COURSE GUIDE

PED234
MAN, ENERGY AND RESOURCES

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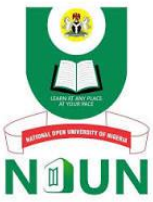

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INTRODUCTION

The course deals with energy utilization and the indispensability of energy in the life of man. The course also touches on the history of origin of life and how man has evolved from his ancestors. You will also be exposed to a number of natural resources found around man in his environment.

In this course, you will be presented information in primary education in an organized way to make learning easier. All the units follow the same pattern and so after the first few units, the rest will become easy to follow.

The Primary School is the foundation of the Educational system in Nigeria, hence Primary Education Studies aims at equipping teachers with the relevant knowledge, skills, attitudes, methods and materials to enable them teach effectively all subjects in the primary school curriculum as contained in the National Policy on Education.

As Primary School teachers, you need to be exposed to a wide range of knowledge to enable you cope with the tremendous task of teaching wide range of subject matter at this level of education. With this background and a good professional training, you can then be acquainted with the necessary skills to achieve this goal of primary education. With this view in mind, we have packaged this course in such a way that you will learn about issues and concepts that will prepare you for the tasks which you may be asked to perform as primary educators.

The course consists of 15 units of teaching. They include materials which bother on the history of life on earth, origin of man, issues relating to energy and its utilization, conversion and conservation. It also discussed a wide range of natural and man-made resources available to man in his environment and the use to which they have been subjected. The course also includes a course guide which sheds light on what to do as you run through the content in such a way that you find the content interesting and enjoyable. There are regular tutorial classes that are linked to the course. You are advised to attend all the sessions.

WHAT YOU WILL LEARN IN THIS COURSE

The overall aim of the course “Man, Energy and Resources” is to expose professional primary school teachers to materials which provide them with a wide range of knowledge about some basic concepts and ideas in science. Therefore, it is expected that, as you run through this course you will be exposed to some basic scientific concepts such as energy, its

forms, conversion and conservation. You will also learn about how life originated on earth.

COURSE LEARNING OUTCOMES

To achieve the broad aims set, the course sets its overall learning outcomes. There are specific learning outcomes stated at the beginning of each unit. These learning outcomes are stated in specific terms. You will need to read these learning outcomes before you start working through each of the units. It will be of great assistance to you if you make them your focus as you run through each of the units. This will enable you check your progress. After going through the unit, try and read over the unit learning outcomes. By doing this, you will be sure that you are doing what is expected of you by the unit.

After you must have successfully completed the study of this course, you should be able to:

1) Identify the major theories accounting for the origin of life on Earth.
2) Identify the role of Evolution in explaining how organisms especially Man have acquired their present forms.
3) Explain the contributions of various interest groups towards the history of origin of man.
4) List the special features which place Man ahead of other creatures.
5) Convince a clergy man that evolution is real.
6) Define Energy
7) Enumerate different kinds of energy
8) State the law of conservation of energy
9) Enumerate the various uses to which man has been able to put energy.
10) Explain the interconvertible nature of energy
11) State the Laws of Thermodynamics.
12) List and explain the recourses that are available to man in his natural environment.
13) List and explain the rationale behind the clarion call for conservation of natural resources.
14) List the uses of all the natural resources with which man is endowed

WORKING THROUGH THE COURSE

To complete this course, you are required to read the study units need set books and other materials provided by the National Open University of Nigeria (NOUN).

Each unit contains self-assessment exercises and at some points in the course, you may be required to submit assignments for assessment purpose. The course should take you about 17 weeks to complete. You will find listed all the components of the course, what you have to do, and how you should allocate your time to each unit in order to enable you complete the course successfully on time.

COURSE MATERIALS

Major components of the course are

1. Course guide
2. Study unit
3. References
4. Assignment files

ASSIGNMENT FILE

There are fifteen Tutor marked assignments in this course. The assignments will cover.

1) The history of the origin of life
2) The theories accounting for origin of life
3) The concept of Energy and man.
4) Energy conversion and utilization
5) Man and Resources.

PRESENTATION SCHEDULE

The presentation schedule included in your course materials gives you the important dates for this academic year. You must ensure that you complete your tutor-marked assignments and attend tutorials. Remember that you are required to turn in your assignments as at when due. You should guard against lagging behind in your work.

ASSESSMENT

There are three aspects to the assessment of the course. First are set assessment exercises; second are the tutor-marked assignments and the third is a written examination. You are urged to be sincere in attempting the exercises. You are expected to apply information knowledge and skill that you have acquired during the course.

The assignment must be submitted to your tutor for formal assessment in accordance to the deadlines stated in the presentation schedule and the assessment file. The work you submit to your tutor for assessment will

account for 40% of your total score in the course. At the end of the course, you will need to sit for a final examination which will also account for 60% of your total marks.

STUDY UNITS

The study units in the course are as follows:

Module 1 History of Life and Man

Unit 1 History of Life
Unit 2 The Theory of Evolution
Unit 3 The Nature of Earliest Organisms
Unit 4 Evidences for the Theory of Evolution
Unit 5 Origin of Man

Module 2 Man and Energy

Unit 1 Energy and its Forms
Unit 2 Man's Energy Needs and Sources
Unit 3 Energy and Chemical Systems
Unit 4 Energy Conversion
Unit 5 Conservation of Energy and Energy Utilization

Module 3 Man and Resources

Unit 1 Food Resources
Unit 2 Rubbers and Related Products
Unit 3 Mineral Resources
Unit 4 Vegetation and Water Resources
Unit 5 Conservation of National Resources

TEXTBOOKS AND REFERENCES

COURSE OVERVIEW

The first five chapters discuss the history of the origin of life as well as the theories surrounding the origin of life and how organisms have acquired their present forms. The next five units focus on energy, its forms and the uses to which man has subjected energy. It also explains the indestructible and the indispensable nature of energy. In the last five units, we dealt with a number of natural resources with which man is endowed. We also explained the location and the threats which man's continuous exploitation of these resources could pose unless steps are taken to conserve them for posterity.

TUTOR-MARKED ASSIGNMENT (TMA)

There are fifteen (15) tutor-marked assignments in this course. You are expected to attempt all the assignments, out of which the best five will be selected for you to give you your 40% continuous assessment score. Each assignment accounts for 8% of your total course work.

However, you are advised to read more widely using other reference materials. This will give you a broader knowledge and a better understanding of the course.

Whenever you have completed your assignment, send it together with a TMA (tutor-marked assignment) form to your tutor, make sure your assignment gets to your tutor on or before the deadline given on the presentation schedule and assessment 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. Extension would not be granted after the deadline except on special grounds.

COURSE MARKING SCHEME

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

Table 1: - Course Marking Scheme.

Assignment	**Marks**
Assignments 1-5	Five assignment, 8% each = 40% of the course mark
Final examination	60% of overall course mark.
Total	**100% of course marks**

The study units provide exercises for you to check your progress at appropriate points just as a lecturer will give you an in-class exercise.

All the units in this course follow a common format. The first item is introduction to the subject matter of the unit. Next is a set of learning objectives. These objectives state in concrete terms what you should be able to do by the time you have read through the unit. You should let these objectives guide you in your study. On completing each unit, you should go back to check if you have achieved the stated objectives. If you cultivate this habit, you will significantly increase your chance of passing this course.

The main body of the unit serves as a guide to be able to run through the unit content materials. Self-assessment exercises are spread throughout the units. At the end of each unit, there is a tutor marked assessment.

Working through the assessments will enable you achieve the objective(s) of the unit and get you prepared for the assignments and the examination. You should be conscientious while you go through the exercises and the tutor marked assignments. Make sure you plan your time on how to go through the course unit and ensure strict adherence to the time schedule. In case you might have difficulty with your schedule, try and let your tutor know about it before it gets out of hand.

After completing the last unit, review the course and get yourself prepared for the final examination. Make sure, you have significantly achieved the unit objectives (listed at the beginning of every unit) and the course objectives (listed in the course guide).

COURSE OVERVIEW

The table 2 below brings together the units, the number of weeks you should take to complete them and the assignment that follow them.

Table 2: Course Organizer

Unit	Titles of Work	Weeks of Activity	Assessment (End of unit)
Module 1	**History of Life and Man**		
1	History of Life	1	1
2	The Theory of Evolution	1	1
3	The Nature of Earliest Organisms	1	1
4	Evidences for the Theory of Evolution	1	1
5	Origin of Man	1	1
Module 2	**Man and Energy**		
1	Energy and its Forms	2	1
2	Man's Energy Needs and Sources	2	1
3	Energy and Chemical Systems	2	1
4	Energy Conversion	2	1
5	Conservation of Energy and Energy Utilization	2	1

	Module 3 Man and Resources		
1	Food Resources	1	1
2	Rubbers and Related Products	1	1
3	Mineral Resources	1	1
4	Vegetation and Water Resources	1	1
5	Conservation of Natural Resources	1	1

HOW TO GET THE MOST FROM THIS COURSE?

One major advantage of a distance learning programme is that, the study unit replaces the lecturer. By this, you have the opportunity of working through specially designed materials at your own pace, time and place that suit your interest. It also affords you the opportunity to read through the specially prepared lecture materials instead of listening to a lecturer.

FACILITATORS/TUTOR AND TUTORIALS

Since this is a 2-unit course, you are expected to attend tutorials for maximum period of hours in your study centre.

Your tutor will mark and comment on your assignment and monitor your progress in the course. He would also render useful assistance to you in case you have any difficulty comprehending any aspect of the course. In case of any difficult, do not hesitate to contact your tutor by phone, e-mail, or any other means of communication if you need help.

You should try as much as possible to attend tutorials. This is the only opportunity to have direct contact with your tutor and to answer all questions which may have been agitating your mind. You may also form tutorial group discussions where you can raise questions amongst yourselves. Try and join these discussion groups whenever they are organized. You will definitely learn a lot from participating actively when sincere group discussions are held. We wish you the very best in the course as you run through the content. No doubt, you will find it interesting and useful.

MAIN COURSE

CONTENTS

MODULE 1 HISTORY OF LIFE AND MAN

UNIT 1 HISTORY OF LIFE

Unit Structure

1.1 Introduction

This unit and indeed, the next four units of this course are committed to discussing the many theories concerning the origin of life and the possible ways in which various species of organisms have originated. A brief outline of the main theories concerning the origin of life is presented such that students are aware that there is a range of opinions on the subject.

1.2 Intended Learning Outcomes

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

- explain the divergent opinions about how life came into being
- mention the major theories accounting for the origin of life on earth
- explain what each of the theories in (ii) above proposes.

1.3 Background Information about the Origin of Life

The issue surrounding how life originated has been a point of controversy among different categories of individuals who are interested in the subject. Traditionally, the study of history of life has been fraught with allegations of indoctrination. Indoctrination may be defined as a conscious attempt to inculcate unshakable commitment to a belief or doctrine. Also, Indoctrination involves teaching a person or group to accept a set of beliefs uncritically. Such approaches are not only unscientific but also intellectually dishonest. Much of the evidences on which range of opinions on the subject are based is metaphysical. This implies that it is impossible to repeat the exact events of the origin of life in any demonstrable way. This is true of both scientific and religious accounts. However, Evolution is the only theory concerning the origin of life that appears scientific. This is because it is made up of a collection of scientific hypotheses that are capable of being tested. Subsequently, we shall see some of these theories and evidences as presented by different individual scientists, who have contributed to the subject.

1.4 Theories of the Origin of Life

Theories dealing with the origin of life on the Earth (on which man lives) and indeed the entire universe, are diverse and uncertain. There have been divergent views about the origin of life. The argument had been between the scientists and theologians, Science, contrary to popular belief, cannot contradict the divine origin of life. Nor theological view necessarily dismisses the scientific hypothesis, that during the origin of life, life acquired those characteristics which are explained by the laws of science.

The major theories that have been put forth accounting for the origin of life on Earth include:

i) **Special creation: -** (i.e. life was created by a natural being at a particular time)
ii) **Spontaneous generation: -** (i.e. life originated from non-living matter)
iii) **Steady state theory** (i.e. life has no origin)
iv) ***Consmozoan theory*** (i.e. life moved on to this planet, Earth, from elsewhere.
v) **Biochemical evolution theory** (i.e. life arose according to chemical and physical laws).

Let us now look at each of these theories in much more detail, as given in each of the sections below.

1.4.1 Theory of Special Creation

This theory is supported by most of the world's major religions (especially, Islam and Christianity) and civilization. It attributes the origin of life and indeed man to a supernatural event at a particular time in the past. According to this theory, the creator – God, created man in His own image. In other words, the diversity of forms as seen among and within organisms are not as a result of either convergent or divergent gradual changes from an earlier structure or form; rather they were created spontaneously, just as we find them. For instance, archbishop Usher of Armagh in support of this theory, calculated in 1650 A.D. that God created the world in 4004 B.C, beginning on October 1 and finishing with Man at 9.00 a. m. on October, 23rd. He achieved this figure by adding up the ages of all the people in the biblical genealogies from Adam to Christ. Though the arithmetic is sound, he placed Adam to have lived at a time when Archaeological evidence suggests that there was already a well-established civilization in the Middle East.

The traditional Judaeo – Christian account of creation given in Genesis 1:1-26 has attracted and still continues to attract controversy. Also, as the Holy Bible stated in the Book of Genesis 1:1-2, it talked about God being the One that created the heavens and the earth, the earth as an empty place and the Spirit of God hovering over the waters. As seen in the Holy Qur'an 38:72, it was written that God (Allah) created man and breathed His Spirit into him. The theory of special creation is based on religious concepts. It is scientifically unacceptable as it lacks empirical basis because it cannot be subjected to testing.

SELF-ASSESSMENT EXERCISE 1

Differentiate clearly between the proposition by theory of special creation and scientific thought.

1.4.2 Theory of Spontaneous Generation

This theory was prevalent in ancient Chinese, Babylonian and Egyptian era, as an alternative to the theory of special creation. This theory holds that living organisms can originate from inanimate or nonliving matter. For instance, maggots rose from rotting meat, fleas were created from dust, etc. Greek philosopher, Aristotle (384-322 BC) was one of the first recorded scholars to believe that life arose spontaneously. His hypothesis of spontaneous generation assumed that certain particles of

matter contained 'an active' principle' which could produce living organism under suitable condition. His active principle includes the fertilized egg. English biologist, John Needham, argued in favour of spontaneous generation.

After a series of experimentations, some scientists disproved this theory. Notable among them are Francesco Redi (1668), Lazzaro Spallanzani (1765) and Louis Pasteur (1864). Afterwards, scientists believed that life comes from other living creatures. This serves as the basis of BIOGENESIS, which negates the Theory of Spontaneous Generation. Biogenesis is a key indicator to the Cell theory, part of which states that ALL CELLS COME FROM PREVIOUSLY EXISTING CELLS.

The validation of Biogenesis raised another problem: Where did the first living organism come from? The Steady State theory has an answer for this as would be seen in the next section.

Self-Assessment Exercise 2

a. What were the basic assumptions of the Spontaneous Generation theory?
b. How does Biogenesis negate the Theory of Spontaneous Generation?

1.4.3 Steady State Theory

This theory asserts that, the Earth had no origin, has always been able to support life, has changed a little and that species had no origin. The theory proposes that species, too never originated, the only alternatives are for its numbers to vary or for it to become extinct. The theory does not accept the palaeontological evidence that the presence or absence of a fossil indicates the origin of extinction of species. The palaoeontological evidence presented in support of the steady state theory describes the fossils appearance in ecological terms. For example, the steady state theory believed that, fossilization is only favoured in an increased population or movement of the organism into an area that favoured fossilization.

1.4.4 Cosmozoan Theory

This theory does not offer a mechanism or account for the origin of life but favours the idea that, it could have had an extra-terrestrial origin. The theory states that life could have arisen once or several times in various parts of our Galaxy or the universe. Also known as the Theory of Panspermia, it suggests that life came from an outer space and reached the earth through meteorites and cosmic dust. As proposed by

Arrhenius {1908}, the origin of life consisted of seeds or spores and microbes that existed throughout the universe, and produced various forms of life. Repeated sightings of café drawings, rocket-like objects and specimens provide some evidence for this theory.

1.4.5 Biochemical Evolution Theory

This theory has its root in the belief of astronomers, geologists and biologists that the Earth is about 4.5-5.0 billion years old. Many biologists believe that the original state of the Earth bore little resemblance to its present day form and had the problem appearance. It was hot (about 4000-8000^{0}C) and as it cooled carbon and the less volatile metal and formed the Earth's core; the surface was probably barren and rugged as volcanic activity. Constant earth movements and contraction on cooling folded and fractured the surface. The theory also described the atmosphere as being completely different from what it was in those days in terms of the component gases or elements. The theory proposed that pre-existing substances would have undergone series of chemical changes. This possible sequence of events would have produced a primitive self-replicating heterotrophic organism feeding on organic-rich materials.

1.5 Summary

In this unit a number of theories supporting the origin of life were looked at and discussed. Many of these 'theories' and the way they explain the existing diversity of species cover similar ground but with varying emphases. Scientific theory may be imaginative on one hand and skeptical on the other. Theological views may also fit into this framework depending upon one's religious belief. No matter what, one major area of controversy between scientists and theological views is the history of origin of life.

1.6 References/Further Reading/Web Resources

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1.8 Possible Answers to Self-Assessment Exercises

Self -Assessment Exercise 1

Answers:

- Special creation (a) it attributes the origin of life and man to supernatural event at a particular time in the past. (b) it is asserted that man was created in god's image (c) it involves a natural (spontaneous) creation.
- Scientific thought (a) creation of man is based on scientific belief (b) supernatural existence of man is unrealistic because it can't be subject to testing (c) it believes in the theory of evolution involving some gradual divergent/convergent changes in earlier form/structure.

Self-Assessment Exercise 2

Answers:

A) It holds that living organisms can emanate from non-living things/inanimate things (b) certain particles of matter contained an active principle which could produce living organisms under suitable conditions

B) In biogenesis, it is of a strong belief that life originated from other living organisms. Therefore, this theory is in full contrast to the theory of spontaneous generation which states that life can come from inanimate things.

UNIT 2 THE THEORY OF EVOLUTION

Unit Structure

2.1 Introduction

The term "evolution" has a special place in the study of the history of life. It has become a unifying concept which underlines the whole study of biological science. It refers to an overall gradual development which is both ordered and sequential. On a general note, it implies the development of differential organisms from pre-existing, less differentiated organisms over the course of time. In this unit you will be exposed to two major theories about the origin of life. These are Lamarck's and Darwin's theories of evolution.

2.2 Intended Learning Outcomes

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

- explain the theory of evolution
- discuss evolution theory based on Lamarckian evolution perspective
- discuss evolution from the perspective of Darwin.

2.3 The Theory of Evolution

The concept of evolution did not start with Darwin, when he published his book on the foundations of evolutionary biology - The Origin of Species. Rather, it had been a point of discourse among several philosophers. The historical background of the theory of evolution reveals that the concept of continuity or gradual development of more complex species from preexisting simpler forms had occurred to several philosophers and natural historians before the declaration of

evolutionary hypotheses were put forward in the early 19th century. Let us now examine two of these theories as proposed by Lamarck and Darwin.

2.3.1 Lamarckian Evolution

Jean-Baptiste Lamarck, a French biologist postulated the Theory of Inheritance of Acquired Characteristics. He proposed a hypothesis to account for the mechanism of evolution based on two conditions. These are,

i. The use and disuse of body parts and
ii. The inheritance of acquired characteristics/traits

According to Lamarck, environmental changes may bring about behavioural changes, which may lead to changes in the patterns of behaviour of an organism. This can bring about the Use or disuse of certain body organs or structures. Extensive use would lead to an increase in size and/or efficiency, while disuse will lead to degeneracy and atrophy. These traits that are considered heritable can be transmitted to the next generation.

In order to explain this theory, based on environmental factors, Lamarck said the long neck and legs of the modern giraffe was due to the short necked and legged ancestral giraffes feeding on leaves of tall trees. The long neck and legs were then passed on to subsequent generations. He also explained the webbed toes of aquatic birds as a result of constant use of the toes (legs) for swimming and then, the extended skin in-between the digits to form webs. Similarly, the characteristics were passed on progressively to successive generations. Lamarck's theory provided the basis for the acceptance of the concept of evolution, but his mechanism of change was not widely accepted.

Lamarck's emphasis on the role of the environment in producing phenotypic (physical appearance) changes in individuals, was correct. For instance, let's consider the body building exercise which will have a resultant increase on the size of the muscles. Relating this example to Lamarck's theory, the regular exposure of the muscles to exercise routines will increase their sizes. This shows that regular exercise brings about phenotypic changes. On the other hand, this trait/characteristic of phenotypic change – big muscles, cannot be transmitted to subsequent generations. If it were, then the new born babies of such individual would have unusual large arms at birth.

This concept of inheritance of acquired characteristics was firmly opposed by August Weismann. In an experiment, he cut off the tails of mice and observed five generations of their progeny (offspring). He observed that they all grew normal tails. In this case, we can say that neither mutilation nor constant use of body organs can be transmitted or inherited in later generations. Weismann then postulated that, body acquired characteristics (resulting in phenotypic changes) do not directly affect gametes and cannot be transmitted to the next generation. The basic assumptions from Lamarck's theory are:

1. Body parts which are usually put in use become more efficient and increase in size, while parts which are not used become smaller and degenerate.
2. Acquired characteristics are passed to the next generations.
3. The new needs or desires of an organism produces new structures and changes its behaviour.
4. An individual is the sum total of acquired characters from past generations.

Self-Assessment Exercise 1

1. Define Evolution.
2. State the postulates (assumptions) of Lamarck's theory of evolution.

2.3.2 Darwin and Wallace on the Origin of Species

Guided by the publication of Reverend Thomas Malthus on the principles of population (which highlighted the consequences of reproductive potential of humans), Darwin observed that under intensive competition, of numbers, in a population, any variation that favoured the survival of any individual would increase that individual's ability to reproduce and lead to fertile offspring. Less favourable variation would lead to decreased number of individuals in the population. This provided Darwin the framework to formulate a theory of evolution by "Natural Selection."

Wallace another naturalist like Darwin working almost at the same time wrote on the same subject matter which was sent to Darwin. This led to their joint presentation in 1858. A year later, Darwin published his work on the "Origin of species by means of Natural Selection."

2.3.3 Natural Selection

Darwin and Wallace proposed that natural selection is the mechanism by which new species arise from pre-existing species. This theory of

hypothesis is based on the following observations which may be summarized as follows:

i) Individuals within a population produce averagely more offspring than are needed to replace themselves. This increases the population size.
ii) Variations appear in every generation and they are transmitted to the subsequent generations. Hence, individuals show different degrees of variation from their ancestors.
iii) As the rate of reproduction increases among organisms within the community, the population level increases. Consequently, the amount of resources, e.g. water, food, space, oxygen; may nit cater for all organisms. This leads to competition and a struggle for existence among community member organisms.
iv) In the struggle for existence, individuals who are best adapted to the environment have a higher chance of survival, as compared to the less adapted ones. These are the individual that are naturally selected.

According to Darwin, favourable variations will be inherited by the next generation. Unfavorable variations are selected out ‘or “selected against”, the presence conferring a selective disadvantage on that organism. In this connection, natural selection leads to increased vigour within the species and ensures the survival of that species.

SELF ASSESSMENT EXERCISE 2

What are the basic assumptions underlying Darwin and Wallace’s theory about the origin of species?

2.4 Misconceptions about Darwin’s Theory of Evolution

Many misconceptions have grown around the theory of evolution as outlined by Darwin. These misconceptions may be summarized as follows:

i) Darwin made no attempt to describe how life originated on the Earth. His major concern was on how new species might arise from pre-existing species.
ii) Natural selection is not simply a negative, destructive force but can be a positive means of change in a population. The struggle for existence was characterized by unhealthy terms like ‘survival of the fittest’ and elimination of the unfit” by the philosopher Herbert Spencer and the press of the day.

iii) The misconception that humans (man) evolved from the 'apes' by some linear progression was over sensationalized by the press and offended both the religious and secular communities. The former saw this as an insult on their belief that "man' was created in the "image of God" while the latter were unhappy by the apparent undermining, of the 'superior position' of humans (man) within the animal kingdom.

iv) The apparent contradiction between the Genesis six-day creation account and the progressive origin of species viz-a-viz the Darwin's conclusions in the origin of species. The claims and counterclaims between the theologists and scientists started long ago and still continues till date. The unfortunate controversy has continued as the Genesis versus Evolution debate which professor R. J. Berry summarized as: -

a) Those who are awed by scientific belief that the Bible has been disproved.

b) Those who cling to the inspiration of scripture and their interpretations of it and shut their eyes to the fact that God's work can be studied by scientific methods.

Self-Assessment Exercise 3

1. What are the major deductions of
a) Lamarck's theory of evolution
b) Darwin's theory of evolution?

2. Enumerate three major misconceptions about the theory of evolution by natural selection.

3. Explain briefly, the correlation between an increase in population size to competition of resources among organisms.

2.5 Summary

In this unit, you have been exposed to the concept of Evolution as a special term in the study of the history of life. You have equally been exposed to two major theories in support of evolution. These are the role of environmental changes and theory of Natural selection on origin of species (Man). Lastly, you were treated to the controversy which these theories generated among the religious and secular communities.
You also that Darwin's theory, despite its wide acceptability, was faced with problems especially from the religious world.

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2.7 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answers:

1a) evolution is a biological process which involves the gradual development of organisms from previously existing ones. (b) evolution is an ordered and sequential biological process in which smaller organisms have undergone changes (structural and functional) over time
2) Assumptions of Lamarck's theory of evolution
a) Regularly used body parts become more efficient and increase in size. Body parts which are not used often degenerate (b) the acquired characteristics of an organisms are passed along to the next generation (c) the changes in environmental factors lead to the origin of new needs in an organism. This brings about changes in habits or behaviour (d) an individual is the sum total of acquired characters from previous generations

Self-Assessment Exercise 2

Answers:
1) There is an increase in the population size of organisms within a community
2) There is a transmission of variations from generation to generation
3) There is competition for resources within a population
4) Individual organisms struggle to survive due to limited resources
5) Organisms which adapt best to environmental changes have a higher chance of survival compound to the less adapted ones.

Self-Assessment Exercise 3

Answers:

1a) scientific thought (a) creation of man is based on scientific belief (b) supernatural existence of man is unrealistic because it can't be subject to testing (c) it believes in the theory of evolution involving some gradual divergent/convergent changes in earlier form/structure
1b) There is an increase in the population size of organisms within a community
2) Misconceptions (a) he made no effort to describe the origin of life (b) the assumed fact that man originated from apes offended the religious and secular communities. People took offence that the assumption was an insult to God (the creator) and also undermined the superiority of

man over other animals (c) there was a contradiction between theologists and scientists on the origin of life

3) Within a community of organisms, reproduction (production of young ones/progeny) brings about the increase in population. As the population level increase, the amount of resources that are essential to the survival of organisms reduce. This causes the competition for resources to increase, as each organism fights for survival at all costs.

UNIT 3 THE NATURE OF EARLIEST ORGANISMS

Unit Structure

3.1 Introduction

In the last two units, you were exposed to the theories supporting the origin of life. You were also treated to individuals' proposed theories concerning changes that have occurred in living things (organisms) and how they have acquired their present forms. In this unit we shall discuss about the nature of the earliest organisms and the modern views concerning how life has evolved on the Earth.

3.2 Intended Learning Outcomes

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

- explain the heterotrophic nature of the earliest organisms according to the bio-chemical theory of evolution
- identify the nature of the earliest organisms
- explain the modern views on evolution
- state the evidences of past evolution

3.3 The Nature of the Earliest Organisms

Current evidence suggests that the first organisms as we discussed earlier in unit one, were heterotrophs. As they were the only set of organisms capable of using the external supplies of available energy locked up in complex organic molecules. The chemical reactions involved in synthesizing food substances appear to have been too complex to have arisen within the earlier form of life

As more complex organic molecules arose through biochemical evolution, it is assumed that some of these organisms were able to harness solar radiation as an energy source, using this to synthesize new cellular materials. Absorption of these into preexisting cells without the need for them to abort organic molecules makes them become

autotrophs. The earliest photosynthetic organisms while utilizing solar radiation as their primary source of energy lack the pathway to produce oxygen. Later, it was believed that oxygen-evolving photosynthetic organisms develop, which results in the gradual buildup of oxygen in the atmosphere.

The increase in atmospheric oxygen and its ionization to form the 'ozone layer' will reduce the amount of ultraviolet radiation (from the sun) reaching the surface of the Earth. Decreasing the rate of synthesis of new complex molecules, the decrease in radiation will bring about stability of successful form of life. A study of the present day organisms reveals a great variation in biochemical pathways associated with energy capture and release, which may show the nature of early experiments with living organisms.

In spite of this simple analysis, the problem of the origin(s) of life remains. All the above account is mere speculation and despite tremendous advances in biochemistry, answers to the problem remain hypothetical. This brief account is a collection of present day hypotheses about the origin of life. However, more of the hypotheses have so far gained universal acceptance to become an all- embracing theory..

3.2.1 Modern Theories of Evolution

In unit two, we discussed about how the theory of evolution as proposed by Darwin and Wallace, has been modified by modern evidences from genetics; molecular biology, paleontology, ecology and ethology. This is known as Neo-Darwinism. (*neo* means new). This may be defined as the theory of organic evolution by the natural selection of inherited characteristics. Neo-Darwinism is simply the combination of natural selection and genetics.

Different types of evidences support different aspects of the theory. In order to accept neo-Darwinism evolutionary theory, it is necessary to:

(i) Establish the fact that evolution (changes) has taken place in the past (past evolution)
(ii) Demonstrate a mechanism which results in evolution (natural selection of genes)
(iii) Observe evolution happening today (evolution in action)

Self-Assessment Exercise 1

(a) What do you understand by Neo Darwninsm?
(b) What steps must we take in order to have a clear view of Neo-Darwinism?

3.2.2 Evidences for Past Evolution

(a) There are evidences from many sources in support of past evolution. Such include geology, fossils, and stratigraphy (the study of the order and ages of rock formations).
(b) Evidence for a mechanism
This is found in the experimental and observational data of the natural selection of characteristics that are inherited such as the selection of shell, colour of the hair in man and mechanism of inheritance as shown in the Mendelian genetics (e.g. Mendel's cowpeas)
(c) Evidence for the action of this process occurring today is provided by studies of present populations such as in artificial selection, and genetic engineering as in the cultivation of wheat and the synthesis of genes.

It should be noted that there are no laws guiding evolution, but well-supported hypotheses which join together to form a convincing theory. There is need to guard against accepting any modern view with dogma simply because they are reproducible under laboratory conditions. This impedes intellectual growth and the search for the truth. The fact that the theories as proposed can be reproduced does not indicate that they did take place. The debate these days is not so much about whether evolution takes place, but how it takes place.

Self- Assessment Exercise 2

1 Enumerate the features of the earliest organisms.
2 What are the evidences to support the Neo-Demonism theory of evolution?

3.4 Summary

In this unit, you have been exposed to the fact about the transition from complex non-living matter to simple living organism. However, the account of how these have come into being has remained elusive. While the propositions appear intellectually sound, the fact remains as to whether they did occur or not. Even if the events took place as proposed about how life originated, it remains a matter for further investigation.

You also learnt that efforts should be made not to accept the evidences provided by the modern view of evolution with dogma, as this stand may stifle intellectual growth and prevent further search for the truth about the origin of life.

3.5 References/Further Reading/Web Resource

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3.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer:

A) Neo-darwinison simply means the modification of darwin's theory of evolution

B) To support the neo-darwinison theory of evolution, one should understand that evolution occurred in the past,2) demonstrate the natural selection of genes in, observe evolution in action as it is happening in the present day.

Self-Assessment Exercise 2

Answer:

1) Features of the earliest organisms

a) The earliest organisms were the heterotrophs

b) They used solar energy to synthesize (produce) food

c) Their primary source of energy is solar radiation

d) The earliest forms of autotrophs were unable to produce oxygen
The earliest organisms are different from the present day forms in their biochemical pathways

UNIT 4 EVIDENCES FOR THE THEORY OF EVOLUTION

Unit Structure

4.1 Introduction

In unit 2, it was emphasized that, evolution cannot be overlooked in discussions that bother on how life originated. In this unit, our focus would be on the evidence in support of the theory of evolution.

4.2 Intended Learning Outcomes

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

- list the various evidences that are available to support evolution
- explain the theory of evolution
- discuss with a skeptic that evolution is real.

4.3 Evidence for the Theory of Evolution

A number of evidence abounds to support the theory of Evolution, as the basis for origin of life on Earth. The main ones are listed hereunder.

- Palaeontology
- Geographical location
- Classification
- Plant and animal breeding
- Comparative anatomy
- Adaptive radiation
- Comparative embryology
- Comparative biochemistry

All these evidence are discussed below.

4.3.1 Paleontology

This is the study of fossils. Fossils are any form of preserved remains thought to be derived from a living organism. Fossils are formed when the remains of an organism (plant or animal) gets embedded in the soil or water, for a long period of time. E.g. millions of years. Fossils may appear as an entire organism, hard skeletal structures, moulds and casts petrifications, impressions, imprints and fossilized faecal pellets. Fossils were interpreted either as the remains of earlier creations or as artefacts preserved in the rocks.

Scientists calculate the age of fossils by using radioisotope dating, and categorize them to determine when the organisms lived; relative to each other. The resulting fossil record tells the story of the past and show the evolution of form over hundreds of thousands or millions of years. For instance, there are detailed records showing the evolution of humans and horses. An example is the evolution of the modern horse (*Equus*) from the dawn horse *(Eohippus),* 60 million years ago.

Evidence based on fossil records alone is insufficient to prove that evolution had occurred, but it also shows progressive increase in the complexity of organisms over time. Palaeontology helps to note the similarities and differences between a present day organism and its ancestor in the past. One major criticism of using fossils evidence in support of evolutionary theory is the lack of a continuous fossil records.

This incompleteness of the fossil record may be explained in terms of the following facts:

(i) Dead organisms decompose rapidly
(ii) Dead organisms are eaten by scavengers
(iii) Soft-bodied organisms do not fossilize easily
(iv) Only a small fraction of a living organism will have died in conditions favourable for fossilization.
(v) Only a fraction of fossils has been discovered.

Alternatively, there is the possibility that new species appeared suddenly without an intermediate form along the sequence of evolution. Hence, evolution may not always follow a gradual process.

Self-Assessment Exercise 1

1a. Define the term 'Palaeontology.'
b. State three forms in which fossil records are obtained.
2. What is the main criticism of using fossils as evidence to support evolutionary theory. Support your answer with three facts.

4.3.2 Geographical Distribution (Biogeography)

This is the study of the geographical distribution of living organisms. This evidence was based on the fact that all organisms are adapted to their environment. If the physical and biotic factors within a geographical area favour a particular species inhabiting such an area, then one can assume that the same species of organism would be found in similar habitat (condition). This may not be the case always as organisms including humans (man) are dichotomously distributed round the world. The reasons for this discontinuous distribution are more than those of ecological factors. This accounts for why many related organisms are found widely separated throughout the regions of the world, despite the confinement of organisms to their natural environment.

4.3.3 Classification

Classification of organisms on the basis of similarities and differences among them has implications on the origin of species and evolutionary theory. Organisms in each taxonomic group (taxon) progressively adapt to environmental conditions over time. This may account for their similarities and differences.

For example, one of the earliest features of human civilization was the art of cultivation of plants and domestic animals from ancestral wild stocks. By selecting members of the species with favourable variations, the desired characteristics were perpetuated (sustained). Other species with less favourable variations were seeded out, thereby obeying the theory of natural selection. This selection uses naturally occurring genes variation in addition to imitations which occur from time to time. These have contributed to the presence of a wide variety of species now on earth, including man. For example, the evolutionary trend/order of organisms from the simplest to the most advanced form is as shown below:

a) Phylum Vertebrata: The simplest class is the Fishes, followed by the amphibians, reptiles, birds and finally, mammals.
b) Plant Divisions: The lowest level of division is the Thallophytes, followed by the bryophytes, pteridophytes and the highest level, the spermatophytes.

3.3.4 Comparative Anatomy

Comparative study of the anatomy of groups of animals or plants reveals great similarities in certain structural features. For example, the Pentadactyl (five digits) limb structures of all tetrapods (animals with limbs) from amphibians to mammals (to which man belongs) has the same basic plan. This has been modified in different ways to suit different purposes in each of the species, as seen in the whales, birds, horses, humans. These kind of organs from different species that have a similar basic form or body position and embryonic development are said to be homologous.

Certain homologous structures in some species with no apparent function are termed as Vestigial organs (e.g. appendix in man) which has no connection with human digestion is homologous tp the functional appendix of herbivorous animals. The vertebrate of the human coccyx is thought to be homologous to the tail possessed by our ancestors and embryos. It will be very difficult to explain the occurrence of vestigial organs without reference to some process of evolution.

Note that, Vestigial organs/structures are body parts that have no specific function. They appear to be residual parts from a past ancestor. Usually, vestigial organs are homologous to functioning body parts in other species. Changes in the environment and behavioural patterns of organisms can serve as basis for the existence of these nonfunctioning organs. Examples of vestigial organs include the coccyx or tail bone (well-developed in other mammals), pelvic bone of a snake, human appendix (functions as the caecum in herbivores), wings of flightless birds, etc.

Self-Assessment Exercise 2

1. What are Vestigial organs?
2. Define the term ‘Pentadactyly.’
3. Mention two examples of vestigial organs.

4.3.5 Adaptive Radiation

(a) Homologous structures and divergent evolution

When a group of organisms share a homologous structure which is specialized to perform a variety of different functions, it shows what is known as adaptive radiation. The presence of a structure or physiological process in an ancestral organism which has become greatly modified or more specialized, in apparently related organisms, may be interpreted as indicating a process of descent by modification. This is the basis of evolution theory as discussed in unit 2. The importance of adaptive radiation is that it suggests the existence of divergent evolution based on modification of homologous structures.

(b) Analogous structures and convergent evolution`

Similar structures, philosophical process or modes of life. Organisms apparently bearing no close evolutionary links at showing adaptation to perform the same functions are described as analogous. Examples of analogous structures include eyes of vertebrates and cephalopods molluscs (snails, squids and octopuses) wings of insects and bats, jointed legs of insects and vertebrates, etc. Analogous structures only bear superficial similarities. The existence of analogous structures suggests the occurrence of convergent evolution. This may be explained in terms of the environment, acting through the agency of natural selection, favouring those variations which confer increased survival and reproductive potential on those organisms possessing them. Generally, the process of convergent evolution shows an evolutionary mechanism.

4.3.6 Comparative Embryology

A study of the embryonic development of the vertebrate groups by Von Barer (1792-1867) revealed striking structural similarities occurring in all the groups especially during cleavage, gastrulation and the stages of differentiation. Haeckel (1834-1919), suggested that this had an evolutionary significance. Similarity in embryonic development is a very indication of organisms having originated from a common ancestry. Study of the embryological development of major groups of organisms reveals structural similarities in the embryonic stages which are not apparent in the adult stages. The implication of this is that an evolutionary process exists. Therefore, the embryonic development of different organisms can be aid to be homologous.

For instance, in humans, the embryo passes through a stage in which it has gill slits or structures like that of fishes, at its early stage of

development. Also, at a late stage, the human embryo develops a tail. Conclusively, we can say that all early embryos of land vertebrates pass through the gill slit stage.

4.3.7 Comparative Biochemistry

With the advent of biochemical analysis, more light has been shed on evolution ideas. The occurrence of similar molecules in a complete range of organisms supports the existence of biochemical homology, similar to the anatomical homology discussed in section 3.5. This evidence of evolutionary theory is supportive of other evidence. Most of the researches which have been carried out on comparative biochemistry has involved analysis of the primary structure of widely distributed molecules, such as protein and nuclei acid molecules. Immunological research has also produced evidence of phylogenic links between organisms. One typical example of biochemical homology is provided by the presence of similar or even identical hormone in vertebrates, where they carry out a range of different functions. For example, a hormone similar to the mammalian prolactin occurs in all vertebrate groups where it is produced by the pituitary gland. Other examples of hormones are Insulin, Adrenalin, Epinephrine, Testosterone, etc.

Self-Assessment Exercise 3

1. How can you convince a skeptic that evolution is real?
2. Differentiate with two examples each, between Homologous and Analogous structures.
3. Give an example each, of evolutionary order in plants and animals.
4. How do you relate the adaptation of organisms to Darwin's theory of evolution?

4.4 Summary

In this unit, you have been exposed to a number of evidence in support of the theory of evolution as the basis of the origin of species; man inclusive. From our discussion, it is evident that though evolution appears to be widely accepted amongst scientists as the basis for origin of life; there is still much work to be done in refining the theory and its application to all circumstances. Generally, all scientific accounts, hypotheses and theories of the history of life are tentative and as long as scientists will remain objective in their search for the truth, they will continue to remain so.

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4.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer:

1a) This is the study of preserved remains (fossils) of an organism (plant or animal) which have been embedded in the soil for a long time

1b) 1) moulds 2) imprints 3) hard sleletal structures

2. The criticism facing the use of fossils records as evidence to support evolution is due to the lack of continuous fossil records this is supported with the following facts

1) scavengers feed on dead organisms
2) soft bodied organisms don't easily become fossils
3) dead organisms decompose at a fast rate.

Self-Assessment Exercise 2

Answers:

1) Vestigial organs are residual body parts from past ancestors. Or they are body parts with no function in particular
2) Pentadactyly is the limb structure consisting of five digits in all tetrapods.
3) Examples of vestigial organs include human appendix, tail bone, pelvic bone of snakes, wings of flightless birds.

Self-Assessment Exercise 3

Answer:

2a) homologous structures are organs/structures in organisms which do similar things but are not exactly the same. These structures come from a common ancestor. These structures are homologous because they have a similar underlying anatomy. Examples include the arm of a human the wing of a bird and flipper of a whale or dolphin. Tail bone (coccyx) of a human and the tail of a monkey, mouthparts and antennae of different insects, forelimbs of a lizard, frog and rabbit

2b) Analogous structures are structures or body parts that have a similar function. Examples are

1 wings of a butterfly and bird
2 fins of fish and penguins
3 eyes of human and other mammals

3. Evolutionary order

a) plants (division): thallophyta-bryophyta-pteridophyta-spermatophyta
b) animals (phyla): fish-amphibians-reptiles-birds-mammals

UNIT 5 ORIGIN OF MAN

Unit Structure

5.1 Introduction

The term "man" refers to all human beings of all ra ces, and gender leaning. (both male and female). Man belongs to a group of higher animals called mammals and the order primate. In this unit you will be exposed to the origin of man and the features that make man a special creature above other creatures.

5.2 Intended Learning Outcomes

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

- describe the origin of man
- state the class and order to which man belongs
- distinguish man from other mammals/primates
- explain certain special features of man.

5.3 Human Phylogeny

As stated earlier on in this unit, human being (man) belongs to an order of mammals called Primate. Other primates include tarsiers, lorisers, lemurs, monkeys and apes (gorilla, Chimpanzee). Many of the features of this order are adaptations to life in a forest environment (tree climbers). Within this order primate are three groups of animals called anthropoids. These include the new world monkeys (marmosets and spider monkeys) the old world monkeys (baboons and long-nosed monkeys) and hominoids (apes and humans). Humans and their ancestors are more closely related to apes than other anthropoids. Man belongs to the family hominidae (the fossil forms and modern human). Recent evidence, based on comparative biochemistry has suggested that

gorillas and chimpanzees may have diverged from the human stock about 5 million years ago.

Of particular significance in the evolution of man is the development of an upright posture and increase in brain size. Freedom of the hands from locomotion enabled them to be used for carrying objects and manipulating environmental activities. In addition, the upright posture which gave the hominoids increased height and range of vision have some advantages for the primates. In addition to their ability to stand erect on two legs, they enjoy the advantage of increasing brain size. This enables control and coordination to be exercised as in special abicularities, such as hunting, tool-making and speech.

The course of human evolution is remarkable in that gradual transformations in physical features (skeleton development) were supported by an accelerating development in social behaviour. This process of becoming human is called hominisation which is believed to be influenced by:

i. The development of manipulative skills and speech.
ii. Changes in sexual behaviour allowing pair bonding and increased parental supervision of children.
iii. The establishment of communal organization and social responsibility, arising from the principle of food sharing.

Self-Assessment Exercise 1

What makes the evolution of human beings remarkable?

5.3.1 Characteristics of the Order Primate

Below are the features of the members of primate,

i. Possession of opposable thumbs with grip for power and precision.
ii. Ability to rotate hands (fore limp) through 180^0Eyes close together on face with parallel optical axis. (i.e. eyes are located in the front part of the head).
iii. Possession of increased number of rods/ cone cells.
iv. Possession of reduced snout allowing a flatter face.
v. Possession of an enlarged skull.
vi. Possession of increased sensory/motor areas, deeply fission.
vii. They undergo long gestation period (period of conception) and exhibit a high level of parental care for their young ones.
viii. They embark on corporate activities and group cohesion.

5.3.2 Origin of Man

The issue of the origin of man in line with the origin of life still remains a controversial issue among different groups of people. This is because there are a number of rival propositions and counterclaims on how man actually originated. For instance, the Yoruba in Nigeria believe that God is the original creator of the heavens and earth with all that dwell in them. It is on the basis of this belief that the whole superstructure of the Yoruba belief rests. According to the Yoruba tradition, as documented by Idiom (1962), some creatures that form the nucleus of the human occupation of the earth had been in existence even earlier than the earth. Traditionally, Yoruba also believe in "Olodumare ", "Orisanla " "Orunmila ," e.t.c. Orisa-nla was regarded as the minister in charge of the creation of the earth and later created humans from the clay or dust of the earth. The duty of Orisa-nla was to create a life-less human, while God will breathe in to the creature and thus, complete the creation of human being. The office of the creator gave the Orisa-nla the freedom of creating at will, human figures, perfect or defective, or whatever colour he wants them to be. Thus, the hunch-back, the cripple, the albino, all are special works of his prerogative or more often than not displeasure. Thus, in the Yoruba belief, variation among human beings was due to the pleasure or displeasure of Orisa-nla.

Other people from different parts of the world have their own way of looking at the origin of man. The Memphis in Egypt, the Shilluk of the upper Nile, the people of Rwanda kingdom in Central Africa, from the republic of Benin believe that God (whom they call different names) molded clay into human beings. According to them, the creation took six days. God rested on the seventh day. According to Chinese myth, the first man that was created is referred to as Pangu (other spellings are Pan-Ku, Pan-Gu). He is said to have emerged from an egg. He has two horns, two tusks and a hairy body. He is believed to have used his giant axe to separate the world into Yin (murky earth) and Yang (clear sky). After 18,000 years, Pangu died. His voice became thunder, breath turned to wine, his left eye became the sun, his right eye; the moon, his blood turned into rivers, his head; mountains, his sweat; rain, and the fleas which were on his body became humans.

The theory of the special creation approached the origin of man from the religious points of view. The holy Qur'an and the holy Bible share the same view about the origin of man. The main point of the two religions has to do with spontaneous creation by God, as we see them.

Self-Assessment Exercise 2

Give a brief summary of the traditional view on the origin of man
Compare and contrast Orisanla and Pangu

5.3.3 Controversy surrounding the Theory of Human Evolution

The theory of organic evolution as discussed in the previous units opposes the theory of special creation which was proposed by spontaneous creation. With all the evidences discussed in favour of the theory of organic evolution, the proposition of the special creation may not hold water. For example, if man were created in God's image then, what is the nature of God's image? Is God black, white or mulatto? Is he a cripple man or hunch-back? Is he tall or short? Many questions follow suit. The controversy about the theory of evolution as it relates to the origin of man had been on for a long time. For example, it was Charles Darwin's work on the Origin of Species that sparked off the controversy in the year 1859. The issue had been that of belief versus hypotheses. For example, White (1960), in assessing the reason for religion/science conflict over Darwin's work noted that:

i) Darwin's theory casts serious aspersion upon the creation story in the Book of Genesis.
ii) Its logical consequences threatened the belief that man was made in God's image.
iii) Its acceptance rendered the doctrine of the fall of man unacceptable.

Edward (1979), however observed that while there is no genuine evidence to back the theory of special creation, it is also very difficult to

Disprove it. According to him, acceptance and adherence to an evolutionary theory in preference to a special creation, simply on the plausibility of the interpretation provided by the evolutionary theory rather than definitive disproof of special creation.

5.3.4 Special Features/Uniqueness of Man

Human beings enjoy some of the following advantages over other primates:

(i) Humans alone have developed spoken and written languages which are used to communicate information not just about the

physical world but to formulate abstract concepts of arts, science, philosophy and religion.

(ii) Development of social behaviour to a greater extent than any other species. This was intimately linked with the development of culture categorized by the

a) Establishment of the family
b) Prolonged childhood during which time children could acquire the prevailing culture.
c) Increased use of speech for communication.
d) Development of the concepts of a home base and food sharing.
e) Increased cooperation in food-gathering enterprises
f) Division of labour by age and sex with older males hunting in bands to increase efficiency of hunting and women staying together to 'educate' children and gain protection from danger
g) Stabilization of a broader social structure where the dominance hierarchy was placed by kinship and prohibition incest.
h) Use of simple tools and eventually the manufacture of complex ones.
i) Use of fire for cracking rocks, hardening wood, cooking food, and defence against animals.
j) Development of folk wisdom, art, religion, philosophy, science and technology.

iii) While humans share many aspects of behaviour with other primates and non-primates, they are very unique in terms of art, religion and free-will Humans are known for carving of wood, ivory, painting. Religiously, it is only humans that have religion and free-will to do things accordingly.

5.4 Summary

In this unit, you have been exposed to the history of the origin of man. You have also learnt that man is a mammal of the order primate and family hominidae. Man happens to be the most advanced of all the mammals, in fact of all creatures. This is because of certain special features which they possess that place them above/ahead all other creatures. You also learnt that different people have different feelings about how man originated.

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5.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer:
The evolution of humans is conserved as remarkable for the fact that the transformation is supported by an accelerated social behaviour and a gradual transformation in man's physical features (skeletal structure)

1. Discuss in details, the special features of human that differentiate them from other primates.
2. Enumerate the features of all primates.

Answers:
1a human are differentiated from other primates are
a) Humans have the inmate ability to communicate with each other in form of speech
b) Humans have larger brains in relation to body size, encouraging a complex thought
c) Opposable thumbs enable the use and handling of tools
2
a) Possession of a large skull
b) Presence of social life (group cohesion)
c) Long gestation period
d) They show a high level of parental care
e) Possession of opposable thumbs to grip objects
Location of eyes on the front part of the head

Self-Assessment Exercise 2

Answers:
Comparison: a) both orisa nla and pangu are gods in traditional mythology. b) both are in charge of creations in their respective beliefs
Contrast
a) Orisa nla existed in the Yoruba tradition while pangu was in the chinese mythology
b) Orisa nla was able to create lifeless humans while pangu's created humans can be assumed to have life when created.

MODULE 2 MAN AND ENERGY

UNIT 1 ENERGY AND ITS FORMS

Unit Structure

1.1 Introduction

Matter is something we can at least in principle touch or see. Energy, however is quite different. It is not a material thing. So by its nature, it is abstract. Energy is a concept used so often in everyday language which seems quite familiar. Energy manifests itself in man's day-to-day activities. For instance, a young child jumping up and down has energy. Motion is certainly associated with energy. Energy comes in other forms too. Heat and light are some forms of energy. Energy not only moves society but also other societies. Computers, planes, cars, bicycles and trains all move by energy. In this unit, we shall define energy and explore some forms its takes.

1.2 Intended Learning Outcomes

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

- Define energy
- List different forms of energy
- Define and explain kinetic and potential energy
- Solve simple problems on kinetic energy and potential energy.

1.3 The Concept of Energy

Energy is defined as the ability or capacity to do work. We can also define energy as the potential or capacity to move matter. To a scientist, this definition means that the energy of anything is related to its ability to move an object over some distance. All forms of energy are capable of doing work (that is, of exerting a force over a distance). Energy is divided into potential i.e. energy due to position, and kinetic (energy produced by a moving object). The most obvious form of energy is kinetic energy (or energy of matter in motion). There are other forms of energy, though, where there is no obvious motion, but where there is a potential for motion.

1.3.1 Forms of Energy

As stated earlier on, energy exists in different forms. The two main forms of energy are potential energy and kinetic energy. Energy may also be electric, chemical, radiant, nuclear or other forms.

A battery is essentially a store of energy because it has chemical substances with the potential to move matter. Imagine an electric car which has a battery pack that drives the car. The battery in the pack contains chemical substances that can react to produce electric current, which goes into the electric motor. The electric motor moves the car. A car in motion has energy as a result of that motion. A battery is said to contain 'chemical energy' because the chemical substances in it has the potential to move matter, irrespective of their being used for this purpose or not.

Heat is another form of energy. When heat passes into a substance such as air, bits of matter (air molecules) begin to move faster. The motion is not that of ordinary-size pieces of matter, rather that of extremely small bits of matter or molecules. Heat is the kinetic energy of moving molecules. Light is another form of energy. When a material absorbs light, it becomes hotter. The hotness is due to extremely small bits of matter (molecules of the material) moving faster than they were before the material absorbed the light. Light then has the potential to move matter and is a form of energy. This indicates that all forms of energy are associated with motion.

In summary, energy comes in various forms including chemical, heat and light. It is possible to change one form of energy into another. Different forms of energy have been mentioned. Below are the explanations of different forms of energy:

i) **Radiant energy:** - This comes from the sun (solar energy) and is earth' primary energy source. Solar energy heats the atmosphere and earth's surface; stimulates the growth of regulation through the process of photosynthesis, and influences global climate patterns.

ii) **Thermal energy**: - This is the energy associated with the random motion of atoms and molecules. The more vigorous the motion of the atoms and molecules in a sample of matter, the hotter the sample and the greater is its thermal energy. Generally, thermal energy can be calculated from temperature measurements.

iii) **Chemical energy**: - This is stored within the structural units of chemical substances. Its quaintly is determined by the type and arrangement of atoms in the substance being considered. When substances participate in chemical reactions, chemical energy is released, stored or converted to other forms of energy.

iv) **Energy is also available by virtue of an object's position:** - This form of energy is called Potential energy. For example, by virtue of its altitude, a rock at the top of a hill has more potential energy and will make a bigger splash in the water below than a similar rock located pathway down. Hence, potential energy can also be expressed in terms of the energy possessed by an object in an elevated position. Chemical energy can be regarded as a form of potential energy because it is associated with the relative positions and arrangements of atoms within a substance.

1.3.2 Kinetic Energy, Potential Energy and Energy Units

The energy of an object as you already know, consists of kinetic energy and potential energy. The object's total energy is the sum of these two forms of energy. Thus, objects, total energy = kinetic energy of object + potential energy of object. Over time, the proportion of each kind of energy in the object can vary.

Kinetic Energy

Kinetic energy is particularly easy to describe quantitatively. Let us look at this form of energy first, then we shall examine potential energy. We shall derive the unit of energy from the quantitative expression for kinetic energy. The same unit is used to measure other forms of energy.

An object that is moving has more energy than when it was not moving. Kinetic energy is the energy associated with an object by virtue of its motion. A car moving down the street has kinetic energy as does a molecule moving across a vessel. The quantity of kinetic energy possessed by the car or the molecule depends on its speed. The faster the car or molecule, the more the kinetic energy it possesses.

Kinetic energy also depends on mass. The higher the mass, the more the kinetic energy. The Kinetic energy for a given object is

Kinetic energy (K.E.) = ½ mass x $(velocity)^2$ = ½ mv^2

The unit of mass in this expression is in kilograms, and the velocity is meters per second (ms^{-1}) giving KE unit of kgm^2s^{-2} is called the joule 1 joule = 1 kgm^2s^{-2}

The joule is popular among scientists primarily because it is defined in S.I units which makes calculation easier to do such calculation is illustrated in the next example.

Example 1.1: What is the kinetic energy of an object of an 80kg adult traveling at $10ms^{-1}$?

Solution: 2

K.E = ½ mv
mass(m) = 80kg
velocity(v) = $10ms^{-1}$
=1/2 (80kg) $(10ms^{-1})^2$
=4.0 x10^3 kgm^2s^{-2}
= 4.0 x 10^3J = 4.0 kJ
The answer is expressed in kilojoules: 1kJ = 1 x 10^3 J

Self-Assessment Exercise 1

Calculate the kinetic energy of an 80kg car moving at $20ms^{-1}$?

Potential Energy
Potential energy is the energy an object has due to its position in a gravitational field, or similar environment that affects the object. The potential energy which an object has by virtue of its initial position is converted to kinetic energy as the speed of the object increases while the potential energy decreases.

The S.I. unit for measuring energy (i.e. Joule) was named after the British physicist, James Prescott Joule, who first showed that the different forms of energy are basically the same. Potential energy and all other forms of energy can be measured in the same unit. However, the joule is an extremely small energy unit. For instance, consider a 40-Watt electric bulb, it uses 40J energy every second it is lit. Because there are 3600 seconds in an hour, a bulb that is lit for an hour uses 3600 x

40J or 144,000J (144 KJ) of energy. The potential energy is dependent on the mass of an object. Another factor upon which the potential energy depends is the height or the elevated position where a falling object is located. The equation which relates potential energy of an object to the mass and height of the object falling under gravity is:

Potential energy = mass x acceleration x height due to gravity

PE = mgh. Where, m is mass in kilogram, g is acceleration due to gravity measured in meter per second squared (ms^{-2}) and h is height measured in meter (m). The product gives the unit kgm^2s^{-2} = joule. 'g' is a constant and its value is approximately $10ms^{-2}$.

Example 1.2

Calculate the potential energy possessed by a coconut fruit of mass 100 kg dropping from the top of the parent plant; 10 metres high.

Solution

P. E = mgh.
= 100 kg x 10 ms^{-2} x 10m.
= 10 000 kgm^2 5^{-2}
Since 1000 kgm^2s^{-2} = 1KJ,
P.E = 10KJ.

Self-Assessment Exercise 2

1. Calculate the potential energy possessed by a rock sample of mass 50kg dropping from the top of a cliff 60 metres high.
2. From the top of a tree 500cm high, a fruit drops on the ground. If the potential energy is given as 1250 J, find the mass of the fruit.

Other units of energy are used in many different fields. A calorie (abbreviated cal) is another unit of energy. (but it is not an S.I unit). The calorie is an energy unit presently defined as 4.184 J, but originally defined as the quantity of energy needed to raise the temperature of 1g of water by 1^oC. The new definition is more precise than the older one.

To convert calorie to joules you need to use the relationship 1 cal = 4.184 J. For example, to change 5 cal to joule, we have 5x4.184 J = 20.92 J.

Example 1.4

It requires 2.4 x 10^3 cal of energy to heat 30.0g of water from 20^0c to 100^0c. Express 2.4 x 10^3 cal. in joules (not that 1 cal = 4.184 J). Leave your answer in the nearest whole number.

Solution
Remember that:

1 cal = 4.184J.
2.4 x 10^3 cal convert to Joules

2.4 x 10^3 cal x 4.184J
= 2.4x1000x4.184 J
= 10041.6 J
= 10042 J. (nearest whole number).

Self-Assessment Exercise 3

A sample of aluminum requires 48.6 J to heat it from 25^0c to 48^0c. How would you express the quantity 48.6 Joule in calories?
Engineers sometimes use BTUs (British Thermal Units) to define energy. A BTU is 1/180 the heat required to raise the temperature of 1 pound of water from 0^0C (32^0F) to 100^0C (212^0f). One BTU is equal to 1055.8J. The BTU is often sued to describe the energy requirements of heating and air condition of equipment.

Kilowatt-hour: -is another energy unit. The power holding company PHCN (formerly NEPA) uses this unit to charge consumers for the electrical energy used. The rate at which energy is produced or used is called Power and the S.I. unit of power is the Watt. I watt (W) is defined as I joule per second (Js^{-1}). 1 kilowatt-hour is equivalent to 1000 watt-hours of energy use. This is equal to 3.6 x 10^6J.

Table 1.1 below shows the three other units of energy discussed in this unit apart from the joules.

Summary of Common Energy Units

Unit	**Abbreviation**	**Equivalent in joules**
Caloric	Cal	1 cal = 418J = 4184 KJ
Colorie	Cal	I cal = 4.184 J
British Themal Union	BTU	I BTU = 1055.8 J = 1.0558 KJ

1.4 Summary

In this unit, we have looked at the definition of energy and the various forms of energy. You have also learnt about the basic unit for measuring energy and the relationship between kinetic energy, potential energy, mass, velocity and acceleration due to gravity. Energy is the capacity to do work. You also learnt that kinetic energy is the energy possessed by a body in motion, while potential energy is the energy possessed by a body in virtue of its position.

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1.7 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer

Mass = 80kg
Velocity = $20ms^{-1}$
K.E = $mv^2/2$
K.E = $80kg \times (20ms^{-1})^2/2$
K.E = $40kg \times 20ms^{-1} \times 20ms^{-1}$
K.E = $40kg \times 400ms^2s^{-2}$
K.E = $16000kgm^2s^{-2}$ = 16000J
Since 1000J = IKJ
∴ K.E = 16KJ

Self-Assessment Exercise 2

Answer:

1. mass = 50kg

Height = 60m
G = $10ms^{-2}$
P.E = mgh
P.E = $50kg \times 10ms^{-2} \times 60m$
P.E = $50 \times 10 \times 60 \times kgm^2s^{-2}$
P.E = 30000J
∴ P.E = 30KJ
The potential energy is 30KJ

2. height = 500cm = 5m

Note that: 100cm = 1m
500cm = 500/100 = 5m
P.E = 1250J
G = $10ms^{-2}$
P.E = mgh
M = P.E/gh
M = $1250J/10ms^{-2} \times 5m$
M = $1250J/50m^2s^{-2}$
M = $25J/m^2s^{-2}$
M = 25kg
Mass of the fruit is 25kg.

Self-Assessment Exercise 3

Answers:

Conversion of 48.6J to calories

Note that:

1 Cal=4.184J

∴ 48.6J/4.184=12Cal (nearest whole number)

Tutor-marked assignment

1a-Thermal energy: This is the energy produced when a substance is heated. The effect of the temperature is that the molecules of the substance move randomly in motion.

b- Chemical energy: This is the energy possessed by the chemical units/parts of a substance

c- Potential energy: This energy is possessed by a body at a state of rest.

d- kinetic energy: it is said to be the energy possessed by a moving body or a body in motion.

2a- heat is the kinetic energy transferred between objects. The difference between the temperature of two objects brings about the transfer of heat.

b- heat differs from thermal energy in that; heat is usually transferred from a hotter particle. Thermal energy is present within a body when heated.

Also, for heat energy, it moves or flows as a result of temperature differences while thermal energy doesn't flow.

3- joule, calorie, kilowatt-hour and British Thermal Units (BTU)

UNIT 2 MAN'S ENERGY NEEDS AND SOURCES

Unit Structure

2.1 Introduction

In the previous unit, energy was defined as the capacity to do work. All living organisms including man, may be regarded as working machines which require a continuous supply of energy in order to keep working. Energy may come in various forms such as light, chemical, heat, electrical, mechanical and sound. All these forms of energy as we shall see in this unit, are of great importance to man.

2.2 Intended Learning Outcomes

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

- state why man requires energy
- explain the various sources of energy
- identify the various uses of energy to man
- identify the basic sources of energy on earth.

2.3 Man's Energy Needs and Resources

The ultimate source of energy on earth to man is the sun (in the form of solar energy). The sun is constantly radiating light on the earth surface. A portion of this light energy falls on earth, and some of it is used by plants to convert carbon dioxide and water into various energy storing

compounds, via a process known as Photosynthesis. During this process, green plants (producers) use water and carbon dioxide in the presence of sunlight and chlorophyll to produce glucose and oxygen.

When such plants are eaten, the chemical energy stored in them (glucose) is used by man for his daily activities to produce energy thus reversing the above process of Photosynthesis into Cellular respiration.

$$\text{Carbon dioxide + water + energy} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{glucose + oxygen.}$$

$$\text{Glucose + oxygen} \xrightarrow{\text{enzyme}} \text{Carbon dioxide + water + energy.}$$

The first chemical reaction shows the process of Photosynthesis while the second implies that of Cellular respiration. However, both reactions can be singly represented as From the above, we can see that both reactions are reversible and enzymatic.

The chemical energy stored in the food eaten by man is converted into heat energy after being subjected to series of physiological processes in man's body. The energy is made available in its various forms depending on man's need at any given point in time. Much of the energy available on earth has been collected by plants during photosynthesis. Man and indeed all animals rely on plants for food energy. Ultimately, the plants and the sun provide man with the food energy we need.

Having examined man's basic source of energy, the next question is: Why does man need energy? In the next section of this unit, you will learn about basic reasons for man's quest for energy.

Self-Assessment Exercise 1

1. Briefly discus the importance of the sun as the ultimate source of energy to man.
2. Write balanced equations for the biochemical reaction leading to Photosynthesis and Cellular respiration.
3. State three differences between the processes mentioned above.

2.3.1 Why does Man Need Energy?

Some common examples of the use of energy by man include

- Synthesis of materials for growth and repairs. For instance, protein synthesis.

- Active transport of materials in and out of cells against diffusion gradients, e.g. the sodium-potassium pump.
- Electrical transmission of nerve impulses
- Heat energy released from respiration is used to maintain constant body temperature in man.
- Mechanical contraction and relaxation of muscles.
- However, human civilization consumes more energy.

We use energy to heat our homes, to power our cars, and to drive technology. Commerce, industries, computers are other vital areas where energy has been found very useful.

3.3 Energy on Earth

As stated earlier on in section 3.1, the sun serves as the basic and ultimate source of energy to man. However, the three largest sources of the energy consumed by man are petroleum, coal and natural gas. These are all "fossil fuels'. The fossil fuels were formed million years ago, when aquatic plants and animals were buried and compressed by layers of sediments at the bottom of swamps and seas. Here again we can trace the origin of energy back to plants, and therefore the sun.

Another large source of energy is the hydroelectric power in which electric power generated by river water flows through a turbine. This energy of the river comes from the sun. The sun's warmth evaporates water and this water vapour later condenses as rain, which later flows to the rivers. Thus, evaporation and condensation complement each other.

Nuclear energy, another source of energy on earth does not originate from the sun. Uranium which is the source of nuclear energy has been present on earth since the solar system first formed about five million years ago.

Self-Assessment Exercise 2

Discuss the relationship between the sun and the following sources of energy. (a) Fossil fuels (b) Hydroelectric power (c) Nuclear energy.

23.3 Sources of Energy

There are a number of sources from which man obtains energy to provide heat, light, and power. These sources can be categorized as:

i) Basic or natural source
ii) Other sources/non-renewable sources.

Let us now look at these two sources of man's energy needs in more details.

2.3.4 Basic/Natural/Renewable Source of Energy

Substantial amount of energy is obtained from natural sources such as wood, water, wind and tide. In this section, you will learn about how some of these natural products have provided man with useful means of obtaining energy.

i) **Wood**: - It serves as a major source of energy today in different parts of the world where other fuels are not available, or their prices are unaffordable. For instance, in Brazil, wood still provides a greater percentage of the nation's non-fuel energy. Nigeria, however is not an exception to this, especially nowadays that the prices of kerosene and other fuels are almost out-of-reach of the common man. Wood is commonly used for cooking and other domestic purposes as a means of obtaining energy in both rural and urban areas.

ii) **Water:** - This is a good source of energy, though, attention is being directed at it presently, as it is estimated to provide less than five percent of the world's energy requirements. Among the limitations placed on power generation via water are: the fact that food from river valleys is more valuable than power obtained from damming the valley as a reservoir in arid lands. Water is essential for farming. Examples of farming importance are found in the lower Ogun irrigation scheme at Iseyin and a number of other River Basin Development Authorities scattered all over Nigeria.

iii) **Wind**: - The wind contains tremendous amount of energy, but it is intermittent and diffuse. Wind mills are usually more expensive relative to the energy delivered. Interest in energy from water, wood and wind mill increases as fossil fuel costs rise and storage is improved. It is used in countries like France. This form of energy is yet to be developed in Nigeria.

iv) **Geothermal Energy**: - This flows from the hot interior part of the earth to the surface where it is lost by radiation into space. Studies have been carried out on how this could be tapped as s useful source of energy. This has been used very successfully in some parts of the world to generate energy and power. This form of energy is in use in places such as Netherlands and North America (for guiding grams in pumping water). In the West Indies it is used for grinding sugar cane. Other nations where this form of energy has been successfully utilized include Italy, Iceland,

v) **Tidal Energy**: - There is a great amount of energy in the tides, but the oceans have been a difficult energy source to harness. This energy comes from the energy of rotation of the earth. Even though only a small fraction of the tidal power can be tapped, this source of energy is expected to be put in greater use in the near future.

All these energy sources are classified as recurring energy sources, because they are continuously being created from primary sources.

2.3.5 Other Sources of Energy (Non-renewable)

In the industrialized society, man's sources of energy have been based on the substitution for animal energy of power from heat of combustion of carboniferous fuels. It seems likely that in future, it will be based largely on heat from the sun and heat which is generated by nuclear reactions. You will learn more about these two sources of energy in subsequent units in this course.

Major carboniferous fuels are coal, petroleum and natural gas-all fossil fuels formed in definite amounts many million years ago. Other important fossil fuels are oil shales and tar sands. A minor amount of energy is also produced from vegetation.

i) **Petroleum and Natural Gas**

Petroleum and indeed natural gas occur together in nature and they are obtained from wells drilled by companies that produce and sell the fossil fuels. Petroleum is the same thing as crude oil. Oil and gas provide about 75 percent of the energy used in the world. Their production has increased tremendously in the world after the development of the internal combustion engine in the 20th century. One thing stands out, and this is the fact that, nations would continue to consume more of these fossil fuels for the next few decades after which the supply will dwindle. Unless new sources are located and fully harnessed, peak world

petroleum production will occur in no distance time. Demand will still be rising when production begins its inevitable decline.

One major problem of the developed world is that, much of the petroleum and gas reserves are located in the developing countries, whose own energy requirement will be growing year-in-year-out. Another problem is that; it constitutes a serious pollutant of the environment. While shipping petroleum overseas, spills are recorded.

Petroleum is found in different locations of the world e.g. Saudi Arabia, Nigeria, Russia, and so on. In Nigeria, about 80% of the energy is derived from petroleum and petroleum products. It also accounts for more than 90% of our source of national income. In fact, it forms the bedrock of Nigeria's economy.

ii) Coal

Large quantity of coal is present in different parts of the world as a great source of energy. Coal has been found very useful especially for moving locomotive engines, providing source of heat energy. One problem with the use of coal is that coal constitutes pollution because coal bumping produces oxides of sulphur and solid waste particles, and the mines themselves empty wastes into the atmosphere.

iii) Oil Shale

Oil Shale and Sand Tar: - They provide other useful sources from which man obtain energy. These materials are found in some areas, such as Ondo in Nigeria. Some deposits of oil shale and sand tar are also found in Albertia, Canada. If properly harnessed, they would constitute about 2-4 percent of man's energy supply. The oil shale deposits are usually rich in bitumen materials called kerosene.

2.3.6 National Energy Policy

From our discussion of this unit, it is clear that life of man on earth depends very much on the availability of energy. No nation can develop without an abundant supply and judiciously managed energy sources. The conventional sources of energy such as wood, coal, petrol or natural water falls used for hydroelectric power are fast becoming inadequate. The erratic nature and "power shedding" system of e lectric power supply in Nigeria are indices to confirm that our energy demand is greater than the supply.

At present, the US, most European countries, Japan and a few developing nations generate substantial amounts of their electrical

supplies from nuclear fuels. This should be the dream of any nation, for her desire to attain, social, economic and technological advancement. More so, "he who has energy has power."

It is in this connection that, it is of utmost importance for a nation to have a clear-cut policy on adequate energy supply, production and management. For example, the forests are being depleted at a fast rate because it appears that is the only source of energy that the ordinary man can afford, and has access to. Industries produce at high cost because they have to procure their own power generating plants due to the erratic nature of power supply in the country which in most cases are not always available.

The housewife is finding it extremely difficult meeting her domestic needs because of lack of energy sources such as cooking gas, kerosene to cook at home. All of these problems, in addition to the daily increase of petrol price are due largely to lack of standing energy policy to regulate and make affordable the various sources of energy that nature has provided us in Nigeria. Nigerians as a whole should start thinking about how nuclear reactions could be harnessed as a way of complementing that which is obtained from natural sources such as fossil and fuels. But certainly not much can be realized until a well-defined energy policy has been well articulated and put in place.

Self-Assessment Exercise 3

1. What is Fossil fuel? Mention three examples.
2. Name three kinds of non-fuel sources of energy.
3. Comment briefly on the need for a clear-cut national energy policy in Nigeria

2.4 Summary

Man cannot survive without constant provision and supply of energy either through the natural and recurring sources, or taking the advantage provided by the energy from fossil fuels. All these and other sources of energy desire proper management through a clear-cut energy policy, and follow-up implementation of such energy policy. You learnt that man's energy sources can be grouped into two: the natural and recurring sources and the fossil fuels; which are finite and non-renewable.

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2.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer:

1) The sun is the only source of energy which radiates heat onto the earth. It provides solar energy which is converted by green plants into chemical energy during the manufacture of food. It is this synthesized food that provides energy for living organisms (animals in particular.) this energy is used by man to carry out all life activities
2) Photosynthesis: carbon di oxide + water + energy $\frac{sunlight}{chlorophyll}$= glucose + oxygen 2b) cellular respiration: Glucose + oxygen$\underline{^{enzyme}}$ carbon di oxide + water + energy

Photosynthesis	Cellular respiration
a it uses carbon di oxide and water	It produces carbon di oxide and water
It uses energy from the environment	It releases energy into the environment
It requires sunlight	No need of sunlight

Self-Assessment Exercise 2

Answer:

a) Fossil fuels: The heat provide by the sun helps in the decay process of fossils buried remains of dead plants and organisms.
b) Hydroelectric power: Solar rays emanating from the sun provides energy which makes the water evaporate as water vapour and later, condenses as rain.
c) Nuclear energy: The sun's energy formation by radioactive elements, e.g. Hydrogen.

Self-Assessment Exercise 3

Answer:

1a- Fossil fuels are dead and decayed remains of plants and animals.
1b- Examples are oil, coal, natural gas.
2- sun, water, wind
3 uses of energy

- Electrical transmission of nervous Impulses
- Production of substances for growth
- Mechanical contraction and relaxation of muscles.

UNIT 3 ENERGY AND CHEMICAL SYSTEMS

Unit Structure

3.1 Introduction

The energy changes that take place during chemical reactions are of much practical interest. For instance, the combustion reactions involving fuels such as natural gas and diesel oil are carried out in daily life especially for the thermal energy they release. Almost all these chemical reactions absorb or produce (release) energy in the form of heat. Basically, heat refers to the transfer of thermal energy between two bodies at different temperatures. The aspect of chemical science that studies the process of change in chemical reactions is called Thermo chemistry. In this unit, you will learn about how heat is converted to other forms of energy especially as it relates to chemical systems. You will also learn about those laws that are related to energy.

3.2 Intended Learning Outcomes

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

- Define the term ‘Heat’
- Differentiate between heat and thermal energy
- Mention three kinds of chemical systems
- State and explain the first law of thermodynamics
- State and explain the second law of thermodynamics
- Define the concept ‘free energy’
- Explain the importance of entropy in chemical systems.

3.3 Types of Chemical System

In order for us to analyze energy changes associated with chemical reactions, there is need to first define "the system" or specific part of the universe that is of interest to us. For chemists, systems usually include substances involved in chemical and physical changes. For instance, in a neutralization reaction involving dilute hydrochloric acid and sodium hydroxide solution in a beaker, the system may be the beaker containing the compounds while the rest of the universe outside the system constitute the surroundings.

Basically, there are three types of systems. These include an open system, a closed system and an isolated system. An open system can exchange mass and energy (usually in the form of heat) with its surroundings e.g. water in an open container. A closed system allows for transfer of energy but not mass. Thus, if the container above is closed such that no water vapour can escape, a closed system is created. If the container is put in a totally insulated condition, an isolated system is created. This does not allow ether mass or energy transfer.

SELF ASSESSMENT EXERCISE 1

1. What do you mean by the term "Heat?"
2. Define (i) a closed (ii) an open and (iii) an isolated system.

Evolution and absorption of Heat Energy during chemical reactions

Energy changes during a process can be explained in terms of absorption or release of energy. Since energy cannot be created or destroyed, any energy lost by a system must be gained by the surroundings. Thus, the heat generated by the combustion of say, acetylene, to produce heat energy is transferred from the system to its surroundings Any process that transfers thermal energy to the surroundings (i.e. gives off heat) is called an exothermic reaction.

In other systems such as the decomposition of mercury (II) oxide at high temperatures, it requires supply of energy for the reaction to take place. This is an example of endothermic reaction process, in which heat has to be supplied to the system by the surrounding.

In an exothermic reaction, the energy of the product is less than that of the reactants. This is due to the energy that is given off from the system to the surrounding. (that is the difference). In the same vein, the energy

of the product is higher than that of the reactants in an endothermic system. The difference is due to the energy supplied to the system from the surroundings.

Energy associated with breaking or forming of a bond

Energy changes in chemical reactions are due to the forming and breaking of bonds. The strength of a bond is determined by the amount of energy required to separate the atoms or ions held by the bond. This energy requirement is known as BOND ENERGY. It is defined as "the average amount of energy required in making or breaking a mole of a particular bond in its gaseous state.

Self-Assessment Exercise 2

1. Define the following terms
    a. Bond energy
    b. Exothermic reaction
    c. Endothermic reaction.
2. What constitutes the source of initial and final energy in each of the processes in 1 (b) and (c) above?

3.3.1 Introduction to Thermodynamics

Thermodynamics is an aspect (of chemistry) that deals with the study of interconversion of heat and other kinds of energy. It expresses the relationships between heat and other forms of energy. In thermodynamics, we study changes in the state of a system; which is defined by the values of all relevant macroscopic properties e.g. composition, energy, temperature, pressure and volume. Energy, pressure, volume and temperature are said to be stated functions. (- properties that are determined by the state of the system, regardless of how that condition was achieved). In thermodynamics, other forms of energy are referred to as work and are represented by, w, while heat is represented by symbol, q. The relationships between heat and work is expressed in the laws of thermodynamics. In the next section, we shall look at this relationship in the first and second laws of thermodynamics.

3.3.2 The First Law of Thermodynamics

The First Law of Thermodynamics: - is based on the law of conservation of energy. It states that energy can be converted from one form to another but cannot be created or destroyed. The validity of the first law of thermodynamics can be determined by considering the change in

3.4 The Second Law of Thermodynamics

Most exothermic processes occur spontaneously, such processes result in a decrease in the overall enthalpy or (heat) of the system. Some endothermic processes also take place spontaneously. Enthalpy (Heat content) alone is not the only factor which determines whether or not a reaction would occur spontaneously. Other conditions are.

Internal energy of a system between its initial and final states. This is given by.

$\Delta E = E_f - E_i$

Where E_f and E_i are the internal energies of the system in the final and initial states respectively. When the conditions of the system change, the internal energy of the system also changes. The relationship between the internal energy of a system and work is given by.

$\Delta E = q + w$

This equation simple means that, the change in the internal energy, ΔE of a system is the sum of the heat exchange q, between the system in the surroundings, and the work done, W, on (or by) the system.

By convention, q is positive for an endothermic process and negative for exothermic process. The sign convention for work done on the system by the surroundings, w is positive. For work done by the system on the surroundings, w is negative.

If a system loses heat to the surroundings or does work on the surroundings, the internal energy decreases since both are energy-depleting processes. Conversely, if heat is added to the system, or if work is done on the system, the internal energy of the system, would increase.

Self-Assessment Exercise 3

1. Write down an expression for the relationship between change in the internal energy of a system, heat and work.
2. Comment briefly on the relationships between work and internal energy of a system. processes in 1 (b) and (c) above?

of the system undergoing a change. Let us now examine these two concepts in more details in order to bring out their meanings. For the purpose of this course, a very simple treatment of the concepts would be embarked upon for the purpose of clarity and understanding.

Entropy
This is a property of a substance measured in JK^{-1} and mol^{-1}. In the simplest sense, entropy means a measure of the degree of disorderliness or randomness of a substance. Solid crystals with orderly array of molecules have low entropy, a liquid has a higher entropy while gases moving in random motion have very large entropy.

Generally, for any given substance, as temperature increases, the degree of disorder or entropy increases. The influence of entropy on a process is given by the second law of thermodynamics, which states that. "a spontaneous process occurs only if there is an increase in the entropy of a system and its surroundings." For a reversible process the entropy change, symbol ΔS at constant temperature is given by

$$\Delta S = \frac{\Delta H}{T}$$

Where, Δ H is the heat evolved or absorbed, and T is the temperature (absolute) at which the process occurs. If heat is absorbed ΔS is positive and there is an increase in entropy. If heat is evolved or released, ΔS is negative and there is a decrease in entropy.

3.3.4 Concept of Free Energy

The free energy of a chemical system, denoted by, G is the energy which is available for doing work. This is the force that brings about a chemical change. In order to determine the free energy of a chemical system, the following expression is used.

$$\Delta G = \Delta H - T\Delta S$$

The (TΔ S) is the free energy change, ΔG. For a chemical change to occur spontaneously, ΔS must be positive as the total entropy must increase and ΔG must be negative.

Self-Assessment Exercise 4

1. Define the following terms.
   Systems, surroundings, open system, closed system, isolated System, thermal energy, chemical energy, law of conservation of energy.

2a) On what law is the first law of thermodynamics based? Explain the sign conventions in the equation, $E = q + w$

b) State the second law of thermodynamics.

3.4 Summary

Any chemical process in nature involves energy changes in terms of absorption or release of energy. Hence, all chemical processes are associated with interconversion of energy from heat to other forms of energy. The relationships between heat energy and other forms of energy are studied in thermodynamics. All these were briefly treated in this unit considering the scope of the course under consideration. You learnt that chemical changes in nature involve energy changes and energy changes are in the form of heat. Chemical changes usually take place in chemical systems and there are three main types of chemical systems which are open, closed and isolated systems.

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3.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer:

1- Heat is the energy form that flows between objects due to difference in temperature

2a- closed system: it allows the transfer of energy but not mass

2b- open system: it involves the transfer or exchange of energy and mass

2c- isolated system: this is the system in which energy and mass are not transferred. This is because the system is in isolation

Self-Assessment Exercise 2

Answer:

1a- bond energy: it is the amount of energy that is needed to make or break a mole of a bond in its gaseous state/form

1b- exothermic reaction: In this reaction, energy is given off or dispensed from the system to the surrounding. Hence, the energy of the product is lower than the energy of the reactants.

c- Endothermic reaction: Here, energy is absorbed into the system from the surrounding. The energy of the products is higher than that of the reactants.

Self-Assessment Exercise 3

Answer:

1- $\Delta E = Q + W$

Where ΔE is change in internal energy

Where Q is heat

Where W is work done

2- If a system does work (loses heat) to the surrounding, the internal energy reduces. If the system gains energy or has work done on it, the internal energy of the system will increase.

i) the entropy

ii) the free energy.

Self-Assessment Exercise 4

Answer:

1a- system refers to the substance that is involved in physical or chemical changes(s). it could also be a container/vessel in which reacting chemicals are contained
1b- surrounding is the area outside a system
1c- open system
1d- closed system
1e- isolated system
1f thermal energy
1g- chemical energy
1h- law of conservation of energy.

UNIT 4 ENERGY CONVERSION

Unit Structure

4.1 Introduction

Although energy can assume many different forms that are interconvertible, scientists have concluded that energy can neither be destroyed nor created. When one form of energy disappears, some other forms of energy (of equal magnitude) must appear and vice versa. In this unit you would learn about interconvertibility of energy from one form to another.

4.2 Intended Learning Outcomes

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

- explain the principle of interconvertibility of energy
- give examples of ways by which energy is converted from one form to another
- relate the interconvertible nature of energy to man's day-to-day activities.

4.3 Energy Conversion

Energy conversion involves the process of changing energy from one form to another. There are many conversion processes that appear as routine phenomena in nature, such as evaporation of water by solar energy. In the world of technology, the term is more generally

applied to man-made operations in which energy is made more usable. For instance, burning of coal in power plants to convert chemical energy into electricity, burning of gasoline in automobile engines to convert chemical energy into propulsive energy of a moving vehicle, or a propellant for rockets and plasma jets.

Objective(s) of Energy Conversion

The predominant objective of energy conversion system is to take raw energy from sources such as fossil fuels, nuclear fuels, solar energy, wind, waves, tides and terrestrial heat, and convert it into electric and/or more usable forms of energy for the benefit of mankind.

4.3.1 Conditions and Limits for Energy Conversion

There are well-established principles in science which define the conditions and limits under which energy conversion can be brought about. Such conditions include, the law of conservation of energy, the second law of thermodynamics, discussed in the preceding chapter of this course, the Bernoulli principle and the Gibb's free-energy relation. Recognizable forms of energy which allow varying degrees of conversion include chemical, atomic, electrical, mechanical, light, potential, kinetic and heat energy. In some conversion operations, the transformation of energy from one form to another and more desirable form may approach 100 percent efficiency, whereas with others, even a 'perfect' device or system may have theoretical limiting efficiency far below 100 percent.

Self-Assessment Exercise 1

1. What do you mean by energy conversion?
2. Outline the main objectives of energy conversion.

4.3.2 Energy Conversion and Efficiency

As stated earlier, it is possible to convert one form of energy into another useful form of energy. For instance, the conventional electric generator, where solid metallic inductors are rotated in a magnetic field, usually converts 95-99 per cent of mechanical energy input to the rotor shaft into electric energy at the generator terminals. On the other hand, an automobile engine might operate at its best point with only 20 per cent efficiency, and even if it could be made perfect, it might not exceed 60 per cent for the ideal thermal cycle.

4.3.3 Example of Energy Conversion Processes

i) **This section of our discussion is concerned with giving example of some processes involving energy conversion**

For instance, let us examine the method involved in producing electric energy in steam power plants. In this case, there are many energy-conversion steps between the raw energy of fuel and the electricity delivered from the plant. For example, chemical energy of fuel to heat energy of steam jets, jet energy to kinetic energy of rotor, and mechanical energy of rotor at generator terminals. This is a typical, elaborate and burdensome series of conversion processes. Many efforts have been made over the years to eliminate some or many of these steps for such objectives as improved efficiency, reduced weight, less bulk, lower maintenance, greater reliability, longer life and lower costs. The main emphasis here is on reducing weight, space and atmospheric contamination on improving efficiency and lowering costs.

4.3.4 Improving Efficiency of the Steam Power Plant

The scientific steps which are recognized within the specification, are electromagnetism, electrochemistry, (fuel cells) Thermoelectricity, thernionics, megnetohydrodynamics, photoelectricity, magnetostriction, femoelectricity, atmospheric electricity, terrestrial currents and contact potential. Nowadays, the electromagnetism principle dominates the field. Electric batteries are an accepted form of electro chemical device of small capacity. For instance, a car battery can cover a distance of 1 km. Further efforts and funds are being given to some fields with attractive prospects of practical adaptation.

ii) Conversion of chemical energy to mechanical energy in an automobile

The combustion engine in automobiles gives a typical example of the process of converting chemical energy to mechanical energy. The energy expended in running the automobile is derived from the large amount of heat energy produced by the combustion of petrol or diesel oil in the engine. The chemical energy contained in the fuel is converted to heat energy when the fuel bums in the combustion engine. The heat energy is in turn converted to mechanical energy which is used to turn the wheel. The heat energy is also converted to electrical energy to operate the various gadgets (radio, radio cassette, air conditioners, etc.) in the automobile. It is also converted into light energy in the lamps, and sound energy from the horns or radio.

iii) Energy conversion in thermal-electricity plants

Many nations are not blessed with water falls through which they can generate electricity via hydroelectricity. Even in countries where they exist, the supply cannot meet the demand of the teeming population. Fuel may be used to generate heat energy which is converted to mechanical energy used in turning the coil, which eventually produces electricity (electrical energy). This is often called thermal electricity. Example of which we have at Egbin power station near Lagos. Here natural gas is produced and sent to the power station directly from the oil field.

iv) Energy conversion through solar energy

The nuclear processes of the sun produce a large quantity of energy which is transmitted in the form of light and heat waves; through space. The energy is known as radiant or solar energy. This energy had been used to prepare solar cells, a device which converts solar energy to electrical energy. A number of such cells can be combined to form solar batteries to generate a large amount of electrical energy for industrial and domestic needs.

Self-Assessment Exercise 2

A device which converts solar energy to electrical energy is called
A, Solar radiation B, Solar Cell C, Solar Energy D, Solar Light

v) Energy Conversion using Electric Iron

The use of electric pressing iron at home involves a series of energy conversion processes. For instance, the pressing iron while not in use possesses a potential energy which is converted to electrical energy when the pressing iron is connected to the electrical mains. The electrical current flowing through the cord gets the coil in the pressing iron heated up, hence the electrical energy is converted to heat energy. The heat energy is what is needed by the dry-cleaner to stretch the squeezed dress or to get it smoothened. The process of ironing the dress involves moving the iron to - and - fro on the dress (kinetic) and the process of handling the pressing iron by the user is mechanical. Hence, the initial potential energy in the iron has been subjected to a series of energy conversion procedure. However, when the pressing iron is disconnected from the electrical mains, the iron returns back to its original potential energy state.

4.3.5 Energy and Life

All forms of energy used in biological processes on the earth come from the thermonuclear reactions which take place in the sun (see 9.5 (iv). A fraction of the radiant energy which falls on the earth's surface is absorbed by green plants, green algae as well as photosynthetic bacteria. The energy is trapped by the chlorophyll in a complex series of bio-chemical reactions leading to the formation of glucose, releasing oxygen as a by-product. The glucose formed is converted to starch and cellulose and stored in the body of plants. Other forms in which locked-up energy is stored include proteins, fats and carbohydrates.

The potential energy stored in these food materials must be converted into useful forms which are employed to affect the energy processes of man. First, the large molecules in these food items are broken down (catabolysed) into the unit components i.e. amino acids, fatty acids and simple sugars. When they undergo series of chemical changes, energy in stepwise manner which is somewhat complex in nature, the energy in these food materials are made available as ATP (Adenosine triphosphate), which is the final chemical compound in which most cellular energy is packaged before use. The energy is usually made available as heat energy. It is measured in calories or joules (see unit 6), which may be converted into other forms to perform useful work. Basically, man's body cells require energy to carry out activities, as well as for growth and development.

4.3.6 Energy Storage

Most energy systems desire a provision for storage to be able to meet power demands or emergencies, or to drive systems that operate entirely on stored energy. Most machines have provisions for storing either potential or kinetic energy. Elevated reservoir stores energy, capacitors in the circuits store small amounts of electricity, batteries store large amount of energy and for long periods. Thermal energy can be stored as chemical energy by combustion with natural oxygen in the atmosphere or with liquid oxygen. The performance of many products is limited by their energy storage capacity.

4.4 Summary

Large amount of energy is at man's disposal. This energy exists in their various forms and can be converted from one form to another. The conversion of energy is noted in man's desire to optimally utilize the abundantly available energy to be able to survive in his environment. For instance, useful mechanical energy can be produced by fuel-burning heat engines. All man's activities domestically and industrially involve

series of energy conversion processes. Certain conditions or factors inhibit the attainment of 100 per cent efficiency in energy conversion.
The functioning of some appliances, e.g. electric pressing iron, involves a series of energy conversion (ranging from potential to electrical to heat to mechanical/kinetic and back to potential). Other examples given in this unit include energy conversion in automobile engines (chemical-heat-mechanical) etc.

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4.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 2

Energy conversion involves the process of changing energy from one form to another.

The predominant objective of energy conversion system is to take raw energy from sources such as fossil fuels, nuclear fuels, solar energy, wind, waves, tides and terrestrial heat, and convert it into electric and/or more usable forms of energy for the benefit of mankind

Self-Assessment Exercise 2

B, Solar Cell

UNIT 5 CONSERVATION OF ENERGY AND ENERGY UTILIZATION

Unit Structure

5.1 Introduction

In line with our discussion in unit 9 of this course, man has learnt to convert the various sources and forms of energy at his disposal into his own uses. At the beginning, man has the knowledge of only one basic source-the food, needed for him to survive. He then learned to make weapons and tools to aid him in his search for game and other food materials. From the hides of animals, he fashioned clothing that enabled him conserve energy in the form of heat. In the same way, he learnt how to use fire for rapid combustion, for his domestic cooking. In this unit, you will learn about how man in his day to day interaction with his environment, has been able to utilize the various forms of energy available to him.

5.2 Intended Learning Outcomes

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

- state the law of conservation of energy
- explain how conservation of energy principle forms the basis of energy utilization
- define the uses of some forms of energy such as solar energy, waves, sound and optics, etc.
- explain nuclear energy
- state the uses of nuclear energy.

5.3 Conservation of Energy Principle

Law of Conservation of Energy states that: the tot al energy of a system is unchanged in any series of processes; energy is rather converted from one form to another. The law explains the indestructible nature of energy and emphasizes the inter convertible nature of energy from one form to another.

For example, when a body is at a height h, it has a P. E. (mgh). If it falls to the ground, it has a K. E. of just before landing will be exactly equal to the P. E. at the top. This implies that energy can be converted from one form to another and $\frac{1}{2}mv^2$ that during the conversion, the total amount of the energy remains constant. This is true for all forms of energy and it is referred to as "conservation of energy principle. This principle forms the basis of energy utilization. Having established the basis for energy utilization, we can now explore the extent to which man has been able to harness different forms of energy at his disposal for his own benefits.

Self-Assessment Exercise 1

State and explain the Law of Conservation of Energy, making reference to a specific example.

5.3.1 Hydroelectric Power Generation

This is one particular invention through which man has harnessed the cost-free potential energy of water falling from a hill or mountain to generate electricity. The falling water is detected through pipes and its energy now in kinetic form is used to turn turbines. The turbines on rotation in a magnetic field convert mechanical energy into electrical energy. The Kainji power station in Nigeria provides a typical example of a hydro- electric power station. Other power stations in Nigeria source their energy inputs from other forms of energy, usually heat.

5.3.2 Heat Energy

As stated in unit 2 of this module, heat is a form of energy and it flows between two points whenever there is a temperature difference between a region of high temperature and a region of low temperature. As of a body which determines the direction of heat flow between it and another body with which it makes a thermal contact.

When heat flows to a body, the kinetic energy of its molecules increases and consequently its temperature rises. The only exception to this is at the point of transition. In the next section we shall discuss more on the importance of heat energy as far as man is concerned.

5.3.3 The Refrigeration

The refrigeration is a modern fashion of the clay pot. It contains a volatile liquid, usually ammonia which is allowed to vaporize in the freezer compartment, therefore extracting heat of vaporization from the freezer. The main function of the refrigeration is to extract heat from the freezer and send it to the surrounding. The freezer compartment gets colder and the surrounding gets warmer. Man has found the refrigerator very useful in the storage and conservation of vegetate food items. Hence, this process releases heat into the environment.

5.3.4 Demand for Heat Energy by Man

Right from the beginning man has made endless and frantic efforts in search for richer and cheaper means of obtaining heat energy which can be readily converted to other forms of energy. From the stone age till date, heat energy and generation has remained the starting point of most energy conversion processes. Hence the search for fuel like petrol, wood, coal, and of recent nuclear materials has been on the increase. Below are some examples of how man has put heat energy in use.

i. Automobile

The energy used in running the automobile is obtained from the large amount of heat produced during the combustion of petrol or diesel oil in the automobile engine. 70% and above of the heat, depending on the efficiency of the engine which is converted to mechanical energy to turn the wheels, electrical energy to operate the various gadgets and devices in the automobile, light energy in the lamps and sound energy from the horns of radio.

ii. **Thermal electricity plants**

As a result of the growing need for electricity supplies, energy generated through hydroelectric turbines can no longer cater for the need of the teeming population in nations where such facilities exist; like Nigeria. As a result, other means of supplementing the power generated through hydroelectric turbines have to be worked out. As stated earlier on, when a coil rotates in a magnetic field, electricity is generated. The problem of generation is usually how to obtain the initial mechanical energy to turn the coil. If this energy is obtained from the heat produced by burning a fuel, the electricity generated thereof is

called thermal electricity. The giant Egbin power station, near Lagos uses fuel, natural gas, piped all the way from the oil field. As we shall see later in this unit, nuclear energy is also a source of large supply of electricity most crucial to the economy of any nation. Thus, the fuels (i.e. petrol and nuclear) are of immense importance in energy utilization by man as they often determine the trend in national and international politics.

5.3.5 Solar Energy

A large quantity of energy is generated through nuclear processes in the sun. This is transmitted in the form of light, and heat waves through space in all directions. The amount that gets to the earth's surface warms and keeps life going on earth. The energy is known as Solar energy and its value known as solar constant; is about 1,400 J/s. Man for quite some time have been tapping this energy for many purposes. The latest is the invention of solar cell. The solar cell is a device that converts solar energy to electrical energy. A number of cell units can be combined to form solar battery, producing a large amount of electrical energy which is used in homes and industries.

5.3.6 Waves, Sound and Optics

A wave is a propagation of energy through a medium of space without the particles of the medium being displaced. The ripples generated when a pool of water is disturbed at a point and which then spread to another part is a form of wave. The wave could be mechanical or electrical and magnetic.

In an electromagnetic wave, it is the electric and magnetic field that oscillate. No material medium is required. Sound is a mechanical wave and hence it requires a medium to propagate. The range of frequency of a sound which can stimulate the human organ of hearing is called the audible range and it has between 20Hz and 20,000Hz (Hz means hertz). Below this range is called the infrasonic wave such as that produced in an earth quake. Above the audible range is the ultrasonic such as that produced by certain crystals in the ultrasound machine.

Ultrasound machine has found a number of fields of application in machine, especially in the area of surgery, therapy and diagnosis.

5.3.7 Electricity and Magnetism

When a charge is in motion, a magnetic field is produced around it in addition to the electric field. Thus, an electromagnetic field is said to exist around a moving charge. A moving charge in a magnetic field will experience a magnetic force. A magnet is a piece metal which when in a magnetized state, is capable of establishing magnetic field around itself. Examples include cobalt and iron, and their alloys. They have the ability to attract pieces of the same set of metals. Magnetic force of this kind has found application in the electric bell, the telephone receiver, fans and motors. Electromagnetism has also found tremendous uses in a compass which is used in air and sea navigations. When a coil rotates in a magnetic field, electric current is established in the coil indicating a conversion of mechanical energy to electrical energy. This electromagnetic induction, accounts for more than 90% of the world's electrical energy generation. Chemical cells and solar cells etc. account for the remaining 10%.

5.3.8 Nuclear Energy

When chemical reactions occur, they are accompanied by changes in energy. Nuclear reactions involve energy changes, and these changes are enormous in comparison to the energy involved with ordinary chemical reactions. There are two ways to obtain this energy. These include, nuclear fission and nuclear fusion.

Nuclear fission involves a process in which the heavy nucleus splits into two lighter and more stable nuclei. During nuclear fission, a large amount of energy is released in addition to radiation. For instance, energy released by the fission of 28g of uranium- 235 is equal to the energy provided by 388.4 barrels of oil. The only set back of this form of energy is that, it is only uranium that is efficient in producing energy. Efforts are being made nowadays to ensure that all ores of uranium and even thorium can be used to generate energy. Example of nation where fission is being used is the United States of America. It is less developed in Africa.

Nuclear fusion on the other hand involves a process in which light nuclear combine to give heavier, more stable nuclei with an accompanying release of energy and radiation. Nuclear fission and fusion have been found to be of immense importance. For instance, nuclear fission is useful in the production of atomic pile and atomic bomb. The amount of energy produced during nuclear fusion is far greater than that liberated by nuclear fission per unit mass of nuclear fuel. Nuclear fusion has been found useful in the production of hydrogen

bomb which has a lethal power. It could also provide possible source of cheap power at a very economic price.

5.4 Summary

From our discussion in this unit, it is evidenced that man requires abundant supply of energy. In addition, a number of energy sources are at man's disposal which he has been able to harness to be able to survive in his natural environment. From time to time, man is in continuous search for other plausible ways of generating more energy to support his ever-growing population. You also learnt that energy cannot be created nor destroyed; rather it can be converted from one form to another.

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5.6 Possible Answers to Self-Assessment Exercise

Self-Assessment Exercise 1

Law of Conservation of Energy states that: the tot al energy of a system is unchanged in any series of processes; energy is rather converted from one form to another. The law explains the indestructible nature of energy and emphasizes the inter convertible nature of energy from one form to another

MODULE 3 MAN AND RESOURCES

UNIT 1 FOOD RESOURCES

Unit Structure

1.1 Introduction

Man's physical environment is endowed with a lot of materials and resources with which he is able to sustain life and maintain superiority over and above all other creatures. These resources are natural things (both living and nonliving) which are available to man and are used as wealth for his wellbeing. These material resources form the focal point of our discussion in the next few units in this course. Specifically, this unit is aimed at discussing the natural food resources such as carbohydrates, proteins and fats/oils. The unit shall delve into the physical and chemical nature of these food resources and their uses will be highlighted.

1.2 Intended Learning Outcomes

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

- define some basic concepts that are related to resources
- identify all the classes of food resources available to man
- state the importance of the various food resources to mankind
- state the chemical composition/constituents of each kind of food item.

1.3 Definition of Some Terms – Environmental Resources

In order to have a firm grip on all that will be discussed under environmental resources, it is desirous that we define some terms that are related to the topic of discourse. This would facilitate an easy understanding of the topic on hand. Some of these terms are defined below.

i) **Environment:** Within the context of our discussion, environment refers to all natural features and/or the attributes of nature that surround man. These include vegetation (forest), rivers, soil, mountains, animals, sun, air, crude oil, food etc.

ii) **Resources:** These are natural attributes that are found useful in a particular place at a particular point in time. They are usually of great importance/value to man. Examples include, oil, iron ore, coal, plant (trees), animals etc.

iii) **Reserve:** This refers to the portion of the resources that can be kept and obtained for Man's use. This is the part that Man can convert to wealth. The reserve is important because even if it is not for immediate use, they can be utilized in future.

iv) **Renewable Resources:** These are resources whose stock are in continuous supply, Examples of renewable resources include solar or radiant energy, water, air etc. Due to constant usage, these resources can replenish to replace the used portions.

v) **Non-renewable Resources:** These are resources whose stock can be exhausted. Typical examples of non-renewable resources are fossil fuels like oil, natural gas, coal.

vi) **Sustainability:** This has to do with the use of resources in such a way that it continues to be available.

Self-Assessment Exercise 1

Define the following terms:
(i)Environment, (ii) Resources (iii) Reserve (iv) Sustainability of Resource
State the meaning of Renewable and Non-renewable resources. Mention three examples each

1.3.2 Food Resources

Food products are a group of naturally occurring materials found in the physical surroundings of man. Such products include carbohydrates, proteins, fats and oils. There are other non-food resources, which are also naturally occurring. These include, crude oil, petrochemicals, etc. In this unit, only food products shall be dealt with. In subsequent units, attention will be directed at discussing other naturally occurring products/resources.

1.3.3 Carbohydrates

These are a group of naturally occurring compounds that contain carbon(C), hydrogen (H) and oxygen (O) atoms in their molecules. They are the most abundant and widespread organic substances. They are of high importance in major metabolic processes. Carbohydrates have the general chemical formula $C_x(H_2O)_y$ which implies some atoms of carbon and water. Thus, the name Carbohydrate means hydrated carbon. Carbohydrates can be classified into two main groups:

a) Sugars (b) Non-sugars

Sugars possess names ending with -ose e.g. fructose, glucose, lactose, sucrose, galactose etc. Structurally, they can further be classified as monosaccharide and disaccharides. Monosaccharides are simple sugars forming the simplest group of carbohydrates. They have between three and six carbon atoms in their molecules. The most commonly occurring simple sugars in plants and animals are the hexose-sugars. Their chemical formula is $C_6H_{12}O_6$. Examples is glucose (grape sugar). Disaccharides are formed as a result of combination of two molecules of monosaccharide sugars with the elimination of one molecule of water (Condensation reaction).

Monosaccharide + Monosaccharide

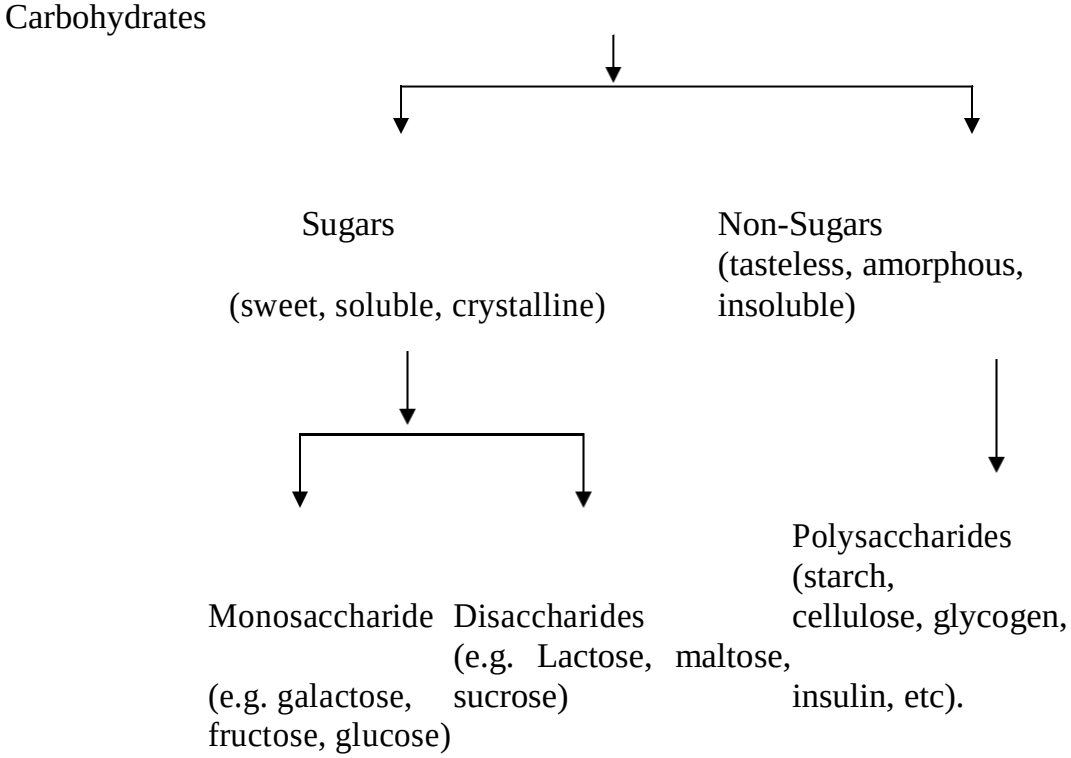
Most commonly occurring disaccharide sugars include sucrose (cane sugar), maltose (malt sugar) and lactose (milk sugar). They have more complex structures than the monosaccharides. Generally speaking, sugars are crystalline in nature, soluble in water and have sweet taste. Glucose is stored as starch and amylopectin (in plants) and as glycogen (in animals). Note that:

i. Glucose + Glucose = Maltose
ii. Glucose +Fructose = Sucrose
iii. Glucose +Galactose = Lactose

Further classification of carbohydrates includes the Polysaccharides (non-sugars). They are formed by the condensation of a large number of

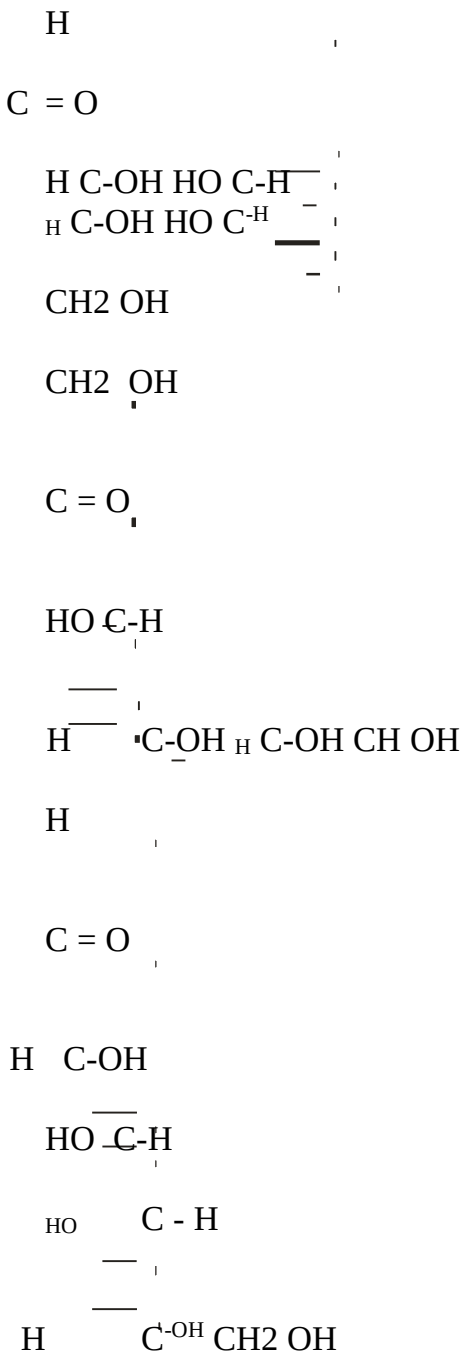
simple sugars. Therefore, they are very large molecules and their chemical formula is $(C_6 H_{10} O_5)_n$, where n is indicating a very large number. They can be broken down by acid hydrolysis into the component monsaccharides as the ultimate products. Examples of polysaccharides are, starch, glycogen (animal starch), cellulose and insulin. They all conform to the general molecular formula $(C_6 H_{10} O_5)_n$ stated above. In cellulose, n is about 3,000. Generally, polysaccharides are non- crystalline (i.e. amorphous), insoluble in water and are tasteless.

Below is figure 3.2 showing an outline classification of carbohydrates.

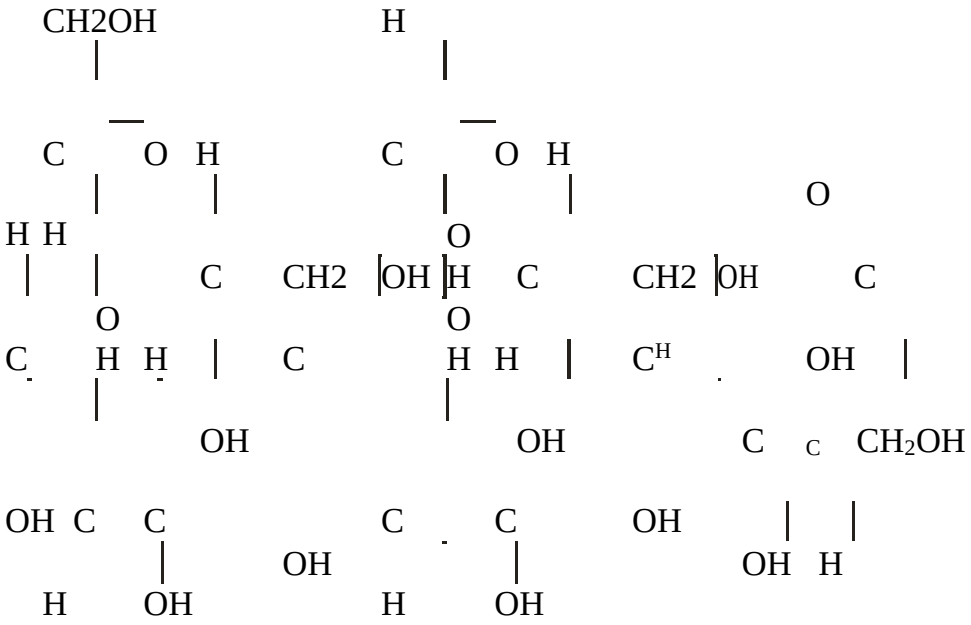


Structure of Sugars

Sugars, especially simple sugars can exist in both open chain or cyclic forms. For the purpose of this course, only the structure of simple sugars shall be shown. Disaccharides and polysaccharides have more complex structures, the structure of which transcends the scope of this study/ course


H
C = O
H C-OH HO C-H
H C-OH HO C-H
CH2 OH
CH2 OH
C = O
HO C-H
H C-OH CH OH
H
C = O
H C-OH
HO C-H
HO C - H
H C-OH CH2 OH

(a) glucose (b) fructose (c) galactose



(d) glucose (e) galactose (f) fructose

Uses of Sugars and Non-Sugars

a) Sugars

Glucose

i. It serves as an immediate source of energy for the sick and sportsmen.
ii. It is used in the synthesis of sweet and jam.
iii. It is an important source of energy
iv. It is a useful raw material in the production of ethanol by fermentation process.
v. It is used to treat hypoglycemia (low blood sugar).

(b) Non sugar (polysaccharide)

Starch

i. It is used principally as food, and a form of energy storage in most green plants.
ii. Industrially, it is converted into sugars and fermented to produce ethanol.
iii. It is used as a softening agent in the textiles industry.
iv. It is used as an adhesive in the paper making process.
v. It is an important constituent in foods like cassava, rice, maize.
vi. When mixed in warm water, it produces a wheat paste which can be used as a thickening or gluing agent.

(c) Cellulose

i. it has no food value, but it is important as roughage in our diet to promote proper functioning of the digestive system.
ii. It is the main raw material used for manufacturing paper.
iii. It is used in the manufacture of cellophane, various types of rayon, cellulose, ethanoate (used for making films, lacquers, and textile fibers)
iv. It is used for making artificial leather and in painting automobiles.
v. It is an essential structural part of the primary cell wall in plants.

Test for Simple Sugars

i) Add Fehling's solution I and II to glucose solution in a test tube and boil. A brick red precipitate is formed or
ii) Add Benedict's solution to an equal amount of sugar solution, boiled and allowed to stand.

A red orange or yellow precipitate is formed; indicating the presence of a simple sugar.

iii) Text for complex Sugar

First boil the complex sugar solution with dilute hydrochloric acid to convert it to simple sugar. The resulting solution is made alkaline by the addition of drops of caustic soda

Then, add Benedict's solution. A red orange or yellow precipitate indicates the presence of a complex sugar.

iv) Text for Starch

Add a drop or two of dilute iodine solution to a slice of yam or boiled rice in clean glass slide. The yam slice or rice grain turn blue black in colour, indicating the presence of starch.

Self-Assessment Exercise 1

1. Give an outline classification of the carbohydrates.
2. Mention two uses of glucose, starch and cellulose.
3. List three examples of Disaccharides and state their monomers.
4. Define Condensation reaction.

1.3.4 Proteins

Proteins are a group of nitrogen containing compounds, along with carbon, hydrogen and oxygen. They constitute an important class of food. Proteins are necessary in order to build new cells and replace the old ones. Proteins are found in the protoplasm of plant cell, muscles (flesh or vertebrates), milk, cheese and egg.

Chemically, their molecules contain, carbon, hydrogen, oxygen, nitrogen and in some cases, sulphur. Some proteins are generally insoluble in water but are soluble in dilute mineral acids and alkali (soluble bases).

When proteins are exposed to drastic conditions such as excessive heating, extreme pH or treatment by surface active agents, they tend to lose their biological activity, and undergo changes in their properties. This is because the very delicate structure which depends on hydrogen

bonding and other relatively weak forces are broken and the molecules loses its shape.
All proteins be it animal or plants are built up from smaller units called amino acids. There are about 20 naturally occurring amino acids. Most proteins contain one amino group ($-NH_2$) and one carboxylic acid group (-COOH) and are said to be neutral. Those with more than one carboxylic acid group are said to be acidic and those with more than one amino group are basic. Animal proteins are built up from about twenty amino acids.

Amino acids have the general formula.

R

|

H–C–COOH

|

NH_2

The smaller units of proteins are the amino acids which are absorbable forms of proteins in the body. The breakdown of proteins starts from the Proteases to Peptones, Polypeptides and finally, the Amino acids.

Generally, proteins can be classified as:

i. Physiologically active proteins, e.g. enzymes, hormones etc.
ii. Structural proteins.

Uses of proteins to man

(i) They form part of the structure of living organisms, e.g. a considerable amount of proteins is found in muscles, bones etc.
(ii) Enzymes are proteins which catalyze biochemical processes and the digestion of food.
(iii) Proteins are important in the formation of hormones.
(iv) It is essential for growth and replacement of old parts
(v) Deficiency of proteins in human diet causes a disease known as Kwashiorkor.

Test for proteins

a. Addition of Million's reagent to a colloidal solution of protein which is heated gives a deep red colour or precipitate.
b. Biuret test: Add few drops of water and 1 cubic centimeter of dilute Sodium hydroxide (NaOH) to a proteinous substance in attest tube. Add one per cent Copper (ii) sulphate solution little

by little and shake well. The protein solution produces a violet colour.

Self-Assessment Exercise 2

1. How can you classify proteins?
2. Outline any 5 uses of proteins
3. Explain the Millon's reagent and Biuret tests.

1.3.4 Vegetable Oils and Animal Fats

Vegetable oils and animal fats are widely distributed in both plants and animals. Along with carbohydrates, proteins and mineral salts, they are necessary components of man's diet.

Oil and fats are lipids. They are substances which contain a high percentage of carbon, hydrogen, but very little oxygen. They are examples of esters. Fats have two main functions. They provide energy (mass for mass two and a half times energy as much as carbohydrates) and they are also carriers of the fat soluble vitamins (A, D, E and K) (Vitamins B and C are water soluble). Fats are solids at room temperature, while Oils are liquids at room temperature.

The products on hydrolysis of vegetable oils and animal fats with caustic soda, indicate that they are esters of long chain carboxylic acids. The other products of the hydrolysis is the trihydric alcohol, propane-1, 2, 3-triol, commonly known as glycerol. Naturally occurring materials such as corn oil, cottonseed oil, coconut oil, tallow, bacon grease and butter are all triglycerides of different carboxylic acids.

Production of Margarine

Selected vegetable oils such as groundnuts, palm kernel, palm oil which have been highly refined are hydrogenated (that is heated to about 200^0c in the presence of a catalyst of finely divided nickel, and hydrogen bubbled under two to five atmospheric pressure). The hydrogenated oil is emulsified with 17 per cent by mass of milk, which has been cultured to give it flavour. Vitamins A and D are then added to increase the food value.

Saponification

When a fat or oil is hydrolyzed by prolonged hydrolysis with caustic soda or caustic potash, it is converted into the sodium salt of the acid and propane 1, 2, 3-triol. The sodium or potassium salts of the acid constitute soaps and the process is known as saponification

$CH_2OOC\text{-}R$ | CH_2OH | $RCOONa$

$CH.OOC\text{-}R^1 + 3NaOh$ | $CHOH$ | R^ICOONa

$CH_2OOC\text{-}R^{II}$ alkali | CH_2OH + $R^{II}COO.Na$

Fat | propane 1, 2, 3 – triol | soaps

Importance of Fats

Fats and oils are also used to prepare detergents which are also sodium salts of long chain fatty acids. The process of formation follows a series of chemical reaction steps. The commercial use of oil includes, the use of peanut oil for making margarine, corn oil is used for cooking and castor oil is used as a powerful purgative. Fats layer beneath the skin act as insulators during the cold season, so as to reduce heat loss.

Self-Assessment Exercise 3

1. Write short notes on the structure of:
a) Carbohydrates
b) Proteins
2. What are the uses of fats and oils?
3. Describe the food tests for simple sugars, complex sugars, proteins and fats.

1.4 Summary

Man is blessed with abundant food resources in his environment. These food resources are naturally occurring. They are readily available in various forms, derivable from plants and animals. Apart from providing man with nourishment, these food resources provide useful means of energy, body maintenance, growth and repairs. These food resources are also of commercial value. In addition, they provide man with energy, maintenance, growth and repairs of body cells

In addition, they provide man with energy, maintenance, growth and repairs of body cells

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1.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 2

Answer:

1. Generally, proteins can be classified as:

iii. Physiologically active proteins, e.g. enzymes, hormones etc.
iv. Structural proteins.

2. Uses of proteins to man

(vi) They form part of the structure of living organisms, e.g. a considerable amount of proteins is found in muscles, bones etc.
(vii) Enzymes are proteins which catalyze biochemical processes and the digestion of food.
(viii) Proteins are important in the formation of hormones.
(ix) It is essential for growth and replacement of old parts
(x) Deficiency of proteins in human diet causes a disease known as Kwashiorkor.

1. Addition of Million's reagent to a colloidal solution of protein which is heated gives a deep red colour or precipitate.
Biuret test: Add few drops of water and 1 cubic centimeter of dilute Sodium hydroxide (NaOH) to a proteinous substance in attest tube. Add 1% Copper (ii) sulphate solution little by little and shake well. The protein solution produces a violet colour.

Self-Assessment Exercise 3

Answers:

1. a). Structure of Carbohydrate:
Carbohydrates are organic compounds that contain only carbon (C), hydrogen (H), and oxygen (O). They contain a chain of carbons, an aldehyde or a ketone, and hydroxyl groups. Every carbon atom is attached to one oxygen atom. There are thousands of different carbohydrates, but they all consist of one or more smaller units called monosaccharides. The simplest carbohydrates are **monosaccharides**. Those with two monosaccharide units are **disaccharides**, and those with many monosaccharide units are **polysaccharides**. Most sugars are either monosaccharides or disaccharides. Cellulose, glycogen, and starch are polysaccharides.

Many carbohydrates exist as **stereoisomers**, in which the three-dimensional spatial arrangement of the atoms in space is the only difference between the isomers. These particular stereoisomers contain at least one **chiral carbon**, a carbon atom that has four different groups bonded to it. A molecule containing a chiral carbon is nonsuperimposable on its mirror image, and two molecules that are nonsuperimposable mirror images of each other are a special type of stereoisomer called **enantiomers**. Enantiomers have the same physical properties, such as melting point, but differ in the direction they rotate polarized light.

(a) Proteins are linear polymers of amino acids. Each amino acid consists of a central tetrahedral carbon atom linked to an amino group, a carboxylic acid group, a distinctive side chain, and a hydrogen. These tetrahedral centers, with the exception of that of glycine, are chiral; only the L isomer exists in natural proteins. All natural proteins are constructed from the same set of 20 amino acids. The side chains of these 20 building blocks vary tremendously in size, shape, and the presence of functional groups. They can be grouped as follows: (1) aliphatic side chains—glycine, alanine, valine, leucine, isoleucine, methionine, and proline; (2) aromatic side chains—phenylalanine, tyrosine, and tryptophan; (3) hydroxyl-containing aliphatic side chains—serine and threonine; (4) sulfhydryl-containing cysteine; (5) basic side chains—lysine, arginine, and histidine; (6) acidic side chains—aspartic acid and glutamic acid; and (7) carboxamide-containing side chains—asparagine and glutamine. These groupings are somewhat arbitrary and many other sensible groupings are possible.

2. Uses of fat and oil:

Fats and oils are used to prepare detergents which are also sodium salts of long chain fatty acids. The process of formation follows a series of chemical reaction steps. The commercial use of oil includes, the use of peanut oil for making margarine, corn oil is used for cooking and castor oil is used as a powerful purgative. Fats layer beneath the skin act as insulators during the cold season, so as to reduce heat loss.

UNIT 2 RUBBERS AND RELATED PRODUCTS

Unit Structure

2.1 Introduction

In the previous unit we discussed about natural products (resources) with particular emphasis on food products. In this unit emphasis shall shift to another useful natural product (rubber) found in human environment. You will also learn in this unit about Rubber-related products such as synthetic rubber, vulcanized rubber and plastics.

2.2 Intended Learning Outcomes

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

- explain the meaning of raw rubber
- describe the production of raw rubber
- mention any five synthetic rubbers
- state constituent monomers
- outline the uses of each of the synthetic rubbers
- define plastics
- list the first set of plastic materials
- mention the types of industrial plastics with examples
- state some properties of plastics and problems associated with their use.

2.3 The Raw Rubber

It is made from a runny milky white liquid called Latex which oozes from a tree species called Rubber tree *(Hevea brasiliensis*) when you cut into them. The latex is held in a colloidal suspension. Naturally, Rubber (a polymer) is made up of monomer units of isoprene. (2-methylbuta-1,3-diene) with the chemical formula. Thousands of basic units of isopropene are loosely joined into long chains. The molecules of these chains can be pulled apart and easily untangled. Once released, they spring back together. This property makes rubber to be elastic.

Production of Rubber

When the bark of the Hevea tree is cut in a wide V-shape in a process called Rubber tapping. This usually occurs in the morning when the internal pressure of the tree is at the highest. The milky latex drips out and it is gathered in a collecting cup. The most common method of extracting rubber from latex is Coagulation in which the latex is thickened or curdled into a mass. In this process, the latex is filtered and reacted with formic acid to make the curds coagulate or stick together. Using roller machines, water particles are squeezed out of the coagulum of rubber.

This results in the production of thin sheets which are dried over wooden racks in smoke houses/hot air. The resulting rubber – ribbed smoke sheets or air-dried sheets. The rubber is compacted into blocks with specific volumes and weight. The blocks are wrapped in polyethylene sheets and packed for shipping to the processors.

Self-Assessment Exercise 1

1. Describe briefly the process by which raw rubber is made.
2. State the name of the monomer units of rubber, its chemical formula.

2.3.1 Synthetic Products

In order to make the best use of the opportunity provided by nature in raw or natural rubber, man has made frantic efforts to change the raw rubber to the forms that can be of immense benefit to him. This has led to the production of derived products such as:

a) Vulcanized rubber
b) Synthetic rubber

a) Vulcanized Rubber

Vulcanization is the chemical process which involves the hardening of rubber. While Sulphur is the most common agent used in vulcanization, other chemicals used are peroxide, metallic oxides, urethrane and acetoxysilane. Traditionally, the definition of Vulcanization is mainly on the hardening of natural rubber with Sulphur treatment. However, it has been discovered that the chemical process also involves the hardening of synthetic rubbers, e.g. Silicone rubber and Neoprene.

Vulcanization involving the Sulphur agent is the most common. During the process, rubber and Sulphur are heated to high degrees of temperatures, Sulphur atoms form cross linkages between individual polymer molecules.

Importance of Vulcanization of Rubber

1. It provides a good tensile strength.
2. It offers resilience, i.e. after deformation, the rubber returns to its original shape.
3. Vulcanized rubber has a reduced tendency of water absorption
4. Vulcanization makes rubber more elastic
5. It provides high abrasion resistance
6. It also improves the chemical resistance of the rubber.

Self-Assessment Exercise 2

1. Define Vulcanization
2. List three chemicals that are involved in the vulcanization process
3. What is the significance of Sulphur in vulcanization of rubber?
4. State three importance of the vulcanization of rubber

b) Synthetic Rubber

Synthetic rubber is made from a variety of unsaturated compounds. The first synthetic rubber was poly (2-chloro buta 1,3-diene) or neoprene. Synthetic rubber does not occur naturally. It is often made by co-polymerizing buta-1,3-diene with syrene in the proportion of 75 per cent to 85 per cent styrene. The polymerization agent is an aqueous emulsion of potassium persulphate. Neoprene is an example of synthetic rubber which is very similar to natural rubber, made from 2-chlorobuta-1,3-diene (chloroprene). An aqueous emulsion of chlroprene polymerizes at 30^0c forming neoprene, the synthetic rubber. Other synthetic rubbers have been made such as styrenebutadiene rubber (SBR) Thiokol, poly (buta 1, 3-diene) and poly (2-methyl propene). Of these, SBR is the most useful, and all-purpose synthetic rubber.

SBR is obtained by the copolymerization of phenylethene (styrene) with three parts of aqueous buta 1, 3-diene. It is vulcanized by carefully heating it with about 3 percent by mass of sulphur. This gives SBR and synthetic rubber. It has a characteristic elasticity and hardness.

SBR rubber is often used in making vehicle tyres and foot-wears because of its high resistance to abrasion. Other rubbers are butyl rubber, a copolymer of but – 1-ene and 2-methyl 1, 3-diene. After vulcanization, it is used for inner tubes and other uses which require a soft rubber. Neoprene described above, (i.e. copolymer of 2-chlorobuta -1,3-diene and 2-methybuta-1,3-diere) is used for hoses, shoot heels and burisen tubing.

Self-Assessment Exercise 3

1. Mention any five synthetic rubbers and state their constituent monomers.
2. Outline the uses of each of the synthetic rubbers mentioned in (1) above.

Self-Assessment Exercise 3

2.3.2 Plastics

A plastic is a substance that is molded in a hot press and hardens on cooking. The first plastic materials - celluloid were made in 1868 and produced on a commercial scale. It was made from cellulose and camphor. It was used to make photographic files and a variety of small articles. Celluloid was highly inflammable; though other plastics have eventually replaced it. The next important plastic was Bakelite invented in 1909; and is used to manufacture small articles such as cups, and accessories, due to its insulating nature. It is also important in the development of radio receivers, and transmitters. After this set of plastics, several others have been synthesized.

Types of Plastics

There are two main types of industrial plastics. These are:

i) Thermoplastic plastics
ii) Thermosetting plastics

i. Thermoplastic Plastics

These are materials which soften on heating and then harden on cooling. They are also known as thermo softening plastics. On heating, they can be remolded to the desired shapes. Thermo softening plastics are usually linear molecules which are held together by weak Van der waal's

bonding. The weak Van der waal's forces are usually disturbed by heat, and equally, they easily reform when the compound is cooled.

Polythene (polyethylene) is a typical example of a thermoplastic material. The basic unit of polythene is ethene ($H_2C = CH_2$). Ethene polymerises when subjected to high temperatures and pressures, in the presence of little oxygen into a substance called Polythene. It consists of long chains of many hundreds of ethene molecules joined together. Polythene which is a plastic is tough, light and easily molded into shapes. Other examples of thermoplastics include, polypropylene, polystyrene, Nylon, terylene and Perspex (acrylic).

ii. Thermosetting Plastics

These are plastic materials that remain set and on heating will not soften for any possible remolding. Thermosetting materials (plastics), once they have been molded, cannot be softened. This is because their formation involves chemical bonds forming across the molecules between the polymeric chains. The energy necessary to break any linkages in the resulting macromolecules results in chemical decomposition.

Polyvinyl/chloride, (PVC) is an example of thermosetting plastics. It is formed when vinyl chloride polymerises under pressure in the presence of oxygen. It is used in the manufacture of gloves. It can also be used in such things as handbags, raincoats, luggage, tank linings, etc. It can equally be molded into plastic articles such as tubings, electrical insulation, radio components and cable coverings. Bakelite is one of the earliest examples of thermosetting plastics used in making light objects. Other examples include, urea methanal (urea formaldehyde), silicones, phenolics, polyesters.

Self-Assessment Exercise 4

1. What are (a) Thermoplastics (b) Thermosets?
2. Give three examples each of themosets and thermoplastics, stating their uses.

Desirable Properties of Plastics

Practically, everything around us is made of some kind of plastic. The following conditions have made our present plastic age possible.

i). Plastics have properties that make them suitable for many purposes. They are strong, but light, inert to air, water and other

chemicals, resistant to fungal and bacterial attacks, and good insulators of heat and electricity.

ii). They can be molded into any desired shape and requirements; they can be made into hard, rigid blocks, thin flexible sheets, fibres that can be made into ropes and fabrics and very light foams. They also have a wide range of application.

iii). The raw materials for the manufacture of plastics are readily and cheaply available from the refining of crude oil. The boom of the petroleum industry has contributed positively to the growth of the plastic industry.

iv). Plastic materials can be produced at very low cost by using moulds and automated manufacturing processes.

Problems Associated with the use of Plastics

There is a heavy dependence on crude oil, since petrochemicals provide the bulk of the raw materials needed for making plastics. This poses a serious problem as the world's oil supply is exhaustible. Alternative energy sources that are being explored, e.g. solar energy, do not provide the raw materials needed for making plastics.

Most plastic materials are non-biodegradable and cannot be decomposed/broken down by microbial action into simple organic forms. Therefore, they cause serious land pollution problems. Burning plastic objects would not be a good alternative as this would liberate toxic vapours or gases into the atmosphere, thereby causing air pollution and consequently contributing to Global warming.

2.4 Summary

In this unit, you have been exposed to the fact that man is endowed with other natural resources in addition to the natural food products. As a result of his interaction with the environment and his quest to maximize the use of the abundant resources at his at disposal, he has been able to synthesize a number of other products which have a wide range of applications. Rubber is a natural product obtained from the latex of the rubber tree (*Hevea brasiliensis*). Apart from the natural rubber (raw rubber), there also exist synthetic ones (vulcanized and synthetic rubbers). Rubber is needed in making car tyres, tubings, hoses, shoe heels and Bunsen tubing.

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2.6 Possible Answers to Self-Assessment Exercise

Self-Assessment Exercise 2

Answers:

1. Vulcanization: is the chemical process which involves the hardening of rubber.
2. Sulphur, Peroxide, Metallic oxides
3. The most common **vulcanization** agent is **sulfur**. It forms bridges between individual polymer molecules when heated with **rubber**.
4. Importance of vulcanization of rubber:

i. Vulcanization makes cross-links between the long unsaturated hydrocarbon chains. This cross links presents intermolecular moments by anchoring, as a result of which, vulcanized rubber regains the original shape on removing stress.
ii. The cross links may be directly from carbon to carbon or through an oxygen atom or through sulphur atom, or through all the three, therefore, percentage elongation at break decreases.
iii. Water absorption tendency of rubber decreases.
iv. Useful temperature range increases from 10-60 degree centigrade to -40-100 degree centigrade.
v. Chemical resistance of vulcanized rubber increases.

Self-Assessment Exercise 3

Answer:

1. Butyl rubber, a copolymer of but – 1-ene and 2-methyl 1, 3-diene
2. Neoprene, a copolymer of 2-chlorobuta -1,3-diene and 2-methybuta-1,3-diere.
3. Styrene butadiene rubber (SBR) Thiokol, poly (buta 1, 3-diene) and poly (2-methyl propene).
4. Acrylic Rubber (ACM), Alkyl acrylate copolymer
5. EPDM Rubber (Ethylene Propylene Diene Monomer)

Uses of the synthetic rubbers

- Butyl rubber can be used of Tyre inner tubes
- Neoprene can be used for hoses
- Styrene butadiene rubber can be used for making vehicle tyres
- Acrylic Rubber (ACM) is widely used in automotive transmissions and hoses.

EPDM Rubber (Ethylene Propylene Diene Monomer) is widely used for manufacturing of sheeting used at high temperatures.

Self-Assessment Exercise 4

Answer:

1. (a) **Thermoplastic Plastics:**

These are materials which soften on heating and then harden on cooling. They are also known as thermos-softening plastics. On heating, they can be remolded to the desired shapes. Thermo-softening plastics are usually linear molecules which are held together by weak Van der Waal's bonding.

(b) Thermosetting Plastics:

These are plastic materials that remain set and on heating will not soften for any possible remolding. Thermosetting materials (plastics), once they have been molded, cannot be softened. This is because their formation involves chemical bonds forming across the molecules between the polymeric chains.

2. i. Examples of thermoplastics include, polypropylene, polystyrene, Nylon, terylene and Perspex (acrylic).

ii. Examples of thermosets include: Urea Methanal (urea formaldehyde), silicones, phenolics, polyesters.

UNIT 3 MINERAL RESOURCES

Unit Structure

3.1 Introduction

In the last two units, we have been discussing some natural resources with which man is richly endowed. The units were dedicated to natural food resources and important tree resource (rubber). Besides these natural resources, a number of other abundant deposits of other natural resources abound beneath the earth crust. These resources are termed Mineral resources. Nigeria is one of the few countries that is richly endowed with the abundance of these mineral resources. Examples of such resources are Iron ore, petroleum, bitumen, coal, limestone, etc. This unit will be committed to discussing these mineral resources.

3.2 Intended Learning Outcomes

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

- identify the mineral resources in Nigeria
- state the location of these mineral resources in Nigeria
- state the importance of these mineral resources to mankind
- state some of the problems associated with the availability of these mineral resources.

3.2 Mineral Resources

3.3.1 Iron Ore

Iron is one of the indispensable metals, needed for industrial development, because it is a constituent of every equipment, machine, tools, automobiles, etc. and materials used in homes, and industries. Iron

is usually found in the combined state as ore; usually in combination with oxygen.

Examples of iron ores are hematite (Fe_20_3), siderite (F_eC0_3) and magnetite (Fe_30_4). The extraction of iron from its ores involves the removal of impurities, followed by reduction of the oxide at a very high temperature in a blast furnace.

Deposits of iron ore are found all over Nigeria. Such places include Agbaja, Hakpe, Ajabonoko, Kotokarfi, Agbende Okudu, Nsude hills and Muro hills. Iron ore deposit is the bedrock of the steel industry and with about 3 billion tonnes of iron ore reserve in the country, one would expect the steel industry to be working at full capacity. This is yet to be realized as our major steel industries (Ajaokuta, Hakpe, Aladja, and Oshogbo) are either at the construction stage or being forced to close down due to the non-availability of raw materials.

Some of the factors militating against the expected development of the steel industry in Nigeria include,

i) Extraction of iron from its ore is a capital intensive project which demands huge and consistent funding. This is in part why the yet-to-take off Ajaokuta steel industry will supply raw iron to other steel industries, when it finally takes off.
ii) The extraction of iron from its ore also involves advanced technology that requires a large number of expertises.
iii) There is the problem of lack of cooperation from host communities where iron ore deposits are found due to politicking
iv) Frequent changes in government and government policies over the years has not helped matters in this connection.
v) Government insincerity and lack of commitment towards developing this sector of the economy poses another problem.
vi) Financial misappropriation also remains a major challenge.

Self-Assessment Exercise 1

1. Mention any five states in Nigeria where iron ore deposits could be found
2. What factors militate against the development of the Steel industry in Nigeria?

3.3.2 Coal

Coal is one of the valuable natural (mineral) resources. It is a bye-product of plant remains or debris that have been buried over a long

period of time. The physical and chemical transformation of the plant debris, which prevents decay usually leads to the formation of coal. Coal is a non-renewable fossil fuel and the most abundant we have ever had The transformation of plant debris into coal is called coalification, which may take millions of years to achieve.

Coalification takes place in six fairly distinct and successive stages. These are the peat, lignite, sub-bituminous, bituminous, semi-anthracite and anthracite stages. The quality of the coal formed depends on such factors as the nature of the starting plant debris, temperature, pressure, moisture content, oxygen content, acidity etc. The higher the temperature, the higher the rank (degree) of transformation. Anthracite is the most preferable due to its high heat content.

About 30 percent of the world's reserve of coal is found in USA, China and the former USSR. In Nigeria, coal was first discovered in Udi near Enugu in 1909, but the actual mining did not commence until 1916. Several other deposits have since been discovered across the country in such locations as Enugu such as Inyi, Orukpa-Ezimo, Okaba, Asaba, lafia obi etc.

Although, exploitation of coal in Nigeria started in 1915. Its production has been on decline since then due to initial problem posed by the last civil war and the recent discovery of crude oil. Other reasons for decline in the production of coal include: its low heat output, untidy appearance, bulkiness which raise high transport cost, and environmental pollution.

Uses of Coal

Coal provides a fair percentage of the world's energy source. Its utilization is of domestic and industrial importance. At home, it is used mainly to produce heat energy for cooking and house warming during cold weather condition. Its industrial applications include generation of electric power, forming of industrial boilers for steam generation, fining of kilns, ovens etc.

In Nigeria, notable application of coal includes;

Power Generation

i) ***Orji power station:*** **-** which receives its supply form Enugu and Inyi deposits.

ii) ***Onitsha power station:*** **-** that receives its supply from Asaba and Onitsha deposits, generating about 1200 MW (mega watts) of electricity.

iii) ***Makurdi power station:*** **-** obtains its coal supply from Okaba and Ogboyoga deposits.

iv) ***Numan power station:*** **-** receives coal from Gombe and Lainja deposit.

(b) **Cement manufacturing**: - the Nigeria cement company Nkalagu uses coal for fining its kilns.

(c) **As a source of chemical**: - A number of chemicals can be derived from coal, which are of immense industrial importance. Examples include graphite, activated carbons, re-carbonization materials in iron and steel making.

(d) **Transport**: - Coal is used in locomotive engines

Self-Assessment Exercise 2

1. Mention the stages of the formation of coal.
2. Outline 2 domestic uses and four industrial uses of coal.

3.3.3 Petroleum

Petroleum or Crude oil is a mixture of many hydrocarbon compounds. It is a bye product of the bio-transformation of remains of plants and animals. Petroleum is separated into constituents by the Fractional distillation process. Some of the products of the refined crude oil are gases, gasoline, kerosene, diesel, fuel oil, bitumen and lubricants.

Crude oil and the associated gases provide about 75 percent of the energy used in the world. Apart from this, some of the hydrocarbon compounds found in it serve as raw/starting materials for many industrial products such as plastics, drug, textile material, soap and detergents, etc. This wide variety of application has made petroleum to be the most treasured and cherished natural resource. A number of oil deposits have been discovered in Nigeria after the initial discovery in 1956 at Oloibiri, Bayelsa state. About thirteen states across the country have been designated as oil-producing states. In these states, oil exploration and exploitation are at different stages of development. Today, Nigeria produces about 2 billion barrels of crude oil and exports more than 85 percent of her total production. However, large deposit of crude oil in Nigeria led to the establishment of four refineries in Port Harcourt, Kaduna, and Warri. However, recent happenings reveal that Nigerians do not enjoy the maximum economic benefits they ought to have enjoyed from its resource. The following are some of the reasons.

i) Oil spillage.
ii) The Niger-Delta crisis
iii) Problem of environmental pollution
iv) Perennial scarcity of petroleum products.
v) Politicking
vi) Over dependence on crude oil as a source of revenue.
vii) Environmental degradation arising from oil exploitation activities.

Self-Assessment Exercise 3

1. Explain why Nigerians have not benefitted optimally from crude oil generation.
2. Suggest ways of combating these problems

Influence of Petroleum on Nigerian Economy

The oil industry has dominated the world's economic scene for quite some time. The impact has been both positive and negative on the lives of Nigerians. Some of these are discussed in this section.

The positive influence includes

i) Socio-economically, the oil industry dictates the pace of political, social and cultural progress in the country. Virtually every aspect of our lives has been influenced directly or indirectly by petroleum.
ii) The crude oil resource has enhanced the growth of Nigeria's national income since the late 196s0, when it became the major source of government revenue.

The Negative Impacts

The following are some of the problems posed by the presence of crude oil in our society.

- Oil spillage arising from normal operations or spills from pipe ruptures or vandalism.
- Loss or destruction of land.
- Destruction of land to construct pads for wells, pipelines or storage tanks.
- Sinking of land as oil and gas are withdrawn
- Pollution of surface and ground waters arising from run-offs and leakages from damaged pipes
- Air pollution by hydrocarbon compounds and sulphur compounds.
- Release of drilling muds which may contain heavy metals such as barium, a toxic chemical to aquatic plants and animals.
- Aesthetic degradation from the presence of off shore oil-drilling platforms which some people consider to be unsightly

3.3.4 Bitumen

Bitumen is another fossil fuel which Nigeria is blessed with. The terms Bitumen and Asphalt are often used interchangeably. For the purpose of

this course, Asphalt will be regarded as a mixture of bitumen and some impurities. Bitumen can be defined as a class of dark coloured solid semi-solid or viscous substances, natural or manufactured. It is composed principally of high molecular mass hydrocarbon of which aspartic tar, pitches and asphaltenes are typical.

Uses of Bitumen/Asphalt

i) The main application of bitumen is found in the construction of highway streets, drive ways, air fields, parking area, petrol station and industrial floors, tennis courts and play grounds, such as basketball floors.
ii) Asphalt is good in roofing all kinds of buildings ranging from individual homes to factory buildings.
iii) Bitumen can be converted into synthetic crude, from which petrol, diesel, kerosene, grease are obtained.
iv) In the production of sulphuric acid, phenol, and petro-chemicals.
v) In the protective coating of hydraulic structures
vi) In the manufacture of battery cases, tyre, automatic brake lining and insulating and sound proofing.

Self-Assessment Exercise 5

Outline the uses of asphalt/bitumen.

3.3.5 Limestone

Limestone is a sedimentary rock whose major component is calcium carbonate (CaCO3). Other constituents of limestone are clay, iron, pyrite, quartz and magnesium. There are two main theories on limestone formation.

These include:

i) Biogenic precipitation from sea water: Limestone resulting from this source is referred to as autochthonous limestone

ii) Allochthonous limestone, believed to have been formed form mechanical transportation and deposition of pre-existing limestone.

Limestone is an important environmental resource. It is the basic raw material for the manufacture of cements. There are many deposits of

Limestone in Nigeria in areas like Nkalagu, Ewekoro, Mfawsing, Ogbolokuta, Yandev, Kanbanu and Ashaka.

Importance of Limestone

It is used in the manufacture of fertilizers (especially phosphate-rich fertilizers). In addition, thermal decomposition of limestone gives lime and carbon (iv) oxide. It is equally very important in glass manufacturing.

3.4 Summary

No doubt, Nigeria is endowed with quite a number of mineral resources, which if properly harnessed, can raise the standard of living of her citizenry. These mineral resources are located across the whole country. The presence of these mineral resources in our environment has a lot of socio-economic influence. A number of problems are also associated with their exploration and utilization. However, there is a need for standing National Policy for the proper management and utilization of these God-given resources. Preservation, renewal and regeneration of natural resources should be embarked upon, while illegal mining should be completely wiped-out.

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3.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer:

i. Cross River **State**
ii. Adamawa **State**
iii. Taraba **State**
iv. Plateau **State**
v. Bauchi **State**

2. Some of the factors militating against the expected development of the steel industry in Nigeria include,

i) Extraction of iron from its ore is a capital intensive project which demands huge and consistent funding. This is in part why the yet-to-take off Ajaokuta steel industry will supply raw iron to other steel industries, when it finally takes off.
ii) The extraction of iron from its ore also involves advanced technology that requires a large number of expertises.
iii) There is the problem of lack of cooperation from host communities where iron ore deposits are found due to politicking
iv) Frequent changes in government and government policies over the years has not helped matters in this connection.
v) Government insincerity and lack of commitment towards developing this sector of the economy poses another problem.
vi) Financial misappropriation also remains a major challenge.

Self-Assessment Exercise 3

Answer:

The following are some of the reasons why Nigerians have not benefitted optimally from oil generation

i) Oil spillage.
ii) The Niger-Delta crisis
iii) Problem of environmental pollution
iv) Perennial scarcity of petroleum products.
v) Politicking
vi) Over dependence on crude oil as a source of revenue.
vii) Environmental degradation arising from oil exploitation activities.

Self-Assessment Exercise 5

Answers
Uses of Bitumen/Asphalt

i) The main application of bitumen is found in the construction of highway streets, drive ways, air fields, parking area, petrol station and industrial floors, tennis courts and play grounds, such as basketball floors.
ii) Asphalt is good in roofing all kinds of buildings ranging from individual homes to factory buildings.
iii) Bitumen can be converted into synthetic crude, from which petrol, diesel, kerosene, grease are obtained.
iv) In the production of sulphuric acid, phenol, and petro-chemicals.
v) In the protective coating of hydraulic structures
vi) In the manufacture of battery cases, tyre, automatic brake lining and insulating and sound proofing.

UNIT 4 VEGETATION AND WATER RESOURCES

Unit Structure

4.1 Introduction

In this unit, you would be exposed to resources that nature has provided man in vegetation and water bodies. These two resources are natural and renewable. You will also be exposed to the economic importance of these two natural resources as they affect man.

4.2 Intended Learning Outcomes

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

- list the different kinds of vegetation in Nigeria
- state the economic importance of Nigeria natural vegetation
- list the importance of water resources to mankind
- describe the limitations of Nigerian water resource.

4.3 Vegetation Resource

The natural vegetation of a particular place refers to the community of plants that covers the region. These include trees and grasses, which are of natural origin. It covers both the natural and man-made vegetation of an area. The vegetation of a forest depends largely on such factors as soil type, rainfall, temperature and human activities. Nigeria has two main distinct natural vegetation belts. These are forest and savannah.

Soil type and Rainfall constitute two major factors which determine the type of vegetation in an area. Soil for example is a mixture of mineral matters, humus, water, air and micro-organisms. Soils vary in their chemical composition from place to place because they are derived from the underlying rock materials. Some countries are endowed with fertile soil for cultivating virtually all types of crops. Nigeria has soil types that

are suitable for trees and arable crops. e.g. trees of cocoa, rubber, coffee, timber, gedu, cassia; and food/cash crops such as beans, cotton, melon, corn etc. In the desert regions, the soil lacks essential plant nutrients and required moisture to support plant population, be it trees or food crops. Soil, apart from supporting plant population, is also useful in making pots and building houses.

Self-Assessment Exercise 1

Discuss the role of soil in sustaining plant population in an area.

Vegetation Zones/Belts in Nigeria

A Biome is a large natural terrestrial ecosystem. The type of vegetation found determines the nature of the biome. The vegetation type depends largely on factors like temperature and rainfall (climatic factors). In Nigeria, the local biomes can be divided into two: Forest zone and Savanna zone.

The Forest Zone

In Nigeria, three kinds of forests can be identified. They include:

a) Mangrove Swamp forest: It is characterized by halophytic (salt loving) trees and shrubs. There are broad leaved trees which grow in shallow brackish waters or wet soils. Soil in the mangrove has a high salt content. Most trees found in the forest have prop roots and breathing roots (pneumatophores) which are specialized for the exchange of gases. These make them grow well in the swampy areas. Mangrove swamp is found along coastal regions and river mouths. In Nigeria, the mangrove can be found in Delta, Cross river, Ondo, Lagos, Rivers and Edo states. In the mangrove, the average monthly temperature is about 26°C round the year, and above 2600mm for annual heavy rainfall.

b) Tropical rainforest: It has high mountainous multilayered forests. The trees of the woody canopy prevent rays of the sun from the forest floor which has a sparse vegetation. In Nigeria, the mean annual temperature is 27ºC and the mean annual rainfall is 2000mm, with a relative humidity of at least 70 per cent. The rainy season is long while the dry season is short and severe. The forest areas found in the lowland areas, extend to a height of 600 or 1000 metre. The trees of the tropical rainforest from three layers. The top of the tree forms the thick woody canopy. For the second and third levels, the trees are strewed with epiphytes, intertwined with lianas (woody climbers) that grow upwards. In

Nigeria, tropical rainforest can be found in Oyo, Cross river, Ondo and Imo states.

c) Montane (alpine) forest: This type of forest zone is located in areas with high mountains. Due to its high rainfall, low temperature levels and a high relative humidity, it's not well developed. It has few tall and scattered trees. It serves as a good pasture for the rearing of cattle. Montane forest is a grassland zone. In Nigeria, the Jos plateau is one of the highest points.

The Savanna Zone

Also known as the tropical grasslands, the savanna is mostly flat on land. In this zone, there is an alternation between the hot, wet season and the cool, dry season. Average monthly temperature is around 29ºC during the hot season, and about 18ºC during the cold season. With an annual rainfall from 500mm-1500mm, most of the rainfall isn't enough to favour the growth of trees, but it can prevent the formation of a desert. The zone is divided into

a) Guinea savanna: The dry Northern Guinea Savanna is characterized with shrubs and scattered trees. The trees are few in number, short and thorny. This savanna type is found in Kwara, Benue, Kogi and Kaduna states. Trees found here include Uapola somon and Isoberlina doka. The Southern Guinea Savanna has short trees with large and broad leaves. Trees found here include Vitex doniana and Afzelia Africana.Savanna

b) Sudan Savanna: It has a low grass cover and thorny bushes. It can be found in states like Sokoto, Kebbi, Bauchi, Zamfara, etc. typical trees include Acacia, Baobab, Palms of doom.

c) Sahel Savanna: This region is an arid zone with clumps of short grasses, and a few isolated shrubs and trees. This savanna borders the Sahara desert and it is found in Borno and Yobe states, near Lake Chad. Mean annual rainfall is 629mm the trees grow up to 10 metres, with small leaves and thorns. During the dry season, bush fires occur mostly. However, the inhabiting trees have adapted by the possession of thick, resistant barks. Common trees include Acacia, Baldrites, Date palsete, etc.

Self-Assessment Exercise 2

1. Describe the features of the following: (a) Mangrove rainforest (b) Evergreen rainforest (c) Montane forest
2. Write a detailed but concise essay on the Savanna vegetation in Nigeria.

4.3.1 Economic Values of Nigerian Natural Vegetation

In this section, we shall examine the benefits of the vegetation resources in Nigeria. The forest habours trees such as Iroko, Mahogamy etc. and as a result, it produces timber from which planks are made. Lumbering and associated activities like saw milling provide job opportunities for a sizeable number of Nigerians. Planks, which are produced from timbers are used for roofing houses, constructing canoes and for making fumitories. In recent times, Nigerian timbers and planks are being exported to neighbouring African countries.

Bamboo and some other trees found in the forest and savanna serve as major raw materials for pulp and paper industry. Trees and grasses remain very good sources of heat energy for cooking in the rural areas. Occasional shortages of kerosene and cooking gas have made urban dwellers to turn to forest products for energy as most families in cities now take solace in the use of charcoal for cooking. Forests also harbour animals which serve as sources of animal protein to men.

The Savanna belt which is predominantly covered with grasses is an extensive pasture land which allows for the rearing of animals in the area. Substantial amount of meat consumed in this country come from this part of the country. Animals like cattle, sheep and goats of various species are reared on a large scale in this area. Cash crops such as groundnut and Cotton are also grown in this region. Conversely, the forest zone supports the cultivation of cash crops such as cocoa, coffee, palm, rubber etc. Food crops grown in the forest region include yam, cassava, maize etc. It should be placed on record that, cotton, cocoa, and groundnut were the mainstay of Nigeria's economy before the discovery of crude oil.

Health-wise, the natural vegetation has contributed immensely to the wellbeing of Nigerians. The use of the bark, fruit, leaves or roots of some plants for the treatment of different kinds of ailments or diseases are enormous. The contribution of vegetation resources to tourism and reserves are also worthy of mentioning.

4.3.2 Decline of Nigeria Natural Vegetation Resources

Nigerian vegetation being an exhaustible resource, though can be replenished if properly managed, is found to be on the decline, in quality and quantity. The following are some of the factors that have contributed to this.

i) Frequent Bush banning
ii) Construction of houses and industries
iii) Overgrazing
iv) Mining and exploitation activities
v) Lumbering
vi) Natural factors (e.g. long drought)
vii) Agricultural activities.

4.3.3 Water Resources

Water resource consists of the rivers, lakes streams, springs, seas and oceans. Nigeria is equally endowed with notable examples of these water resources. Notable rivers in Nigeria include Niger, Benue, Osun, Hadejia, Sokoto, Kaduna. etc. There is also lake Chad in Nigeria, while Nigeria is bound in the south by the Atlantic Ocean.

The features of rivers in Nigeria include.

i) The volume of water varies every season.
ii) Rivers in the south take off from the western highlands and flow into the sea, whereas rivers in the northern part of the country take off from the North central plateau and move in different directions.
iii) Nigerian rivers are located with weathered part of the soil on which they flow. Some of these materials remain suspended in the water while some are dissolved.
iv) The topography of the land on which they flow has a great influence on their usage. For instance, rivers that are intercropped by many rapids are suitable for building dams for hydroelectric power generation, whereas, rivers with little or no rapids are suitable for navigation.
v) Nigerian rivers vary in length. For instance, Rivers Niger and Benue are the two long rivers in Nigeria that have their sources from outside the country. Other short but notable rivers include, Sokoto, Osun, Ogun, Hadejia, Imo and Katsina, etc.

Self-Assessment Exercise 3

Mention the features of Nigeria rivers.

4.3.4 Nigerian Water as a Resource

Water is one of the indispensable needs of man. Its contributions to man's well-being is unquantifiable. Starting from the home, water is needed for drinking, cooking and other domestic uses. Man also depends on rivers and streams as sources of water for cooking and other domestic purposes.

Apart from domestic utilization, majority of the industries require water in large quantities for their operations. These include washing, production, generation of steam, cooling, etc. Some industries rely so much on water that they have to be cited very close to a source of water (river) e.g. Nigerian Sugar Company Limited, Bacita, Kwara state; located near River, Niger.

Agriculturally, water is important in food production. Rivers and streams harbour a wide variety of fish and other aquatic animals which serve as sources of proteins. A number of River Basin authorities have been established to raise the level of food production in the country in addition to providing job opportunities for the citizenry. In the same vein, some rivers have been dammed for the purpose of generating electricity e.g. Kanji Dam (Niger) and Shiroro dam, (Kaduna), Lagos, Port Harcourt and Calabar seaports were built due to the fact that the towns are very close to the Atlantic Ocean. The ports are of great economic values to Nigeria as they serve as entry/exit points for imported/exported goods.

In the area of transport, inland rivers serve as means of inter-and intra-city movement of people and goods. People living in the riverine areas such as Onitsha, Benue, Bayelsa, Lagos; depend mainly on navigation for the movement of goods and people.

Self-Assessment Exercise 4

1. . Name any five rivers in Nigeria, stating their location and their economic value.
2. Cite the importance of water in the industrial, transport and agricultural sectors of the country.

4.3.5 Some Limitations of Nigerian Water Resources

Below are some of the limitations of the Nigeria water resources (rivers).

- Seasonal variation affects the volume of water in the rivers
- Hardness of water, which makes it unsuitable for some applications.
- The presence of some land forms along the courses of rivers hinders navigation.
- Industrial activities have rendered some rivers unfit for both domestic and industrial application e.g. pollution in oil producing areas like Bayelsa state.

4.4 Summary

- It is evidenced from our discussion in this unit that water is an indispensable natural resource which nature has provided man with. The role of water in the well-being of man is unquantifiable. Its contributions to man's wellbeing can be seen in the areas of drinking, crop production, energy generation, transportation, etc. You have also learnt about some Nigerian rivers, such as River Niger, River Benue, River Hadejia, Sokoto river, etc., their importance and limitations.

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4.6 Possible Answers to Self-Assessment Exercise

Self-Assessment Exercise 1

Answer:
Soil type and Rainfall constitute two major factors which determine the type of vegetation in an area. Soil for example is a mixture of mineral matters, humus, water, air and micro-organisms. Soils vary in their chemical composition from place to place because they are derived from the underlying rock materials. Some countries are endowed with fertile soil for cultivating virtually all types of crops. Nigeria has soil types that are suitable for trees and arable crops. e.g. trees of cocoa, rubber, coffee, timber, gedu, cassia; and food/cash crops such as beans, cotton, melon, corn etc.

In the desert regions, the soil lacks essential plant nutrients and required moisture to support plant population, be it trees or food crops. Soil, apart from supporting plant population, is also useful in making pots and building houses.

Self-Assessment Exercise 2

Answer:

i. Features of Mangrove rainforest
It is characterized by halophytic (salt loving) trees and shrubs. There are broad leaved trees which grow in shallow brackish waters or wet soils. Soil in the mangrove has a high salt content. Most trees found in the forest have prop roots and breathing roots (pneumatophores) which are specialized for the exchange of gases. These make them grow well in the swampy areas.

iii. Features of Evergreen rainforest:
The characteristic features of Tropical evergreen forests are the following:

- High animal and vegetal biodiversity
- Obviously evergreen trees
- Sparse undergrowth interspersed with clearings
- Scarce presence of litter (organic matter settling on the ground)
- Presence of "strangler", creepers (e.g. *Ficus*spp.)
- Presence of "buttresses" (i.e. large winged ribs at the base of trunks) and spindly roots in trees living in often-flooded areas

iv. Features of Montane forest:
This type of forest zone is located in areas with high mountains. Due to its high rainfall, low temperature levels and a high relative humidity, it's not well developed. It has few tall and scattered trees. It serves as a good pasture for the rearing of cattle. Montane forest is a grassland zone.

Self-Assessment Exercise 3

Answer: The features of Nigeria rivers include:

i) The volume of water varies every season.
ii) Rivers in the south take off from the western highlands and flow into the sea, whereas rivers in the northern part of the country take off from the North central plateau and move in different directions.
iii) Nigerian rivers are located with weathered part of the soil on which they flow. Some of these materials remain suspended in the water while some are dissolved.
iv) The topography of the land on which they flow has a great influence on their usage. For instance, rivers that are intercropped by many rapids are suitable for building dams for hydroelectric power generation, whereas, rivers with little or no rapids are suitable for navigation.
v) Nigerian rivers vary in length. For instance, Rivers Niger and Benue are the two long rivers in Nigeria that have their sources from outside the country. Other short but notable rivers include, Sokoto, Osun, Ogun, Hadejia, Imo and Katsina, etc.

Self-Assessment Exercise 4

Answers:
1. Five rivers and their location in Nigeria
i. Kanji Dam (Niger)
ii. Shiroro Dam (Kaduna)
iii. Oueme River (Benin)
iv. Osun River (Osun)
v. Niger River (Niger)

2. Importance of water in the industrial sector:
Some industries rely so much on water that they have to be cited very close to a source of water (river) e.g. Nigerian Sugar Company Limited, Bacita, Kwara state; located near River, Niger. In the same vein, some rivers have been dammed for the purpose of generating electricity e.g. Kanji Dam (Niger).

Importance of water in the transport sector:
In the area of transport, inland rivers serve as means of inter-and intra-city movement of people and goods. People living in the riverine areas such as Onitsha, Benue, Bayelsa, Lagos; depend mainly on navigation for the movement of goods and people.

Importance of water in the agricultural sector
Agriculturally, water is important in food production. Rivers and streams harbour a wide variety of fish and other aquatic animals which serve as sources of proteins. A number of River Basin authorities have been established to raise the level of food production in the country in addition to providing job opportunities for the citizenry

UNIT 5 CONSERVATION OF NATURAL RESOURCES

Unit Structure

5.1 Introduction

It is an established fact that, man has an abundant array of resources at his disposal that are continuously being harnessed for the betterment of his well-being. For instance, the roles of these resources in the areas of nourishment, energy generation, housing, building, transportation and income generation are unquantifiable. But the rate at which these resources are disappearing from our environment is alarming, such that a drastic step is desirous in order to ensure continuous supply and availability of the resources. In the light of this, this unit will focus on efforts being made to ensure continuous and steady supply of resources through conservation.

5.2 Intended Learning Outcomes

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

- define the term ‘Conservation.’
- outline the needs for conservation of resources
- mention some organizations that are responsible for conservation in the world
- distinguish between renewable and non-renewable resources
- mention and explain the various methods of conservation of resources.

5.3 Conservation of Natural Resources

5.3.1 Meaning and the Need for Conservation

At the beginning of this unit, it was shown that the world's resources at man's disposal are fast disappearing from the Earth's surface. Man's activities in agriculture, fishing, dumping of refuse in water has made water bodies so bacteria-ridden, that he can neither drink nor swim in it. The water bodies are filled with junks and refuse that one can hardly imagine its once natural beauty.

The present environmental crisis has risen because man has in various ways, disrupted the natural cycle of life which characterize the ecosystem. As such, anything removed from the ecosystem needs a replacement. While deforestation, soil loss, degradation of water sheds, loss of vital water supplies and reduced agricultural productivity pose serious problems to a continued development, they are parts of broader problems that need urgent attention. Along with these are the problems of misuse of dangerous chemicals, shortages of domestic supply of energy, over fishing, overgrazing and marine pollution. These pose the serious problem of impeding our development in the near future.

With man's activities and associated environmental hazards and problems, the only saving grace for man is to embark on speedy and effective conservation efforts, and environmental awareness.

However, the main issue is whether or not man should exploit natural resources. The main crux of the matter is that he reserves the duty to preserve the total environment even while exploring some of its resources and exploitation must be sustained. Man's actions should be such that serve the needs and desires of the present generation, without compromising the survival and well-being of future generations. This is what conservation stands for. Hence we can define conservation as "the wise use of naturally available resources in such a way that wastage, loss and harm are prevented or reduced.

Generally, Conservation involves the exploitation of natural resources through rational use to ensure their continued use and preserving the quality nature of the natural resources and the environment.

Having discussed the meaning of conservation, what then are the rationale for conserving our natural resources? Reasons for conservation include.

To reduce indiscriminate destruction of the natural environment

ii) To preserve rare and valuable species of animals and plants for future generations to recognize; thereby preventing their extinction.
iii) To preserve naturally beautiful sceneries e.g. Osun-Osogbo, Ikogosi warm spring, etc., for their aesthetic values.
iv) To ensure a steady and continuous cycling of some scarce mineral resources such as gold, tin, silver, etc.
v) To enhance man's continued use of natural resources such as water, animals, plants and food resources.
vi) To ensure a steady supply of mineral resources for research purposes
vii) For preservation of natural ecosystem.

Self-Assessment Exercise 1

1. What do you understand by the word 'Conservation?'
2. Why is it necessary that man should conserve his natural resources?

5.3.2 Some International Concerns of Conservation

Conservation efforts in the world and indeed Nigeria have been a great concern for the United Nations (UN) to the extent that the EARTH SUMMIT was held between June 3-14 1992, held in Rio de Janerio, Brazil. Similarly, the UN held a conference on Environment and Development (UNCED) where the conference sought to promote environmental code of ethics.

The Global Ecological Marshall Plan (GEMP), by 1995 planned to seek support for saving the environment with the motto: "Keeping this earth habitable for our children. The GEMP has the following objectives to achieve.

i) To protect the climate
ii) To save the tropical forest
iii) To stabilize the population, and
iv) To promote East-West environmental cooperation.

The effect of increasing population of the world and its attendant poverty which has direct link with environmental degradation, has a high correlation between poverty and pollution. As noted by the World Commission and Development (WCED) also known as Brundtland Commission; a report which, in the World Health Magazine of 1990 says thus:

"Poverty *pollutes the environment, creating environmental chaos in different ways. Those who are poor and hungry will often destroy the environment in order to survive.''*

It went further to say that people's activities will result into such environmental hazards as deforestation, overgrazing (over use of marginal land), overcrowding, etc. The International Union for the Conservation of Natural Resources (IUCN) working under the auspices of Ecosystem Conservation Group (ECG) published a book "The Red Data Books"; the world's most comprehensive report on the conservation of biological species. The book published information about 2 86 types of fish, 189 amphibians and reptiles, 428 birds and 385 mammals. They also described 250 out of the estimated 25,000 endangered species of plants and 200 examples of threatened insects, molluscs, corals, worms and other invertebrates.

5.3.3 Conservation Agencies

There are bodies whether government or private which are responsible for conserving natural resources. These include

i) The Federal and State governments that make laws on conservation. For example, in 1983, the Nigeria Conservation Foundation was established to conserve the forests and wildlife.
ii) The Local governments also enact conservation bye-laws or regulations and enforce them.
iii) The Ministries of Agriculture and Natural Resources at the state and federal levels have officials and departments responsible for soil, forest, animals and water conservation.

Voluntary agencies or organizations also promote conservation.

Such include;

a) The Society for the Promotion of Kindness to Animals (SPKA) which are established in some of our educational institutions.
b) The Natural Wildlife Conservation Society (NWCS) is another body that has conservation concern.

c) In countries like the United Kingdom, there is the Royal Society for the Prevention of Cruelty to Animals (RSPCA.)

Self-Assessment Exercise 2

1. Mention any four international organizations that show concerns for conservation.
2. Mention any five agencies in charge of conservation in Nigeria

5.3.4 Conservation in Nigeria

Renewable and non-renewable resources form the core of the much depleted natural resources with which Nigeria is endowed. Renewable resources include those resources from forests, wildlife, fisheries, soil and water. These are natural resources which could be regenerated. Non-renewable resources cannot be regenerated. Examples are petroleum, limestone, coal etc. Uncontrolled and indiscriminate exploitation of these resources coupled with the ever increasing population has made conservation programmes inevitable in Nigeria.

Part of the conservation efforts in Nigeria had been the establishment of National parks which were set up to pursue conservation and balanced development of the nation's natural resources for the future, working towards sustainable development efforts for the much needed relief to the communities that live in harmony with the parks, the nation and humanity in general. The parks were set up to preserve endangered species such as elephants, leopards, pythons, chimpanzees, etc. It was also meant to preserve timber species that are being exploited on daily basis, and to prevent Deforestation (indiscriminate felling of trees), especially the mature ones.

Furthermore, the Natural Resources Conservation Council (NARESCON) was established by Decree No 50 of 1989 and inaugurated in February 1991 in fulfillment of the 1968 OAU conservation treaty on protection of plants and animals to which Nigeria is a party.

The Biological Resources Development Department under the auspices of the NARESCON has been promoting research into the development of indigenous vegetables, ornamentals and medicinal plants. It is also the duty of NARESCON to locate cites and species of conservation interest, sharing responsibility for the conservation of Trans-boundary biomes. It also emphasizes sustainable management areas in productive use of timber and other forest products.

Self-Assessment Exercise 3

Discuss Nigeria's efforts in conserving and preserving her natural floral (plants) and fauna (animals) communities.

4.3.5 Method of Conservation

There are three main methods of conservation which are:

i) Establishment of forest and games reserves in various locations to assist in preserving plant and animal life. A number of these games reserves are found located in different parts of Nigeria. Examples are Yankari game reserve (Bauchi state), Borgu games reserve (Niger state), Old Oyo National Parks (Oyo state), etc

ii) Establishment of laws in order to protect and conserve natural resources. This kind of law will prohibit

a) indiscriminate felling of trees without official permission
b) indiscriminate bush burning
c) deforestation and encourage afforestation or reforestation
d) the shooting of endangered species such as elephants
e) the exploitation of minerals by individuals
f) indiscriminate killing of fishes by means of toxic chemicals like Gamalin 20.
g) shooting of animals inside the games reserves without permission.

iii.) Education on Conservation by making people aware of the need for conservation through various steps such as;

a) showing programmes on the national television station about the need for conservation.
b) embarking on advertised campaigns for tree planting on television and radio, using slogans such as, “Plant a tree per day” and “Fell a tree and plant two in turn”, etc.
c) embark on radio campaign programmes against indiscriminate fishing with toxic chemicals.

Self-Assessment Exercise 4

List the three main methods of conservation.

5.4 Conclusion

In this unit, you have been exposed to the fact that degradation and destruction of environmental systems has assumed a massive proportion in the world, Nigeria inclusive. In some developing countries, it poses a serious threat to sustainable development. These and many other reasons have necessitated the clarion call for “conservation” to avoid total disappearance of natural resources from our environment.

5.5 References/Further Reading/Web Resources

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5.6 Possible Answers to Self-Assessment Exercises

Self-Assessment Exercise 1

Answer:

1. Conservation can be defined as "the wise use of naturally available resources in such a way that wastage, loss and harm are prevented or reduced.
2. Some of the reasons why it is necessary for man to conserve his natural resources include:

i) To reduce indiscriminate destruction of the natural environment
ii) To preserve rare and valuable species of animals and plants for future generations to recognize; thereby preventing their extinction.
iii) To preserve naturally beautiful sceneries
iv) To ensure a steady and continuous cycling of some scarce mineral resources such as gold, tin, silver, etc.
v) To enhance man's continued use of natural resources such as water, animals, plants and food resources.
vi) To ensure a steady supply of mineral resources for research purposes.
vii) For preservation of natural ecosystem.

Self-Assessment Exercise 2

Answer:

1. Four international organization that show concern for conservation

i. In countries like the United Kingdom, there is the Royal Society for the Prevention of Cruelty to Animals (RSPCA.)
ii. The International Union for the Conservation of Natural Resources (IUCN)
iii. The Global Ecological Marshall Plan (GEMP)
iv. The Natural Wildlife Conservation Society (NWCS) is another body that has conservation concern

2. Any five agencies in charge of conservation in Nigeria

a. Federal Environmental Protection Agency (FEPA) – defunct
b. Forestry Research Institute of Nigeria (FRIN)
c. National Biosafety Management Agency (NBMA)
d. National Environmental Standards and Regulations Enforcement Agency (NESREA)
e. National Oil Spill Detection and Response Agency (NOSDRA) Abuja Environmental Protection Board (AEPB) Read

Self-Assessment exercise 3

Answer

Some of Nigeria's efforts in conserving and preserving her natural flora and fauna communities are:
Establishment of National parks: National parks which were set up to pursue conservation and balanced development of the nation's natural resources for the future, working towards sustainable development efforts for the much needed relief to the communities that live in harmony with the parks, the nation and humanity in general. The parks were set up to preserve endangered species such as elephants, leopards, pythons, chimpanzees, etc. It was also meant to preserve timber species that are being exploited on daily basis, and to prevent Deforestation (indiscriminate felling of trees), especially the mature ones.

Establishment of Natural Resources Conservation Council (NARESCON): Natural Resources Conservation Council (NARESCON) was established by Decree No 50 of 1989 and inaugurated in February 1991 in fulfillment of the 1968 OAU conservation treaty on protection of plants and animals to which Nigeria is a party.

The Biological Resources Development Department under the auspices of the NARESCON has been promoting research into the development of indigenous vegetables, ornamentals and medicinal plants. It is also the duty of NARESCON to locate cites and species of conservation interest, sharing responsibility for the conservation of Trans-boundary biomes. It also emphasizes sustainable management areas in productive use of timber and other forest products.

Self-Assessment Exercise 4

Answer:
i. Establishment of forest and games reserves in various locations to assist in preserving plant and animal life.
ii. Establishment of laws in order to protect and conserve natural resources.
iii. Education on Conservation by making people aware of the need for conservation

1(a) Distinguish clearly between Renewable and Non-renewable resources in Nigeria, with two examples each.
(b) Enumerate the advantages of enacting a conservation law in a country
2(a) Define "Conservation"

(b) What actually informed the clarion call for conservation?

Answer:

1(a) Renewable are natural resources which could be regenerated. They include those resources from forests, wildlife, fisheries, soil and water.
Non-renewable resources cannot be regenerated. Examples are petroleum, limestone, coal etc.

(b) The advantage of enacting a conservation law in a country is to protect and conserve natural resources.

2(a) conservation can be defined as "the wise use of naturally available resources in such a way that wastage, loss and harm are prevented or reduced.

(b) Due to the fact that the world's resources at man's disposal are fast disappearing from the Earth's surface, hence, there is a huge need to conserve these resources. Reasons for conservation include:

i) To reduce indiscriminate destruction of the natural environment

ii) To preserve rare and valuable species of animals and plants for future generations to recognize; thereby preventing their extinction.

iii) To preserve naturally beautiful sceneries e.g. Osun-Osogbo, Ikogosi warm spring, etc, for their aesthetic values.

iv) To ensure a steady and continuous cycling of some scarce mineral resources such as gold, tin, silver, etc.

v) To enhance man's continued use of natural resources such as water, animals, plants and food resources.