

**Activities Based on Low Cost Materials
(Equipment, Glassware, Chemicals)
in Teaching Chemistry at
Secondary School Level in Pakistan**

by

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Activities Based on Low Cost Materials
(Equipment, Glassware, Chemicals)
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It is recommended that the thesis prepared by Mrs. Iffat A. Hussain entitled "Activities Based on Low Cost Materials (Equipment, Glassware, Chemicals) in Teaching Chemistry at Secondary School Level in Pakistan" be accepted as fulfilling this part of the requirement for the degree of Doctor of Philosophy in Education.

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WE HEREBY APPROVE THE THESIS OF MRS. IFFAT A. HUSSAIN
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(EQUIPMENT, GLASSWARE, CHEMICALS)
IN TEACHING CHEMISTRY AT SECONDARY SCHOOL LEVEL
IN PAKISTAN"
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Dedicated to:
all those, Who Somewhere on
This Planet Think the Way
I Do.

ABSTRACT

Science education has remained one of the top priority issues of developing countries for the last few decades. In this age of science and technology, the developing countries face an increasing demand for scientific and technical manpower due to the increased awareness and emphasis on rapid industrialization as well as agricultural development on the national level. It is now well recognized that science education has a direct and very significant influence on numerous activities in the daily life and environment of both rural and urban communities.

It is in this context that the natural and physical sciences, study and use of environment and local resources has been recognized as one of the basic areas of school curriculum in many developing countries including Pakistan. Keeping in view the significance, study in hand is selected to design low cost activities based on low cost materials (equipment, glassware, chemicals) in teaching chemistry at secondary school level in Pakistan.

The nature of the study is experimental. Two semi standardized academic achievement tests in the selected content areas of chemistry for IX

class were prepared and administered to 9th class as pretest and posttest. Sample was selected randomly. Experimental and Control Groups were formulated from the sample. Experiments were conducted to experimental group with low cost materials and to control group with high cost materials. Data was collected through pretest and posttest, tabulated accordingly and statistical analysis was carried out. On the basis of the analysis, findings, conclusions are being quoted. Recommendations have also been suggested to popularize the use of low cost materials in science education at secondary school level.

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CHAPTER-I

DESCRIPTION OF THE STUDY

1. Introduction:

For those with curious eye, the world around us is filled with fascinating happenings. Some of them such as earthquakes, volcanic eruptions, and lightening which occur on a large and fearsome scale, the germination of seed takes place under more serene conditions. Every day, grass grows, iron rusts, and human race goes through growth, death and birth.

Throughout history, thoughtful people have wondered at the natural phenomena and tried to look for the understanding of the nature. The curiosity among early civilizations led them to understand fire, so that it could be of some benefit for their work. Successful attempts were, however made in 1789, when French scientist Antoine Lavoiser discovered that fire results due to the combination of Oxygen with certain substances in the fuel. Today human curiosity goes onward to unveil the secrets of life. (Brady, 1981).

For a scientist in today's world it is important to be equipped with basic knowledge in areas, that overlap one's own specialities. It means that the cross fertilization of ideas among various disciplines of science are apparent

everywhere. It includes wide range of discoveries ranging from electronic calculators to computers, from Insecticides to plastics, to life saving drugs.

If science is perceived as the systematic investigation of reality by observation, experimentation, and induction, then the scientific progress must always proceeds in a systematic and orderly manner. The sequence of steps ranging from the formulation of hypothesis, making observation, gathering empirical facts, and summarizing the information discovered is called scientific method. This method is not restricted to scientists, but an automobile mechanic, while listening to the engine, making certain tests to determine, what is the fault and after replacing certain parts sees that the problem is now solved, has certainly made use of scientific method. A physician uses scientific method all the time, while diagnosing various diseases. On the basis of data (temperature, blood pressure, ultra sound test, blood tests, and X-rays) the doctor forms a hypothesis regarding the illness, which serves as a basis for prescription. So the scientific method is used almost by everyone mostly through instinct than design. (Brady, 1981, pp 27-28)

Science teachers have realized that learning through investigations helps pupils to gain maximum understanding of the scientific concepts. Pupils having the opportunities to investigate explore, and drawing conclusions learn faster

than those who lack these opportunities. Teachers, who teach science to children are expected to be the interpreters of the ways of a scientist therefore, one of the main goals of science education in schools should be to help pupils understand the ways of a scientist, that is, to help students to develop

- i) Thinking power and
- ii) Basic Scientific Skills.

It means that a pupil like a scientist, should be able to observe, , measure, compare, classify, describe and evaluate. Another important goal for a teacher should be to form a basis for the understanding of their lives. Hence science education enables pupils to understand problems in their personal and social life. These problems for example range from malnutrition, drug abuse, AIDS epidemic to environmental pollution. The third goal is related to the authenticity of science education, that is, the contribution of the scientist, the range of the concepts and the image of the science.

A brief discussion is given here regarding the scope of science education at school level in the light of its purposes.

- 1) Students should understand science. this involves learning scientific concepts (both concrete and abstract).
- 2) Students should acquire and use basic skills required for scientific method. These skills include observation, formulation of hypotheses, collection of data, using precise methods, analysis and interpretation of results, and drawing inferences.
- 3) Students should be able to make use of acquired knowledge in their personal lives. (Hull, 1994 pp 46-60).

The essence of science education is an involvement and understanding of the processes of science. Therefore, the effective use of the laboratory is a prerequisite in science education, as science is an experimental, observational and laboratory oriented discipline. The significance of laboratory activities can be understood in the light of the following four broad roles.

1) Laboratory Activities can be:

- i) A means of gaining basic laboratory skills, e.g. using a thermometer or measuring out a certain volume of liquid

- ii) A means of developing observational skills, e.g observing the formulation of precipitates.
- iii) A means of explaining a particular concept e.g. current carrying characteristics possessed by certain chemicals and
- iv) A means of having best experience of what real science is all about. (Ibid, 1994, pp 66-68).

In recent years, there has been focus on the popularization of science education and on making the content of science education more relevant to the present and future needs of individuals and the societies. Most developed countries have implemented new curricula, in which there is strong emphasis on popularization of science in the light of its relevance to the needs of the society. In developing countries like Bangladesh, China, India, Malaysia, Pakistan and Sri Lanka, new science policies are being developed , which emphasize the significance of science education. The National Educational Policy of Pakistan (1979) deals with science education as an integral part of general school curriculum.

The provision of well-equipped laboratories seems to be one of the major constraints in the popularization of science education. Research indicates that in Pakistan, more than 80% of school laboratories are either poorly equipped or have no equipment at all. A number of strategies are being used to improve the prevailing situation in chemistry, physics, and biology laboratories. The Institute for the promotion of science education and training (IPSET), ministry of education has been engaged, on one hand to redesign science curricula for schools, and on the other hand, sponsors various projects on low cost activities in chemistry, physics, and biology. In addition, teachers-in-service programmes are geared towards the maximum use of locally available resources for science teaching.

In spite of various efforts, shortage of school laboratory equipment continues to be a major problem which should be of serious future concern. There should be a gradual shift from importing expensive and sophisticated science equipment to a reliance on low cost equipment designed and manufactured by utilizing locally available resources. As the economic and national development of our country greatly depends on the quality of education, we provide to our future scientists. (UNESCO, 1983 PP 15-18)

2. Statement of the Problem:

The problem in hand is "to design activities based on low-cost materials (glassware, equipment and chemicals) in teaching chemistry at secondary school level in Pakistan and determine their effectiveness".

3. Hypotheses of the Study:

The following hypotheses have set to govern the study.

- i) The use of low-cost materials in teaching chemistry at secondary level will not be effective as compared to high cost materials.
- ii) Students won't be able to acquire skills for handling high cost equipment in the chemistry laboratory.
- iii) Students will not be able to understand concepts of chemistry taught with the help of low-cost equipment.
- iv) Organization of low-cost activities will not help teachers to motivate students to work in the chemistry laboratory.
- v) The use of low-cost materials, will not improve teaching - learning situation in the laboratory.
- vi) Students will not be able to apply the concepts of chemistry in daily life if taught with the help of low cost materials.

4. Expected Outcomes of the Study:

This study is expected to contribute towards the promotion of science education at secondary level in the following manner.

- i) To offer alternatives to the teachers to improve their teaching methods.
- ii) To change the traditional classroom into an activity oriented place.
- iii) To enable students to acquire and practice skills essential for the learning of science.
- iv) To enable teachers to develop the habit of identifying and utilizing the local resources in the teaching of chemistry.
- v) To make policy makers, planners, administrators and science teachers to realize that non-availability of sophisticated equipment in chemistry laboratory is a problem , but one that can be solved to some extent.

5. Delimitation of the Study:

The study is delimited to:

- i) Prepare two objective type tests in chemistry for 9th class.
- ii) Administer pre-test and post-tests to 9th class students of PAF Model School, Shaheen Camp, Peshawar Cantt.
- iii) Design twenty laboratory activities based on low-cost materials parallel to high cost materials prescribed in the chemistry practical note book for IX & X.

CHAPTER-II

REVIEW FOR THE RELATED LITERATURE

1) The Aims of Science Education at Secondary School Level:

Aims in any area of the studies, should be regarded as "Direction of Growth" and not as ultimate ends to be completely reached". Heiss (1950, p-24) According to Trowbridge (1982, p 115) "Aims are broad statements that give a general direction to the science curriculum or classroom instruction". Aims of science education on one hand are related to formal education, society and on the other hand provide direction to planning and instruction in the classroom. Education in science can be regarded as having five dimensions, each producing one category of the aims of teaching science.

- i) A Content Dimension
- ii) A Process Dimension
- iii) A Context Dimension
- iv) An Affective Dimension
- v) A Meta Scientific Dimension (Nellist (1986, P 1)

These above mentioned dimensions of science education provide us with five categories of aims. It is necessary, therefore, to deal with each of these aims in detail.

i) Aims Related to Content:

A basic concept of science education is to enable students to have broad range of understanding of scientific concepts, theories, principles, and laws through the systematic study in the areas of biology, chemistry and physics. Content should be elected , keeping in view the whole range of natural and applied sciences.

ii) Aims Related to Process:

Children can acquire much scientific knowledge and distinctive ways of thinking If science teachers organize practical activities, encourage students to communicate ideas to others. In other words, development of the following skills among students is one of the important aims of science education.

a) Thinking Skills:

- * The capacity to think in a scientific manner
- * Make hypotheses.
- * Devise situations to test hypotheses,
- * Draw conclusions from evidence
- * Explain phenomena (in terms of appropriate principles or theories)
- * Solve Problems
- * Evaluate claims in relation to evidence.

b) Practical Skills:

The ability to:

- * Make careful and systematic observations and measurements.
- * Carry out experiments and practical assignments confidently, competently and safely.
- * Improvise sensibly when circumstances demand it.

c) Communication Skills:

The Ability to:

- * Communicate orally/present in an appropriate

form, observations, investigations, insights, solutions and explanations.

- * Comprehend the instructions, descriptions, and explanations of others both orally and in printed form.
- * Seek out, select and apply knowledge from a variety of written and other sources. (Nellist, (1986, p 5).

It is important to note that the development of above mentioned skills among youngsters will enable them to carry out the scientific investigations, which require the identification of the problems the methods, procedures evaluation of the experiments and the communication of results and conclusions in a proper manner. Nellist (1986 p 6).

iii) Aims Related to Context:

Science education should be primarily oriented toward the understanding of science in the following contexts.

- a) In the context of pure science, the students should be able to understand the scientific definitions of the words

and concepts.

- b) In the context of solving day to day problems. The students should master the basic skills to tackle issues, which occur on daily basis.
- c) In the context of environment, the students should develop an awareness regarding the environment. It includes understanding of environmental concepts, global issues, socio economic applications and interdisciplinary studies. Nelist (1986, p 6), Bybee (1986, p117)

iv) Aims Related to Attitudes:

Science education when provided to youngsters in an interesting and enjoyable way is likely to promote positive attitude among students.

The aims of science educations related to content, process and context implies providing children

- a) with scientific competencies knowledge and skills appropriate to his immediate needs, and

b) developing positive attitudes towards science, enabling them to

- * Value the significance of science and scientific approach in daily life.
- * Value social worth and appreciate the importance of science and technology in the improvement of the quality of life for individuals and communicates at all levels in the society "UNESCO" (1983, p 31).

It is important to note that science education provides excellent opportunities for the development of the following attitudes among children. "Adaptability, commitment, cooperation, reliability, self-confidence, self discipline, perseverance, tolerance, empathy, consideration for others curiosity, honesty and integrity". Nellist (1986, p 7).

v) **Aims Related to the Meta-Scientific:**

In the light of the above mentioned aims of science education, it is perceived that science education is now increasingly being

considered as an integral part of basic education. This, certainly "contributes to an awareness of the value and limitations of science and of the inherently provisional nature of established scientific knowledge ". Nellist (1986, p 7). The content of science education should be comprised of the following parts.

- a) The nature and scope of science, that is all of these aspects of knowledge that come from the work of the scientists.
- b) The use and understanding of scientific method.
- c) The way in which scientific knowledge be integrated with other types of knowledge in technological and environmental contexts.
- d) The historical development of science and technology.

It should be clear that the careful pursuit of the above mentioned aims in an inter connected way must be the main vehicle for carrying science education in the right direction.

2. Science Education at Secondary School Level:

The emphasis on science education can be observed in the educational policies of the developing countries of the world during the last three decades. As a result of variety of efforts for the qualitative improvement of science education in schools, there is a "significant change in the understanding of the roles science education has to play, of its goals and objectives. There has been a change from an education for an elite to a search for more appropriate and defective ways and means for the delivery of scientific knowledge, skills , attitudes to different groups of the population and makes it more relevant to the needs of a larger section of the school population. Science education is now considered to be an integral part of basic education The developing countries are at a different stages of implementation, but almost all of them are on the move, at least in the formal sector". (UNESCO 1983, p 5)

The promotion of science education in Pakistan has been the focal point of National Educational Policy (1979). It stressed upon the following and developments in science education.

- i) An integration of science content with life situations and environment.

- 2) Discovery laboratory techniques to be used, greater reliance should be on using inexpensive equipment produced from local resources.
- 3) Laboratory activities must focus on three dimensions.
 - a) Experiments.
 - b) Demonstration
 - c) Open ended enquiry
- 4) Periodic revision of the science curriculum to keep it in line with modern trends. In addition emphasis to be given to learning process, acquisition of skills, like observation, exploration, experimentation and the development of positive attitude.
- 5) Teacher's guide for chemistry, physics, biology and mathematics.
- 6) Teaching kits and laboratory manual to be available.
- 7) At the institute of Education and Research University of Punjab, Science Education Centre has been established which provides experiences in research in science education.
- 8) In Islamabad, The Institute for the Promotion of Science Education and Training (IPSET) not only redesign science curricula for schools, but also sponsors projects in low cost activities in physics, chemistry

- 9) A national equipment centre in Lahore has been established since 1976. This centre has been designing, developing and supplying equipment to schools regularly, while systematically expanding at the coverage of the subjects and disciplines. Although the application of "low cost technology" is the main concern, but it is gradually moving towards the manufacture of sophisticated laboratory equipment.
- 10) The national educational equipment centre has produced more than 100,000 kits for elementary school teachers. It establishes the specifications as well as standards of quality of materials to be used in production. (UNESCO 1977, pp 115,124), (UNESCO 1983, pp 50-53)

In spite of the systematic efforts to make science education effective and popular, there are many problems faced by planners and people responsible for the development of science education at secondary level in Pakistan. Among these problems are.

- 1) Teachers should be trained in the production and use of low cost material for science laboratories.

- 2) Teachers in general are reluctant to use innovative techniques in science teaching.
- 3) In service training programmes for science teachers need to be organized systematically to update their knowledge and to change their attitudes towards the profession.
- 4) Innovations need to be introduced in the entire science curriculum, which would certainly improve the instructional strategies for science teaching.
- 5) Teachers need to realize the significance of practical work in science education as well as the use of local resources in laboratory activities.
- 6) Lack of physical facilities due to financial constraints.
- 7) It is very difficult to establish science laboratories and demonstration rooms due to financial constraints.
- 8) Teachers training institutions are poorly equipped. The available equipment is of classical type and out dated.
- 9) Because of the over crowded classrooms, teachers can not provide individual attention to students. (Ghaffar A. 1994, pp 18-22)

In order to overcome the problems and to introduce innovations, in science education, there is a need for the establishment of "science and technological education centres" which will provide opportunity for "action research in curriculum developments, methods and techniques of science, first hand, open ended laboratory experiences using low-cost materials to in-service and pre-service science teachers". (UNESCO, 1977, p 125)

3) Experimentation in Science Education:

The science laboratory is generally called the "heart of science" where students have easy access to explore means and work with the materials, processes and equipment to understand abstract - content and to grow intellectually.

a) Characteristics of good laboratory experience:

There are many kinds of laboratories, many types of equipment. But on the basis of certain characteristics a good laboratory experience can be differentiated from "A trite", a "Stale" one. Each laboratory experience can be characterized according to the following criteria.

- 1) It allows students to inquire by formulating an " if ____ then hypothesis.

- 2) It involves students by requiring them to devise techniques and strategies for conducting the investigation.
- 3) It introduces students to the importance of qualitative measurement and accurate collection of data.
- 4) It requires students to establish controls.
- 5) It is open-ended and results in unanswered questions which lead to further experimentation.

One of the most important tasks of a science teacher is the selection of laboratory experiences which are open-end and inquiry oriented leading towards an understanding of the process of science. (Kahle, 1979, p 123-153)

b) Contribution of Science Laboratory:

Kahle pointed out that "one of the overall objectives in teaching science is an involvement with and an understanding of the processes of science, so the effective use of the laboratory is a prerequisite in science instruction: (1979, p 124). There is a lot of evidence that secondary school students need concrete experiences in order to develop intellectually, therefore, laboratory is viewed as a place, where students gain insights into

the processes of science, establish suitable controls, formulate hypotheses, collect data, interpret results and draw conclusions. According to Richardson, the following are the main "contributions of a laboratory to the teaching of science".

- 1) The science laboratory is a place, where space and resources are available for the solution of problems, these problems may arise during classroom discussions, demonstrations, field trips, and experimentation.
- 2) The science laboratory provides opportunities to students to verify the laws, principles, and generalizations through scientific investigations.
- 3) The science laboratory can be used effectively in the development of scientific skills, interpersonal skills, scientific attitude, habits, and acquisition of knowledge coming students.
- 4) The science laboratory can be useful in developing and increased awareness and understanding of a scientist's role in the society among students. A recognition of the contribution to science made by scientists is possible when students work in the laboratory.

- 5) The science laboratory has a potentially important role to play in understanding essential principles and processes of science. (Richardson, 1957, pp 70-73) (Hull, 1994, pp 66-68)

c) Alternative Laboratory Experiences:

So far, one type of experience, that is the laboratory experiments have been discussed. But there are many other kinds of practical experiences for students. These include laboratory demonstrations, inquiry exercises projects and field work. All of these activities are laboratory based and should be part of science course.

Demonstrations:

Frequently the science teacher would like to use demonstration techniques for confronting a class with a problem, for posing questions for further work, for introducing a basic skill or technique and for bridging from one concept to another. A demonstration has been defined as "the process of showing something to another person or group. An demonstration can also be given inductively by the instructor asking several questions but seldom giving answers. An inductive demonstration has the advantage of stressing inquiry,

which encourages students to analyze and make hypotheses based on their knowledge". (Trowbridge, 1986, p 204)

Demonstration can become an excellent example of teaching for the following reasons.

1) Lower Cost:

Demonstration are economical in terms of equipment and materials to be needed. Sometimes it is not possible that the entire class involves in setting up the experiments or activities. Therefore, it becomes a valuable activity, as it develops skills of observations, which tended to be neglected in traditional science schemes.

2) Non-Availability of Equipments:

Non-availability of equipment for all students brings problem for the teacher. The problem can be manageable by using demonstration effectively in the laboratory.

3) Less Hazard from Dangerous Materials:

The science teachers can use and handle dangerous chemicals with special precautions. In addition, they become experts in working with sophisticated apparatus.

4) Direction of the Thinking Process:

During the demonstration, a science teacher can foster logical reasoning among students. Moreover, the teacher can stimulate and sustain an interest in and enjoyment of science and its applications.

5) Show the use of equipment:

Sometimes the teacher might want to show to the students the use of certain sophisticated equipment like an electronic balance, videotape recorder etc.

Good demonstrations are not simply illustrations of a fact that could be presented more efficiently in other ways. Demonstrations should be used as a basis for summarizing earlier studies or as a spring board to further study. Furthermore, they can provide ideas for students' independent projects. The key to

stimulating students to identify projects lies principally in effective class discussions in which more questions are raised than are answered. Demonstration can provide excellent opportunities for this kind of discussion, and they can provide effective bridges between laboratory and class work (Trowbridge, 1986, pp 203-209)

Inquiry Exercises:

Another type of alternative laboratory experience depends primarily upon the interpretation of experimental data. This instructional technique approaches a simulation situation and involves inquiry exercises. The purpose of these inquiry exercises is to introduce students to problem situations, suitable for their levels of competence. Each sample is incomplete, requiring student response. The omission may be the design of an experiment, the way to control an experimental factor, the conclusion to be drawn from given data or the hypothesis to account for data given.

The inquiry exercise in the science laboratory can be fostered "by fairly simple but important changes". Paul Brandivein and Joseph Schwab in describing the inquiry curriculum" mentioned about inquiry method.

In general, conversion of the laboratory from the dogmatic to the inquiring mode is achieved by making two changes. First a substantial part of the laboratory work is made to lead rather than to lag the classroom phase of science teaching --- second the merely demonstrative function of the laboratory serves the purpose of the dogmatic curriculum is subordinated to two other functions.

One of these functions consist in a new service to the classroom phase of instruction. With classroom materials converted from a rhetoric of conclusions alone will no longer be the major component. Instead, these will be units, dealing with the statement of the problem, a view of the data needed for its solution on account of the interpretation of these data, and a statement of the conclusions followed by the interpretation.

The second function of the inquiry exercises is to provide occasions for an invitation to the conduct of miniature but exemplary programs of inquiry. (Trowbridge, 1986, pp 210-211)

The use of inquiry method by the teacher and students require higher level of proficiency in the use of the tools of inquiry. Students are expected to use knowledge, skills, and understanding to carry out inquiry in which they.

- a) Ask questions and hypothesise.
- b) Observe, measure and manipulate variables
- c) Interpret their results and evaluate scientific evidence.

The inquiry exercise in science forces students to think about what they have done and what further learning experiences on the concept involved are needed to be dealt next time. (Hull, 1994, pp 69-75)

Individual Student Project:

The inclusion of individual student projects in science course is dependent upon a number of factors. These factors include questions like the following:

- 1) Does the science teacher have time to individualize?
- 2) Does school have sufficient resources?
- 3) Does the school have enough space, where long range projects may be set up and left?

It is usually not possible to get students started on really good investigations early in the session. In general, the science teacher should wait till all students have had several good laboratory experiences and students

developed an understanding in which data is collected and interpreted. Before students are encouraged to initiate the project, certain points need to be taken into account.

- 1) Students must be asked to "Write a careful statement of these problem and the major factors they hope to investigate".
- 2) Students should prepare a sample data sheet where they can record information as it is collected.
- 3) The teacher should discuss the problem in detail with the student. The proposed plan and schedule need to be thoroughly discussed.

Individual project work involves pupils in thinking, creating, imaging, predicting, doing, sharing ideas, discovering, presenting and discussing. The main aim of these activities is the same; to give learners opportunities to develop their understanding by actively engaging with some form of relevant challenging situation (Kahle, 1979 pp 149, 152)

Field Trips:

Individual projects can be used to extend science laboratory into the field. The purpose of organizing field trip is to "provide a learning experience

that is unique and cannot be accomplished in the classroom. A science teacher will have to decide the appropriateness of the timing, destination and place for the trip in the instructional sequence". (Trowbridge, 1986, p 281)

Before a field experience is conducted on or off school property , a preview visit to the site is essential. In this way science teacher can assure students that the time spent will be worthwhile to visit that place. In addition, students need to be prepared for the trip by providing information regarding " the objectives, activities and required behaviours and teacher's expectations in general".

After the field trip. students converse, share experience and argue. It is quite obvious that "all of the concrete experiences in the world can not promote the acquisition of abstract concepts unless they are accompanied by social interaction via the use of language. (Kahle, 1979, p 6)

The key to successful field trips is careful planning. Pre planning is important for all teaching but without it a field trip can turn into a horror. Field trips like all the other experiences discussed above require a great deal of planning. Moreover, they can be rewarding and motivating experiences both for the students and the science teachers. (Kahle, 1979, pp 151-537)

4. Equipment and materials Used in Science Laboratories at Secondary Level.

Practical work holds a central place in the teaching of science. Ideas about the nature and value of practical work have already been discussed in detail. The intended purposes of the use of hands - on practical activities include: development of scientific concepts and provision of opportunities for scientific investigations. In addition, laboratory experiences are important in motivating students and developing attitude such as curiosity, objectivity and willingness to evaluate evidence.

In secondary schools the three main science subjects: chemistry, physics and biology require their own equipment and materials. Clearly physics teachers need their "Magic Boxes" of electronic Instruments and chemistry teachers depend upon bottles beakers bunsens and the like/ The amount of practical work in science classes, the availability of equipment and consumable are important concerns for science teachers. To use carefully stock control and avoid wastage of the limited budget available for the resources, can be one of the responsibilities of science teachers.

The availability of adequate science equipment continues to be a major problem in a large number of countries. In fact, the schools of much Asia are far more deprived and backward than is generally confessed at International forum. Reports from Bangladesh, China, India, Maldives, Nepal, Pakistan and Philippines indicate that "80% of schools are poorly equipped or have no equipment at all. The underlying reasons for the lack of adequate laboratory equipment are as follows:

- a) High rate of inflation in the industrial countries from where it is usually ordered.
- b) The phenomenal increase in the school going population.

A rapid deterioration in facilities is being experienced in all but few private institutions. This is particularly alarming situation as the hopes of economics progress are closely tied to the rate at which scientists, engineers and doctors may be trained (APEID, 1983, pp 9-10)

The problems highlighted above have been dealt to certain extent by "the use of multipurpose kits, which cost very little but with which most of the important principles could be demonstrated or tested. Overseas manufacturers have already turned out such kits for chemistry, mechanics, electricity

electronics etc. Many third world countries are also producing their own versions through such groups as the science education project Unit (SEPU) in Kenya, the Zimbabwe secondary school science project (Zim-Sci) in Zimbabwe and similar ones in many universities in Nigeria (Carelse, 1983, p xi)

Bangladesh, Iran, Malaysia, Nepal, Pakistan, the republic of Korea, Sri Lanka and Turkey have established National equipment centres for the design, development, manufacture and distribution of equipment. Some countries have developed teaching kits containing basic equipment and tools that are supplied to the schools. According to Rehman M, "a project on low cost activities was submitted by professor Dr. Naseer ud Din chemistry department Peshawar University sponsored by the Institute for the Promotion of Science Education and Training (IPSET) Ministry of Education, Islamabad. A series of activities have been suggested in this project which are based on low cost materials (equipment and chemicals) and can be very conveniently conducted by teachers and students at schools where there are no regular laboratories for chemistry". (Rehman 1995, p 90).

5. The Development of Low Cost Materials in Science Education:

The Asian Programme of Educational Innovation for Development (APEID) initiated on the recommendation of the third Regional Conference of Ministers of Education and those Responsible for economic planning in Asia (May-June 1971, Singapore) and the authorization of the General Conference of UNESCO at its seventh session (Paris, 1972) aims at stimulating and encouraging educational innovations linked to the problems of national development in the Asian region.

In APEID, there are twenty one countries from Asia and the Pacific. These countries are Afghanistan, Australia, Bangladesh, China, India, Indonesia, Iran Japan, Lao People's Democratic Republic Malaysia, Maldives, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Singapore, Socialist Republic of Viet Nam, Sri Lanka and Thailand. Each country has set up a National Development Group (NDG) to identify and support educational innovations for development within the country and facilitate exchanges between countries.

The Asian centre of Educational Innovation for development (ACEID), an integral part of the UNESCO Regional office for Education in Asia and the Pacific in Bangkok, coordinates the activities under APEID and assists the associated centres (AC) in carrying them out.

The scarcity of resources in Asia and the Pacific is increasingly recognized as an important barrier in improving the quality of education. It has also been realized by all participating countries of APEID that there is a strong need for designing, developing and utilizing low cost/simple educational material and use of environment and various local resources. (UNESCO, 1981, p 1). The efforts of APEID participating countries to develop and utilize low cost educational material were:

- * The campaign started by organizing a regional workshop in educational technology with special reference to the development of low-cost educational materials in Malaysia in December 1977, in which thirteen member states participated.
- * A first series of National workshop on the same subject held in Afghanistan, India, Japan, Malaysia, Nepal and the Philippines, during 1978.

- * The above mentioned six countries, along with Pakistan, participated in the first sub regional workshop in Educational Technology with special reference to the development of low-cost educational materials, held in Nepal in November 1978.
- * A second series of National workshops on the same issue was held in 1980 in the following six countries.
Bangladesh, Papua New Guinea, Republic of Korea, socialist - republic of Viet Nam, Sri Lanka and Thailand. (Ibid, 1981, pp 1-4)

The various activities of the first series by APEID countries included the following.

- i) A Regional Workshop
- ii) National Workshops
- iii) A Sub - Regional Workshop
- iv) Follow-up National Workshops
- v) Second Series of National Workshops during 1980.
- vi) The publication of a volume of inventory of low - cost educational materials.

i) First Regional Workshop in Malaysia (1977):

The first regional workshop at Kaula Lumpre, Malaysia was organized as a joint venture of the Curriculum Development Centre and ACEID on 5-15 December 1977. Twenty three participants from Afghanistan, Bangladesh, India, Indonesia, Iran, Japan, Malaysia, Nepal, Philippines, Republic of Korea, Singapore, Sri Lanka and Thailand participated in the workshop. The objectives of the workshop were:

- * "To facilitate exchange of experiences in the development of low cost simple educational materials and
- * To consider the use of the environment and locally available materials and other appropriate or adopted methods and techniques to develop low cost aids in the Asian countries (UNESCO, 1981, p 4)

During the workshop, the experiences, problems, range and scope of the materials related to low cost activities were taken into account. In addition, specific strategies were formulated to design, develop and to evaluate low cost materials.

The participants also submitted proposals, related to the re-orientation and strengthening of national efforts and a detailed list of low cost materials for different levels of education, alongwith their application and mode of production. (UNESCO, 1980).

Fifth Regional Consultation Meeting on APEID (Bangkok, March 21/30/1978)

The meeting focused on the scheduling and sequencing of the activities related to the development of low cost materials and indigenous teaching devices based upon cost effective techniques. It was recommended that before organizing the first sub regional workshop, a series of national workshops should be planned in the member countries of APEID, who were going to participate in the Sub-regional workshops (UNESCO 1980).

ii) First Series of National Workshops (August-October 1978).

The first series of National Workshops were organized in the following countries.

a) Afghanistan (21-26 October, 1978)

In this workshop, 30 participants from different educational institutions and agencies participated. During the workshop, informal and cordial exchange of ideas took place. In addition, forty eight different items of low cost educational materials with appropriate instruction sheets were developed during the workshop.

b) India:

The centre for educational technology of NGERT. Organized the national workshop in October 1978. The activities during the workshop included (1) display and demonstration of 1,500 items of toys and games brought by the participants, (2) identification and preparation of a list of unused and under utilized, inexpensive raw materials available in different regions of the country; (3) discussions on innovative techniques and methods for production of low cost, simple play material; and (4) preparation of teacher's guide lines for design, development and utilization of such materials. In the end, recommendations for further development of low cost

educational materials were made.

c) Japan (11-15 October, 1978)

The national study workshop was organized by the Centre for Research and Development of Educational Technology (CRADLE). Tokyo. Seven persons from different organization of educational technology participated and discussed the relevance, development and utilization of low cost educational materials and toys. It was recommended that surveys should be conducted of those companies, who produce interesting and appropriate educational materials and toys.

d) Malaysia (2-7 October, 1978)

The national Workshop was sponsored by the Curriculum Development Centre and the Educational Media Service, at the Curriculum Development Centre Kuala Lumpur. There were forty five participants, which included teachers, audio visual officers, and officials of the ministry of education. The participants remained engaged in (a) group and panel - discussions and talks on the various

aspects of low-cost educational materials. A number of low cost educational aids were prepared.

e) Nepal (25 September - 1 October, 1978)

A National Workshop on educational technology with special reference to low cost materials was organized by the Centre for Educational Research, innovation and Development (CERID). The twenty six participants comprised of teachers head of the institutions, supervisors, specialists, and administrators during the workshop. The following developments took place.

- * Sixty low cost educational material.
- * A list of basic tools and raw materials necessary for the preparation of low cost aids.
- * The drafting of a teacher's hand book.
- * The drawing up of a list of games and toys available in the country.
- * The identification of strategies in utilizing local resources in the development of low cost educational materials.

f) Philippines (21-25 August, 1978)

The National Workshop was organized at Batangas by the Ministry of Education and Culture in Collaboration with ACEID. The thirty participants of the work shop included teachers, supervisors, experts from curriculum development centres and personnel from the centre office. An exhibition of models of materials developed was carried out. The raw materials and tools required to develop the models were also on display. In the end, recommendations were made for the promotion of low cost educational materials in the country.

iii) First Sub-Regional Workshop in Nepal (7-21 November 1978)

The first sub regional workshop in Educational Technology with special reference to the development of low cost education materials was held at Kathmandu. The National Education committee, Centre for Educational Research, Innovation and Development, Nepal and ACEID. The fifteen participants from the following seven member countries attended the workshop, Afghanistan, India, Japan, Malaysia, Nepal, Pakistan and Philippines.

1) Multi-level National work conference on educational technology in the Philippines.

The conference was held at Baguio cityon 26-29 November, 1979. In the conference, the following points were taken into consideration.

- * A national programme to maximize the production and utilization of low cost educational materials.
- * Certain guide lines to design, develop and utilize low cost materials.
- * Inventories of low cost materials in different regions and indigenous raw and/or discarded materials, which could be used in making low cost materials and
- * How to utilize local resource centres for the display and menstruation of aids.

2) Follow - up National workshop in India March 1979.

In this workshop, thirty three primary and pre school teachers participated. Also they prepared a number of educational games and toys for children.

3) Follow-up National Workshop in Afghanistan September 1979:

The National Service Center, Afghanistan organized a workshop in September 1979. The thirty five participants developed low cost materials for seventy two experiments in biology, chemistry, physics, and mathematics.

4) Follow up National Workshop in Pakistan July/August 1979.

The Curriculum Wing, Ministry of Education, Islamabad organized a workshop on educational technology with special reference to low cost aids. Twenty seven participants during the workshop focused on four points.

- i) Display and demonstration of materials brought by the participants.
- ii) Establish guidelines for the identification of low cost materials.
- iii) Production of audio-visual aids in the light of prepared guidelines; and
- iv) Evaluation of the low cost educational material (UNESCO, 1981, pp 1-10).

v) Inventories of Low Cost Educational Materials.

ACEID published the first volume of inventory of low cost educational materials. It described in detail eighty five selected items under the title "How to make, how to use, how to adapt" (UNESCO 1984 p 1). The second volume of the inventory consists of 52 low cost educational materials and instruction sheets developed during the second series of national workshops held in Bangladesh, Indonesia, the Republic of Korea, Papua New Guinea, Sri Lanka, Thailand and the socialist republic of Viet Nam during 1979/1980 as well as those developed during the second sub-regional workshop in educational technology held in Dacca, 1980.

The third volume includes sixty one items ranging from educational games to toys. Which on one hand entertain the children and on the other fosters the achievement of many educational objectives for example cognitive development, creativity and mastery over certain manipulative skills (UNESCO, 1984, p 1).

vi) Second Series of National Workshops during 1980.

A comprehensive programme of workshops was conducted by following member countries of APEID during 1980.

i) Bangladesh:

During the workshop, thirty three items of equipment were produced to support primary and secondary science programmes. The following recommendations were made.

- * Teachers, students, parent and the community members should use their expertise in the development of low cost materials.

- * Workshops on low cost equipment should be organized on yearly basis and.
- * The exhibitions of low cost educational materials should be carried out through out the country.

ii) Papua New Guinea.

The national workshop in 1980 focused on the preparation of educational games and the development of skills among elementary school children. As an innovative measure, three basic tool kits were made and distributed to three centres.

iii) Sri Lanka:

The following activities were carried out during the workshop:

- * Development of design techniques to control the cost and improve the function of low cost equipments.
- * Exhibition of low cost science equipment produced by state enterprise and private companies.

- * For the evaluation of the equipment made at the workshop, questionnaire was distributed.

iv) Thailand

During the workshop twenty educational materials for science, social studies, languages and moral education, geography, industrial arts and arithmetic. The following inventories were produced in the work shop.

- * In expansive raw material for preparing low cost educational materials.
- * Basic tools and
- * Low cost educational materials already used in schools. (UNESCO 1981, p 11-46)

Recommendations:

The workshops that have been organized so far suggest the following guiding principles to foster further development and utilization of low cost materials in.

- i) The curricula for teacher training programmes, both pre-service and in service must be restructured, with more emphasis on the relevant aspects of educational technology.
- ii) Competitions and exhibitions should be organized among member countries with special reference to low cost and cost effective materials.
- iii) The educational mass media should be utilized to wide spread dissemination of information on the use of low cost materials among teachers, parents and the community.

- iv) The holding of national seminars and workshops on educational technology should be periodically organized.
- v) Frequent visits to educational technology centres should be organized within the country to identify qualified personnel to improve educational technology in the region and to explore opportunities where exemplary materials can be put on demonstration.
- vi) It was suggested that a team of educational technologists from various member countries be constituted . The team would prepare guidelines to assess and evaluate the activities in educational technology in the member countries with more emphasis on low cost educational materials. (UNESCO, 1983 p 54-55).

6. The Present Status of the Development of Low Cost Materials in science education in the Selected Member Countries of (APEID). Bangladesh, India, Nepal and Pakistan.

The current realization for improved educational opportunities in Asian countries require greater efforts to develop low cost additional materials the "abundance of raw indigenous raw material and other resources, which can be utilized into useful educational materials, and the rich cultural heritages and traditions from which to create relevant curricula programmes and activities for children must also be taken into account:. (UNESCO, 1979, p 4).

Increasing evidence of the use of local resources is reflected in an interest in indigenous medicine work on windmills and improved cottage industry. In brief, the responses for the use of local resources in education are encouraging and with the passage of time, availability of low cost equipment in schools will balance the sophisticated, expensive and unattainable equipment.

The current situation regarding the development of low cost educational materials in the selected member countries of APEID are discussed in much greater detail in the proceeding papers.

i) **Bangladesh:**

1) **National Policy and the Status of Low Cost Educational Materials:**

The increase in the rate of population growth resulted in the large number of educational institutions in Bangladesh. The importance of reliance on local resources for the improvement of teaching learning situation has been realized at all levels. Efforts have been made to relate science and technology to real life situations and are reflected in new curricula.

Low cost educational materials refer to the material available in the "local environment, industrial and domestic wastes or carded, useable and inexpensive materials" (UNESCO, 1980, p 11) In institutions, where there is no blackboard, text books, exercise books or pencils are few. But more pertinent to the problem of teaching some elements of simple science, there are no devices of even the simplest kind such as rulers, crude balances, etc.

Another problem is that of non-availability of skilled and trained teachers who can utilize local resources to develop low cost educational materials. In addition, teachers do not have the knowledge about the importance and use of low cost materials, chemicals and equipments.

Considering the current situation in the country, the government is planning to reorganize the existing curricula for schools and colleges to achieve quality education. Moreover, the existing educational equipment Bureau has focused on the improvement of planning and research in the area of design and development of low cost materials with acceptable quality. The government of Bangladesh intends to provide low cost educational materials to 43,000 primary schools, and 2,000 secondary schools to facilitate laboratory activities in the next ten years.

2) Institutional Arrangements:

The Government of Bangladesh has established two organizations, the Bangladesh Educational Equipment Development Bureau and the Audio Visual Education Centre for performing certain responsibilities.

The Bangladesh Educational Equipment Development Bureau, designs in low cost science equipment, promotes local manufacture, provides quality control and price standardization services, and conducts training of teachers in the use and maintenance of equipment. The Bureau has so far developed equipment for secondary and higher secondary level. The products quality was evaluated and found satisfactory as well as competitive against imported ones.

The Audio-Visual Education Centre designs, develops and distributed audio-visual educational material and conducts in service training programmes for teachers "how to use and care audio-visual materials The centre has so far produced and distributes charts, models, slides and films among primary and secondary schools.

The Bangladesh Education Extension and Research Institute and the Institute of Education and Research have been developing and improving certain educational materials during in-service training programmes.

Science clubs are organized by secondary school students. They prepare low cost equipment and glassware in physics, chemistry and biology. Village Education Resource Centres and the Central Extension Resource Development Institutes are respectively busy in designing and developing non-formal, cost effective materials and agricultural equipment. (UNESCO, 1981, pp 11-16)

ii) India

1) National Policy and the Status of Low Cost Educational Materials:

Nearly half of India's population is comprised of children. The number of schools and teachers runs into millions. Since the schools in general, lack the basic facilities, therefore, Government in its national policies, encourages teachers to design and develop low cost

educational materials by utilizing local resources. Synthesis of low cost educational materials is carried out at the following levels.

- a) The National Council of Educational Research and Training (NCERT). It develops low cost educational materials for primary , secondary and higher secondary schools.
- b) In-service teacher training programmes are organized by NCERT to train teachers, "How to utilize local resources in the development of low cost materials.
- c) Each department of the State Institute of Education Organizes seminars, which are geared towards the Identification of unutilized materials and innovative methods for the production of cost effective equipment in science.
- d) The NCERT organizes the National Science Exhibition on annual basis at district level. Children not only make low cost equipment, but also come-up with innovative ideas to improve

science education.

- e) The state institutes of Education (SIE), the State Institute of Science Education, the State Audio-Visual units and the educational technology cells organize workshops and seminars for primary, secondary, and higher secondary school teachers to foster the production of low cost educational materials.
- f) The local manufacturers have produced varieties of low cost educational materials and science equipment, but many schools cannot purchase these materials due to the limited school budget. (UNESCO, 1979, pp 6-9).

iii) Nepal:

- 1) National policy and the status of low cost educational materials.

The following programmes have been launched to improve the quality of education and to fulfill a variety of other purposes.

- a) Science Teaching Enrichment Programme (STEP).
- b) Programme for Revision and Improvement in Mathematics Education (PRIME).
- c) Curriculum, Text Book and Supervision Development Centre (CTSDC)
- d) Science Equipment Centre (SEC)

The STEP and PRIME are provided with equipment and materials given by UNICEF. The CTSDC is responsible for designing, developing and revising the curricula in all subject areas. The SEC has been developing and producing curriculum based science and vocational education equipment.

The Institute of Education (IOE) has been conducting in service and pre-service teacher training programmes to fulfill the National need for trained teachers.

2) Problems related to the use of low cost educational materials.

The following problems have been identified.

- * Inadequate emphasis on the development and use of low cost materials.
- * Inadequate budgetary provision for the development of low cost educational material in teacher training.
- * Inadequate emphasis on practical aspects of the development of low cost educational materials in teacher training.
- * Inadequate classroom and storage facilities in the schools.
- * Lack of trained personnel in the area of educational technology.

In spite of the above mentioned problems, the need for simple, low cost and indigenously prepared equipment and materials is felt at the national level. The SEC has started developing two kinds of prototype equipment. One that can be produced by the centre and the other

which can be prepared by teacher themselves by using local materials. The CTSDC has conducted several short term teacher training programmes with special emphasis on the use of simple materials.

The CTSDC conducts national science education workshops, which are effective in providing knowledge and skills to key persons in this field. The CTSDC and the centre for Education Research , Innovation and Development (CERID) jointly conduct regional workshops in which teachers are given training on how to prepare simple, low cost, indigenous materials for science teaching.

Finally, the development and use of low cost educational materials is a major activity during the short term training programmes organized by the District Education Officer in their respective districts. The Institute of Education is also contributing significantly to the development and use of simple low cost educational materials by way of its teacher training programme. (Ibid, pp 13-20).

iv) Pakistan:

i) **National Policy and the Status of Low Cost Educational Materials.**

New national policy of the Government of Pakistanis linked with the concept of Indogenous economic and social development - general education at the primary and lower secondary level s is also geared to fulfill the socio-economic needs of the country.

The Audio-visual and teacher-Education unit of the curriculum wing, Ministry of Education has been planning and designing the National Teaching Kits since 1974 in the "spirit of Educational policy 1972-80 which envisaged variety of measures to be taken to improve the existing facillties methods of teaching,provision of instructional materials and teaching aids for primary education" (Ghaffar,1995,P-2).

The National Educational equipment centre has been designing developing and supplying equipment to schools regularly, while systematically expanding the

coverage of subjects and disciplines. Although the application of low cost technology is its main concern the centre is also endeavouring to introduce gradually the degree of sophistication necessary for the equipment to be standardized.

The center activities are supported and supplemental by the education extension centers, in service training centers, the Institute of Education and Research, the Allama Iqbal Open University and the Pakistan radio and Television.

The introduction of teaching Kits into the school curriculum is one of the goals of the center. For this purpose, the curriculum wing of the Ministry of Education conducts periodic work shops for master trainers who in turn train classroom teachers. The National Educational Equipment center has been designing, developing, and producing teaching kits since 1976. The center has already produced more than 100,000 kits at the primary level alone.

The institute for the promotion of science Education and Training (IPSET) Ministry of Education sponsors various projects on low-cost activities in chemistry, physics, and biology. In addition, In 1994, IPSET completed a research project "Benefit Monitoring and Evaluation, Report on Base line study for classes IX-X". The purpose of the study was "to investigate and report on the situation regarding the teaching of Biology, chemistry, physic and general science in classes IX-X, in project schools. The profile would describe the physical resources available for teaching and learning science at school level, the processes being used to exploit there in the classroom or laboratory, and their educational outcome" (Slimming, 1994 p-4).

The Institute for the promotion of Science Education and Training (IPSET) also undertake researches on Science curriculum development and text books, organize training programmers for the popularization of science education (Afzal, 1984, pp-13-14).

ii) Problems and Issues Related to Low-Cost Educational Materials.

- 1) Several components of the curriculum activity kits are produced commercially. The rate of production is however, slow.
- 2) Distribution of the kits is another problem because of the inaccessibility of some schools in the remote areas.
- 3) Training of teachers in the effective use of the kit, its care and maintenance is another big problem.
- 4) Primary school teachers are restricted to the kit and its manual. There are no guides for development, production, and utilization of other low-cost educational materials (UNESCO, 1981 pp-50-53).

CHAPTER-III

RESEARCH DESIGN

1. The Nature of the Study:

According to Borg and Meredith D.Gall (1983, p 351) "Selection of a research design usually involves a complex undertaking what is most rigorous? What is most natural? and what is most possible". The nature of study in hand is experimental. The experiment is generally regarded as the most sophisticated research method for testing hypotheses. This method begins with a question concerning the relationship between two or more variables. At the same time, the researcher advances one or more hypotheses. The experiment is the event planned and carried out by the researcher to gather evidence relevant to the hypotheses. In conducting an experiment, the researcher devotes great care to the manipulation and control of variables and to the observation and measurement of the results.

The experimental method in its simplest form has "three characteristics.

- 1) an independent variable is manipulated.
- 2) all other variables except the independent variable are held constant.

- 3) the effect of the manipulation of the independent variable is observed". (Ary. D: 1979, p 225) Experiments in education may be conducted in either a laboratory or in a field situation. Field experiments can be conducted in classrooms, play grounds, or other natural settings. There are two general types of experimentation conducted under classroom conditions; 1) the method study; in which two or more ways of doing something are compared in an unbiased fashion, and 2) fundamental research, the purpose of which is to derive general principles applicable beyond the immediate situation (Ary D. 1979 pp 224-228).

2) Design:

The researcher selected the following design, the most highly recommended for experimentation in education.

Design: RANDOMIZED GROUPS, PRETEST - POST TEST - DESIGN.

In this design, subjects are assigned to the experimental and control groups by random methods and are given a pretest on the dependent variable. The treatment is introduced only to the experimental subjects for a specified

time, after which the two groups are measured on the dependent variable. The average difference between the pretest and post test ($Y_2 - Y_1$) is found for each group and then these average difference scores are compared in order to ascertain whether the experimental treatment produced a change than the control situation. The significance of the difference in average changes is determined by an appropriate statistical test, such as the t-test or f-test.

The before and after measures in this design permit the researcher to study change and it is often referred to as the a classical design for change experiments. The main strength of this design is the initial randomization, which assures statistical equivalence between the groups prior to investigation; also the fact that the experimenter has control of the pretest can provide an additional check on the equality of the two groups, on the dependent variable. This design with its randomization thus controls most of the extraneous variables that pose a threat to internal validity.

Internal validity is concerned with a change in the dependent variable as a result of the experiment treatment. the independent variable can make a significant difference if the design provides adequate control of extraneous variables. the design of appropriate controls is a matter of finding ways to eliminate extraneous variables, which could lead to alternative interpretations.

The main concern in using this design is external validity. The problem arises from the use of the pretest, an essential feature of the design. It is assumed that there might be an interaction between the pretest and the subjects that can sensitize them in certain ways, which can cause the experimental group to respond to the experimental treatment in a particular way just because of their increased sensitivity. In spite of this short coming, this design is widely used because the interaction effect is not a serious problem in most educational research. The pretests used are generally achievement tests of some type and therefore, do not have significant - sensitizing effects on subjects who are accustomed to such testing. (Ary. D; 1979 pp 225-267)

3. Procedure:

The study was conducted in seven phases.

- i) Preparation of the test instruments.
- ii) Designing laboratory experiments with low cost materials parallel to experiments with high cost materials.
- iii) Administration of the pretest
- iv) Formulation of two groups. Experimental and Control
- v) Preparation of the laboratory experiments.
- vi) Conducting the experiments.

- vii) Administration of the post test.

The following is a detailed discussion on these stages.

i) PREPARATION OF THE TEST INSTRUMENTS

Justification:

According to Zaffarullah (1993), No efforts so far have been made in Pakistan to prepare standardized achievement tests in any subject area at any level. There were no standardized academic achievement tests in chemistry available for secondary school students. The researcher was, therefore, forced to construct two academic achievement tests in chemistry. These tests were prepared in specific content area of chemistry for secondary school students. The pretest was constructed for the following purposes:

- a) To determine the current level of students's knowledge in the selected content area of chemistry.
- b) To formulate experimental and control groups on the basis of performance.

Whereas, the purpose of preparing post test was to assess change in the performance the two groups of students after they complete laboratory experiments with low cost and high cost equipment (for a detailed description of the pretest and post test, see appendixes "A" and "B")

Researcher tried to construct the test items keeping in mind the following consideration.

- a) Clear directions have been given along with each part.
- b) Simple language is used.
- c) Items have been kept short.
- d) Care has been taken to avoid ambiguity in test items.
- e) Each test item has been based on an important fact, concept or skill.

Format of the Test:

The test are the main instruments for assessing student's performance, which would reflect their level of knowledge in chemistry before and after the experiment. The researcher tried to construct test

items which could reflect what Bloom describes as knowledge, comprehension and application. (Trowbridge; 1986, pp). In addition, few test items were related to arithmetic skills, essential for the interpretation of data obtained through laboratory experiments. While constructing the tests the researcher chose multiple choice test items, fill in the blanks and short answer questions.

Trial of the Test Instruments:

Since these tests were constructed by the researcher, therefore, she strived to attain the desirable characteristics of a measuring procedure, that is validity, reliability, item difficulty etc. For that purpose a test-re-test procedure was carried out. The ambiguities of the test items, too easy or too difficult test items were eliminated from the final versions of the two test, in order to meet the standards. The following test items were removed from the pretest and post test.

Pretest:

- i) The ratio of oxygen atoms to hydrogen atoms in $(\text{NH}_4)\text{SO}_4$ is:
- a) 1:1 b) 2:1 c) 1:2 d) 1:4

Almost two third of the students did not even attempt the item, among one third of the class, few students could attempt successfully.

- ii) Which of the following is the best definition of an exothermic reaction.
- a) One which occurs between a metal and oxygen.
 - b) One which takes in heat.
 - c) One which occurs between metals and non metals.
 - d) One which gives out heat.

The test item was ambiguous as students could not understand the phrases.

- iii) The formula of sucrose is $C_{12}H_{22}O_{11}$. What is molecular mass of sucrose.

All the students in the class attempted it successfully.

Post Test:

The following items were eliminated from the test.

- i) Calculate the pH of 0.1 M aqueous solution of hydrochloric acid.
- Five students out of forty students attempted successful.

- ii) Which of the following are classified as transition elements.
Cu, Pb, Fe, P, O, Sb, Hg, Ca, Al, N, As, Sn
None of the students in the class did it right.
- iii) The solubility of a solute in water at a particular temperature is the maximum amount of solute that will dissolve in _____ gms of water at that temperature.
Thirty seven students out of forty attempted it successfully.
- iv) From the position in the periodic table, the element sodium is:
a) A liquid b) a metalloid, c) a non metal
d) a low melting metal (ambiguous)
The researcher selected 9th class in Sarhad Model School, Peshawar Cantt, to carryout test-retest procedures.

**ii) Designing Laboratory Experiments with Low Cost Materials
Parallel to Experiments with High-Cost Materials.**

Objective

The following were the objectives for designing experiments with low cost materials.

- a) To conduct these experiments in the laboratory with experimental group.

- b) To develop the understanding of concepts and to help students acquire skills.
- c) To assess the effectiveness of low cost activities in the development of concepts and skills related to chemistry.

Source to be consulted for the designing of the experiments.

Islamia Chemistry Practical Notebook for Class 9th & 10th (English Medium Schools)

The following criteria were taken into consideration as recommended in one of the national workshops organized by APEID on low cost materials (UNESCO, 1979, p 47)

- a) Relevancy b) Simplicity c) Raw material Cost
- d) Durability e) Safety in operation f) Ease of handling
- g) Multipurpose use h) Suitability to local environment
- i) Time saving j) Ease of maintenance
- k) Transportability

Keeping in view the extreme significance of the role of laboratory experiences in science education the investigator selected the experiments to be designed with low cost materials, which would

enhance the acquisition of skills and promote the understanding of concepts. Selected laboratory experiments focused upon:

- a) Basic laboratory activities, for example glass cutting, bending of glass tube etc.
- b) Basic skills (How to handle apparatus, how to measure how to take readings etc)
- c) Concepts (for example, density, sublimation, crystallization distillation etc.)

The researcher developed the experiments in a systematic way moving from simple to more complex activities. The notion was that the experiments should be completed in the limited time available. The fear that this intensive programme may cause excessive stress among students was minimized by the latest belief that stress if kept within limits can be more fruitful than a lack of it.

iii) Administration of the Pretest:

The pretest was administrated to Seventy students of 9th class in PAF Model School, Peshawar Cantt. The chemistry teacher and his assistance administered the test under the supervision and

guidance of the researcher. Almost two third of the class completed the test in the allotted time (One hour), The test was collected, scored and compiled by the researcher. (For detail, see Appendix _____)

iv) Formulation of Two Group -Experimental and Control.

Sampling: Randomized Matching:

Justification of the Randomized Matching:

According to Best (1970), Random sampling in educational research is the most useful procedure as most of the principles of statistical inferences are based upon the assumption of random selection. One of the procedures for assigning subjects to groups is to match individual subject on one or more than one variables. Variables such as I.Q. Socio economic status, pretest scores, or reading scores can be used (Ary D. 1979 p 231) According to Borg (1983, p 669), "The usual steps in carrying out a study using the pretest posttest control group design with matching are as

follows.

- 1) Administer measures of the dependent variable to the research subject.
- 2) Assign subjects to matched pairs on the basis of their scores on the measures described in step 1.
- 3) Randomly assign one member of each pair to the experimental group and the other to the control group.
- 4) Expose the experimental group to the experimental treatment and alternative treatment to the control group.
- 5) Administer measures of the dependent variables to the experimental and control groups.
- 6) Compare the performance of the experimental and control groups on the posttest using tests of statistical significance.

Procedure for Matching Person to Person Procedure

The researcher decided to use person to person procedure in her situation.

Justification:

According to Ary. D. (1979, p 231), "The usual method is to use a person to person procedure in which an effort is made to locate two persons from among the available subjects who score within the limits decided upon and then randomly assigns one subject to the experimental group and the matching subject to the control group", used pretest scores for matching. The researcher prepared a list of students and their scores respectively using the above mentioned procedure, the experimental and control groups were formulated. Both the groups contained thirty five students each. (for detailed description see appendix).

v) Preparation of the Laboratory Experiments:

The researcher selected twenty laboratory experiments out of thirty prescribed for class 9th and 10th for all boards of Punjab, Baluchistan, NWFP, Azad Jammu & Kashmir and Federal Board.

Objectives of the Preparation of the Laboratory Experiments:

- a) To develop requisite laboratory skills.
- b) To promote understanding of the concepts of chemistry.
- c) To provide opportunities for learning by doing.
- d) To provide training in handling the apparatus. (Kahle: 199, p 131)

Although limited, these objectives were difficult to achieve. Keeping this fact in mind, the researcher tried her best in the preparation and scheduling the experiments, so that the experiments could be conducted in an organized way.

According to the schedule, the experimental and control groups worked in the same laboratory under similar weather conditions. The researcher selected morning

hours in a way that on first day of the week, the experimental group will be working first and then the control group. On the second day, the control group will be working first and then the experimental group. This schedule continued through out six weeks.

vi) Conducting the Experiments:

After the preparation of the experiments, the next task was to conduct the laboratory activities with both groups. The task would not have been completed without the full participation and cooperation of the chemistry teacher with the researcher. Since the role of the teacher was very important, the researcher, therefore, provided the general guidelines and encouraged him to use them. The following were the guidelines.

- a) To use denotative language, while giving instructions to both experimental and control groups.
- b) To encourage students to ask questions and make comments wherever a need is felt.
- c) To explain the nature of experiments, equipment, glassware, and chemicals used during the activities and try

to relate these activities to daily life.

- d) To encourage students to think critically.
- e) To be patient and tolerant with students, not to hurry them to finish the experiment fast.

The researcher formulated a team of chemistry teacher and laboratory assistance, who could work under the supervision of the investigator.

Keeping in view the educational significance of the laboratory experiences, the researcher's main concern was to facilitate the process, so that it could be successfully completed in the allotted time. For that purpose, the researcher provided guidelines to the chemistry teacher for conducting laboratory experiments using low cost materials with experimental group and high cost materials with control group.

a) Before Laboratory Activity:

The teacher is expected to:

- i) Introduce students to the purpose of the laboratory activity.

- ii) Describe the key feature of the activity.
- iii) Show the type of equipment to students, which they will be using.

b) During Laboratory Activity:

- i) Encourage students to be fully involved in the activity by asking questions occasionally to test their comprehension of what is being going on.
- ii) Elaborate on the activity, when appropriate in order to help students understand the concepts inherent in the laboratory experience.
- iii) Encourage students to ask questions if they do not understand the procedures.

c) After Laboratory Activity:

- i) Help students to make necessary calculations and to arrive to the final conclusions.
- ii) Discuss results

- iii) Evaluate Results
- iv) Encourage students to be prepared for the next activity. (Kahle; 1979, pp 131-132)

Organization of the Laboratory:

One of the main concerns of the researcher was the practical organization of the laboratory to maximize the use of equipment and to minimize confusion and safety hazards. A number of factors were taken into consideration to control situational differences. According to Ary. D. (1979 p, 234) if situational variables are not controlled in an experiment, one cannot be sure whether it is the independent variable or these incidental differences operating in the groups that is producing the difference in the dependent variables".

The researcher tried to control the contaminating situational variables by one of the most commonly used method, called " hold them constant". The

experimental and control group received same instructions, and used same procedures. Environmental conditions such as temperature, light intensity, humidity, ventilation, space and noise distractions were the same for both the groups (for more details, see appendix)

Laboratory Groups:

Justification:

According to Kahle (1979), Laboratory groups are crucial part of any laboratory experiment. Obviously, sets of supplies and equipment will determine the nature of the working laboratory groups". In the laboratory, there were seven sets of equipment for thirty five students. Therefore, the researcher formulated laboratory groups, each comprised of five students.

After accomplishing these tasks, the researcher with the help of the team conducted twenty experiments in six weeks.

vii) Administration of the Post Test:

In order to assess the change and to ascertain whether experiments carried out with low cost materials produced a change or not. The researcher and her team (chemistry teacher and his assistance) administered the posttest to experimental and control groups under similar environmental conditions as were available for pretest. Both the groups completed the test in the allotted sixty minutes with the exception of few students.

CHAPTER-IV ANALYSIS OF DATA

TABLE-I
MEASURES OF CENTRAL TENDENCY
THE MEAN - PRETEST AND POST TEST
GROUPS - EXPERIMENTAL AND CONTROL

EXPERIMENTAL GROUP Low Cost Activities						CONTROL GROUP High Cost Activities					
Sub No.	Pretest Score	Posttest Score	S. No.	Pretest Score	Posttest Score	S. No.	Pretest Score	Posttest Score	S. No.	Pretest Score	Posttest Score
1	25.5	36.5	19	16	17	1	30	37	19	13.0	19.0
2	23.5	27.0	20	16	21	2	25.5	29	20	13.0	13.0
3	22.0	27.0	21	16	29	3	25.5	28	21	13.0	13.0
4	21.5	22.0	22	14.5	18	4	22.0	17	22	13.0	18.0
5	21.5	22.0	23	14.0	27	5	22.0	28	23	12.0	6.0
6	20.5	23.0	24	14.0	26	6	21.0	28	24	12.0	24.0
7	20.0	20.0	25	13.5	21	7	20.0	25	25	11.0	10.0
8	20.0	21.0	26	13.5	20	8	20.0	32.5	26	11.0	11.5
9	19.5	22.0	27	13.0	26	9	18.0	22.0	27	11.0	19.0
10	19.5	25.0	28	12.0	12	10	17.0	26.0	28	10.0	25.0
11	18.5	24.0	29	12.0	9	11	17.0	18.0	29	10.0	24.0
12	18.5	19.0	30	11.5	19	12	17.0	24.0	30	9	22.0
13	18.0	17.5	31	11.5	17	13	16.5	19.0	31	8	29.0
14	18.0	22.0	32	10.5	15	14	16.0	26.0	32	8	18.0
15	18.0	20.5	33	10.0	18	15	15.0	28.0	33	8	16.0
16	17.5	23.0	34	10.0	18	16	15.0	21.0	34	6	8.0
17	17.5	20.0	35	8.0	8	17	14.5	11.0	35	5	13.0
18	17.0	15.0				18	14.0	10.0			
EXPERIMENT GROUP Mean (Pretest) = $X_{1(E)} = \frac{\sum X_1}{N}$ = $\frac{572}{35} = 16.35$ Mean (Posttest) = $\frac{\sum X_2}{N} = \frac{\sum X_2(E)}{N}$ $\frac{727.5}{35} = 20.78$ $X_{2(E)} = 2.78$						CONTROL GROUP Mean (Pretest) = $X_{1(C)} = \frac{\sum X_{1(C)}}{N}$ = $\frac{519}{35} = 14.82$ Mean (Posttest) $X_{2(C)} = \frac{\sum X_{2(C)}}{N} =$ = $\frac{718}{35} = 20.51$					

ANALYSIS:

The table indicates that the mean scores of both experimental and control groups are compatible in Pretest i.e 16.35 for experimental and 14.82 for control group. The difference between the two mean scores is 1.50 where as the difference between the two mean scores on posttest is 0.27, a negligible difference. which certainly reflects that laboratory experiments carried out with low cost materials and high cost materials produced almost same positive effects on the achievement of students.

TABLE-II
SIGNIFICANCE OF THE DIFFERENCE BETWEEN
TWO MEANS ON POSTTEST

EXPERIMENTAL GROUP						CONTROL GROUP					
S. No.	X_1	X_1^2	S. No.	X_1	X_1^2	S. No.	X_2	X_2^2	S. No.	X_2	X_2^2
1	15.72	247.11	19	-3.78	14.28	1	16.49	271.9	19	-1.5	2.25
2	6.22	38.68	20	0.22	0.05	2	8.49	72.08	20	-7.5	56.25
3	6.22	38.68	21	8.2	67.56	3	7.49	56.1	21	-7.5	56.25
4	1.22	1.48	22	2.78	7.72	4	-3.51	12.32	22	-2.5	6.25
5	1.22	1.48	23	6.22	38.6	5	7.49	56	23	-14.5	210.25
6	2.22	4.92	24	5.22	27.24	6	7.49	56	24	3.5	12.25
7	-0.78	0.608	25	0.22	0.05	7	7.49	20.16	25	-10.5	110.25
8	0.22	0.05	26	0.78	0.608	8	11.99	143.7	26	-9	81
9	1.22	1.48	27	5.22	27.24	9	1.49	2.22	27	-1.5	2.25
10	4.22	17.8	28	8.78	77	10	5.49	30.1	28	4.49	20.16
11	3.22	10.36	29	-11.78	138.76	11	-2.5	6.25	29	3.5	12.25
12	-1.78	3.16	30	-1.78	3.16	12	3.5	12.25	30	1.49	2.22
13	-3.28	10.75	31	-3.78	14.28	13	-1.5	2.25	31	8.49	72
14	1.22	1.48	32	-5.78	33.4	14	5.49	30.1	32	-2.5	6.25
15	-0.28	0.07	33	-2.78	7.72	15	7.49	56	33	-3.5	12.25
16	2.22	4.92	34	-2.78	7.72	16	0.5	0.25	34	-12.5	156.25
17	-0.78	0.608	35	-12.78	163.32	17	-9.5	90.25	35	-7.5	56.25
18	-5.78	33.4				18	-10.5	110.25			

EXPERIMENTAL GROUP

$$\text{Mean } X^1 = 20.78$$

$$\text{Deviation from mean} = \Sigma X^1 = -0.12$$

Square of the deviation from mean

$$\Sigma X_1^2 = 1046$$

CONTROL GROUP

$$\text{Mean } X^2 = 20.51$$

$$\text{Deviation from mean} = \Sigma X^2 = -1.13$$

Square of the deviation from mean

$$= 1890$$

a) To Calculate the variance

$$S_1^2 = \frac{\Sigma X_1^2}{N} = \frac{1046}{35} = 30$$

a) To Calculate the variance

$$S_2^2 = \frac{\Sigma X_2^2}{N} = \frac{1890}{35} = 54$$

b) To calculate standard deviation

$$S_1 = \sqrt{\frac{\Sigma X_1^2}{N}} = \sqrt{30}$$

$$S_1 = 5.47$$

b) To calculate standard deviation

$$S_2 = \sqrt{\frac{\Sigma X_2^2}{N}} = \sqrt{54}$$

$$S_2 = 7.3$$

c) To determine whether the samples meet the criterion of equality of variances on Fmax test is used.

$$F = \frac{S_2^2}{S_1^2} = \frac{(\text{Largest Variance})}{(\text{Smallest variance})} = \frac{54}{30} = 1.8$$

Result : Variances are homogeneous.

d) Standard error of the difference between two means, when variances are not equal.

$$SX_1 - SX_2 = \sqrt{\frac{SX_1^2}{N} + \frac{SX_2^2}{N}} = \sqrt{\frac{30}{35} + \frac{54}{35}}$$

$$= 9.1$$

TABLE-III
COMPARISON OF PERFROMANCE BETWEEN
EXPERIMENTAL AND CONTROL GROUPS IN THE
DOMAIN KNOWLEDGE ON PRETEST

S. No.	Domain Knowledge	EXPERIMENTAL		CONTROL	
		Correct	Incorrect	Correct	Incorrect
1.	Measuring of Volume	31	4	25	10
2.	Definition - Molecule	22	12	17	18
3.	CO ₂ - Acidic	10	25	10	25
4.	Photosynthesis	15	20	17	18
5.	Definition - Acid	12	23	11	24
6.	Definition - Boilling Point	3	32	3	32
7.	Definition - Melting Point	5	30	24	31
8.	Definition - Freezing Point	10	25	4	31
9.	Solubility - Definition	5	30	3	32
10.	Definition - Electrolysis	5	30	0	35
11.	Definition - Neutralization	7	28	3	32
12.	Definition - Solution	9	26	7	28
13.	Definition - Volume	28	7	29	6

ANALYSIS:

Experimental Group = % Correct Responses

$$= 16200/455 = 35.60\%$$

Control Group = % Correct Responses

$$= 13300/455 = 29.23\%$$

$$\text{Difference in \%} = ,35.60-29.23 = 6.37$$

The above indicates that the percent performance of experimental group in the area of knowledge is 35.60%, where it is 29.36% for the Control Group. The percent difference is 6.37.

TABLE-IV
COMPARISON OF PERFORMANCE BETWEEN
EXPERIMENTAL AND CONTROL GROUPS IN THE
DOMAIN OF UNDERSTANDING ON PRETEST

S. No.	Understanding of Concept	EXPERIMENTAL		CONTROL	
		Correct	Incorrect	Correct	Incorrect
1.	Strong and Weak Bases	13	22	15	20
2.	Concept - Electrolysis	3	32	3	32
3.	Concept - Electrolytes	33	2	30	5
4.	Concept - Density and Specific Gravity	7	28	20	15
5.	Concept - Boiling Point	23	12	19	16
6.	Concept - Effects of Pressure	23	12	15	20
7.	Concept - Effects of Impurities on melting & Freezing Points	15	20	10	25
8.	Concept - Effect of Temperature on Solubility	6	29	4	31
9.	Concept - Strong & Weak Electrolytes	5	30	0	35
10.	Concept - Acids	4	31	1	34
11.	Concept - Density of Ice is less than Liquid H ₂ O	11	24	10	15
12.	Concept - Density of Ice is less than Liquid H ₂ O	11	24	16	19
13.	Concept - Boiling Point	26	9	28	7
14.	Concept - Neutralization	5	30	7	28
15.	Concept - Salt	19	16	9	26

ANALYSIS:

Experimental Group = % Correct Responses

$$= 20400/525 = 38.85\%$$

Control Group = % Correct Responses

$$= 18700/525 = 35.61\%$$

$$\text{Difference in \%} = 38.85 - 35.61 = 3.24$$

It is indicated in the Table that the percent performance of Experimental Group in the area of understanding on Pretest is 38.85. Compared to 35.61 for Control Group. The observed difference 3.24% reflects superiority of experimental group over the control group.

TABLE-V
COMPARISON OF PERFORMANCE BETWEEN
EXPERIMENTAL AND CONTROL GROUPS IN THE
DOMAIN OF APPLICATION ON PRETEST

S. No.	Domain = Application	EXPERIMENTAL		CONTROL	
		Correct	Incorrect	Correct	Incorrect
1.	Concept - Conversation of Units	26	9	28	7
2.	Concept - Molecular mass	15	20	24	11
3.	Concept - Density	4	31	11	24
4.	Concept - Density	6	29	10	25
5.	Concept - Solubility	30	5	30	5
6.	Concept - Conductivity	26	9	25	10
7.	Concept - Electrolytes & Non Electrolytes	9	26	15	20
8.	Concept - Conductivity	6	29	8	27
9.	Concept - Acids	24	11	17	18
10.	Concept - Acids	0	35	0	35
11.	Concept - Acids	4	31	0	35
12.	Concept - Salts	6	30	2	33
13.	Concept - Bases	9	26	5	30
14.	Concept - Solubility	10	25	7	28
15.	Concept - PH	0	35	2	33
16.	Concept - Dissociation	11	24	11	24
17.	Concept - Dissociation	12	23	11	24

ANALYSIS:

Experimental Group = % Correct Responses on Pretest.

$$= 19700/595 = 33.10\%$$

Control Group = % Correct Responses on Pretest.

$$= 20600/595 = 34.62\%$$

Difference 1.52

The above mentioned table reveals the percent performances of experimental and control groups in the area of application on pretest are 33.10% and 34.62% respectively. The observed difference better performance of control group.

TABLE-VI
COMPARISON OF PERFORMANCE BETWEEN
EXPERIMENTAL AND CONTROL GROUPS IN THE
DOMAIN OF KNOWLEDGE ON POSTTEST

S. No.	Knowledge	EXPERIMENTAL		CONTROL	
		Correct	Incorrect	Correct	Incorrect
1.	Measures of Length	33	2	28	7
2.	Definition - Sublimation	27	8	23	12
3.	Definition - Boiling Point	20	15	26	9
4.	Definition - Acids	6	29	5	30
5.	Definition - Neutralization	34	1	27	8
6.	Definition - Allotropy	8	27	12	23
7.	Name of the Gasses in air	35	0	30	5
8.	Definition - Density	27	8	22	13
9.	Definition - Sp. Gravity	6	29	3	32
10.	Units of Density	6	29	12	23
11.	Definition - Crystal	8	27	15	20
12.	Definition - Boiling Point	10	25	13	22
13.	Definition - Range	1	34	0	35

ANALYSIS:

Experimental Group = % Correct Responses

$$= 22100/455 = 48.57\%$$

Control Group = % Correct Responses

$$= 21300/455 = 46.81\%$$

$$\% \text{ Difference Between two groups} = 48.57 - 46.81 = 1.76\%$$

Above table indicates that the percent performance of experimental group in the area of knowledge is 48.57 on posttest slightly better than the control group 46.81.

TABLE-VII
COMPARISON OF PERFORMANCE BETWEEN
EXPERIMENTAL AND CONTROL GROUPS IN THE
DOMAIN OF UNDERSTANDING ON POSTTEST

S. No.	Understanding of Concepts	EXPERIMENTAL		CONTROL	
		Correct	Incorrect	Correct	Incorrect
1.	Concept - Molarity	12	23	12	23
2.	Concept - Solubility of H ₂ gas	13	22	21	14
3.	Concept - H ₂ ↑ lighter than air	20	15	22	13
4.	Concept - Solution	5	30	15	20
5.	Concept - PH of the solution	21	14	6	29
6.	Concept - Strong & Weak electrolytes	17	18	16	19
7.	Concept - Positive & Negative Electrodes	10	25	10	25
8.	Concept - Effect of Pressure Solubility	28	7	24	11
9.	Concept - Bases	15	20	16	19
10.	Concept - Bases	5	30	8	27
11.	Concept - Acid	6	29	14	21
12.	Concept - Acid	13	22	10	25
13.	Concept - Distillation & Filtration	17	18	14	21
14.	Concept - Electrolytes	21	14	27	8
15.	Concept - Chemical Composition	21	14	4	31

ANALYSIS:

Experimental Group = % Correct Responses

$$= 22400/525 = 42.66\%$$

Control Group = % Correct Responses

$$= 21900/525 = 41.71\%$$

$$\% \text{ Difference Between two groups} = 42.66 - 41.71 = 0.95\%$$

Above table indicates that in the area of understanding on posttest the percent performances of both groups (42.66 of experimental, 41.71% Control) are compatible. As the observed difference (0.95%) is not that high.

TABLE-VIII
COMPARISON OF PERFORMANCE BETWEEN
EXPERIMENTAL AND CONTROL GROUPS IN THE
DOMAIN OF APPLICATION ON POSTTEST

S. No.	Application	EXPERIMENTAL		CONTROL	
		Correct	Incorrect	Correct	Incorrect
1.	Concept - Conversion of Units	17	18	21	14
2.	Concept - Molecular mass	22	13	19	16
3.	Concept - CO ₂ Gas	25	10	27	8
4.	Concept - CO ₂ Gas	25	10	26	9
5.	Concept - Solubility	34	1	30	5
6.	Concept - Acid	12	23	10	25
7.	Concept - Fractional Distillation	6	29	8	27
8.	Concept - Filtration	6	29	2	33
9.	Concept - Density	9	26	13	22
10.	Concept - Acid	4	31	14	21
11.	Concept-Related to C&S	4	31	2	33
12.	Concept-Related to H ₂ ↑	12	23	8	27
13.	Concept-Chemical Formulae	7	28	5	30
14.	Concept - Conductivity	29	6	18	17
15.	Concept-Related to CO ₂	25	10	19	16
16.	Concept - Chemical	27	8	25	10
17.	Concept - Process	31	4	29	6

ANALYSIS:

Experimental Group = % Correct Responses

$$= 30100/595 = 50.58\%$$

Control Group = % Correct Responses

$$= 27600/595 = 46.38\%$$

$$\% \text{ Difference Between two groups} = 4.2\%$$

Above table indicates that percent performance of experimental group in the area of application of posttest is (50.58%) superior than the control group (46.38%). As the observed difference is (4.2%).

TABLE-IX

COMPARISON OF PERCENT PERFORMANCE BETWEEN THE
THREE DOMAINS OF BOTH PRETEST AND POSTTEST.
(EXPERIMENTAL GROUP).

Domain	Pretest	Posttest	Increase
Knowledge	35.60	48.57	12.97
Understanding	38.85	42.66	3.91
Application	33.10	50.58	17.48

ANALYSIS:

Above table shows that in the domain of knowledge the percent performance of the students has increased i.e the percent increase is 12.97 a significant positive change.

In understanding, the percent increase is 3.81, once again positive change is noticeable.

In application, the test results, reveal that the percent increase is 17.48 a significant improvement, in the area of application.

The percent increase in the performance of students in all three domains of posttest is encouraging.

TABLE-X
COMPARISON OF PERCENT PERFORMANCE IN
THREE DOMAINS OF PRETEST AND POSTTEST
(CONTROL GROUP).

Domain	Pretest	Posttest	Increase
Knowledge	29.23	46.81	17.58
Understanding	35.61	41.71	6.1
Application	34.62	46.38	11.76

ANALYSIS:

Above Table indicates that the control group students showed significant improvement in the domain of particularly knowledge and application. The percent increase in the performance in all three domains of posttest. (i.e 17.58% knowledge, 6.1% understanding, 11.76% application) is encouraging.

TABLE-XI
COMPARISON OF PERCENT INCREASE IN
THREE DOMAINS OF POSTTEST BETWEEN
EXPERIMENTAL AND CONTROL GROUPS

Domain	Experimental Group % Increase	Control Group % Increase	% Difference
Knowledge	12.97	17.58	4.61
Understanding	3.81	6.1	2.29
Application	17.48	11.76	5.72

ANALYSIS:

Above table indicates that the control group has shown superiority in the domains of knowledge and understanding i.e, 4.61 and 2.29 respectively. Where as the experimental group has shown superiority in the domain of application i.e (5.72).

TABLE-XII

THE T-TEST FOR THE EXPERIMENTAL GROUP

TEST SCORES OF THIRTY FIVE STUDENTS IN THE
EXPERIMENTAL GROUP (LOW COST ACTIVITIES:

Sub No.	Pretest Score	Posttest Score	D	D2	Sub. No.	Pretest Score	Posttest Score	D	D2
1	25.5	36.5	+ 11	121	19	16	17	+ 1	1.0
2	23.5	27.0	+ 3.5	12.25	20	16	21	+ 5	25.0
3	22.0	27.0	+ 5.0	25	21	16	29	+ 13	169.0
4	21.5	22.0	+0.5	0.25	22	14.5	18	+ 3.5	12.25
5	21.5	22.0	+0.5	0.25	23	14.0	27	+ 13	169.0
6	20.5	23.0	+ 2.5	6.25	24	14.0	26	+ 12	144.0
7	20.0	20.0	0	0	25	13.5	21	+ 5.5	30.25
8	20.0	21.0	+ 1.0	1.0	26	13.5	20	+ 6.5	42.25
9	19.5	22.0	+ 2.5	6.25	27	13.0	26	+ 13	169.0
10	19.5	25.0	+ 5.5	30.25	28	12.0	12	0	0
11	18.5	24.0	+ 5.5	30.25	29	12.0	9	-3	9.0
12	18.5	19.0	+0.5	0.25	30	11.5	19	+ 7.5	56.25
13	18.0	17.5	-0.5	0.25	31	11.5	17	+ 5.5	30.25
14	18.0	22.0	4.0	16.0	32	10.5	15	+ 4.5	20.25
15	18.0	20.5	+ 1.5	2.25	33	10.0	18	+ 8.0	64.0
16	17.5	23.0	+ 5.5	30.25	34	10.0	18	+ 8.0	64.0
17	17.5	20.0	+ 2.5	6.25	35	8.0	8	0	0
18	17.0	15.0	-2.0	4.0					

The formula for the T-Test is

$$t = \frac{D}{\frac{\sum D^2 - \frac{(\sum D)^2}{N}}{N(N-1)}}$$

Where

t = the t-value for non independent samples.

D = the difference between the paired scores

D = The mean of the difference

$\sum D^2$ = the sum of the squared difference scores

N = the number of students.

$(N-1)$ = Degree of freedom

Calculating the values of the following from Table-XII.

$$\sum D = 152.5 \quad D = \frac{\sum D}{N} = \frac{152.5}{35} = 4.35$$

$$\sum D^2 = 1297.5$$

$$\frac{(\sum D)^2}{N} = 660$$

Substituting the values in the formula.

$$t = \frac{4.35}{\sqrt{\frac{1297-660}{1190}}} = \frac{4.35}{\sqrt{0.53}} = 5.95$$

$$t = 5.95$$

The number of degrees of freedom is 34. In the table of t-values, with 30 degrees of freedom at value of 2.052 is needed for the t to be significant at the 0.05 level and a t-value of 2.704, for significance at the 0.01. The obtained value of 5.95 exceeds the given value for both 0.05 level and 0.01 level. Therefore, the null hypothesis, "the use of low cost materials in teaching chemistry at secondary level will not be effective as compared to high cost materials" is rejected. In addition, all the following highly interrelated null hypotheses of the study are rejected.

- a) Students will not be able to understand concepts of chemistry taught with the help of Low Cost Materials.
- b) The use of the Low Cost Materials will not improve teaching learning situation in the laboratory.
- c) Organization of low cost activities will not help teachers to motivate students to work in the chemistry laboratory.

- d) Students will not be able to apply the concepts of chemistry in daily life, If taught with the help of low cost materials.

TO SUMUP:

As the observed difference in the tests performances of experimental group were in the positive direction, it shows that the use of low cost materials in chemistry laboratory experiments was a success as a whole.

CHAPTER-V

FINDINGS, CONCLUSION AND RECOMMENDATIONS

A) FINDINGS:

In the following section, a summary of the principal findings is derived and presented from the statistical analysis of the data.

1) Pretest:

A statistical analysis of the pretest results revealed that was not a significant difference in the average scores of both experimental and control groups. The observed difference was 1.53. The pretest scores of experimental group were compatible with the control group as it was an essential pre requisite for matching the two groups.

On the test items related to knowledge, the experimental group showed better results (35.6) compared to the control group. The results of the understanding related test items showed that the experimental group had a slight edge (38.85%)

over the control group (35.61%). Test items related to Application, however, showed compatibility between the groups i.e experimental (33.10%) and control (34.62%).

2) Posttest:

A statistical analysis of posttest revealed that there was negligible difference in the average scores of both group groups. i.e the mean score of control group was X_2 20.51, and of experimental group $X_1 = 20.78$. The standard error of the difference between two means was 9.1 where as the variance S^2 , standard deviation S , and co-efficient of correlation turned out to be as follows.

Variance S_1^2 and standard deviations for experimental group were 30 and 5.47 respectively. Whereas the variance S_2^2 , standard deviation S_2 were 54 and 7.3 respectively. The co-efficient of correlation r (calculated from the posttest scores of the two groups) was +0.25. The variances ($F_{\max} = 1.8$) were homogenous. Further the significance of the difference between means of two groups (matched) was 0.19.

The results related to knowledge test items showed that both groups performed better on posttest compared to pretest, i.e experimental group (48.57%) and control group (46.81%). On the test items related to understanding, both groups were compatible, i.e experimental group (42.66%), whereas control group (41.71%). Test results related to application revealed that the experimental group (55.56%) performed better than the control group (46.38%).

3) Comparison of Percent Performance between Three Domains of Both Pretest and Posttest (Experimental Group).

Tests, results related to knowledge, understanding and application revealed the following:

- a) In the area of knowledge, the percent increase in performance was 12.97.
- b) In the domain of understanding, the observed percent increase in performance was 3.81.
- c) In the test items related to application, the experimental group showed the percent increase of 17.48.

4) Comparison of Percent Performance between Three Domains of Both Pretest and Posttest (Control Group).

Tests results related to knowledge understanding and application revealed the following:

- a) In the area of knowledge, the percent increase was 17.58.
- b) In the area of understanding, the percent increase was 6.1.
- c) In the domain of application, the percent increase was 11.76.

5) Comparison of Percent Performance between Three Domains of Both Pretest and Posttest (Experimental and Control Group).

The comparison of performance (in percentage) on posttest between the groups revealed the following:

- a) In the areas of knowledge, the control group superceded the experimental group by 4.61%
- b) In the test items related to understanding, the control group was superior by 2.29%.

- c) In the domain of Application, the experimental group showed superiority by 5.72%.

6) The T-Test for Experimental Group

The T-Test for the experimental group = 6.95 exceeds not only 0.05 level of significance, but also 0.01 level of significance.

B) CONCLUSIONS:

The following conclusions have been drawn from the statistical analysis of the study.

- 1) The use of low cost materials in the organization of experimental work in chemistry can provide purposeful and meaningful experiences for high school students.
- 2) Activities based on low cost materials enhance the conceptual understanding of chemistry at secondary school level.
- 3) For the development of scientific skills, illustrations and provision of opportunities for scientific investigations, use of low cost and high cost materials (equipment, glassware, chemicals) are equally

effective.

- 4) Introduction of the use of low cost materials in teaching chemistry enhances developing a new way of looking at the teaching learning situation in the classrooms as well as in the laboratory.
- 5) The use of low cost materials in organizing laboratory activities can motivate students in understanding the breadth of scientific concepts.
- 6) Organization of experiments with low cost materials help students in learning new concepts and skills and also in the progression of ideas.
- 7) The use of low cost materials in teaching chemistry help students to develop the attitude of objectivity

C) RECOMMENDATIONS:

The following recommendations are made to promote the development and utilization of low cost materials in science education.

- 1) In view of the effectiveness of the use of low cost materials in chemistry teaching. Provisions should be made to use low cost materials in the teaching of other science subjects.
- 2) Teachers should be encouraged to organize their practical sessions utilizing the low cost materials.
- 3) The idea to use low cost materials in science education should be spread through out the country to correct the imbalance between the rich and the poor.
- 4) Science teachers should be exposed to various types of low cost materials.
- 5) In service training programmes, workshops, seminars, conferences, demonstrations by experts and specialists should be organized on regular basis in school, to promote the use of low cost materials in teaching science subjects.
- 6) Schools should organize science exhibitions and science fairs to popularize the concept of low cost materials in science

education.

- 7) There should be competitions and contests on the construction and designing of low cost materials in science education at school level.
- 8) The science curricula for teachers training courses should be restructured so that special focus is placed on how to make, how to use low cost materials in science laboratories.
- 9) Instead of subjecting science teachers trainees to lectures on the use of low cost materials they should be exposed to practical demonstrations of the use of low cost materials.
- 10) Attempts should be made to involve parents and the community in the activities of the school systems especially in the development of low cost materials.
- 11) National competitions and exhibitions should be organized to stimulate and encourage active participation by science teachers and students in the development programme for low cost materials in science education.
- 12) The establishment of special centers should be encouraged to concentrate on the use of local resource for the popularization of science education/

- 13) The mass media should be fully utilized to emphasize the significance of the use of low cost materials with emphasis on science education, among teachers, parents and the community.
- 14) Government should provide facilities to arrange National Workshop on regular basis to strengthen the importance and use of improvised materials in science education at the secondary school level.

D) RECOMMENDATIONS FOR FURTHER RESEARCH

- 1) Attitudes of chemistry teachers in the development and use of low cost materials at the secondary school level.
- 2) A study to evaluate in service training programme for chemistry teachers at secondary school level.
- 3) A study to explore the need for using materials in science education at secondary school level.
- 4) A comparative study on the effects of the use of low cost and high cost materials on the motivation among Science students at secondary school level.
- 5) A study on the effectiveness of the use of low cost materials in teaching science at the elementary school level.
- 6) Development of a package for chemistry teachers to use low cost materials in teaching chemistry at higher secondary level.
- 7) A study on the effects of the use of low cost materials on the development of critical thinking at secondary level.
- 8) A study on the effects of the use of low cost materials on the development of problem solving skills at secondary level.

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PRE-TEST

- Instructions:
- 1) Attempt all questions
 - 2) Max: Marks : 45
 - 3) Time allowed : One Hour

Part-I

Directions: Circle the alphabet, which in your opinion provides the best suitable answer. Each questions carries 1 mark.

- 1) The temperature of human body is 98.6°C . What is the corresponding temperature on the centigrade scale.
a) 34°C b) 36°C c) 37°C d) 34.5°C
- 2) Which of the following units is a measure of volume
a) Kg b) m c) cm^3 d) gm
- 3) A molecule contains two or more than two
a) Compounds b) Elements c) Moles d) Atoms
- 4) The relative molecular mass of calcium hydroxide $\text{Ca}(\text{OH})_2$ is :
a) 57 b) 58 c) 74 d) 104
- 5) During electrolysis of water one molecule of Oxygen gas is formed at the anode, while hydroxide ions give up

- a) 1 electron b) 2 electrons c) 3 electrons
d) 4 electrons
- 6) Which of the following is the strongest base?
a) NaOH b) $\text{Ca}(\text{OH})_2$ c) NH_4OH d) NaHCO_3
- 7) The pH of rain water is 6, because air contains:
a) Nitrogen b) Oxygen c) Carbon dioxide
d) Argon
- 8) Which one of the following lowers the amount of CO_2 in the atmosphere:?
a) fermentation b) Decaying c) Respiration
d) Photosynthesis
- 9) The compounds, which yield positive and negative ions in aqueous solutions, and conduct electricity are called:
a) Radicals b) Electrolytes c) Solute d) Solvent
- 10) "An acid is a species (molecule or ion), which can accept a pair of electrons". This concept is given by:
a) Lewis b) Bronsted c) Sorenson d) Arrhenius

Part-II

Directions: Provide the answers for the following questions in a precise and brief manner.

- 11) What is the difference between density and specific gravity?
- 12) Why ice floats on water?
- 13) Is kerosene oil heavier than water?
- 14) Define boiling point of a liquid?
- 15) Is boiling point of an impure liquid is higher than the pure one?
- 16) Does boiling point of a liquid increase if pressure increases?
- 17) Define melting point?
- 18) Do melting and freezing points determine the purity and impurities of substances?
- 19) Define freezing point.
- 20) Define solubility?
- 21) What is the effect of temperature on solubility?
- 22) Is salt more soluble in water or kerosene oil?
- 23) Why copper, iron and zinc wires are called conductors?
- 24) Can non-electrolytes conduct electric current?
- 25) Can pure water conduct electric current?
- 26) Can you define electrolysis?
- 27) Why NaOH is strong electrolyte compared to NH_4OH ?

- 28) Why HNO_3 is strong acid compared to CH_3COOH ?
- 29) Is lemon juice acidic or basic in nature?
- 30) Name the acid present in sour milk?
- 31) Name the acid present in vinegar?
- 32) how can you prove that fresh milk is neutral in nature?
- 33) Why table salt does not have any effect on blue or red litmus paper?
- 34) Which litmus paper be effected by soap solution?
- 35) Define neutralization?

Part-III Fill In the blanks:

- 36) When water turns into ice, the average distance between water _____ increases.
- 37) A homogenous mixture of two or more than two substances is called _____.
- 38) Volume is defined as the _____ occupied by a body.
- 39) The density of ice is _____ than that of liquid water.
- 40) The amount of solute dissolved in a specific amount of solvent is called its _____.
- 41) We can protect ourselves from cholera by _____ water before we drink it.

42) In neutralization reactions, OH^- ions react with ions to give _____.

43) An aqueous solution of an acid reacts with a base to give _____ and _____.

44) $\text{Ca}(\text{OH})_2(\text{aq}) <===== > \text{Ca}^{2+}(\text{aq}) +$

45) $\text{CH}_3\text{COOH}(\text{aq}) <===== > \text{CH}_3\text{COOH}^-(\text{aq}) +$

POST TEST

Name

Class:

- Instruction: 1) Attempt all questions:
2) Max: Marks 45
3) Time Allowed: 1 Hour

Part-I

Directions: Circle the alphabet, which is your opinion provides the best possible answer. Each question carries 1 mark.

- 1) The temperature of water bath was 25.6°C . What is the corresponding temperature on the Fahrenheit ($^{\circ}\text{F}$) Scale.
a) 76°F b) 78°F c) 76.5°F d) 79°F
- 2) Which of the following units are measures of length?
a) Kg, g b) m, mm c) cm^3 , ml d) None of the above
- 3) The relative molecular mass of sodium hydroxide (NaOH) is:
a) 40, b) 38 c) 39 d) 37
- 4) The conversion of solid into vapours without changing into liquid state, by heating is called.
a) Distillation b) Crystallization c) Sublimation

- d) Oxidation.
- 5) The temperature at which the vapour pressure of a liquid is equal to that of atmospheric pressure, termed as:
- a) Freezing point, b) Boiling point c) Melting point
d) None of the above
- 6) An acid is a substance, which produces H^+ ions in aqueous solution. This definition is given by:
- a) Lowery and Bronsted, b) Lewis c) Arrhenius
d) Sorenson
- 7) The reaction of an acid with a base is called.
- a) Neutralization b) Standardization c) Oxidation
d) Reduction
- 8) The gas used in soft drinks (Like Coke, 7-up etc) and fire extinguisher is:
- a) H_2 gas b) SO_2 gas c) O_2 d) CO_2 gas
- 9) The amount of Na_2CO_3 required to dissolve in 10ml of water to make 1 molar solution is:
- a) 1.06 gms b) 2.06 gms c) 3.06 gms d) 0.06 gms
- 10) When H_2 gas cylinder is inverted over water in a container. Water level does not rise, because H_2 gas is:
- a) Insoluble in water b) Soluble in water

c) Less Soluble in water

d) None of the above.

Part-II Provide the Answer for the following questions in a precise and brief manner. Each question carries 1 mark.

- 11) Is H_2 heavier than air?
- 12) All the food on earth is produced by photosynthesis. Which gas is consumed in this process.
- 13) Sea water is a solution. What is the solvent in it?
- 14) How can you prove that water is neutral in nature?
- 15) Define allotropy?
- 16) What is the difference between strong and weak electrolyte?
- 17) During electrolysis, on which electrode, electrons gather?
- 18) Does the solubility of a substance increase with increase in pressure?
- 19) Which of the following are soluble in water.
Sand, Salt, Sugar, Cement, Glucose D.
- 20) Name the acid present in vinegar?
- 21) Which litmus paper will be affected by soap solution?
- 22) Name the process which is used to separate two liquids having different boiling points.
- 23) Which ion do all the bases contain?

- 24) Are filtration and distillation same processes or different? if different, then give a reason.
- 25) Which acid is present in your stomach?
- 26) Name the process, used to purify sodium chloride (NaCl) from rock salt?
- 27) Name three main gases in air?
- 28) Is cooking oil heavier or lighter than water?
- 29) When HCl gas is dissolved in water, which acid is formed?
- 30) What is the formula to calculate the density of a liquid?
- 31) Name the acid present in lemon.
- 32) Identify the elements, when dissolved in water produce acid rain?
- 33) Name the gas used in the preparation of vegetable ghee.
- 34) Write the chemical formulae of the following compounds.
- i) Caustic Soda ii) Washing Soda iii) Baking Soda
- iv) Lime water
- 35) Can pure water conduct electricity?

Part-III

Directions: Fill in the blanks, Each carries 1 mark.

- 36) The ratio of density of water, which is considered as standard to the density of solid and liquid is called _____.
- 37) The units of density is _____.
- 38) The particular shape of a substance is called _____.
- 39) The process in which a liquid is changed to its vapours on heating or room temperature is called its _____.
- 41) The difference between melting point and freezing point is called the _____ of melting.
- 42) The compounds which ionize into negative and positive ions in aqueous solution and conduct electricity are called _____.
- 42) The excess of CO_2 is _____ to human health.
- 43) The ratio of oxygen atom to Hydrogen atoms is _____.
- 44) $\text{FeS} + 2\text{HCl} \text{ -----} > \text{FeCl}_2 + \text{ -----} \uparrow$
- 45) $\text{Zn} + \text{H}_2\text{SO}_4 \text{ -----} > \text{ZnSO}_4 + \text{ -----} \uparrow$

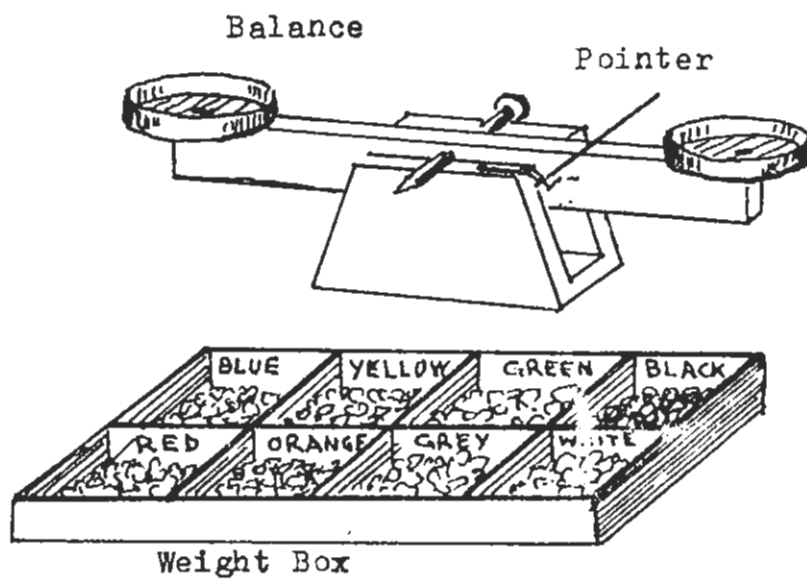
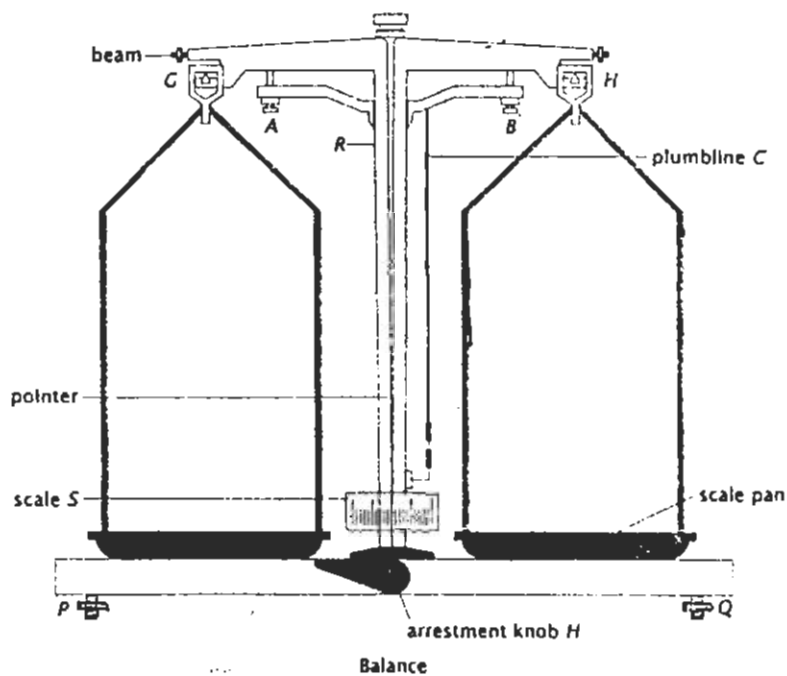
Appendix "C"

TIME TABLE FOR LABORATORY EXPERIMENTS LOW COST AND HIGH COST

	1	2	3	4	5	6	7	8
MON	Experimental Group						Control Group	
TUES	Control Group						Experimental Group	
WED	Experimental Group						Control Group	
THURS	Control Group						Experimental Group	
FRIDAY	Experimental Group						Control Group	
2SAT.	Control Group						Experimental Group	

- 1) Space available in the laboratory per student
= 27.65 sq.ft. (appropriate)
- 2) Temperature throughout six weeks remained between 20-25°C.
- 3) Proper Ventilation i.e
Six large Windows
Eight Ventilators
- 4) Lights:
10 Double tube lights each 40 watts.

WEIGHING ON A BALANCE.



APPENDIX-D

Experiment No. 1

WEIGHING ON A BALANCE

HIGH COST

APPARATUS

A) A simple weighing balance

1) Beam 2) Pans 3) Pillar 4) Adjusting Screws 5) Pointer 6) Scale 7) Pump line 8) Handle 9) Leveling Screws 10) Wooden box.

B) WEIGHT BOX

It contains the following weights

1) Grams 100,50,20,10,5,2,1

2) Milligrams

Hexagonal shape	500	200	100	Triangular Shape
	50	20	10	
	05	2	1	

Rectangular shape

LOW COST

APPARATUS

A) Weighing Balance

2 empty polish tins.

1 wooden strip, few nails ($\frac{1}{2}$ ", 1 nail 3" or 4")

B) WEIGHT

8 pebbles with different colours showing different weights. For example

Black & white = 0.5g

Blue = 1g

Yellow = 2g

Red = 3g

Orange = 5g

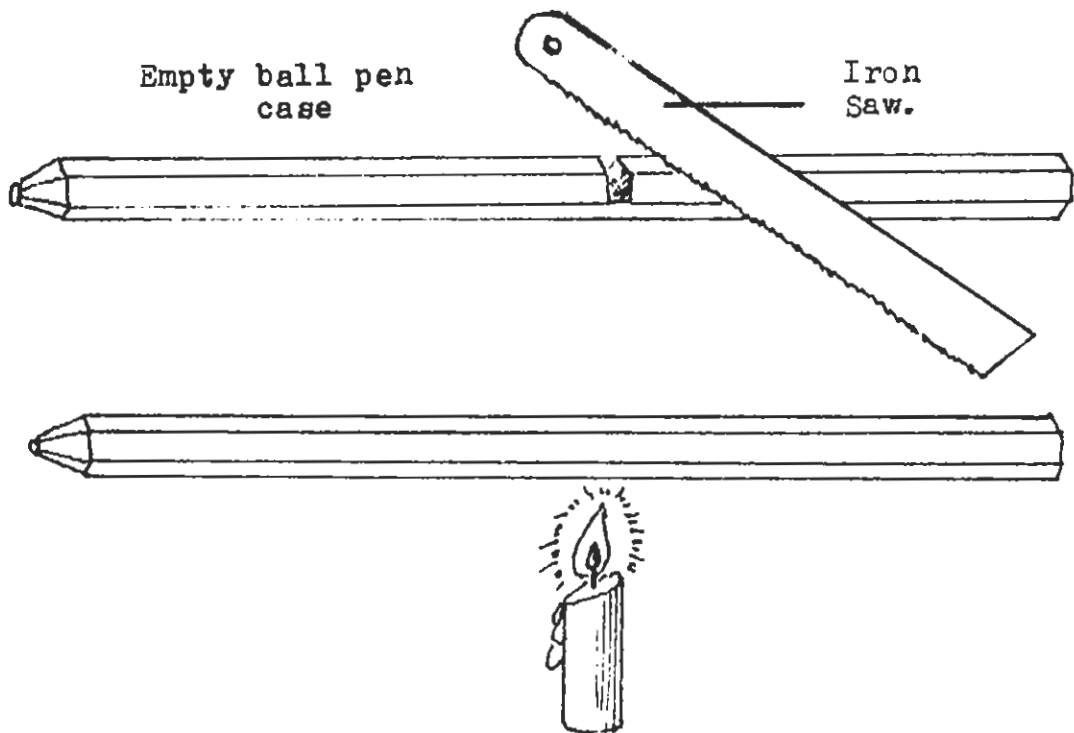
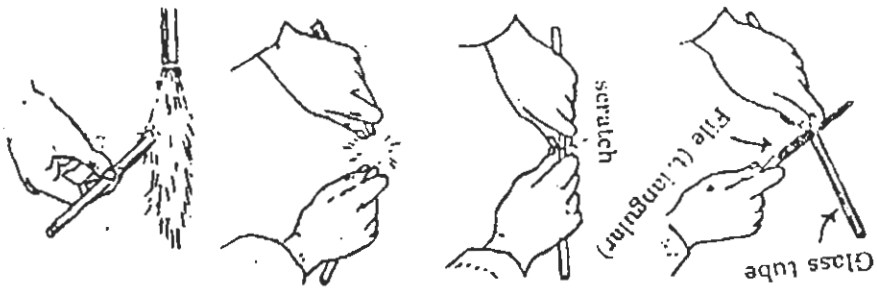
Green = 10g

White = 20g

PROCEDURE:

1. Set the balance as directed.
2. Bring it in resting condition.
3. Put the object in the left pan.
4. Put a suitable weight in the right pan.
5. Add or reduce the weights to bring the pans to resting conditions.

BASIC LABORATORY PRACTICES.



BASIC LABORATORY TECHNIQUES

HIGH COST

A) Glass Cutting

Things to be needed:

1. Soft glass tubes
2. Bunsen Burner
3. Triangular file

PROCEDURE

1. Take a fine glass tube.
2. Put it on the table and hold it on the table and hold it with left hand.
3. Make a scratch on it with triangular file at a point to be cut.
4. Hold the tube in both the hands with the thumb opposite to the scratch.
5. Slowly force the thumb outward

The tube will cut into two pieces, then blunt it edges with the file.

LOW COST

A) Cutting a Tube

Things to be needed:

1. Empty ball pen cases (transparent)
2. Candle
3. Iron Saw

PROCEDURE

1. Take an empty ball pen case.
2. Put it on the table and hold it with left hand.
3. Make a scratch on it with iron saw at a point to be cut.
4. Hold the ball pen case in both the hands with the thumb opposite to the scratch.
5. Slowly force the thumb outward.

The ball pen case will cut into two pieces, then blunt its edges with iron saw.

HIGH COST

B. Bending the Glass Tube:

1. Hold the glass tube in the upper part of flame at the point where bending is desired.
2. Keep on rolling the tube for uniform heating.
3. When the tube becomes red hot, it becomes very soft. It starts bending with the weight of your hand, but you control its bending to the required angle as slow as possible.
4. Keep it to cool on an asbestos sheet.

LOW COST

B. Bending of Tube:

1. Hold the ball pen case in the upper part of the candle flame at the point where bending is required.
2. Keep on rolling the ball pen case for uniform heating.
3. When the ball pen case becomes hot, it becomes soft and starts bending with the weight of your hand.
4. Keep it cool on the wooden block.

HIGH COST

C. Making a Jet:

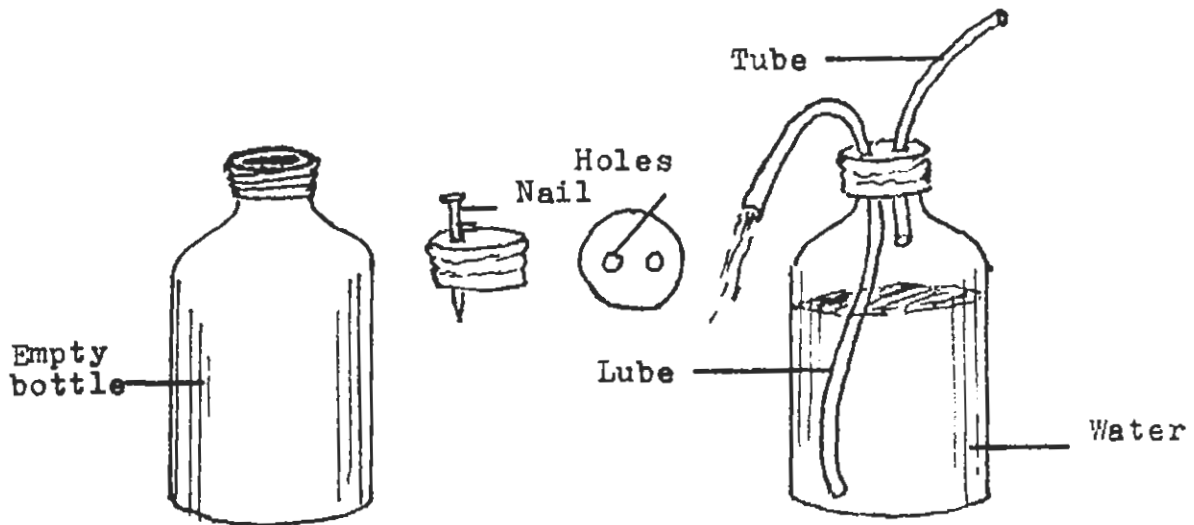
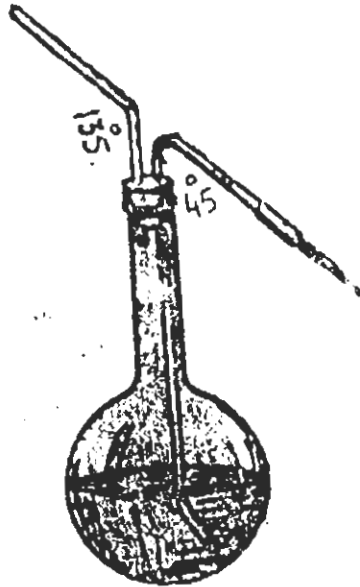
1. Hold the tube lengthwise in the flame, and keep it rotating.
2. When it becomes soft, pull the tube side-wards in a straight line.
3. Two jets are formed.
4. Cut the jet end at a suitable point and round it off with flame.

LOW COST

C. Making a Jet:

1. Hold the ball pen case lengthwise in the candle flame and keep it rotating.
2. When it becomes soft pull the ball pen case side-wards in a straight line.
3. Two jets are formed.
4. Cut the jet end at a suitable point and round it off with candle flame.

MAKING A WASH BOTTLE.



Experiment No. 3

MAKING A WASH BOTTLE

HIGH COST

A) REQUIREMENTS:

Two Glass Tubes, Cork, Cork borer, Flask

B) PROCEDURE:

1. Select the length of the tube according to the size of the flask and cut it to the size.
2. Make two parallel bores in the cork.
3. Bend one tube at an angle of 135°
4. Bend the other at 45° . keeping the jet arm smaller than the other.
5. Fill the flask with water.

LOW COST

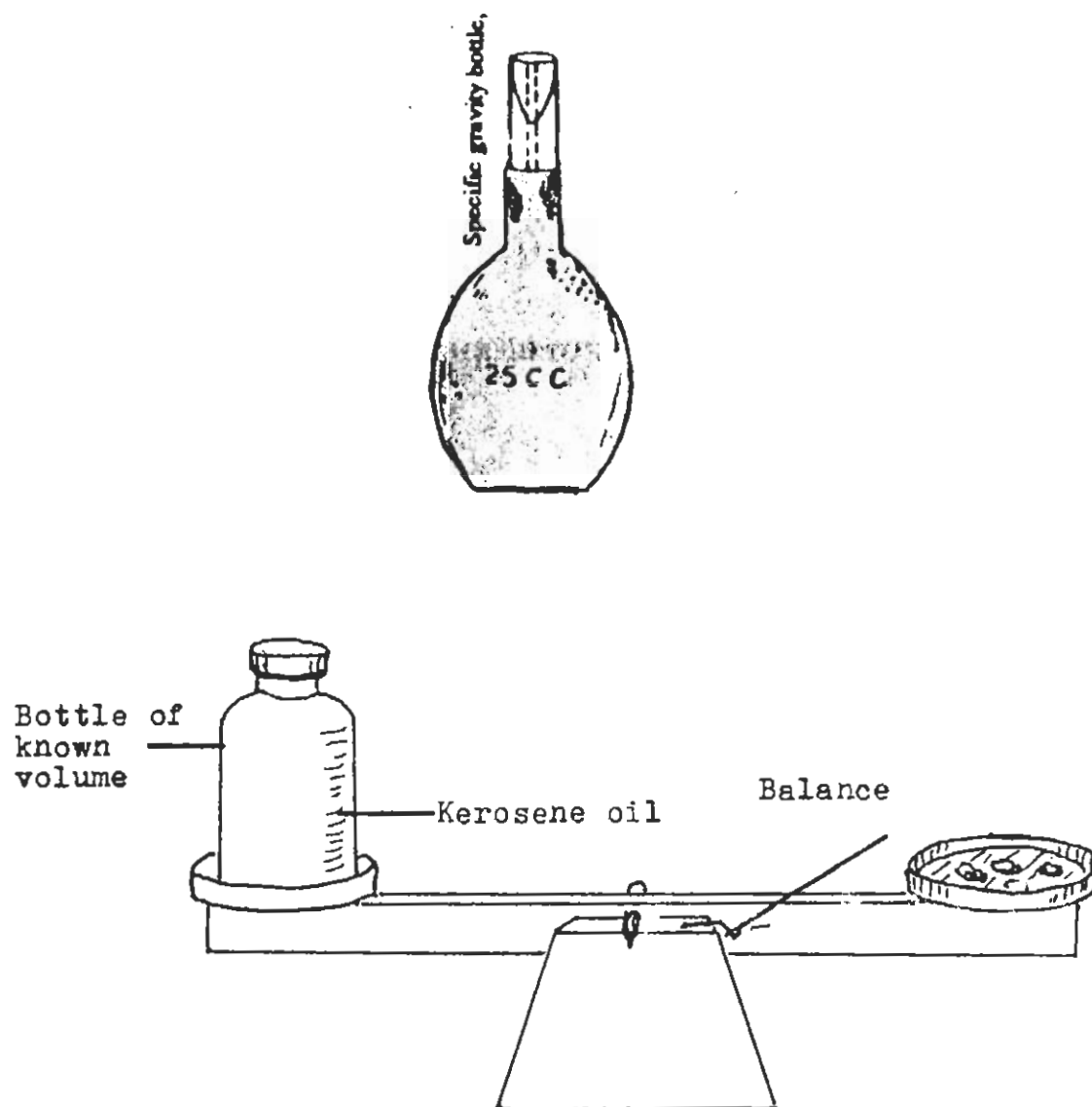
A) REQUIREMENTS:

An empty bottle, a nail, used tubes from glucose bags (available in the Hospitals and at doctor's clinics)

B) PROCEDURE:

1. Select the length of the tube according to the size of the bottle.
2. Make two parallel bores in the lid of the bottle with a nail.
3. Fill the bottle with water.
4. Put the long tube and the small one through the lid in the bottle.

TO DETERMINE THE DENSITY OF KEROSENE OIL.



Experiment No. 4

TO DETERMINE THE DENSITY OF KEROSENE OIL

HIGH COST

A) APPARATUS:

Balance, Weight box, Specific gravity bottle, beaker

B) CHEMICAL

Kerosene Oil

C) PROCEDURE:

1. Weigh the SP. gravity bottle along with its stopper.
2. Fill the SP. gravity bottle with oil and insert the stopper, Dry it from outside with a cloth.
3. Note the volume of the SP. Gravity bottle casually written on it (25.00 cc).

LOW COST

A) APPARATUS:

Balance and Weights any bottle (small sized) but whose volume is known.

B) CHEMICAL:

Kerosene Oil

C) PROCEDURE:

1. Weigh the bottle along with its lid.
2. Fill the bottle with oil and put the lid on the bottle.
Dry it form outside with a cloth.
3. Note the volume of the bottle.

D) Tabulate your findings as under.

Room Temperature

No.	Wt. of Bottle	Wt. of Bottle + Oil	Wt. of Oil	Volume
1.				
2.				
3.				

E) CALCULATION:

Wt. of oil = M

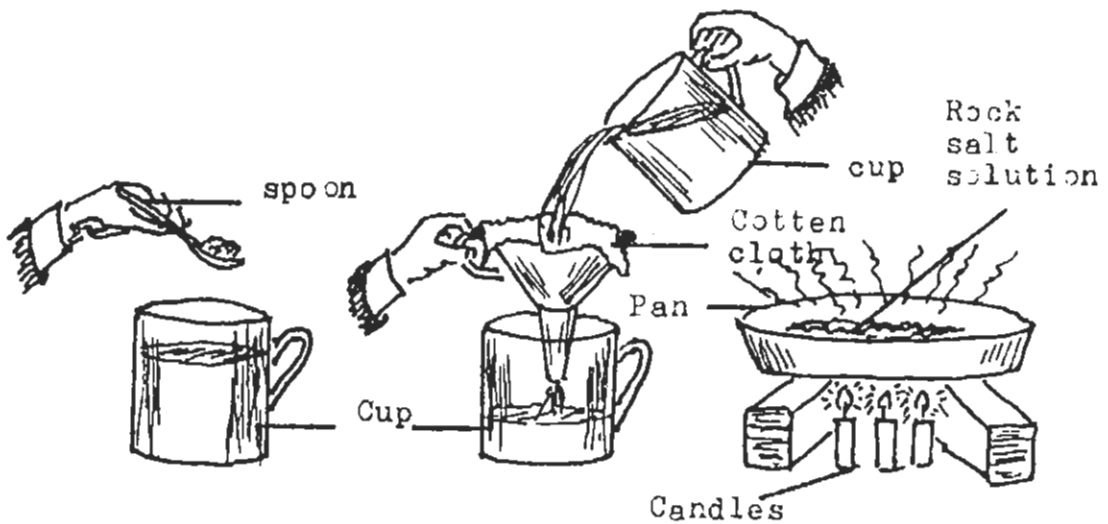
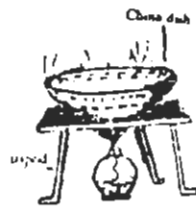
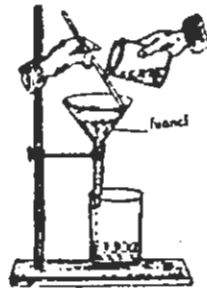
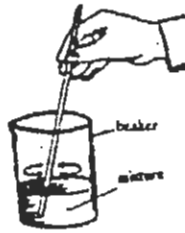
Vol of oil = V

Density = D = M/V

F) PRECAUTIONS:

1. Bottles used in LOW COST & HIGH COST Experiments should be clean and dry.
2. Fill the bottles only up to the mark.

CRYSTALLIZATION.



Experiment No. 5

TO PREPARE SAMPLE OF THE GIVEN SUBSTANCE BY CRYSTALLIZATION

HIGH COST

A) APPARATUS:

China dish, Stirrer, Stand, Beaker, Burner.

B) CHEMICALS:

Sodium Chloride having sand as impurity.

C) PROCEDURE:

1. Take few grams of the sample.
2. Put it in a beaker or China dish and add some water.
3. Stir it well till it gets dissolved.
4. Filter it through a filter paper in a China dish.
5. Gently heat the filtrate till "crystal point is reached".
6. Remove the flame and keep on the sample to cool undisturbed, crystal will appear.
7. Get it dry with a filter paper.
8. Observe the crystals under microscope.

LOW COST

A) APPARATUS:

Plastic funnel, A square piece of cotton cloth, Aluminum glasses a small sized aluminum/steel made pan, candle, plastic teaspoon.

B) CHEMICALS:

Rock salt, Water

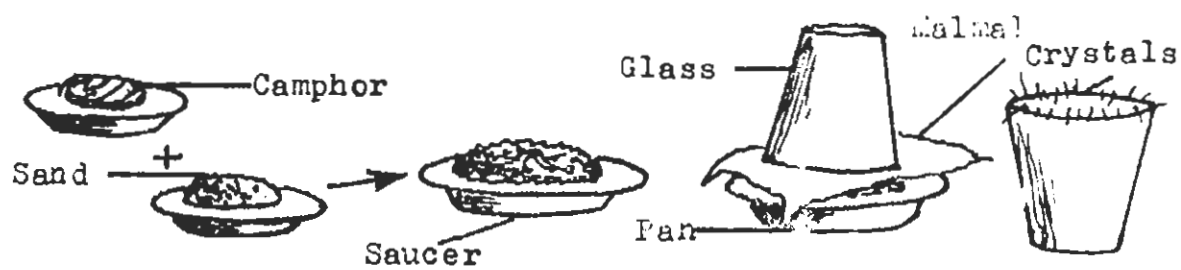
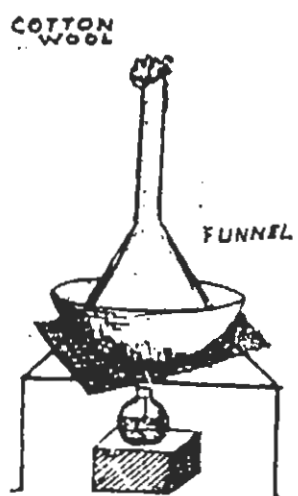
C) PROCEDURE:

1. Take few grams of the sample.
2. Put it in a glass and add water into it.
3. Stir it well with a spoon till it is dissolved.
4. Filter it through a cotton cloth into the small pan.
5. Gently heat the filtrate using candle flame till "crystal point" is reached.
6. Remove the candle and let the pan cool down undisturbed crystals will appear.
7. Let the crystals dry on a piece of paper.
8. Observe the crystals in the sunlight.

D) PRECAUTIONS:

1. Slowly heat the filtrate.
2. Do not dry the sample completely.
3. Sample should be cooled at room temperature.
4. Solution should not be disturbed.

SUBLIMATION.



Experiment No. 6

**TO SEPARATE NAPHTHALENE OR NH_4Cl
OR IODINE FROM IMPURITY.**

HIGH COST

A) APPARATUS:

Glass funnel, China dish, tripod, Sand Bath, Asbestos sheet, with a central opening, cotton, burner.

B) CHEMICALS:

Naphthalene, Sand

C) PROCEDURE:

1. Put the sample in the china dish.
2. Mount it on the stand placing sand bath beneath it.
3. cover it with a perforated filter paper and invert a glass funnel on it.
4. Shut the end of the funnel with cotton.
5. Slowly start heating the apparatus.
6. Naphthalene will get evaporated as white fumes and these vapours condense on the inner surface of the funnel. When fumes cease to evolve, stop heating.
7. Cool the funnel with cotton dipped in cold water, so that the vapours are condensed.

LOW COST

A) APPARATUS:

Glass , Pan (small size) Saucers, Wooden block, candle, cotton cloth (thin), Candle

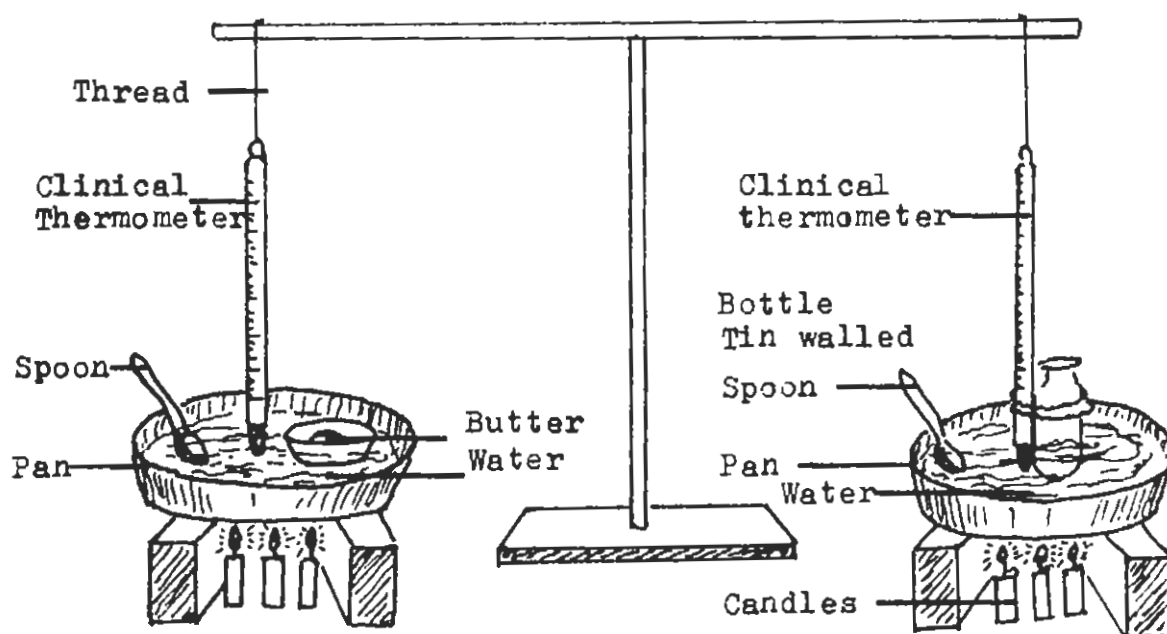
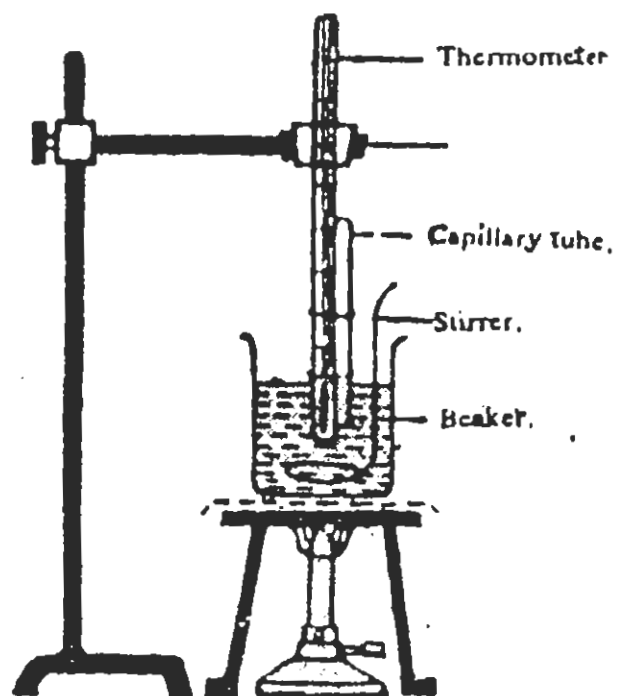
B) CHEMICALS:

Napthelene, Sand

C) PROCEDURE:

1. Take some sand and camphor and mix them.
2. Put the mixture in the pan.
3. Place it on
4. Cover the pan with cotton cloth and place an inverted glass on it.
5. Heat the pan slowly with candle.
6. Camphor, when started evaporated, its white fumes will condense on the inner surface of the glass. When fumes stop coming from the pan. Stop heating.
7. Cool the glass with damped cloth, already soaked in cold water, so that vapours are condensed.

TO FIND MELTING POINT OF WAX OR BUTTER.



Experiment No. 7

**TO DETERMINE THE MELTING POINT OF
WAX, NAPHTHALENE, OR ANY OTHER
COMPOUND.**

HIGH COST

A) APPARATUS:

Capillary tube, Thermometer, Beaker, Stand, Wire gauze, Burner, China Dish.

B) CHEMICALS:

Wax or Naphthalene

C) PROCEDURE:

1. Hold one end of the capillary tube in the flame, so that it is closed.
2. Take some wax in China dish melt it, and dip the open end of the capillary tube to allow some wax into it.
3. If the wax solidified or sticks throughout the capillary tube, slightly warm it, the wax will settle down at the closed end of the capillary tube.
4. Wet the bulb of the thermometer and stick the capillary tube with it and tie it with fine thread (if it does not stick)

5. Insert the bulb and a portion of the capillary tube into water taken in a beaker.
6. Start heating with a gentle flame.
7. Remove the flame for some time so that the wax solidifies. Also note the temperature.
8. Repeat again and find the melting point.
9. Find a few consecutive readings. Then take mean of all readings.

LOW COST

A) APPARATUS:

Bottle (thin walled, transparent), Clinical thermometer, Stand, candles, spoon, thread

B) CHEMICALS:

Butter, Water

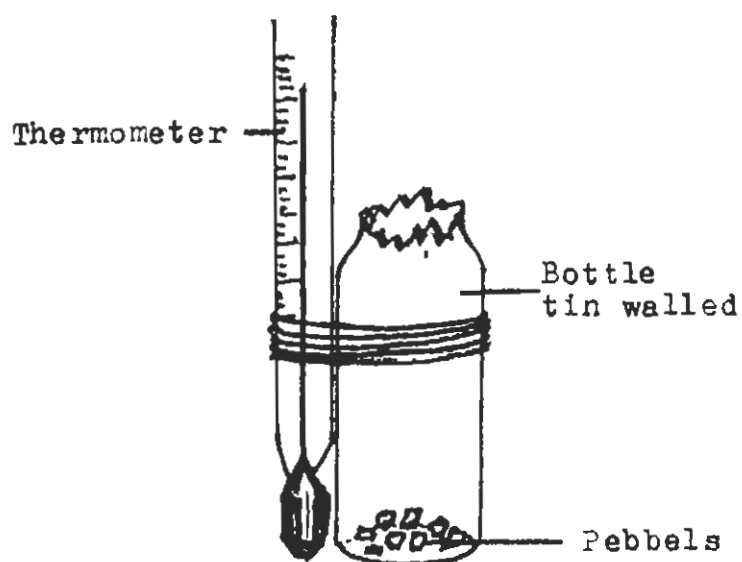
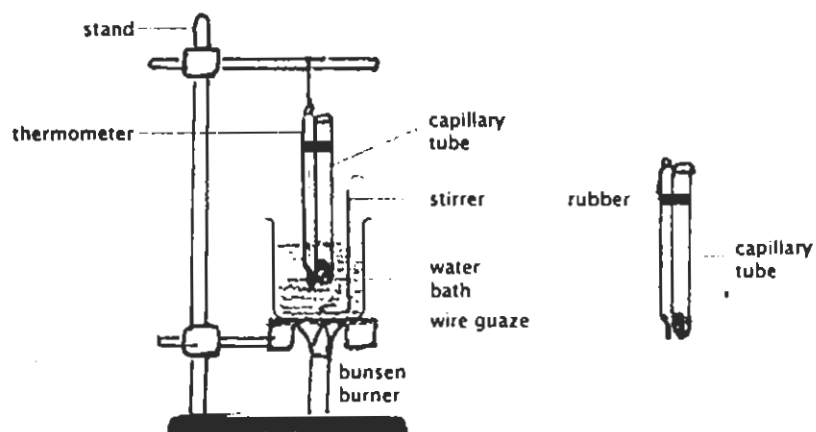
C) PROCEDURE:

1. Take some butter in a pan and put some of it in the transparent bottle with the help of a spoon.
2. Put some cold water in the big pan, place the bottle in the water. Hang the clinical thermometer in water with a thread. The other end of the thread is tied to a stand.
3. Heat the water gently with candle.

4. When butter starts melting note the temperature. Then remove the bottle and the thermometer from the pan. When it solidified, again note the temperature.
5. Repeat the experiment and determine the melting point.
6. Take a few consecutive readings and calculate the average of all readings.

No. Obs	Temperature when substance starts melting $t_1^{\circ}\text{C}$	Temperature when substance begins to solidify $t_2^{\circ}\text{C}$	Average melting point $t = \frac{t_1 + t_2}{2}^{\circ}\text{C}$
1.			
2.			
3.			

TO FIND THE BOILING POINT OF WATER AND ALCOHOL/SPIRIT..



Experiment No. 8

TO FIND THE BOILING POINT OF WATER AND ALCOHOL OR VINEGAR

HIGH COST

A) APPARATUS:

Thermometer, Flask, Glass tube, stand, wire gauze, burner, cork with two holes, beakers, test tube

B) CHEMICALS:

Water, Ethyl Alcohol

C) PROCEDURE:

FOR WATER:

1. Take some water in a flask.
2. Fix a cork in it having a bent glass tube and thermometer.
3. Keep the bulb of thermometer just above the level of water.
4. Mount the flask on stand placing wire gauze beneath it.
5. Start heating the flask.
6. Temperature will start rising when it reaches to the maximum it does not rise further. Note the temperature. This is the boiling point of water.

FOR ALCOHOL:

1. Take some water in a beaker.
2. Place it on the tripod
3. Take some ethyl alcohol in the test tube, put some chips in the tube. Insert the thermometer in the test tube. and place it in the beaker.
4. Heat the beaker.
5. Thermometer will show rise in temperature, till it reaches its maximum. When the temperature becomes constant. Note the temperature. It will be the boiling point of alcohol.

LOW COST

A) APPARATUS:

Bottle (thin walled, transparent) Aluminum pans (small and big), thread stand, candles, pebbles.

B) CHEMICALS:

Water, spirit, and vinegar

C) PROCEDURE:

FOR WATER:

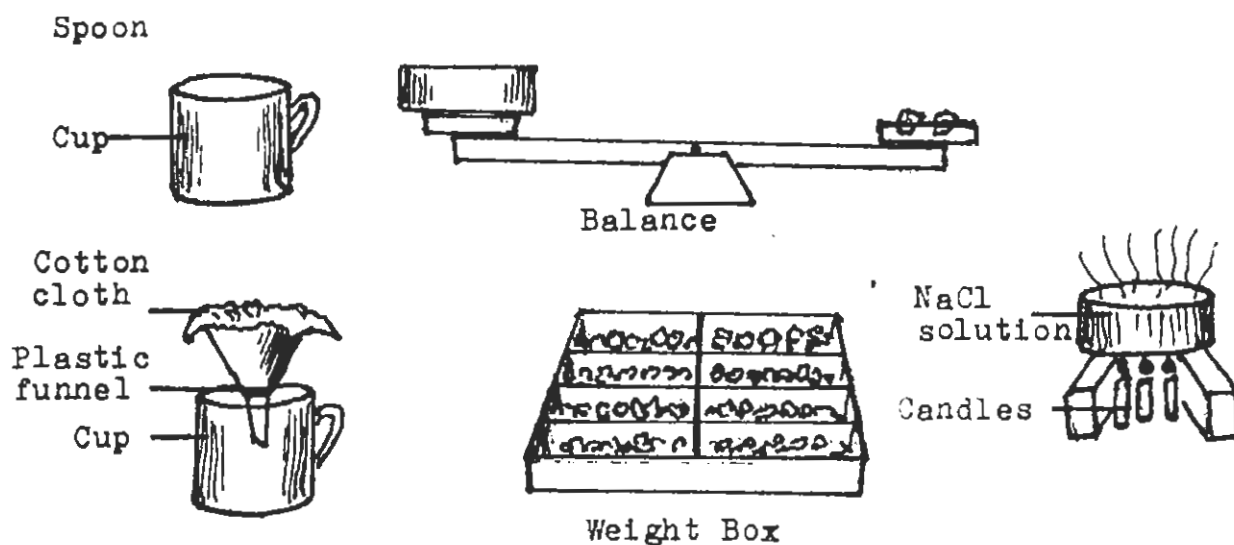
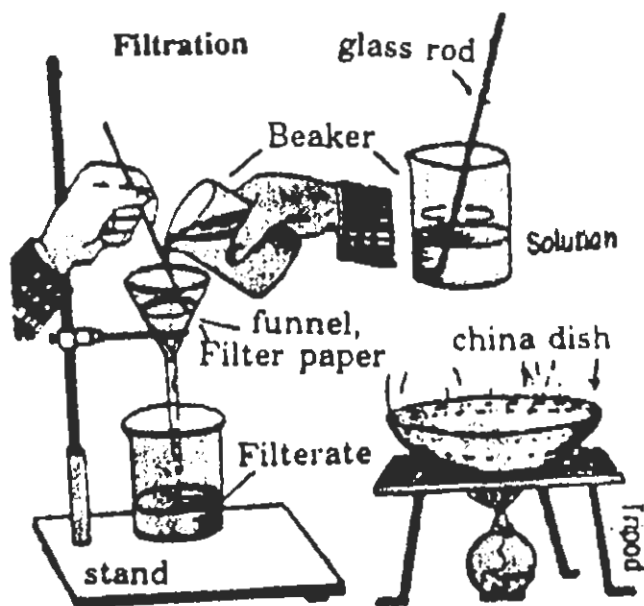
1. Take some water in a pan, place a thermometer in the pan, with its bulb just above the level of water.

2. Heat the pan with candle.
3. Temperature will start rising, when it reaches to the maximum, it does not rise further. Note the temperature. This is the boiling point of water.

FOR VINEGAR:

1. Take some vinegar in the bottle.
2. Put some pebbles in it. Insert the thermometer in the bottle with its head above the water.
3. Put some water in the pan (big), and place it on the tripod.
4. Place the bottle in the pan and heat it with candle.
5. Thermometer will show rise in temperature, till it reaches to its maximum. When the temperature becomes constant. It will be the required boiling point of vinegar.

TO DETERMINE THE SOLUBILITY OF SALT AT ROOM TEMPERATURE.



Experiment No. 9

TO DETERMINE THE SOLUBILITY OF NaCl AT ROOM TEMPERATURE

HIGH COST

A) APPARATUS:

Beaker, Tripod stand, Wire gauze, Filter paper, Funnel, China Dish,
Balance, Weight box, glass rod.

B) CHEMICALS:

Common salt, That is NaCl (Sodium chloride)

C) PROCEDURE:

1. Take some water in a beaker.
2. Put some salt in it and stir it well. Go on adding the salt till saturated solution is formed.
3. Filter it through a filter paper. Filtrate is obtained.
4. Weigh a china dish.
5. Put some filtrate in it and again weigh.
6. Now heat the china dish till and water is evaporated and salt is left.
7. Again weigh the china dish along with dry salt.

LOW COST

A) APPARATUS:

3 cups, Aluminum pan, Balance, Cotton cloth, Plastic funnel, Candles,
Spoon, Tripod

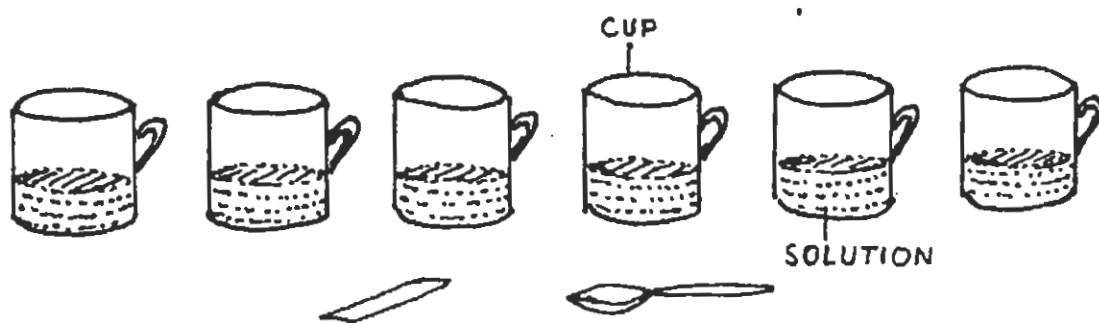
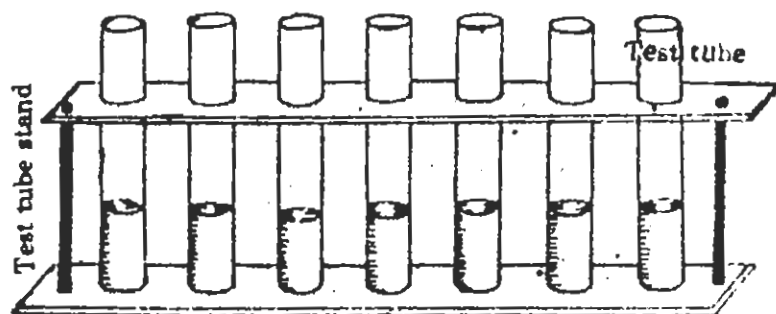
B) CHEMICALS:

Rock salt, water

C) PROCEDURE:

1. Take some water in a cup.
2. Put some salt in it and stir it well. Go on adding the salt till saturated solution is formed.
3. Filter it through a cotton cloth. Filtrate is obtained.
4. Weigh an aluminum pan.
5. Put some filtrate in it and again weigh it.
6. Now heat the pan till all the water is evaporated and salt is left.
7. Again weigh the pan along with dry salt.

**TO TEST THE NATURE OF THE VARIOUS CHEMICALS
WITH LITMUS.**



Experiment No. 10

TO TEST THE NATURE OF THE FOLLOWING CHEMICAL WITH LITMUS PAPER

HIGH COST

A) APPARATUS:

Test tube, Test tube stand, Beaker, Samples of the solution, Blue and red litmus

B) CHEMICALS:

Vinegar, Soap solution, Baking soda, Table salt, Detergent, Fresh milk, Sour milk, Lemon juice.

C) PROCEDURE:

1. Take in a clean test tube one of the samples.
2. First dip piece of blue litmus in it and see the effect, if it turns red the sample is acidic.
3. If there is no effect, the sample is either neutral or basic, therefore, add a piece of red litmus - if turned blue -- the solution is basic, otherwise it will be neutral.

LOW COST

A) APPARATUS:

2 6 cups, Spoons

B) CHEMICALS:

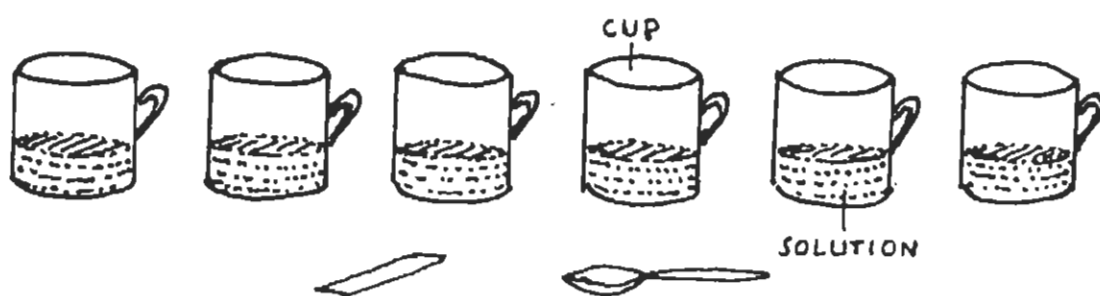
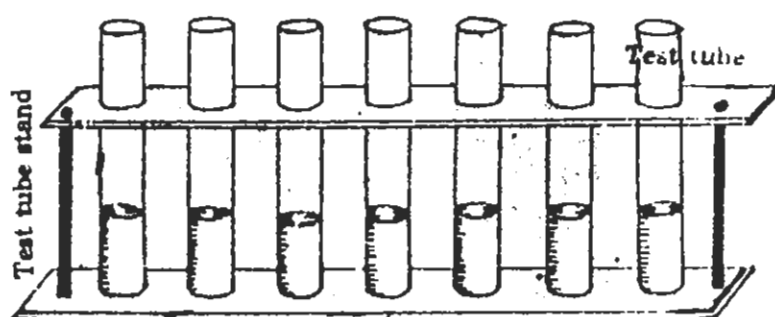
Water, Sodium carbonate (Na_2CO_3), Sodium Bicarbonate (NaHCO_3), Sodium Chloride (NaCl), Lemon juice, Vinegar, Sugar, Blue and Red Litmus papers.

C) PROCEDURE:

1. Take clean cups and prepare solutions by dissolving the above mentioned chemicals in water.
2. First dip pieces of blue litmus in each solution and observe it. The litmus papers will either turn red or remain un-effected. Those solutions, in which litmus paper turned red are acidic in nature.
3. Now dip pieces of red litmus papers in each solution and observe the colour change. Those solutions in which the litmus paper turns blue are basic in nature. Whereas solutions in which litmus paper remained un-effected are neutral in nature.

No. of Obs.	Sample of Substance	Red Litmus	Blue Litmus	Result
1.	Table Salt			
2.	Vinegar			
3.	Lemon Juice			
4.	Sugar			
5.	Baking Soda			
6.	Fresh Milk			

**DETERMINATION OF P^H OF DIFFERENT ACIDS
AND BASES WITH THE HELP OF P^H PAPER.**



Experiment No. 11 & 12

DETERMINATION OF PH

HIGH COST

A) APPARATUS:

Test tubes with stand. Marker pen, Funnel, and Filter paper

B) CHEMICALS:

Acids: HCl , H_2SO_4 , CH_3COOH

Bases: NaOH , Lime Water, Na_2CO_3 , Salt NaCl , Soil Samples

C) PROCEDURE:

1. Place clean and dry test tubes in the stand.
2. Write the number and name of the given sample on each test tube.
3. Take the given solutions in these test tubes.
4. Dip the PH paper in each solution.
5. Compare the colour of the PH paper with the standard colours of the PH scale.
6. Record it on the note book.

7. In case of soil, prepare its saturated solution in a beaker and then filter it. Take the filtrate in the test tube, number it and find its PH.

LOW COST

A) APPARATUS:

Six cups, and spoons, plastic funnel and cotton cloth.

B) CHEMICALS:

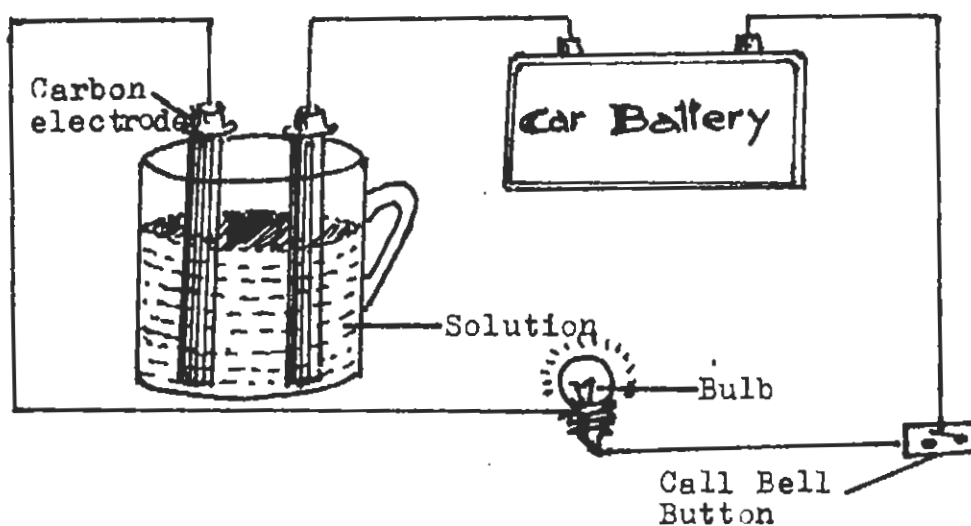
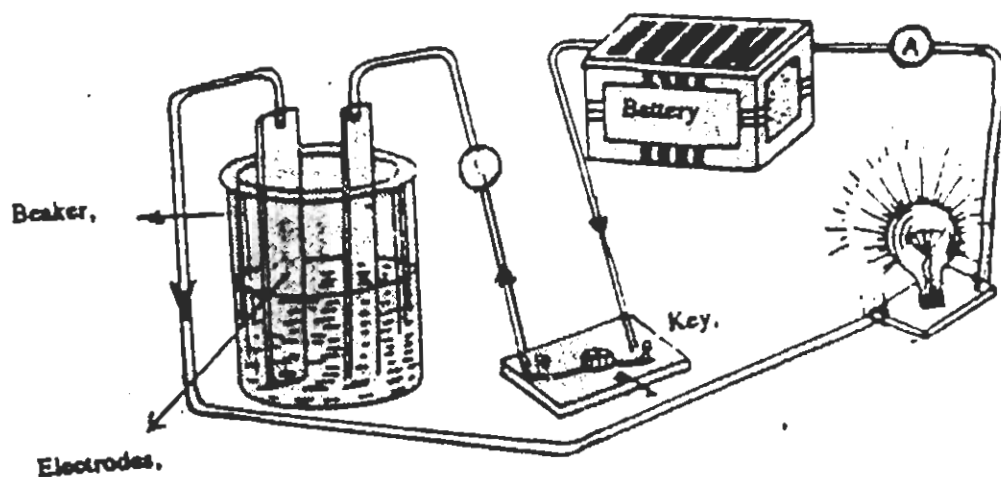
Acids: Lemon juice (Citric Acid), Vinegar (CH_3COOH)

Bases: Na_2CO_3 , Caustic Soda, Salt, Sodium Chloride, Soil Samples, PH paper.

C) PROCEDURE:

1. Place clean and dry cups in a row.
2. Write the number and name of the given sample on each of the cup.
3. Prepare solutions in each cup by dissolving each sample in water.
4. Dip the PH paper in each solution.
5. Compare the colour of the PH paper with the standard course of the PH scale.
6. Record it on the note book.
7. Prepare saturated solution of the soil in the cup, then filter it through cotton cloth number it and find its PH.

TO MEASURE THE CONDUCTIVITY OF VARIOUS ELECTROLYTES.



Experiment No. 13

TO MEASURE THE CONDUCTIVITY OF VARIOUS ELECTROLYTES IN TERMS OF VOLTAGE

HIGH COST

A) APPARATUS:

Battery 6 volts, push button, insulated copper wires, Volt meter (10 volts), Beakers containing electrolytes.

B) CHEMICALS:

Pure water, NaCl solution, NH_4Cl solution, Acetic Acid, Sugar solution, Benzene, H_2SO_4 , $(\text{CH}_3\text{COO})_2\text{Ca}$.

C) PROCEDURE:

1. Set the apparatus according to the diagram.
2. Put the two electrodes in the beaker containing the electrolyte under test.
3. Switch on the current and measure the voltage on the volt meter.
4. If the bulb gives light, it means current is passing and the solution is an electrolyte. On the other hand If bulb does not give light, the solution is non electrolyte.

LOW COST

A) APPARATUS:

Six cups, Two carbon electrodes of dry cell, wire, one car battery (used and discarded), one car bulb, one call bell button.

B) CHEMICALS:

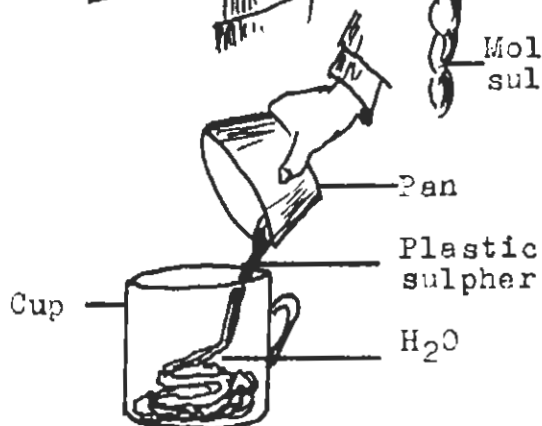
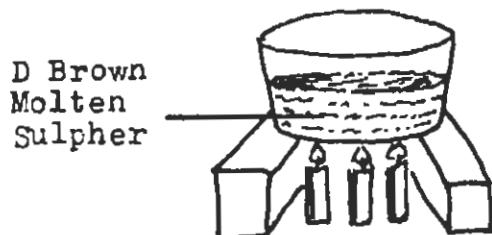
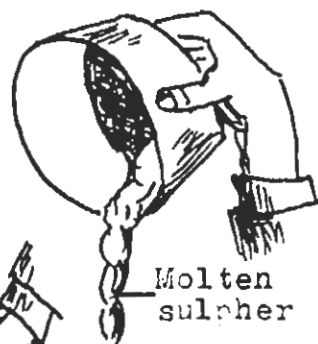
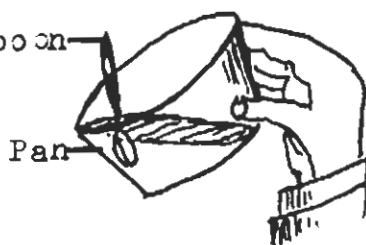
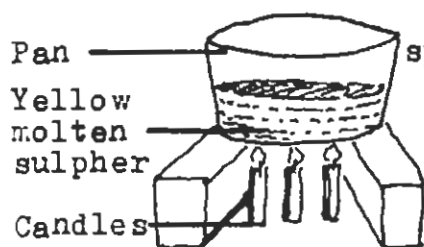
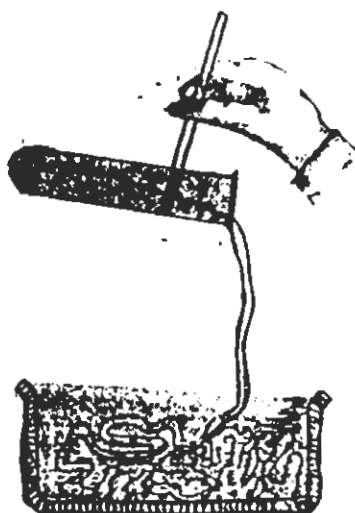
H₂O, Na₂CO₃, Sugar, Vinegar, NaCl, Distilled water.

C) PROCEDURE:

1. Set the apparatus according to the diagram.
2. Put the two carbon electrodes of dry cell in the cup containing the electrolyte under test.
3. Switch on the call bell button.
4. If the car bulb gives light, it means current is passing and the solution is an electrolyte. On the other hand if bulb does not give light, the solution is non-electrolyte.

No. of Obs.	Name of Solution	Volt meter/ Bulb reading	Electrolyte or Non- Electrolyte
1.	NaCl		
2.	Na ₂ CO ₃		
3.	Vinegar		
4.	Sugar		
5.	H ₂ SO ₄		
6.	Water		
7.	NH ₄ Cl		
8.	CH ₃ COO ₂ Ca		

TO PREPARE ALLOTROPIC FORMS OF SULPHUR.



Experiment No. 14

TO PREPARE ALLOTROPIC FORMS OF SULPHUR

HIGH COST

A) APPARATUS:

China Dish, Watch glass, Test tube, Burner, Micro scope, Glass slide,
Filter paper.

B) CHEMICALS:

Powder Sulphur

C) PROCEDURE:

MONOCLINIC SULPHUR

1. Take some powder sulphur.
2. Heat it gently in a china dish.
3. When it just melts, keep away the flame and cool it.
4. A thick crust is formed on the surface of melted sulphur.
5. Make two holes on different points in the crust and invert the china dish to flow out the liquid portion of sulphur.
6. Needle shaped crystals appear over the surface of the mass.

PLASTIC SULPHUR

1. Take 5-6 grams of powder sulphur in a china dish or test tube.
2. Start heating it with a gentle flame.
3. It melts as yellow liquid, then becomes red ... then dark red at this stage, pour it in a beaker of water. On cooling the sulphur will appear to be rubber or plastic like soft.

LOW COST

A) APPARATUS:

Pans (small), Candles, Two cups

B) CHEMICALS:

Sulphur (bought from local market)

C) PROCEDURE:

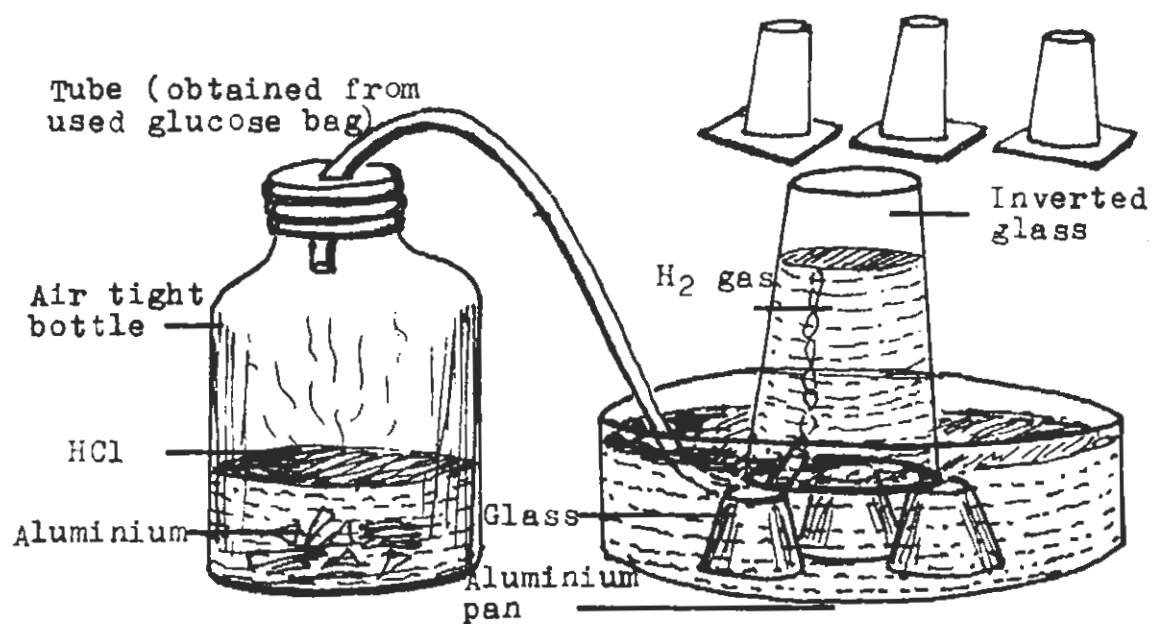
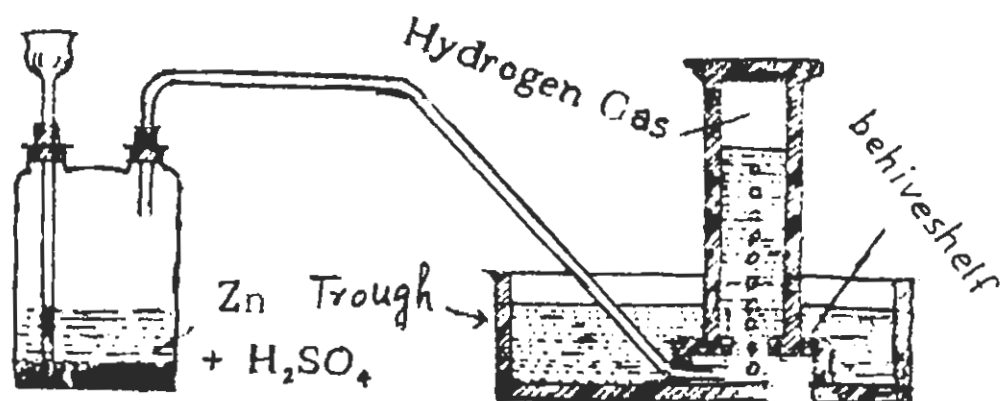
MONOCLINIC SULPHUR

1. Put some sulphur in a pan.
2. Heat it gently under the candle flame.
3. When it starts melting, put off the candle and cool the molten sulphur.
4. A thick crust will form on the melted sulphur.
5. Make two holes on different points in the crust and invert the pan to flow out the liquid.
6. Needle shaped crystals appear over the surface of the mass.

PLASTIC SULPHUR

1. Take 5-6 grams of powder sulphur in a pan
2. Start heating it with a gentle flame.
3. It melts as yellow liquid, then becomes red ... then dark red at this stage, pour it in a pan of water. On cooling the sulphur will appear to be rubber or plastic like soft.

TO PREPARE HYDROGEN GAS AND STUDY ITS PROPERTIES.



PREPARATION OF HYDROGEN GAS AND STUDY ITS PROPERTIES

HIGH COST

A) APPARATUS:

Woulf's bottle, glass tubes, thistle funnel, gas cylinders, beehiveshelf.

B) CHEMICALS:

Zinc, Sulphuric Acid (H_2SO_4)

C) PROCEDURE:

1. Put some pieces of zinc in woulf's bottle
2. Shut its mouth with cork having thistle funnel and delivery tube.
3. Add dilute H_2SO_4 or HCl through the funnel so that the zinc is covered and end of the thistle funnel is dipped in acid.
4. Reaction starts, forming H_2 gas.
5. Allow the first few bubbles of the air to escape.
6. Collect the gas in a few jars by displacement of water.
7. Place the gas cylinders in inverted position.

LOW COST

A) APPARATUS:

Bottle (air tight). Tube, Lids, Aluminum Pan (big), Candle, Match box, Glasses.

B) CHEMICALS:

Aluminum, HCl from the local market is available, Water, Litmus paper.

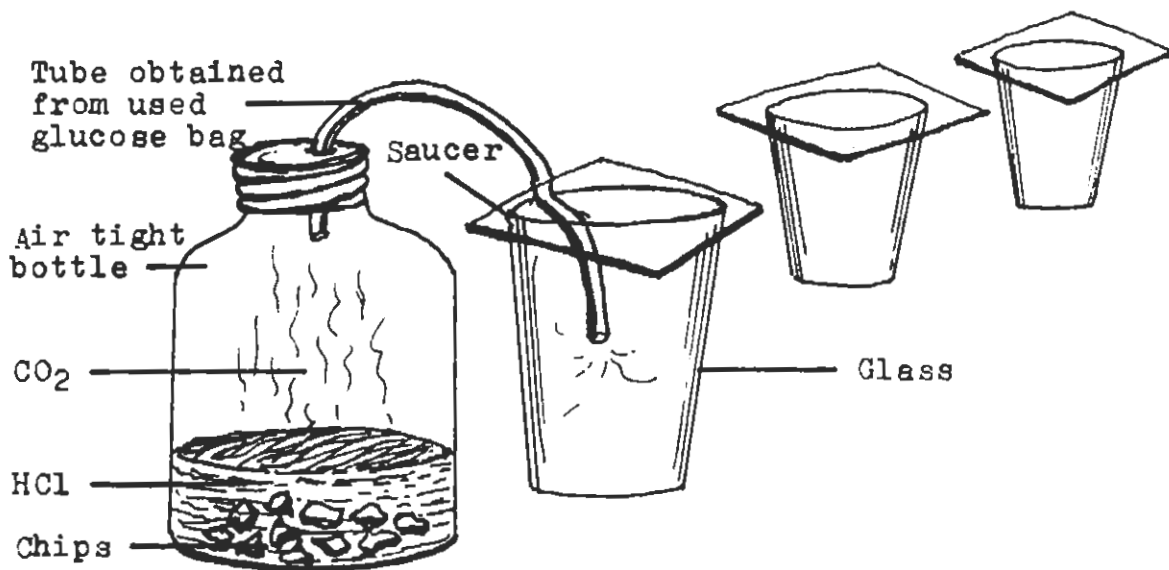
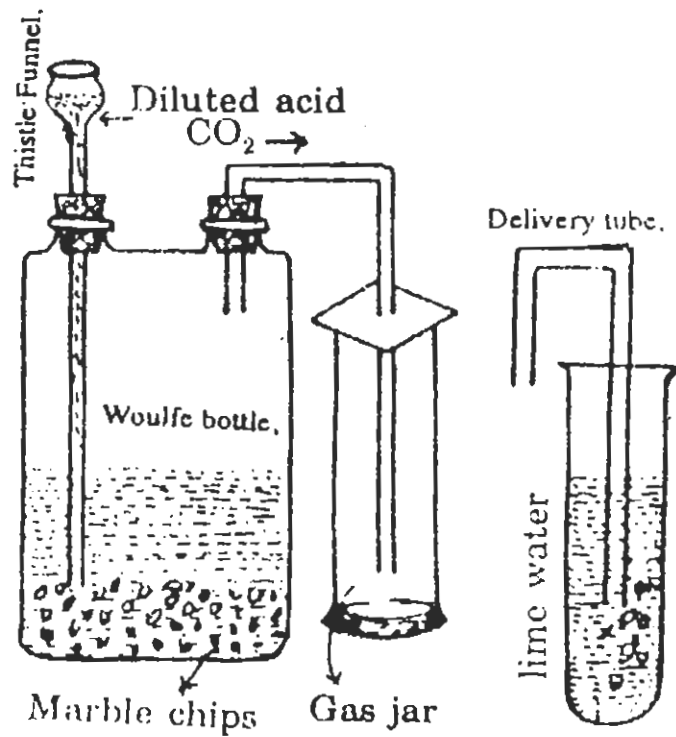
C) PROCEDURE:

1. Put some pieces of aluminum in the bottle.
2. Add HCl acid in it, to cover the pieces.
3. Insert a tube in the lid, and close the bottle tightly.
4. Take a pan and fill $\frac{2}{3}$ of it with water. Put three small size glasses in the inverted position. Invert a big glass on them and put the other end of the tube in it.
5. First let few bubbles of the air to escape.
6. Collect H_2 gas in few glasses.
7. Place the gas filled glasses in inverted position.

D) PROPERTIES:

No.	Experiment	Observation	Inference
1.	Observe the colour and smell of gas	The gas is invisible and has no smell	H ₂ is a colour less and adourless gas.
2.	Introduce a burning match stick into a glass/cylinder	The gas burns with a blue flame and match extinguished	H ₂ is a combustible gas and extinguishes the burning things.
3.	Put red and blue litmus in gas filled jar	There is no effect on both litmus papers	H ₂ is neutral in nature
4.	Invert gas filled glass over water in a container	Water level does not rise in the glass	H ₂ is insoluble in water.

TO PREPARE CARBON DIOXIDE GAS AND STUDY ITS PROPERTIES.



Experiment No. 16

TO PREPARE CARBON DIOXIDE AND STUDY ITS PROPERTIES

HIGH COST

A) APPARATUS:

Woulf's bottle, Thistle funnel, A delivery tube, Gas jar, Test Tubes, Beaker.

B) CHEMICALS:

Calcium Carbonate, Dilute HCl, Lime water, Blue litmus, Water, Candle, match box, Mg-ribbon.

C) PROCEDURE:

1. Take some CaCO_3 pieces (marble) in a woulf's bottle.
2. Fit a thistle funnel in its one end and delivery tube in the other.
3. Make it air tight with wax using a candle.
4. Add dilute HCl through the thistle funnel.
5. Reaction starts -- and collect the gas in a gas jar by upward displacement of the air.

LOW COST

A) APPARATUS:

Bottle (air tight), Tube, Glasses, Saucers, Tube, Nail

B) CHEMICALS:

Chips (CaCO_3), HCl (from the local market), Lime water (from the local market), Match stick, and litmus paper.

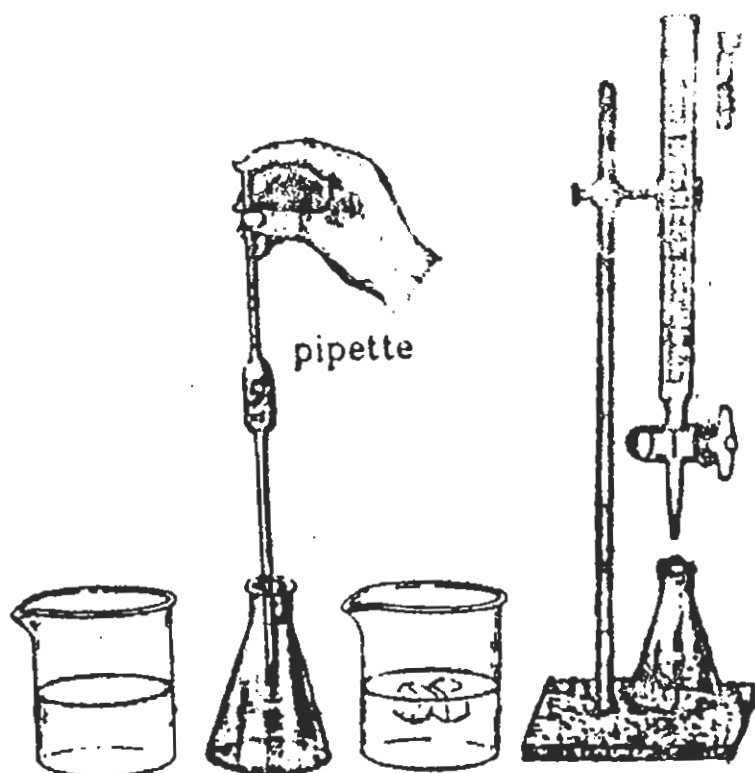
C) PROCEDURE:

1. Place some chips in the bottle.
2. Make a hole in the lid of the bottle with the help of a nail and insert a tube (obtained from used glucose bag).
3. Pour HCl on the chips to cover them up.
4. Put the other end of the tube in the glass covered with the saucer.
5. Reaction starts. Collect the gas in the glass with sauer on it.

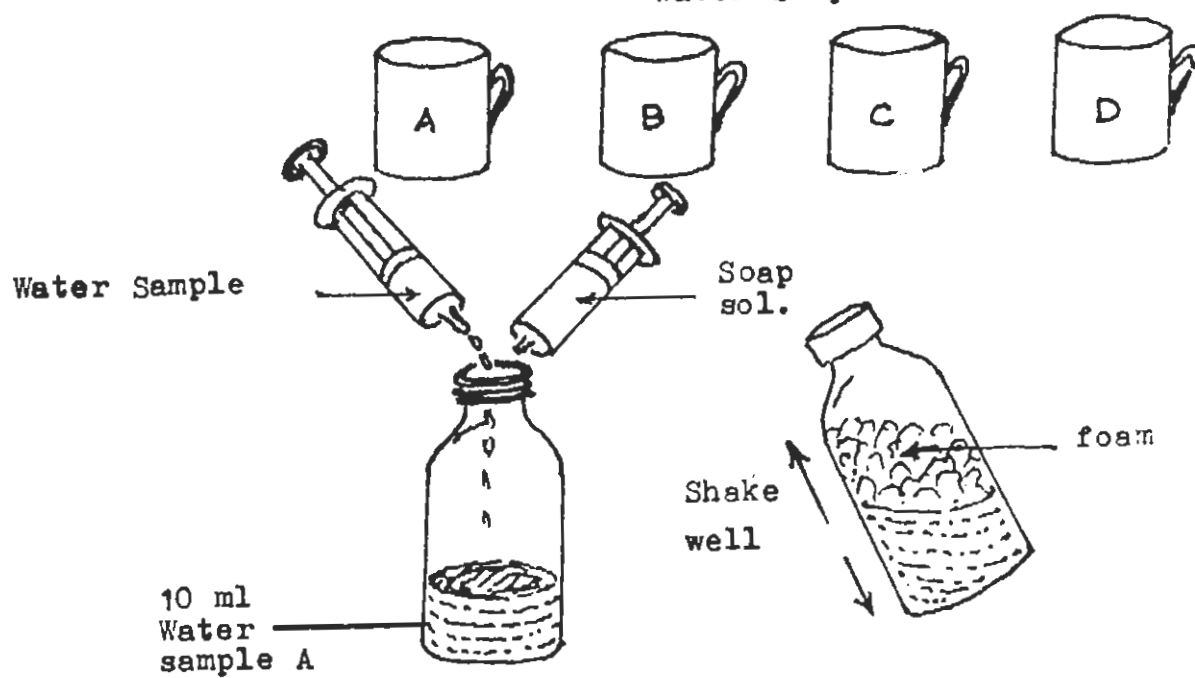
D) PROPERTIES:

No.	Experiment	Observation	Inference
1.	Observe the colour and smell of the gas.	The gas is invisible and has no smell.	CO ₂ is colour less and odour less gas.
2.	Invert a gas cylinder/glasses over water in a container	Water level rises in the cylinder.	CO ₂ is soluble in water.
3.	Put a burning match stick in gas cylinder	Match stick is extinguished and gas does not burn.	CO ₂ gas neither burns nor help in burning.
4.	Introduce a moistened blue litmus paper to a gas cylinder	Blue litmus turns red.	CO ₂ is an acidic gas.
5.	Put some lime water in cylinder/glass	Lime water is turned milky. $\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$	CO ₂ gas turns lime water milky.

COMPARE THE HARDNESS OF WATER COLLECTED.



Water Samples.



COMPARE HARDNESS OF WATER

HIGH COST

A) APPARATUS:

Beakers, Pipette. Burette with stand, Marker.

B) CHEMICALS:

Samples of hard water.

C) PROCEDURE:

1. Collect different samples of water from various sources in plastic bottles.
2. Take each sample in a separate clean beaker and number it with a marker.
3. Fit a burette in a stand and fill it with soap solution upto mark 0.
4. Take 10 ml of water from beaker No. 1 by means of a pipette into a titration flask.
5. Shake it well. if foam is produced note this volume of soap solution used in the note book.

6. If no foam, appears, then add more soap solution, until foam is produced.
7. Note the volume of soap solution used for each sample. Greater the hardness, more will be the volume of soap solution used.

LOW COST

A) APPARATUS:

Bottles, cups, syringes, marker

B) CHEMICALS:

Soap solution, Distilled Water, Tap Water, Well water, Canal water.

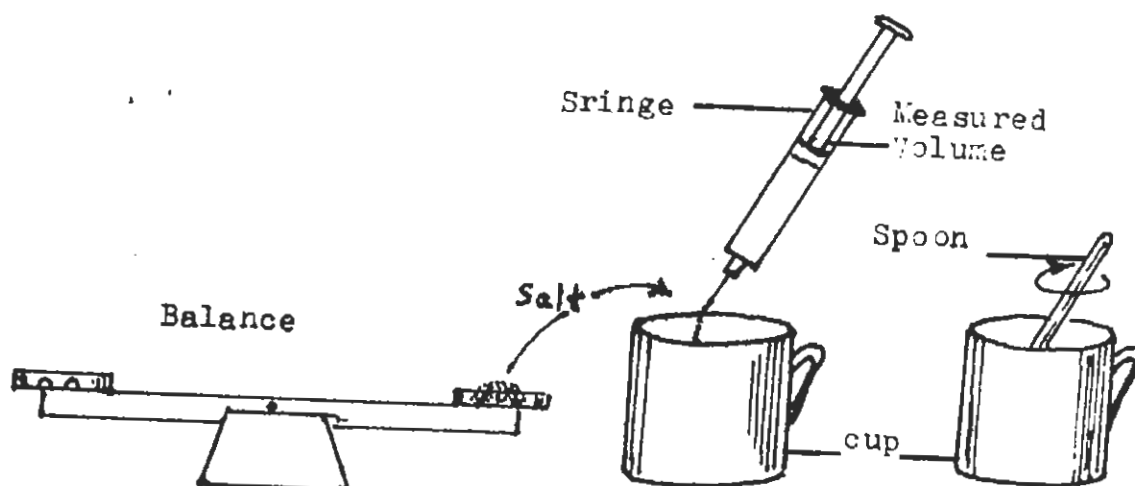
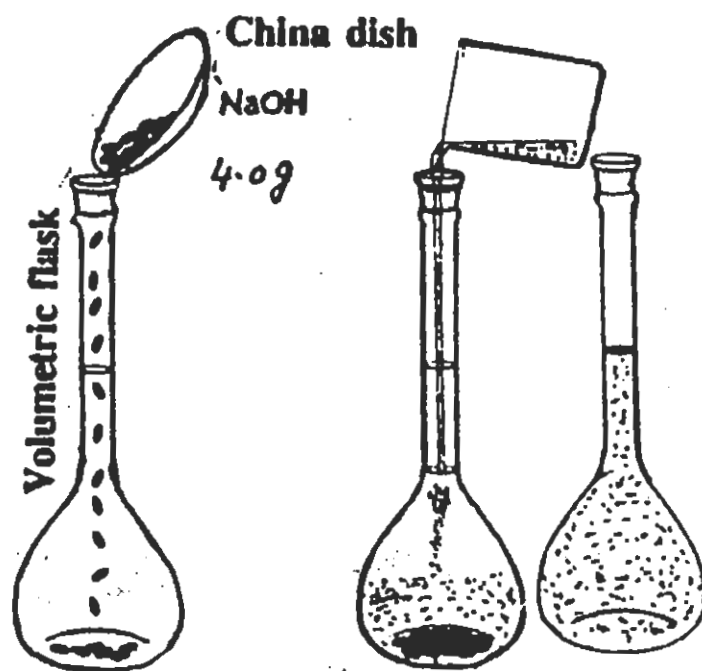
C) PROCEDURE:

1. Take each sample in separate clean cups and number them with marker.
2. Fill the syringe with soap solution and pour it in cup No. 1. If foam is produced on shaking. Note the volume of soap solution used in the note book.
3. If no foam appears, then keep adding more soap solution until foam is produced.
4. Note the volume of soap solution used for each sample. Greater the hardness, more will be the volume of soap solution used.

D) OBSERVATIONS:

Sample No.	Volume of Soap Solution used	Order of Hardness
1.	0.5ml	First
2.	2.0ml	Fourth
3.	1.5ml	Third
4.	1.2ml	Second

**TO PREPARE SOLUTIONS OF DIFFERENT MOLAR
CONCENTRATIONS e.g NaCl , Na_2CO_3 AND $\text{C}_{12}\text{H}_{22}\text{O}_{11}$**



Experiment No. 18

SOLUTION WITH DIFFERENT CONCENTRATIONS

HIGH COST

A) APPARATUS:

Beaker, Weight Box, Balance, Measuring Flasks, Glass Rod.

B) CHEMICALS:

Na_2CO_3 , NaCl, and Distilled Water

C) PROCEDURE:

1. Preparation of 1M solution of NaCl.

Molecular weight of NaCl = 58.5g

1 liter of 1M NaCl solution requires = 58.5g

100ml of 1M NaCl Solution requires =

$$\frac{58.5}{1000} \times 100 = 5.85\text{g}$$

2. Weigh exactly 5.85gms of NaCl solid on a watch glass and put it in the beaker. Add 20 ml of distilled water and dissolve NaCl by stirring with glass rod. Transfer the solution to 100ml measuring flask. Add more distilled water in the beaker. Rinse

the sides of the beaker and transfer the contents to 100ml measuring flask. Add more distilled water in the flask so that the volume is up to the mark of 100ml. Close the flask by the glass stopper and shake the flask up and down to ensure homogeneous mixing of NaCl. The solution is prepared now.

3. In a similar manner prepare 2M Na_2CO_3 solution by dissolving 21.2g of Na_2CO_3 in 100 ml of distilled water.

LOW COST

A) APPARATUS:

Cups, Spoon, Balance, Weights, Syringe

B) CHEMICALS:

NaCl, Na_2CO_3 , NaHCO_3 , Sugar, Water

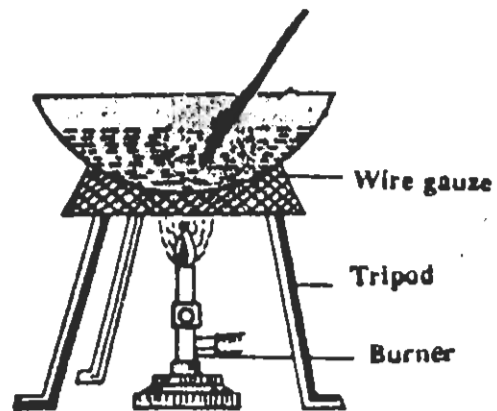
C) PROCEDURE:

1. Preparation of 1 M solution of NaCl, Na_2CO_3 , Sugar, NaHCO_3
2. Preparation of 1M solution of NaCl.
10ml of 1 M NaCl solution requires
= 0.585gms NaCl
3. Preparation of 1M solution of Na_2CO_3 = 106g
10ml of 1 M Na_2CO_3 requires

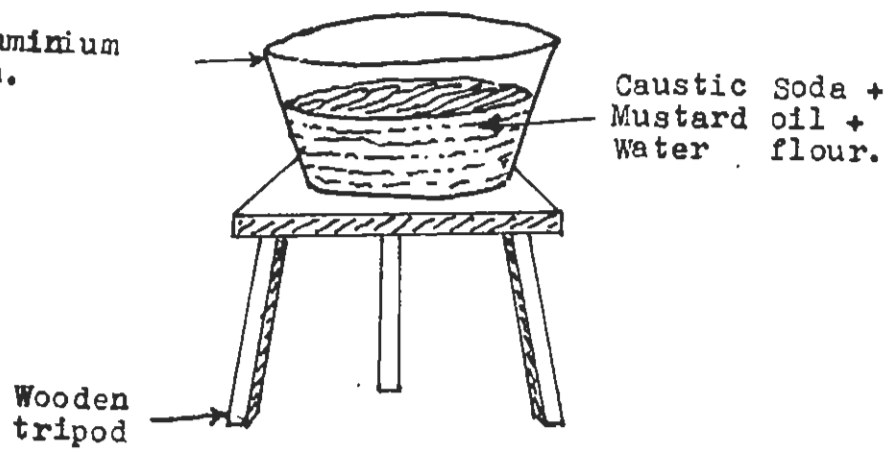
$$= \frac{106}{100} \text{ gms} = 1.06 \text{ gms of Na}_2\text{CO}_3$$

4. After weighing the required amounts of all the substances. Then label the cups as 1,2,3.
5. Put the solutes in the cups and with the help of the syringe, add 10 ml H₂O in each cup, stir it with spoons, till the solute is dissolved. 1M solutions are ready.

SOAP FORMATION.



Aluminium
pan.



PREPARATION OF SOAP

HIGH COST

A) APPARATUS:

Evaporating dish, Glass rod, Burner

B) CHEMICALS:

Caustic Soda, Cotton seed or mustard oil, Ethyl alcohol

C) PROCEDURE:

1. Pour 8ml of the oil and 8ml ethyl alcohol into an evaporating dish. Add 1-2 ml of NaOH solution. Warm very gently and stir with a glass rod. If the alcohol catches on fire, place a sheet of heavy paper on the top of the dish to extinguish it. Allow the substance to cool. Soap in the form of yellow scum will be formed on the surface. Remove the solid soap and cut it with a thread or wire into cakes. Wrap it into a paper.

LOW COST

A) APPARATUS:

Aluminum pan, Spoon, Syringes, Cups

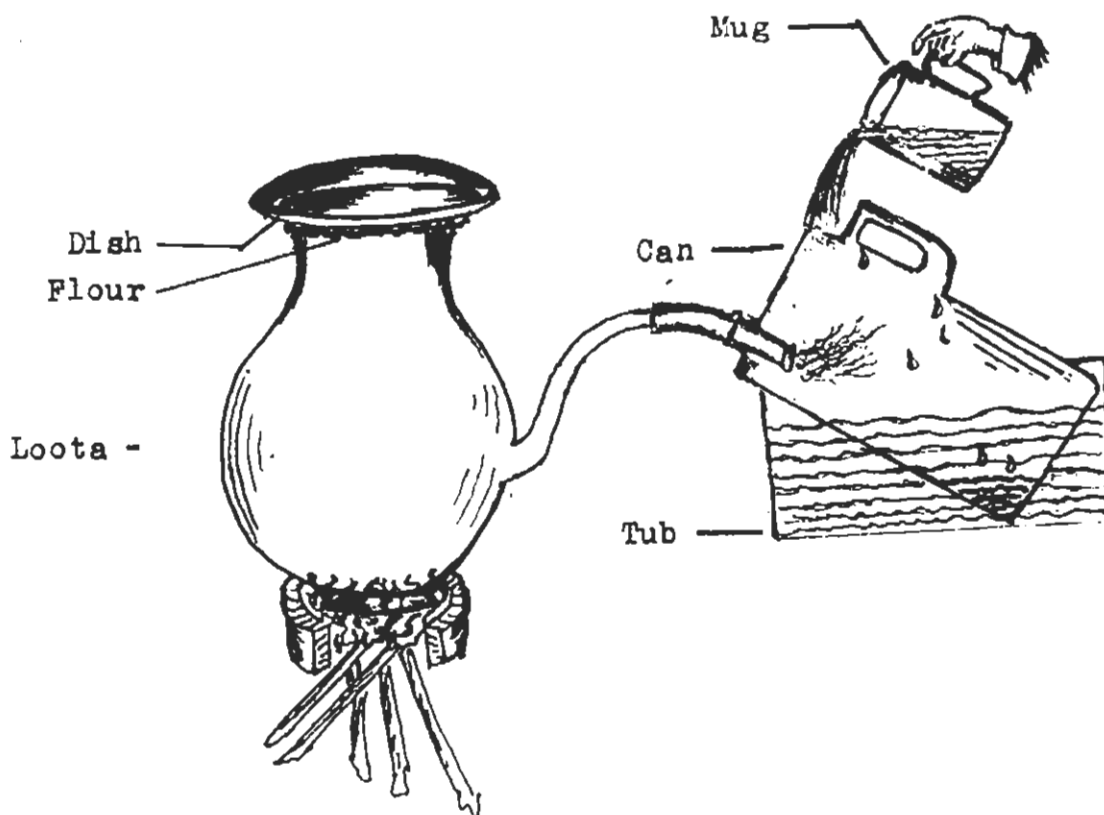
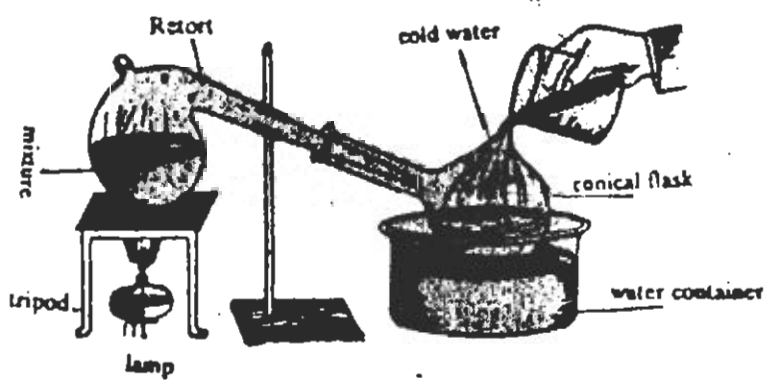
B) CHEMICALS:

Mustard oil, Caustic Soda, Flour, Water

C) PROCEDURE:

1. Prepare caustic soda in 5ml of water. Take a pan, put 5 ml of oil and 5ml of water stir it well, put 1-2 ml of NaOH solution and one teaspoon of flour in it. Stir the mixture really well. Allow it to cool. Soap in the form of yellow scum will be formed on the surface. Remove the solid soap and cut it with a thread or wire into cakes. Wrap it into a paper.

DISTILLATION.



Experiment No. 20

DISTILLATION

HIGH COST

A) APPARATUS:

Retort Distilling flask, Condenser, a Receiving flask, Burner, Stand, Water.

B) CHEMICALS:

Water having KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$ or any other coloured impurity: (dissolved or undissolved).

C) PROCEDURE:

1. Put the sample in a retort.
2. Connect to it a condenser and fit the end of the condenser in a receiving flask.
3. Make the retort and condenser air tight so that steam may not escape.
4. Fix it to a stand.
5. Place a wire gauze below the retort.
6. Now, start heating the retort.
7. As the sample (liquid) begins to boil, vapours will go up, through the condenser and will be collected as liquid in a

receiving flask. The Clear solution (water) obtained will be free of all kinds of Impurities.

LOW COST

A) APPARATUS:

Loata, Rubber pipe, Plastic Jug, Plastic Mug, Mud Tripod, logs.

B) CHEMICALS:

Water, KMnO_4 (obtained form local market)

C) PROCEDURE:

1. Put the sample in the loata.
2. Connect the loata with a rubber pipe and put the end of the pipe into the plastic jug.
3. Make the loata and the jug airtight with the flour dough.
4. Put it on the mud tripod.
5. Now, start heating the loata.
6. As the sample (liquid) begins to boil, vapours will go up through the plastic pipe and will be collected as a liquid in the receiving jug. The clear solution (water) obtained will be free of all kinds of impurities.

Appendix "E"**COMPARISON BETWEEN THE COSTS OF EQUIPMENT,
GLASSWARE, AND CHEMICALS USED FOR BOTH
EXPERIMENTAL AND CONTROL GROUPS.**

EXPERIMENTAL GROUP (LOW COST)	CONTROL GROUP (HIGH COST)
Experiment No. 1 Rs. 5/-	Experiment No. 1 Rs. 1400/-
Experiment No. 2 Rs. 26/-	Experiment No. 2 Rs. 58/-
Experiment No. 3 Rs. 0.50	Experiment No. 3 Rs. 250/-
Experiment No. 4 Rs. 11/-	Experiment No. 4 Rs. 1472/-
Experiment No. 5 Rs. 19/-	Experiment No. 5 Rs. 571/-
Experiment No. 6 Rs. 13/-	Experiment No. 6 Rs. 194/-
Experiment No. 7 2Rs. 5/-	Experiment No. 7 Rs. 518/-
Experiment No. 8 Rs. 10/-	Experiment No. 8 Rs. 38/-
Experiment No. 9 Rs. 23/-	Experiment No. 9 Rs. 1892/-

EXPERIMENTAL GROUP (LOW COST)	CONTROL GROUP (HIGH COST)
Experiment No. 10 Rs. 26/-	Experiment No. 10 Rs. 86/-
Experiment No. 11 Rs. 32/-	Experiment No. 11 Rs. 75/-
Experiment No. 12 Rs. 26/-	Experiment No. 12 Rs. 72/-
Experiment No. 13 Rs. 58/-	Experiment No. 13 Rs. 498/-
Experiment No. 14 Rs. 26/-	Experiment No. 14 Rs. 480/-
Experiment No. 15 Rs. 39/-	Experiment No. 15 Rs. 340/-
Experiment No. 16 Rs. 18/-	Experiment No. 16 Rs. 128/-
Experiment No. 17 Rs. 17/-	Experiment No. 17 Rs. 704/-
Experiment No. 18 Rs. 31/-	Experiment No. 18 Rs. 1493/-
Experiment No. 19 Rs. 21/-	Experiment No. 19 Rs. 1400/-
Experiment No. 20 Rs. 52/-	Experiment No. 20 Rs. 326/-

To

The Principal,
P.A.F. Model School and college,
Shaheen Camp, Peshawar.

Appendix "F"

Subject: CONDUCTION OF LABORATORY EXPERIMENTS.

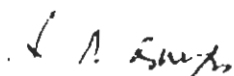
Dear Sir,

I feel pleasure In introducing you Ms. Iffat Ara Hussain,
Associate Professor, I.E.R. University of Peshawar who is Intending to
conduct doctoral research on," Activities Based on Low Cost Materials
(Equipment, Glassware, Chemicals) in teaching Chemistry at Secondary
School Level in Pakistan.

She has prepared laboratory activities. You are requested to
kindly provide requisite cooperation to the researcher.

Thank you for your kindness and co-operation.

Sincerely Yours

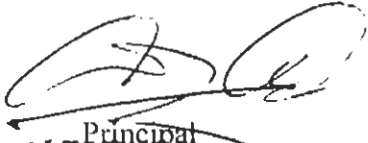

Dr. S.A. Ghaffar
Advisor,
Associate Professor (Rtd)
University of Peshawar:

TO WHOM IT MAY CONCERN

Ms. Iffat Ara Hussain, Associate Professor, I.E.R, University of Peshawar is conducting a research for her Ph.D on "Activities Bases on Low-Cost Materials (Equipment, Glassware, Chemicals) In Teaching Chemistry at Secondary School Level In Pakistan".

All concerned are advised to co-operate with her in this regard.




Principal
ALTAMASH ALI
P.A.F. Shaheen Intermediate College,
Shaheen Camp Peshawar.
PAF Shaheen College
Peshawar