safety in the laboratory.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss two of the preventive measures taken in your laboratory to ensure safety.

7.0 REFERENCES/FURTHER READING

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UNIT 2 LABORATORY RULES AND REGULATIONS

CONTENT

1.0 INTRODUCTION

In the last unit you learnt about your obligation to ensure safety in the laboratory and preventive measures you could take. In this unit, the need to have rules and regulations was emphasized. These rules were clearly discussed and the importance of wearing appropriate protective devices to minimize the risk of injury to the staff members was highlighted.

2.0 OBJECTIVES

After studying this unit you should be able to:

- discuss the need for rules and regulations in the laboratory
- state the need for wearing appropriate protective clothing in the laboratory
- explain the hazards of ignoring the rules and regulations in the laboratory.

3.0 MAIN CONTENTS

3.1 The Need for Rules and Regulations in the Laboratory

Many accidents as you were told in unit 9 usually occurred due to lack of knowledge, control, right attitude, and awareness on the part of the students or teachers. This means that with greater precautionary measure the laboratory which is a potentially dangerous working environment could be a safe place. The students learn faster from what they see you or the laboratory attendants do since they feel you are the experts. Hence your responsibility among others is to build the right

attitude, knowledge and skills to carry your students along and avoid accidents in the laboratory. So the need for rules and regulations for the staff and students.

3.2 Rules and Regulations for Laboratory Staff

Exercise 10.1

You have rules and regulations for the laboratory staff and attendants in your school list them.

Below are set of rules you must follow while working in the laboratory.

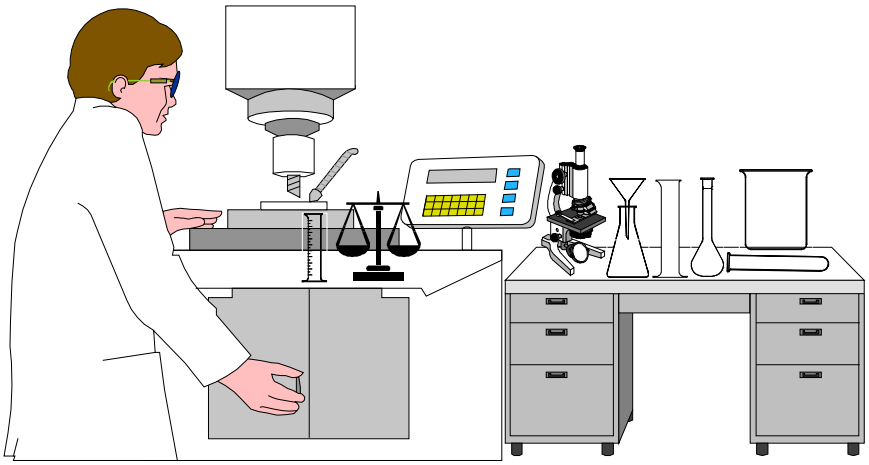
- Never eat, drink or smoke in a laboratory
- Always wear your overall coat at every practical lesson
- Get familiar with the locations of fire alarm, first aid kit, fire extinguisher, telephone (where applicable) and other safety equipment.
- Get familiar with the position of the main switches for water, gas and electricity supply to the laboratory.
- Always be careful when opening and closing the laboratory doors
- Always put on your shoes in the laboratory
- Long hair or head ties should be well packed and avoid lose jewelry in the laboratory
- Be familiar with the emergency routes and procedures
- Avoid looking at the mount of the test tube while heating or adding reagents
- Ensure there are no obstructions with the door ways and emergency exits
- Never allow your students to work alone in the laboratory without supervision.
- Always wash your hands before leaving the laboratory
- While diluting strong acids, add the acid a little at a time to water never add water to acid.
- Never try to slow down or stop a centrifuge with your hands
- Always label containers accurately with the full name and concentration of contents
- Avoid testing chemicals, or eating seeds or plants meant for biology practicals
- Do not sniff materials that may be toxic
- Always use the fume cupboard in carrying out experiment that produces harmful gases
- Do not handle materials or operate apparatus you are not familiar with
- All apparatus not in immediate use should be kept in cupboards

- Make sure the laboratory is kept clean after each practical exercise.
- Make sure all services e.g. gas, water, electricity are put off at the end of the day's work
- Inform other staff members of any breakage, faulty equipment and other defects
- Check that all bunsen burners are put off and there are no naked flame before using flammable solvent.

Above are some of the rules for you and other laboratory staff members. These rules are not exhaustive, so space has been provided for you to add more.

3.3 Protective Devices for the Staff

Although under the rules and regulations, some of personal protective devices such as shoes and laboratory coat have been mention, there is the need to discuss some details to minimize the risk of personal injury and damage through various contacts with hazardous suhskires.



Exercise10.2

From the figure above list the personal protective devices the science teacher is wearing.

Safety Spectacles

You need to use the safety spectacles to protect your eyes from splashes of chemicals or fragments of dust or glass etc.

Gloves

You should always put on gloves while mixing or transferring toxic, radioactive and carcinogenic compounds, intents and corrosive liquids. It is however not recommended that the gloves be worn throughout a practical exercise as the hands get very moist and sweaty, prone to skin infection and the gloves makes difficult to grip wet glass thereby resulting into accident.

Safety Shoes

You should always make sure you put on your shoes while in the laboratory. These should be covered shoes not open-toed to avoid any injury and contamination.

Lab Coats

Your lab coat should fit well and buttoned up. It is advisable to have one made with cotton as it absorbs more liquid and offer more protection against spilled chemicals than those made with nylon. It also does not generate sparks by static electricity that would ignite highly flammable organic solvent.

Aprons

Apart from the lab coat, a rubber apron is necessary for work with some amount of chromic acid, hydrofluoric acid and other highly corrosive liquids.

4.0 CONCLUSION

We have seen that the watchword in any laboratory is safety and so the need to have rules and regulations in the laboratory is emphasized in this unit. Also some of these rules as it affects laboratory staff members were stated and the importance of the staff having protection devices during practical lessons was also mentioned.

5.0 SUMMARY

In this unit you learnt that;

- There is the need to have rules and regulations to ensure safety in the laboratory
- That your students learn more from what they see from you and your lab attendant in the laboratory. So the need for you to have the right attitude.

- There are so many rules and regulations you need to familiarize yourself with while working in the laboratory.
- There are some protective devices you need to put on to minimize the risk of personal injury and contacts with hazardous substances.

6.0 TUTOR-MARKED ASSIGNMENT

1. State the possible hazards that could be caused by

    - Having a long dangling hair
    - Looking into the mouth of a test tube during chemical reactions.
    - Not wearing a safety spectacle
    - Not wearing a lab coat.

7.0 REFERENCES/FURTHER READING

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UNIT 3 FIRST AID IN THE SCHOOL LABORATORY

CONTENT

1.0 INTRODUCTION

In unit 9 you learnt about the causes of the various accidents in the laboratory. In this unit you will be introduced to the first aid you could provide incase of any accident. So the objectives and the general features of the first aid is discussed in this unit. Make sure you locate the first aid box in your laboratory before starting this unit.

2.0 OBJECTIVES

After studying this unit, you should be able to:

- define first aid
- list the contents of a first aid box
- describe the general features of the first aid procedure
- explain the first aid procedure for specific situations – eye injury, bleeding etc.
- state 3 objectives of first aid.

3.0 MAIN CONTENTS

3.1 First Aid and its Objectives

First aid is the immediate treatment and care given to a victim (who might be your student) of an accident or sudden illness until the necessary professional medical assistance is available. The treatment in the first aid is only temporal and it is given to achieve three (3) major objectives.

- to sustain or preserve life
- to prevent the victims condition getting worse
- to promote the victims recovery

You have been told in unit 9 that laboratories are potentially dangerous working places and as a science teacher, you should know how to provide first aid depending on the nature of the injury.

Exercise 11.1

Has any of your students ever had an accident or injury while working in the laboratory? What was the nature of the injury and how did you cope with it?

Always remember that first aid is a skill which you have to learn by proper training and practice. And your direct responsibility to provide first aid ceases as soon as a professional medical assistance is available. But a report of the first aid you provided must be given to the doctor.

3.2 The First Aid Box

Exercise 11.2

Where is the first aid box placed in your laboratory? Have you ever opened it to see its content?

First aid box or equipment should be placed as close as possible to where accidents are likely to occur, so there should be no obstruction but easy access to the first aid. First aid boxes should be kept as simple as possible. The following are suggested minimum content of a first aid box:

- One pair of scissors (blunt pointed)
- Bandages of different sizes
- one triangular bandage
- One tin of adhesive plasters and dressings
- One rubber bandage or pressure bandage
- Glucose
- A bottle of dettol
- A bottle of spirit
- Sterilized gauze and large dressings
- Sterilized cotton wool
- Sterilized eye pads in small and medium size sterilized unmedicated cottons for injured fingers/hands etc.
- One bottle of “TCP” or other mild antiseptic solution

- Small forceps
- One clinical thermometer
- Pen touch
- Copies of forms to be filed reporting first aid treatment to the medical doctor
- Telephone numbers needed to call the school doctor or an ambulance

Exercise 11.3

Do you have any other thing that you think is necessary in the first aid box. List it in the space provided.

3.3 The General Features of First Aid Procedure

Remember your first objective of first aid is to safe life. Not to lose one in order to save the other. So it is essential to keep calm and access the situation rapidly before deciding what steps to take. For one or two minutes can make a difference between life and death.

The action you should take in any emergency should depend on the circumstance. Below is a suggested procedure (IGNOU 2001):

- Quickly remove the victim from the hazards (provided it is safe to do so)
- Ensure that the patient's breathing is maintained (if the victim is not breathing, begin artificial respiration immediately. If the heart beat is absent begin resuscitation, for these, the services of a trained person is helpful.
- Control serious bleeding to prevent heavy blood loss
- Treat for shock
- Treat burns and deal with localized injuries (such as cuts or foreign bodies in the eye)
- Reassure the casualty and help lessen the anxiety
- Do not allow people to crowd around as fresh air is essential. Get them to contact the ambulance and a doctor.
- Where necessary, your last action is to hand the victim to the doctor or take him to the hospital.

Exercise 11.4

An accident has just happened and the whole students in the class are gathered. What would you do?

3.4 First Aid for Some Injuries

It will be necessary here to discuss more on some of the injuries mentioned that require immediate attention:

Severe bleeding: If you observe severe bleeding from the artery associated with spurting flow of bright red blood, the flow can be stopped by applying pressure at a appropriate point on the wound for 5-15 minutes with a clean pad of cloth. You can also use your bare hands or fingers if not available. If direct pressure is not possible, apply indirect on any artery between the heart and the wound. Then carefully lay the victim down with the head lower than the rest of the body.

Absence of breathing: If the victim has stopped breathing then artificial respiration or mouth to mouth respiration must be started at once to get a supply of air into the lungs. The procedure here involves:

- ❖ pinch and compress the nose to close it
- ❖ take deep breath
- ❖ place your mouth round victims mouth make an airtight seal and quickly breath into victims mouth
- ❖ watch the victims chest movement for rise and fall
- ❖ repeat this and continue at your natural breathing rate until normal breathing is restored.

Eye Injury: If corrosive materials have been splashed into the eye; the eye should be held opened and washed with copious amount of water. This can be done with short length of rubber tubing attached from the tap so that a steam of water may be directed at the eye. All eye injury should be referred to the doctor.

Shock: injuries are always associated with some degree of shock. Shock may be recognized by faintness, blurred vision, giddiness, collapse, clammy or cold skin or the breeding into sweat and anxiety. Shock can be serious, fatal and requires prompt action.

- ❖ The victim should be laid down with feet raised slightly higher than the head.
- ❖ The clothes or belt should be loosened
- ❖ The victim’s needs to be reassured and the patients anxiety should as far as possible be played.
- ❖ Do not remove the victim unnecessarily nor should they be kept unduly warm.

Burns: The commonest type of accident in the laboratory is burning or scalding chemicals burns. This should be washed with copious amount of water and no attempt should be made to carry out neutralization reaction on the skin. Some cause severe burns and medical advice must be sought as a matter of urgency. Heat burns are accompanied by loss of fluid from the blood into the tissue causing blisters to form. Small burns should be treated by cooling the injured area as rapidly as possible using running water or ice packs. A suitable sterile dressing should be applied, but lotions, ointments and oily dressings should be avoided.

4.0 CONCLUSION

The importance of first aid has been outlined in this unit. You were also exposed to the minimum requirement of the first aid box in your school. The objectives, general procedure for first aid was also discussed.

5.0 SUMMARY

In this unit you learnt that

- The most important objective of first aid is to save life
- Every school laboratory should have a first aid box and some listed materials in it
- There are certain procedures in sequence that should be taken in emergency cases.

6.0 TUTOR-MARKED ASSIGNMENT

1. Identify any of the commonest injury or accident. Outline in sequence the procedure to be taken.

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UNIT 4 DISPOSAL OF WASTE MATERIALS IN THE LABORATORY

CONTENT

1.0 INTRODUCTION

Waste materials from the laboratory needs to be disposed from time to time to prevent health hazards or inconveniences for free movements especially in times of emergency. In this unit, the various types of waste are considered and the procedure for disposal.

2.0 OBJECTIVES

After studying this unit, you should be able to

- state the methods of disposal of waste materials in laboratory
- discuss the hazards involved in wrong procedures of disposing waste materials
- list the various types of waste in a laboratory.

3.0 MAIN CONTENTS

3.1 Various Types of Waste

Exercise 12.1

Do you have waste as you work in the laboratories? What type of waste are these and how do you get rid of them?

You can have chemical waste, broken glassware, unserviceable non-consumable items, obsolete instruments, used biological specimens and radio-active materials that need to be disposed off from time to time. Biological specimen disposal will be treated in unit 16. Keeping most

of these wastages could create some hazards to you and others in the laboratory. To start with, it will be important to explain some of these terms to you.

- **Unserviceable non-consumable items:** These are broken or non-functional items like broken burettes, stands, furniture, Bunsen burners etc. and non-functional instruments like galvanometer, ammeters, refridgerator etc.
- **Obsolete instruments:** these are old model instruments which are functional but of old model and not currently in use. Examples are old model calorimeters, computers, pit meters etc.
- **Chemical waste:** the chemical waste can be gotten from breakage's of containers caused by accident, partial decomposition because of improper storage and atmosphere action due to its moisture, carbon dioxide or oxygen content.

3.2 Disposal of Unserviceable and Obsolete Items

As the head of department or science teacher, you need to bring to the attention of your head of department all those old or and unserviceable items you observe while carrying out your practicals and in cupboards in the laboratory. Checking through the students drawers could be so many croaked burette, broken burette stands or bunsen burners. Some of the students stools could be broken and some ovens, ammeters refrigerators may have been non-functional. Make a list of this with request for replacement to the head of department.

Exercise 12.2

Now check your laboratory and make a list of these unserviceable and obsolete items.

3.3 Disposal of Chemical Waste

Supposing your student carelessly throws a toxic waste into the dust bin, have you considered the harm this might have on the sweeper who cleans? Even some waste in the sink that are flammable, volatile and water immiscible can cause accumulation of flammable vapours in the drainage. So to dispose a waste safely:

- You must use protective devices like the safety spectacles and gloves
- You must be aware of the contents of the chemical waste and its nature
- You must shut off all possible source of ignition while dealing with flammable waste.

- You must use any of the appropriate methods to be discussed.

3.4 Various Methods Involved in Chemical Waste Disposal

You can use the following two methods in chemical disposal.
Removing the bulk of the chemical waste.

- **For water soluble/miscible solid and liquid waste:** Where you have miscible/soluble waste hat are harmless (in high dilution) and non reactive with water, you can run the waste with plenty of water into the drainage e.g. hydrogen peroxide potassium hydroxide, sodium hydroxide, lead, nickel etc.
- **For highly volatile liquid waste:** you can dispose highly volatile liquid waste by effective ventilation until the liquid completely evaporates, e.g. Diethyl ether.
- For moderately volatile liquid wastes this could be absorbed on sand, shoveled into bucket(s) and transported to a safe open space for evaporation.
- For water immiscible/insoluble liquid/solid waste which can be emulsified, spillage of this could be scrubbed with brush in the presence of soap or detergent solution. Then run the emulsion into the drainage with plenty of water e.g. benzene, toluene, chloroform etc.
- For chemically reaction waste. This waste could be disposed by considering the chemical property of the waste concerned.
- For all other wastes, other waste could be disposed by

    - ❖ The spillage could be burned by mixing with sand and burned deep or could be swept with 1:1 mixture of saw dust and zinc dust and burned at an isolated site.
    - ❖ Mixing with sand and disposal as waste excess sand can be used to mix some water – insoluble inorganic waste and disposed as normal garbage.
- The second method of chemical waste. Disposal is the treatment of the spillage site for after removing its traces after removal of the bulk of the waste to remove the final traces of the spillage. The following methods may be used depending on the nature of the spillage:

    - ❖ The spilled area should be ventilated to dispel the vapours in case of easily volatile waste.
    - ❖ The spillage site is to be washed with water incase of water soluble/miscible waste.
    - ❖ The site of spillage is to be washed thoroughly with water and soap/detergent in case of water immiscible/insoluble wastes.

4.0 CONCLUSION

In this unit we considered how to dispose of unserviceable non-consumable, obsolete items and waste chemicals in the laboratory. These items need to be disposed from time to time since they could constitute health hazards.

5.0 SUMMARY

In this unit you learnt that

- unserviceable non-consumable items need to be disposed
- old or obsolete instruments in the laboratory should be disposed off
- chemical waste can be disposed using various methods depending on the nature of the chemicals
- some safety procedures must be observed in disposing chemical waste.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the various methods you could use to dispose chemical waste in your laboratory.

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MODULE 3 HAZARDS IN THE LABORATORY

This third module deals with another very important aspect associated with safety in the laboratory. It is about the possible hazards in the laboratory, procedures to be taken to prevent any accident in the laboratory. The module is divided into 7 units as follows:

Unit 1 Glassware Hazards in the Laboratory
Unit 2 Chemical Hazards in the Laboratory
Unit 3 Electrical Hazards in the Laboratory
Unit 4 Hazards in the Biology Laboratory
Unit 5 Fire Hazards in the Laboratory
Unit 6 Extinguishing a Fire in the Laboratory
Unit 7 Research Report on Laboratory Safety and Hazards**.**

Realizing that in any science laboratory you work with chemicals, gases, electrical equipment, glass wares, instruments etc, there is the need to have unit 16 on hazards that are peculiar to the biology laboratory resulting into infection and diseases. The last unit 19 in this module envelopes module 2 and 3. This is to expose the students to research reports in the area of laboratory safety and hazards.

UNIT 1 GLASSWARE HAZARDS IN THE LABORATORY

CONTENTS

1.0 INTRODUCTION

You must be aware of various accidents caused by glass wares in the laboratory. In this unit, you are introduced to some of the hazards that may be involved in the constant use of these and how it could be prevented.

2.0 OBJECTIVES

After studying this unit you should be able to:

- state the need to be careful in handling, use and disposal of glass wares
- explain the hazards involved in handling large glass containers by the neck
- explain why glass tubings are usually carried vertically not horizontally
- advance reasons why pipetting liquid using the mouth should be avoided
- advance why reagents in glass bottles should not be stored in direct sunlight.

3.0 MAIN CONTENTS

3.1 Glass Wares

With the number and frequent usage and breakages of glassware in the laboratories, it is important to guard against the risks from it.

Exercise 13.1

During your practical lessons, do you usually have breakages of glass wares?

Glass wares are produced and used in vast quantities in most laboratories but the production from the factories differs in quality. So while some are more durable, some easily break.

Broken glass needs to be treated with particular cover and should be cleared up as soon as possible. Small pieces of glass could be collected by means of a piece of plasticine and should be discarded in a clearly marked container used exclusively for the purpose.

Most students have also been observed using chipped or cracked glass ware. This is so common with burettes, pipettes, test tubes, beakers and others. You should try to avoid this because of the danger it constitutes to the students in handling.

Breakages are expected although this does not mean carelessness. Where you establish the latter, then the students should be made to pay for it.

Dirty glassware can be washed with hot water and small amount of detergent. You should make sure gloves are worn by whoever does the washings to prevent cuts. It may also be necessary to spread plastic mat in the sink to avoid breakages

3.2 Glass Tubings

Exercise 13.2

Fatimah has just collected a burette from the laboratory attendant for her titration. She held the burette horizontally and was walking hurriedly back to her titration desk. Ojo mistakenly clashed with her. What do you think happened?

It is most likely that the burette will get broken and the students injured. Glass tubings have remained the cause of many unnecessary accidents in the laboratory. The length of glass tubing should be carried vertically and not horizontally.

Also, it should not be stored above the head height. Also a glass file or knife to make the initial mark when cutting a glass tubing. Then apply pressure to break the glass while keeping the hands away. Always make sure it is fire polished by rotating in the bunsen burner.

Another aspect that constitutes risks from glassware is when passing glass tubing or a thermometer through a cork or rubber bung. It is very important to use the correct technique. That is the cork – borer, which is lubricated with glycerol (propane 1, 2, 3 – trio) and of slightly greater diameter than the tubing is passed through the bund or cork.

The tubing will then be inserted into the borer and the borer withdrawn. You should repeat this same procedure in the reverse while removing the sized tube from the bung.

3.2 Pipettes and Burettes

Has any of your students in the process of using the mouth operated pipettes gotten some of the liquid into the mouth? Or has any burette slipped and broken because it was not properly clamped?

You could have so many accidents while performing practicals with pipettes and burettes. In fact, they can be dangerous if they are not properly used.

Although mouth-operated pipettes are inexpensive to purchase; most schools would rather do with pipette fillers. This helps to prevent the

hazards resulting when students fail in using the mouth operated pipettes.

You should also emphasize to your students the danger of using he mouth pipettes to draw up volatile liquids, aqueous ammonia, concentrated acids or alkali and toxic liquids. Always wash your pipettes or burettes immediately after use and store in a proper rack. Laying a pipette on a laboratory bench could also contaminate the mouth piece.

You should make sure that your students burettes are properly clamped and brought down below their eye level. This should be down before they fill the burettes using a funnel. Climbing of stools by student in order to fill liquid into the burettes should be avoided.

3.3 Glass Bottles or Containers

There are some risks involved in the use and handling of glass bottles or containers you should be aware of. For instance, large glass containers must not be handled by the neck and Winchesters of reagents need special care in this respect.

Reagents in glass bottles must not be stored in direct sunlight, near radiators or on warm floors. Also with your experience in physics, you should remember that liquids in spherical containers can act as a lens and focus enough sunlight to cause fire. Also your glass stoppers which have tapping gently with a wooden block wrapped in a soft cloth or long as the contents are suitable, by running warm water over the neck of the bottle. In either case, your hands should be protected with gloves or a cloth.

4.0 CONCLUSION

This unit dealt with the risk involved in the use and handling of glasswares, such as glass tubing, pipettes burettes, and large bottle/containers. The teacher was made to be aware of the means of avoiding accident caused by this in order to train the students or laboratory assistants to handle the equipments and materials safely.

5.0 SUMMARY

In this unit you learnt that

- Some glasswares although cheap are not durable
- There is need to be very careful in the handling, use and disposal of glasswares
- Glass tubings should be carried vertically and not horizontally
- Glass tubings should not be stored above the head height
- Accident caused by pipetting using the mouth can be avoided by the use of pipette fillers
- Mouth operated pipettes should not be used for toxic liquids
- Pipettes and burettes should be stored properly to avoid contaminations
- Burettes should be properly clamped to avoid risk of breaking as it slips off
- Large glass containers should not be handled by the neck
- Reagents in glass bottles must not be stored indirect sunlights
- Jammed stoppers can be loosened by tapping gently or running warm water over the neck of the bottle.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss in not more than 3 pages the hazards caused by glassware in the laboratory and how it could be avoided.

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UNIT 2 CHEMICAL HAZARDS

CONTENTS

1.0 INTRODUCTION

In unit 9 you were introduced to ways of ensuring safety in the laboratory. In this unit you will learn how chemicals in the laboratory can constitute a hazard. The classification, handling, labels and packing of chemicals is also discussed.

2.0 OBJECTIVES

After studying this unit you should be able to:

- list the different classes of hazardous substances
- explain handling aspects of hazardous chemicals substances like labels, packing
- match the colours with the nature of the chemicals

3.0 MAIN CONTENTS

3.1 Human Contact with Chemicals

You must be used to working with chemicals in your laboratory. It is always good to assume that all the chemicals are toxic and flammable unless you are sure of its nature. Your body also contains some chemicals but these are so well controlled in term of their amount, nature and action. The nature and extent of hazards varies from one chemical to other and the effect of some are still unknown so it is advised that you as the science teacher exhibit a lot of caution in handling chemicals and minimize your exposure to t hem.

Exercise 14.1

List two ways by which your body can contact chemicals in the laboratory.

Human contact with chemicals can take place through the following ways:

- ingestion
- direction contact from spills or by improper handling
- inhalation of vapours, fumes or dust
- indirectly e.g. through explosion

3.2 Classification of Hazardous Chemicals

Types of hazards are classified into nine classes and each except the last having a United Nation Hazard class symbol to ease transportation of hazardous goods. The colours and the nature of the substances are given below:

Colour	**Nature**
Orange	Explosive
Red	Flammable
Blue	Water reactive
Yellow	Oxidiser
White	Toxic or Infectious
White or yellow	Radio Active
Black & White	Corrosive

The nine classes are discussed below (IGNOU 2001)

Class 1 – Explosives

These are commercial explosives preparations and substances used for blasting agents, ammunition, fireworks etc.

Class 2 – Gases

Gases can be divided into 3 sub-classes on the basis of their hazardous nature. Human contacts with chemicals can take place through:

- flammable gases e.g. acetylene, liquefree petroleum gas
- toxic gases e.g. chlorine, sulphur dioxide
- non-flammable non-toxic gases e.g. carbon dioxide, nitrogen etc.

Class 3 – Flammable Liquids

Flammable liquids are those liquids or mixture of liquids containing solids in suspensions or solution and gives off flammable vapour of temperature not more than 60.5^{o}C.

Class 4 – Flammable Solids

These are substances that are flammable or liable to spontaneous combustion or emit flammable gases on contact with water.

Class 5 – Oxidising Substances

This includes oxidizing substances and the organic peroxides. Oxidizing substances are by themselves not combustible but by feeding oxygen to other substances cause or contribute to t heir combustion.

Class 6 – Poisonous and Infectious Substances

These are substances liable to cause death or serious injury to health if swallowed or inhaled or allowed to come in contact with the skin. Infectious substances are these contaminated with disease inducing micro-oranisms.

Class 7 – Radio-active Substances

These are substances which undergo spontaneous disintegration to form atoms of different elements. The disintegration is usually accompanied with 3 types of reductions (alpha, beta, gamma) when the ionizing rays pass through living organisms, it can cause damage to body tissue.

Class 8 - Corrosive Substances

These can cause severe damage by chemical action when in contact with living tissue or incase of leakage, destroy/damage other materials.

Class 9 – Miscellaneous Dangerous Substances

This includes other hazardous substances.

3.3 Handling of Chemicals

This has been discussed under safety. But it is important for you and other lab staff to always pay attention to handling of laboratory chemicals. Be sure of the safety and ensure safety procedures.

3.4 Labels and Packaging

It is so easy for you to mistaken one chemical for another without clear labeling. The labels on the container should provide a guide as to the nature of the substance – whether flammable, toxic or corrosive. You should make sure that suppliers of chemicals to the laboratory keep to this. So labeling is another aspect of ensuring safety in handling chemicals and it must show:

- the name of the substance – the 1UPAC as well as trivial name of chemicals.
- an indication of the general nature of the risk i.e. if explosive or flammable, etc
- a risk phrase – which gives nature of risk and safety phrase which gives advise on necessary precaution should have the following: the name and address of manufacturers as regards packing
- all parts of a package must be assigned to prevent leakage of content when handled normally. Packaging materials must not be damaged if they come into contact with their contents.
- Packages that are intended to be opened and closed repeatedly must be assigned so that they do not become worn out after repeated close.

4.0 CONCLUSION

The importance of ensuring safety as regards chemical hazards was emphasized in this unit. Also the ways in which the body can contact chemicals in the laboratory, classification, handling, label and packaging were also discussed.

5.0 SUMMARY

In this unit you learnt that

- you should exhibit caution in handling chemicals to avoid contact with the body
- hazard can be classified according to colour and nature
- types of hazards can be classified into nine classes according to the United Nations standard.
- You need to exhibit care in handling chemicals
- You should ensure safety by making sure that chemicals are well labeled and packaged from the suppliers.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss four of the classes of hazardous chemicals giving examples for each of the classes.

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UNIT 3 ELECRICAL HAZARDS IN THE LABORATORY

CONTENTS

1.0 INTRODUCTION

Have you ever experienced electricity shock from any of the appliances especially when your hands are wet? Or have you heard of people being electrocuted from high voltage rails or cables? No matter how small the electric shock is, it could be very dangerous. In fact, the availability of electricity power has posed a number of potential hazards for its misuse usually results into serious injury or death.

Short circuits and other electrical source are also common cause of fire. So these dangers must never be under estimated. In this unit you will be exposed to the human body as it conducts electricity and some of the cause of these electricity mishap or shock.

2.0 OBJECTIVES

After reading this unit, you should be able to:

- describe how the human body conducts electricity
- state the danger involved in having a wrong connection in appliances
- state the danger of colour blindness
- advance reasons why some worn out equipment are still kept in the laboratory
- state the importance of the proper choice and use of fuse
- list some cause of electric mishaps or shocks.

3.0 MAIN CONTENTS

3.1 The Human Body and Electricity

Your body can conduct electricity and its resistance varies widely from one person to the other. It is also dependent on the condition of the body – principally if it is wet or dry. If it is wet, the resistance is very low and electric shock can be very dangerous resulting in severe injury or death, even if voltages considerably lower than that of the main supply, with dry skin, the resistant may be higher and this would allow some current to pass through the body and could also be less fatal.

For this reason, switches, sockets and electrical equipment should not be placed near or close to taps, sinks and other areas where water could easily splash on them. Also the severing would be so great having electricity passing through a wet skin in a bath of water as the water will conduct the current to the pipe work and the electric shock would probably be very fatal.

3.2 Improper Wiring

There might be times when you need to change the plug in an appliance might be from a round plugs mouth to square plugs in order to fit the socket on the laboratory tables or workstations. It is important to make sure the connections are correctly and firmly done. The colour codes should be followed while wiring a plug. These are:

Earth	:	Green and Yellow
Live	:	Dark Brown
Neutral	:	Light Blue

These are the new connections codes. Although it is possible for you to have foreign equipments with earth-green, live-red, and neutral-black; they are older equipment and such equipment should be fitted with the new international colour codes as soon as possible.

Exercise 15.1

Unscrew one of the plugs on any of your appliances. What color code does it have – old or new? If new, does the connection conform with the figure above?

You need to note the implication of colour blindness in connection. So if you are colour blind, always get assistance in your connections to avoid electric hazards.

3.3 Worn Out Equipment/Appliances

Look around at some of the electrical equipment you have in your laboratory, check the records how long ago were they brought. With the state of the economy in the country, most schools have found it difficult to replace some equipment. Some are so old that the cables have given up commonly called "black tapes" are used to hold together or secure the students from danger while handling. Do you have such "black taped" equipment in your laboratory? It is high time you made request to the school authority for replacement. Emphasizing the risk associated with such worn out equipment.

3.4 Selection of Fuse

You have been told about the conduction of electricity by the human body just as our bodies are limited to the current they can withstand. So are electrical appliances, wiring, plugs and other apparatus are limited to the current they can handle. So the selection of a proper fuse for a given equipment or appliance depends on amount of current drawn by it. So if the flex, plug or fuse of an appliance is not appropriate to the amount of current drawn by it, serious damage or injury might result. So for you to decide on the fuse to use, you must know how to calculate the current drawn by your equipment. Your colleagues in physics or chemistry could help to do this if you are not able to.

3.5 Faulty Workmanship

Electrical accident could also be caused by faulty workmanship. Most of the so called "electricians" we call into the school to get the equipment fixed end up worsening the situation. This is so because:

- they never take their time to do a good job.
- if it is so well done initially, how do they get call back as often as they will.
- they might not be paid well
- the economy situation forces them to manage some of the materials that should be replaced
- lack of experience on the job
- lack of knowledge of what to do
- lack of expertise
- not getting the right materials in the market and trying to substitute
- instead of replacing the worn out materials with new, another fairly used one is used.

Now try to fill in your own reasons since the list can never be exhausted. Anyway, whatever the reason, you as the science teacher or head of the department should try to make sure a good job is done. Always try the appliances or equipment before the electrician leaves and make sure all materials to be replaced are with new ones.

4.0 CONCLUSION

In this unit you have seen how the human body could conduct electricity and some various other causes of electric shock or mishap. In the next unit you will be considering hazards that could result from fire in the laboratory.

5.0 SUMMARY

In this unit you learnt among others that

- electricity has posed a number of hazards usually resulting into serious injury or death
- the human body conducts electricity and resistance varies according to the person and condition
- switches, sockets and electrical appliances should not be placed in wet areas
- plugs should be properly wired using the colour codes
- worn out equipment which could be a source of electrical hazards should be replaced
- appropriate fuse should be used to avoid serious danger
- electricians should be supervised to take time and effort to do a good job.

6.0 TUTOR-MARKED ASSIGNMENT

1. Write a report on accident you witnessed due to electrical faults.

7.0 REFERENCES/FURTHER READING

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UNIT 4 HAZARDS IN THE BIOLOGY LABORATORY

CONTENTS

1.0 INTRODUCTION

In units 13,, 14, 15 we have dealt with hazards associated with glassware, chemicals and electrical equipment. These three hazards cut across most of the laboratories. But in case you are working in a biology laboratory and handling plants, animals, dissections, microorganisms etc, this unit helps you with the hazards involved. Also, disposal of biological materials was mentioned in unit 12, more detail will be provided in this unit.

2.0 OBJECTIVES

After studying this unit you should be able to:

- state the principal hazards of biology laboratory work.
- describe the ways to minimize the hazards
- explain the necessity of using fresh needle, disinfectant and gloves while studying the blood samples.
- explain the importance of getting supply of animals from accredited dealers
- discuss the need to be careful in handling, storage and disposal of sharp pointed objects.

3.0 MAIN CONTENTS

3.1 Hazards in the Biology Laboratory

Although hazards considered under the chemical, electrical, glassware could also be applicable in the biology laboratory. There are additional hazards encounter in the laboratories which deal with diseases such as infections and allergies. These can be caused by the inhalation and ingestion of substances in the form of fumes, fine spray or aerosol produced during pouring, stirring, centrifugation. Infected matter can also penetrate the body through cuts, scratches and other break in the surface of the skin. Keeping of experimental animals and the possibility of stings, bites and scratches could be other sources of danger.

Exercise 16.1

As you work in the biology laboratory what are the causes of the common danger encountered?

Below are other listed causes

- sharps e.g. razors, glasses etc
- laboratory animals and their carcasses and bedding
- electrical equipment such as water baths, incubator, ovens
- heater such as autoclaves
- solvents for chromatography
- toxicants or toxic substances
- micro organisms, culture
- radioactive trears

3.2 Causes of Common Dangers in the Biology Lab

Sharps

Sharps such as sectioning razors microtone, blades etc. are the common cuts here due to careless handling. So these objects must be handled with great care as cut gotten from it during dissection has the risk of introducing micro-organism into the body from a contaminated object.

Blood Sampling

Blood sampling is another delicate procedure that must be handled with care. It involves a deliberate puncture of the skin to take a sample and it is so easy for microorganism to enter the blood stream of the donor, from the lancet used or from the donors blood to the environment and

contaminate it virus diseases such as viral hepatitis and AIDS have been found to transmit through small cuts. So always use fresh and sterilized needle to prick the finger tips when taking blood samples. For disposal, sharps blades lancet or needle can simply be posted through the slot and when there are enough old ones in the box, plaster of pans can be poured into the box and thrown away in the dust bin.

Have you taken a blood sample before?

If you were not careful enough try to be more careful next time.

Micro Organisms

You should take great caution when you are performing micro biological experiments. For although any microorganisms are normally harmless they can produce diseases in a different habitat. The most common sources of microorganism are culture, dissection materials, laboratory animals and soil. These can get into the body through inhalation (nose and mouth), ingestion (nose and mouth into digestive system and penetration through skin injuries). The following are the precautionary measures you could take in handling microorganism.

Handling

As discussed in unit 9, you can reduce the risk especially of direct contact with microorganisms by carefully handling and wearing protective clothing such as rubber gloves, mask, lab coat etc. Non-pathogenic and approved cultures can be transferred in the open laboratory as long as you ensure that the work bench is cleaned with spirit.

You could easily get contamination from culture plates so you should see Petri-dishes with clear tab before allowing them to be examined by you or your inexperienced students. You should always take care to sterilize the equipment after you have used it as it may contain infection. You can also encounter cuts, allergies and bruises while working with plants materials. So do not forget to put on your gloves, masks and laboratory coat. There are more precautions you may have noticed in handling. Can you write one more?

Disposal

It is so easy to just dispose the materials. But it is important that you always sterilize cultures all contaminated instruments and glasswares before disposing them or before washing up. This can be done by autoclaving or soaking overnight in a suitable disinfectant.

3.3 Laboratory Animals

Wild animals, mammals and birds could also introduce disease and so you must make sure laboratory animals are obtained from accredited dealers. Apart from harm to the laboratory staff they can pass on diseases to other animals. Therefore make sure they are free of lees, ticks, mites, skin fungi and pathogenic gut bacteria.

3.4 Handling

You should always take normal hygiene precautions when handling animals, their cages litter or bedding. Remember their ability of even the finny animal to scratch and bite. So always wear your rubber gloves and wash your hands afterwards. It is also important that you keep to your anti-tetanus injections.

3.5 Disposal

Opaque bags can be used in disposing off carcasses. So put your freshly plastic bags, seal them and dispose them by burying. But the animal bedding can be disposed in normal refuse except infected or diseased animal that you need to incinerate the opaque bags.

4.0 CONCLUSION

Although hazards and disposals related to chemicals have been dealt with in units 12 and 15, this unit discussed procedures to contain hazards such as infections and diseases from the biology laboratory. The causes of the most common dangers in the laboratory were also outlined.

5.0 SUMMARY

In this unit you learnt that:

- the necessity of using fresh needle, disinfectant and gloves while taking blood samples
- the precautionary measure you need to take to handle micro-biological experiments and laboratory animals.
- the disposal procedures in the biology laboratory

6.0 TUTOR-MARKED ASSIGNMENT

1. Your students will be having micro-biological practical next lesson. Write out the safety procedures you will past on the board

7.0 REFERENCES/FURTHER READING

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UNIT 5 FIRE HAZARDS

CONTENTS

1.0 INTRODUCTION

In the unit 15 you learnt about hazards due to electricity in the science laboratories. As you were told some of the consequences of electricity hazards could also cause fire. In this unit you will learn about the fire triangle, the causes and classification of fire.

2.0 OBJECTIVES

After studying this unit you should be able to:

- explain the significance of the fire triangle
- list 5 common causes of fire
- classify different type of fire
- draw the fire triangle and how the absence of one factor makes fire outbreak impossible

3.0 MAIN CONTENTS

3.1 The Fire Triangle

Usually for any fire to take place there must be three main factors illustrated in the figure below:

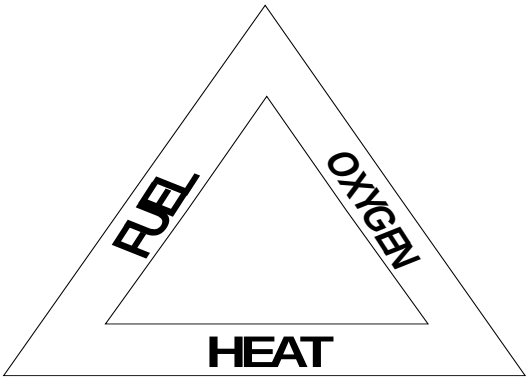

Fig. 17.1 - Fire Triangle

These factors are represented diagrammatically as 3 side of what is called the fire triangle. The fire triangle cannot stand if one of the factors is removed. It will collapse which indicates that fire outbreak will be impossible or could be prevented or stopped just by removing one of the factors.

So as a teacher, you need to bore this simple principle in mind while attempting to extinguish a fire or when planning the construction and layout of a laboratory, workshop or store. This is to minimize the possibility of fire outbreak and to reduce its possible effect should a fire occur. Most fire extinguisher act by excluding the oxygen supply from the fire temperature to a level below which burning will continue. The oxygen supply for a fire generally comes from air (about 20% by volume of air).

Although air is the common sources of oxygen others especially in the laboratory include

- peroxides
- chlorates
- permanganates
- nitrates
- dichromates

and other oxidizing agents. Therefore, you should keep these oxidizing agent away from organic solvents and highly inflammable materials. Fire is a self sustaining combustion process which takes place in the vapour phase, producing heat and smoke. Solid such as wood and paper will usually have to be heated to a sufficiently high temperature to give off an inflammable vapour before they ignite. But the situation is different with organic solvents. Many of which produce organic vapour even at very low temperature. The vapour from flammable solvents can just be ignited by mere spark bringing about a fire.

3.2 Causes of Fire

The damages caused by fire in Nigeria run into billions of Naira not to talk of deaths, injuries and sufferings which the fire might cause. In fact, fire was once described as "a thief that leaves nothing behind for the owner" the potential risk for fire arises from the presence of combustible with ignition sources.

The ten most likely ignitions for fire are:

- Smoking materials (cigarettes, matches etc)
- Misused or faulty electrical installation
- Naked lights (e.g. candles that often used)
- Mechanical produced heat or sparks
- Malicious or intentional ignition
- Oxyacetylene equipment
- Children playing with fire
- Gas appliances and installation
- Oil appliances and installation
- Burning of waste and bushes

Although some of these might not be directly related to the laboratory, those directly connected could be seen from four main sources:

- Hazardous materials and reactions
- Compressed and liquefied gasses
- Flammable substance
- The availability of sources ignition

3.3 Classification of Fire

Since there are various sources of fire, the standard international practice is to classify the main sources according to their nature. The classification is given on table 17.1 below.

Table 17.1: Classification of fire source (IGNOU 2001)

CLASS OF FIRE	TYPES OF NATURE
A	Fire involving materials that contain carbon, e.g. wood, clothes, paper, rubber
B	Fires involving flammable liquids e.g. petrol, oil, alcohol, and many other organic solvent
C	Fires involving flammable gases e.g. methane, propane, hydrogen, ethane and butane
D	Fires involving flammable metals e.g. sodium, potassium, calcium, magnesium and other combustible metals or their hydrides
E	Electricity and electrical appliances

4.0 CONCLUSION

This unit dealt with another type of common hazard which is fire. The main factor for fire to take place was illustrated on the fire triangle and the cause and classification of fire was discussed. In the next unit you will be hearing about the different types of fire extinguishers and their uses.

5.0 SUMMARY

In this unit you learnt

- that there are several causes of fire
- that significance of the fire triangle
- how to classify the different types of fire
- the relationship in the fire triangle

6.0 TUTOR-MARKED ASSIGNMENT

1. Has there been any fire mishap that you read about or witnessed?
2. Give a report of the likely causes.

7.0 REFERENCES/FURTHER READING

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UNIT 6 EXTINGUISHING A FIRE IN THE LABORATORY

CONTENTS

1.0 INTRODUCTION

In this unit you will learn how to extinguish fire as an amateur fireman. The equipment is only meant to contain and extinguish small fire outbreak in the laboratory or elsewhere. So it is only a first and fire fighting measures only. Also the types of extinguisher which depends on the class of fire is also discussed.

2.0 OBJECTIVES

After studying this unit you should be able to:

- list types of fire extinguishers
- describe the use of different types of fire extinguishers
- list five principles to be obeyed in fire fighting

3.0 MAIN CONTENTS

3.1 Types of Extinguisher

Exercise 18.1

Supposing you are in the laboratory and one of your students clothing starts burning; what would you do?

There are various ways of extinguishing fire depending on the class of fire as discussed in the last unit; but you have to remember that in using whatever procedure, the moment you find that you can no longer contain

or extinguish the fire, then you are advised to evacuate the building immediately and call on the fire brigade.

Now look at the table below. You need to refer to table 17.1 to remind you again of classes of fire A to E. The ticks indicate if the extinguisher can be used for the particular class of fire or not.

Table 18.1: Summary of fire extinguishers for different types of fire. Source IGNOR 2001

EXTINGUISHERS	**CLASS OF FIRE**				
	A	B	C	D	E
Water	√√	NO	NO	NO	NO
CO_2	√	√	√	NO	√
Foam	√	√√	NO	NO	NO
Vapourising liquids	√	√√	NO	√	√
Dry powder	√	√	√	√	√
Dry sand	√	√	√	√	√
Fire blanket	√	√	√	√	√

Exercise 18.2

In your school laboratory, which of the above fire extinguisher do you have in your laboratory?

Most school laboratories in Nigeria have the sand bucket, water and other fire extinguishers. It is important that you train your laboratory staff to make use of the fire extinguishers for different situations.

3.2 The Use of Fire Extinguishers

Since there are various types of fire extinguisher according to the class of fire, it is necessary for you as the science teacher to study about the different types and how it is used. "For there is a technique to be learnt for each type of extinguisher."

- **Water Extinguisher**

With water, try to direct your hose or jet to the base of the flame and keep moving it across the fire. Attack the fire which is spreading vertically from the lowest point and move upward. Concentrate the jet on any identified hot spot even when the main fire is extinguished.

- **Carbon Dioxide, Dry Powder & Vapourising Liquid**

In this case, first switch off the current if the fire is close to any electrical equipment. If the fire is produced by spilled liquid, extinguish by directing the jet towards the near edge of the fire and with a rapid sweeping motion, drive the fire towards the far edge until all the flames are extinguished. Any other type of fire you could extinguish by directing the jet of the burning materials. You should not use the vapourising liquid extinguishers in a confined space for the danger of the fumes being inhaled.

- **Fire Blankets**

You can use a fire blanket in conjunction with carbon dioxide for extinguisher instead of flammable liquids and other fire, first smothered the fire with the blanket and the carbon dioxide extinguisher will be used to ensure all the flames are extinguished. Also where a students clothes is burning, allow the student to roll in the fire blanket on the floor. You should note that the fire blankets are now usually made of glass fibre instead of asbestors.

Can you add more to list above?

- **Fire Buckets**

Do your laboratory have a fire bucket? Have you ever used it? The fire bucket is not only used for carrying water to the fire pot but it is filled and used to keep sand and scoop. Since sand can extinguish fire quickly and effectively, it is particularly useful for spilled liquid or reactive chemicals such as alkali metals. In pouring the sand, put too little, if not it will be useless and not carelessly to splash the burning liquid and make the hazard worse. It should be poured liberally and quickly and aim to cover the whole area of the flames or spillage.

- **Foam Extinguisher**

In using the foam extinguisher, stand far from the fire spot and direct the jet with a gentle sweeping movement to allow the foam to drop down and form a layer on the surface of the liquid. You should not aim the jet directly into the liquid as this will put the foam under the surface and it will be ineffective and may spread the fire by splashing the liquid all around.

3.3 Principles to be obeyed in Fire Fighting

- Always take a position between the fire and the exit so that your escape route cannot be cut off.
- Fire extinguishers should be placed closed to the doors and other exits.
- Use your extinguisher as a first aid fire fighting measure only
- Use your extinguisher for small fires
- Do not continue to fight the fire if your escape route will be cut off with smoke
- Do not continue to fight the fire when you have exhausted your extinguisher and the fire is still raging
- Remember your life can easily be lost in an effort to extinguish the fire
- Concentration of carbon dioxide can quickly build up if carbon dioxide extinguisher is used in an enclosed space.

4.0 CONCLUSION

In this unit you have been exposed to the main types of fire extinguisher and their uses. Principles to be obeyed fire fighting is also discussed. It is important for you and your staff to be trained in using the different types of fire extinguisher devices to make the laboratory a safe place to work.

5.0 SUMMARY

In this unit you learnt that

- there are various ways of extinguishing fire depending on the class of the fire
- there are various types of fire extinguishers and their uses
- there are some important principles you have to obey in fighting fire
- the fire you are extinguishing should be small and still under control.

6.0 TUTOR-MARKED ASSIGNMENT

1 List six principles to be obeyed in fire fighting.

7.0 REFERENCES/FURTHER READING

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UNIT 7 RESEARCH REPORT ON LABORATORY SAFETY AND HAZARDS

CONTENTS

1.0 INTRODUCTION

In unit 8, you were introduced to how to write a research report on a chosen topic from the sub-themes related to module 1. For module 2 and 3 which is on laboratory safety and hazards you will use your experience in unit 8 to summarize current research reports (2000 to date) related to this topics. You need to be able to spend some time in the library to do this assignment. In fact, you might have to visit the library more than once to get the assignment completed.

2.0 OBJECTIVES

After studying this unit you should be able to:

- retrieve information from the library
- state the procedure of writing the research report
- locate authors and subject matters through the author and subject index or the computer
- summarize an article in a journal
- write down comments and observations on articles read in the journals.
- differentiate between the author and subject index in the library.

3.0 MAIN CONTENTS

3.1 What To Do

In unit 8 you were given a topic and sub-themes you could write on. In this situation, you are to look for what others have written and published as research work in recent journals (2000 to date) make a summary of this.

The following steps which will be discussed in details later will help you to do this assignment.

- getting back into the library
- identify the subject index (if you already know an author)
- identify the subject index (which you have been give)
- use of computer in identifying the subject or author index
- locate the materials on the shelves numbering
- be sure they are current materials (2000 to date)
- reading through the materials (articles)
- summarizing
- observations

3.2 Getting Back into the Library

You have been given a topic on laboratory safety and hazards. You are expected to summarize current researches related to this topic. That it might be connected to the safety in the laboratory or the hazards in the laboratory. Since you were in the library for unit 8, you should be used to the library now, so first by going to the card index section. There are two ways of getting your information from the card index either through the author index, or subject index. In libraries where you have a computer to assist, it makes it easier as will be indicated later.

3.3 Author Index

If for instance you have heard of someone who wrote on laboratory safety and hazards or on related topics, you could just check the surname from the author index. Usually, the author index is arranged alphabetically making it easy to access. Take note of the shelve number where you could get your materials.

3.4 Subject Index

This is the most appropriate for this assignment as you have already been told the topic. So check for subjects related to laboratory safe or

hazards. If you are successful take note of the shelve number where such journals could located.

3.5 The Use of Computers in Locating Materials

Very few schools or institutions now have computers in their libraries. You could use any of these facilities in any institution close to you. It is a technological innovation which saves your effort and time in identifying the materials you need. You just need to type in the name of the author or the subject matter and all related matters to the subject or author will be displayed on your screen. Ask whoever is in charge of the computers in the library to put you through this process.

3.6 Shelf Labeling

In most of the libraries, the shelves are labeled with both alphabets and numbers. These alphabets combined with numbers are indicated below:

- the section where the materials can be found
- the row
- the position of the material relative to others. So if you have JQ21, it means the materials is in J which stands for journal section; Q stands for row, Q 21 stands for the position of the material on the row i.e. 21st position.

Different libraries have different ways of labeling their shelves. The library attendant should be able to explain this to you. So check the label in front of the material you have identified.

3.7 Making Use of the Current Materials

You were asked to report journal from (2000 to date). Whether you are using the computer, author or subject index, the date of publishing for each materials is always indicated. So check and make sure they fall within the specified date before going to locate them on the shelves. Check the content in the journal and take note of the pages connected to the research topic you are looking for.

Now get a convenient seat and flip through the materials you have located. Be sure it is directly related to the topic – laboratory safety and hazards. Now pick any of the articles and read through carefully from the abstract to the recommendation (conclusion). Read over and over again until you understood the content of the paper. This is very important because some journal articles are not easily comprehensive at first reading. When you are sure you have understood then move to the next page.

3.8 Summary and Observation of the Research Report

Your summary for each of the article should also include:

- the introduction
- the procedure used for data collection
- the result
- the analysis
- conclusion and recommendation.

After the summary you can now make your observations as regards each of the articles. The applicability, merits and demerits.

4.0 CONCLUSION

This unit which is directly connected to unit 8 took you back to the library to search for current research report on laboratory safety and hazards. You were able to read and make your summary and observations on each of the four articles you were assign to do. This assignment also prepares you for your post graduate dissertation.

5.0 SUMMARY

In this unit you learnt that

- information can be retrieved from the library using the index or subject card or the computer
- you can easily locate a material on the shelf. If you have the descriptive label.
- There is a procedure for writing a research report
- You need to spend more time in the library for research work.

6.0 TUTOR-MARKED ASSIGNMENT

1. Submit the summary of the two current research report on laboratory safety and hazards.

7.0 REFERENCES/FURTHER READING

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MODULE 4 LABORATORY MANAGEMENTS

This fourth module deals with the management of the laboratories. It centres on the major human resource person that involve in the managing of the laboratory. The module is divided into 4 units as follows:

Unit 1 The Head of Department
Unit 2 The Science Teachers
Unit 3 The Laboratory Technician and Assistants
Unit 4 Storage and Material Management in the Laboratory.

UNIT 1 THE HEAD OF DEPARTMENT

CONTENTS

1.0 INTRODUCTION

In previous units, you have learnt about the laboratory design, organization and safety. But there is need to know how the laboratory itself is fun on day to day basis or managed. This unit deals with a major human resource person (the head of department) managing the laboratory.

2.0 OBJECTIVES

After studying this unit, you should be able to:

- discuss the major roles of the head of the department
- state the responsibility of the head of department as regards time table, notice board filing of information and establishing resources centres
- outline what the head of department should do to keep make his/her members cooperative
- advance reasons for the importance of identifying staff members talents and capabilities

3.0 MAIN CONTENTS

3.1 The Head of Department

The task of managing the affairs of the science department is visualized as a joint responsibility among the head of department and other staff members. This includes science teaching staff and laboratory attendants/technicians.

The head of department who is one of the human resources in the department has some major areas to be concerned about.

- Organization and coordination of duties
- There should be an open and effective communication channel between himself and other staff members, that is he/she should operate an "open door" policy for corrections, advice and suggestions towards the progress of the department.
- Delegation of responsibilities – he should identify staff members with their talents and capabilities and delegates duties like wise.
- Training of personnel in the department should be a major concern of the department. He should make sure that the staff members under him are recommended for promotions, attend conferences, workshops and seminars and are given study leave when appropriate. The above are very sensitive areas that easily frustrates some staff members not giving them job satisfactions.

Exercise 20.1

What other role do you think your head of department should play to enhance productivity in the department?

3.1 Some Responsibilities of the Head of Science

- **The School and Science Time Table**

The head of science always contact the teacher in charge of school timetable of the special requirements for double periods of laboratory practical for the various science subjects. On his/her own, the head uses the general school timetable for scheduling the departments timetable involving the staff members and displayed in the laboratory.

- **Notice Board**

The head of department should provide up to date information on a notice board in the science department as an aid of communication. The notice board should be divided into sections and each section labeled using section headings preferably written out in block letters on different coloured carried (e.g. Red for Urgent or Emergency). The heading could be

- School time table
- Science laboratory time table
- Science teachers time table
- Local STAN Activities
- Science club activities
- Today's announcement
- Teachers' information centre
- Urgent

Exercise 20.2

Do you have a science department notice board? List other headings that you have.

- **Filing Information**

The head of department should be responsible for storing and retrieving information by maintaining two separate filing cabinets or shelves. "Confidential files": These would contain examination information, students records, correspondence confidential reports on students and staff etc.

The "Open – access": files. These should contain past question papers, science syllabuses, career information, catalogues for books and science equipment, safety information etc.

Do you have the confidential and the open file in the department? What do they also contain?

- **Staff Resource Centre**

A resource centre within the science department for the staff members should be arranged. For close monitoring, this could be a room adjacent to the head of department office. The following could be included in such resources centre:

- reference library
- audio visual aids
- worksheet store
- stationery
- duplicating facilities
- projection facilities

- **Money Management**

The head of department needs to consult with other staff as regards the needs of the department. This is presented to the college or school. The estimates should be broken down to include

- equipment cost
- running cost
- stationery
- books and audio-visual aids
- workshop/conference, seminar needs
- living organism funds
- replacement funds
- practical examinations funds

Exercise 20.3

Space has been provided for you to add more to this list

4.0 CONCLUSION

The management of the department has been seen to be a joint responsibility of the head of department and other staff members. For the head of department to succeed certain roles and responsibilities were outlined in this unit.

5.0 SUMMARY

In this unit, you learnt that

- The head of department has joint responsibility with other staff member to manage the department
- The head of department should organized and coordinate the duties of other staff member.
- He/she should have an open and effective communication channel for advise, corrections, suggestions from staff members.
- The head of department should delegate responsibilities and encourage the training of his staff members (staff development)
- The head of department has other responsibilities concerning the timetable, notice board, filing of information and establishing the staff resource centre.

6.0 TUTOR-MARKED ASSIGNMENT

1. As the head of science department in your school, discuss your roles and responsibilities

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UNIT 2 THE SCIENCE TEACHERS

CONTENTS

1.0 INTRODUCTION

In unit 20 you were told of the importance of the head of department in delegating duties to his staff members. In this unit 21 you will learn about the responsibilities (delegated) to the science teacher who is another human resource person in the management of the laboratory. The science teacher works closely for smooth running of the department.

2.0 OBJECTIVES

After studying this unit you should be able to:

- state the responsibility of the science teacher in the laboratory
- discuss the role of the science with the subject matter
- explain other responsibilities of the science teacher as regards departmental meetings, science library, wall charts, examinations, safety etc.

3.0 MAIN CONTENTS

3.1 The Science Teacher and the Laboratory

The responsibility of the science teacher towards the laboratories depends on the particular laboratory used for students. It is a joint responsibility of all teachers and laboratory assistants responsible for using the laboratory since there are likely to be more than one teacher per science discipline. The teacher is responsible for the following:

- **Preparation of materials, solutions and specimens**. It is the responsibility of the science teacher to prepare all necessary materials or items for practical activities. This should be prepared well ahead of the practical lesson to take note of all the inadequacies.
- **Training of the laboratory assistants**. It is necessary for the laboratory assistants to be well trained since you know that students learn a lot of things from them either directly or indirectly. So the need for them to continually improve their skills by attending workshops, stock control, requisitioning and receipt of supplies. As a sincere teacher, you should make sure you record the incoming and outgoing stock from the store; have a requisition book for your request and always issue a receipt or sign for supplies made to the store room.
- **Recording Breakages:** As discussed in unit 8, there are so many breakages especially with glassware in the laboratory. These breakages should be recorded for replacement and if it is due to the students carelessness, they should be made to pay for it.
- **Proper storage and distribution of materials:** Materials should be stored according to the nature and the storage procedure should be simple for safety and ease of retrieval.
- **Implementation of safety regulations:** In Unit 10 you learnt about the safety rules and regulations. It is one of the teachers duty to make students and other supporting staff keep to these rules.
- **Supervision and control of laboratory assistants:** The science teacher should highlight the duties of the laboratory assistant and paste it where it can easily be made reference to. There is need to have a close supervision and control of the laboratory assistants at all times to ensure safety in the laboratory.

3.2 The Science Teacher and Subject Matter

Each science teacher should be assigned the subject in the area of specialization for teaching. That is, there are separate teacher for Biology, Chemistry, Physics, Integrated Science, Agricultural Science etc. depending on the teacher's area of specialization. But this is not the practice in most schools where there is scarcity of science teachers. There are instances where a graduate in Biology Education is made to teach Integrated Science or a graduate in Physics Education made to teach Mathematics. It is always important for you as a science teacher in your area of specialization since this is an area of expertise and you should feel more comfortable with it. Also you need to continuously develop your knowledge and skills by attending conferences, workshop and seminars. This will keep you abreast with recent development in science.

3.3 Other Responsibilities of the Science Teacher

- **Wall Chart:** The science class or laboratory should be a conducive and attractive environment for learning science. So the science teacher should get resource packs in form of charts to paste on the wall from which students can easily learn certain concepts.
- **Films :** Most students love to watch films. So it would be exciting if you could get educating scientific films that your students could watch during their science or practical classes.
- **Library:** As mentioned earlier, in unit XX, the need to have a resource library in the science department is very important. One of the science teachers should be responsible for keeping track of the resource materials.
- **Secretary:** In any department meeting, one of the science teachers should stand as the secretary and take the minutes of the meeting. This should be typed, circulated to each staff before the next meeting and filed. In fact there should be a particular file for departmental meetings.
- **Examination:** Each science teacher is responsible to set and mark assignment, continuous assessment and examination questions. The marking scheme for the examination should also be attached.
- **Safety:** As mentioned in unit 9, the safety of the laboratory should be of concern to the science teacher who is really liable for whatever careless accident to any students. So the safety rules and regulations should always be emphasized.
- **Science teaching scheme:** For every teaching subject allocated to science teacher, there is need at the beginning of each term to break it down according to the number of contact hours and content converge during each period.
- **Displays and Exhibitions:** The Science Teachers' Association of Nigeria at its annual conference each year encourages schools to bring the students unique exhibitions for display. The best exhibitions are identified and given prizes. There are other science fairs that are taking place all over the nation. So your students should be encouraged to take part in exhibitions.
- **Science Clubs:** Juniors and seniors students should be encouraged to join the science clubs where they could interact in a more relaxed atmosphere and learn from each other.
  You as the science teacher could be a patron to such clubs to coordinate their activities.

4.0 CONCLUSION

In this unit we have seen the science teachers responsibility to his subject matter, the laboratory and other assignments. In unit XXII we shall be considering the laboratory assistant.

5.0 SUMMARY

In this unit you learnt that:

- The science teacher has a joint responsibility towards the laboratory with other staff members in the same discipline
- The science teacher should see to the preparation of materials, solutions and specimens before each practical lesson.
- The training, supervision and control of the laboratory assistant should be his concern.
- The science teacher should control the stock and record breakages.
- The science teacher should keep storage of materials and ensure safety in the laboratory.
- The science teacher should try to teach in the area of his/her expertise and training.
- The science teacher has other responsibilities connected with the science library, department meetings, examinations safety etc.

6.0 TUTOR-MARKED ASSIGNMENT

1. Due to shortage of science teachers in the school, most science teachers have been made to teach out of their areas of specialization. Discuss.

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UNIT 3 THE LABORATORY TECHNICIANS AND ASSISTANTS

CONTENTS

1.0 INTRODUCTION

In this unit you will learn about those that assist you to make the work easier in the laboratory. These are the Laboratory Technicians and Assistants. Their roles in the management, organization, maintenance and safety in the laboratory is emphasized.

2.0 OBJECTIVES

After going through this unit you should be able to:

- state the need for adequate maintenance of the various equipment and services in the laboratory.
- discuss the importance of having a well trained laboratory assistance and technicians in the laboratory.
- state the role of the teacher in helping to recruit the laboratory assistant and technicians.

3.0 MAIN CONTENTS

3.1 The Laboratory Technicians

Do you have a laboratory technician in your school? Well trained laboratory technicians are sometimes rare to come by and most science departments usually employ the services of the laboratory attendants and train them on the job to play both roles. Your school may be lucky to have a laboratory technician. If this is so, it is important to note that the

amount of servicing and repair of equipment which can be undertaken by a laboratory technician in school is limited. So attention should be given to the manner in which the equipment is used and the type of environment it is subjected to. The following will help the laboratory technician in the maintenance of equipment, apparatus and furniture.

3.2 Maintenance of Equipment, Apparatus and Furniture by the Laboratory Technician

Protection of these materials from dust, vibrations, corrosion and excessive heat will enhance the maintenance of the equipment. So use the following instruction to reduce the tear and wear as well as damage to the materials.

- **Prevention of Dust**

Depending on the amount of dust and rate of accumulation, there should be routine cleaning and dusting of equipment to remove lots of visible dust. But certain environment are likely to encourage fast accumulation of dust than other so the technician should

- ❖ Dust on barriers on windows (install air conditioners where possible)
- ❖ Keep the doors closed most of the time
- ❖ During the raining season and the surrounding has a lot of mud than provide door mats at entrances and mop the floor instead of sweep.

- **Reduction of Vibration**

Your equipment might loose its alignment, precision and accuracy due to contact vibration. The common sources of vibrations are

- ❖ Moving equipment from place to the other without care
- ❖ Hammering on walls, benches and floors
- ❖ Banging doors and windows
- ❖ Loud noises
- ❖ Heavy traffic close

- **Prevention of Corrosion and Rust**

Some laboratory equipment are constructed with metals and plastics that could be affected and corroded by fumes and spillage from mineral acids and organic solvents. So the laboratory should:

- ❖ Have efficient ventilation system
- ❖ Wipe equipment after use to remove liquid and chemical dust
- ❖ Cover equipment or store them in cupboards.

- **Prevention of Equipment From Excessive Heat**

Heat generating equipments should be kept too close to other equipments and electrical operated equipment should be switched off after use. Also avoid direct sunlight into the laboratory.

- **Correct Usage of Instructional Manuals.**

Each laboratory equipment should come with its manual. Always make sure the equipments are operated in the manner recommended by the manufacturer. Also make sure the copy of the instruction is available to other users.

- **Servicing of Equipment**

Some servicing of laboratory equipment are simple enough for the technician; for example:

- Replacing bulbs, belts, nuts, bolts and screws
- Tightening of units, bolts and screws
- Lubrication
- The internal cleaning by use of solvents, blow brushes, vacuum compressed air.

- **Servicing of Furniture**

The type of care of furniture depends on the materials used for construction. For instance, where wood tops are used, care must be taken to avoid long contact with water and chemicals. So there should be immediate mopping of spillage to prevent damage. Wax polish which makes the surface more resistant could be applied occasionally.

Exercise 124

List the types of simple servicing of equipment done by your laboratory technicians.

3.3 The Laboratory Attendants

In order to facilitate the effective management of the laboratory, the choice of good laboratory assistant is very important so a space should

be created for him close to the teacher's preparation room to make him accessible to both the teachers and the students.

3.4 Selection of a Laboratory Assistant

The head of department and staff should have a say in the employment of a laboratory assistant where there is a vacancy. This laboratory assistant should be trained by the teacher in laboratory organization and maintenance. In-service courses in the polytechnics and the university will also be helpful in increasing his competence and efficiency.

3.5 Duties of a Laboratory Assistant

Any science teacher should work better in a well equipped laboratory assisted by a qualified experienced laboratory assistant. The duties of the laboratory assistant should include:

- ❖ Preparing materials, solutions, specimens and apparatus required for practical work.
- ❖ Setting up and testing demonstrations (under the supervision of the science teacher) before any practical work.
- ❖ Assisting in the use of visual aids
- ❖ Ensuring security in the laboratory etc.

You can list more in the space

4.0 CONCLUSION

This is the last unit on the human resources management and it dealt with the laboratory technicians and assistants. Although most schools may not employ a full time technicians, the need to train the laboratory assistant in the laboratory is very crucial. In the next unit (23) you will be introduced to how the materials resources are managed in the laboratory.

5.0 SUMMARY

In this unit, you learnt that the laboratory technicians should help in the maintenance of equipment, apparatus, and furniture in the laboratory.

- the need for a well trained technician
- the need to protect equipment from dust, excessive heat and rust
- the need to service and use instructional manuals for the equipment
- that the laboratory assistant are valuable asset to the science teacher if they are well trained and experienced

- the science teacher should assist in the recruiting of the laboratory assistant or technician.
- duties of the laboratory assistant include learning, ordering and organizing materials before the practical exercises.

6.0 TUTOR-MARKED ASSIGNMENT

1. A well trained laboratory assistant is a valuable asset to the science laboratory. Discuss.

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UNIT4 STORAGE AND MATERIAL MANAGEMENT IN THE LABORATORY

CONTENTS

1.0 INTRODUCTION

One of the major problems you may have observed in most laboratories is the management of materials and the storage difficulties. For adequate storage is still not recognized as an essential feature of a modern science laboratory as emphasized in Unit 4. So this unit introduces you to the various procedures in laboratory material management.

2.0 OBJECTIVES

After going through this unit you should be able to:

- state the importance of considering temperature in storage
- discuss the importance of storage in laboratory material management
- state the need for order arrangement of materials
- state some general guidelines to storage procedure

3.0 MAIN CONTENTS

3.1 Material Management

In a science department of any size, you will notice that materials or equipment can easily get misplaced or finished and not re-ordered; unfortunately their disappearance or unavailability is only noticed just before you want to use them. To reduce this problem to a minimum, you need to manage the laboratory materials properly. One of the areas continually affected in this management is the storage. For the orderliness of the laboratory itself adds to proper storage.

3.2 Storage

Exercise 13.1

What happens as regards the materials in your laboratory when there is a sudden change in biology teacher or science teacher?

Usually if there is no good labeling or direction as regards where items could be located, the new science staff may be lost. Except with a competent laboratory assistant to assist. In fact many laboratories still contain much of the storage provisions in the form of underneath drawers. A well organized storage system should

- Enable equipment to be checked and serviced easily
- Be accessible to those using it
- House all equipment, poisonous, corrosives, fragile, flammable etc.

Temperature is another factor that should be considered in storage. Where you have very dry conditions with high or moderate temperature, materials should be stored in cupboard and drawers or apparatus locked up in rooms for very humid condition with high or moderate temperature, storage on slatted shelves in fan ventilated stores will be more effective.

So a wall arranged science room should be characterized by the following:

- orderly arrangement for materials
- simple display of charts, kits etc
- trends in the use of materials and replacements

To assist the head of department or science teacher in management, the following are the general guidelines:

3.3 General Guidelines to Storage Procedures

Each cupboard should bear a general label indicating the type of apparatus it contains

- Allied non dangerous equipment should be stored in some or near cupboard for instance materials for mechanics in physics could be stored in the same area as materials for optics, electrical etc.
- Storage should be planned in an orderly way so that each piece of equipment is kept in a specific place.

- Chemicals that can react with each other must never be stored together
- Beakers should be stored properly in constructed cupboard or cage that is kept locked.
- Sodium is to be stored in kerosene while phosphorus is to be stored in water.
- Reagent bottles should be shelved where the bottles cannot be easily knocked off.
- Cabinets containing suitably sized drawers should be used in storing software items like slides, films, strips and film loops.
- Large charts are best stored hanged vertically on the laboratory wall.
- Objects such as spring balances and pulleys can be kept hanging from the cuphooks.
- Lenses or glass blocks can be kept in slots.
- Glass tubings that is not used must be securely kept in a safe place.
- Strict attention must always be paid to the security of cages and animals to prevent escape
- Quantities of flammable liquids or solids kept in the store should not exceed one year before replacement
- All poisons in the laboratory must be labeled in red capital letters with the word poison and kept under lock and key.
- Acid resistant troughs are for storage of concentrated acids.
- All reagent bottles must be labeled. Those that contain volatile toxic or combustible chemicals should be marked with red to indicate danger.

4.0 CONCLUSION

In unit 22 you learnt how some human resources (the head of department, the science teacher and the laboratory technician -assistants) are managed in the laboratory. In this unit, you were introduced to how to manage your materials in the laboratory with emphasis on storage. The general principles for proper storage was discussed. This is your last unit in this course.

5.0 SUMMARY

In this unit you learnt that:

- materials or equipment can easily be misplaced or get out of stock (without replacement) if the laboratory is not properly managed
- there should be orderly arrangement of materials in the laboratory

- temperature is a factor to be considered in storage
- there are certain general guidelines on storage of materials and this depends on the nature of the materials, the temperature and the general environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. How will good storage help the science teacher in the management of materials in the laboratory? Discuss any five points.

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