COMPUTER ASSISTED LEARNING (CAL) OF SOME LABORATORY EXPERIMENTS IN PHYSICS

BY

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A PROJECT SUBMITTED TO THE DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF POSTGRADUATE DIPLOMA IN COMPUTER SCIENCE

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~~APRIL~~ 1999

DECLARATION

It is hereby declared that this project was carried out by me under the supervision of prince R.O Badmus of the Department of Mathematics and Computer Science, Federal University of Technology Minna. The project is a record of my own research and has never been submitted anywhere also for the award of degree or diploma.

AJE JULIUS DELE   DATE

CERTIFICATION

This project has been and approved as meeting the requirements of the department of mathematics and Computer Science of the Post Graduate School, Federal University of Technology, Minna Nigeria.

_____   _____
PRINCE R.O. BADMUS   DATE

_____   _____
PROF. K.R. ADEBAOYE   DATE
(HEAD OF DEPARTMENT)

_____   _____
EXTERNAL EXAMINER   DATE

DEDICATION

This work a dedicated to my beloved wife Bosede and my children; Tosin, Ifelola, Ayomide and Ireti for their sense of endurance during this course.

ACKNOWLEDGEMENT

The ovation with which this work had been received and accepted had been due to the collective contributions of some intellectuals of high repute. I particular appreciate the efforts of the course co-ordinator, Prince R.O Badmus for his imense contributions in making the course work an investment of great benefit. His adequate attention and sense of tolerance during his supervision of this project deserves a high degree of commendation.

My profound gratitude goes to prof. K.R. Adeboye for his leadership role and his noble interest for making it possible to achieve the lot the course had offered. I wish to register my appreciation to all the members of staff of Mathematics and computer science department and also members of staff of physics department F.U.T Minna for their laudable gestures and wonderful co-operation to make this project work a successful one.

I salute the courage of my dearest wife Bosede for her words of encouragement all along and for her imense contributions infact, her endurance and patience for my absence during the course is highly commendable.

My sincere gratitude goes to Mr. A. Fasasi and mr George the young and dynamic potential intellects who were never tired of making useful suggestions to make sure the project meet the required standard. Their contributions to the success of this project will remain in my evergreen memory.

TABLE OF CONTENT

ABSTRACT

The Technological advancement of any developing nations depends very much on the effective implementation of her educational curriculum at school levels. It surpases to say that greater emphasis and attention must be focussed on the study of science and allied subject both at secondary and tertiary institutions.

The situation guiding the conduction of Science Enperiments at these levels in Nigerian School today is in the state of appauling. To arrest this situation in the face of ever dweldling Economy, where there is no sufficient fund to procure new and mordern day scientific apparatus for schools,. It has been taken as a challenge in this project to design COMPUTER ASSISTED LEARNING PACKAGE (CAL) at least to demostrate that a lot of our school Enperiments could be carried out using computer and with less rigour.

The merits of CAL has been discussed to further justify its important position in our school system for the sake of users who will like to adopt it.

CHAPTER ONE

INTRODUCTION .

Computing can be best explained on the basis of the purpose it serves. It is the act of processing of data into information. Data itself mean symbolic representation of facts about people, Objects, places etc. Usually such data are very raw in their initial state and hence need to be refined to a better desired form. The form into which data is finally transformed after a series of process is called information.

From the foregoing a computer is an Electronic Machine that follows sequence of instruction in order to process data, solve a specific problem or accomplish a particular task or objective. A computer works under the control of stored programs, automatically accepting, storing and processing data to produce an output. The output is the result of the data that have been processed. Generally, computer science deals with the application of scientific principles to design, construct and maintenance of the systems that are based upon the use of computers.

OBJECTIVE OF THE PROJECT

CAL of some Laboratory Experiments in Physics is designed for learning due to the aims and objectives that it is attended to achieve few among these are as follows:-

1.   To simplify methods of learning and learning process.

2.   To allow students of certain levels to learn at their own desired time and at their own pace.

3.   To overcome many difficulties that are being encountered with classroom teachings.

4.   To present the P.C. as an important and essential useful device in Educational and technological development.

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Personnel, pay roll, financial and administrative procedures have become computerised. The role of computer in science and Engineering have continued to gain more prominence; crop data management, land records and water management are some of the areas that can not underate the use of computers in the field of Agriculture and Agro-allied industries.

The era when customers go and waste most of their times in banks to cash cheques and make other financial transactions is gradually widing away. This is because Banks world wide are now embracing the use of computers in cheque processing, management and data network just to mention a few.

Computer games and computer diaries abound everywhere today and have greatly improved man's awareness in recreation and the importance of record keeping respectively.

COMPUTER ASSISTED LEARNING (CAL) AND ITS ADVANTAGES

Computer aided Learning (CAL) is a process of using the computer as a resource of learning in order to assist students in the process of studying to achieve a particular objective or goal. CAL is used for describing the learning activities promoted by a computer or in which it is directly involved.

Interactive CAL encourages active learning in which the learner participates very actively and objectively. The system allows the learner to obtain the immediate feed back about the status of his action whether right or wrong. If the approach is wrong there is help given at the appropriate time needed to benefit the learner. CAL will continue to attract the attention of many learners as the use of computer continue to gain worldwide acceptance. In the design of this interactive CAL there had been provisions of short and precise questions on each Experiments treated to test the understandability of the students.

ADVANTAGES OF CAL

1. A well produced CAL does not allow the students to be bored down in the learning of the subject at hand.

2. The computer does not forget any facts and does not commit error in his processing or calculation. Any instances is bound to be as a result of human error. This accounts for the popular computer saying "GIGA IN GIGA OUT"

3. Since a student can easily boot a computer system to resume his lesson irrespective of the presence of his lecturer, CAL then allows Education to process beyond the realms of classrooms.

4. The role of Computer in simulating Scientific Experiments, accessing a pool of data base in accounting, Environmental Sciences, Engineering and in other fields of human endeavour has made CAL a resource to reckon with in our modern Educational system.

5. With the advent of CAL , students can use computer to learn at their own pace; and provide opportunity for self accessment on the chosen topic.

6. With an interactive CAL at students' disposal learning becomes more interesting and allows leisure time to be more wisely utilised.

TYPES OF CAL

Generally CAL can be classified into three different types as follows;-

1. SIMULATION CAL

2. TUTORIAL CAL

3. DRILL AND PRACTICE CAL

The three types of CAL fall under two major basic categories:-

A.   A PASSIVE CAL

Here the learner is not directly involved in the process. It is found to be very useful in a computer assisted lecture where the use of the keyboard is not very much required at the initial stage of learning in which new topics or subjects are introduced to the learners.

B   INTERACTIVE CAL

In interactive CAL, the learner is involved very actively in the process of learning. There is a great deal of interaction between the learner and the computer, which is helped by the quick response given to the learner by the computer in response to enquiries from the learner.In this way, the learner knows wether what he/she is doing is right or wrong, so that corrections could be done by the computer. There are always rooms for dialoguep in an interactive CAL between the computer and the learner. This dialogue is as follow:-

1.   the teacher types on the computer screen.

2.   the input is accepted and analysed by the computer.

3.   The output is printed on the computer screen for the learner to see and take the next line of action.

DRILL AND PRACTICE CAL:-

In this type of CAL Training is given on how to apply what has been taught by the teacher. New materials are not introduced in most cases. There is always an advantage of having an instant feed back from the learner immediately the computer ask a question.

TUTORIAL CAL:-

In this concept, the computer teaches new information. The process resembles the interaction between the student and a tutor engaged in face to face discussion. The students understanding of each concept being taught is checked and subsequent instruction is provided based on the student's response.

SIMULATION CAL

A simulation CAL is that type which comprises of computer programs that mimic; the behaviour of a system of real-life situations. It is found natural to model the interactions of the real life objects by exchanges of messages.

Today computers are used very extensively for performing simulation due to their ability to preform tedious, and repetitive computations. With computer simulation one is able to provide valuable insights into the behaviour of complex systems. Simulation is a powerful tool for the analysis of the performance of complex systems that consist of many components whose performance depend on the behaviour of the individual components.

ADVANTAGES OF SIMULATION

1. With simulation it is possible to study the behaviour of very complex systems for which analytical solution can not easily be found.

2. Simulation is very flexible. By changing the input parameters we can study the effect of these changes on system performance without having to resort to costly and dangerous life experiments.

3. By simulations, one can carry out experiments on systems that do not exist at all, without disturbing the existing ones where such disturbance might be harmful or costly.

4. Simulation is useful for laboratory experiments where manipulating the object in real life could destroy the system one is working with.

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CHAPTER TWO

A FOCUS ON SOME PHYSICAL CONCEPTS AND THEIR EXPERIMENTAL INVESTIGATIONS

LIGHT

The study of light deals with the nature and properties of radiation that produces the sensation of sight. In the nut shell, light is a train of disturbances i.e radiations (emission) That produces sight, and it is usually respresnted by a number of rays which may be either diverging, converging or parallel. Light is a form of wave motion and shows the same kind of behaviour as water waves. It consists of stream of tiny wavelike packets of energy called photons, which travels at a speed of 3×10^8 m/s.

I **Optical properties of light**

Among other properties, light can undergo reflection, refraction, absorption as well as diffraction. Module 1 of this work is mainly concerned with the second property, i.e refraction and attention had been focused on one of the methods of investigating the concepts experimentally.

2 **Refraction of Light.**

This is the change of direction which generally occurs when light passes from one medium to another in which the speed of propagation is different. The change in the direction accounts for why a pond or swimming bath appears much shallower than they actually are, or why a stick partly submerges in water appears to be bent where it enters the water. Though, light goes straight in one material where it crosses from one to another, it suffers a sudden shift of direction. The following diagram represents the passage of ray of light from air to glass.The angle of incidence is the angle between

the incident ray and the normal at the point of incidence. The angle of refraction is the angle between the refracted ray and the normal. When a ray of light passes from one medium to a more optically dense medium, the ray bends towards the normal, conversely a ray that passes from glass or water into air is bent away from the normal.

N

A

i

Air
Glass   O

r
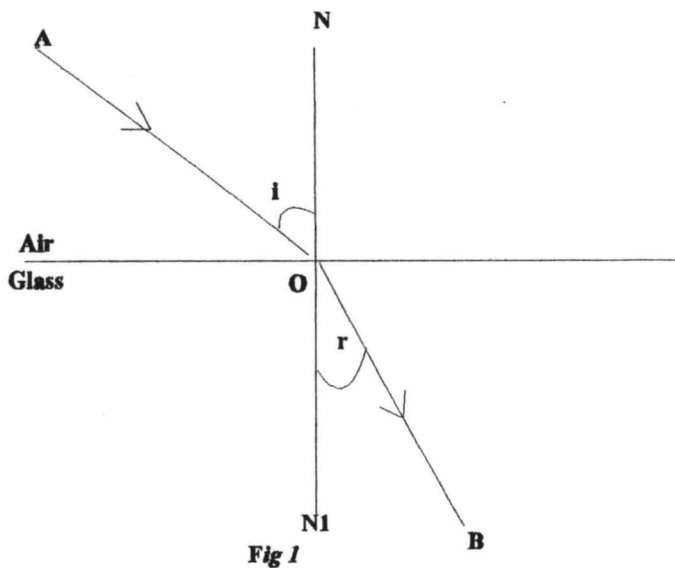
N1   B
Fig 1

Refraction of light through a glass medium

AO = Incident ray

OB = Refracted ray

NN = Normal

i = Angle of incidence

r = angle of refraction

SNELL'S LAW

As discovered by a snell dutch professor in 1620, the laws of refraction are stated as follows:-

1.   The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.

2.   The ratio of the sine of the angle of incidence to the sine of angle of refraction is a constant. The second law is mathematically expressed as follows:-

$$\frac{\sin i}{\sin r} = \mu$$

μ is called the refractive index of the medium.

2.I.4   EXPERIMENT 1

TO DETERMINE THE REFRACTIVE INDEX OF A PRISM

Fig 2

PROCEDURE:-

Pin the sheet of paper to the cardboard. Place the prism on the sheet of paper and draw its outline ABC. Remove the prism, on the side AC and draw ON at O and construct and incidence ray making an angle of incidence i = 30°. Replace the prism, let the incident ray be represented by two pins P1 and P2. Looking through the side AB of the prism. Look for the direction in which the images of the pins P1 and P2 are in line and put two pins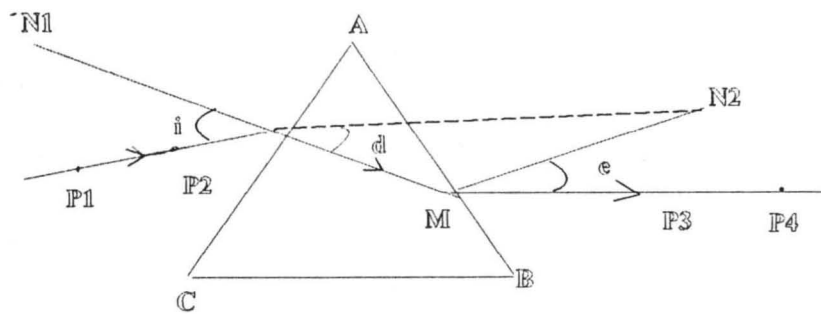 P3 and P4. Remove the prism and all the pins. Draw the emergent ray by joining the positions of P3 and P4 by a short line and keeping the side AB of the prism at M. Draw the refracted ray OM construct the Normal MN_2 at M. Find the angle of deviations produced by the intersection between the incident ray and the emergent ray. Measure the angle of deviation r and the angle of deviation D for the angles of incidence given in the table on sperate sheet for each.

THEORY

If Dm be the minimm deviation of a ray of light refracted thorough the principal section of a prism of refracting angle A, then the refraction index of the material of the prism with respect to the surrounding air is given by

n= $\underline{\text{sin (A + Dm)}}$

         $\underline{\quad A \quad}$

         $Sin^A/_2$

CALCULATION;-

i.   Plot sin i (y-axis) as a function of sin r (x-axis) and from it calculate the average refractive index of the prism. Note that sin i =n sin r.

ii.   Plot D(y-axis) against (i) (x-axis) Observe that d varies as i is measured and passes through an extreme Dm. Note that corresponding angle of incidence for the

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extreme Dm. Now calculate the refractive index by knowing the angles of the prism A

and the minimum deviation Dm. Note that

$$n = \frac{\sin\frac{(A + Dm)}{2}}{\sin {}^A/_2}$$

2.2   ELECTRICAL RESISTANCE OF A CONDUCTOR

As far as current electricity is concerned, we usually think in terms of the ability

of a material to resist the flow of electricity through it. A good conductor is therefore

said to have a low resistance. The resistance R of any given conductor is the

ratio V/I where V is the potential difference P.d across the conductor and I is the current

flowing in it.

If the same potential difference (V) is applied0 to two conductors A and B, and

a smaller current I flows in A then the resistance of A is greater than that of B, hence,

we write.

$$\frac{V}{I} = R$$

Resistance is usually measured in ohms.

The ohm is the resistance which exist between two points when a potential

difference of 1 volt between those points causes a current of I ampere to flow.

2.2.I EXPERIMENT 2

MEASUREMENT OF THE SPECIFIC RESISTANCE OF A GIVEN WIRE

APPARATUS:-

Accumulator, Milliametre,Voltmeter, Rheostat,Key, Screw gauge, Resistance wire etc.

Fig 3
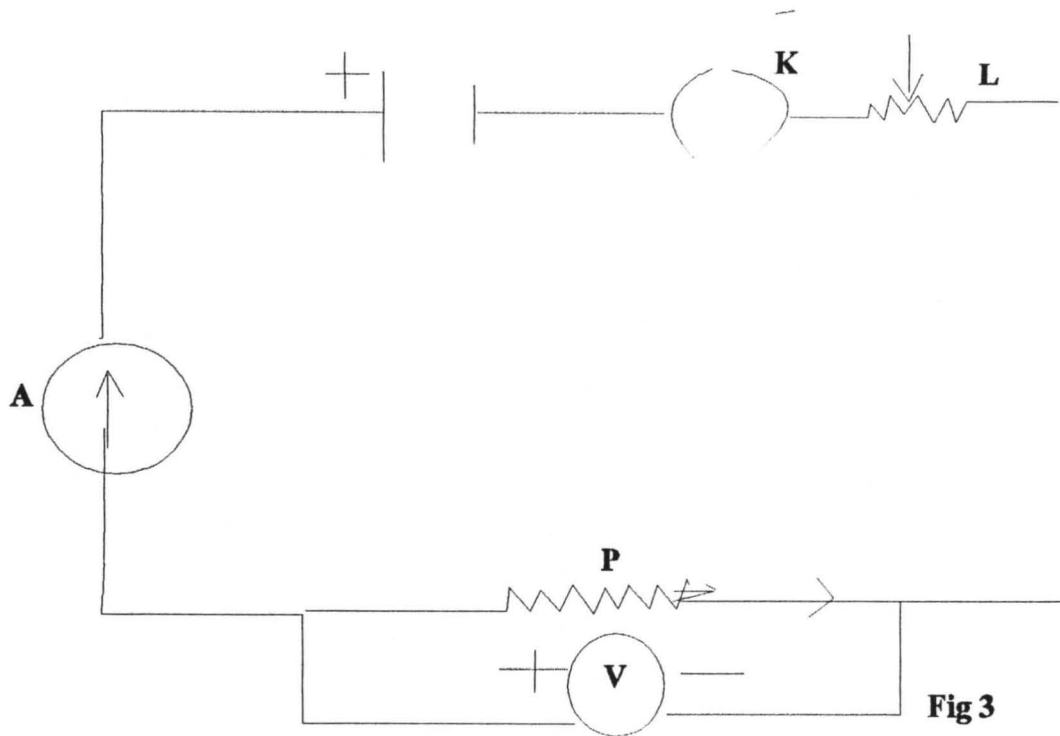
METHOD:-

Complete this circuit as in the diagram above. Voltameter is connected across the resistance wire. Take different sets of V and I by adjusting the rheostat. Measure the length of the wire and also its diameter using a micrometer screw gauge. and record your results as follows:-

TRIAL	I (Amp)	Volts (V)	R = V/I	Mean value R ohm
1 2 3 4 5 6 7 8 9 10				

Table 1
THEORY:-

$R = V/I$

$\rho = R*a\rho/L$

Where ρ = specific resistance of a wire.

a = Cross-sectional area of the wire

L = Length of the wire used in the circuit.

CELL

A cell could be defined as a composition of two dissimilar metal rods or plates called electrodes that are interleaved or separated by a solution of Electrolyte of one of the metal electrodes. A simple example of a cell is the combination of copper and silver rod dipped in a solution of copper two sulphate.

A cell could be primary or secondary depending on its combination which determines the life span of its conductivity.

A cell is called a primary cell if it spontaneously provides an e.m.f, while it is called a secondary cell if it has to be charged by the electrolytic action of a current which is made to pass through it by another source of e.m.f. An example of a primary cell is the Daniel cell while an example of a secondary cell is the accumulator. In an elementary teaching laboratory a more standard cell whose e.m.f varies very little with time, and with temperature is often employed for standardisation purposes. e.g. standardisation of a potentiometer.

It is often used as a standard of a potential difference in potentiometer expenments.

The commonest example in this regard is the weston cadmium cell whose e.m.f is 1.08 Volts. As a result of the importance of the role of this cell in the teaching laboratory it has become very necessary in this project to computerise its structure for learning by students of physics and hence pose further challenges for possible modification even by future scientists.

THE WESTON CADMIUM CELL

The diagram of weston cadmium cell is as shown below:-. It consists of two glass vessels G1 and G2 joined together by cross tube T.

platinum wire P1 and P2 are sealed below the vessels G1 and G2 which serve as the positive
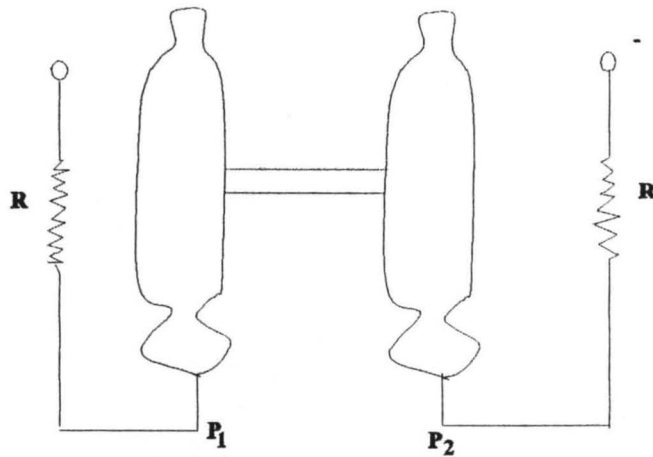
FIGURE 4

and negative electrodes directly. the positive electrode is made up of pure mercury and above it has a paste of cadmium sulphate (cdso4) and mercurous sulphate (Hgso4). The negative electrode is made up of an almagan of cadmium, above which there are also crystals of cadmium sulphate. The two tubes contain saturated solution of cadmium sulpate above the crystals. The solution extends above the connecting tube T and is maintained saturated by cadmium sulphate crystals.

fraction passes through the galvanometer and thereby the galvanometer is saved from damage. Thus the function of the shunt is to save the galvanometer from damage by reducing the current flowing through the galvanometer. see fig 5
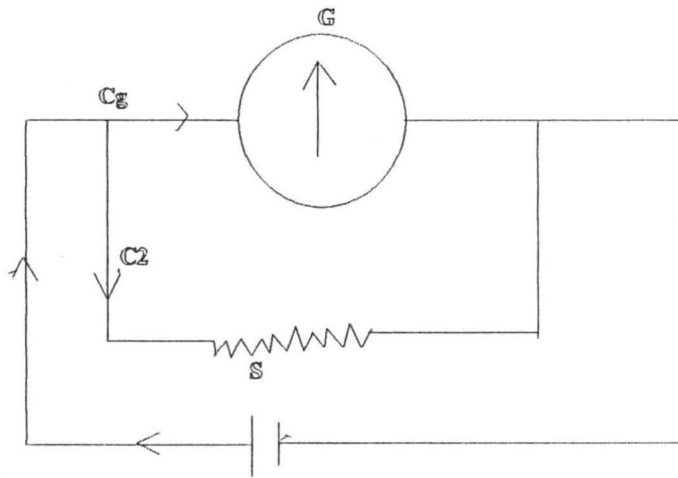
Fig 5

Let G ad S respectively be the resistances of galvanometer and shunt, while the current through galvanometer and shunt are Cg and Cs respectively. If C be the main current then

$C = Cg + Cs$

Now current in a branch is inversely proportionally to its resistance hence,

$Cg/Cs = S/G$

or $Cg/Cg + Cs = S/(S+G)$

or $Cg/C = S/(S+G)$

or $Cg = C*(G?S+G))$.................1

similarly $Cg = C* (G/(S+G))$..............2

I/nth shunt is the shunt that will allow I/nth of main current C to pass through the galvanometer hence,

$Cg = C/n$

or $C/n = C*(S(S+G))$

or $nS = S+G$

or $S = G/n-I$........................3

Equation (3) gives than shunt resistance which will allow I/nth of the main current to flow.

SOUND

Sound is the sensation which we perceive without ears. It is produced by the vibration of the body from which it originates this is easily verified by touching a sounding bell or a violin sting. A vibrating source of sound sets the air (or other medium) in its neighbourhood into oscillation and causes sound waves to travel outwards from it. On reaching the ear, The waves cause the eardrum to vibrate in way which reponduces the Oscillations of the source.

There are two categories of sound i.e Noises and Musical Notes.

NOISES

Noises are produced when the motion of the sounding body is irregular, in the sense that it does not repeat itself rhythmically with any definite frequency.

MUSICAL NOTES

On the other hand, when a vibrating body performs a type of motion which is regularly repeated with a higher frequency, and the hearer becomes aware of a sound of definite pitch.

The range of sound frequencies is about 15 to 20Kz depending on the observer. However, there are sound waves of higher frequency than 20kz which are not audible to human being. These are called ultrasonics. They are used for killing bacteria in liquids and are used for locating faults and cracks in metal castings. The ultrasonics are sent into the metal under investigations, and the beam reflected from the fault is displayed on a cathode ray-tube screen together with the reflection from other end of the metal. Sound is normally propagated inform of longitudinal wave. A wave is a continuous train of disturbances travelling with a speed depending on the properites of the medium. The wave is said to be longitudinal if the particles move in the direction of propagation.
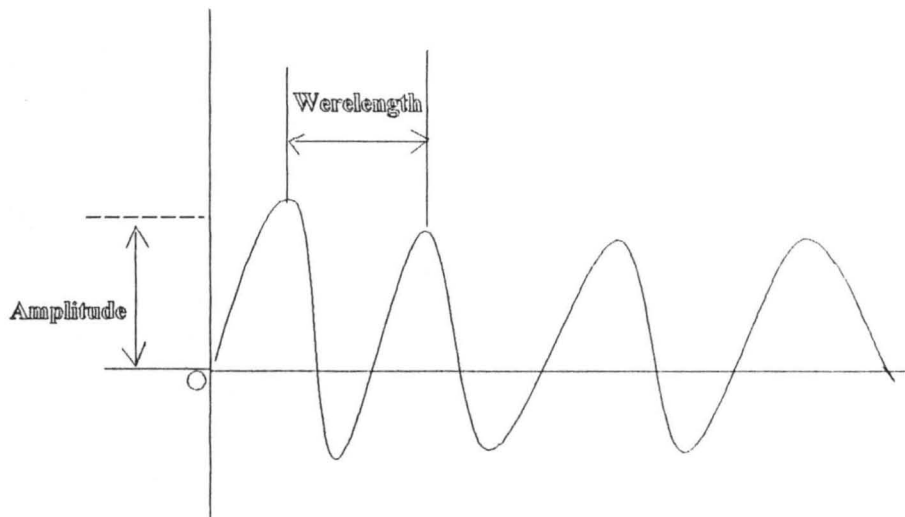
Fig 6 INAVEPROPAGATION

PROPERTIES OF WAVE

Phase:-

This is the relative position which particles of the medium have reached in their paths at different times.

Frequency:- (f)

The number of waves which pass a point per unit time is called the frequency of the wave.

Period:- The time required for a single wave to pass a point is called a period.

Amplitude:- The amplitude of a wave is the maximum displacement of a particle from its equilibrium position.

The wave length:- This is the distance between any two successive points in the same phase (or the distance between successive maxima).

Velocity of sound:- This is the distance the sound wave advances per unit time. It depends on the type of wave and the properties of the medium.

For all types of waves,

$C = f \ast \lambda$

Where C is the wave speed, f is the frequency of the wave, and λ is the wavelength of the wave. whenever a sound wave travels in any given medium e.g gas, liquid or solid, the particles in the medium are subjected to varying stresses, with some resulting strains.

The velocity of sound V in air at OoC is related to its velocity Vo at OoC by the expression.

$$V/Vo = SQR (273+\theta/273)$$

$$= SQR (1+\theta/273)$$

2.3 **EXPERIMENT 3**

MEASUREMENT OF VELOCITY OF SOUND BY KUNDT'S TUBE

APPARATUS:- Kundt's tube, metre rule, lycopodium powder etc.
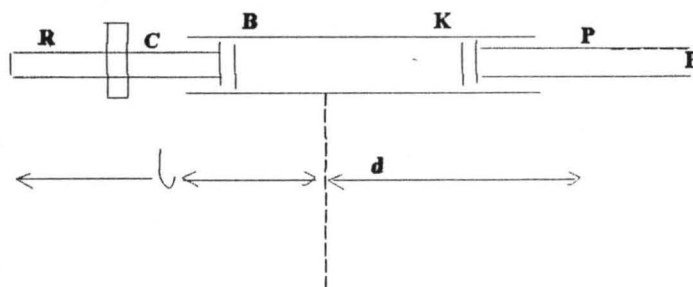
Fig 7

Thoroughly clean and dry the wide glass tube K and introduce a thin layer of lycopodium powder along its length. The powder may be conveniently sprinkled on a

metre rule, which is then inserted into the tube and turned over. Clamp the rod R at its midpoint by means of C, with the disc B well inside the tube K, but not touching its wall. The rod is made to sound by drawing a friction pad from the clamp towards the free end. As R is made to sound a clear loud note, into the tube , move the plunger P slowly into the tube until the motion of the powder is maximum. The powder will settle with clearly defined nodes N (between which will be striations due to higher harmonics). Note that there are nodes at B and P. Count the number n of antinode the tube between B and P. Measure the length L of the rod.

MEASUREMENTS

Length of rod L = M

Length of air column d = m

No of antinodes =n

Room temperature t = 0°C

CALCULATION:-

Calculate the velocity of sound V in air at room temperature t°C from the equation.

$$\frac{V}{Vo} = SQR (t+273/273)$$

2.4 THE TRANSISTOR

The transistor is a single piece of silicon or germanium with three ehstinct regions of n-type or P-type material in it. These two kinds of materials are produced by the process of doping in which an impurity is allowed to diffuse into the crystal. Two different impurities are used to produce the two different kinds of material. There are only two different arrangements of the three this regions of semiconducting materials in a transistor. These arrangements are:-

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1. Two N-regions sandwitching a very thin P-type region. This arrangement produce the N-P-N transistor.

2. Two P-region sandwiching a very thin N-type region. This type of arrangement given the P-N-P transistor.

    In both cases the transistor consists of two PN junction placed back to back and very close together in one single piece of semiconductor crystal. The two outer regions are called the emitter and collector. The centre is the base region.

Graphical Symbols
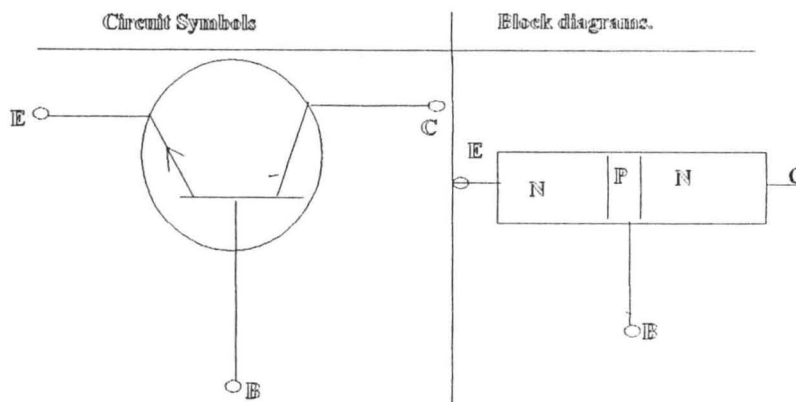
Fig 8

In order to understand how the two P-N junctions of a transistor interact, it is necessary to recall a few of the facts regarding the operation of P-N junctions.

1. A forward bias applied to a P-N junction increases the minority carrier density on each side of that junction.

2. A reverse bias applied to a P-N junction decreases the minority carrier density on each side of the P-N junction. The entire principle of the operation of the transistor is based on the action of two P-n junction (diodes) in the structure. To obtain transistor action, the emitter base region must be forward biased and the collector base region reverse biased.

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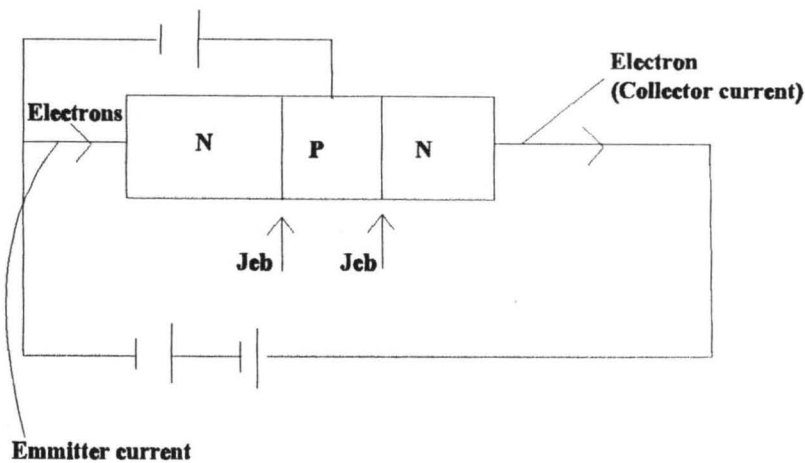
FIG. 9 THE NPN TRANSISTOR

Consider the operation of the N-P-N transistor shown above. When the battery polarities are applied to the junctions as shown the majority carriers (electron) is the N-region cross the junction into the central base region. This creates a large minority carrier density gradient in the base region. The base is very thin (less than a millionth of a metre) and is highly doped so only a small proportion (about 1%) of the electrons combine with holes in the base and are lost as charge carriers.

The rest flow through the base and are swept across the base collector Junction to become the collector current in the external circuit. For each electron that comes out of the collector and enters the positive battery terminal, an electron enters the emitters from the negative battery terminal. This forms the emitter.

It was noted earlier that a portion of the electrons diffusing away from the emitter base junction recombine in the central base region and are lost. The holes required for this recombination come into the base through the contact to the central base region and this constitute a small base current . The number of holes available for the recombination is controlled and hence the amount of recombination it self controlled.

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The peak a.c current I_b flowing in the base circuit is

I_b = 0.01/200A

= 5*10^ -6A

∴ Ic = β* I_b

= 50 * 5 * 10^ - 6

= 2.5 * 10^ - 4A

∴ V_o = IcR

= 2.5 * 10^ - 4 * 5000

= 1.25 V peak

Also, power gain   = current gain * Voltage gain

= 50 * 125

= 6250

CHAPTER THREE

SYSTEM ANALYSIS AND DESIGN

INTRODUCTION

In this chapter, the detailed account of the package will be examined with regard to usage, evaluation and modification. As earlier mentioned, the aim and objectives of this work is not to discourage or eliminate laboratory bench work and teaching, rather it is meant to serve as a compliment to all other existing teaching aids and learning methodologies. The system has an advantage of easy usage, serving as a source of reference for further studies. It is particularly very suitable as an eye opener to those who intends to take up a carrier in experimental physics and allied fields. The project has been carried out to contribute immensely to the computer literacy needs of many learners willing to be carried along with this computer era. The contents of the presentation is in accordance with the physics syllabus areas of both secondary and tertiary institutions, and those of some professional institutions like the Nigerian Institute of Science Technology etc.

Also, the work in one hand serves as a manual of tutorial on some selected topics in physics and on the other hand serves as a laboratory reference of the experiments that are associated with such topics.

An effective use of the system is made possible for students of whatever class in computer science either skilled or unskilled. The skilled computer scientist may even find some of the contents as a good reference whenever he intends to refresh his memory.

At this juncture, it is of pertinent importance to give a brief account of the system with reference to output, input, source documents and output documents, files and procedures.

INPUT AND INPUT DEVICES

The input devices are those devices that fascilitate the flow of information into the computer memory. They also translate information in the form that is acceptable to the computer. This form is in Binary numbers. The major input devices used in this project work are keyboard which is the part of the computer that resembles a type writer. Data entry into the computer is done via the keyboard. Others are disk drive which is an electromechanical device that reads from and writes to disks. A "3.5" floppy diskette which serves as a secondary storage medium was also used.

The notes and the experiments selected from some topics in physics form the major input in this system. Four main topics were selected for the inputs even though they were not treated into deep details. The topics are optics, sound and waves, Electricity and Electronics. Circuit diagrams have been drawn to show clearer understanding of the subjects where necessary. Each of the topic is held in a textfile on a floppy diskette. Learners choice has been adequately loaded into the computer memory so as to be able to extract the information on unit basis as output by responding to various systems prompts. On the other hand a computer output device is that which displays the result of the processed computer data. The main one which is commonly in use is the visual display unit (VDU). It is essentially a cathode ray tube. The medium is very noiseless and displays information very fast. The output of this work is made up of the processed form of the data fed in from those four selected topics in physics. Programs were written to accomplish certain tasks and were fed in and run

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on the computer, and the output were displayed on the monitor. (Diskette attached). Subjects are produced in modules which essentially contains the units of the study. A unit is a computer screen of relevant information on the lesson under study. Hence the output is a mere retrieval of the information loaded into the computer memory.

SOURCE DOCUMENT AND OUTPUT DOCUMENT

The source documents have been generated using selected textbooks and experimental manuals on physics. With the scopes suitable for secondary schools, remedial programme, advanced level and professional institutions. Output documents is easily obtained by printing the screen on the display of each unit, when the package is under utilisation.

The source programme is code named AJE with a system generated extension. PAS and is resident in the floppy diskette. The following Text files make up the program, they are:-

i.   Introduction Text file (INTRO TEXT)

ii.   Illustration Text files (ILL TXT)

iii.   Precaution Text file (PRE. TEXT)

iv.   Experiment Text file (EXPT. TXT)

The program file contains all the lines of instructions that constitute the program as well as the data for text. The files are correctly stored up in a 3.5" diskette with free space to allow for necessary editing and modification. The programme is the most sensitive among all the files. Adequate attention has been given to its security. In order to avoid unnecessary tampering that can damage the package, it has been converted to an executable file using a tubo pascal compiler. Also, unauthorised users are denied access to the package by the program itself through a password subroutine which has

to be activated first. It is only when the correct password is keyed in that one could use the package.

4   DRILLS AND PRACTICE

Having gone through some experimental fundamentals, it is necessary to have a brief test of our understanding so far. This calls for some drills and practice.

1.   What is light?

Mention three distinct properties of light?

2.   A ray of light experiences minimum deviation when passing symmetrically through an equilateral glass prism. Model the information and write a short computer program that will calculate the angle of incidence of the ray given that refractive index of glass is 1.5.

3.   Examine carefully the setup of fig 3.

What is the significance of P in this set up?

How is it different from L? attempt using a suitable computer fascility to reproduce Table 1.

4.   What are utral sonics? Mention two technical applications of these. Point out the essential differences between Noises and ultrasonics.

5.   What is a Shunt? What is this used for?

6.   Describe an experiment to determine an unknown resistance of a given piece of wire. What precautions would you take to obtain an accurate result?

7.   A given piece of constantan wire has a diameter of 0.50m and resitiviity $1.1 \times 10^{-6}\Omega$. Write a computer program that will calculate the length required to construct a standard resistor of resistance 35Ω.

CHAPTER FOUR

SYSTEM IMPLEMENTATION

For this package to be effectively utilised, the user must be very familiar with the set up of a computer system i.e both its hardware and other related peripherals. He must be very well acquainted with booting systems. More over, the user must be able to get enough information on the facilities. That can be obtained from the package itself. This form the primary focus of this chapter.

UTILISING AJE.PAS

For the satisfaction of the user of any given package to be met, simplicity, flexibility and effectiveness of the package itself is of paramount importance. This package has therefore been developed to be effectively executable on personal computers. The choice of the programming language. Is TURBO PASCAL which is a very simple version of PASCAL programming language.

REQUIREMENTS OF AN ENVIRONMENT FOR THE DEVELOPMENT OF PASCAL PROGRAM.

Editor

For one to type a pascal program at the keyboard and save the programme on a disc it is necessary to run a program called an editor. An editor allows a program to be retrieved from disc and amended as necessary. The pascal program is stored in a text mode so that the programmer can read the program as it was written.

Compiler:-

The computer translate the program stored in a machine- oriented language on disc.

There are several dialects of pascal program available. The one used for this work is that of turbo pascal from Borland International Inc. However, the same program in text form is transferable to an IMB PC and translated into machine-Oriented language using the turbo pascal compiler. This accounts for the portability of the work.

The portability of the language only refers to the language in the text mode and not machine code. The programs have been developed using turbo pascal version 5.5 on an IBM PC Microcomputer.

Link/Loader:-

Before a compiled pascal program can be run or executed by the computer, it must be first converted into an excutable form. The link loader therefore takes the machine oriented progromme and combine it with any naccessary software already in machine oriented form to enable it to run.The complete machine code is then loaded into memory ready for execution. The package itself is held on a diskette and can be copied to the hard disk of a computer system. Ones this has been done, one can just change directory to TP at the Dos-prompt, and press Enter-key, Again, TURBO is typed and enter key pressed. For the execution of the program, it must be loaded into the computer memory, taking the following steps one after the other. i.e press. ALT+F, and selecting open from the submenu; the Enter key is pressed again. This step is followed by typing AJE.PAS and pressing Enter key. To run therefore, the ALT+R are pressed together and RUN selected again from the submenu displayed and enter key pressed. The next action is to type BGI i.e "Borland Graphic interface". The size of the programe is made up of 1134 lines. The extended version of the program can equally be run from drive A in the following manner. The user only needs to change directory into Drive A.

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The diskette containing the executable file of the source program is then inserted into the "A" drive and AJE is typed and followed by pressing the enter key. The space bar is then used for continuous scrolling of the pages until the end is reached. escape key is then used to exit finally.

To study a particular module, it is chosen from the main menu by pressing the module number that is desired and the program presents the topic lesson automatically. At the end of the module, it is possible for the user to enter another module since the main menu is automatically represented. At this juncture, it is of pertinent importance to high light few points on the staff training and change over procedure. For the intending users of this package. It is assumed that the computer science teachers in each school will be able to guide the students on how to make use of the package. They must be acquainted with the good knowledge of how to take care and safekeeping of the floppy diskette containing the package. It is recommended that series of demonstrations, on the use of the package be carried out with the students before they are left alone for continuous use.

.2 **PROGRAM FACILITIES**

The following fascilites are built within AJE.PAS program, so as to make the whole package easy to use, educative and more interactive.

Menu-Driven Interface:-

The package incorporates a menu driven user interface ,which provides the user with a number of options and a simple means of selecting between them. The user is presented with a choice and therefore does not need to have remembered any commands. The interface is therefore suitable for beginners and infreqernt users. What the user need do is to make a choice.

Error trapping facility:-

An error trapping subroutine has been built in. It notifies the user of the occurence of errors and offers an assistance to the users by instructing him on how and what to do for continuous program execution.

Exit Facility:-

This is a facility that is built in to enable user to eixt AJE. PAS program at any point in time, along the line of execution of the program.

CHAPTER FIVE

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS.

In this chapter, the conclusions that are derivable from the user of the package is given, the scope of the project is also given, so as to guide the subsequent interested witters on this particular topic for necessary improvement. The chapter also gives some recommendations in order to enhance better performance and to improve on this work by future witters.

CONCLUSIONS

AJE is the code name of the package resulting from this project. It has been tested by computer software users, computer teachers as well as teachers of physics.

The random opinion of students were also sought on the package as per its suitability for the desired objective. the overall comments point to the fact, that the package is efficient, simple and of inmese benefit in the field of learning. As a result I have no reservation in recomending it as an efficient "TUTOR" of the experiments in the physics topics selected. It would be of tremendous benefit to schools with personal computers or to any other individual with access to personal computers outside the school environment.

LIMITATIONS

The scope of this work is only limited to some selected experiments that illustrate some foundamental laws and principles in optics, Electricity, Sound and Electronics. How ever, the limitations do not in any way affect the quality of this work.

The branches of the subject invoved can be treated separately without loss of concepts involved, in the understanding of laboratory physics. Questions and answers

could have as well been added at the end of each text, but it is hoped that this could be taken up as a modifying step for improvement in the subsequent work by any writer who may be interested in a similar topic.

5 RECOMENDATIONS

Based on the enthuciasm shown by the randomly selected students of physics who test-run this package, it is stongly recomended that more and adequate fundings should be allocated to the use of computer as teaching and learning aid both in secondary schools and tertiary institutions.

It is of pertinent importance, also that computer programmers, accademicians and professionals in various subject should work together to develop resourceful softwares that are applicable in computer Assisted learning packages.

There should be greater challenges from other students to come out with similar packages insome other type of programing languages like FORTRAN, BASIC and D-base IV to expand the scope of the objective of this work which is wider coverage among others.

Based on the above recomendations among others, CAL will continue to be an important and useful teaching aid to reckon with at all school levels.

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START

DISPLAY INTRO
SCREEN

DISPLAY
MAIN MENU

ACCEPT CHOICE

IF
CHOICE = 1 — Y → ILLUSTRATION

IF
CHOICE =2 — Y → GENERAL
PRECAUTION

IF
CHOICE =3 — Y → EXPERIMENT

IF
CHOICE =4

QUIT

AJE . PAS

```
                      ┌─────────────────┐
                      │  ILLUSTRATION   │
                      └─────────────────┘
                               │
                        ╭─────────────╮
                        │   DISPLAY   │
                        │    MENU     │
                        ╰─────────────╯
                               │
                        ╱───────────────╱
                       ╱ ACCEPT CHOICE ╱
                      ╱───────────────╱
                               │
                          ◇─────────◇         ┌──────────────┐
                         ╱    IF     ╲    Y   │    OPEN      │
                         ╲ CHOICE = 1 ╱ ─────▶│  STANDARD    │
                          ◇─────────◇         │  CELL FILE   │
                               │              └──────────────┘
                          ◇─────────◇         ┌──────────────┐
                         ╱    IF     ╲    Y   │ OPEN SHUNT   │
                         ╲ CHOICE = 2 ╱ ─────▶│ AND ITS' USES│
                          ◇─────────◇         │ FILE         │
                               │              └──────────────┘
                          ◇─────────◇         ┌──────────────┐
                         ╱    IF     ╲    Y   │   OPEN       │
                         ╲ CHOICE = 3 ╱ ─────▶│ AMETERS FOLE │
                          ◇─────────◇         └──────────────┘
                               │
                          ◇─────────◇         ┌──────────────┐
                         ╱    IF     ╲    Y   │   OPEN       │
                         ╲ CHOICE = 4 ╱ ─────▶│ VOLTMETER    │
                          ◇─────────◇         │ FILE         │
                               │              └──────────────┘
                      ┌─────────────────┐
                      │   READ FILE     │
                      └─────────────────┘
                               │
                          ◇─────────◇
                         ╱    IF     ╲
                  ◀───── ╲ CHOICE = 5 ╱
                          ◇─────────◇
                               │ Y
                        ╭─────────────╮
                        │   RETURN    │
                        ╰─────────────╯
```

AJE . PAS

```
          ┌─────────────────────┐
          │     READ FILE       │
          └─────────────────────┘
                    │                              ←─────────────┐
                    ▼                                            │
          ╱─────────────────────╱                               │
         ╱   READ TEXT FILE    ╱                                 │
        ╱─────────────────────╱                                 │
                    │                                            │
                    ▼                                            │
          ╱─────────────────────╱                               │
         ╱   DISPLAY TEXT      ╱                                 │
        ╱   FILE              ╱                                  │
       ╱─────────────────────╱                                  │
                    │                                            │
                    ▼                                            │
                 ╱─────╲                                         │
               ╱   IF    ╲ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┘
               ╲   eof   ╱
                 ╲─────╱
                    │
                    ▼
          ╭─────────────────────╮
          │      RETURN         │
          ╰─────────────────────╯
```

AJE . PAS

EXPERIMENT

DISPLAY
MENU

ACCEPT CHOICE

IF
CHOICE = 1   Y →   OPEN
EXPERIMENT 1
FILE

IF
CHOICE = 2   Y →   OPEN
EXPERIMENT 2
FILE

IF
CHOICE = 3   Y →   OPEN
EXPERIMENT 3
FILE

IF
CHOICE = 4   Y →   OPEN
EXPERIMENT 4
FILE

IF
CHOICE = 5

Y

RETURN

Computer Assisted Learning

OF

SOME LABORATORY
EXPERIMENTS IN PHYSICS

- Press any key to continue

INTRODUCTION

This program has been designed
to meet the needs of Advanced
level students of practical
physics both at the senior
secondary school and those who
are in the first year of their
degree program in physics and
Engineering discipline. The
materials presented are in

Space bar =>Continue,Esc=>End

```
M A I N    M E N U

1. Illustrations

2. General Precautions

3. Experiments

4. Quit

Enter Choice(1-4) _
```

```
ILLUSTRATION MENU

[1] Standard Cell

[2] Shunt & Its uses

[3] Ammeters

[4] Voltmeter

[5] Exit

Your Choice (1-5) _
```

```
EXPERIMENTS MENU

[1] Experiment One
[2] Experiment Two
[3] Experiment Three
[4] Experiment Four
[5] Experiment Five
[6] Exit

Your Choice (1-4) _
```

Standard Cell

Of the two stardard cells which are available, Weston cadmium cell is usually employed. It cinsists of two glass vessels G1 and G2 joined together by a cross-tube T. Platinum wires P1 and P2 are sealed below the vessels G1 and G2 which respectively serve as the positive and negative electrodes. The positive electrode is pure mercury(1) , above which there is a paste(2) of CdSo4 and HgSo4. Above this paste there are also crystals of CdSo4 (3). Both the tubes contain saturated solution of CdSo4 (4). Above the CdSo4 Crystals. The solution extends above the connecting Tube and this solution is maintained saturated by CdSo4 crystals.

General Precautions in Electrical

(i) All junctions must be made tight and to ensure good electrical contact, the ends chicch are in the junctions must be made clean by sand paper. To ensure the tightness of a wire in a binding screw, the wire should be pulled out gently to see whether it comes out or not.

(ii) Plugs of resistance boxes or of P.O. boxes must be inserted tight by rotating the plug and at the same time pushing it downward, otherwise an extra resistance will be inserted in the circuit for which we take no account.

(iii) Whenever a suspended cell galvanometer is to be introduced in a circuit, either a series high

Experiment Four

What is transistor ?

How does it work ?

Read the reference carefully to answer above questions.
In this experiment, you have to plot characteristic
curves of a n-p-n transistor. These curves are the
collector characteristics, and are analogous to the
plate characteristics, of the triode, except that for
the transistor the base current IB, rather than the base
voltage is the controlled variable. You have to measure
Ic(collector current) with Vce (collector-Emitter
Voltage drop) for various values of IB. Also measure
IC as a function of IB fro various values of Vce to

Measurement of velocity of sound by k

PROCEDURE:

Thoroughly clean and dry the wide glass tube K, and introduce a thin layer of lycopodium powder along its length. The powder may be conveniently springled on a meter rule, which is then inserted into the tube and turned over. Clamp the rod R at its midpoint by means of C, with the disc b well inside the tube K, but not touching its walls. The rod is made to sound by drawing a fraction pad from the clamp towards the free end. As R is made to sound a clean loud note, move the plunger P slowly into the tube until the motion of the powder is maximum. The powder will settle with clearly defined nodes N(between which
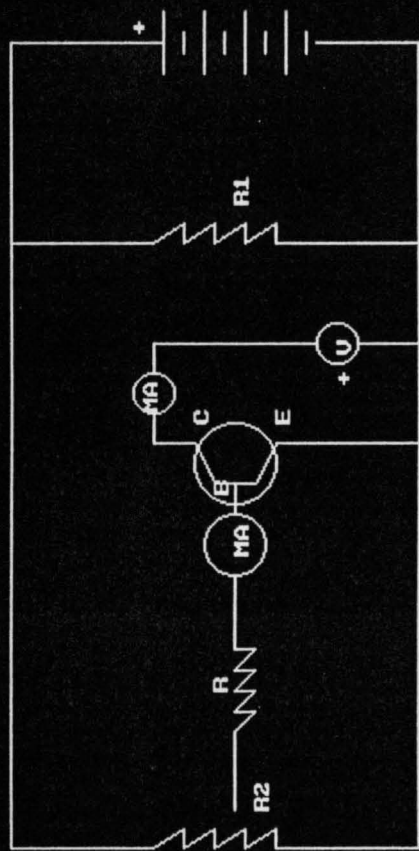
```pascal
Program CAL(Input, Output);
Uses Crt, Printer, Graph;
Const
  {User define fill pattern}
  User1 : FillPatternType = ($AA, $59, $AA, $55, $AA, $55, $AA, $55);
  User2 : FillPatternType = ($FF, $10, $FF, $10, $FF, $10, $FF, $10);
  User3 : FillPatternType = ($AE, $A4, $AE, $A4, $AE, $A4, $AE, $A4);
  Dat:Array[1..7] of String[4] =
  ('32o', '37o','42o','47o','52o','55o','60o');
  Hint:Array[1..6] of String[1] =
  ('1', '2','3','4','5','6');


  Spacebar=chr(32);
  Esc=chr(27);


Var
  {Variable Declaration of Main File Record}
  GraphDriver : integer;   { The Graphics device driver }
  GraphMode   : integer;   { The Graphics mode value }
  OldExitProc : Pointer;   { Saves exit procedure address }
  Datfile:Text;
  MaxX, MaxY  : word;        { The maximum resolution of the screen }
  ErrorCode   : integer;   { Reports any graphics errors }
  MaxColor    : word;        { The maximum color value available }
  Mainfile:Text;
  Lin,Ans:String[80];
  Units, v,x,y0, y1, y2,x1, x2,i,n,j,k,m: integer;
  Resp,Key:Char;
  Rep,ct,choice,choice3,choice1,choice2,Choice4,ecode,tot:integer;
  Keyp:String[1];
  linn:String[35];


{$F+}
procedure MyExitProc;
begin
  ExitProc := OldExitProc; { Restore exit procedure address }
  CloseGraph;              { Shut down the graphics system }
end; { MyExitProc }
{$F-}

Procedure Initialize;
{ Initialize graphics and report any errors that may occur }
var
  InGraphicsMode : boolean; { Flags initialization of graphics mode }
  PathToDriver   : string; { Stores the DOS path to *.BGI & *.CHR }
begin
  { when using Crt and graphics, turn off Crt's memory-mapped writes }
  DirectVideo := False;
  OldExitProc := ExitProc;                    { save previous exit proc }
  PathToDriver := 'C:\TP\BGI';
  repeat

{$IFDEF Use8514}                              { check for Use8514 $DEFINE }
    GraphDriver := IBM8514;
    GraphMode := IBM8514Hi;
{$ELSE}
```

```
    GraphDriver := Detect;                     { use autodetection }
{$ENDIF}

    InitGraph(GraphDriver, GraphMode, PathToDriver);
    ErrorCode := GraphResult;             { preserve error return }
    if ErrorCode <> grOK then             { error? }
    begin
      Writeln('Graphics error: ', GraphErrorMsg(ErrorCode));
      if ErrorCode = grFileNotFound then  { Can't find driver file }
      begin
        Writeln('Enter full path to BGI driver or type <Ctrl-Break> to quit:');

        Readln(PathToDriver);
        Writeln;
      end
      else
        Halt(1);                           { Some other error: terminate }
    end;
  until ErrorCode = grOK;
  Randomize;                     { init random number generator }
  MaxColor := GetMaxColor;   { Get the maximum allowable drawing color }
  MaxX := GetMaxX;           { Get screen resolution values }
  MaxY := GetMaxY;
end; { Initialize }

function Int2Str(L : LongInt) : string;
{ Converts an integer to a string for use with OutText, OutTextXY }
var
  S : string;
begin
  Str(L, S);
  Int2Str := S;
end; { Int2Str }


Procedure box(x1,y1,x2,y2,r1,r2,c1,c2,c3:integer);
{Draw box with given parameters}
begin
  setcolor(c1);
  setlinestyle(Solidln,0,Normwidth);
  arc(x1+r1,y1+r1,90,180,r1);
  arc(x2-r2,y1+r2,0,90,r2);
  arc(x1+r2,y2-r2,180,270,r2);
  arc(x2-r1,y2-r1,270,0,r1);
  line(x1+r1,y1,x2-r2,y1);
  line(x2,y1+r2,x2,y2-r1);
  line(x2-r1,y2,x1+r2,y2);
  line(x1,y2-r2,x1,y1+r1);
  floodfill(x1+10,y1+10,c1);
  setlinestyle(Solidln,0,Thickwidth);
  setcolor(c2);
  arc(x1+r1,y1+r1,90,180,r1);
  arc(x2-r2,y1+r2,0,90,r2);
  setcolor(c3);
  arc(x1+r2,y2-r2,180,270,r2);
  arc(x2-r1,y2-r1,270,0,r1);
  setcolor(c2);
  line(x1+r1,y1,x2-r2,y1);
  line(x2,y1+r2,x2,y2-r1);
  setcolor(c3);
  line(x2-r1,y2,x1+r2,y2);
```

```
  line(x1,y2-r2,x1,y1+r1);
end;

Procedure Secter(x1,y1,st,ed,xr,yr:Integer);
Begin
 Sector(x1,y1,st,ed,xr,yr);
 line(x1+xr,y1,x1,y1-yr);
 line(x1,y1-yr,x1-xr,y1);
 line(x1,y1,x1,y1-yr);
End;

Procedure Press;
Begin
  Setcolor(red);
  Settextstyle(Defaultfont, Horizdir,2);
  Outtextxy(50,440,'Space bar =>Continue,Esc=>End');
  repeat
    Keyp := Readkey;
  until (keyp = Spacebar) or (keyp = esc);
  if keyp = esc then halt;
End;


Procedure Initial(Name:String);
Begin
  Initialize;
  Settextstyle(Triplexfont,Horizdir,4);Setcolor(Yellow);
  Outtextxy(10,5,Name); Setcolor(White);
  bar(5,40,630,50);
  bar(5,430,630,440);
End;


Procedure Background;
{Display Background}
Begin;
  initialize;
  setfillpattern(user1,2);
  box(2,10,Maxx-2,Maxy-10,20,20,2,15,15);

End;



Procedure Intro;
Begin

  Assign(Datfile,'Intro.txt');
  Reset(Datfile);
  i := 0; Keyp := '';
  Background;

  While not eof(Datfile) do
    Begin
      i := i + 1;
      Readln(Datfile,Linn);
      Settextstyle(Defaultfont, Horizdir, 2);
      Outtextxy(50,i*40,Linn);
```

```pascal
        if i >= 10 then
          Begin
              Press;
              i := 0;
              Background;
            End;
      End;
      Close(Datfile);
      Press;
End;

Procedure Exercise;
Begin
        i := i + 1;
        Readln(Datfile,Lin);
        Settextstyle(Sansseriffont, Horizdir, 1);
End;

Procedure Draw211;
Begin
Initialize;
      line(100,100,200,100);         line(200,93,200,107);
      line(204,95,204,105);          line(204,100,240,100);
      arc(250,100,150,215,10);        arc(240,100,330,30,10);
      line(250,100,290,100);          line(290,100,295,105);
      line(295,105,300,100);          line(300,100,305,105);
      line(305,105,310,100);          line(310,100,315,105);
      line(315,105,320,100);        line(320,100,325,105);
      line(325,105,330,100);        line(320,95,320,87);
      line(320,87,340,87);        line(340,87,340,220);
        line(100,100,100,150);           circle(100,155,5);
        line(100,160,100,220);           line(100,220,200,220);
        line(200,220,205,225);           line(205,225,210,220);
        line(210,220,215,225);           line(215,225,220,220);
        line(220,220,225,225);           line(225,225,230,220);
        line(230,220,235,225);           line(235,225,240,220);
        line(240,220,340,220);           line(175,220,175,280);
        line(175,280,205,280);           line(225,280,255,280);
        line(255,280,255,220);           circle(215,280,10);
        settextstyle(0,0,1);             outtextxy(190,90,'+');
        outtextxy(214,90,'-');           outtextxy(202,85,'B');
        outtextxy(244,85,'K');           outtextxy(300,85,'Rh');
        outtextxy(150,97,'<');           outtextxy(265,97,'<');
        outtextxy(105,145,'+');          outtextxy(105,160,'-');
        outtextxy(85,150,'A');           outtextxy(150,217,'>');
        outtextxy(300,217,'>');          outtextxy(225,290,'V');
        outtextxy(197,270,'+');          outtextxy(230,270,'-');
    Press;
End;


Procedure draw212;
Begin
   Outtextxy(250,30,'FOR RESISTANCE');
   line(50,100,550,100);
   line(50,150,550,150);
   line(50,100,50,430);
   line(250,100,250,430);
   line(150,100,150,430);
   line(350,100,350,430);
   line(450,100,450,430);
```

```
      1: Begin
            Press;Initialize;i:=3;
            Draw11;Initial('Standard Cell');
         end;
       2: Begin
            Press;Initialize;i:=3;
            Initial('Standard Cell');
         end;



       else
      Begin
      if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
      end;
      end;
      if i = 16 then
        Begin
          Press;
          i := 3;
          Initial('Standard Cell');
        End;
    End;
    Close(Datfile);
End;




Procedure one2;
begin
  Initial('Shunt and Its uses');
  Assign(Datfile,'ILL2.txt');
  Reset(Datfile);
  i := 3;
  While not eof(Datfile) do
    Begin
        Exercise;
        val(Copy(lin,1,1),j,ecode);
        case j of
         1: Begin
                Press;Initialize;i:=3;
                Draw13;Initial('Shunt and Its uses');
             end;



        else
       Begin
       if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
       end;
       end;
       if i = 16 then
         Begin
           Press;
           i := 3;
           Initial('Shunt and Its uses');
         End;
    End;
    Close(Datfile);
End;
```

```pascal
Procedure one3;
begin
  Initial('Ammeters ');
  Assign(Datfile,'ILL3.txt');
  Reset(Datfile);
  i := 3;
  While not eof(Datfile) do
    Begin
       Exercise;
       val(Copy(lin,1,1),j,ecode);
       case j of
        1: Begin
              Press;Initialize;i:=3;
               Initial('Ammeters ');
           end;
         2: Begin
              Press;Initialize;i:=3;
               Initial('Ammeters ');
           End;
        else
        Begin
        if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
        end;
        end;
        if i = 16 then
          Begin
            Press;
            i := 3;
            Initial('Ammeters ');
          End;
    End;
    Close(Datfile);
End;


Procedure one4;
begin
  Initial('Voltmeter');
  Assign(Datfile,'ILL4.txt');
  Reset(Datfile);
  i := 3;
  While not eof(Datfile) do
    Begin
       Exercise;
       val(Copy(lin,1,1),j,ecode);
       case j of
        1: Begin
              Press;Initialize;i:=3;
               Initial('Voltmeter');
           end;
        2: Begin
              Press;Initialize;i:=3;
               Initial('Voltmeter');
           End;
        else
        Begin
        if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
```

```pascal
      end;
      end;
      if i = 16 then
        Begin
          Press;
          i := 3;
          Initial('Voltmeter');
        End;
    End;
    Close(Datfile);
End;


Procedure one;
Begin
  Background;
  setfillpattern(user2,4);
  box(80,80,Maxx-80,Maxy-80,0,0,4,15,8);
  Setcolor(White);
  Settextstyle(Triplexfont, Horizdir, 4);
  Outtextxy(140,40,'ILLUSTRATION MENU ');
  setcolor(Yellow);
  settextstyle(Defaultfont, Horizdir,2);
  Outtextxy(100, 120,'[1] Standard Cell');
  Outtextxy(100, 150,'[2] Shunt & Its uses');
  Outtextxy(100, 180,'[3] Ammeters ');
  Outtextxy(100, 210,'[4] Voltmeter');
  Outtextxy(100, 240,'[5] Exit');
  settextstyle(Defaultfont, Horizdir,2);
  Setcolor(White);
  Outtextxy(100, 280,'Your Choice (1-5) _');
  repeat
  Gotoxy(50,18);Readln(Choice4);
  until (choice4 <= 5) and (choice4 > 0);
  Settextstyle(Sansseriffont, Horizdir, 3);
  Case Choice4 of
        1:one1;
        2:one2;
        3:one3;
        4:one4;

  End;
End;


Procedure two;
begin
  Initial('General Precautions in Electrical');
  Assign(Datfile,'Pre.txt');
  Reset(Datfile);
  i := 3;
  While not eof(Datfile) do
    Begin
      Exercise;
      val(Copy(lin,1,1),j,ecode);
      case j of
       1: Begin
            Press;Initialize;i:=3;
            Initial('General Precautions in Electrical');
          end;
       2: Begin
```

```
        if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
        end;
        end;
        if i = 16 then
          Begin
            Press;
            i := 3;
            Initial('Refractive Index of a prism');
          End;
    End;
    Close(Datfile);
End;




Procedure three2;
begin

  Initial('Experiment Two');
  Assign(Datfile,'exp2.txt');
  Reset(Datfile);
  i:=3;
  While not eof(Datfile) do
    Begin
        Exercise;
        val(Copy(lin,1,1),j,ecode);
        case j of
         1: Begin
               Press;Initialize;i:=3;
               Draw211;Initial('Measurement of the specific resistance of a wire');
               end;
         2: Begin
               Press;Initialize;i:=3;
               Draw212;Initial('Measurement of the specific resistance of a wire');
               end;
         else
        Begin
        if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
        end;
        end;
        if i = 16 then
          Begin
            Press;
            i := 3;
            Initial('Measurement of the specific resistance of a wire');
          End;
    End;
    Close(Datfile);
End;




Procedure three3;
begin

  Initial('Experiment Three');
  Assign(Datfile,'exp3.txt');
  Reset(Datfile);
  i:=3;
  While not eof(Datfile) do
    Begin
```

```pascal
            i := 3;
            Initial('The Transistor');
         End;
      End;
    Close(Datfile);
End;


Procedure three;
begin
  Background;
  setfillpattern(user2,4);
  box(80,80,Maxx-80,Maxy-80,0,0,4,15,8);
  Setcolor(White);
  Settextstyle(Triplexfont, Horizdir, 4);
  Outtextxy(140,40,'EXPERIMENTS MENU ');
  setcolor(Yellow);
  settextstyle(Defaultfont, Horizdir,2);
  Outtextxy(100, 120,'[1] Experiment One');
  Outtextxy(100, 160,'[2] Experiment Two');
  Outtextxy(100, 200,'[3] Experiment Three');
  Outtextxy(100, 240,'[4] Experiment Four');
  Outtextxy(100, 270,'[5] Exit');
  settextstyle(Defaultfont, Horizdir,2);
  Setcolor(White);
  Outtextxy(100, 300,'Your Choice (1-4) _');
  repeat
  Gotoxy(50,19);Readln(Choice4);
  until (choice4 <= 5) and (choice4 > 0);
  Settextstyle(Sansseriffont, Horizdir, 3);
  Case Choice4 of
        1:three1;
        2:three2;
        3:three3;
        4:three4;


  End;
End;


Procedure Page2;
Begin
  Background;
  settextstyle(Defaultfont, Horizdir,5);
  Setcolor(Yellow);
  Outtextxy(80, 50,'COMPUTER');
  Outtextxy(180, 170,'ASSISTED');
  Outtextxy(240, 290,'LEARNING');
  Setcolor(Blue);
  Keyp := Readkey;
  Press;
  for i := 1 to 20 do
  Begin
    Sound(1238);
    delay(100);
    box(15*i,10*i,Maxx-(15*i),Maxy-(10*i),20,20,4,15,15);
    NoSound;
  End;
  for i := 20 downto 1 do
```

Thus the number of electrons which reach the collector is controlled by the base current and hence the external current at the junction is controlled by the base current.

EXPERIMENT 4

TRANSISTOR CHARACTERISTICS

The electrical performance of a transistor is best represented by means of a graph. This graph is obtained experimentally and shows the relationship between various current and voltages. It enables us to see how best to use a transistor.
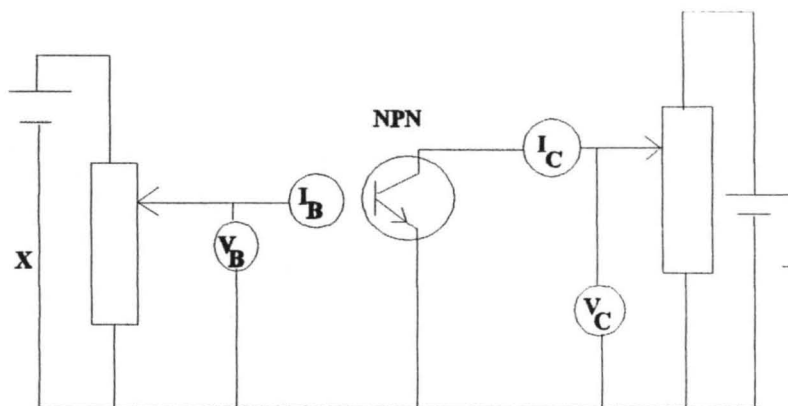
FIG. 10 NPN COMMON EMITTER CHARACTERISTICS

The above figure shows a circuit for obtaining the characteristics of an NPN transistor in the common emitter mode. X and Y may be batteries of 1.5V and 4.5V respectively, connected to potentiometers P and Q of 1kΩ and 5KΩ. This enables the base-emitter P.d V_{CE} or V_c to be varied. The P.d is measured by high resistance voltmetres, preferably d.c. Solid state voltmeters types capable of measuring P.d in steps such as 50mv. The meter for base current I_B should be a microameter and for the collector current, I_c a millimetre. Typical results are shown in the following figures.

OUTPUT CHARACTERISTICS (I_c - V_c, WITH I_B CONSTANT)

The `Knee' of the curves shown in the following figure corresponds to a low potential difference of the order of about 0.2V. For higher potential difference, the output current I_c varies lin linearly with V_c for a given base current. The linear part of the characteristics is used in audio frequency amplifier circuit so that the output voltage variation is then undistorted. The output resistance y_o is defined as $\Delta Vc/\Delta Ic$ where the changes take place on the straight part of the characteristics. y_o is an a.c resistance. It is the effective resistance in the output circuit for an a.c signal input. It should be distinguished from the d.c resistance, V_c/I_c, which is not required in amplifier circuit analysis. The small gradient of the straight part of the characteristics shows that r_o is an a.c resistance. It is the effective resistance in the output circuit for an a.c signal input. It should be distinguished from the d.c resistance, V_c/I_c, which is not required in amplifier circuit analysis. The small gradent of the straight part of the characteristics shows that r_o is high. For example, suppose $\Delta V_c = 2V$ and $\Delta Ic = 0.2MA$

$$= 2* 10^\wedge - 5$$

Then $r_o = 2/2 *10^\wedge - 5 = 100000\Omega$

If a varying resistance load is used in the output or collector circuit, the high value of r_o relative to the load shows that the output current is fairly constant. So the ouput voltage is proportional to the load resistance.
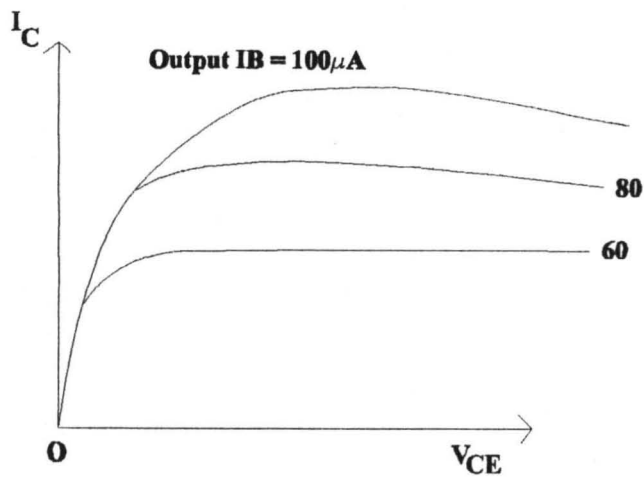
FIG. 12 OUTPUT CHARACTERISTICS (Ic - Vc WITH IB CONSTANT)

Transfer Characteristics (I_c - I_B, V_c constant)

The output current I_c varies fairly linearly with the input current I_B. The current transfer ratio β, or current gain is defined as the ratio $\Delta I_c / \Delta I_B$ under a.c signal conditions.

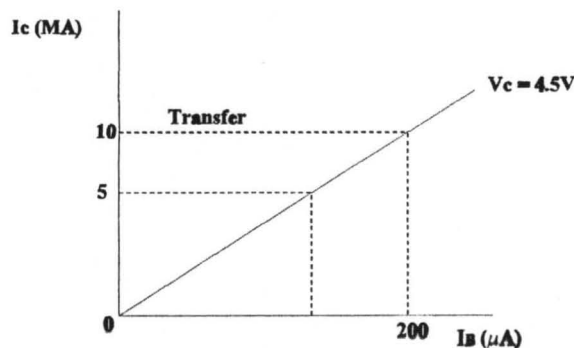It should be distinguished from the d.c current gain, I_C/I_B, from the following figure,

FIG. 13 TRANSFER CHARACTERISTICS

$\beta = (10 - 5)/(200 - 100) \, \mu A$

$= 50$

Input Characteristics (I_B - V_B, V_c constant)

The input resistance r_1 is defined as the ratio $\Delta V_B/\Delta I_B$. Since it is a non linear curve, r_1 varies. At any point of the curve, r_1 is equal to the gradient of the tangent to the curve and is of the order of kilohms.
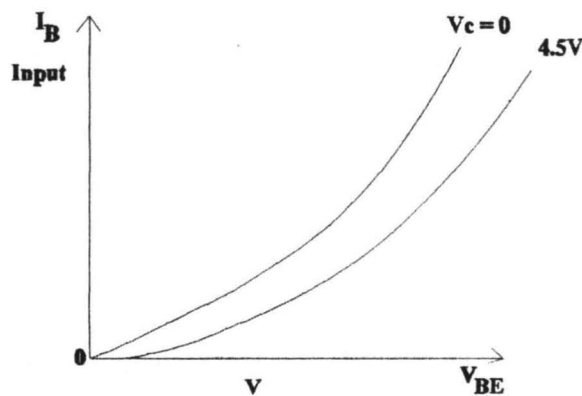
FIG. 14

Current Amplification in Common Emitter Mode

In general, the magnitude of β, $\Delta I_C/\Delta I_B$, for the common emitter circuit is high from about 20 to 500 for many transistor, thus the base current is a sensitive control over the collector current. We can obtain a rough value for β by assuming that when electrons, are emitted from the n- emitter towards the P-base, a constant fraction α reduces the n-collector where α is typically 0.98. Thus I_C = i.e. $\alpha^* I_E$

Now $I_E = I_C + I_B$

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```pascal
        Exercise;
        val(Copy(lin,1,1),j,ecode);
        case j of
         1: Begin
               Press;Initialize;i:=3;
               Draw37;Initial('Measurement of velocity of sound by kundt s tube');
             end;
          else
         Begin
         if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
         end;
         end;
         if i = 16 then
           Begin
             Press;
             i := 3;
             Initial('Measurement of velocity of sound by kundt s tube');
           End;
      End;
    Close(Datfile);
End;


Procedure three4;
begin

  Initial('Experiment Four');
  Assign(Datfile,'exp4.txt');
  Reset(Datfile);
  i:=3;
  While not eof(Datfile) do
    Begin
        Exercise;
        val(Copy(lin,1,1),j,ecode);
        case j of
         1: Begin
               Press;Initialize;i:=3;
               Draw41;Initial('The Transistor');
             end;
         2: Begin
               Press;Initialize;i:=3;
               Draw42;Initial('The Transistor');
             end;
         3: Begin
               Press;Initialize;i:=3;
               Draw43;Initial('The Transistor');
             end;
         4: Begin
               Press;Initialize;i:=3;
               Draw44;Initial('The Transistor');
             end;

          else
         Begin
         if copy(lin,1,1) <> '@' then Outtextxy(1,i*25,Lin);
         end;
         end;
         if i = 16 then
           Begin
             Press;
```

```pascal
        line(340,250,310,250);
        line(350,280,420,280);
        line(250,280,190,280);
        line(250,260,190,260);
        Settextstyle(0,0,1);
        OuttextXY(200,80,'+');
        OuttextXY(400,80,'-');
        OuttextXY(360,320,'-');
        OuttextXY(260,320,'+');
        OuttextXY(350,340,'P1');
        OuttextXY(240,340,'P2');
        OuttextXY(190,200,'R');
        OuttextXY(420,200,'R');
        OuttextXY(360,130,'G2');
        OuttextXY(270,130,'G1');
        OuttextXY(300,160,'T');
        OuttextXY(430,280,'5');
        OuttextXY(180,280,'1');
        OuttextXY(180,260,'2');
        line(270,175,330,175);
        line(270,185,330,185);
        OuttextXY(300,200,'4');
        OuttextXY(300,250,'3');
    Press;
End;


Procedure Draw13;
Begin
        Initialize;
        line(200,150,300,150);
        line(340,150,440,150);
        circle(320,150,20);
        line(310,160,330,140);
        line(330,140,330,145);
        line(330,140,325,140);
        line(440,150,440,300);
        line(440,300,330,300);
        line(310,300,200,300);
        line(200,300,200,150);
        line(250,150,250,200);
        line(250,200,280,200);
        line(320,200,390,200);
        line(390,200,390,150);
        line(310,285,310,315);
        line(330,295,330,305);
        line(200,230,195,235);
        line(200,230,205,235);
        line(250,170,245,165);
        line(250,170,255,165);
        for i := 0 to 3 do
        Begin
            line(280+(i*10),200,290+(i*10),210);
            line(290+(i*10),200,290+(i*10),210);
        End;
        Settextstyle(0,0,1);
        OuttextXY(180,230,'C');
        OuttextXY(315,120,'G');
        OuttextXY(300,220,'S');
        OuttextXY(260,170,'Cs');
        OuttextXY(270,140,'Cg');
```

```pascal
      OuttextXY(300,310,'+');
      OuttextXY(340,310,'-');
   Press;
End;


Procedure Draw31;
Begin
   SetLineStyle(SolidLn,0,ThickWidth);
   line(320,50,220,250);  line(220,250,420,250);
   line(420,250,320,50);  SetLineStyle(SolidLn,0,NormWidth);
   line(160,180,267,150);SetLineStyle(DottedLn,0,NormWidth);
   line(160,180,400,112);SetLineStyle(SolidLn,0,NormWidth);
   line(267,150,380,170);line(380,170,500,230);
   SetLineStyle(DottedLn,0,NormWidth);line(500,230,310,135);
   SetLineStyle(SolidLn,0,NormWidth);  line(220,110,310,178);
   line(430,160,320,180);  settextstyle(0,0,2);
   Outtextxy(310,30,'A');  Outtextxy(200,260,'C');
   Outtextxy(430,260,'B');  settextstyle(0,0,1);
   Outtextxy(160,190,'P1');  Outtextxy(210,170,'P2');
   Outtextxy(200,90,'N1');  Outtextxy(267,160,'O');
   Outtextxy(440,155,'N2');  Outtextxy(480,210,'P4');
   Outtextxy(430,185,'P3');  Outtextxy(400,170,'e');
   Outtextxy(370,180,'M');   Outtextxy(297,160,'r');
   Outtextxy(240,140,'i');   arc(267,150,136,199,15);
   Outtextxy(340,135,'d');   arc(310,135,340,10,25);
   arc(267,150,330,350,28); arc(380,170,340,10,15);
   settextstyle(Triplexfont,0,4); Setcolor(Yellow);
   Outtextxy(100,350,'REFRACTIVE INDEX OF A PRISM');
   Setcolor(White); Key:=Readkey;
   Press;
End;


Procedure Draw32;
Begin
   line(200,100,500,100);
   line(200,150,500,150);
   line(200,100,200,430);
   line(300,100,300,430);
   line(400,100,400,430);
   line(500,100,500,430);
   settextstyle(0,0,3);
   Outtextxy(240,110,'i');
   Outtextxy(340,110,'r');
   Outtextxy(440,110,'d');
   settextstyle(0,0,2);
   for i := 1 to 7 do
      Outtextxy(210,120+(i*40), Dat[i]);
   Press;
End;


Procedure Draw33;
Begin
   line(250,100,450,100);
   line(250,150,450,150);
   line(350,100,350,300);
   settextstyle(0,0,2);
   Outtextxy(270,110,'Sin i');
   Outtextxy(370,110,'Sin r');
```

```pascal
    Press;
End;

Procedure Draw37;
Begin
     Initialize;
     ellipse(150,120,0,90,100,20);
     ellipse(350,120,90,180,100,20);
     ellipse(150,120,270,360,100,20);
     ellipse(350,120,180,270,100,20);
     bar(245,150,255,210);
     bar(120,175,350,185);
     bar(350,160,352,200);
     bar(500,160,502,200);
     bar(500,175,600,185);
     line(300,160,520,160);
     line(300,200,520,200);
     settextstyle(0,0,1);
     outtextxy(180,160,'R');
     outtextxy(260,150,'c');
     outtextxy(350,150,'B');
     outtextxy(380,150,'k');
     outtextxy(540,160,'P');
     line(120,240,348,240);
     line(352,240,500,240);
     settextstyle(0,0,2);
     outtextxy(230,235,' l ');
     outtextxy(400,235,' d ');
     k := 0; v := 332;
     repeat
     v := v + 18;
     k := k + 1;
     x := v + 18;
     for i := 1 to 5 do
          line(v+(i*4),180-(i*3),v+(i*4),180+(i*3));
     for i := 1 to 5 do
          line(x+(i*4),160+(i*3),x+(i*4),200-(i*3));
          v := v + 18;
     until k = 4;
     Press;
End;


Procedure Draw41;
Begin
     Initialize;
     line(100,150,500,150);
     line(500,150,500,225);
     for i:= 1 to 4    do
          line(485,205+(i*20),515,205+(i*20));
     for i:= 1 to 8    do
          line(495,215+(i*10),505,215+(i*10));
     line(100,150,100,220);
     line(100,280,100,350);
     for i := 0 to 3 do
     Begin
          line(100,220+(i*15),110,235+(i*15));
          line(110,235+(i*15),100,235+(i*15));
     End;
     line(400,150,400,220);
     line(400,280,400,350);
```

```pascal
    for i := 0 to 3 do
    Begin
        line(400,220+(i*15),410,235+(i*15));
        line(410,235+(i*15),400,235+(i*15));
    End;
    line(500,300,500,350);
    line(100,350,500,350);
    line(350,350,350,320);
    line(350,300,350,220);
    circle(350,310,10);
    line(350,220,335,220);
    line(315,220,300,220);
    circle(290,260,20);
    circle(325,220,10);
    line(300,220,300,240);
    line(300,280,300,350);
    line(300,240,280,250);
    line(280,250,280,270);
    line(280,270,300,280);
    circle(250,260,15);
    line(265,260,280,260);
    line(235,260,200,260);
    line(160,260,120,260);
    for i := 0 to 3 do
    Begin
        line(160+(i*10),260,170+(i*10),270);
        line(170+(i*10),260,170+(i*10),270);
    End;
    Settextstyle(0,0,1);
    OuttextXY(505,210,'+');
    OuttextXY(180,250,'R');
    OuttextXY(120,270,'R2');
    OuttextXY(245,260,'MA');
    OuttextXY(275,250,'B');
    OuttextXY(310,240,'C');
    OuttextXY(310,280,'E');
    OuttextXY(420,260,'R1');
    OuttextXY(345,310,'V');
    OuttextXY(330,310,'+');
    OuttextXY(316,215,'MA');
Press;
End;


Procedure Draw42;
Begin
    Initialize;
    line(200,150,200,400);
    line(200,400,450,400);
    ellipse(350,400,90,180,150,100);
    ellipse(350,400,90,180,150,140);
    ellipse(350,400,90,180,150,180);
    settextstyle(0,0,1);
    outtextxy(180,150,'Ic');
    outtextxy(210,150,'Output');
    outtextxy(450,410,'Vce');
    outtextxy(360,220,'Ib = 100');
    outtextxy(360,260,'80');
    outtextxy(360,300,'60');
Press;
End;
```