EFFECT OF WASTE POLYMER MATERIALS ON THE ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY SCHOOL CHEMISTRY STUDENTS ON POLYMERIZATION IN BOSSO LOCAL GOVERNMENT AREA OF NIGER STATE

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ABSTRACT

The topic of the study is the Effect of waste polymer materials on the academic achievement of senior secondary school chemistry students on polymerization in Bosso Local Government Area of Niger State. The purpose of the study was to investigate the effect of waste polymer materials on the academic achievement of chemistry students. The work was a pre-test, post-test of control and experimental group. The research design is quasi- experimental design. The researcher formulated two research questions and two hypotheses that guided the study. The researcher used chemistry achievement test on waste polymer materials as an instrument of data collection, the population of the study is 3,600 and the sample size is 360 in four selected government secondary schools in Bosso Local Government Area of Niger State. The data collected was analyzed using mean, standard deviation for the research questions and ANCOVA for the hypothesis analysis at 0.05 level of significance. The validity is face and content validity, the reliability is tested to be 0.75 using Karl Pearson Correlation. The study revealed that the academic achievement of chemistry students depends on the use of instructional materials and teacher's attitude to arouse the interest of the chemistry students. Results also showed that there is no significant difference between male and female students taught with waste polymer materials. The following recommendations were made , Governments should organize workshops and seminars for teachers on the use of instructional materials to arouse students' interest and then educational planners should implement it in the school curriculum.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Over the years, science has been the study of both physical and natural world through observation of which chemistry is a branch which is also seen as the study of chemical reaction, composition and properties of matter. Polymerization as it's sub branch also deals with the process by which polymer are formed. The concept of polymerization can not be taught effectively without the aid of instructional material and as such students' achievement in chemistry has been a pressing issue with great concern to chemistry teachers and as well other stakeholders. Students academic achievement in every field of study is seen in their performance and external examination results after being taught of which this process has taken place over a stipulated period of time in both formal and informal educational setting, chemistry students are expected to show some level of competence and outstanding performance after being exposed to their senior secondary chemistry curriculum for over three years in their various schools.

In Nigeria, the level of wholesomeness and dedication of chemistry students as expected of them, in their overall performance in external examinations has not been incredible enough over the time. This has brought about perpetual concerns to science educators and especially chemistry instructors due to the fact that the primary blame of this downward trend in performance of chemistry students in external examinations has been shouldered on the poor understanding of the subject matter, techniques and strategies of teaching, non dedication and weak determination of teachers' obligation. Nevertheless, numerous strategies and aids have been diagnosed and a number of them employed in the study in order to make teaching and learning of science subjects significance and effective,

constructivist technique and the use of material resources in our environment have been recognized and suggested for their effectiveness in coaching and studying.

This state of affairs worsened mainly at this period of facts that technology usage has over ridden students interest in studying, with this gadgets like GSM via secondary school students has eroded deep into the educational interest of the students, this has made them carried away by using this gadgets negatively in preference to studying their books, instead for meaningful studying, making researches. The poor academic performance has been confirmed by the evaluation of results of the performance of candidates in May/June West African Examination in chemistry from 2010. Asiem, Basset & Essien (2005); WAEC (2006), Research and statistic unit, WAEC, Lagos, (2010), in accordance reported on the performance of students in WAEC chemistry from 2009-2010. In these reports, the mean performance score in chemistry essay was 35 in 2009, 36 in 2010. In practical's, the mean score in 2009 was 29 while in 2010 was 24. Also, included in the reports were the candidates strength and weakness in some difficult topics with suggested remedies and detailed comments on each questions. Different factors have been implicated as being answerable for the downward trend in success in chemistry outside examination. The factors ranging from eroded academic interest and distraction of students by the use of mobile phones, i- pads, laptops, lack of incentive for the academic teachers, poor teaching method, abstractness of the subjects or ideas, poor background information of the subjects, lack of dedication by teachers. Betiku (2002) grouped these factors as government- related, teacher-related, home-related, student-related, textbook-related. Teacher-related factors starting from how to educate, what to teach and approaches had been specifically diagnosed by Olorutebe, Orele & Oduttuy (2005) as the maximum vital elements affecting

the students' poor performance. Thus, the teachers resourcefulness and dedication to responsibility will move in a protracted way in neutralizing the impact of different factors and additionally enhance learner's fulfillment and other learning outcomes. Nwachukwu (2004) in settlement discovered the lukewarm attitudes of some teachers to duty as well as the depth of competence of instructors and suggested updating of teachers understanding by training and retraining programmes, organizing workshops, seminars and the use of incentives and rewards to inspire the teachers as well as recapture their zeal which has been varied to different areas of incomes.

From the ongoing, it is very clear that instructional material should be an irreplaceable part of teaching and learning of chemistry in schools and colleges. As such, instructional material are essential and a significant tools needed for teaching and Learning of school subjects to promote teachers efficiency and improve students learning outcomes. They make learning more interesting, practical, and realistic and appealing, they also enables both teachers and students to participate actively and effectively in lesson session. They give room for acquisition of skills, knowledge, self- confidence and self actualization. Abdu-Raheem (2011) asserted that non-availability and inadequacy of instructional materials are major causes of ineffectiveness of the school system and poor performance of students in schools. Ahmed (2003) confirmed that in most secondary schools in Nigeria, teaching and learning takes places under most unconducive environment without access to essential materials. Eniayewu (2005) posited that, it’s very important to use instructional aids for instructional delivery to make students acquire more knowledge and to promote academic standard. The use of instructional materials can enhance the learning outcome of students. For polymerization to be effectively taught, the teacher is expected to make use of

instructional material of which waste polymer materials was used for that purpose. Hence, this waste polymer materials are gotten from already used plastics such as plastic bag, plastic bottle container for drinks, footwear's, rubber-rings, clothes, cable insulators, glasses, automobile tyres, PVC roofing, crates, pipes, baby toys, banknotes, CD and DVD cases, foams and so many, all these are found in our environment causing pollution to us but can still be used in an innovative way for effective teaching and learning process on polymerization in chemistry. Effect of this waste polymer materials can go as far as stimulating the learners in learning the concept of polymerization which cannot be achieved without bringing to the knowledge of the students what polymer is all about and where this polymer can be found and their various applications for use. As such this waste polymer materials arising from plastic can be used in teaching students of chemistry polymerization which will bring about an increased interest and positive attitude towards the concept with a high academic achievement. Because, the effect of this waste polymer will equally expose the students the importance of keeping their environment clean. It is true, that this plastic waste has become land pollution to our environment because it is widely used in our everyday life due to their special properties such as durability, easy processing, and lightweight nature of their low cost of production. However, because of their stable and non bio- degradable nature, post consumer plastics become an issue to the environment. The growing amounts of waste are generated as plastics products which are commonly used only once before disposal. The alternative of practical techniques for solid waste management is redesign, reprocessing and recycling. Thus, even recycling is not the most profitable technique for the treatment of plastic waste but it should be constantly developed, the recycling of plastic waste only helps to conserve natural resources due to the polymeric

materials being made from oil and gas, as the synthetic polymers are made from crude oil. Therefore its effect on teaching is such that the students would be able to identify each plastics under the monomer of which it is built-up to form a polymer, uses and their various properties. For instance ethylene is the monomer built-up to form poly(ethylene) which has a wide range of application, example of such applications are the production of plastic bags, plastic bottle water containers, pipes, components of chemical plants, crates and items for electrical insulators. Another polymer with an enormous use is poly (methylmethacrylate) which is known from x-ray studies to be amorphous at the molecular level. The main applications for PMMA arise from the combination of its transparency and its good outdoor weathering properties, these are coupled with reasonable toughness and rigidity, so PMMA is a useful material in a range of glazing applications for example, it is used for display signs, street lamp fittings and ceiling light in factories and offices, eyeglasses and bottles for drinks. It is also the standard material for automobile rear lamp housing.

Importance of instructional material considering waste polymer materials in teaching polymerization.

Instructional materials have great enormous value in education:

i. They contribute to effective, permanent and transferable learning as such the students will be able to identify various waste polymer materials and classify each under their monomer, polymer, uses and also their various properties.
ii. They also help to increase teachers confidence if properly used. Their importance has also been deflected even outside the classroom.

Oyeyemi (1991) also pointed out that military leaders who applied visual methods in training people during the second world war claimed that 40 percent of instructional time is

saved while psychologist said that 85 percent of human knowledge is absorbed through the sense of sight.

Oyeyemi (1991) further listed some proven contributions of instructional material to learning. This includes:

a. They supply a concrete basis for conceptual thinking and reduce verbatim.
b. Produce high degree of interest
c. Contribute to growth and meaningful vocabulary development
d. Develop continuity of thoughts
e. Provide for experiences not easily obtained through other materials.
f. Stimulate self activity.
g. Provide motive for free - reading
h. Increase concentration
i. Make learning more permanent.

Also, instructional material tends to reinforce and add effectiveness of teaching and learning process which will provision for extension and beyond the physical limitation of the visual instructional material.

According to Agun (1998), instructional material if effectively utilized will accomplish the followings:

a. Stimulate interest on the part of the students and teachers
b. Enhance the viewer's sense of appreciation and understanding of the exercise.
c. Provide defined skills and techniques on the part of the users.
d. Factual information will be made easily available to the users.
e. Upgrade and enrich the experimental background of the students.

Hence, waste polymer material will provide the true picture of the concepts to be addressed; the material must be helped to broaden the intellectual experience of the students, providing them with values that would otherwise be inaccessible to their reach. The materials must be appropriate in relation to the age and comprehension level of the students. From all indication, instructional materials if properly utilized will enhance high academic achievements.

Consequently, the effect of waste polymer materials on senior secondary school students academic achievement on polymerization is such that the students would be able to understand the concept of polymerization and the students will be able to see, feel and touch different waste polymer materials and be able to distinguish them into their various polymer name. Hence, the learning outcome is such that the students will have interest learning the concept with a good academic achievement and a positive attitude towards their environments, knowing that these plastics are all over their surroundings.

1.2 Statement of the research problem:

In view of the abstract nature of chemistry, polymerization can not be taught effectively without the aid of instructional materials and as such waste polymer materials arising from plastics disposed in our environment was used in teaching this concept. Therefore, this study sought to investigate the effective of waste polymer materials on senior secondary school students academic achievement on polymerization in chemistry. As such different types of learners would be carried along. According to the popular theory, the VARK model identifies four primary types of learners which are visual, auditory, reading/writing and Kinesthetics learners. Each learning type responds best to a different method of teaching. More so, without the use of this waste polymer materials as an instructional aids,

the concept would not be properly understood by the students and their academic achievement could be below average which could lead to poor academic performance amongst students.

1.3 Aim and objective of the study

The main aim of the study is to critically analyze the effect of waste polymer materials on the academic achievement of senior secondary school chemistry students on polymerization in chemistry Bosso local Government Area of Niger State.

Objectives of the study:

1. The mean achievement scores of chemistry students taught with waste polymer materials and those taught without waste polymer materials.
2. To determine if such effect depends on gender of students.

1.4 Research questions

In the field of chemistry, it has been observed that the use of instructional material plays a major role to the teaching and learning of chemistry. Based on the above observation, the researcher generated this questions to guide the study:

1. What is the mean achievement scores of chemistry students taught with waste polymer materials on polymerization and those taught without waste polymer materials?
2. What are the mean achievement scores of male and female students taught with waste polymer materials on polymerization?

1.5 Research Hypothesis

The following hypothesis were generated for the study:

Ho_1: There is no significant difference in the mean achievement scores of chemistry students taught with waste polymer materials on polymerization and those taught without waste polymer in the experimental and control group.

Ho_2 : There is no significant difference in the mean achievement scores of male and female students taught with waste polymer materials on polymerization in chemistry.

1.6 Significance of the study

Students: The study will change students attitude towards polymerization in chemistry since the use of waste polymer materials in the teaching and learning would make the lesson very interesting by having direct contact with the materials by touching and feeling different waste plastics thereby enhancing their performance on the concept in chemistry. This is because according to Nwadinigwe (2000), Learning is a process through the use of instructional material.

School: The study will help the school to have a well equipped laboratory and a good environment on the manufacturing of improvised and standardized resource material suitable for teaching and learning without waiting for government. It also helps to know the number of students in the classroom and proper monitoring of teachers or students teachers on the use of instructional material.

Text book writers: Inclusion of instructional material needed to teach particular topics base on specific objectives would be of good reminder to the authors.

Chemistry teachers: The effective use of standardized or improvised materials to make the teaching effective and productive base on observation and evaluation will be a reminder to teacher in order to improve in their method of teaching and bringing to the knowledge of the students what is expected of them to learn by the use of available instructional materials. This is in line with assertion of Ekwueme and Igwe (2001) who noted that, it is only teachers who will guarantee effective and adequate usage of instructional material and thereby facilitate success. He further says that instructional materials are of high value in importing information, clarifying difficult and abstract concepts. Thus, the teachers should endeavor to make available the needed instructional materials for teaching which will facilitate the teaching and learning process.

Curriculum planner: when developing syllabus and scheme of work, the provision of instructional material should be made available with related topics and days of supervision of teachers with instructional materials to ensure the objectives are met.

Government: Manufacturing and provision of instructional materials to schools base on the subjects offered, organizing of seminars and workshop on the appropriate usage of instructional material should be cared for especially in the area of science and technology.

1.7 Scope of the study

This study is focused on investigating the effect of waste polymer materials on the academic achievement of senior secondary school chemistry students on polymerization in Bosso local Government Area of Niger state. It was carried out in senior secondary class three (SS III) public schools in Bosso local Government. But was restricted to four senior secondary schools.

The schools limited to Bosso local Government Area of Niger state:

i. Day Secondary School Maikunkele 'A'

ii. Bosso Secondary School Minna.

iii. Day Secondary School Maitumbi.

iv. Sir Ahmadu Bello Model Secondary School.

The topics are:

1. Polymer
2. Mechanical properties of polymer.

1.7 Basic assumptions of the study.

The researcher made the following assumptions that:

a. The availability of instructional material, waste polymer materials such as plastic bags, plastic bottle water containers, foot wears, clothes, cable insulators, automobile tyres, banknotes and many others contributes to the academic achievement of students on polymerization in chemistry.

b. The good use of instructional material is dependent on the teachers qualification and experience to influence students academic achievement on polymerization in chemistry.

c. Students taught with instructional material do perform better than the students taught without instructional material.

d. The factors affecting the use of instructional material are built-up on the class size or students population.

1.8 Operational definition of terms/ Abbreviations

Polymerization: This refers to the process by which polymers are formed.

Polymer: This refers to a large molecule built -up from numerous smaller molecules called monomers.

Monomers: Are those small molecules used as the basic building blocks for these large molecules.

Spinnability: Is the ability for polymer to be converted to filaments.

Dyeability: Meaning a polymer that has a good chemical resistance.

Resilience: Is the ability for a polymer to be stretch and retract rapidly.

PE: stands for polyethylene

PS: stands for polystyrene.

PP: stands for polypropylene

PMMA: stands for polymethylmethacrylate.

PVC: stands for polyvinylchloride

PVA: stands for polyvinyl acetate

LDPE: stands for low density polyethylene.

HDPE: stands for high density polyethylene

Tm : Polymer melting temperature

Tg: stands for glass transition temperature which is a transition between the glassy state where in the mobility of the segment is frozen and the elastic state where in the chain mobility increases with rise in temperature. When Tg of a polymer is below room temperature, such polymer has property of flexibility and softness while polymer with Tg above room temperature are hard, rigid, strong and stiff.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter treats the review of the related literature under the following headings. Conceptual framework, theoretical framework, empirical studies and summary of literature review.

2.1.1 Conceptual frame work

a. Teaching.
b. Instructional material.
c. Waste polymer materials.
d. Concept of polymerization in chemistry.
e. Gender.
f. Teaching method.
g. Students academic achievement on polymerization in chemistry.

2.1.2 Theoretical frame work

a. Jean Piaget cognitive development and behavioral theory
b. Constructive theory

2.1.3 Empirical studies

- Influence of instructional materials on the academic performance of senior secondary school students in chemistry.
- Improvisation of instructional materials in an inclusive environment in Nigeria.

- Effect of instructional material on the achievement and retention of biology.
- Effect of Gender on students achievement in chemistry using inquiry role instructional mode.
- Effect of locally available instructional materials on students achievement in chemistry in secondary schools.
- Effect of instructional materials on Academic achievement of physics students in secondary schools.
- Influence of instructional materials on the academic performance of students in Agricultural Science in secondary schools.
- Teaching interactive Art lessons with recycled waste materials as instructional Resources.

2.1.4 Summary of literature review

2.2 Conceptual frame work

TEACHING: Teaching in education is the concerted sharing of knowledge and experience which is usually organize within a discipline and more generally,the provision of stimulus to the psychological and intellectual growth of a person by another artifact.. Hence teaching at any degree requires that students be exposed to some form of simulation.

INSTRUCTIONAL MATERIAL, By Ikerionwu, (2000) refers to instructional materials as objects or devises that help the teacher to make learning meaningful to the learners. Instructional materials, which are educational inputs, are of vital importance to the teaching of any subject in the school curriculum. Wales (2000), opined that the use of instructional materials would make discovered facts glued firmly to the memory of students. A teacher

who uses suitable instructional materials to supplement his teaching will assist students progressive and creative thinking as well as assist them become enthusiastic, Ekwueme and Igwe (2001).

Instructional materials are teaching aids or materials used to illustrate the teaching process and makes instruction more comprehensive to the learner. Instructional aids are devices or pieces of equipment, graphics or sound representation or illustration that helps pupils to learn. Instructional materials refer to objects or devices which help the teacher to make learning meaningful to the learners, (Ikenionwu, 2000). Ezegbe, (2000), classified them into two; visual materials made up of reading and non reading materials, and audio visual materials comprising electrically operated and none electrically operated materials. Yero (2000) mentioned types of instructional aids, these are:

Visual Aids: - These include chalk board, posters, bulletin board, displayed models, motion pictures, slides, projected transparences, flip chart and flannel boards. In fact they represent all the materials the eyes can focus and is used by the teacher or instructor in delivering the lesson to the pupils, it makes visual impression.

Auditory Aids: - These include record players, tape recorders and language laboratory and all that appeals to the sense of hearing only.

Audio-visual Aids: - These include aids that make use of both sight and hearing such as sound motion, pictures, slide on sound and television. Instructional materials have brilliant value in education. In this era of science and technology, the government of Nigeria is admonishing the use and easy access for computer training and usage (Minister of Education 2014). The ITC training i.e. instructional technology communication between teachers and students is for better improved in science and technology. The modern and

latest instructional aid in this 21st century is the use of instructional technology media such as making use of computer, television, projectors, slides, filmstrips etc, which give access to other information and easy development The use of computer in modern teaching makes it faster because facts and contents are stored and recalled; it generates lots of advantages such as self confidence in the part of students and also improves teaching and learning. According to Aduwa (2005), these materials and resources includes, audio tapes recorders, video tape recorders, slide projectors, still pictures, programmed instructional film strips, maps, chart, graphs and many more, which provide a variety of learning experiences. The above reviewed works have a relationship with the present study as they all focused on some elements of instructional materials as waste polymer materials serves the purpose, this waste polymer materials which serves as the tools needed for teaching and learning of polymerization in chemistry and also serves as a gear towards the assimilation and understanding of the concept which will promote teachers' efficiency and improve students' performance. They make learning more interesting, practical, realistic and appealing. They also enable both the teachers and students to participate actively and effectively in lesson sessions. They give room for acquisition of skills and knowledge and development of self- confidence and self- actualization. Instructional materials include items such as: kits, textbooks, magazines, newspapers, pictures, recording videos etc. At this time that knowledge has unfold extensively, talk 'n' chalk and then oral teaching cannot be the key to successful pedagogy. According to Akude and Ofoefuma (1990) learners should embrace the use of resources to maximize learning. The use of teaching aids give way to varieties to teaching and learning such as project method, self-learning, discovery learning and others yet to be known. Teachers should consequently make use of

instructional materials for impacting knowledge. Teaching without instructional materials would look like a dancer without listening to musical instrument. Okpala (2010) reported that government indicated that efforts would be made, in providing some educational services such as counseling and educational resource centre amongst others and also maintained that teaching should be practical, exploratory and experimental in nature. According to Eya (2006) it serves as a key challenge for the development of the future of education in Nigeria through ICT emergence. Instructional materials are wide varieties of equipment and materials used for teaching and learning by teachers to stimulate self-activity on the part of the students. The teaching of polymerization in chemistry without instructional materials will certainly result to poor academic achievement. Poor academic achievement in chemistry could also be attributed to so many other factors such as, low interest of students in chemistry, inadequate motivation from teachers, poor incentives to chemistry teachers, lack of adequate supply of instructional material, lack of qualified teachers, use of teacher centered instructional strategies, inadequate use of instructional materials and use of abstract standardized materials (Nwagbo 2006). Among these factors, the use of improvised instructional strategy is considered as an important factor in this study. This implies that the mastery of polymerization concepts in chemistry was not fully achieved without the use of instructional resources that the students are abreast with. According to Okebukola (2004), the poor state of laboratory facilities and inadequate use of instructional materials has constituted a cog in the wheel of students' achievement in the Senior Secondary School Examination. The verbal exposition does not promote skill acquisition, objectivity, and critical thinking abilities that will enable the child to function effectively in the society. This according to the researcher leads to poor achievement of

students. Okebukola and Jegede (1986) stressed that a professionally qualified teacher no matter how well trained, would be unable to put his ideas into practice if the school setting lacks the equipment and material resources necessary for him or her to translate his competence into reality.

2.2.1 Waste polymer materials.

A research on polymer waste management by Huang.(1995). The increasing volumes of synthetic polymers are manufactured for various applications. The disposal of the used material is becoming a serious problem. Unlike natural polymers, most synthetic macromolecules can not be assimilated by micro organisms. Although polymers represent slightly over 10% of total municipal waste. The problem of non biodegradibility is highlighted by over flowing landfills, polluted marine waters and unsightly litter. Existing Government regulations in Europe and anticipated regulations in the united states will greatly limit the use of polymers in large volume application (packaging plastics, water treatment, paper and textile sizing e.t.c) Unless acceptable, means of waste management are available. Total management of polymer waste requires complementary combination of biodegradation, incineration and recycling. Biodegradation is the most desirable long-term future solution and requires intensive research and development before it becomes practical. On the other hand, incineration and recycling can become operational in a relatively short time for the near future.

Over the years polymers have been recycled, such that polymer recycling has an advantage with polymer synthesis due to their durability. However, in this age of environmental awareness, durability can also be limited because polymers particularly plastics and rubber

are highly visible components of the society waste stream, there are variety of addressing the polymer waste:

I. Making polymer degradable for composting in sanitary landfills.

II. Incinerating combustible polymer for energy recovering.

III. Recycling.

IV. Finding innovative uses for used polymers.

Some used automobile tyres for example are grinded and blended into molded rubber products or Asphalt paving materials while others are used to produce barrier reefs, such measures however do little to reduce the amount or magnitude of scrab tyre discarded each year. While recycling of paper(primarily the natural polymer cellulose) has been effect for a good number of years. Recycling of plastics is still in it's infancy with only 2 - 10% being recycled in a world wide basis, in 1988. The society of the plastic industry (SPI) adopted the voluntary plastic container coding system to aid in the identification of various type of plastics for recycling, the code now widely accepted consist of series of symbol in printed or molded on the bottom of the plastic container, each symbol consist of a number in the centre of a three(3) arrow triangle with identifying letter printed below.

Recycling methodology varied from remolding, blinding and depolymerization to monomers with subsequent depolymerization. Polyethylene terephthalate bottles for example are reduced to monomers by hydrolysis or alcoholysis which are then repolymerized to polyester. For fibres or film applications or reformulated into polyurethanes or thermosetting unsaturated polyester, polyethylene terephthalate and high density polyethylene share more than 70% of the demand for recycled plastics. The recycling industry has expressed economic difficulties because most virgin plastics are not

only of better quality than their recycled counterpath but are often less expensive. Nevertheless, a considerable research effort is now directed towards recycling and the demand for recycled polymers are inevitably increased as automated sorting methods are refined in the quality. The above reviewed work has a relationship with the present study as they all focused on how to properly manage polymer wastes. As such, in this study polymer wastes is managed by reuse which is finding innovative uses for used polymers, in this case waste polymer materials serves as an instructional material to the researcher in teaching polymerization in chemistry. Hence, the reuse method of managing polymer wastes has positive effect on students learning outcome such that different waste polymer materials are presented to students during the teaching and learning process. More so, this will make the learning more interesting, practical, realistic and appealing. It will also enable both the teachers and students to participate actively and efficiently during the lesson sessions.

2.2.2 Concept of polymerization in chemistry.

Polymerization is the process in which polymer are formed. Therefore, the word polymer is derived from the Greek words 'poly' meaning many and 'meros' meaning part. They often then infer that this term applies to giant molecules built up of large number of interconnected monomer units. According to Seymour and Carraher polymer chemistry Dekker 1993. Saw polymers as substance containing a large number of structural units joined by the same type of linkage. These substances often form into a chain-like structure. Polymers in the natural world have been around since the beginning of time. Starch, cellulose, and rubber all possess polymeric properties. Man-made polymers have been studied since 1832. Today, the polymer industry has grown to be larger than the aluminum, copper and steel industries combined. Polymers already have a range of applications that

far exceeds that of any other class of material available to man. Current applications extend from adhesives, coatings, foams, and packaging materials to textile and industrial fibers, **elastomers,** and structural plastics. Polymers are also used for most **composites**, electronic devices, biomedical devices, optical devices, and precursors for many newly developed high-tech ceramics.

2.2.3 Applications of Polymers: Agriculture and Agribusiness

Polymeric materials are used in and on soil to improve aeration, provide mulch, and promote plant growth and health.

Medicine: Many biomaterials, especially heart valve replacements and blood vessels, are made of polymers like Dacron, Teflon and polyurethane.

Consumer Science: Plastic containers of all shapes and sizes are light weight and economically less expensive than the more traditional containers. Clothing, floor coverings, garbage disposal bags, and packaging are other polymer applications.

Industry: Automobile parts, windshields for fighter planes, pipes, tanks, packing materials, insulation, wood substitutes, adhesives, matrix for composites, and elastomers are all polymer applications used in the industrial market.

Sports: Playground equipment, various balls, golf clubs, swimming pools, and protective helmets are often produced from polymers.

Future Trends: Just as nature has used biological polymers as the material of choice, mankind will chose polymeric materials as the choice material. Humans have progressed from the Stone Age, through the Bronze, Iron, and Steel Ages into its current age, the Age of Polymers. An age in which synthetic polymers are and will be the material of choice.

Polymeric materials have a vast potential for exciting new applications in the foreseeable future. Polymer uses are being developed in such diverse areas as: conduction and storage of electricity, heat and light, molecular based information storage and processing, molecular composites, unique separation membranes, revolutionary new forms of food processing and packaging, health, housing, and transportation. Indeed, polymers will play an increasingly important role in all aspects of your life.

The large number of current and future applications of polymeric materials has created a great national need for persons specifically trained to carry out research and development in polymer science and engineering. A person choosing a career in this field can expect to achieve both financial reward and personal fulfillment.

Scientific Principles: The field of polymers is so vast and the applications so varied, that it is important to understand how polymers are made and used. Since there are over 60,000 different plastics vying for a place in the market, knowledge of this important field can truly enrich our appreciation of this wonder material. Companies manufacture over 30 million tons of plastics each year, and spend large sums on research, development, and more efficient recycling methods. Below we learn some of the scientific principles involved in the production and processing of these fossil fuel derived materials known as polymers.

Polymerization Reactions: The chemical reaction in which high molecular mass molecules are formed from monomers is known as polymerization. There are two basic types of polymerization, chain-reaction (or addition) and step-reaction (or condensation) polymerization.

Chain-Reaction Polymerization: One of the most common types of polymer reactions is chain-reaction (addition) polymerization. This type of polymerization is a three step process involving two chemical entities. The first, known simply as a monomer, can be regarded as one link in a polymer chain. It initially exists as simple units. In nearly all cases, the monomers have at least one carbon-carbon double bond. Ethylene is one example of a monomer used to make a common polymer.

The other chemical reactant is a catalyst. In chain-reaction polymerization, the catalyst can be a free-radical peroxide added in relatively low concentrations. A free-radical is a chemical component that contains a free electron that forms a covalent bond with an electron on another molecule. The formation of a free radical from an organic peroxide is shown below:

In this chemical reaction, two free radicals have been formed from the one molecule of R2O2. Now that all the chemical components have been identified, we can begin to look at the polymerization process.

Step 1: Initiation: The first step in the chain-reaction polymerization process, initiation, occurs when the free-radical catalyst reacts with a double bonded carbon monomer, beginning the polymer chain. The double carbon bond breaks apart, the monomer bonds to the free radical, and the free electron is transferred to the outside carbon atom in this reaction.

Step 2: Propagation: The next step in the process, propagation, is a repetitive operation in which the physical chain of the polymer is formed. The double bond of successive monomers is opened up when the monomer is reacted to the reactive polymer chain. The free electron is successively passed down the line of the chain to the outside carbon atom.

This reaction is able to occur continuously because the energy in the chemical system is lowered as the chain grows. Thermodynamically speaking, the sum of the energies of the polymer is less than the sum of the energies of the individual monomers. Simply put, the single bounds in the polymeric chain are more stable than the double bonds of the monomer.

Step 3: Termination: Termination occurs when another free radical (R-O.), left over from the original splitting of the organic peroxide, meets the end of the growing chain. This free-radical terminates the chain by linking with the last CH2. component of the polymer chain. This reaction produces a complete polymer chain. Termination can also occur when two unfinished chains bond together. Both termination types are diagrammed below. Other types of termination are also possible.

This exothermic reaction occurs extremely fast, forming individual chains of polyethylene often in less than 0.1 second. The polymers created have relatively high molecular weights. It is not unusual for branches or cross-links with other chains to occur along the main chain.

Step-Reaction Polymerization: Step-reaction (condensation) polymerization is another common type of polymerization. This polymerization method typically produces polymers of lower molecular weight than chain reactions and requires higher temperatures to occur. Unlike addition polymerization, step-wise reactions involve two different types of di-functional monomers or end groups that react with one another, forming a chain. Condensation polymerization also produces a small molecular by-product (water, HCl, etc.). Below is an example of the formation of Nylon 66, a common polymeric clothing material, involving one each of two monomers, hexamethylene diamine and adipic acid, reacting to form a dimer of Nylon 66.

At this point, the polymer could grow in either direction by bonding to another molecule of hexamethylene diamine or adipic acid, or to another dimer. As the chain grows, the short chain molecules are called oligomers. This reaction process can, theoretically, continue until no further monomers and reactive end groups are available. The process, however, is relatively slow and can take up to several hours or days. Typically this process breeds linear chains that are strung out without any cross-linking or branching, unless a tri-functional monomer is added.

Polymer Chemical Structure: The monomers in a polymer can be arranged in a number of different ways. As indicated above, both addition and condensation polymers can be linear, branched, or cross-linked. Linear polymers are made up of one long continuous chain, without any excess appendages or attachments. Branched polymers have a chain structure that consists of one main chain of molecules with smaller molecular chains branching from it. A branched chain-structure tends to lower the degree of crystallinity and density of a polymer. Cross-linking in polymers occurs when primary valence bonds are formed between separate polymer chain molecules.

Chains with only one type of monomer are known as homopolymers. If two or more different type monomers are involved, the resulting copolymer can have several configurations or arrangements of the monomers along the chain. The four main configurations are depicted below:

Polymer Physical Structure: Segments of polymer molecules can exist in two distinct physical structures. They can be found in either crystalline or amorphous forms. Crystalline polymers are only possible if there is a regular chemical structure (e.g., homopolymers or alternating copolymers), and the chains possess a highly ordered

arrangement of their segments. Crystallinity in polymers is favored in symmetrical polymer chains, however, it is never 100%. These semi-crystalline polymers possess a rather typical liquefaction pathway, retaining their solid state until they reach their melting point at Tm.

Amorphous polymers do not show order. The molecular segments in amorphous polymers or the amorphous domains of semi-crystalline polymers are randomly arranged and entangled. Amorphous polymers do not have a definable Tm due to their randomness. At low temperatures, below their glass transition temperature (Tg), the segments are immobile and the sample is often brittle. As temperatures increase close to Tg, the molecular segments can begin to move. Above Tg, the mobility is sufficient (if no crystals are present) that the polymer can flow as a highly viscous liquid. The viscosity decreases with increasing temperature and decreasing molecular weight. There can also be an elastic response if the entanglements cannot align at the rate a force is applied (as in silly putty). This material is then described as visco-elastic. In a semi-crystalline polymer, molecular flow is prevented by the portions of the molecules in the crystals until the temperature is above Tm. At this point a visco-elastic material forms. These effects can most easily be seen on a specific volume versus temperature graph.

Members of the Polymer Family: Polymers can be separated into two different groups depending on their behavior when heated. Polymers with linear molecules are likely to be thermoplastic. These are substances that soften upon heating and can be remolded and recycled. They can be semi-crystalline or amorphous. The other group of polymers is known as thermosets. These are substances that do not soften under heat and pressure and

cannot be remolded or recycled. They must be remachined, used as fillers, or incinerated to remove them from the environment.

Thermoplastics: Thermoplastics are generally carbon containing polymers synthesized by addition or condensation polymerization. This process forms strong covalent bonds within the chains and weaker secondary Van der Waals bonds between the chains. Usually, these secondary forces can be easily overcome by thermal energy, making thermoplastics moldable at high temperatures. Thermoplastics will also retain their newly reformed shape after cooling. A few common applications of thermoplastics include: parts for common household appliances, bottles, cable insulators, tape, blender and mixer bowls, medical syringes, mugs, textiles, packaging, and insulation.

Thermosets: Thermosets have the same Van der Waals bonds that thermoplastics do. They also have a stronger linkage to other chains. Strong covalent bonds chemically hold different chains together in a thermoset material. The chains may be directly bonded to each other or be bonded through other molecules. This "cross-linking" between the chains allows the material to resist softening upon heating.

Thus, thermosets must be machined into a new shape if they are to be reused or they can serve as powdered fillers. Although thermosets are difficult to reform, they have many distinct advantages in engineering design applications including:

1. High thermal stability and insulating properties.
2. High rigidity and dimensional stability.
3. Resistance to creep and deformation under load.
4. Light-weight.

A few common applications for thermosets include epoxies (glues), automobile body parts, adhesives for plywood and particle board, and as a matrix for composites in boat hulls and tanks.

Polymer Processing: There are five basic processes to form polymer products or parts. These include; injection molding, compression molding, transfer molding, blow molding, and extrusion. Compression molding and transfer molding are used mainly for thermosetting plastics. Injection molding, extrusion and blow molding are used primarily with thermoplastics.

Injection Molding: This very common process for forming plastics involves four steps:

1. Powder or pelletized polymer is heated to the liquid state.
2. Under pressure, the liquid polymer is forced into a mold through an opening, called a sprue. Gates control the flow of material.
3. The pressurized material is held in the mold until it solidifies.
4. The mold is opened and the part removed by ejector pins.

Advantages of injection molding include rapid processing, little waste, and easy automation. Molded parts include combs, toothbrush bases, pails, pipe fittings, and model airplane parts.

Compression Molding: This type of molding was among the first to be used to form plastics. It involves four steps:

1. Pre-formed blanks, powders or pellets are placed in the bottom section of a heated mold or die.
2. The other half of the mold is lowered and is pressure applied.
3. The material softens under heat and pressure, flowing to fill the mold. Excess is squeezed from the mold. If a thermoset, cross-linking occurs in the mold.

4. The mold is opened and the part is removed.

For thermoplastics, the mold is cooled before removal so the part will not lose its shape. Thermosets may be ejected while they are hot and after curing is complete. This process is slow, but the material moves only a short distance to the mold, and does not flow through gates or runners. Only one part is made from each mold.

Transfer Molding: This process is a modification of compression molding. It is used primarily to produce thermosetting plastics. Its steps are:

1. A partially polymerized material is placed in a heated chamber.
2. A plunger forces the flowing material into molds.
3. The material flows through sprues, runners and gates.
4. The temperature and pressure inside the mold are higher than in the heated chamber, which induces cross-linking.
5. The plastic cures, is hardened, the mold opened, and the part removed.

Mold costs are expensive and much scrap material collects in the sprues and runners, but complex parts of varying thickness can be accurately produced.

Blow Molding: Blow molding produces bottles, globe light fixtures, tubs, automobile gasoline tanks, and drums. It involves:

1. A softened plastic tube is extruded
2. The tube is clamped at one end and inflated to fill a mold.
3. Solid shell plastics are removed from the mold.

This process is rapid and relatively inexpensive.

Extrusion: This process makes parts of constant cross section like pipes and rods. Molten polymer goes through a die to produce a final shape. It involves four steps:

1. Pellets of the polymer are mixed with coloring and additives.
2. The material is heated to its proper plasticity.
3. The material is forced through a die.
4. The material is cooled.

An extruder has a hopper to feed the polymer and additives, a barrel with a continuous feed screw, a heating element, and a die holder. An adapter at the end of an extruder blowing air through an orifice into the hot polymer extruded through a ring die produces plastic bags and films.

Table 1: Comparison of polymer processing techniques for thermoplastics and thermosets

Process	**Thermoplastic (TP) or Thermoset (TS)**	**Advantages**	**Disadvantages**
Injection Molding	TP, TS	It has the most precise control of shape and dimensions, is a highly automatic process, has fast cycle time, and the widest choice of materials.	It has high capital cost, is only good for large numbers of parts, and has large pressures in mold (20,000 psi).
Compression Molding	TS	It has lower mold pressures (1000 psi), does minimum damage to reinforcing fibers (in composites), and large parts are possible.	It requires more labor, longer cycle than injection molding, has less shape flexibility than injection molding, and each charge is loaded by hand.
Transfer Molding	TS	It is good for encapsulating metal parts and electronic circuits.	There is some scrap with every part and each charge is loaded by hand.
Blow Molding	TP	It can make hollow parts (especially bottles), stretching action improves mechanical properties, has a fast cycle, and is low labor.	It has no direct control over wall thickness, cannot mold small details with high precision, and requires a polymer with high melt strength.
Extrusion	TP	It is used for films, wraps, or long continuos parts (ie. pipes).	It must be cooled below its glass transition temperature to maintain stability.

2.2.4 Mechanical Properties of Polymer

The majority of polymers of commercial or technical importance are organic in nature. Yet unlike the low molecular weight compounds of conventional organic chemistry, they are not simply liquids or relatively low melting point crystalline solids. Instead, they presents themselves in a variety of physical forms, including liquids, rubbers and brittle glasses or as relatively soft and flexible solids. The physical properties of these materials can be explained, broadly at least by their underlying molecular structure. Polymers that are cross linked into three dimensional network may be very brittle; uncross linked materials are much less so. Crystallinity of certain regions of the polymer may impart rigidity, as if the polymer is below its glass transition temperature, may simple intermolecular forces between individual macromolecules. In addition there may be a marked anisotropy of behavior, depending on the precise direction and orientation of the polymer mole When we consider the mechanical properties of polymeric materials and in particular when we design methods of testing them, the parameters most generally considered are stress, strain and young's modulus. Stress is defined as the force applied per unit cross sectional area, and has the basic dimension of N/m^2 in SI units. These units are alternatively combined into the derived unit of Pascal's (abbreviated as Pa). In practice they are extremely small, so that real materials needed to be tested with a very large number of Pa in order to obtain realistic measurements of their properties. Strain is a dimensionless quantity, defined as increase in length of the specimen per unit original length. It represents the response of the material to the stress applied to it. The ratio of stress to strain is known as Young's modulus. This parameter also has dimensions of force per unit area, but is a characteristic of the material not merely a value imposed on it by a specific set of test condition, as is the case for stress

itself. Materials for which the evaluation of Young's modulus is particularly appropriate are those which most closely approximate to an ideal elastic solid. These materials obey Hooke' law, and for such materials the assumption that strain occurs immediately on applying the stress is essentially correct. And for such a solid, releasing the stress causes an immediate return to the original dimensions.

Mode of failure in polymer, there are two types of fracture or failure in polymer with minimal deformation, which are brittle fracture, in which the material experiences a sudden rupture such as polystyrene and poly methylmethacrylate, and ductile fracture, in which there is substantial deformation of the specimen in the form of necking and narrowing, prior to breaking such as polyethylene and Cis-1,4-poly isoprene

2.2.5 Historical Development of Polymers

Polymers have existed in natural form since life began and those such as DNA, RNA, proteins and polysaccharides play crucial roles in plant and animal life. From the earliest times, man has exploited naturally-occurring polymers as materials for providing clothing, decoration, shelter, tools, weapons, writing materials and other requirements. However, the origin of today's polymer industry is commonly accepted as being the nineteenth century when important discoveries were made concerning the modification of certain natural polymers. In eighteenth century, Thomas Hancock gave an idea of modification of natural rubber through blending with certain additives. Later on, Charles Goodyear improved the properties of natural rubber through vulcanization process with sulfur. The Bakelite was the first synthetic polymer produced in 1909 and was soon followed by the synthetic fiber, rayon, which was developed in 1911. The systematic study of polymer science started only

about a century back with the pioneering work of Herman Staudinger. Staudinger has given a new definition of polymer. He in1919 first published this concept that high molecular mass compounds were composed of long covalently bonded molecules.

The concept of polymerization was originally applied to the situation in which molecules had identical empirical formula but very different chemical and physical properties. Examples are benzene and acetylene. However, there are numbers of classification: one is to adopt the approach of using their response to thermal treatment and to divide them into thermoplastic and thermosets. Another is based on the nature of the chemical reaction employed in the polymerization. Here, the two major groups are the condensation and addition polymers. But the structures and properties of polymers has severally resulted in the common poly (ethylene) which may result from either High pressure processes, Ziegler processes, the Philips process or the standard oil(Indiana) process, poly(propylene), poly(methyl methacrylate), poly(styrene), poly(vinyl chloride, PVC), Nylon, Expoxy, Resins, phenol- formaldehyde polymers, Amino Resins, poly(tetrafluoroethylene, PTFE), polymethanes, poly(ether ketones), silicones, naturally occurring polymers, cellulose, starch, natural rubber, protein and poly(3- hydroxybutynate).

But basically, Saunder (1998) asserts that a polymer is a large molecule built up from numerous smaller molecules. These large molecules may be linear, slightly branched or highly interconnected. In the latter case, the structure develops into a large three - dimensional network. The smaller molecules used as a basic building blocks for these large molecules are known as monomers. A good example is the commercially important material poly(vinyl chloride) made from the monomer vinyl chloride (Nicholson, 2011). The repeat units in the polymer usually correspond to the monomer from which the

polymer was made. There are exceptions to this, though poly (vinyl chloride) is formerly considered to be made up of vinyl alcohol [CH_2CHOH] repeat units but there is, in fact no such monomers as vinyl alcohol. The appropriate molecular unit exists in the alternative tautomeric form, ethanol CH_3CHO. To arrive at this polymer, it is necessary first to prepare poly (vinyl ethanoate) from the monomer vinyl ethanoate, and then to hydrolyse the product to yield the polymeric alcohol. The size may be defined either by mass or by number of repeat units in the molecule, it is this later indicator of size that is called the Degree of polymerization (DP). The relative molar mass of the polymer is thus the product of the relative molar mass of the repeat unit and the DP. There is no clear cut bound between polymer chemistry and the rest of chemistry. As a very rough guide, molecules of relative molar mass of at least 1000 or a DP of 100 are considered to fall into the domain of polymer chemistry (Al-Keem, 2006). The vast majority in commercial use is organic in nature, that is, they are based on covalent compounds of carbon. This is also true of the silicones which, though based on silicone - oxygen backbones, also generally contain significant proportions of hydrocarbon groups. The other elements involved in polymer chemistry mostly includes hydrogen, oxygen, chlorine, fluorine, phosphorus and sulphur. That is, those elements which are able to form covalent bounds albeits of some polarity with carbon. However, it is critical to know that plastics is synthetic, moldable materials made of a chemical compound or 'polymer' that consists primarily of carbon atoms derived from petroleum (petrochemicals) and generally from polymers. Common uses for the plastics includes textiles, food packaging, bottles, shower curtains, plumbing pipes, furniture’s, flooring, eyeglasses and coatings.

Most plastics contain other organic or inorganic compound additives. Many of the controversies associated with plastic surround additives (such as BPA), biodegradability, post consumer waste, and the use of oil in manufacturing, production and transportation. The production and use of bioplastics is generally regarded as a more sustainable activity when compared with plastic production from petroleum (petrol plastic), because it relies less on fossil fuel as a carbon source and also introduces fewer, net new greenhouse emissions, if it biodegrade. They significantly reduce harzadous waste caused by oil-derived plastics which remain as solid for hundreds of years and open a new era in packing technology and industry (Nicholson,2012).

Irrespective of the structures, uses and others, plastics/polymers are commonly found everywhere, anywhere and put to use in day to day activities of man. No wonder, the rapid increase in number of petrochemical plants around the globe (Hong, Peter, You & Chee 1999 and Roy, Rollin & Schreiber, 2004). The duration of its specific usage differ significantly based on several measures but is consequently 'discarded' as unwanted materials and thus become part of wastes in our locality and it usefulness is also appreciated either in its original form and/or as it might have been modified for use.

2.2.6 Classification of Polymers

Polymer is a generic name given to a vast number of materials of high molecular weight. These materials exist in countless form and numbers because of very large number and type of atoms present in their molecule. Polymer can have different chemical structure, physical properties, mechanical behavior, thermal characteristics, etc., and on the basis of these properties polymer can be classified in different ways

Basis of Classification of Polymer Type

Origin - Natural, Semi synthetic, Synthetic Thermal Response - Thermoplastic, Thermosetting Mode of formation - Addition, Condensation Line structure - Linear, Branched, Cross-linked Application and Physical Properties - Rubber, Plastic, Fibers Tacticity - Isotactic, Syndiotactic, Atactic Crystallinity - Non crystalline(amorphous), Semi-crystalline, Crystalline Polarity - Polar, Non polar Chain - Hetro, Homo-chain.

2.2.6.1 Origin

On the basis of their occurrence in nature, polymers have been classified in three types:-

a. Natural polymer:- The polymers, which occur in nature are called natural polymer also known as biopolymers. Examples of such polymers are natural rubber, natural silk, cellulose, starch, proteins, etc..
b. Semi synthetic polymer:- They are the chemically modified natural polymers such as hydrogenated, natural rubber, cellulosic, cellulose nitrate, methyl cellulose, etc.
c. Synthetic polymer:- The polymer which has been synthesized in the laboratory is known as synthetic polymer. These are also known as manmade polymers. Examples of such polymers are polyvinyl alcohol, polyethylene, polystyrene, polysulfone, etc.

2.2.6.2 Thermal Response

On the basis of thermal response, polymers can be classified into two groups

i. Thermoplastic polymers:- They can be softened or plasticized repeatedly on application of thermal energy, without much change in properties if treated with

certain precautions. Example of such polymers are Polyolefins, nylons, linear polyesters and polyethers, PVC, sealing wax etc..

ii. Thermosetting polymers:- Some polymers undergo certain chemical changes on heating and convert themselves into an infusible mass. The curing or setting process involves chemical reaction leading to further growth and cross linking of the polymer chain molecules and producing giant molecules. For example, Phenolic, resins, urea, epoxy resins, diene rubbers, etc.

2.2.6.3 Mode of Formation

On the basis of mode of formation, polymers can be classified as

A. Addition polymers:- They are formed from olefinic, diolefnic, vinyl and related monomers. They are formed from simple addition of monomer molecules to each other in a quick succession by a chain mechanism. This process is called addition polymerization. Examples of such polymers are polyethylene, polypropylene, polystyrene.

B. Condensation polymer:- They are formed from intermolecular reactions between bifunctional or polyfunctional monomer molecules having reactive functional groups such as -OH, -COOH, -NH2, -NCO, etc..

2.2.6.4 Line Structure

On the basis of structure, polymers are of three types.

A. Linear polymer:- If the monomer units are joined in a linear fashion, polymer is said to be linear polymer.

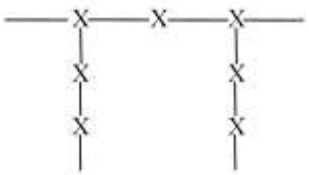
——X——X——X——

Linear Homopolymer

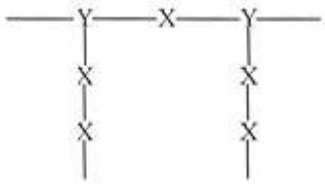
——X ——Y ——X——

Linear Copolymer

B. Branched polymer:- When monomer units are joined in branched manner, it is called branched polymer.

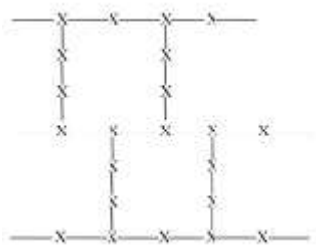


Branched Homopolymer

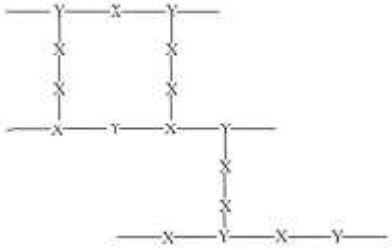


Branched Copolymer

D. Cross linked polymer:- A polymer is said to be a cross linked polymer, if the monomer units are joined together in a chain fashion.



Cross linked Homopolymer



Cross linked Copolymer

2.2.6.5 Application and Physical Properties

Depending on its ultimate form and use a polymer can be classified as:

i. Rubber (Elastomers):- Rubber is high molecular weight polymer with long flexible chains and weak intermolecular forces. They exhibits tensile strength in the range of 300-3000 psi and elongation at break ranging between 300-1000% . Examples are natural and synthetic rubber.

ii. Plastics:- Plastics are relatively tough substances with high molecular weight that can be molded with (or without) the application of heat. These are usually much stronger than rubbers. They exhibit tensile strength ranging between 4000-15000 psi

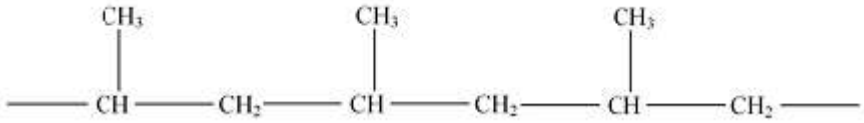
and elongation at break ranging usually from 20 to 200% or even higher. The examples of plastics are, polyethylene, polypropylene, PVC, polystyrene, etc.

iii. Fibers:- Fibers are long- chain polymers characterized by highly crystalline regions resulting mainly from secondary forces. They have a much lower elasticity than plastics and elastomers. They also have high tensile strength ranging between 20,000- 150,000 psi., are light weight and possess moisture absorption properties.

2.2.6.6 Tacticity:-

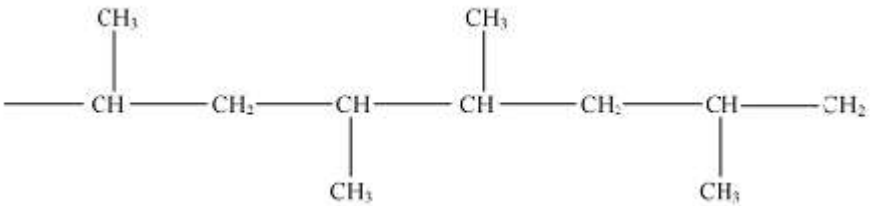
It may be defined as the geometric arrangement (orientation) of the characteristic group of monomer unit with respect to the main chain (backbone) of the polymers. On the basis of structure, polymer may be classified into three groups:-

A. Isotactic polymer:- It is the type of polymer in which the characteristic group are arranged on the same side of the main chain.



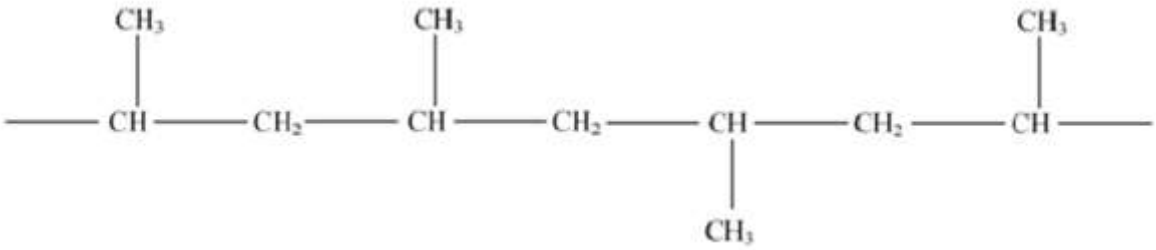
Isotactic Polypropene

B. Syndiotactic polymer:- A polymer is said to be syndiotactic if the side group (characteristic group) are arranged in an alternate fashion.



Syndiotatic Polypropene

C. Atactic polymer:- A polymer is said to be atactic, if the characteristic groups (side group) are arranged in irregular fashion (randomness) around the main chain. It has proper strength and more elasticity.



Atactic Polypropene

2.3 Overview of Students' Academic Achievement in Chemistry

The learning outcome of students in this study refer to Academic Achievement of students which is an important educational variable that shows the success or failure in a teaching and learning process in school. The extent to which a student, teacher or institution acquires knowledge depends on their educational goals'. Similarly Adeyemi and Olaleye (2010) described academic achievement as the scholastic standing of a student at a given moment which states individual's intellectual abilities; which can be measured by grades obtained from examinations or continuous assessments (tests or quiz). In Nigeria, the level of students' learning outcomes in the senior secondary school is determined by their performance and grades obtained from external examination on Senior School Certificate Examination conducted by external bodies WAEC and NECO respectively. Hence, learning outcome refers to the accomplishment of educational goals, the learning outcomes of students or rather the extent to which a student, a teacher has achieved the stated educational objectives. In the school system, a poor or an under achiever is someone whose

performance is consistently below average. Bassey (2006) defined academic achievement as the performance of the students in the subjects they study in the school. Academic achievement determines the students' status in the classroom activities. It gives children an ample opportunity to develop their abilities, improve their grades and that they are prepared for life challenges, students with high academic achievement are often time considered to high achievers in the society, get good career opportunity, get acquited with peers, parents and teachers, and enhance their self confidence and self-efficacy.

In today's comtemporay world, Where the world only celebrates brilliant students, a child regarded as high achiever with a good academic performance is likely to be rated as an excelling individual in his/her career, where as academic failure leads to frustration, stress, inferiority complex, rejection by loved ones and corruption sets in, which might lead to cheating and other social vices. Achievement is considered as one of the criteria to judge one's wholesomeness in their field of study. Learning outcome in this study, as said earlier is students academic achievement through the use of waste polymer materials as instructional material. The WAEC chief examiners reports from 2010 to 2017, from the analysis of the students' performance in WAEC shows that the raw students' mean scores from 2010 to 2017 never exceed 40%. The problem of poor academic achievement in chemistry seems to be the bone of contention in most science educational research now adays. Most of the researchers aim at finding the solutions to students' continuous poor academic achievement reported in science subjects including chemistry. However, to the best of the researchers' knowledge, focus was made on the students involvement in the learning process as waste polymer materials was used in teaching the concept of polymerization in chemistry.The reseacher therefore, saw the need to explore this area to

determine whether the approaches that challenge the performance of students on polymerization in chemistry could significantly affect the achievement in chemistry. Thus this concept is best taught practically, since chemistry is a practical oriented science subject in which students can not do without motivations from the government, parents and guidance. With all of this, it is clear that lack of motivation and interest of the students from their parents and guidance would hinder the study of polymerization in chemistry. The lack of understanding of this concept is another source of difficulty in understanding polymer chemistry,it follows that those areas of polymerization containing more of such understanding will be prone to difficulties. To understand these basic concept, proper explanations would be needed, students who do not understand what polymerization is all about at first instance, usually find the study of polymer science so difficult. With this, it's quite open that when students lack the concept of polymerization, their later studies on polymerization will be affected. Hence, the teaching of polymerization without instructional material results to poor academic performance in chemistry

2.9. Gender and students academic achievement in chemistry

Gender is a social term that is set to distinguish males and females in terms of their exclusive roles and obligations. Gender appears more often in recent science education researches. This may be in attempt in finding ways of closing the gap between the participation rates of the two sexes in science education. Akinsola and Igwe as cited by Eze (2008) are of the opinion that gender issue is a pertinent factor in educational setting in Nigeria and could be a factor that leads to low achievement of learners in chemistry as a science subject. It has also been seen that there is a minimal participation of females in

physical science and technology courses as well as the number holding professional career in sciences. The ladies themselves feel discouraged by the attitudes of teachers and parents and often suffer from low self esteem. Nevertheless, female in single schools who are science oriented, that is science colleges tends to do better than those females in mixed coeducational schools because they are more exposed to science subjects with a lot of pace for individual learning which may not be possible or available for those in the mixed school. Research findings on gender as a factor in students achievement in sciences are mixed, some finding indicated no significant effect of gender in chemistry achievement as some researchers reported significant influence of gender on academic achievement.

2.4 Teaching Methods

2.4.1 Discussion Method

The method is trainer/learner centered. It involves the teacher and learner interacting thereby discovering new ideas and facts by inquiry. The teacher becomes a resource rather than an authority. Discussion could be on individual bases i.e. student to student or class/group interactions also referred to as tutorial.

2.4.2 Inquiry Method

Inquiry approach is also referred to as quest solving method. Man is faced with everyday problem and in attempt to find an answert to the problems inquiry approach is applied based on the situation. Bichi (1989) mention three types of inquiry as: -

i. Guided inquiry

ii. Modified free inquiry

iii. Inquiry role approach

In guided inquiry the teacher poses a problem for the students to answer. The hint could be given as to fixing the problem while the students employs the use of their initiative to tackle the problem.

Modified free inquiry involves the teacher formulating the problem while the students decide on the way and manner to find solution to the problem. This method is very suitable for secondary school students and is applicable in biology and most science classes. It is learners centered.

2.4.3 Demonstration method of teaching:

Demonstration is an vital objective method of teaching in which the trainer conducts the operation, while explaining what he/she is doing before the students.

In an ideal scenario, the teaching approach would affect the learners' success and motivation to learn chemistry. In practical situations the learners' achievement and motivation to learn chemistry will be influenced by various factors which include, experimentation, demonstration and practicals .This is due to the fact that the concepts involved are considered too abstract to understand and the content too complex. The concepts, principles and skills involved in the topic are essential in the study of other topic. Hence, this method of teaching is suitable for this study, such that the teacher conducts the operations while explaining his/her actions before the students using waste polymer materials in teaching polymerization.

2.1.2 Theoretical Framework

Theory can suggest various things to one of a kind of human beings, in general terms; it is an explanation to what is happening within the state of affairs. A volume of theories had

been relevant to knowledge statistic on the impact of instructional material on decrease reaching to children in primary schools in Nigeria. They encompass

Behaviourism theory

Cognitive and constructive theory

2.1.2.1 The Basics of Behaviorism

The concept of behaviorism examines the study of overt behaviors that can be seen and measured (Good &Brophy, 1990). In Nigeria, the behaviorist theory has a long tradition in school rules. Many components of trendy education along with curriculum, pedagogy and evaluation have been formed by the ideas and principles of behaviorist studying precept. According to James, (2009) bahaviourism considers the environment for learning to be the determining factor. The use of Jean Piaget on the cognitive development and behavioral studying principle which center on the child improvement and knowledge, intelligence and high level of thinking that allows the child to acquire problem solving skills by constructing reality out of experience and thus mix their observation with their ideas about how the world works. It also provides individual with a certain behavioural management plan or change based on observation in the classroom. On the practical aspect, the findings of the study will benefit the followings, the students, schools, chemistry teachers, textbook writers, curriculum planners and government

2.1.2.2 What is Cognitivism?

"Cognitive theorists understands that a good learning involves institutions established via contiguity and repetition. They also acknowledge the significance of reinforcement, although they strain its role in presenting feedback about the correctness of responses over its role as a motivator.

According to James, (2006) the reference to 'Cognition' makes that clear, these theorist are interested in mind, thinking, as functioning a (brain). This is primarily on how people assemble meaning and make sense of the world via organizing shapes, ideas and principles in schema. Problem solving is observed as the context knowledge construction, processing strategies, together with unfavorable reasoning from principles and inductive reasoning from proof.

2.1.2.3 The Basics of Constructivism

Constructivist teaching is based on the belief that learning takes place as learners are actively involved in a process of meaningful construction in place to passively receiving information. Through interplay with the physical conditions, or concrete objects, a toddler's physical experience accumulates and he is able to conceptualize, think creatively and logically. The child consequently develops talents to abstract problems. According to this theory, learners are the makers of knowledge and that means Constructivists accepts that "learners construct their own reality based upon their views of experiences, so an individual's knowledge is a function of one's prior experiences, mental structures, and beliefs that are used to interpret objects and events." "What someone knows is grounded in view of the physical and social experiences which are comprehended by the mind." (Jonasson, 1991).Realistic constructivism - cognition is the process by which learners eventually construct mental structures that correspond to external structures located in the

environment and radical constructivism - cognition serves to organize the learners experiential world rather than to discover ontological reality..

Constructivists‟ teaching fosters crucial thinking, and creates encouraged and impartial learners. Constructivists suggest that getting to know is more effective when a learner is engaged in the learning process rather than attempting to receive knowledge passively. Children learn best when they are allowed to construct a personal understanding based on experiencing things and reflecting on those experiences.

Paget's theory focuses on how learners interact with their environment to develop complicated reasoning and information. As children interact with their surroundings and new events, they analyze and develop ideas. According to Piaget, knowledge is the interplay between the individual and the surroundings. In addition asserts that experimenting and manipulation of physical objects is the main manner by which children learn to gain new knowledge

John Dewey rejected the notion that Schools need to focus on repetitive memorization and proposed a method of directed residing in which students would have interaction in the actual world practical workshops in which they would demonstrate their knowledge through creativity and collaboration Dewey encouraged hands-on learning and states that it is impossible to purchase knowledge without the use of items which galvanize the thoughts. As a constructivist, Dewey believed that teachers are accomplices in the learning process whose guidance and assistance help learners to construct their learning and independently finds meaning within the subject area. The apparent implication of Dewey's theory in this study is that in the learning process, learners must be involved in meaningful activities that induce them to apply the concepts they are trying to learn. The teacher's role should be to

provide enabling environment for active learning to take place, such an environment could be the guided inquiry approach. This research therefore intends to support either of these two groups of philosophers by investigating the effects of demonstration and lecture methods on students' achievement and retention in teaching and learning. He inferred that education should be grounded in actual real experience.

In the classroom, constructivist view on mastering can be point towards a number of different teaching strategies. In the most fashionable experience, it usually means encouraging leaners to use active techniques (experiments, real world problems) to create extra knowledge and then to reflect on and talk about what they are doing and how their understanding is improving. The instructor makes sure he/she understands the learners previous knowledge on the conceptions and guides the activity to address them and then develop on them. Learners in the constructivist classroom becomes "expert learners". This gives them over-widening tools to keep learning and discovering the unknown. With a well organized classroom environment the learners learns effectively. Constructivism transforms the learner from an inactive recipient of knowledge to an active participant in the learning process. Always guided by the instructor, the learners construct their knowledge actively rather than just mechanically igniting knowledge from the instructor or the textbook.

2.1.3 Empirical Study

2.1.3.1 The influence of instructional materials on academic performance of senior secondary school students in chemistry.

Stephen A. Adalikwu and Isaac T. (2013) investigated the influence of instructional materials (teaching aids) on students academic performance in senior secondary school

chemistry in Cross River State. A two group pre- test and post test quasi- experimental design was adopted for the study. One research question and one hypothesis were formulated to guide the study. A total of 100 senior secondary one (SS1) chemistry students were selected from five (5) schools in Yakur local Government Area of Cross River State through simple random sampling and stratified random techniques. 50 SS1 students (Experimental group) were taught with instructional materials and another forty (Control group) were taught without instructional materials. A validated chemistry Achievement test (CAT) was used to gather data for the study and a spli-half was carried out using the Pearson product moment correlation to obtain a reliability coefficient of 0.67. Independent t- test was used to test the hypothesis at 0.05 significant level while the Pearson product moment correlation coefficient at that level was used to analyses the research questions. The study revealed that students taught with instructional materials performed significantly better than those taught without instructional materials and also that the use of instructional materials generally improved students understanding of concepts and led to high academic achievements. Recommendations were made on how to improve academic performance of chemistry students by encouraging the use of instructional materials in teaching - learning chemistry.

2.1.3.2 Improvisation of instructional materials in a inclusive environment in Nigeria.

Christopher Mtagherornyi Vandeh ph.D & Gbaq Dyako Jacob Awambe, Kwaghngee Emmanuel (2014) Investigated the improvisation of instructional materials in an inclusive setting which has become the focus of extension research in education. It has both academic and social benefits for all students. It ensures that the special needs children have

equal access to knowledge, skills and information in the same way as the normal children. This paper looks at children with hearing impairment in an inclusive classroom, benefits of inclusive education and more clearly the study to a great extend provided information on the importance of instructional materials in an inclusive setting. The paper finally identifies dome requirements for inclusive education. Based on these discoveries a conclusion is drawn.

2.1.3.3 Effect of instructional material on the achievement and retention of biology concept

Victoria Ozoemezinem Enohuean (2015) carried a study on the effects of instructional materials on achievement and retention of biology concepts among secondary school students (SS II). The study consisted of 86 ss2 biology students randomly selected from a population of 5, 626 students drawn from 18 public schools. An instrument designed and developed from past WAEC questions by the researcher known as biology achievement test (BAT) was validated by some lecturers in science, English and Statistic from Ahamudu Bello University and senior biology teachers in delta state. The instrument used was tested and certified to be reliable at 0.65 coefficient. Quasi-experimental design was adopted which involves two groups, experimental and control groups. The experimental group was subjected to instructional material while the control group were taught without instructional material. Four null hypothesis were tested using t-test statistics.

2.1.3.4 Effect of Gender on students achievement in chemistry using inquiry role instructional model.

H.C.O. Aniodoh, Joy Johnbest Egbo (2013) Investigated the effect of inquiry role instructional model on students' achievement in chemistry. Two research questions and two null hypothesis were formulated to guide the study. It was conducted in public single sex secondary school in Enugu education zone of Enugu state, Nigeria. Purposive sampling technique was used to select the four schools. A sample of 141 SS2 chemistry students was used. Researchers developed instrument, Chemistry Achievement Test (CAT) was used to collect data for both pre test and post test. Mean and standard deviation scores were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypothesis at alpha level of 0.05. The findings showed that students taught with inquiry role instructional model achieved higher than those taught with expository method. It was also found that the female students performed better than their male counter parts when taught using inquiry role instructional model. This study is related to the present study because it investigated the influence of gender on students academic achievement in chemistry, but differs in terms of the method that were used to carry out the two studies.

2.1.3.5 Effect of locally available instructional materials on students achievement in chemistry in secondary schools

Bernardine Ngozi Nweze investigated the effect of the locally available instructional materials on chemistry students achievement in the separation of mixture. Two out of six classes of senior secondary one were sampled using simple random sampling technique.104 students were sampled from 320 students. The study adopted quasi experimental research design. Validated Senior Secondary Chemistry Achievement Test (SSCAT) with a reliability and stability indices of 0.90 and 0.83, respectively, was used to collect data. Mean and standard deviation were used to answer two research questions while the

hypotheses were tested at 0.05 alpha level using analysis of covariance (ANCOVA). The findings revealed that students' achievements was enhanced with the use of locally available instructional materials. Also, gender had no significant effect on students' achievement. Teachers should, therefore, be encouraged to source and use locally instructional materials so as to motivate, encourage active participation and generally improve chemistry students' academic achievement.

2.1.3.6 Effect of instructional materials on Academic Achievement of physics students in secondary schools

Okpe Venansia O. (2018) carried out a study to determine the effect of instructional materials on the academic achievement of physics students. The work was a pre - test, post - test of control and experimental group. The research design is quasi-experimental design. The researcher formulated two research questions and two hypotheses that guided the study. The researcher used physics achievement test as an instrument of data collection, the population of the study is 525 and the sample size is 80 in four selected school government secondary schools in UDI local Government Area of Enugu State. The data collected was analysed using mean, standard deviation for the research questions and ANCOVA for the hypothesis analysis. The validity is face and content validity. The reliability is tested to be 1.0 using Karl Pearson correlation. The study revealed that the academic achievement of physics students depends on the use of instructional materials and teachers' attitude to arouse the interest of the physics students. Result also showed that there is significant difference between male and female students taught with instructional materials because physics is seen as a hard course. The following recommendations were made, government

should organize workshop and seminar for teachers on the use of instructional materials to arouse the interest of the students and educational planners should implement it in school curriculum among others. This research work is related to the present study because it investigated the effect of instructional materials on academic achievement of physics students in secondary school, but differs in terms of the instructional materials used on students academic achievement on polymerization in chemistry as carried out in the two studies.

2.1.3.7 Influence of instructional materials on the academic performance of students in Agricultural science in secondary schools.

Umar, kolo Ibrahim (2011). Investigated the study that examined the availability of instructional materials, its adequacy and relevancy: characteristics of instructional materials, importance of instructional materials and factors affecting the use of instructional materials on students' academic performance in Agricultural science. This study made use of survey Research Design. Thirty (30) Government and private secondary schools were used. It had the population of 8,142 agricultural science students and 73 agricultural science teachers, sample of 206 students were randomly selected with 30 agricultural science teachers. The instrument used for collection of data was a questionnaire designed by the researcher for the teachers and students of agricultural science. The instrument used in this study was vetted by the supervisors and experts in the field of measurement and evaluation in the faculty of Education to determine the face and content validity of the instrument. The data collected for the pilot study was used to calculate the reliability coefficient using slit-half method and also Pearson product Moment Correlation Coefficient (r), which gave 0.87. Four research questions and four null hypotheses (H_0) were formulated to guide the study.

Contingency chi-square statistical tool was used in testing the hypotheses at 0.05 level of significance. The analysis yielded the following findings that good and relevant textbooks were the instructional materials available to be used to influence students academic performance in Agricultural science. That instructional materials should possess characteristics of visibility, simplicity, attraction and clarity. That instructional materialsl is important to influence students academic performance in Agricultural science. That teachers qualification and experience were the major factors affecting the use of instructional materials to influence students academic performance in Agricultural science in secondary schools. Recommendations were made in line with the findings, which include the agricultural science teachers should endeavour to use and try to improvise instructional materials for effective teaching of agricultural science in secondary schools. Government should ensure the adequate employment of dedicated and qualified agricultural science teachers and make funds available and sponsor the teachers attendance at conferences, seminars and workshops on utilization of agricultural science. The agricultural science knowledge and subsequent performance of students in both junior and senior secondary schools and agricultural science as a subject becomes more interesting to learn when it was taught by experienced, well committed, dedicated and qualified agricultural science teachers. Teaching of agricultural science will not be completed if the instructional materials needed to facilitate learning are not sourced for, and properly utilized for each agricultural science topic designed to be taught and construct others using available local materials.

2.1.3.8 Teaching interactive Art lessons with recycled waste materials as instructional Resources.

Rita Yeboah, Eric Appau Asante and Nana Afia Opoku-Asare (2016) Investigated the study that examines the use of waste materials as instructional resources in teaching and learning Art lessons. Primary, junior and senior High school Art teachers in Ghana mostly teach their lessons without instructional resources because the government is not able to provide materials to create the needed resources. The study therefore explored local waste materials which create nuisance in the environment in Ghana to create appropriate teaching resources for Art in Ghana. This study shows differences in classroom atmosphere and students performance when instructional resources are used or not used in teaching and learning. The study adopted the exploratory, quasi - experimental and descriptive research methods. Art teachers from Kumasi were selected to teach with developed instructional resources after which lessons taught with and without instructional resources were compared. The study found that when instructional resources are used for teaching and learning, lessons becomes more practical, interesting and real to pupils and students, and enables them to perform better in their academics.

2.1.4 Summary of Literature Review

The review of related literatures on the views of teachers on the effect of instructional material in the study of students revealed that instructional material maybe print and non-print items that are of great impact to knowledge on students in the learning process. They give room for acquisition of skills, knowledge and self- confidence and self- actualization. From the review, polymerization in chemistry was seen originally to be applied to the situation in which molecules had identical empirical formula but with very different

chemical and physical properties, examples are benzene and acetylene. Polymer was also seen as a word derived from the Greek words 'poly' meaning many and 'meros' meaning part. Therefore, polymer is a large molecule built up from numerous smaller molecules, these polymer are classified into six which are classification by origin, by structure, by morphology, by response to heat, by end-use and by mode of synthesis. The performances of students depend on the effect of instructional materials like chemistry laboratory, electronics in chemistry by the chemistry teachers depending on the topic in order to arouse the interest of the student. Therefore teachers should change their attitude towards teaching. The theoretical frame work by Jean Piaget on the cognitive development and behavioral learning theory which center on the child development knowledge, intelligence and high level of thinking that allows the child to acquire problem solving skills by constructing reality out of experience and thus mix their observations with their ideas about how the world works. It also provides individual with a certain behavioural management plan or change based on observation in the classroom. Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaningful knowledge construction as opposed to passively receiving information. Through interaction with the physical situations, or concrete objects, a child's physical experience accumulates and he/she is able to conceptualize, think creatively and logically. The child therefore develops skills to abstract problems or to solve problems identified. According to this theory, learners are the makers of knowledge and meaning Constructivists believe that "learners construct their own reality or at least interpret it based upon their views of experiences, so an individual's knowledge is a function of one's prior experiences, mental and beliefs that are used to interpret objects and events."

In the review of empirical studies, studies on effect of instructional materials, studies on gender and locations were reviewed. From the reviewed studies, in spite of the importance of chemistry as it recreate nature for mankind and it's benefits in the educational sector, the achievement of students in this subject appears to be very poor and this poor academic achievement of students in the subject was because of lack of instructional material, interest and teachers attitude to the learner, the nature of instructional materials used by the teachers. It was also seen that there have been studies carried out on the effect of instructional materials on students' academic achievement in different subject areas and in different locations, but no study has been carried out on effect of waste polymer materials on senior secondary school students learning outcome on polymerization in chemistry, therefore the study investigate the influence of gender, the effect of waste polymer materials on students academic achievement on polymerization in chemistry and different teaching method employed in teaching the concept.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

In this chapter the researcher describes the methods adopted for the study under the following headings, the design of the study, the area of the study, the population of the study, sample and sampling techniques, instrument for data collection, validity of the instrument, reliability of the instrument, method of data collection and method of data analysis.

3.2 The Research Design

Ogula (2005) describes a research design as a plan, structure and strategy of investigation to obtain answers to research questions and control variables. The research design made used of Quasi-experimental design, the design involved students from intact classes. The study also made use of experimental group and control group. The experimental group was taught with waste polymer materials while the control group was taught without waste polymer materials. A pre-test on chemistry achievement on the selected topics was administered by the teachers to ascertain the students present level of academic achievement in the control and experimental groups of the students. After the pre-test, the regular chemistry teacher commenced the experiment on the selected schools, adhering to the topics given by the researcher. The experimental group was provided with the waste polymer materials needed for the teaching which includes Styrofoam, plastic bags,carpet, banknote, CD and DVD plate, crate, plastic bucket and many others after the teaching process. Then the post-test was administered on the two groups to test their level of achievements.

The study design is illustrated as follows;

Group 1 y_1 z_1 y_2

Group 2 y_1 z_2 y_2

Where y_1 = pre-test

y_2= post-test

z_1= experimental variables

z_2= control variables

3.3 Area of the study

The area of the study is Bosso local Government Area of Niger state.

3.4 Population of the study

The population of the study comprised of all the government secondary school in Bosso L.G.A. There are 20 government owned senior secondary schools in Bosso L.G.A with a population of 11,538 consisting all senior secondary classes, ranging from sciences, commercial and Arts, with the target population of 3,600 for SS III, sciences only, then 4 schools were selected with a sample size of 360, (159 Male and 201 Female). Using "Yaro Yamane's" formula for a finite population with 0.05 level of significance (See Appendix A).

3.5 Sample and sampling techniques

The investigator used multistage procedure because the experimental class lasted for a period of time before administering the second test. Simple random sampling techniques was used. The two intact classes of senior secondary three were randomly selected for the study. One forms the experimental group and the other one forms the control group, in the selected four secondary schools from Bosso L.G.A of Niger state, since a centralized and standard curriculum is used in all schools, thus what is taught in one school is expected to be the same in all schools. Therefore student of senior secondary class three (SS III) chemistry students were randomly selected and all the chemistry teachers from each of the four selected schools were used for the study. The researcher through simple random sampling selected four schools in Bosso L.G.A of Niger state. Three hundred and sixty copies of test questions were administered to the students.

3.6 Instrument of data collection

The principal instrument used for data collection in this study is Chemistry Achievement Test (CAT). The chemistry achievement test contains thirty (30) items and four multiple choice options of objective questions A, B, C and D. Based on the selected topics on polymerization in the SS3 chemistry curriculum which has been proven challenging for students over the years. A pre-test on chemistry achievement on the selected topics was administered by the teachers to ascertain the students present level of academic achievement on the control and experimental groups of students. After the pre-test, the regular class teachers of chemistry commenced the experiment in the selected schools, adhering to the topics given by the researcher. The experimental group was provided with

waste polymer materials needed to teach polymerization in chemistry on the selected topics. The control group was taught without using waste polymer materials.

3.7 Validation of instruments

The face and content validity of the instrument was done by a chemistry Lecturer in Department of Physical Science (Analytical Chemist) and one in Science Education, an educational test and measurement expert. The experts were requested to validate the instrument and the lesson note along with the lesson plan, in order to measure what is expected to measure and if the objectives were achieved at the end of the lessons (see Appendix 2)

3.8 Reliability of instrument

Reliability of a test instrument refers to the consistency of the scores obtained, how consistent they are from one administration of an instrument to another. (Kombo & Tromp, 2006). Therefore, a reliable one will often time produce the expected results even when used over and over again to obtain samples from two different samples randomly drawn from the same population. The researcher used test - retest method of reliability which was conducted in Abdullahi Dada secondary school. The test - retest method of reliability was used to administer CAT to total number of 10 students and the data obtained from the students were used to calculate the reliability of the instrument. The reliability coefficient of Pearson product moment correlation was used to determine the reliability showing the relationship between the test scores in the two groups which gave 0.75. This means, it is reliable. (see Appendix 3)

3.9 Method of Data Collection

The chemistry achievement test was delivered by the researcher in the schools selected. The test was administered to a total number of Eighty four chemistry students from each schools that was selected through simple random sampling. Based on the pre-test administered to the students, two equivalent groups of group A and B consisting of one hundred and sixty eight chemistry students were used for the study for each group. The students subjected to experimental group were taught using waste polymer materials and at the end of the teaching period, Chemistry Achievement Test with thirty (30) questions based on the content taught by the regular teacher were administered to the students under a good supervision. The test materials were retrieved from the students after thirty minutes (30 mins).

3.10 Method of Data Analysis

The statistical method used in analyzing the data collected from the pre-test and post-test is f-test for independent group and Analysis of covariance (ANCOVA) is used for testing the hypothesis at 0.05% level of significance because there is significant difference between the pretest scores of experimental and control groups.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

The reason behind this study was to determine the effect of waste polymer materials on senior secondary school students academic achievement on polymerization in Bosso local Government Area of Niger state. The chapter contains the presentation of the result, data analysis and the discussion of the results.

4.1 Presentation of Results

The data gathered through the administration of the achievement test on polymerization taught were analyzed. Two research questions were raised and respective null hypotheses formulated were tested at 0.05 level of significance for the analysis which formed the basis for accepting or rejecting the null hypothesis indicated. The results of the analysis are presented below.

4.1.1 Research Question

1. What is the mean achievement scores of chemistry students taught with waste polymer materials on polymerization and those taught without waste polymer?
2. What are the mean achievement scores of male and female students taught waste polymer materials on polymerization?

4.1.2 Testing of Null Hypotheses

H_{O1}: There is no significant difference in the mean achievement scores of chemistry students taught with waste polymer materials on polymerization and those taught without waste polymer

H_{O2}: There is no significant difference in the mean achievement scores of male and female students taught chemistry with waste polymer.

Pretest Result

ANOVA table of pretest

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	261.422	1	261.42	6.79	0.01
Within Groups	13775.989	358	38.48		
Total	14037.411	359			

Research Question one: What is the mean achievement scores of chemistry students taught with waste polymer materials on polymerization and those taught without waste polymer?

Table 4.1: Mean and Standard Deviation of Pretest and Posttest Scores of Experimental and Control Group

GROUP	N	Pretest		Posttest		Mean Gain
		X	SD	X	SD	
Waste Polymer	176	27.11	5.91	76.90	13.58	49.79
Control Group	184	25.41	6.46	46.41	7.65	21.00

Table 4.1 shows the mean and standard deviation of the mean achievement scores of experimental group and control group in pretest and posttest. The result revealed that mean and standard deviation scores of the pretest and posttest experimental group are $\bar{X}$ =27.11, SD = 5.91 and $\bar{X}$ = 76.90, SD = 13.58 respectively. This gives a mean gain of 49.79 in favour of the posttest. On the other hand, the mean and standard deviation of the pretest and posttest of the control group are $\bar{X}$ = 25.41, SD = 6.46 and $\bar{X}$ =46.41, SD = 7.65 respectively and gives a mean score of 21.00 in favour of the posttest. The result also revealed that experimental group and control group had mean gain of 49.79 and 21.00 respectively, and with the experimental group having the highest mean gain of 49.79.

Research Question Two: What are the mean achievement scores of male and female students taught waste polymer materials on polymerization?

Table4.2: The mean and standard deviation of pretest and posttest scores of male and female students taught waste polymer materials on polymerization

Group	N	Pretest		Posttest		Mean Gain
		$\bar{X}$	SD	$\bar{X}$	SD	
Male	81	28.35	6.45	77.12	12.61	48.77
Female	95	26.06	5.21	76.70	14.42	50.64

Table 4.2 shows the mean and standard deviation of the pretest and posttest scores of male and female experimental group. From the result, it can be seen that mean score of the pretest and posttest score of the male are $\bar{X}$ =28.35, SD = 6.45 and $\bar{X}$ = 77.12, SD =12.61. The mean gain is 48.77 in favour of the male posttest achievement score. Similarly, the mean and standard deviation of pretest and posttest score of female are $\bar{X}$ = 26.06, SD = 5.21 and $\bar{X}$ = 76.70, SD = 14.42, the mean gain is 50.64 in favour of the female posttest score. Also the result reveals the difference of 1.87 between the posttest mean gains score of male and female in favour of the female.

Hypothesis One: There is no significant difference in the mean achievement scores of chemistry students taught with waste polymer materials on polymerization and those taught without waste polymer

Table 4.3: ANCOVA Comparison of the Post test Mean Scores of the Experimental Groups (chemistry with waste polymer), and Control Group (chemistry without waste polymer)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	84091.469[a]	2	42045.734	352.96	0.00
Intercept	83863.950	1	83863.950	704.01	0.00
PRETEST	483.280	1	483.280	4.05	0.04
GROUP	83778.831	1	83778.831	703.30	0.00
Error	42526.539	357	119.122		
Total	1480302.384	360			
Corrected Total	126618.007	359			

Table 4.3 shows the ANCOVA comparison of Posttest Scores of waste polymer materials and Control Group. An examination of Table 4.12 with F (1, 357) = 703.30, p = 0.00, the results of the analysis indicates that this hypothesis is rejected on the basis that the main effect (treatment) was significant. The results revealed that the chemistry with waste polymer materials produced a significant effect on the achievement scores of students when covariate effect (posttest) was controlled. The result indicates that the treatment, using chemistry with waste polymer materials and control group(without waste polymer) accounted for the difference in the posttest achievement scores of the students. This implies that a statistical significant difference exists among the two groups of taught chemistry with waste polymer materials and those taught without waste polymer (control group).

Hypothesis Two: There is no significant difference in the mean achievement scores of male and female students taught chemistry with waste polymer.

Table 4.4: ANCOVA Analysis of achievement of Male and Female Students Taught Chemistry with Waste Polymer

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	692.545[a]	2	346.273	1.89	0.153
Intercept	56545.163	1	56545.163	309.49	0.000
PRETEST	684.852	1	684.852	3.74	0.054
GENDER	60.406	1	60.406	0.33	0.56
Error	31607.338	173	182.701		
Total	1073172.144	176			
Corrected Total	32299.883	175			

Table 4.4 shows the ANCOVA comparison of Posttest Scores of waste polymer materials and Control Group. An examination of Table 4.4 with F (1, 173) = 0.33, p = 0.56, the results of the analysis indicates that this hypothesis is accepted on the basis that the main effect (treatment) was not significant. The result shows that there was no significant difference in the achievement of male and female students taught chemistry with polymer. On this basis, the hypothesis two is accepted. This shows that there is no statistical difference in the achievement of male and female students taught chemistry with waste polymer materials

4.2 Major Findings of the Study

The findings for this study are:

1. Statistical significant difference exists among the two groups taught chemistry with waste polymer materials and those taught without waste polymer (control group).

2. There is no statistical difference in the achievement of male and female students taught chemistry with waste polymer materials.

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION, RECOMMENDATIONS, AND SUMMARY

In this chapter, the findings of the study are based on two research questions and two null hypotheses that guided the study is to be discussed. The discussion of the results, conclusion, educational implication, recommendations, limitations of the study, suggestions for further research and summary of this study are also presented.

5.1 Discussion of the Results

From the response of the achievement test administered to the students, the researcher was able to find out the effect of waste polymer materials on the academic achievement of senior secondary school chemistry students on polymerization in Bosso L.G.A of Niger State.

Data in table 1: From the pretest conducted, it showed that there is significant difference of 0.01 between those taught with waste polymer materials and those taught without waste polymer materials.

Data in table 2: The data showed there is significant difference between the mean achievement scores of students taught with waste polymer materials and those taught without waste polymer with a mean gain of 49.79 in the experimental group, and 21.00 in the control group with $F(1,357)=703.30, P=0.00$. Therefore, the result of the analysis indicated that the null hypothesis is rejected on the basis that the main effect was significant for the mode of instruction on students' achievement in chemistry. Thus, indicating that there was significant difference in the mean achievement score of chemistry students taught

with waste polymer materials than those in the control group. The findings provided the researcher the concept on the effect of waste polymer materials on students' academic achievement in secondary schools. The use waste polymer materials as instructional materials in the teaching and learning of chemistry influences the cognitive, affective and psychomotor achievement of chemistry students when evaluated. It enables the chemistry students to recall and recognize information and principles during the lessons and which also make the teaching and learning interactive and engaging by providing the students with firsthand experience. The use waste polymer materials in the teaching and learning influences the classroom performance positively, it makes the teacher to deliver without stress.

Data in table 3: Showed the mean and standard deviation of the pretest and posttest scores of male and female students in the experimental group, with a mean gain of 48.77 for male and 50.64 for female with $F(1,173)=0.33$, $P=0.56$. The result of the analysis indicated that the hypothesis is accepted on the basis that the main effect was not significant as such, the result showed there was no significant difference in the achievement of male and female students taught chemistry with waste polymer materials.

5.2 Conclusion

The purpose of the study is to investigate the effect of waste polymer materials on the academic achievement of senior secondary school chemistry students on polymerization in Bosso L.G.A of Niger State.

Findings from the analysis showed that the effect of waste polymer materials in the control group of the schools mentioned is due to lack of instructional materials, unqualified teachers, teachers attitudes towards the teaching and improper teaching methods used by the teachers due to lack of skills. Teacher's attitude towards the students in effective teaching and learning of chemistry is poor because most teachers are reluctant on improvisation making the lesson boredom for the students.

5.3 Educational Implications of the Findings:

It is recognized there is need for instructional materials in teaching and learning of chemistry in all secondary schools within Bosso Local Government Area of Niger state so as to enhance a quality academic performance of chemistry students. The acquisition of knowledge can be effective when teachers combine theory with practical concepts in teaching chemistry.

The findings of this study have implications on education particularly in teaching chemistry in secondary schools. The implications of this study is shouldered on the need for teachers in making use instructional materials in teaching and learning of chemistry. The study also revealed that the experimental group was higher than the control group in their mean achievement scores. The findings of this study equally implicated the science teacher's attitudes and methods in teaching chemistry. In addition, science teachers should ensure that students' cognition during lessons are sound, this will make them to be focus on the learning tasks. Also, the findings of the study shows that male and female students exist in separate world in performance. Hence, science teachers should consider the gender difference

5.4 Recommendations

Based on the findings, the following recommendations were made:

1. For teachers and students, the educational administrators and policy makers should attach greater importance to the use of instructional materials in teaching and learning of chemistry in our senior secondary schools.
2. Government, Ministry of education and educational bodies should provide instructional materials for secondary schools to enhance effective teaching and learning and also include it in curriculum and making compulsory for teachers.
3. Seminars and workshops on the use of instructional materials should be organized for chemistry teachers in order to help update their knowledge and improve on the method of teaching.
4. Teachers and students should be courage to form the habit of improvising instructional materials to make up for the shortfall in supply.

5.5 Limitations of the study:

The generalizations made with respect to this study are however subjected to the following limitations:

i. Since the same teachers was used for different groups, it could be assumed that they might not have been of equal attributed like in their method of teaching and personality.

ii. There was also the problem of poor turn out among the students, unwillingness to participate in lessons.

5.6 Suggestions for further study:

Based on the factors that might have affected the findings of the study, the following suggestions were made by the researcher:

i. Effect of waste polymer materials on the academic achievement and retention of senior secondary school chemistry students on polymerization.

ii Effect of waste polymer materials on students Interest and Attitude on polymerization among senior secondary schools.

ii. The use of large class in administering instructional materials in secondary school.

5.7 Summary

The main purpose of the study is to investigate the effect waste polymer materials on the academic achievement of senior secondary school chemistry students on polymerization in Bosso Local Government Area of Niger State. The population of the study consist of all the government secondary schools in Bosso local government area of Niger State. Simple random technique was used in sampling four schools. Chemistry Achievement Test on Waste Polymer Materials was used for data collection, it was validated by a chemistry lecturer and expert in test and measurement.

The results from the analysis showed that the effect of waste polymer materials on the academic achievement of senior secondary school chemistry students on polymerization, shows that there is need for instructional materials.

Some solutions includes: The Government/Ministry of Education should provide adequate qualified teachers, instructional materials, laboratory and regular supervision on the use of the instructional materials.

There is also need of competent chemistry teachers in the use of instructional materials and the use of adequate laboratory in relating abstract ideas into practical view. According to Ekweme and Igwe (2001), The quality of education does not only depend on the teachers as reflected in the their duties but also on the abilities to explore their environments by making abstract ideas real and practical.

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APPENDIX A

Names of all the secondary schools in Bosso L.G.A of Niger State.

Abdullahi Dada Secondary School Maikunkele.

Bosso Secondary school, Minna.

Day Secondary School Gbada Gidan Mongoro.

Day Secondary School Chanchaga, Minna.

Day Secondary School Garatu.

Day Secondary School Maikunkele 'A'

Day Secondary School Maitumbi Minnna.

Day Secondary School Pyata Bosso.

Day Secondary School Shatta.

Federal Government College Minna.

Govrenment Army Day Secondary School.

Government Day Secondary School Beji

.Government Science College Chanchaga.

Government Senior Secondary School Kampala.

Government Technical College Minna.

Maryam Babangida Girls Science College.

Model Science College Tudun Fulani.

Niger State School For Special Education Minna.

Sheikh Muhammed Saned College Of Arts and Islamic Students Tudun Fulani Minna.

Sir Ahmadu Bello Model Secondary School Minna .

The Population of all the Government Secondary Schools in Bosso LGA amounted to 11,538 comprising of both Sciences, Arts & Commercials.

Target Population consisting of only Sciences 3,600 for SS III. Sample Size Using Yaro Yamane's Formula with 0.05 level of Significance.

Sample Size, n =

$$\frac{N}{1 + N(e)^2}$$

$$\frac{3600}{1+3600\,(0.05)^2}$$

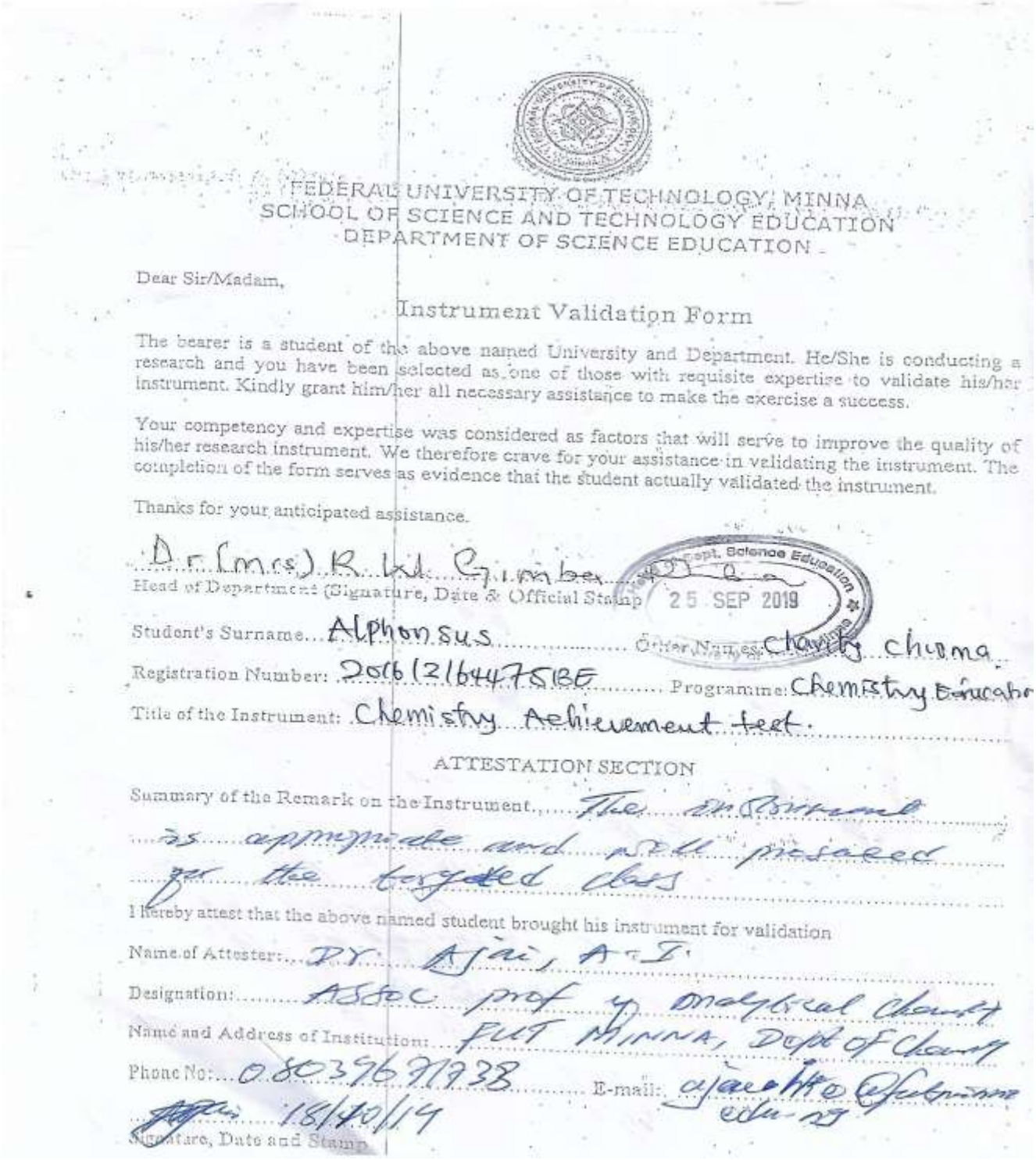
$$\frac{3600}{1+3600(0.0025)}$$

$$\frac{3600}{1+9}$$

$$\frac{3600}{10}$$

360.

APPENDIX B



FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF SCIENCE EDUCATION

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) R. Ld Chimbe
Head of Department (Signature, Date & Official Stamp) Dept. Science Education 25 SEP 2019

Student's Surname: Alphonsus Other Names: Charity Chioma

Registration Number: 2016/216447SBE Programme: Chemistry Educatio

Title of the Instrument: Chemistry Achievement test.

ATTESTATION SECTION

Summary of the Remark on the Instrument: The instrument is appropriate and well prepared for the targeted class

I Hereby attest that the above named student brought his instrument for validation

Name of Attester: Dr. Aji, A.I.

Designation: Assoc prof of Analytical Chemistry

Name and Address of Institution: FUT Minna, Dept of Chem

Phone No: 08039677338 E-mail: ajaeito@futminna.edu.ng

18/10/19
Signature, Date and Stamp

Please comment on the following:

1. Appropriateness of the instrument for the purpose it's designed for: It is appropriate
2. Clarity and simplicity of the language used: Yes simple & clear
3. Suitability for the level of the targeted audience: Suitable for the proposed level (SSS3)
4. The extent in which the items cover the topic it meant to cover: The topic is reasonable covered
5. The structuring of the Questionnaire: The questions were well structured
6. Others (grammatical errors, spelling errors and others): Fair, Should see enhancement and effect correction
7. General overview of the instrument: It is appropriate for the mixed class

Suggestions for improving the quality of the instrument

1. The questions raised should
2. be effected
3. Also if the topic is for one lesson
4. it should be trimmed down. It
5. is bulky it could be effectively be covered within the mentioned

Name of Validator: Dr. Ajai A-I

Areas of Specialization: Analytical chemistry

Name of Institution: FUT - Minna Designation

Signature: [signature] Date: 18/10/19

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF SCIENCE EDUCATION

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

25 SEP 2019

Dr (mrs) R. Ld. Gimbes
Head of Department (Signature, Date & Official Stamp

Student's Surname: Alphonsus Other Names: Charity Chioma

Registration Number: 2016/3164475BE Programme: Chemistry Education

Title of the Instrument: Chemistry Achievement Test

ATTESTATION SECTION

Summary of the Remark on the Instrument:

Good

I hereby attest that the above named student brought his instrument for validation

Name of Attester: AR (MRS) Chado, Amina Mohammed

Designation: Senior Lecturer

Name and Address of Institution: FUT Minna

Phone No: 07035765345 E-mail:

Signature, Date and Stamp

Please comment on the following:

1. Appropriateness of the instrument for the purpose it's designed for: Good

2. Clarity and simplicity of the language used: Clear & Simple

3. Suitability for the level of the targeted audience: Suitable

4. The extent in which the items cover the topic it meant to cover: Adequate

5. The structuring of the Questionnaire: Good

6. Others (grammatical errors, spelling errors and others): Good

7. General overview of the instrument: Good

Suggestions for improving the quality of the instrument

1. .....

2. .....

3. .....

4. .....

5. .....

Name of Validator: DR (MRS) A. M Chacha

Areas of Specialization: Science Education

Name of Institution: UT Mbeya Designation: Senior Lecturer

Signature: ..... Date: 07/10/19

Appendix 3

Correlations

		X	Y
X	Pearson Correlation	1	0.748*
	Sig. (2-tailed)		.013
	N	10	10
Y	Pearson Correlation	0.748*	1
	Sig. (2-tailed)	.013	
	N	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

APPENDIX 4:

CHEMISTRY ACHIEVEMENT TEST ON WASTE POLYMER MATERIALS

SECTION A

INSTRUCTION: Circle the correct answer

GENDER: Male { } Female: { }

CLASS : S S 3

SCHOOL : ……..

SECTION B

Instructions: answer all questions in this section

1. _____ is defined as a large molecule built-up from numerous smaller molecules (a) Monomer (b) Polymer (c) Depolymerization (d) Polymerization.
2. P. M. M. A stands for _____ (a) Polymethyl methacrylate (b) Polymethyl methyl acetate (c) Polymethyl methylapple (d) Polymethyl metal alum.
3. _____ are those polymer that do not melt when heated at sufficiently high temperature and decompose irreversibly (a)Thermoset (b)Thermoplastic (c) Thermorubber (d) Thermopower.
4. The followings are general properties of plastics EXCEPT (a) plastics are strong but light, inert air, water and other Chemicals (b) They have no resistance to fungal and microbial attacks (c) plastics are good insulator (d) The raw materials are readily and cheaply available from the refining of crude oil.
5. _____refers to as the measures of how much stress or force a sample will withstand before it fails.(a) micropolymer (b) physical properties (c) mechanical properties of polymer (d) chemical properties of polymer.
6. _____ is a force applied per unit cross sectional area.(a) Strain (b) Stress (c) young modulus (d) Compression
7. Spinnability in polymer science is referred to as……. (a) Ability to be converted to filament (b) Ability to stretch (c) Having a good chemical resistance (d) Ability to iron out.
8. What are derived polymers?(a) polymers that are obtained from naturally occurring polymer (b) polymers that are obtained from crude oil product (c) polymer that are synthetic in nature (d) polymers that occurs by chance.
9. The classification of polymer by end-use is based on three (3) modes which are (a) As fibres, plastics and elastomers (adhesives) (b) As fabrics, textiles an clothe(c)plastics,rubbers and leathers (d) soft, intermediate and hard
10. Young modulus of a material is sometimes referred to as (a) Tiredness (b) Toughness (c) Strongness (d) Stretchness
11. For polymer that have a good chemical resistance is refers to as (a) Spinnability (b) Stretchability (c) Longitivity (d) Dyeability
12. The followings are some of the applications (uses) of polysytrene EXCEPT one (a) Biro case (b) disposable cup (c) food container (take -away plate) (d) clothes
13. HDPE stands for? (a) High Density Polyethylene (b) High Density polyester (c) High Disposable Polyethylene (d) High Density Packing Ethers.
14. The following polymer materials are classified under their polymer names EXCEPT one (a) eyeglass-polymethylmethacrylate (b) plastic bag-polyethylene (c) chewing gum-polyvinyl acetate (d) disposable cup-polyvinylchloride.
15. The plastic bag called baco-super bag is a polymer of which kind and of what density

(a) Low density polyethylene (b) High density polyethylene (c) Medium density polyethylene (d) Bigger density polyethylene.

16. The other name for synthetic polymer is known as

(a) Rubbers (b) Leathers (c) Plastics (d) Woods

17. What is styrofoam used for

(a) it is use for sleeping (b) it is use for packaging electronic to prevent cracks/breakages (c) it is use for packaging clothes (d) it is use as animal feeds.

18. Ice-cream container is a polymer material of what monomer name?

(a) Ethylene (b) propylene (c) Vinyl acid (d) Vinyl acetate

19._____is a polymer material used in connecting water to our houses and then collect liquid waste to the sewage (a) styrofoam (b) pipe (c) laboratory equipment (d) street lamp fitting.

20. The following polymer materials will undergo thermoplastic as regards to their response to heat EXCEPT (a) polyethylene (b) polypropylene (c) polyester (d) cis-1,4-poly isoprene

21. _____Are the general problem associated to the use of plastic EXCEPT (a) Heavy dependence on crude oil (b) they are non-biodegradable and can not be broken down by microbials (c) they are environmentally friendly (c) they causes severe land and air pollution.

22. What is the polymer name of a banknote (a) polyethylene (b) polypropylene (c) polyvinyl acetate (d) polyvinyl chloride.

23. The followings are the physical properties of polypropylene EXCEPT (a) they are inelastic in nature (b) they are thermoplastic in nature (c) they are hard, tough and semi hard (d) they are very very transparent in nature.

24.Transparent films made of low density polyethylene is used for (a) for packaging clothes (b) for packaging foods and fruits (c) for holding materials together (d) for preserving foods in the refrigerator

25.Polyvinyl acetate has the following physical properties EXCEPT one (a) they are inelastic in nature (b) they are poor conductor of heat (c) they are thermoset in response to heat (d) they are brittle in nature.

26. Ceiling light bulb is an example of what polymer type_____(a) polystyrene (b) polymethylmethacrylate (c) polyvinyl chloride (d) polypropylene.

27.Polystyrene is known with the followings EXCEPT (a) brittle nature (b)they are inelastic in nature (c) they are thermoset in nature (d)they are very very hard in nature.

28.Baco-super bag is regarded as_____a) Low density polyethylene (b) High density polypropylene (c) Low density polyvinyl acetate (d) High density polyethylene.

29_____Is used for holding or binding little materials like papers (books) only. (a) water gum (b) paint (c)super glue (d)top bond.

30. _____ is a polymer material that is use to renew our breath and keep our mouth fresh from smelling

(a) rubber ring (b) chewing gum (c) super glue (d) water gum.

LESSON PLAN

Teaching chemistry of polymer science using demonstration method.

Name: Charity Chioma Alphonsus

School: Bosso secondary school / Sir Ahmadu Bello secondary school

Class: S.S.III

Subject: Chemistry

Date: 15/10/2019

Time: 11:30-12:15pm/10:40-11:25am

Duration: 45Mins

Topics: (i) Polymer
(ii) Mechanical Properties of Polymer

Specific objective: By the end of the lesson the students should be able to

i. Define the term polymer
ii. Mention two (2) types of polymerization process
iii. List the classification of polymer and identify five (5) different plastics (synthetic polymers), then providing their monomer, polymer, repeat unit and uses for each plastic identified.
iv. Outline three (3) different plastics based on their response to heat.

Instruction materials: Waste polymer materials (plastics) such as plastic bags, banknotes, disposable cups, baby toys, automobile tyre, take-way plate, bottle drink, glass (eye), CD and DVD case, chewing gum, top-bonds, matches, foil paper, hand glove and many others.

Previous knowledge: Students have learnt about carbohydrate which are naturally occurring organic compounds containing carbon, hydrogen and oxygen. Carbohydrate is classified into monosaccharide, disaccharide and polysaccaride. Monosaccharide is made of 1 unit sugar consisting of 3-6 carbon sugar e.g glucose, fructose and galactose with molecular formular of $[C_nH_{2n}O]$ e.g$[C_6 H_{22}O_{11}] n + [H_20] n \rightarrow [C_6H_{12}O_6]$

Introduction: The teacher introduces the lesson by bringing to the knowledge of the students about waste materials around our environment and defining waste materials as everything that could be presented in time without losing its characteristic, everything that is thrown away after use at home or work considering they are now useless, something that is preserved by saving and keeping in another place and something that is

natural, factory-made or hand-made. Hence, waste materials like plastics are example of a polymer material.

Activity 1: Presentation.

Step I: Teacher explain what polymer means, polymer is a large molecule built-up form numerous smaller molecules. The process by which polymer are formed is referred to polymerization.

Step : The Teacher explains further, the smaller molecule which serve as building block for the large molecules are called monomers. The teacher illustrates this using Ethylene (plastic bag) in which the repeat unit usually corresponds to the monomers from which it's made up. i.e Ethylene (monomer, $[CH_{2}{=}CH_{2}]_n$),polyethylene (polymer), $[CH_2\text{-}CH_2]$n (repeat unit)

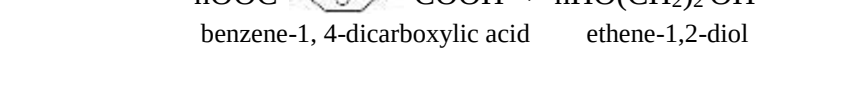
Step II: Students form the structures of the next polymer (polystyrene) providing the monomer, polymer and repeat unit using the materials providing to them.

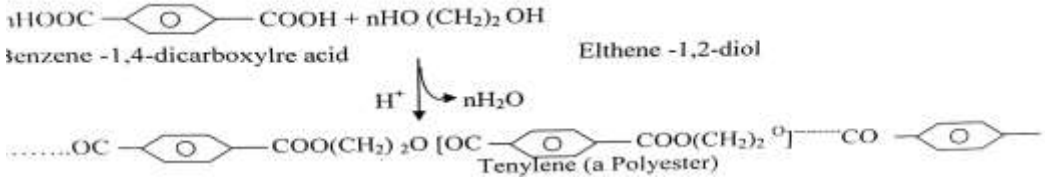
Step III: Teacher explain the two (2) types of polymerization process which are:

1. Additional polymerization
2. Condensational polymerization.

<u>Additional polymerization:</u> This is a process whereby two or more of the same monomers joined together to form polymer which has the same empirical formula as the monomer, but is of a higher molecular mass e.g poly (ethylene), this polymer is represented as $[CH_{2}{=}CH_{2}]_n$ where n=100-1000.

<u>Condensational polymerization:</u> in this process whereby two or more monomers link together to form the process differs form additional polymerization in that small molecules such as water, ammonia or hydrogen chloride are eliminated during the formation of the polymer e.g Terylene is made by heating benzene-1, 4-dicarboxylic acid with ethene-1, 2-diol in the presence of an acid catalyst.





Step IV: Students using the guideline combine the appropriate monomers, polymer and repeat unit of vinyl acetate. Then identify the plastics made of polyvinylacetate and their uses.

Activity 2: The teacher guides the students in Naming polymers.

Step I: Teacher list the guidelines as follows

a. Identify the polymer (plastic)
b. Provide its monomer and then add 'poly' to the monomer name which become polymer
c. Write the repeat unit from the monomer but with single bond e.g

Monomers	**Polymers**	**Repeat units**
Ethylene	polyethylene	$[CH_2\text{-}\ CH_2]_n$
Propylene	polypropylene	$[CH_2{=}CH_2]_n$ CH_3

Step II: Students were asked to give the monomer, polymer, repeat unit and uses of a banknote:

i. Monomer name and structure
ii. Polymer name
iii. Repeat unit
iv. Uses

Step III Classification of polymer

The teacher guides the students to classify the various polymers according to their :

i. Origin
ii. Response to heat
iii. End-use
iv. Mode of synthesis

Step IV: The teacher guides the students to give examples and identify the polymers mentioned.

The students, then mention the polymers that undergoes thermoplastic and thermosets as regard to response to heat. The teacher, also demonstrates their response to heat using matches, foil paper with the identified plastics.

Activity 3:

Step I: Teacher explain mechanical properties of polymer which refers to as the measure of how much stress or force a sample will withstand before it fails.

Step II: The teacher guides the students to identify some polymer possessing mechanical properties such as polyvinylacetate,

polyethylene, polyester. Thus, this polymer are grouped into three (3) which are plastics, fibres and elastomers.

Step III: The teacher guides the students to identify the two (2) major mode of failure in polymer which are brittle failure and ductile failure.

i. Brittle failure: Is one in which the material experience a sudden rupture with minimum deformation called catastrophic failure e.g biro case (polystyrene), eyeglass (polymethymethacrylate)

ii. Ductile failure: is one where there is substantial deformation in the form of networking, narrowing and prior to breaking e.g plastic bag (polyethylene), rubber ring (ci-1, 4-polyisprone). The teacher then demonstrate their failure using the waste polymer materials (plastic) as mentioned.

Evaluation: The teacher evaluates the lesson by asking the students questions ;

1. Define polymer
2. Provide the monomer/ polymer, repeat unit and use of the following waste plastics
   i. Banknotes
   ii. Plastic bag
   iii. Chewing gum
   iv. Eyeglass
3. Mention two (2) types of polymerization process
4. What are the classification of polymer
5. Enumerate two (2) different plastics and classify them into their polymer group base on their response to heat.

Summary: Teacher summarizes the lesson briefly

Conclusion: The teacher concludes the lesson and give the students note to copy with an assignment

1. Mention five (5) different plastic and classify them under their monomer, polymer, repeat unit, properties and their uses.

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Encyclopedia of Polymer Science and Engineering volumes 1-17, John wiley and sons, New York 1985.

Odesina 1.A (2008) Essential Chemistry for Senior Secondary School.

Ozatagan, N, and Baran, G. (2001) The use of recycled materials in the early childhood period (pp 66-88). Ankara university, school of Domestic Economy.

Name: **Charity ChiomaAlphonsus**

Matric No: **2016/3/64475BE**

Project Topic: Effect Of Waste Polymer Materials On The Academic Achievement Of Senior Secondary School Chemistry Students On Polymerization In Bosso Local Government Area Of Niger State

Class: **S S 2 or 3**

Topic 1: **Polymerization**

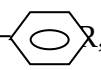
Polymerization is the process by which polymer are formed.

Polymer is then a large molecule built-up from numerous smaller molecules while monomer are the small molecules used as the basic building blocks for these large molecules. For example the commercially important material poly (Viny/chloride) is made from the monomer viny/chloride. The repeat unit in the polymer usually correspond to the monomer from which the polymer was made.

There are two (2) types of polymerization process which are:

i. Addition polymerization
ii. Condensation polymerization

Addition Polymerization: This is a process whereby two or more of the same monomers join together to from the polymer which has the same empirical formularas the monomer, but is of a higher molecules mass e.g

nA → (A)n, where A is the monomers the monomers must be simple, unsaturated molecules with double bonds e.g ethene and propene or substitute ethenes such as CH_2byCHx, where x can be  , -CL or –CN or Some important addition polymers are poly(ethene) poly (chloroethene), poly (phenylethene) Perspex and poly

(propenonitrile). The physical properties of the polymer can be varied to some extent, by altering the polymerization conditions i.e. the temperature, pressure or polymerization catalyst.

Example, Poly (Ethene): This is polymerised ethene and is formed when ethene is heated to a high temperature of about 250°C and pressure above 500 atm, together with traces of oxygen. This polymer can represented as $[CH_2 =CH_2]_n$ where n= 100 to 1000. In the polymerization process, the double bond of ethene becomes converted to a single bond leaving free electrons which can link up with similar electrons in other molecules to form the chain.

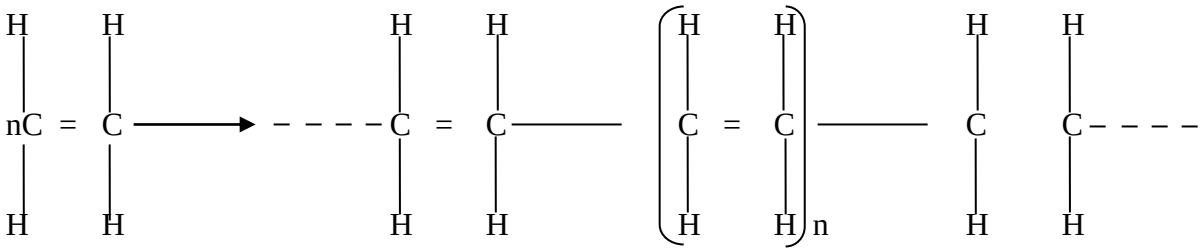
The poly(ethylene) obtained by the below method is called low density poly(ethylene), there is also a high density poly (ethylene), prepared at a lower temperature and pressure in the presence of catalysts.

Uses:

Low density polyethylene is used in making plastic bag, bottles, kitchen wears and transparent films for packing garments and foodstuffs.

It is also used as wire and cable insulators because of its insulating properties.

High density polyethylene is used for making boxes, crates, detergent bottles, dustbins and harder plastic bags.



N number of elthene molecules Poly(elthene) or Poly ethane
Ethene molecule

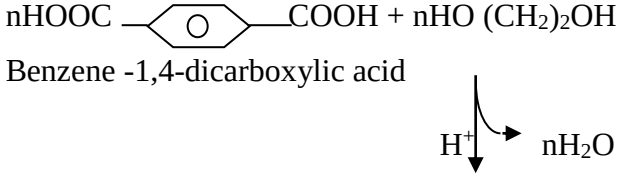
Or $nCH_2 = CH_2 \longrightarrow CH_2— CH_2 — [CH_2— CH_2]_n—CH_2—CH_2$where $—CH_2 —$ CH_2 is the repeating units

Condensation Polymerization: in this process whereby two or more monomers link together to form the process differs from addition polymerization in that small molecules such as water, ammonia or hydrogen chloride are eliminated during the formation of the polymer. If the two condensing mono are different types the resulting polymer is called copolymer if they are the same, the resultant polymer is a homopolymer.

nB
nA ----------A-B-[A-B]n---A-B--------- + X (Copolymer)
nA ----------A-A[A-A]n---A-A--------- + X (Homopolymer)

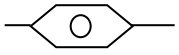
X is a small molecular by product like H_20, HCL or NH_3. There are two main types of condensation polymer which are polyester e.gterylene and polyamiidee.g nylon.

Terylene: is made by heating benzene -1, 4 –dicarboxylic acid with ethane -1,2-oliol in the presence of an acid catalyst



nHOOC —C6H4—COOH + nHO $(CH_2)_2$OH
Benzene -1,4-dicarboxylic acid Ethene -1,2-diol

H^+ ↓ → nH_2O



Terylene(a Polyester)

Terylene is a soft, synthetic fibre capable of retaining and almost permanent creas.

Uses:

Terylene is used in the manufacture of synthetic textiles.

Woven terylene is used for making the sails of boats where a strong rot-proof material is required

CLASSIFICATION OF POLYMERS

Classification of Polymer

1. Classification by origin
2. Classification by structure
3. Classification by morphology
4. Classification by response
5. Classification by End-Use
6. Classification by mode of synthesis

NB: Only four classification shall be considered

3. Classification of origin

Naturally occurring polymer such as wood, silk starch, cotton, wood and protein

i. **Natural Polymers**: Are polymers substances that occurs in nature, they are found widely in living things where they play important structure and functional roles. Certain carbohydrate. Such as starch and cellolose and all proteins, are macromolecules that are polymers found in plants, fats and oil are not large enough to be considered as macromolecules and hence are not polymers. Therefore they are subjected to poly chemical treatment in order to produce artificial polymers with certain desire qualification e.g Cellulose produces cellulose acetate and viscose rayon when subjected to chemical treatment this lead to the production of very useful synthetic polymers.

ii. Derived polymers (obtained from natural polymer) this include cellulose acetate

iii. Synthetic polymers (plastic): are commonly called plastic which are obtained from crude oil product and this plastics can be softened by heat or pressure and then moulded into any desirable shape. Plastics are either thermoplastic or thermosets

Classification by Response to Heat

Polymers are classified base on their response to heat i.e when heat is applied on them, this include:

Thermoplastics: are polymer which melt when heated andresolidify when cooled examplepolyethylene(e.gplasticbag)polypropylene(e.gpipes)Cis-1,4,-polyisoprene,(e.grubberring)polyurethane(e.gplasticbottle).

Thermosets: are those which do not melt when heated but, at sufficiently high temperature, decompose irreversibly. thermosets cannot be softened or melted by heat and remoulded once they are formed or set e.g Polyacrylonitrile (sweater), polyvinylacetate (e.g chewing gurn), polystyrene (e.g packaging foam used for electronics) and polyamides (e.g carpets).

Classification by end-use

As fibres, plastic and elastomers or adhesive

Classification by mode of synthesis

This classification explain how this polymers comes about, which include

i. Addition polymer
ii. Condensation polymers

As discussed under types of polymerization process

General Properties of Plastics

- Plastics are strong but light, inert to air,water and other chemicals
- They have resistance to fungal and microbial attacks
- Plastics are good insulators of heat and electricity

- They have wide application and be made into specific requirement i.e into hard rigid blocks, flexible sheets, fibres fabric and very light foams
- The raw material are readily and cheaply available from the refining of crude oil.

Problem Associated to the use of Plastic

1. Heavy depending on crude oil
2. Plastic material are non-biodegradable and cannot be able broken down by microbial action into simple morganic forms therefore become solid waste in the environments
3. They causes severe land and air pollution problems, when it is burn, it liberate toxic vapours or gases into the atmosphere

Topic 2: Mechanical Properties of Polymers

When a stress or force is applied to a polymer, they deform or flow. The science of flow is called Rheology or rheological. The Rheological properties of polymer vis-a-vis that appy stress constituent the mechanical properties.

Mechanical properties of polymer: refers to as the measure of how much stress or force a sample will withstand before it fails. These propertice are based on the inter-molecular forces between the polymer molecule as well as the molecular weight.

Factor governing the mechanical property of a polymer

1. Structure of the polymer
2. The physical state of the polymer e.g Tg, degree of crystallinity, molecular weight, distribution and extent of branding
3. Experimental condition under which the properties are measured of all this factor the greatest contribution to the mechanical behavior of polymer sample is the molecular weight some of the parameter include

    i. Stress : is force applied per unit cross sectional area which is given as, stress

    $=\frac{force}{area}=\frac{n}{m2}$=n/m^2

    ii. Strain: Is the increase in length per original length

    Strain = $\frac{increase\ in\ lenght}{original\ lenght}=\frac{dx}{x}(dimensionless)$

    iii. Young modules of a material is sometimes referred to as toughness, there are several ways in which mechanical properties manifest, a few of them that are of interest to mechanical scientist are: Tensile, flexural, compressive (strength and their corresponding modulus). Impact resistance: properties related to this include hardness, abrasion resistance,

tear resistance in addition there is also fatigue which is defined as the measure of how well a sample can with stand repeated application of tensile, flexural and compressive stress.

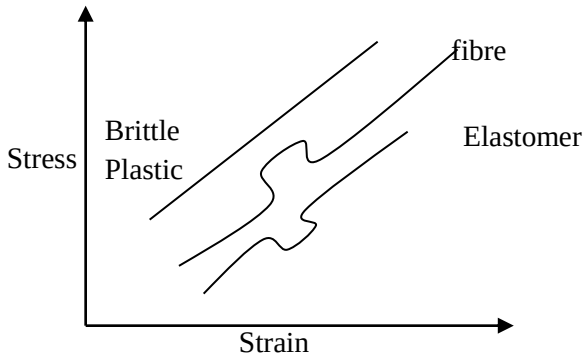


Fig.Tensile stress strain curve for plastics, fibre and elastomers. Both plastics and fiber exhibit a steep slope (high modulus) but the fibre can sustain greater stress before breaking.

Fibres: they have high strain and high modulus, good elongation (stretchability), good thermal stability enough to withstand. Ironing, spinnability (ability to be converted to fitaments) dyeability (good chemical resisyance) e.g polyester (Terylene)

Elastomers: they have low modulus example polyvinyl acetate (adhesive such as top bond), initially

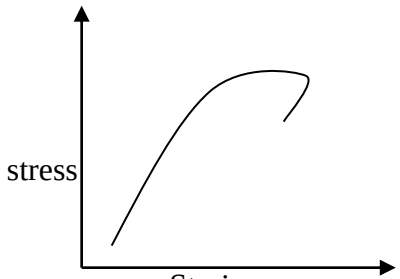
i. But once in the stretched state, the modulus increase sharply
ii. They exhibit resilience (ability to stretch and retract rapidly)
iii. Most elastomers have network structures, the non network type are called thermoplastic elastomer

Plastics: they have high modulus which are commodity plastics of PP, PS, PE, PVC and the engineering plastic are polyacctal, polycarbonate, polycphelere-oxide

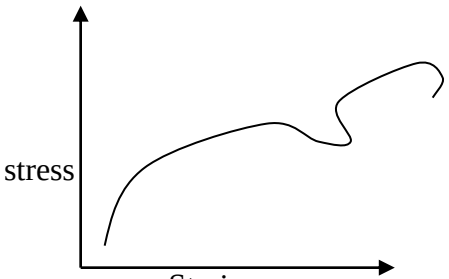
Modes of Failure in Polymers

Brittle failure (fracture): is one in which the material experience a sudden rupture (shattering) with minimum deformation called catastrophic failure e.g (biro case) PS, PMMA

Ductile fracture (Tough): this is one where there is substantial deformation in the form of networking, narrowing and prior to breaking e.g (plastic bag) PE, Cis-1,4- polyisoprene.



Brittle failure



Ductile failure

LETTER OF INTRODUCTION

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

School of Science and Technology Education

DEPARTMENT OF SCIENCE EDUCATION

Vice Chancellor: Prof. Abdullahi Bala, PhD, fssn
H.O.D.: Dr. (Mrs.) R. W. Gimba B.Ed., M.Tech, PhD Mathematics Education

Federal University of Technology,
P.M.B. 65,
Minna, Niger State.
Nigeria.

*Your Ref:*_____

*Our Ref:*_____

Date: 25/9/2019

The Principal,
Abdullahi Dada
Secondary School

TO WHOM IT MAY CONCERN

The bearer Charity Chioma Alphonsus ..... With REG. No 2016/3164475BE ... is a undergraduate (B.TECH) student of Science Education Department He/She needs your assistance to enable him /her carry out his research work.

We will appreciate your anticipated co-operation.

Thank

Head of Dept. Science Education
25 SEP 2019
Minna

Dr (Mrs) R.W. Gimba
HOD, Science Education