DEVELOPMENT OF COMPUTERIZED TECHNICAL DRAWING LEARNING DESK FOR SECONDARY SCHOOLS.

BY

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(MEE / 97 / 9769)

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTERS OF ENGINEERING (M. ENG) IN PRODUCTION ENGINEERING

JUNE 2006

CERTIFICATION

We certify that this project was carried out by Omotoso, Olufiropo Abiye in the Department of Mechanical Engineering and Engineering Technology, Federal University of Technology, Akure, in partial fulfillment of the requirement for the award of Masters of Engineering (M. Eng) in Production Engineering.

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DEDICATION

This project is dedicated to my wife, Bukola and my children for their endurance and encouragement throughout the duration of this course.

ACKNOWLEDGEMENT

To God be the glory, for making this project work a success. My special gratitude goes to my project Supervisor, Engr. Professor Adeyemi Aderoba for the fatherly role he played and the thorough supervision he gave during the entire duration of the programme. My thanks to my head of department, Dr O. P. Fapetu for giving the opportunity to be a partaker in the programme and his cooperation throughout the duration of the entire programme. All the lecturers in the Mechanical Engineering Department deserve my thanks and commendation because they are all wonderful lecturers.

Finally, I remain grateful to everyone associated with my success and achievement in life.

OMOTOSO O. A.

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ABSTRACT

The study involves the development of a technical drawing software package called T.D. BASICS for the teaching and learning of technical drawing at secondary school level. A modular approach was adopted using the computer as medium of instruction. T.D BASICS is an individualized learning form of programs arranged in sequential order and broken down into small tasks or activities for the leaner to progress at his or her own rate.

The technical drawing software package is divided into two lessons. Lesson one; Technical Drawing Basics. Lesson two; Geometry Lesson one presents a check list of what a student of technical drawing should learn for effective drawing. These are;-Uses and care of drawing instruments, lines and lettering techniques, board practice, freehand sketching, dimensioning and notation. Lesson two presents in detail the technique associated with geometric constructions. It covers both the plane and solid geometry. Each lesson is divided into a number of modules programmed in a logical step by step order from simple to complex for use at all levels of the secondary school educational setting (JSS1 – SSS3).

The objectives for each module are outlined at the beginning to give an insight into the expected learning outcome. Questions are equally provided at the end of each module for student evaluation. The software was developed with visual basic programming language. T.D BASICS was found to be useful in the teaching and learning of technical drawing and as a self-educator. The application software is fully interactive and user friendly. It runs on Microsoft windows operating system.

CHAPTER ONE

INTRODUCTION

The current educational system in Nigeria has, as one of its novel elements, the introduction of pre-vocational and vocational subjects into the secondary school system. The pre-vocational subjects are offered during the first three years of secondary schooling while the vocational subjects are offered during the last three years of secondary schooling. In all a Nigerian child is expected to have had six years of exposure to vocational education before completing secondary schooling. These six years are partitioned into two tiers. Three years of junior secondary schooling and three years of senior secondary schooling.

The national policy on education (federal republic of Nigeria, 1989) describes the junior secondary level as both academic and pre-vocational. This means that all the basic subjects which would enable pupils to acquire further knowledge and develop skills are taught in the junior secondary school. The pre-vocational subjects currently offered (Federal Ministry of Education 1985) include introductory Technology, practical Agriculture, Home Economics and Business studies.

Introductory technology as a course comprises technical drawing, metal work applied electricity/ Electronics, wood work, Auto-mechanics and building work. In the senior secondary school courses such as metal work Auto mechanic, applied electricity, wood work, Technical drawing, etc are offered and taught separately.

Vocational education viz-a-viz technical drawing according to the National Policy on Education (1989 revised) is designed to accomplish the following objectives among others:

- To enable the student to acquire the basic knowledge of engineering.
- To develop basic skills in the Engineering education.
- To prepare students for further training in Engineering
- To provide orientation and basic skill with which to start a life work for those who may not undergo further training.
- To provide basic skill for personal use in future.
- To relate the knowledge and skills to the national economy.

Evidently, the most important goal which the National policy set out to achieve is to make education both functional and utilitarian. Like a nation poised to break away from its colonial past. The opening paragraph of the policy stated that the Federal Government has adopted education as an instrument per excellence for national development. Further on the policy described education as the surest route to technological, industrial, social, economic and political development.

Unfortunately the state of vocational education in Nigeria secondary schools today exemplifies more than any other, the dilemma of a country at the cross roads. A country desiring to take its place among the country of the developed nations but unable to get it's acts together in stimulating a national consciousness that can propel self – motivated development.

Vocational education is perhaps one of the most critical aspects of our educational system, which needs to be supported by active research. At least two explanations can be proffered for this assertion. First, vocational education has been a misconceived area of the educational systems since the days of the early missionaries. Also the importance of vocational education was only realized after independence and thus given prominence in the National policy on Education. Therefore, research in vocational education in Nigeria is a relatively recent phenomenon and the problems that have accumulated over the years must be solved quickly, through research to pave way for progress in the area.

The Nigerian National Education policy with reference to Technical drawing (Vocational Education) compares favourably with any educational policy in other developed countries of the world. Unfortunately the implementation is faulty not only at the secondary school level but also regrettably at the higher institutions – with specific reference to the propagation and teaching of the concepts of technology in Nigerian higher institutions of learning.

Technical drawing as one of the vocational subjects offered in secondary schools have not been accorded the necessary recognition at this level of education. The teaching and learning of the subject is been hindered by a lot of problems, which needs urgent solution. Today our contemporary schools have left undone those things, which they ought to have done. In many secondary schools, there are no qualified technical drawing teachers; no appropriate textbooks or instructional materials, there are no technical drawing rooms. Where there is provision for technical drawing lesson on timetable, the period is usually earmarked as free period for relaxation or playtime for students. Technical drawing is a laughing stock to many secondary school administrators and teachers alike. Despite the laudable National Education Policy objectives concerning the compulsory implementation of the subject in junior secondary schools (introductory technology) and senior secondary schools, there is a low priority for it at those levels of education. Superior status is ascribed to science education including mathematics at the expense of technical drawing.

1.1 The Role of Technical Drawing in Technology and Engineering

1.1.1 Concept of technical drawing

Technical drawing according to Hart (1972), is the principal means of communication in engineering. It is the method used to impart ideas, convey information and specify shape, and is often said to be the language of the engineer. It is an international language and bound like any other language by rules and conventions. These may vary slightly in detail from country to country but the underlying basic principles are common and standard.

Elekwa, et al (1983) defined drawing as a universal language used for communication among technical people. These are engineers, technicians, draughts men, etc.

Technical drawing according to Fadakini (1995) is generally a special study in the fields of technology and engineering which greatly enhances clear communication through technical graphics. Technical drawing is very important in technology and engineering due to it generic and inevitable application in engineering graphic design and communication. One cannot stress the importance of technical drawing fully without linking it with these two related disciplines that really give it that high recognition. Hence, technology and engineering, which demand the study of technical drawing are discussed here in relation with each other to reveal the essential of technical drawing in engineering graphic communication.

1.1.2 Technology

Technology has a wide meaning. Adejuyigbe (1998) sees technology as the study, mastery and utilization of manufacturing and industrial methods, systematic application of knowledge to practical tasks in industry Olaitan (1996) defines technology as the use of products of creativity, inventions and scientific research in the service of man. Jackson (1970) sees technology as the process of applying scientific principles to the achievement of defined material objectives. Horby (1974) postulates that technology is an "expert application of scientific knowledge in problem solving. Technology therefore means those activities which produce alteration in the material world in order to satisfy human needs easily. Technology simply means skillfully changing the form of natural resources to satisfy human needs. It is difficult to distinguish technology from other activities such as technical drawing in so far as the former relies on the latter.

1.1.3 Engineering

Fadakini (1995) defines engineering as a profession that deals with, the development and services of technology to the benefit of man kind. It is a profession devoted to the development and services of technology for social civilization, comfort, safety, and health of human being in the society. Engineering is the profession that puts power and materials to work for man. Once a scientific principle is understood the next is engineering which translate the scientific discoveries into soft ware for facilitating concrete products or goods for man's comfort.

1.1.4 Technical drawing and technology / engineering

The role of technical drawing in the development of technology cannot be over emphasized. The idea of "technical drawing for technical drawing sake" is as strange in our times as wealth for wealth sake" "science for science sake" and so forth. All human activities must serve mankind if they are not to remain useless and idle occupations. Wealth exists so that man may benefit by it:

science exists in order to be man's guide: technical drawing too must serve some useful purposes and not fruitless pleasure

The input of technical drawing cannot be under estimated in technological development. Experts in the fields of engineering have recognized the contributions of technical drawing to technology and development" without technical drawing and creativity there is no technology: technology is a by-product of creativity". The material aspect technology (machines tools, products apparatus) undergoes a process of design.

From the available literature on technology, we could develop some basic facts about technology. Technology is developed and not necessarily transferred or imported as many people think, people develop technology, when they improve their knowledge, skills and procedures of making and doing things. One of the conditions most favourable to invention is to accommodate knowledge and experience in technical drawing and creativity. Technical drawing is the basis of all engineering disciplines and the foundation of discovery. There is need to provide knowledge in technical drawing, science and technology as integrated study. industrial products are first drawn on paper prior to the mechanical mass production. The design engineer indicates the possibilities of a new product through his creative skills in technical drawing, the scientists creates the knowledge of its realization through the systematic study of natural phenomena or abstract ideals and the engineer/ technology /technician deals with the use of organized skill to the problem.

Leonardo Davinci was the first to suggest graphically the idea of a flying machine and it has taken science and engineering four hundred years to catch up with him. In like manner, the concept of a rocket to the moon was first conceived through drawing Talabi (1979). The relationship between technical drawing and technology could be seen in all objects of our daily use like In all modern architecture, TV sets, bridges, cars, aero plane, etc. Such basic aspects of life as communications transportation, shelter, health, etc would be virtually impossible without the knowledge of the technical drawing.

Most often, one finds it difficult to describe in full detail engineering idea conceived in the mind or the shapes and appearances of engineering structures or goods such as roads bridges, buildings, aero planes, radio, television, motor cars, machine parts, etc in verbal or mathematical expressions except by drawing. Therefore technical drawing is a language developed through the use of technical graphics to describe the shape of objects in technology and engineering.

Technology does not only involve science and mathematics. It relies much on technical drawing skills. The technological concept may require science, but the imagery or creativity is technical drawing. The important relationship between technical drawing and technology is that the later draws on the former. Technological products have to be designed through the knowledge of technical drawing by a design engineer, before they are fabricated. The skill of the design engineer, his ability to imagine and create what is yet to be are all assets to the technological era.

1.2 Importance of Technical Drawing in the Secondary School System.

A basic knowledge of technical drawing is desirable for every student who has passed through a secondary school. Whether he aspires to be a doctor, lawyer, economist, policeman or a man of any other profession, he will need to develop the ability to express himself through simple drawings. A policeman can describe the scene of an accident by means of a simple sketch. A manager can also describe the arrangement of his office with simple drawing.

One of the problems facing the students of engineering and technology in the developing countries is that of inadequate communication in technical graphic language. Every secondary school student intending to choose technology or engineering as a career must be able to develop skill in this distinct mode of communication in order to describe and understand clearly any technical concept. It is an important subject that must be understood by any intending student of engineering, if he intends to function well at his fullest capability in his choice of engineering profession.

1.3 Computerized Learning Desk in Technical Drawing for Secondary Schools

Computerized learning desk in technical drawing for secondary Schools simply means the creating or developing computer software that could be used in the teaching and learning of technical drawing in the secondary school. This software is an individualized self-learning form of programmes arranged in sequential order and broken down into small tasks for the learner to progress at his/her own rate to elicit predetermined responses.

Computer have been performing a vital role in the life of man, especially in the area of education where it is excellently making waves, suffice to say that it is making learning to be more interesting and versatile hence enhances understanding and mastering of the subject matter in our secondary and tertiary schools. Computer as a teaching machine (instructional material) has become something of an ideal concept that allow each student to progress through an entire curriculum at his or her own speed without interference from the teacher or educational institution.

1.4 Objectives of the Research Project

The objectives of the Research work are to:

(a) Develop a technical drawing software that is directly tailored to the need and background of the students for the teaching and learning of technical drawing at secondary school level.

(b) Present in a simple and imaginative form software that is user friendly.

1.5 Research Methodology

A study of teaching and learning of technical drawing in secondary schools was undertaken to proffer solutions to the problems of imparting the knowledge of the subject at this level of education.

A modular approach using the computer as a medium of instruction was adopted. This was followed with the development of technical drawing software package. This software is an individualized self-learning form of programmes arranged in sequential order and broken down into small tasks or activities for the learner to progress at his/her own rate. The code, other wise known as program, consists of language statements, constants and declarations arranged together in a logical manner on the code window. The order in which the code executes depends on the user.

The software for the computerized learning desk in technical drawing for secondary schools was developed using visual basic language. A flowchart relating the activities involved in the project was developed to provide a clear diagrammatic representation of the steps involved in the use of the software.

The application software was test run, it was found to be fully interactive and user friendly. It runs on Microsoft windows operating system and found to be appropriate for the teaching and learning of technical drawing.

1.6 Project Significance

The successful execution of this project work will enable technical drawing students to gain first hand knowledge and relevant technical information. This will go a long way in improving curriculum development for technical education.

CHAPTER TWO

LITERATURE REVIEW

There has been a number of studies that have dealt with the teaching and learning of vocational subjects vis-à-vis technical drawing in our secondary schools. While some have taken a look at the attitudes of students towards technical drawing, some have considered the effects of teachers' characteristics on the performance of students in technical drawing. A number of others laid emphasis on the usefulness of instructional materials in the teaching of the subject. Not many studies however, have so far been carried out on the development of technical drawing soft ware. Never the less, the various studies, which have been carried out on the teaching and learning of technical drawing, will be re-viewed

2.1 Issues in the Teaching and Learning of Technical Drawing

Technical drawing occupies an important position in the sphere of technology in the world. It is both a subject of study as well as an important medium of communication in virtually all levels of engineering.

The important roles assigned to technical drawing in the various disciplines of engineering where technical drawing is required has created awareness in learners of the need for them to attain an adequate level of proficiency in it. Thus the teaching and learning of technical drawing, form an integral part of the technology education process in the country.

In recent times, however, there have been hues and cries over the poor level of mastery and proficiency in technical drawing by learners. Scholars at one time or the other have researched into the performances of students in technical drawing at all levels of our educational system. For instance Ogunmola et al (1979), in their findings describe these performances as indeed very low. These findings per harps prompted the investigation of Oluwaseyi (1981) and Franklin (1992) who both claim that the performances of SSCE candidates in technical drawing are grossly below the average. Each year that the west African Examination council (WAEC) releases the secondary school leaving examination results, students performance in technical drawing shows a progressive decline over that of the previous year (s) so also, at the tertiary level of education students competence in technical drawing has become a major concern and source of worry to experts in the fields of engineering. Even where students claimed to have credit in and distinctions in the technical drawings their actual performance in the subject negates and makes nonsense of such results and certificates.

The teaching and learning of technical drawing have over the years been hindered by a number of problems. A number of experts in the field of engineering and vocational technical education have, over the years, focused attention on different problems associated with technical drawing teaching and learning in Nigerian secondary schools. Olawoye (2000) carried out an investigation into the learning of technical drawing in some of the Nigerian secondary schools and observed that first. there is the need to identify student's problems in the learning of technical drawing. And that, these problems should be ranked according to their degrees of frequency in order to find solutions to such problems. So also Akinsowon in earlier study (Akinsowon: 1985) carried out a nation wide study into the problems of teaching and learning of technical drawing in some Nigerian tertiary institutions. Among his findings, is that the correct principles are not observed from the outset of drawing.

There is no doubting of the fact that the teaching and learning of technical drawing in Nigeria is bedeviled by various problems. These problems ranges from those inherent in the technical drawing itself to others associated with the learners and still others which are related to the teaching process including teachers.

Lanworys (1969) noted that no educational system can be higher than the teachers because the strength of any educational system largely depends on the effectiveness of its teachers. However enlightened the aims, however up to date and generous the equipment, however efficient the administration, the value of education to the learners is determined by the teacher. One of the problems of teaching and learning technical drawing is the issue of teachers with inadequate mastery of the subject. Mayock (1982) has observed that teachers who teach technical drawing at the secondarv school level are not the best one can find. In his submission, he noted that in very many cases they are tne most in experience and less qualified teachers who handle the teaching of technical drawing at the secondary school. Okoro (1980) among other scholars discovers that teachers nowadays contribute to the declining performance of students in technical drawing. His findings which confirms the submission of Mayork (1982) reveals that there are teachers whose methods of teaching can be described as obsolete. Apart from this, he argues that the levels of academic attainment of some do not in anv wav measure up with the demands of the new educational system. He there fore blames the teacher being inadequately prepared to teach according to the demands of today's educational standard while Ojetayo (1985) agrees with the notion that teacher's poor academic background in technical drawing can hinder his performance in the subject he is equally of the opinion that the technical drawing teachers of today lack the necessary commitment and the necessary dedication to their job as it used to be.

As a result of the teachers' poor ability in the subject, they do not follow the teaching of technical drawing in the appropriate order. The four areas of technical drawing VIZ technical drawing fundamentals, plane geometry, solid geometry and engineering aspects are either presented in the wrong sequence or everything is lumped together from the learners first week at school. The use of the wrong methodology by teachers also contributes to learner's inability to understand technical drawing. With the faulty foundation being laid at this level where most students have their first encounter with the learning of technical drawing learners start learning wrong things which become very difficult to correct in future.

Another contributing factor to student poor performance in technical drawing is the students themselves. Apathy is a general feeling towards technical drawing by some students who are of the opinion that technical drawing is a daemon intractable to students. Working on the issue of low student enrolment in technical drawing in the secondary schools, Thomas (1971) commuted that many students were not aware of what the study of technical drawing entails, and consequently did not enroll in the subject. He also found that the reputation technical drawing has as a difficult and sophisticated course of study, contributed to student refusal to enroll in the subject.

Coupled with inadequacies on the part of the teachers and the lukewarm attitude of the students is the problem of teaching and learning technical drawing. In some cases relevant texts and instructional materials are in insufficient quantities, thereby making them unaffordable to parents. Fadakini (1995) in his book pointed out that the lack of appropriate indigenous text books on the subject that are directly tailored to the needs and background of the students is one of the problems facing the students of engineering and technology in the developed countries.

The end result of the problems highlighted above is that learners leave secondary school with a poor and shaking foundation in technical drawing. Thus there can be no doubt that the continued poor performance of engineering students in Technical drawing examinations has its origin in the poor foundation laid at the secondary school level. However students have better chances to study' technical drawing with appropriate instructional materials to supplement the classroom teaching.

Technical drawing teaching and learning in Nigeria suffers from a dearth of instructional materials and equipment. Vital instructional materials for teaching are unavailable because the nation can no longer afford to import from other countries since it has become very expensive to do so. Secondly importation of teaching materials can hardly be justifiable in a country that is committed to the goals of self-reliance and self-sufficiency. Alternative ways of developing the needed instructional materials within the country therefore has to be examined. The Nation cannot achieve technological and industrial greatness through the use of obsolete instructional materials in teaching and learning or training for occupations.

2.2 The Role of Instructional Technology Vis – A - Vis Computer in the Teaching and Learning of Technical Drawing in our Schools and Colleges.

2.2.1 The concept of instructional technology

Brown Lewis and harceload (1977) presented a definition of instructional technology as a systematic way of designing, carrying out and evaluating the total process of learning and teaching, in terms of specific objectives based upon research in human learning and communication and employing a combination of human and non human resources to bring about more effective instruction. Instructional technology is a field involved in the facilitation of human learning through the systematic identification, development, organization and utilization of a full range of learning resources and through the management of these resources. Instructional technology according to

Lumsdaire (1967) is grouped under 3 categories. These are:-

i Instructional Technology 1

ii Instructional Technology 2

iii Instructional Technology 3

Instructional technology 1 is what may be regarded as the hard ware or product approach or conception of instructional technology. It refers to the use of media and equipment in teaching – learning process. The emphasis is on the use of varieties of hardware such as radio and television, complex teaching or simulation devices and computer assisted instructional devices at high technology level. In the view of Davies (1978) the hardware conception sees instructional technology as a means of mechanizing or automating the process of teaching with devices that have the potential to transmit, amplify distribute record and reproduce stimulus materials.

Instructional technology (2) is regarded as the soft ware or process approach. It is concerned essentially with the development of learning experience through the application of the sciences of learning. Instructional technology 2 is associated with principles of programmed learning or instruction.

Instructional technology (3) according to Davies (1973) is referred to as the new instructional technology. This tended to reconcile instructional technology (1) and (2) it essentially combined both hardware and software approaches and emphasized the application of systemic or organic rather than rigid or mechanistic procedures. The focus is thus on the application of the concept of system analysis to education so as to enhance and promote efficiency and effectiveness in the teaching – learning process.

The role of computer in the teaching and learning of technical drawing cannot be over emphasized today in our schools and colleges. The contemporary teaching and learning process of engineering in general and technical drawing in particular are characterized by a host of innovations and manipulations. The need to incorporate instructional technology 3 vis-a=vis computer in today's teaching and learning has become imperative in view of its importance in engineering teaching in general and technical drawing in particular.

Computerized instruction is a new dimension to the educational system of Nigeria, emphasizing all other school subjects. Specifically, the application of computer in technical drawing lesson activities is in evitable. In the national policy on education (1977 Revised 1981) instructional technology grouped under educational services (section 10), has the objective of enhancing learning and improving the competence of teachers and also of making learning more meaningful for children. Instructional technology facilitate better understanding, captures more authentic information with a better view of images and general sharpening of intelligence and the teaching and learning process has been in recent times improved by a change in the use of instructional media from using pegs, peddles and beads to using video tape, tape recorders, television and computers.

In teaching learning situation, there is the need to generate or arouse and maintain students interest. Once interest is built up, effective learning is likely to take place. Computerized instruction as noted by Erickson, and Cur (1972) assist in making the learner more alert and attentive. With interest developed in addition to being alert and attentive students would like to follow explanations procedures or exercises sequentially and faithfully so as to comprehend the whole learning episode.

Ighamadu (1992) noted that computerized instruction makes education more productive since it helps to speed up the rate of students learning. In addition to making students learn faster or promote greater acquisition of knowledge computerized instruction also makes them to understand deeper, retain longer and apply accurately what has been learned as compared with other approaches. The use of computerized instruction according to Ighamadu (1992) help to make learning real and more permanent. It create impression that are so vivid and powerful that learners hardly forget experiences they are exposed to through the computer. Other benefits are:

- Capacity building of problem solving in students
- Helping to clarify complex events
- Helping to overcome physical limitations in the teaching and learning environment or situation.

For the giant plan being pursued by the federal government to make vocational education in general and technical drawing in particular a means towards technological break through to materialize a lot of effort and recourses both material and financial must be put in place so that schools and colleges can have access to electronic media.

From the highlighted, it is crystal clear that instructional technology plays a dominant and important role in the teaching learning process. Hence

From the highlighted, it is crystal clear that instructional technology plays a dominant and important role in the teaching learning process. Hence the need for a computerized instruction in the area of engineering in general and technical drawing in particular.

CHAPTER THREE

THE TECHNICAL DRAWING LESSONS

3.1 Lesson One-Technical Drawing Basics

This topic "Technical drawing basics" presents a checklist of what students of technical drawing should learn for effective drawing.

The major areas covered in this topic include: uses and care of drawing instruments, lines and lettering techniques, board practice, free hand sketching and dimensioning and notation, their purpose/applications and regulations.

The topic is divided into five 5 modules with assessment questions provided at the end of each module to test the student knowledge on the area covered in the module. These modules are:

Module 1: Uses and care of drawing instruments

Module 2: Lines and lettering techniques

Module 3: Board practice

Module 4: Freehand sketching

Module 5: Dimensioning and Notation.

The practical problems provided at the end of the topic is for the student to practice by following the examples already presented in the topic.

HOW TO STUDY THIS LESSON

- Study each module presented in this lesson separately;
- As you read through each module try to know the main and important ideas. When you find an unfamiliar word, go to Microsoft word.
- Study each module step by step as they have been arranged for you.
- Do all the self-assessment questions for a chosen module before proceeding to the next.
- To get the best result out of studying this lesson, you should and obey all the instructions and observe all the rules.

3.1.1 Module I-Uses and care of drawing instruments

The purpose of this module is to enable students of technical drawing to gain knowledge of basic drawing instruments and to instruct students of their proper use and care. After they have become familiar with these basic "tools" they can easily acquire skill with more specialized instruments used in technical drawing.

OBJECTIVES

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

- Identify and list the basic drawing equipment and materials
- State the uses of each of these drawing instruments and materials
- Draw the instruments
- Take proper care of these instruments

HOW TO STUDY THIS MODULE

- Read through the whole module in order to get the general idea.
- As you read this module, note any word you find difficult and check for the meaning in the Microsoft Word.
- Study the module by carefully reading it through step by step.
- Answer all the assessment questions at the end of the module.
- Check the answers at the end of the exercise.

Some of the instruments needed in technical drawing are listed below:

- Drawing board
- T – square
- $30^0 - 60^0$ degree triangle (set square)
- 45^0 degree triangle (set square)
- Adjustable triangle

- Protactor
- French curve
- Templates
- Soft rubber eraser
- Dusting brush
- Drawing paper
- Cellotape or clip
- Pencils
- Dividers
- Pair of compasses
- Lead sandpaper

ACTIVITY 1.0-1: DRAWING BOARD

The drawing board is a rectangular piece of good quality wood with a smooth, flat surface. It is used to hold the drawing paper on the smooth at surface. The ends are usually cleaved to prevent warping. Batterns are also fitted at the back to strengthen it.

In addition to a smooth surface, the drawing board must have a straight working edge to serve as a base for the T-square and a reference line for drawing.

There are five standard sizes of drawing boards, namely A^0 = 841 x 1189, A^1 = 594 x 841, A^2 = 420 x 594, A^3 = 297 x 420 and A^4 = 210 x 297. The A^2 - size drawing board measuring 420mm x 594mm is the ideal board for the use of students.

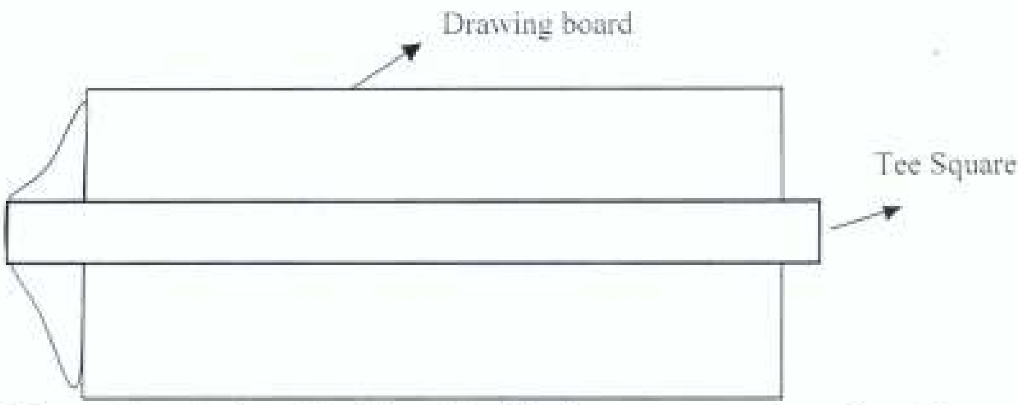


Figure 1: A drawing board with Tee-square placed on top

ACTIVITY 1.1-1: T- SQUARE

The T-square consists of two parts, a head and a blade fastened together, T-square is either made of wood or plastic. T-square range in length between 450mm to 1500mm. The length should be approximately the same as the width of the drawing board being used.

The three major uses of the T-square are:

- To draw horizontal lines
- For placing or setting drawing paper on the board
- To serve as a base for triangles

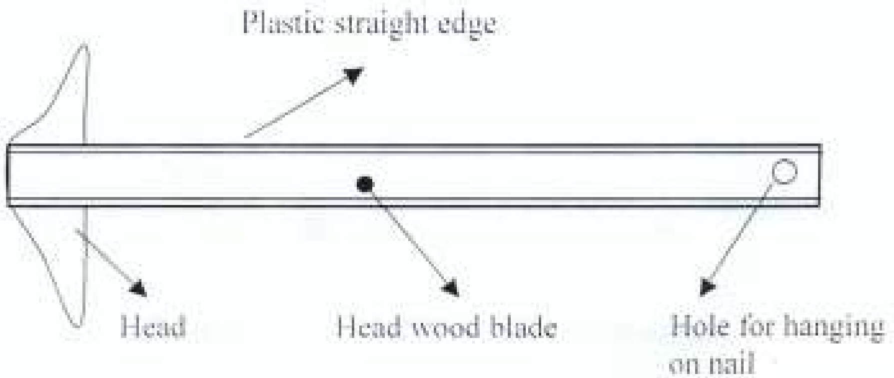


Figure 2: A T-square with transparent plastic edges provides a better view of the work.

ACTIVITY 1.2-1: TRIANGLES (Set squares)

The most commonly used drafting triangles are $30^0 \times 60^0$ degree and 45 degree types. They are made of transparent plastics. figure 3.

Triangles are used to;

- Draw lines perpendicular to those drawn with the tee-square.
- Draw lines that are inclined to vertical or horizontal directions.

Special purpose triangle (adjustable triangle) is used in laying off of any angle from 0^0 to 90^0

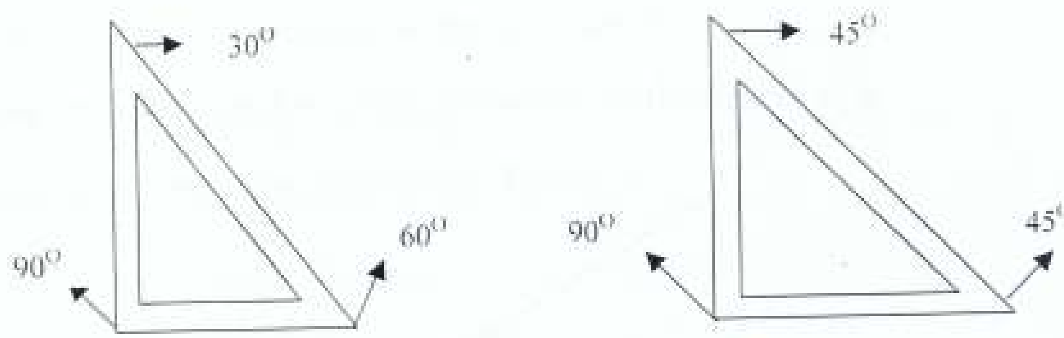


Fig.3 (a) 30^0 – 60^0 triangle Fig.3 (b) 45 degree triangle

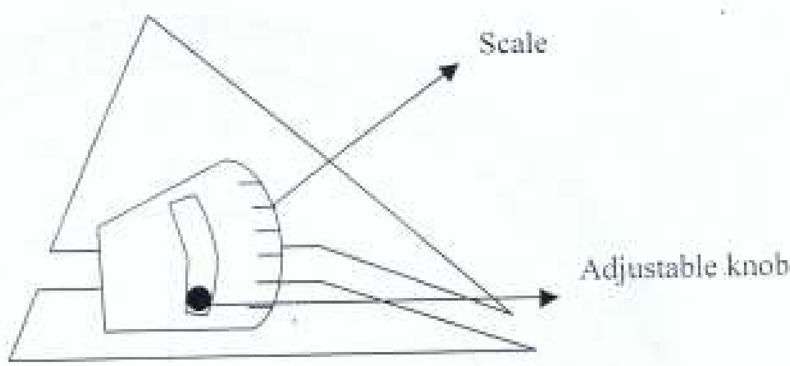


Figure 3 (C) : Adjustable Triangles

ACTIVITY 1.3-1: PROTRACTORS

Protractors are used for measuring or setting off angles other than those obtainable with the triangles. Protractors are made of nickel silver material. It is graduated near the circular edge into angles, from 0^0 – 180^0. The scale is numbered clockwise, from 0^0 – 180^0 and anticlockwise from 180^0 - 0^0 .

Measuring angles with the protractor

- Place the centre 0 of the protractor on the intersection of the two lines that formed the angles figure 4 so that one of the lines coincides with the zero line of the protractor.
- Read from the zero line of the protractor to the degree that corresponds with the other lines. Figure 5.

Figure 4: intersection of the two lines

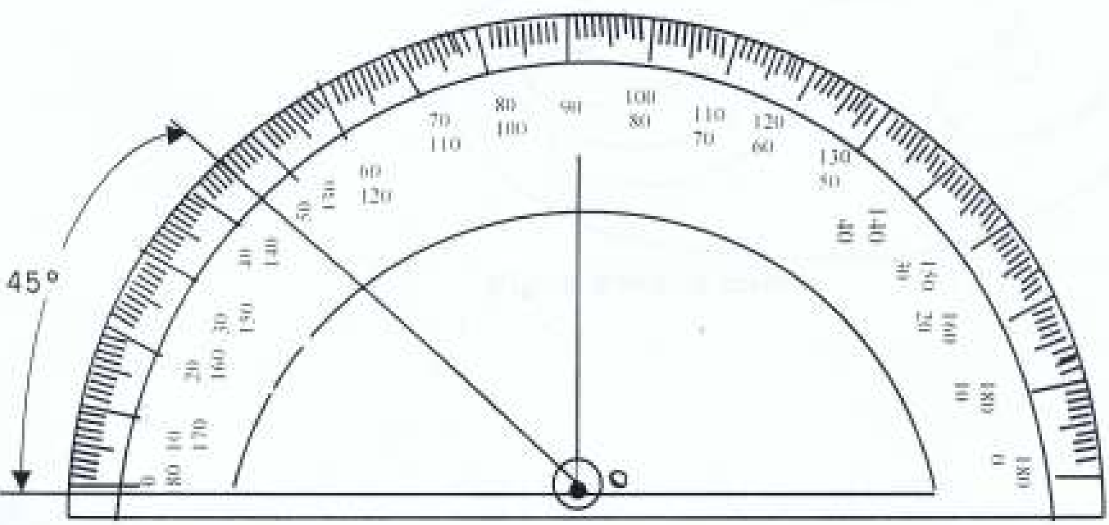


Figure 5: Reading from right to left (anticlockwise) angle θ is 45⁰.

ACTIVITY 1.4-1: TEMPLATES

A variety of templates are available for drawing threads bolts, screws, nuts and head types. Templates are used in drawing to save a great deal of time and to produce more uniform representations of threaded fasters.

Templates are used to save time in drawing.

They are available for drawing circles, ellipses, plumbing fixtures, bolts and nuts, screw threads, electronic symbols, springs, etc.

ACTIVITY 1.5-1: FRENCH CURVES

They are used to draw noncircular curves such as involutes, spirals, ellipses and so forth. In addition, they can be used to plot motions and forces and to make some engineering and scientific graphs. They are made of plastic and come in many different forms.

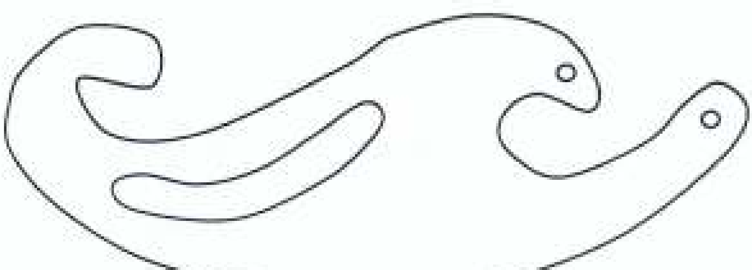


Fig. 6 French curve.

ACTIVITY 1.6-1: **ERASERS**

Erasing is carried out when mistakes do happen or change in existing drawings is to be made. Erasing can be minimized if the drafter can do good work.

Much erasing time and damage to drawings may be saved by drawing all lines first as construction lines and by using the correct grade of pencil.

The two types of erasers used in technical drawing are:

- The firm textured rubber eraser figure 7 for erasing ink lines and
- The soft vinyl eraser for erasing pencil lines and cleaning drawings.

When erasing, the drawing sheet must be held firmly on the drawing board with the free hand while the eraser is rubbed lightly back and forth to erase detail or line. Erasure dust must be removed with dust brush or soft cloth instead of hand as most people do.

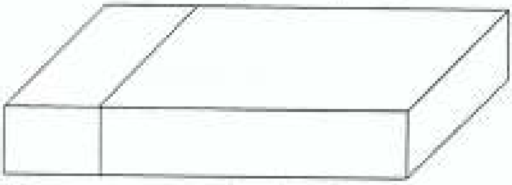


Figure 7: Soft vinyl eraser

ACTIVITY 1.7-1: DUSTING BRUSH

It is useful for removing eraser crumbs without smearing the drawing. figure 8.

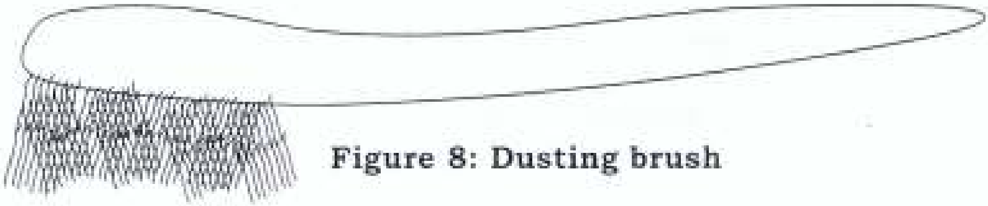


Figure 8: Dusting brush

ACTIVITY 1.8-1: DRAWING PAPERS

Drawing papers are in various sizes as shown in table 1 below:

MILLIMETERS	
SIZE	**DIMENSIONS**
A – 4	210 x 297
A – 3	297 x 420
A – 2	420 x 594
A – 1	594 x 841
A – 0	841 x 1189

Table 1: Showing the Various Sizes of Drawing Sheets

The A^2 size is the recommended type for student of technical drawing.

ACTIVITY 1.9-1: CELLOTAPE OR CLIP

Drawing papers are held on the drawing board with Cellotape or clips. Pins are no longer used because they make holes on the drawing paper and board.

ACTIVITY 1.10-1: PENCILS

Pencils for technical drawing comes in degree of hardness, ranging from HB, which is soft to 9H, which is very hard. For lettering, visible lines, cutting plane lines and freehand sketching, HB or H pencils are used while for other types of lines such as construction lines, hidden lines, centre lines, dimension lines etc. H, 2H, 3H pencils are used. The line thickness produced by a pencil sometimes depends on the pressure applied.

Pencil point for lettering, freehand sketching, circles, arcs and curves, must be sharpened to a conical point figure 9a while pencils for straight lines must be sharpened to a chisel like point figure 9b. The edges are used for drawing lines

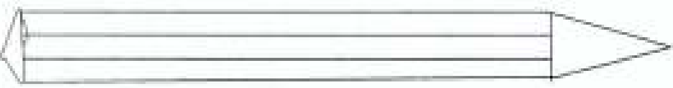


Figure 9a: Pencil sharpened to conical point

Figure: 9b pencil sharpened to chisel like point.

ACTIVITY 1.11-1: PENCIL SHARPENERS AND GLASS PAPER BLOCK

If a lead mechanical pencil is used no sharpening is required since the lead diameter determines the line width. If a wood pencil is used it is necessary to sharpen the end either with a mechanical sharpener or a sharpening knife depending on the shape desired.

Glass paper block is required for maintaining the pencil point at all time.

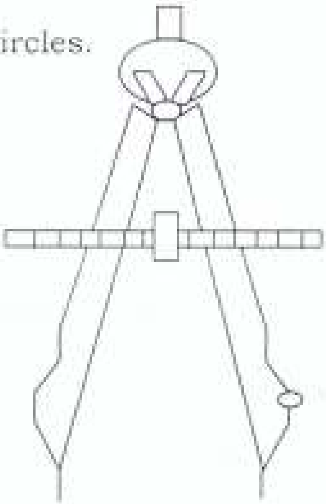
ACTIVITY 1.12-1: COMPASSES

Technical drawing consists of straight lines and curved lines. Most of the curved lines are circles, semi-circles and arcs and they are drawn with the compasses.

The two common types of compasses used in technical drawing are:

(i) The bow compass figure 11a is used for drawing arcs and circles of small radius,can be adjusted for large circles.

(ii) Beam compass figure 11b is used for drawing large arcs and circles.



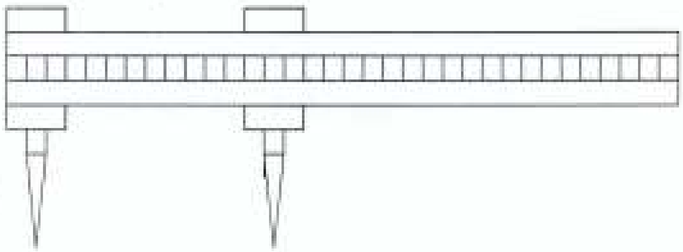


Figure 11b: Beam compass

Figure 11a: Bow compass

ACTIVITY 1.13-1: DIVIDERS

Dividers are used to transfer or step off distances and to divide straight and circular lines into equal parts. Two types of dividers are used extensively in technical drawing. They are:

- Bow dividers - which is the same as the bow compass. The only replacement is the placing an additional point where the lead normally goes.
- Friction joint divider figure 12, which is common with the student mathematical sets.

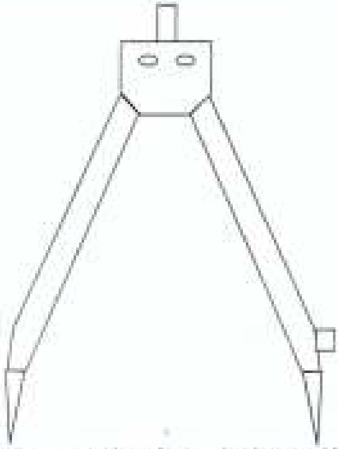


Figure 12: Friction joint divider

ACTIVITY 1.14-1: SCALES

Scales are used for laying off distances and for making measurement, measurements can be full size, or in some exact proportion to full size (i.e. enlarged or reduced). The common type of scale used in technical drawing is the metric scale.

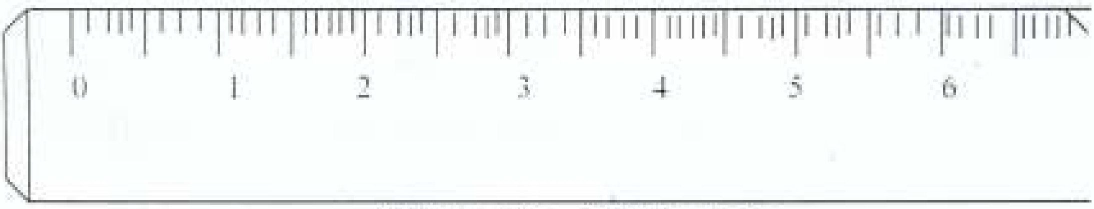


Figure 13: Metric scale.

ACTIVITY 1.15-1: CARE OF DRAWING INSTRUMENTS

(i) Drawing board should not be used for any other purpose

(ii) Pin should not be used on the drawing board except tapes and chips

(iii) The face of the drawing board should be covered when it is not used.

(iv) Sharp object such as razor blade should not be used on edges of drawing instruments like tee-square, set square, French curve,etc.

(v) Tee-squares should not be converted to a walking stick.

(vi) Do not play with drawing instruments so as not to damage them or cause injury to yourself and those around you.

SELF ASSESSMENT QUESTIONS

Read each question carefully. Complete the blank spaces provided by choosing the correct option from the options (A – D) provided for each question.

(1) Drawing board is made of ________ material

(A) Ceramics (B) Rubber (C) Wood (D) Iron

(2) The straight edge of the drawing board serves as a base for ________ instrument.

(A) Set-square (B) T – Square (C) Protractor (D) Compass

(3) The following are standard sizes of drawing board except ________

(A) B^1 (B) A^0 (C) A^1 (D) A^3

(4) The following are the major uses of a T-square except ________

(A) To draw curved line

(B) To draw horizontal lines

(C) For setting drawing paper on the drawing board

(D) To serve as a base for set squares

5) The following are types of triangles except ___________

(A) 60^0 x 70^0 triangle

(B) 30^0 x 60^0 triangle

(C) 45^0 triangle

(D) Adjustable triangle

(6) Type of triangle that can be used in laying off of any angle from $0^0 - 90^0$ is _____

(A) 30^0 x 60^0 triangle

(B) 45^0 triangle

(C) 70^0 triangle

(D) Adjustable triangle

(7) The instrument used for measuring angle is___________

(A) Triangle (B) T-Square (c) Protractor (D) Divider

(8) French curve can be used to draw any of these except ___________

(A) Non circular curves

(B) Plat motion and forces

(C) Make engineering graphs

(D) Perfect triangles

(9) In order to save much erasing time the drafter must ______________

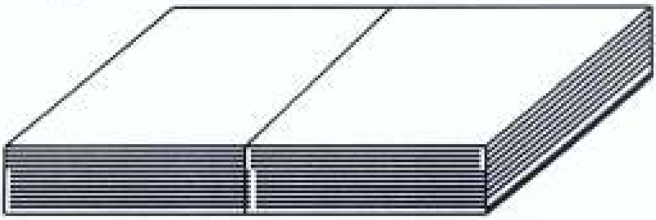
(A) Draw all lines first as construction lines

(B) Draw all lines first as outlines

(C) Draw all lines as hidden lines

(D) Use 2B pencil

(10) The object shown below is a/an



(A) Sharpener (B) Eraser (C) Pencil (D) Crayon

(11) One of the following is an instrument material for holding drawing papers on drawing board

(A) Cellotape (B) Pencil(C) Pin (D) Eraser

(12) The object drawn below represents a /an ________________

(A) Eraser

(B) Pencil

(C) Compass

(D) Divider

(13) The pencil for lettering must be sharpened to ____________ point

(A) Chisel

(B) Conical

(C) Square

(D) Rectangular

(14) A pair of compasses is used to draw all of the following except ___________

(A) Circles (B) Straight lines (C) Semi-circles (D) Arcs

(15) Scales are used for ________ in technical drawing

(A) Laying off distances and making measurement

(B) Drawing circles and arcs

(C) Drawing triangles and arcs

(D) Drawing circles and triangles

ANSWERS TO ASSESSMENT QUESTONS

(1) C	(2) B	(3) A	(4) B	(5) A	(6) D
7) C	(8) D	(9) A	(10) B	(11) A	(12) B
(13) B	(14) B	(15) A			

If your score is up to 60% congratulations, proceed to the next module if otherwise go over the module again

3.1.2 Module 2 – Lines and lettering techniques

This module covers two of the basics that are needed in preparing all types of technical drawings. The major topics covered in this module are lines and lettering techniques. For the attainment of good standard drawing, neat line work and good lettering are essential. Good line work and neat lettering are very pleasing to look at on a drawing.

OBJECTIVES

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

(i) Identify different types of lines

(ii) Apply these lines in drawing

(iii) State the different types of pencil lead grades used for drawing each type of line.

(iv) Carry out good lettering using the single stroke gothic lettering.

HOW TO STUDY THIS UNIT

Read through the whole module in order to get the general idea.

Open to Microsoft word to check the meanings of words you do not understand.

- Answer the questions at the end of the module. Do not look up answers to questions before you answer them.
- To get the best result out of studying this module, you should obey all the instructions and observe all the rules.

ACTIVITY 2.0-1: LINES

Each line on a technical drawing has a definite meaning and is drawn in a certain way.

The line convention used in technical drawing are represented in figure 13 below together with illustrations of various applications.

Two line thicknesses are recommended, thick line 0.7mm wide and thin line 0.3mm wide. There is a good contrast between different kind of lines.

Continuous thick line

Visible Line H. F or HB.

Thin short dashes

Hidden Line 2H or H.

Thin continuous

Section Line 2 H or H

Thin continuous

Projection Line 2H or H

Thin long chain

Centre Line 2H or H

Thin line with arrow heads

Dimension Line 2H or H

Cutting plane line or Viewing plane line. H. F or HB.

Thick long chain

Thick short break line H. F. or HB.

Freehand line for short or limit of partial views

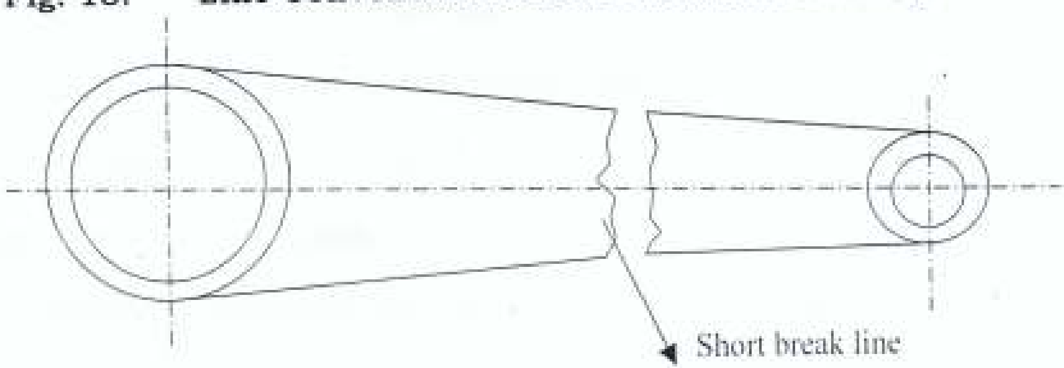
Long break line 2H or H

Thin ruled line with freehand zig zag.

Phantom line 2H or H

Thin for alternate positions, repeated details and paths of motion

Fig. 13: Line Convention used in Technical Drawing



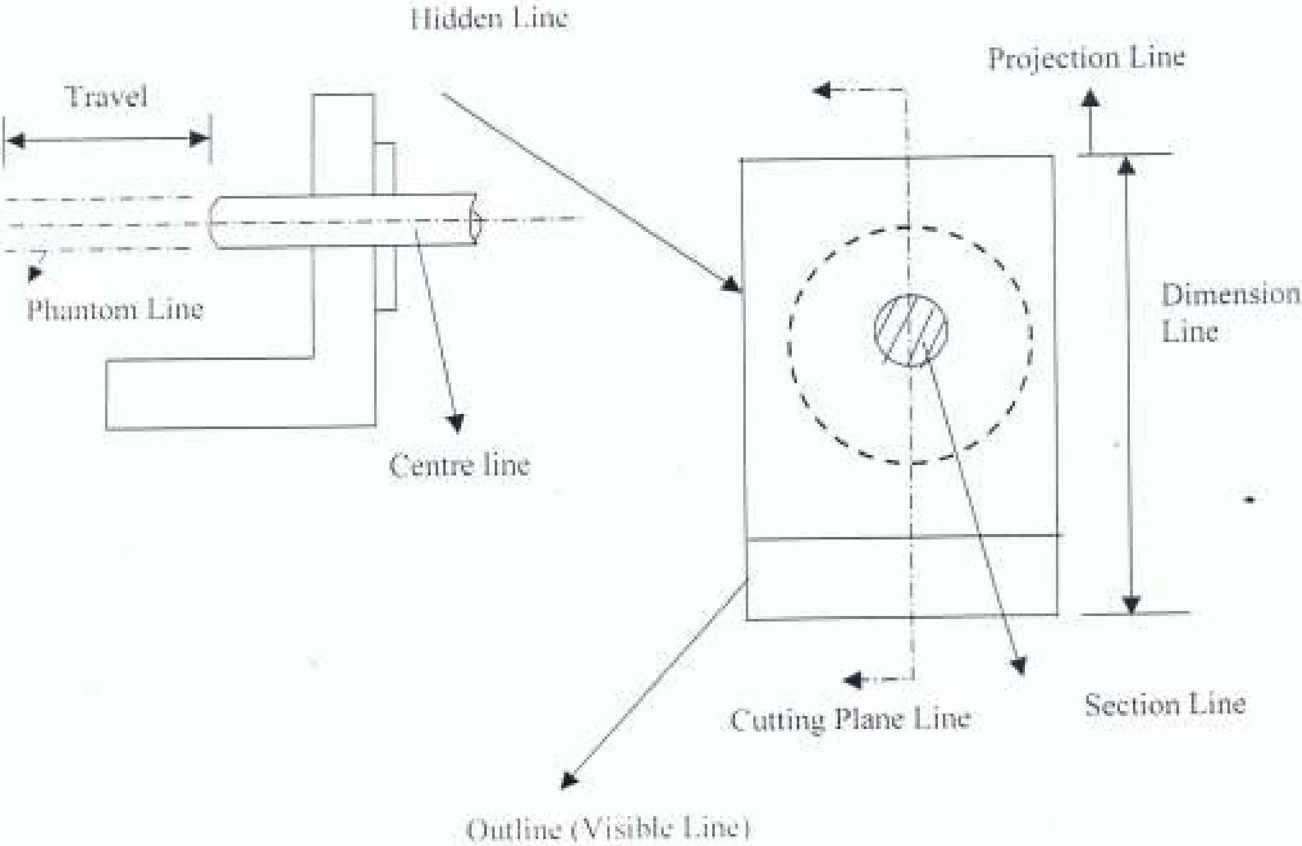


Fig. 13 : Line Conventions used in Technical Drawing.

ACTIVITY 2.1-1: LETTERING

Regardless of the type of lettering adopted in technical drawing, the most important features of good lettering are: neatness, uniformity, stability, speed, proper spacing and above all eligibility.

Lettering in technical drawing consists of dimensions, notes and other data that are best conveyed using alphanumeric characters.

Different ways are used for lettering in technical drawing. These methods are:

- Traditional lettering created by freehand lettering
- Mechanical lettering techniques by scriber templates.

- Type written notation and
- Typed lettering generated by computer.

The focus in this section is on freehand lettering.

There are several lettering styles in technical drawing. The standard style established for freehand lettering on technical drawings is the single stroke Gothic lettering. Gothic letters may be vertical (figure 14a) or inclined slightly to the right figure 14b. The lettering character may be upper or lower case (capital or small letters).

ACTIVITY 2.3-1: GUIDES TO GOOD LETTERING

(i) Pencils for lettering (H or HB) must be sharpened to a conical point.

(ii) Always turn the pencil frequently to a new position in order to wear the lead down uniformly and keep the lettering sharp.

(iii) All vertical strokes should be drawn downward while all horizontal strokes are drawn from left to right.

Light horizontal and vertical guidelines are necessary to regulate the height and width of letters respectively. Hard pencils such as 4H to 6H are used for guide lines because they should be barely visible.

(iv) A mixture of both straight and inclined lettering is not acceptable. It is either straight or inclined lettering.

(v) Space between two letters of a word should be smaller than that between two words.

(vi) Except for brief notes, small letters are rarely used. Each letter or number should be approximately 6mm high with a gap of 3mm or 4mm in between horizontal guidelines.

(vii) For dimensions and notes a character height of about 3mm should be used, and characters should be about the same width.

(viii) Decimal marker used with metric units should be bold, given a letter space and be placed on the base line e.g. 18.07

(ix) Dimensions les than unity should be preceeded by '0' e.g 0.3

(x) In single stroke strike lettering, all the strokes are uniform in thickness and each stroke is produced by one movement of the pencil.

Figure 14a: Pencil strokes for making vertical Gothic upper case letters, lower case and numerals

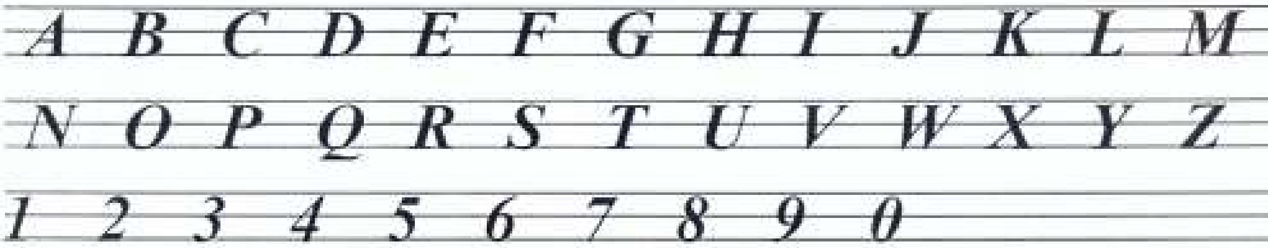


Figure 14b: Pencil strokes for making inclined Gothic upper case (letter and numerals).

ASSESSMENT QUESTIONS

(1) How many line thicknesses are recommended in technical drawing? (A) Four (B)Five (C) Three (D) Two

(2) The type of line used for visible outline is ____________

(A) Thin short dashes

(B) Thin continuous line

(C) Thin long chain line

(D) Continuous thick line

(3) The type of line used for sectioning is __________

(A) Long chain line

(B) Thick long chain line

(C) Thin line with arrow heads

(D) Thin continuous line

(4) Phantom line is drawn with ___________ grade of pencil

(A) 2H (B) 5H (C) 2B (D) 5B

(5) The following are lettering methods except ____________

(A) Traditional lettering created by freehand lettering

(B) Mechanical lettering techniques by scriber templates

(C) Painting

(D) Type writing notation

(6) Lettering may be ________ or ____________

(A) Inclined, Irregular

(B) Vertical, Irregular

(C) Vertical, Inclined

(D) None of the above.

(7) The type of pencil recommended for lettering is __________

(A) 5H (B) 4H (C) 3B (D) HB

(8) Dimensions less than unity should be preceded by _________

(A) 1, (B) 0 (C) A (D) B

ANSWERS TO ASSESSMENT QUESTIONS

1 1. D 2. D 3. D 4. A 5. C 6. C 7. D 8. B

Move to the next unit if your score is 60% and above, if not repeat the study.

3.1.3 Module 3 – Board practice

Drawing board practice involves the correct use of the drawing board and other drawing instruments to produce good and accurate technical drawings.

OBJECTIVES

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

- ❖ Fasten drawing paper on the drawing board with the aid of the T-square.
- ❖ Draw different types of lines such as horizontal, vertical, inclined, parallel and boarder lines
- ❖ Draw different types of title blocks
- ❖ Use some of the instruments to draw certain objects or shapes

HOW TO STUDY THIS MODULE

Read through the module once. When you find any unfamiliar word, go to Microsoft word for the meaning.

- You should study this module step by step as it has been arranged.
- You should do all the exercises you are expected to do at the end of the module.
- Do not look at the answer before answering or attempting the exercise.

Basic board practice procedures in technical drawing are shown below:

ACTIVITY 3.0-1: Procedures for fastening paper to the board

(i) The drawing paper should be placed close enough to the working edge of the board to reduce error resulting from bending of the blade of the T – square.

(ii) Drawing paper should be fixed close enough to the upper edge of the board to permit space at the bottom of the sheet for using the T-square and supporting the arm while drawing.

(iii) Cellotape (drafting tape) should be used for fastening the drawing paper to the board to avoid damage to the paper and the board.

(iv) To fasten the paper in place, the head of the T-square is pressed firmly against the working edge of the board with the left hand, while the paper is adjusted with the right hand until the top edge coincides with the upper edge of the T-square.

(v) Move the T-square to the middle as shown in figure 15 and fasten the upper corners followed by the lower corners. Additional fastening may be required for large paper.

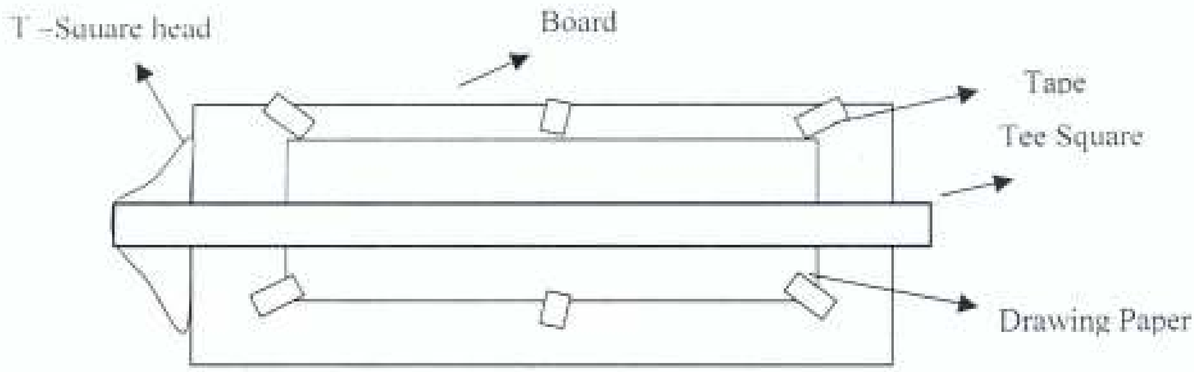


Figure 15: Fasten paper on drawing board.

ACTIVITY 3.1-1: DRAWING HORIZONTAL LINES

(i) The T-square should be tight against the working edge of the drawing board (left hand edge).

(ii) Slide the left hand inward a little so as to press the T-square blade tightly against the paper while the head still maintain the squareness with the drawing board edge.

(iii) With your drawing hand, incline the pencil in the direction of the lines to be drawn and draw figure 16. Rotate the pencil between thumb and fingers slowly to retain a conical point.

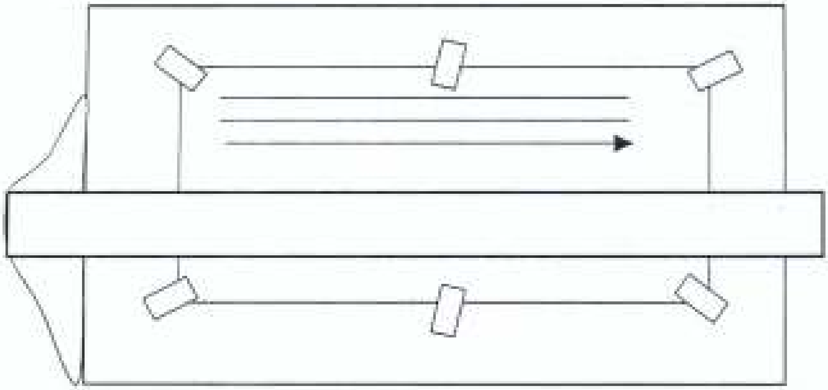


Figure 16: Drawing horizontal lines. The arrow indicate the direction of pencil.

ACTIVITY 3.2-1: VERTICAL LINES

Vertical lines are drawn with the aid of the set square (45^0 or 30^0 x 60^0 triangle)

PROCEDURE

(i) Set the T-square head against the edge of the board and press it with your left hand.

(ii) Place the triangle on the T-square with the vertical edge on the left, and the base resting properly on the blade of the T-square figure 17.

(iii) Press both the blade and the T-square against the board.

(iv) Draw the vertical line upward on the left side of the triangle

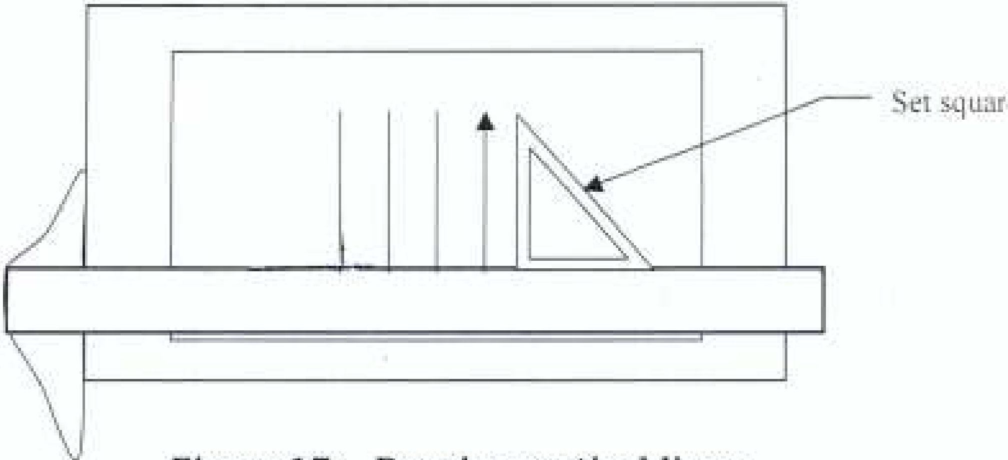


Figure 17: Drawing vertical lines

ACTIVITY 3.3-1: INCLINED/PARALLEL LINES

Inclined lines are drawn either with the aid of T-square and any of the triangles figure 18a or by placing the triangles against each other shown in figure 18b.

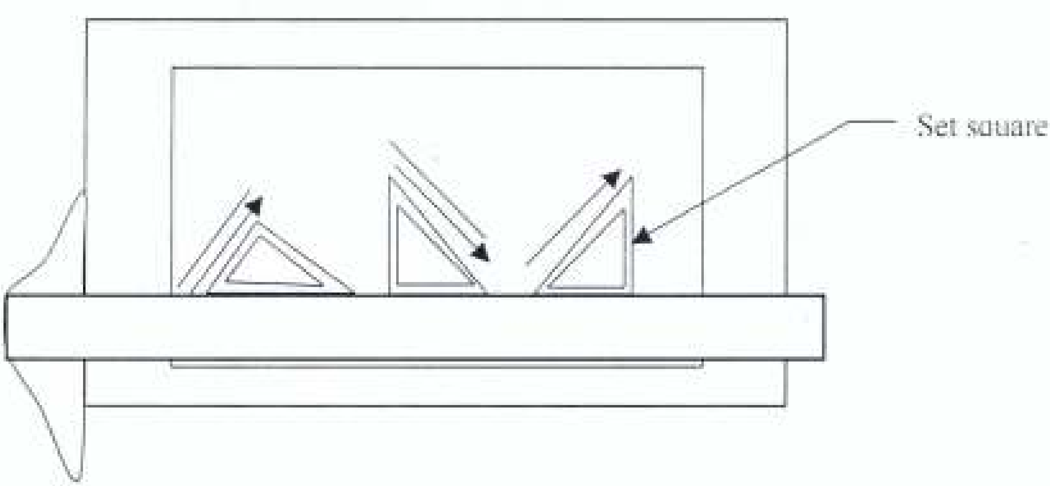


Figure 18a: Showing the various position of the triangles against the T-square in drawing inclined/parallel lines.

NOTE: Either the triangle or the T-square could be adjusted to draw more lines depending on what is desired.

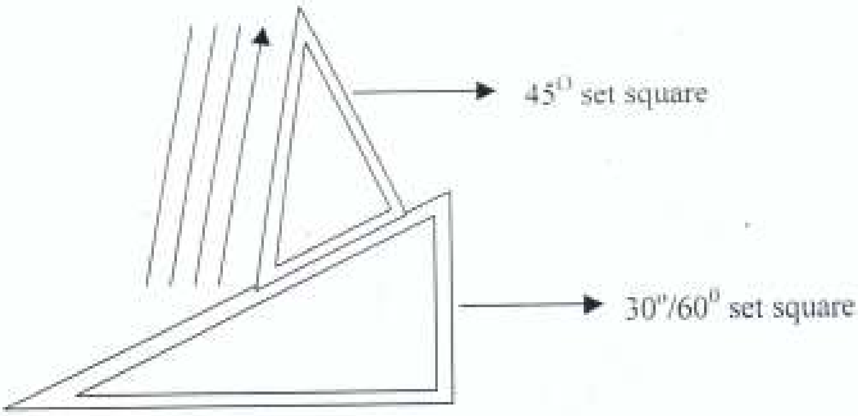


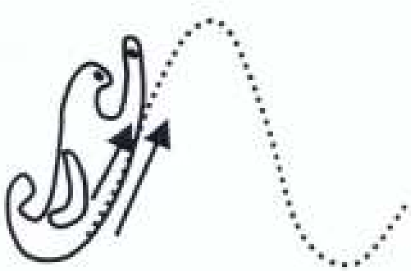
Figure 18b: Drawing parallel lines

NOTE: The lower setsquare is held with the left hand firmly on the board while the upper set square is allowed to slide while the lines are drawn. The position of the setsquares can be interchanged depending on what is desired.

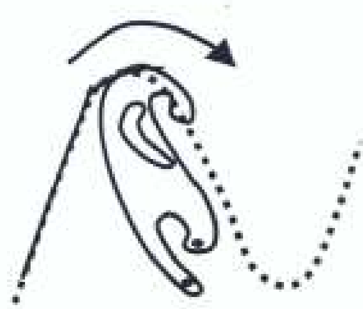
ACTIVITY 3.4-1: IRREGULAR CURVES

To draw irregular curves, a series of points are plotted to accurately establish the curve. The French curve is then matched with three or more points and a segment is drawn at a time until the line is complete.

Figure 19a – e



A



B

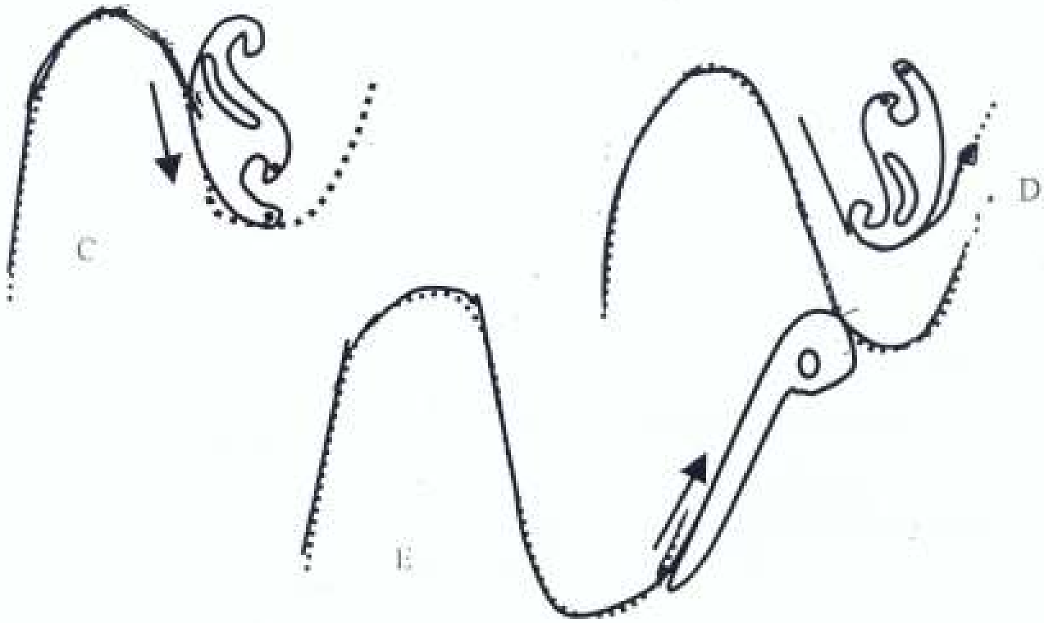


Figure 19 a – e: The use of French curves to draw curve lines

ACTIVITY 3.5-1: TITLE BLOCKS

The title block contains the title of the drawing and other related information such as: Name of drafter, school scale, date, dimensions etc. There are two types of title blocks. These are:

(i) Corner title block figure 20a. It is usually placed at the bottom right corner of the drawing sheet.

(ii) Full-length title block. Figure 20b. It is usually drawn across the length of the sheet at the bottom.

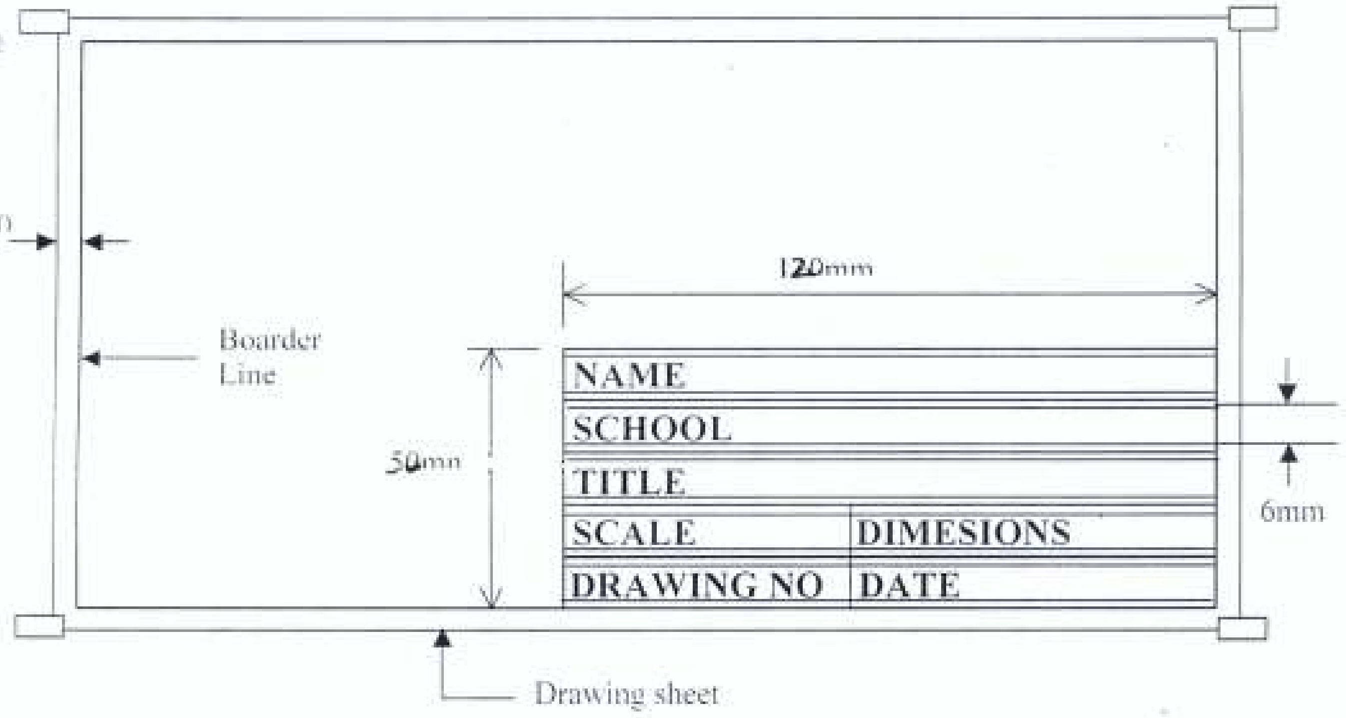


Fig. 20a : Corner Title Block

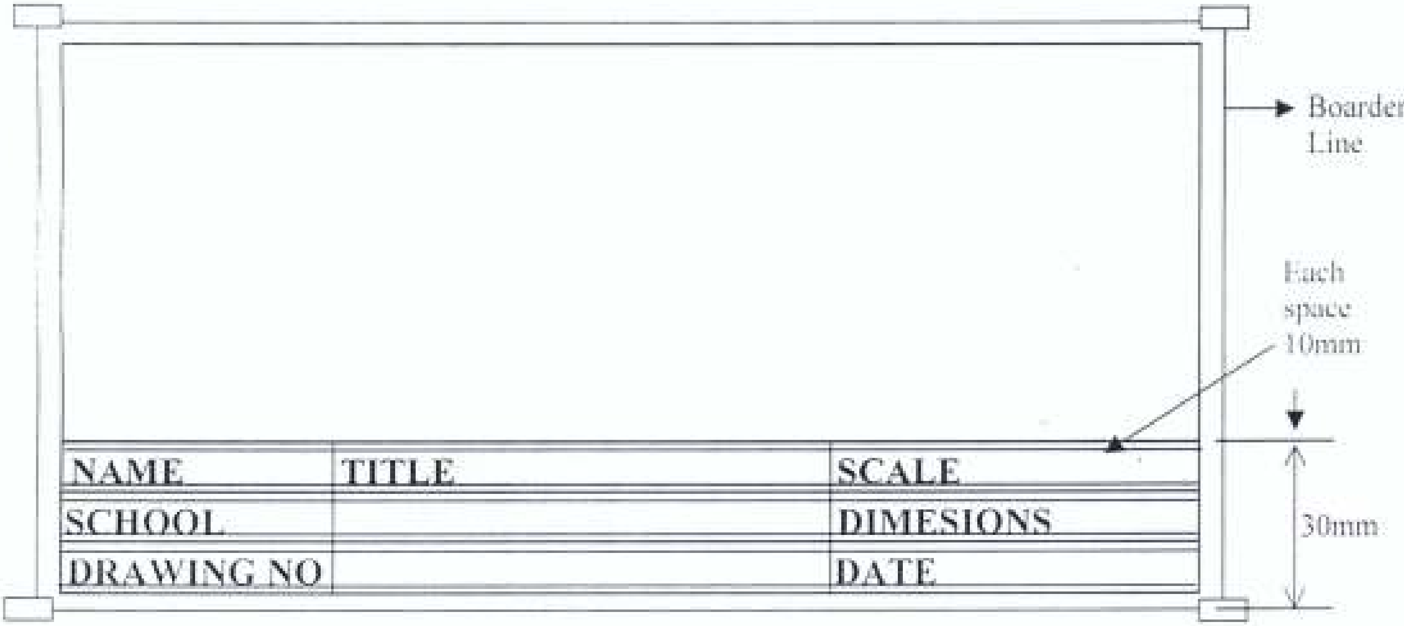


Figure 20b: Full-length title block

- The boarder line is usually drawn in thick continuos line and always 10mm to the edge of the drawing paper.

❖ Upper case characters (capital letters) are preferred to lower case characters in title block.

ACTIVITY 3.6-1: CARE OF DRAWING

Cleanliness in technical drawing is very important and should become a habit. The following precautions should be observed by the technical drawing student, to ensure neatness in drafting:

(i) Hands should be clean at all times. Wet hands should be wiped frequently with a clean cloth.

(ii) Drawing equipment should be frequently cleaned with a clean cloth.

(iii) Sliding of the drawing instruments like T-square, protractor, triangles, French curves,etc on the drawing should be avoided.

(iv) Dusting brush and not hand palm should be used when removing eraser particles from the drawing.

(v) Pencil should not be sharpened over the drawing or any drawing equipment.

(vi) Try as much as possible to avoid resting the hand or any part of the body on the drawing.

(vii) Store completed drawings in a save apartment to prevent damage.

(viii) Layout all views with light lines using a hard pencil. "Heavy–in" lines only when all parts are correct.

(ix) Use a paper overlay to cover completed parts of the drawing.

SELF ASSESSMENT QUESTIONS

(1) Why should drawing paper be placed close enough to the working edge of the board________

(A) To reduce error (B) Increase error (C) To prevent the paper from falling off the board (D) To prevent warping.

(2) What must be used to fasten the drawing paper on the board?

(A) Pin (B) Compass (C) Divider (D) Cellotape

(3) The hand that is used to press the T-square head against the working edge of the drawing board is ____________ hand

(A) Right (B) Left

(4) The instrument used for drawing horizontal line is ______________

(A) Divider (B) Compass (C) Protractor (D) T-square

(5) Why must the pencil be rotated between thumb and fingers when drawing? ____

(A) To maintain a conical point (B) To relief the fingers from fatigue (C) To produce irregular curve (D) None of the above

(6) The instrument used for drawing vertical lines is ______________

(A) Protractor (B) Divider (C) Compass (D) Set - square

(7) When drawing vertical lines with the aid of Set-square and T-

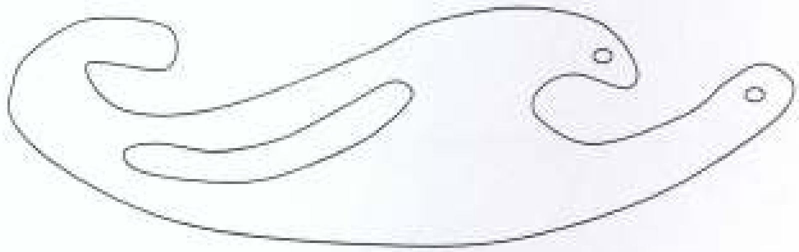
square, the vertical edge of the set square must be on the

__________ side (A) Right hand (B) Left hand

(8) The Setsquare can be used to draw inclined line by pairing it with

__________ instrument. (A) Compass (B) French curve

(C) Sharpener (D) T – square.



(9) What is the name of the drawing instrument shown above.

(A) Set square (B) French curve (C) Sharpener

(D) Eraser

(10) The instrument in question 9 above is used in drawing ______ line

(A) Horizontal (B) Vertical (C) Curve (D) Straight

(11) To draw irregular curve a series of __________ must be plotted to accurately establish the curve. (A) Points (B) Lines (C) Circle

(D) Arcs

(12) The title block contains the following information except.

(A) Name of drafter (B) School (C) Scale (D) Drawing instrument

(13) __________ and _________ are the two types of title block used in technical drawing. (A) Horizontal & Vertical (B) Upper and Lowe cases (C) Circles and Arcs (D) Corner and full length

(14) The boarder line is usually drawn in ________ line

(A) Thick continuous (B) Thin continuous

(C) Short dashes (D) Long dashes.

ANSWERS TO ASSESSMENT QUESTIONS

(1) A (2) D (3) B (4) D (5) A (6) D (7) B

(8) D (9) C (10) C (11) A (12) D (13) D (14) A

Move to the next module if your score is up to 65%, if below study the module again.

3.1.4 Module 4-Freehand sketching

Freehand sketching is a method of making a drawing without the use of instruments except drawing pen or pencil. It is one of the first steps in communicating ideas for a design, and it is used in every step thereafter.

OBJECTIVES

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

- Sketch different types of lines and curves
- Sketch areas circles and semicircles
- Carry out different types of sketches such as orthographic, axonometric, oblique and perspective.

HOW TO STUDY

- As you read through this module try to note the main and important ideas. Look up any unfamiliar word in the Microsoft word.
- Study this module step by step as they have been arranged for you.
- Do all exercises that you are required to do.

ACTIVITY 4.0-1: REASONS FOR SKETCHING

There are many reasons for carrying out technical sketching. Some of these reasons are:

(1) To quickly put an idea that may likely escape the mind on paper

(2) To develop a series of ideas for refining a new product or machine part.

(3) To develop and analyze the best methods and materials for making a product.

(4) To give design ideas to drafters so that they can do the detail drawings.

(5) To persuade decision makers or client about a project that an idea is good.

(6) To show that there are different ways to look at or to solve a problem.

(7) To spend less time in drawing.

ACTIVITY 4.1-1: SKETCHING LINES

The lines used in creating sketches closely correspond to those used in creating technical drawings except that they are not as share.

ACTIVITY 4.2-1: SKETCHING RULES

When sketching the following general rules apply:

(a) Hold the pencil firmly, but not so tightly to avoid tension or hand fatigue.

(b) Grip the pencil about 25mm up from the point.

(c) Horizontal lines should be drawn from left to right using short, slightly overlapping strokes

(d) Vertical lines should be drawn from top to bottom using slightly overlapping strokes.

(e) Draw curved lines using short, slightly over lapping strokes.

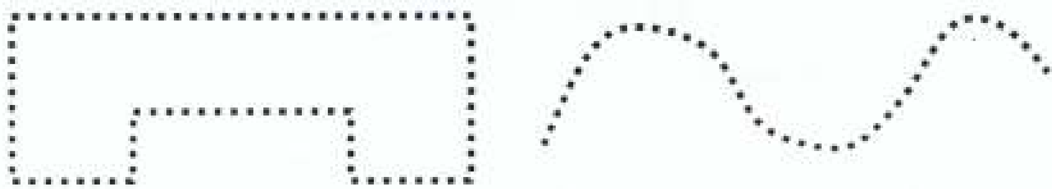


Figure 21a: using dashes or dots as guides for sketching.

ACTIVITY 4.3-1: SKTECHING STRAIGHT LINES

STYEP 1: Put a series of pencil dots or dashes on the paper which provide a basic outlines as to the shape of the object. Fig. 21a.

STEP II: Draw lines to join the dashes or dots. Fig. 21b.

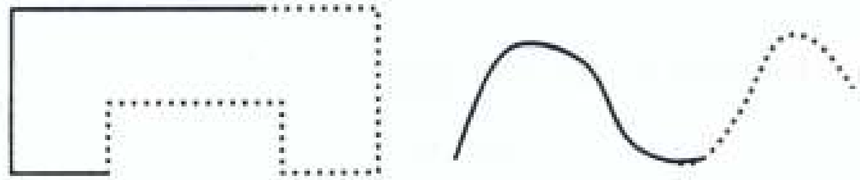


Figure21b: Connecting the dots to produce object

STEP III: Complete the sketch made by using dots or dashes as guides fig. 21c.

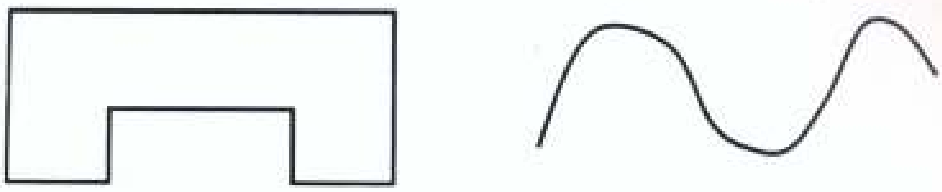
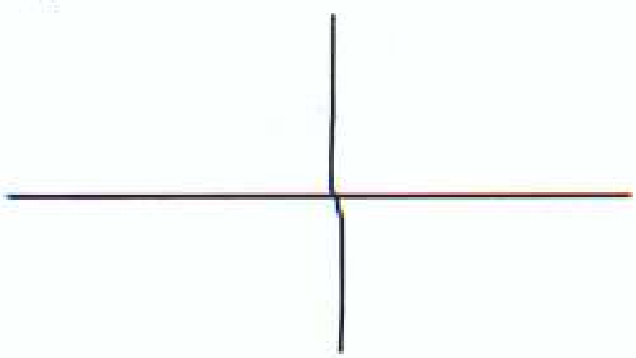


Figure 21c: Complete sketch made by using dots or dashes as guides

ACTIVITY 4.4-1: SKETCHING CIRCLES

STEP 1: Sketch the vertical and horizontal centre lines to locate the centre of the circle figure 22a.



Step I

Fig. 22a

STEP 2: Mark off the radial distance of the circle on these lines, equidistant from the centre. Fig. 22b

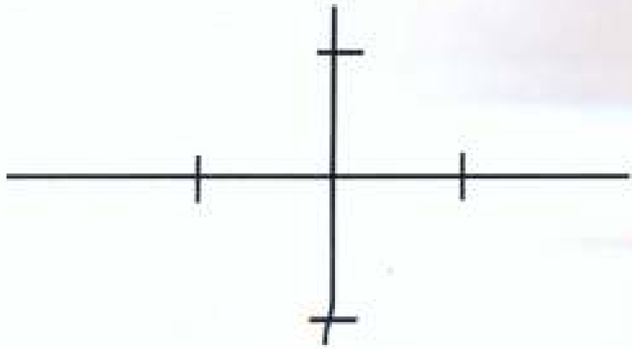


Fig. 22b

Step 2

STEP 3: Draw a square through the marked off points. Fig. 22c

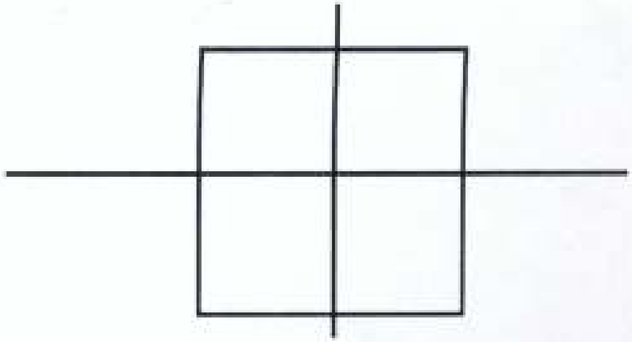


Fig. 22c

Step 3

STEP 4: Draw the diagonals of this square and mark off the radial distances from the centre on these diagonals. Fig. 22d

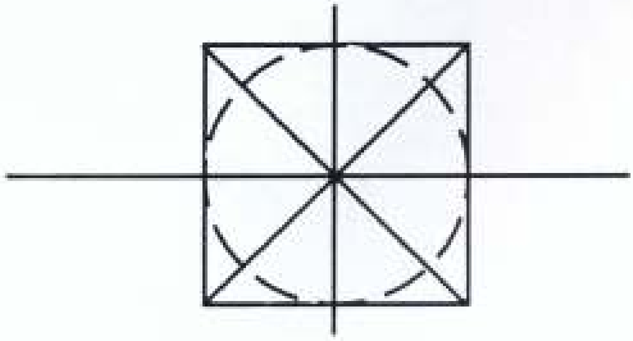


Fig. 22d

Step 5

STEP 5: Join these marks with overlapping strokes. First from the right side of the circle from top to bottom, followed by the left side, the same way. Fig. 22e

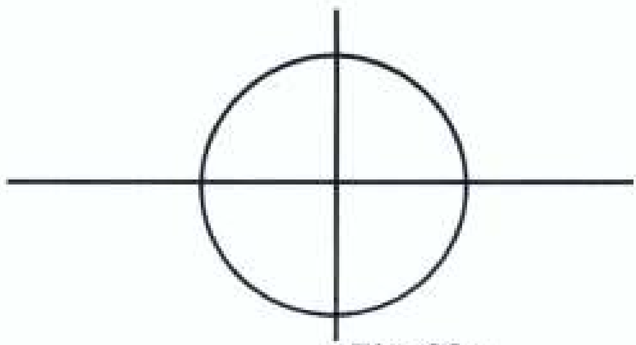


Fig. 22e

Step 5

ACTIVITY 4.5-1: **SKETCHING OF ELLIPSE (Fig. 2.3a produce)**

A similar technique for circle is used for sketching ellipses except that the square becomes a rectangle.

STEP I: Locate the centre lines of the ellipse by sketching the major and minor axes.

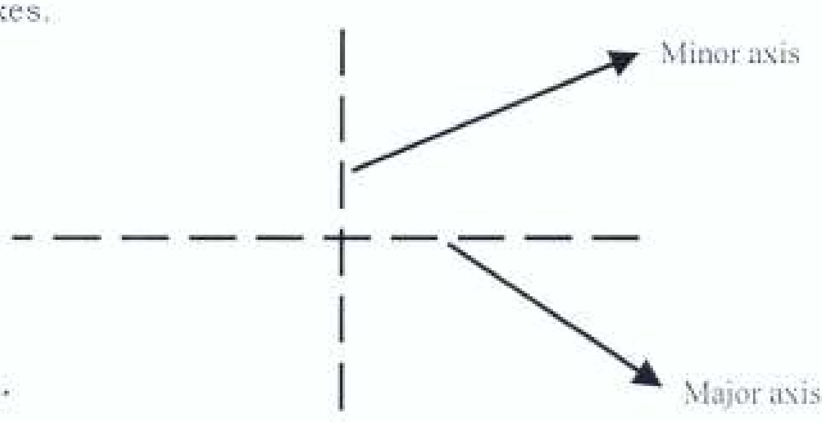


Fig. 23a.

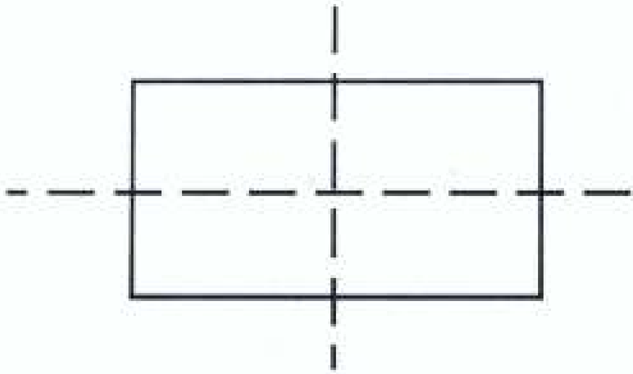


Fig. 23b

STEP III: Sketch arcs where the centre lines touches the box.

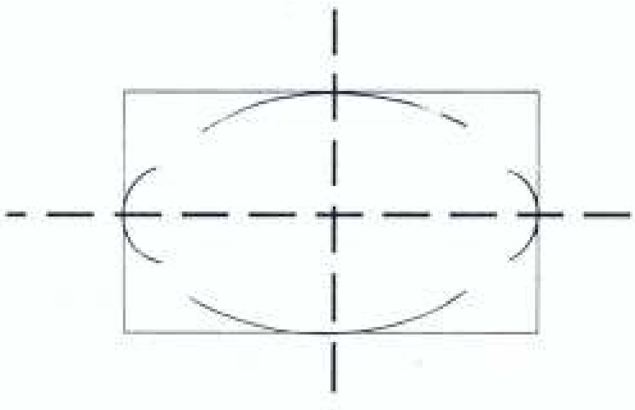


Fig. 23c

STEP IV: Sketch the ellipse by joining these arcs.

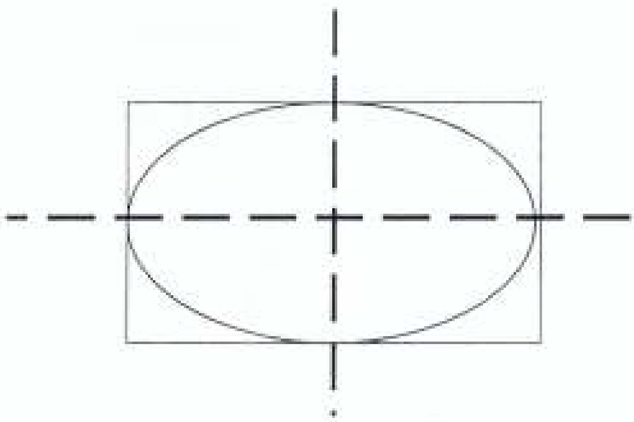


Fig. 23d

STEP V: Clean off the rectangle. This method can be used to draw gaskets having the shape of an ellipse.

Another method of sketching ellipse is the trammel method (see Loci). The points are joined with hand instead of French curve.

ACTIVITY 4.6-1: TYPES OF SKETCHES

There are four types of sketching. Orthographic, axonometric, oblique and perspective.

A skilled sketcher must learn to maintain proportion without the use of tools and aids. The best device for accomplishing proportion in sketching is human eye and constant practice.

Guides relating to proportion in sketching:

STEP 1: Isometric grid or squared papers inform of graph paper should be used where possible. The lines are normally spaced at 10mm intervals.

STEP 2: Break the object into component parts.

STEP 3: Layout the largest components according to the proportions.

ACTIVITY 4.7-1: ORTHOGRAPHIC SKETCHING

The six principal views of an orthographic sketch are: top, front, bottom, back, right side and left side. The views selected for use in a sketch depends on the judgement of the drafter and the nature of the object. The views selected must be views that shows the most detail and the fewest hidden lines.

STEP I: After selecting the views, block in the entire sketch before adding details

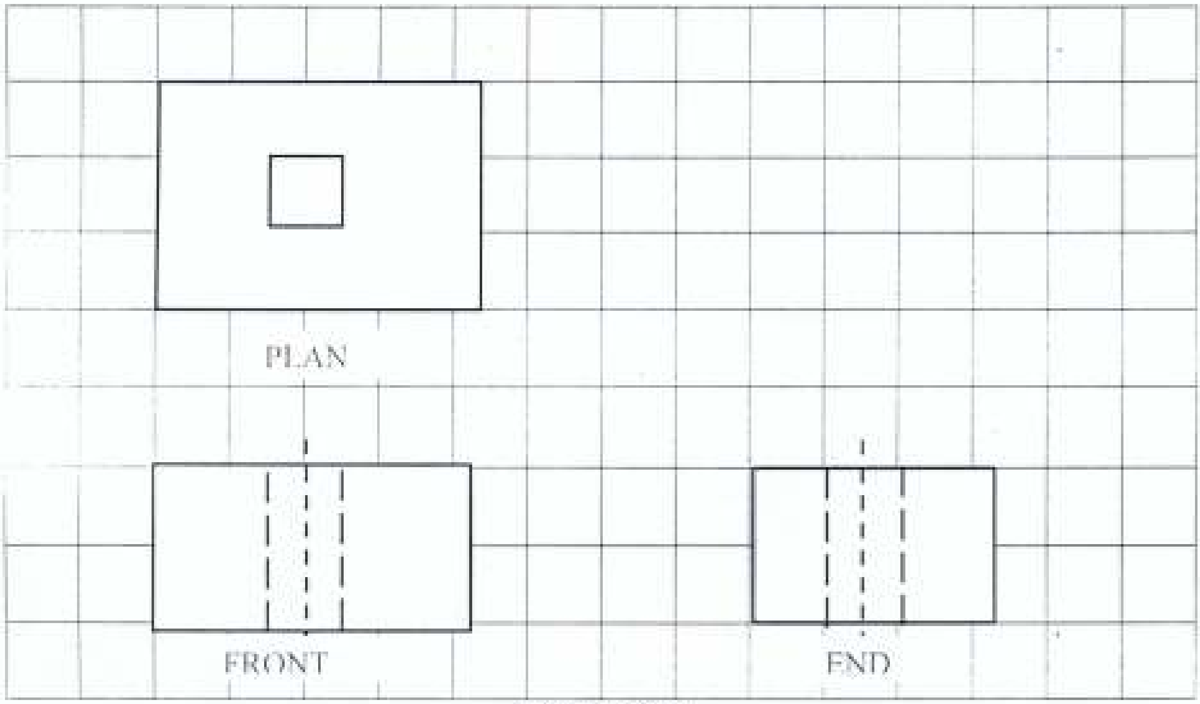


Figure 24a

STEP II: Add the details once the layout is blocked in **Figure 24b**

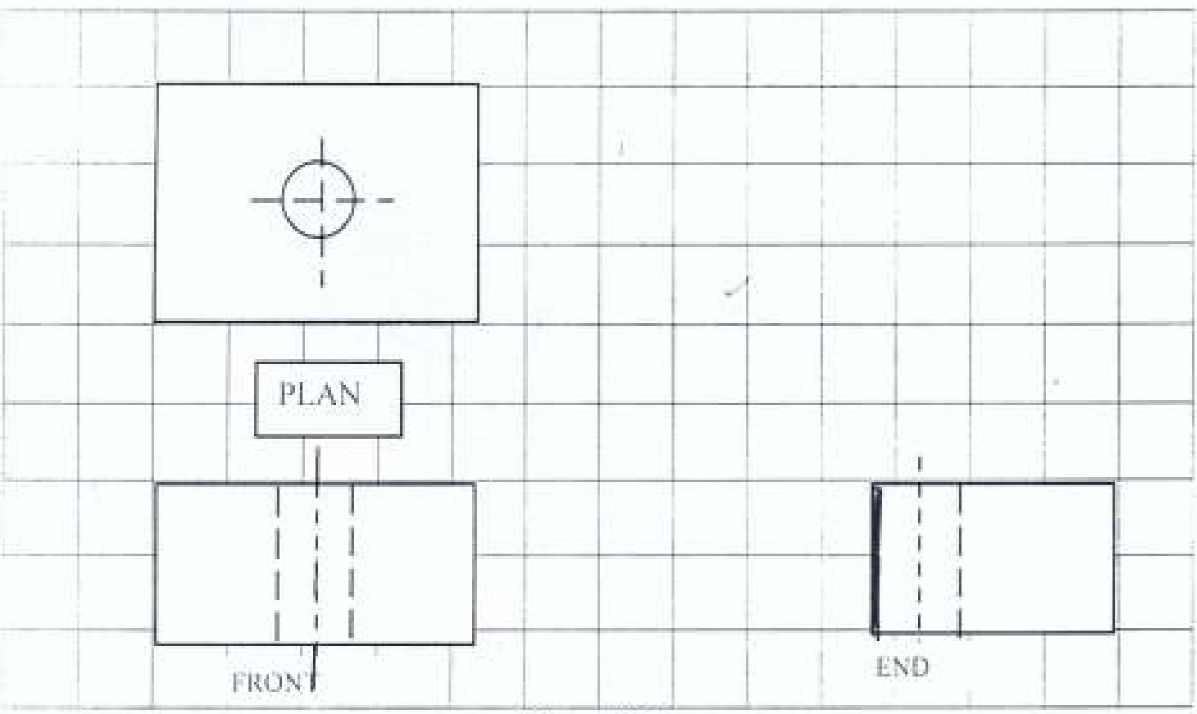


Fig. 24b

ACTIVITY 4.8-1: AXONOMETRIC

There are three types of axonometric projection: Isometric, diametric and trimetric. The latter two projections are rarely used in sketching due to the difficulty in proportioning scale values of length, width and height.

ACTIVITY 4.9-1: Isometric Sketch Procedure

STEP I: Draw the isometric grid assuming the square is 10mm.

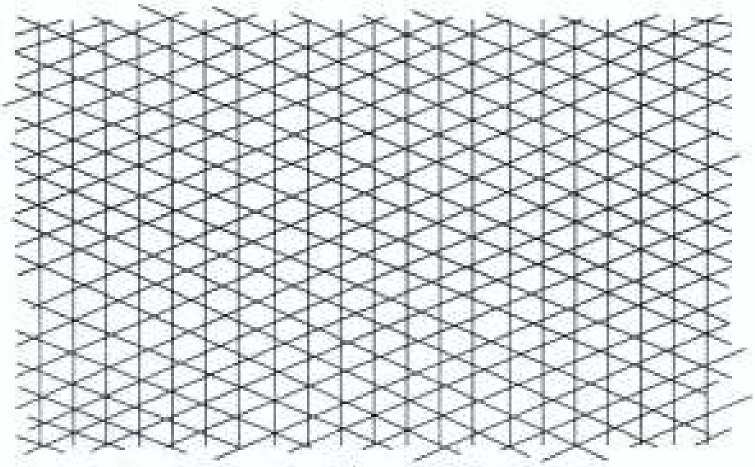


Figure 25a

STEP II: Layout the isometric axes.

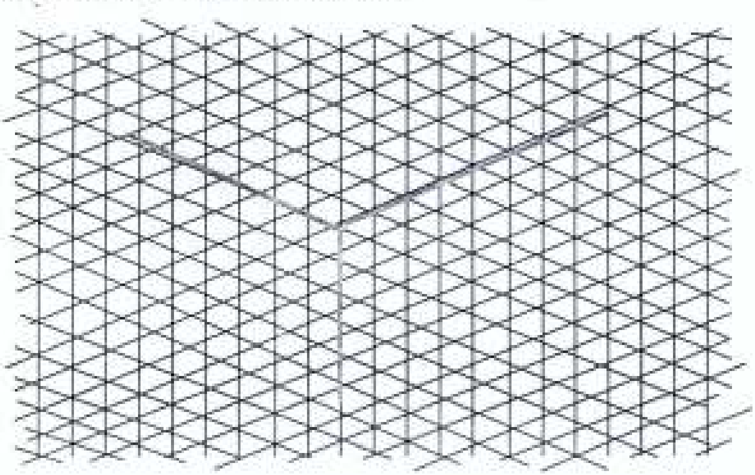


Figure 25b

STEP III: Block in the object using construction lines.

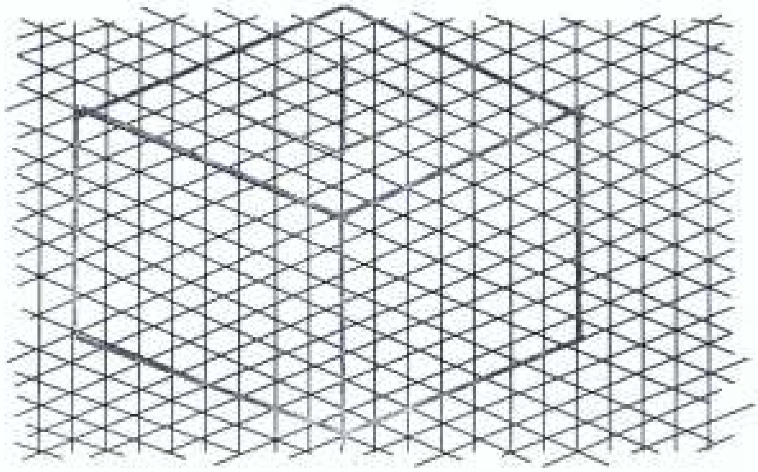
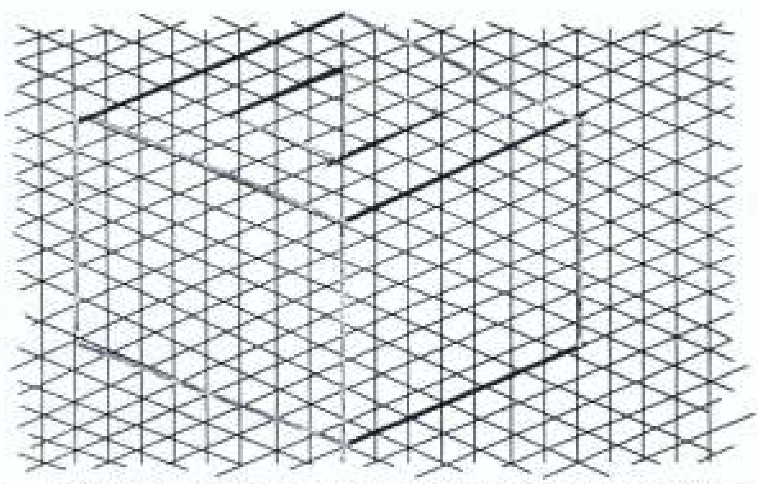
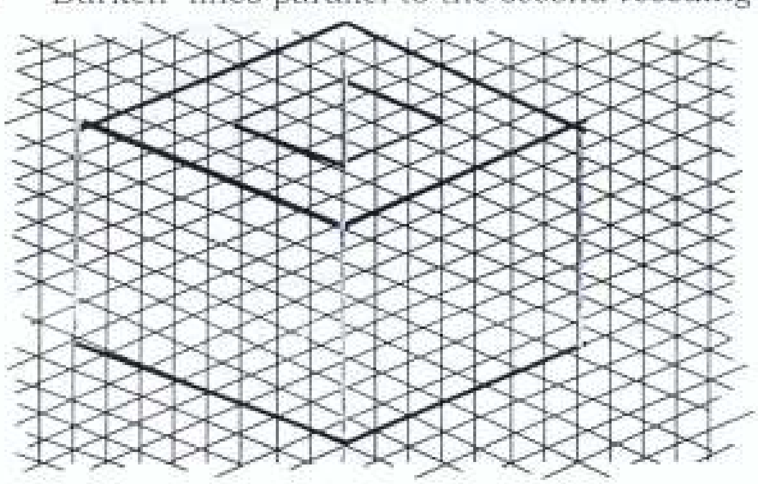


Figure 25c

STEP IV: Darken lines parallel to one receding line



STEP V: Darken lines parallel to the second receding line.



STEP VI: Darken all vertical lines to complete the drawing.

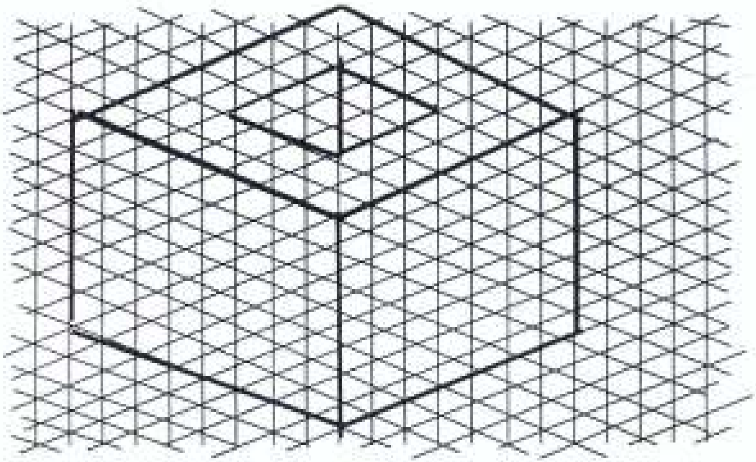


Figure 25d

Note: Circle in isometric sketching will appear elliptical.

ACTIVITY 4.10-1: TO DRAW A CYLINDER IN ISOMETRIC PROJECTION

STEP: Sketch a box and add the centerlines. The two ends should be squares drawn in isometric projection. Fig. 26a

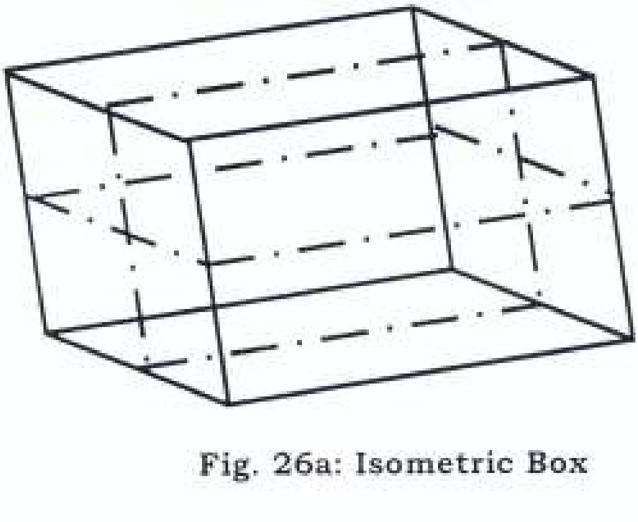


Fig. 26a: Isometric Box

STEP VI: Darken all vertical lines to complete the drawing.

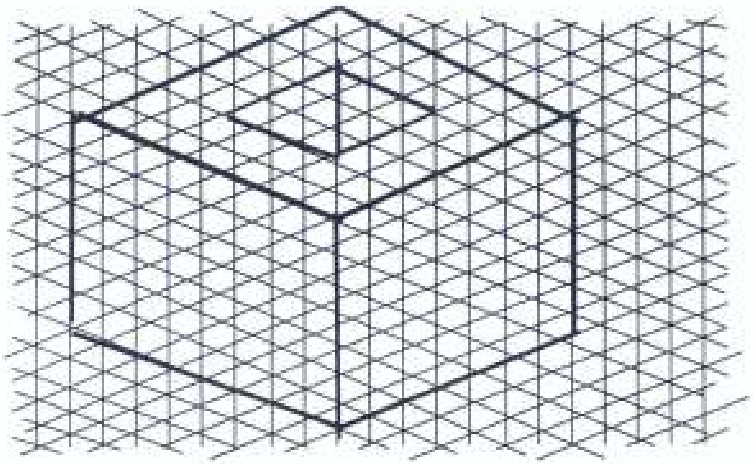


Figure 25d

Note: Circle in isometric sketching will appear elliptical.

ACTIVITY 4.10-1: TO DRAW A CYLINDER IN ISOMETRIC PROJECTION

STEP: Sketch a box and add the centerlines. The two ends should be squares drawn in isometric projection. Fig. 26a

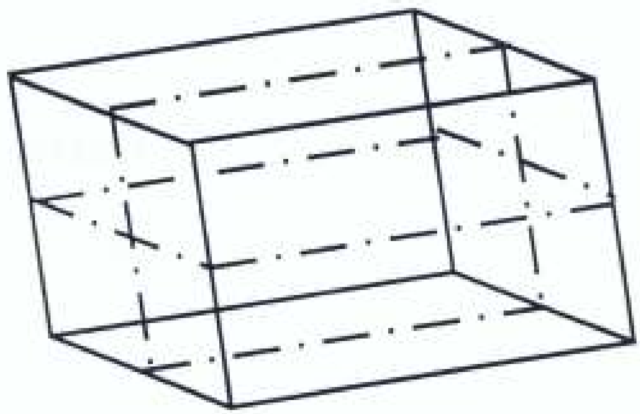
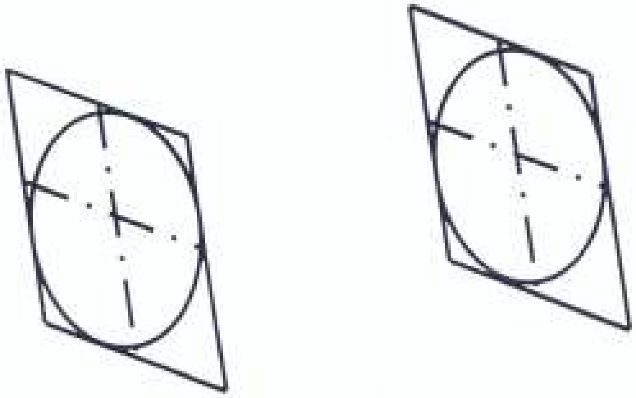


Fig. 26a: Isometric Box

STEP II: Sketch the circles at both ends. Fig. 26b



STEP III: Sketch in the sides so that they are tangential to the circles and clean off the square. Fig. 26c

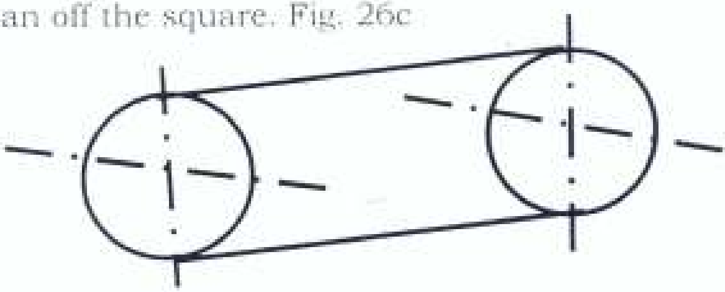


Fig. 26c: Isometric Cylinder

ACTIVITY 4.11-1: **OBLIQUE SKETCHING:** Involves a combination of a flat orthographic front surface with depth lines receding at an angle of 45^0.

Procedure: **STEP I:** Draw the horizontal, vertical and receding lines. Fig. 27a

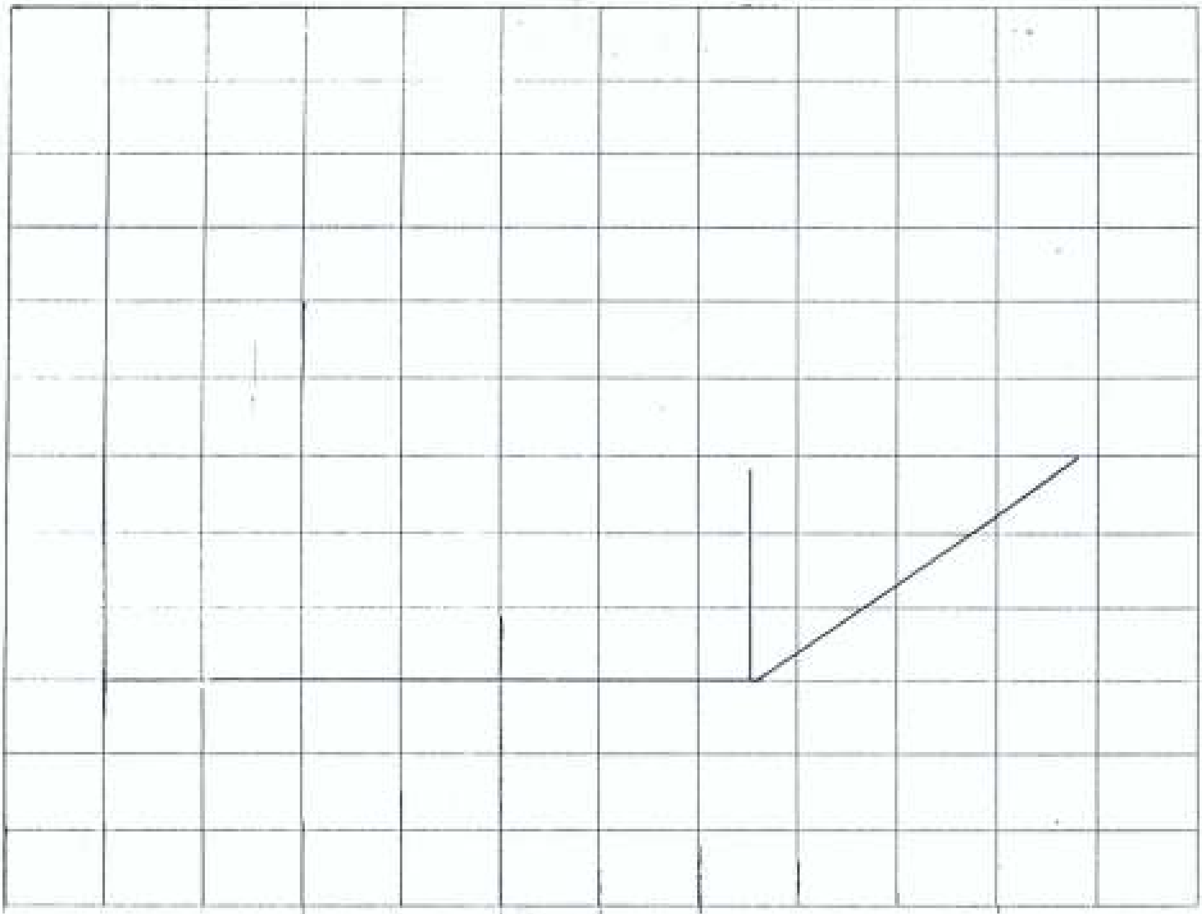
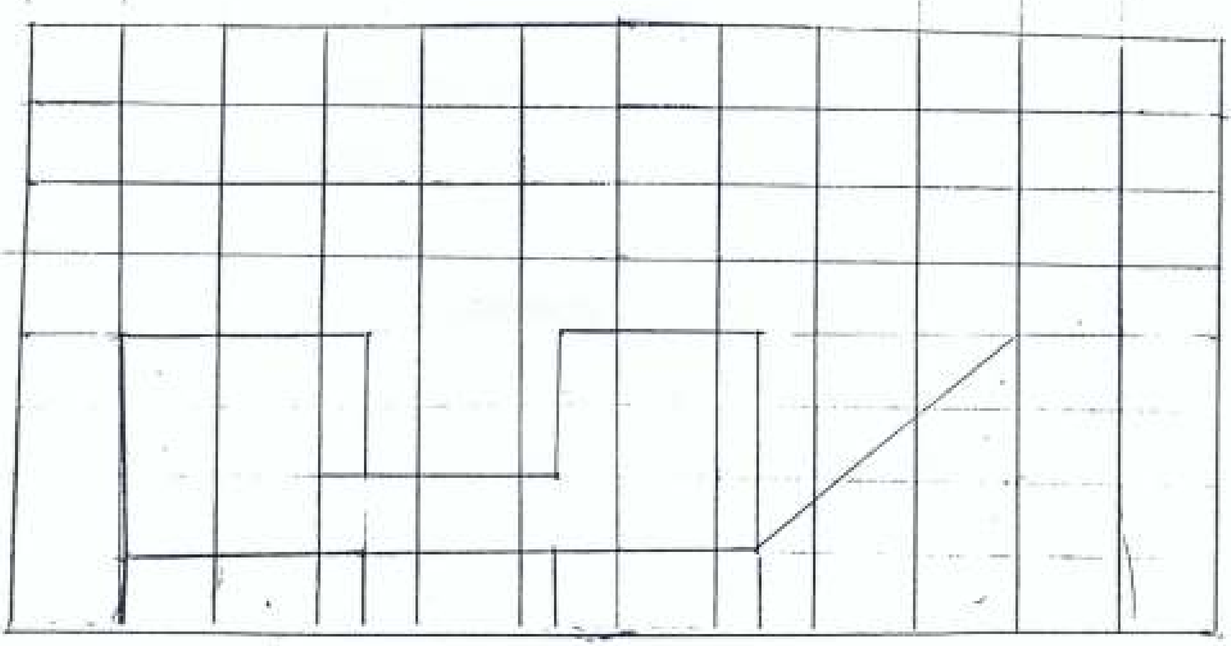


Fig. 27a Oblique Sketching

STEP II: layout the flat front surface of the object.



STEP III: Block in the depth by drawing parallel lines. Fig. 27b

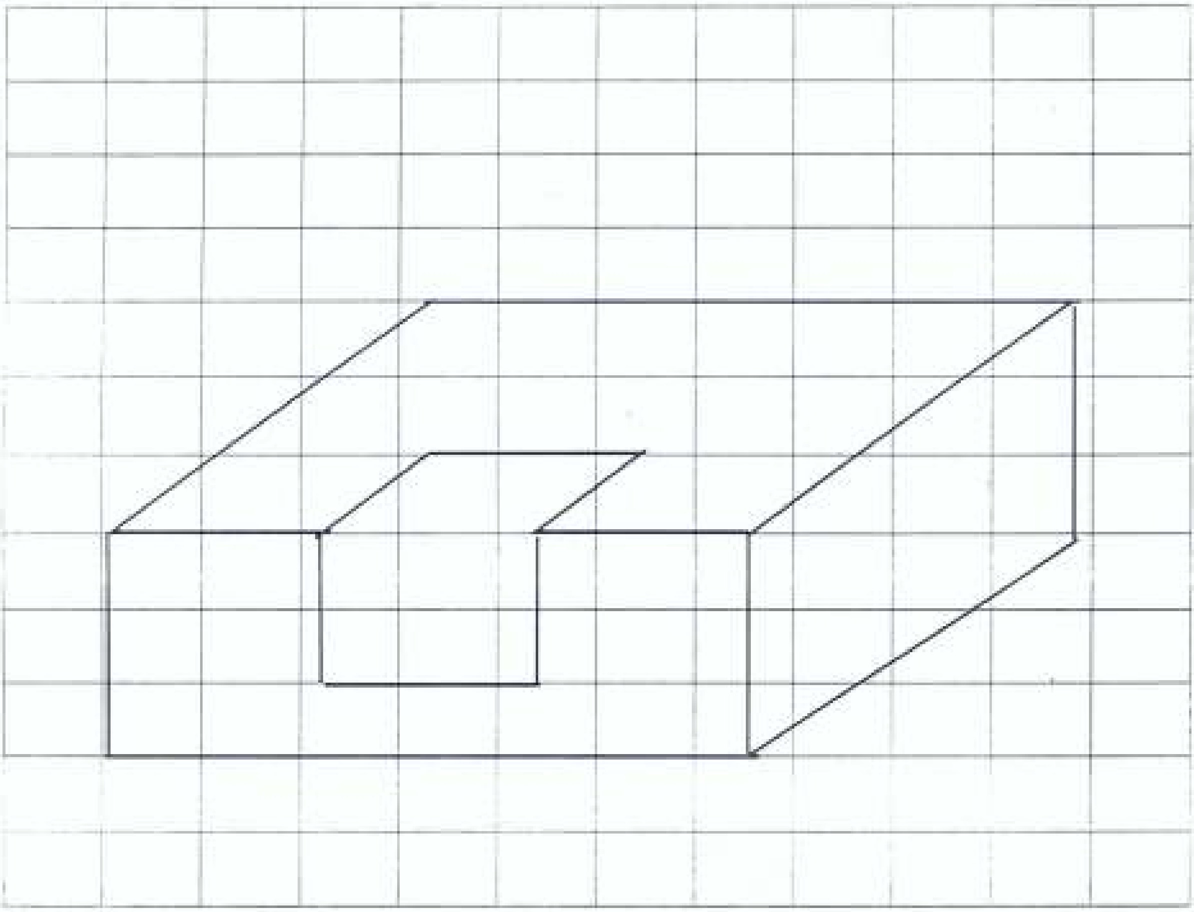


Figure fig. 27b Oblique Drawing

Oblique sketching allows round components to be drawn round rather than elliptical.

ACTIVITY 4.12-1: PERSPECTIVE DRAWINGS

Are the type of pictorial drawings that most nearly represent what is seen by the eye. In perspective drawings parallel lines tend to converge as they receed from persons view while parallel lines remains parallel in other pictorial drawings. The two common types are the "single point perspective" and the "Two point perspective"

ACTIVITY 4.13-1:Sketching perspective (single point)

STEP I: Draw the front surface of the object. Fig. 28a

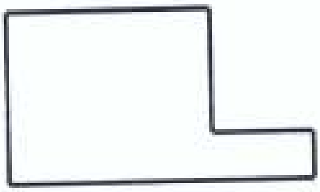


Fig. 28a

STEP II: Select and mark a single vanishing point (VP). Project all points on the font surface back to the vanishing point. Fig. 28b

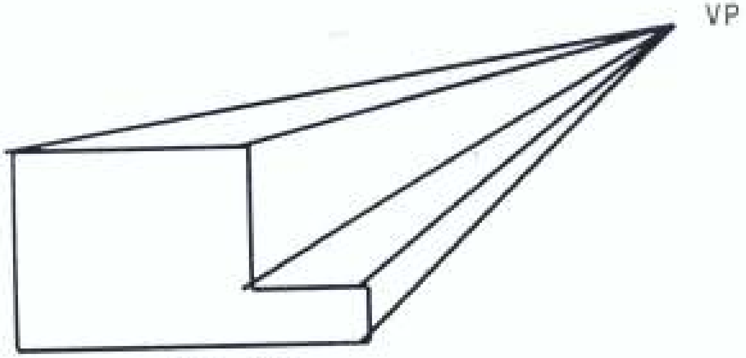


Fig. 28b

STEP III: Estimate the depth of the object and mark off on all line projected. Fig. 28c

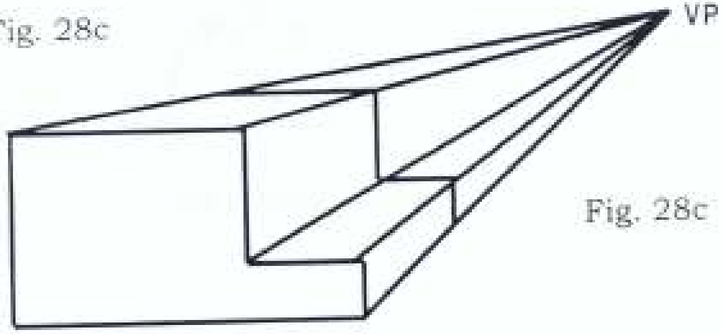


Fig. 28c

STEP IV: Complete the sketch by outlining the exposed profile of the rear surface. Fig. 28d

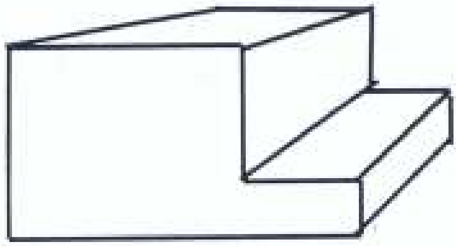


Fig. 28d

ACTIVITY 4.14-1: TWO POINT PERSPECTIVE

STEP I: Layout the two point perspective frame the two point vertical height and the two vanishing points (right and left) and the receding lines. Fig. 29a

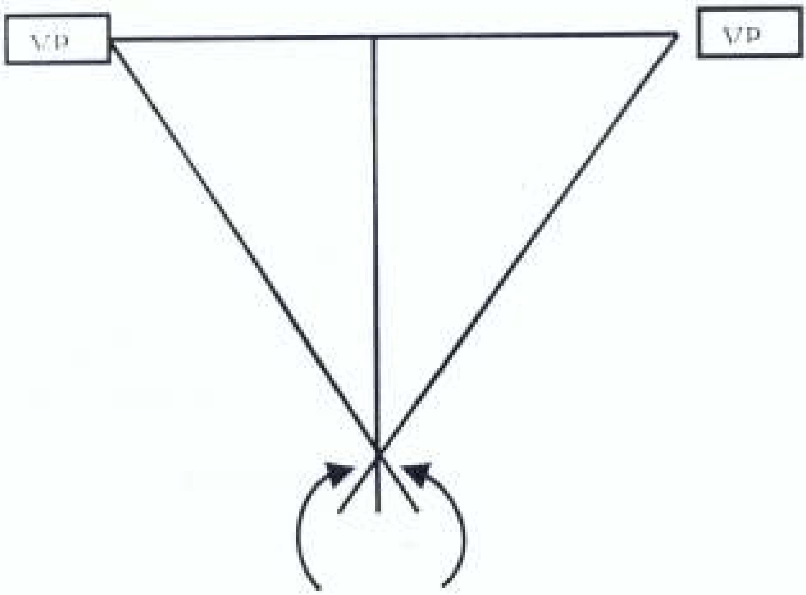


Fig. 29a: **Receding lines**

STEP II: Layout the details of the object. Fig. 29b

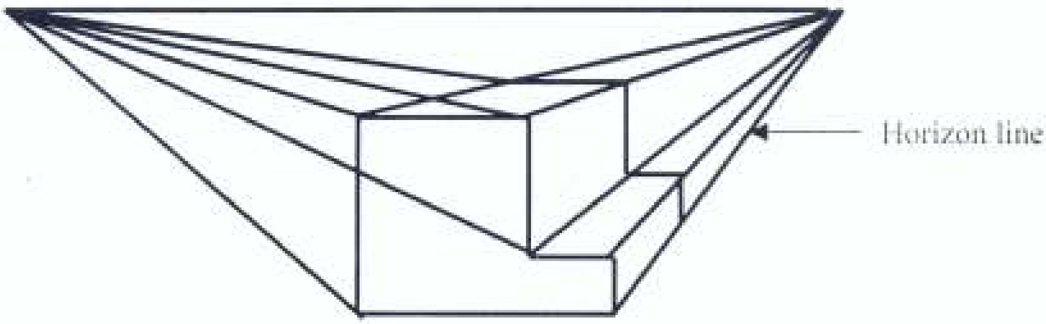


Fig. 29b

The horizon line when positioned below the view provides a view of the bottom of the object, and when positioned above shows the top.

ASSESSMENT QUESTIONS.

(1) The following are reasons for carrying out technical sketching except. ____________

(A) To quickly put an idea on paper

(B) To develop a series of ideas for refining are new product.

(C) To develop and analyze the best methods for making a product

(D) To determine the type of instrument to be used.

(2) Freehand sketching is a method of making a drawing using _________ only

(A) Crayon (B) Colours (C) Pencil (D) Ruler

(3) ________ are used as guides for sketching straight or curve lines

(A) Dashes or dots (B) Circles (C) Arcs (D) Rule

(4) The first step in sketching a circle is__________

(A) Marking off the radial distance of the circle

(B) Drawing a square through marked points

(C) Drawing a rectangle through marked points

(D) None of the above

(5) The two axes needed in sketching an ellipse are__________

(A) Upper and Lower axes (B) Upper and Middle axes

(C) Major and Upper axes (D) Major and Minor axes

(6) How many types of sketches do we have? __________

(A) 3 (2) 4 (C) 5 (D) 6

(7) The following are types of sketches except____________

(A) Orthographic (B) Axonometric (C) Oblique (D) Quadrilateral

(8) The following are principal views of orthographic sketch except__________

(A) Top (B) Front (C) Bottom left side (D) Flat side

(9) One of the following is not an axonometric projection ____________

(A) Isometric (B) Oblique (C) Diametric (D) Trimetric

(10) The size of isometric grid square used in sketching is ________

(A) 5mm (B) 8mmm (C) 10mm (D) 15mm

(11) An isometric circle will give _____ shape

(A) Perfect circle (B) Elliptical (C) Square (D) Rectangular

(12) The depth lines of an oblique sketching receed at an angle of ____

(A) 30^0 (B) 60^0 (C) 45^0 (D) 35^0

(13) The first step in oblique sketching is ____________

(A) _______ Layout the flat front surface of the object

(B) _______ Block in the depth by drawing parallel lines

(C) _______ Draw the horizontal, vertical and receeding lines

(D) _______ None of the above.

(14) The shape of round object in oblique sketching is _________

(A) Elliptical (B) Round (C) Square (D) Rectangle

(15) The two common types of perspective are __________

(A) _______ Single point and two point perspectives

(B) _______ Isometric and single point perspective

(C) _______ Two point and oblique point perspective

(D) _______ Five point and six point perspective

(16) When the horizon line in a two point perspective is positioned above the view, it provides a view of the ______ of the object.

(A) Top (B) Right (C) Left (D) Bottom

ANSWERS TO ASSESSMENT QUESTIONS

(1) D (2) C (3) A (4) C (5) D (6) B (7) D (8) D (9) B

(10) C (11) B (12) C (13) C (14) B (15) A (16) A

If you get at least 2/3 of the questions correctly go to the next module, if no re study the module.

3.1.5 Module 5-Dimensioning and notation

This module covers in depth the fundamentals of dimensioning and notation. The areas covered include: specifying the scale (measuring systems), dimension elements, dimensioning features for size, dimensioning features for position, rules for good dimensioning and notes.

OBJECTIVES

After studying this module you should be able to:

- Identify the various dimension elements and apply these elements in technical drawing.
- Identify the measuring systems and use them in technical drawing
- Dimension features for size and position.
- Identify the various dimensioning rules and apply them in technical drawing
- Put notes on drawings

HOW TO STUDY THIS MODULE

- Read through this module thoroughly. You should as you read, try to note the main and important ideas. When you find an unfamiliar word, try and look up the meanings of such unfamiliar word in Microsoft Word.
- You should study this module step by step as they have been arranged for you. You must do the exerise at the end of the module. Do not try to look at the answers before answering or attempting the questions.
- At the end of the module answer the review questions that covers the topic before proceeding to the next topic

DEFINITION

Dimensioning is defined as the process of defining the size, form and location of geometric components on engineering drawings. Notation is the process whereby needed information not covered by dimensions is placed on a technical drawing.

ACTIVITY 5.0-1: TYPES OF DIMENSIONS

There are two basic kinds of dimesions used on drawings: "Size dimension and Location dimensions".

ACTIVITY 5.1 – 1: SIZE DIMENSIONS: Are dimensions, which indicate the overall size of the object and the various features, which make the object. Parts are usually broken down into basic geometric shape for dimensioning. Fig.30

ACTIVITY 5.2-1: LOCATION DIMENSIONS

Are used to show the relative positions of the basic shapes of an object from some specified surface. Fig. 30

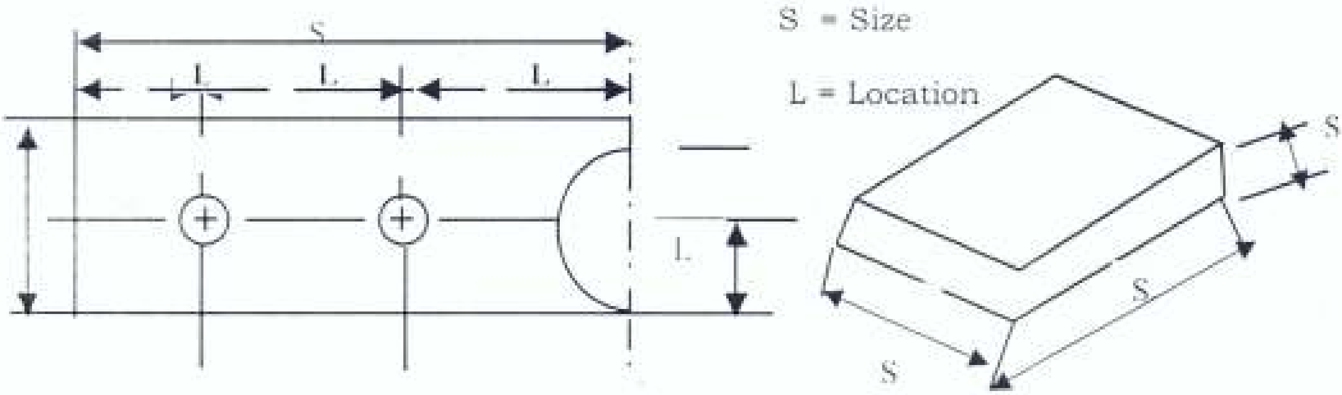


Fig. 30: showing Location and Size Dimensions

ACTIVITY 5.3-1: DIMENSIONING SYSTEM

The dimensioning systems used on technical drawings are the; Metric dimensioning, decimal inch dimensioning and fractional dimensioning. The metric system of dimensioning has been widely adopted and is gaining favour worldwide.

ACTIVITY 5.4-1: Metric Dimensioning: When the metric system is used, dimensions on drawings are given in millimeters, meters and micrometers. The millimeter is the standard metric unit of measurement on technical drawings.

ACTIVITY 5.5-1: Metric Dimensioning Rules

(i) Dimensions which are less than unity (less than 1mm) should be preceeded by zero "0". Fig. 31a

(ii) When a dimension is a whole number, neither the zero nor the decimal is required. Fig. 31b

(iii) Digits in metric dimensions are not to be separated into groups by use of commas or spaces. Fig. 31c

(iv) There should be consistency with the unit of measurement.

(v) When a metric dimension consists of a whole number and a decimal portion, the whole number is written first, followed by the decimal point and finally, the decimal part of the number. Fig 31d

(vi) The unit of the dimension should be indicated in the tile block or in a small rectangle below the part. e.g.

"ALL DIMENSIONS IN MM"

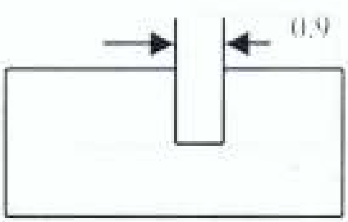


Fig. 31a

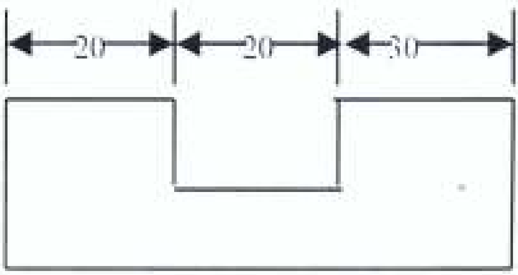


Fig. 31b

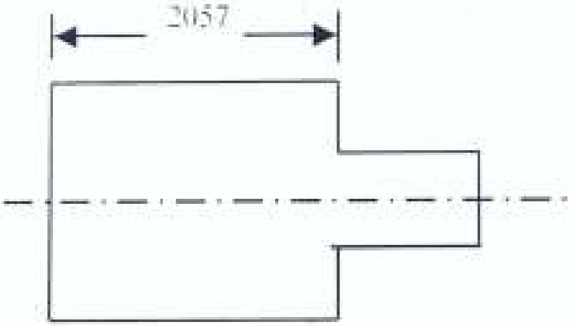


Fig. 31 c

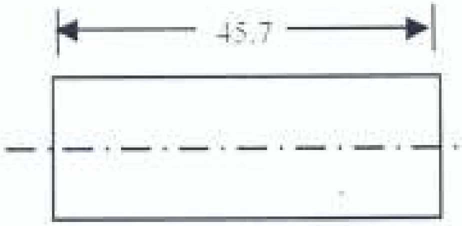


Fig. 31 d

ACTIVITY 5.6-1: DIMENSION ELEMENTS

A standard set of components are recommended for use on technical drawing. These components include dimension lines, extension lines, arrow heads, leaders and the real numbers or dimensions.

ACTIVITY 5.7-1: Dimension lines

Dimension lines are thin lines with arrow heads at each end used to indicate the distance being dimensioned. Dimensioning lines are drawn as thin lines using H or 2H.

Dimension lines may be broken for the placement of dimensions.

Fig. 32a

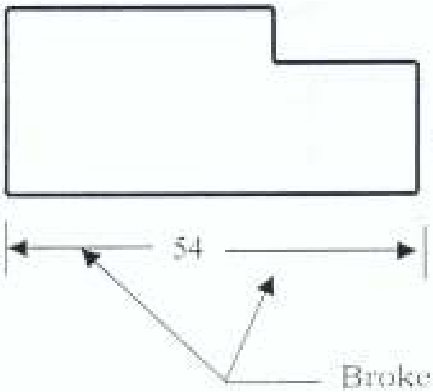


Fig. 32a

Broken dimension lines to allow for the placement of dimensions.

Where dimension line is not broken the dimensions are placed above the line. Fig. Fig. 32b

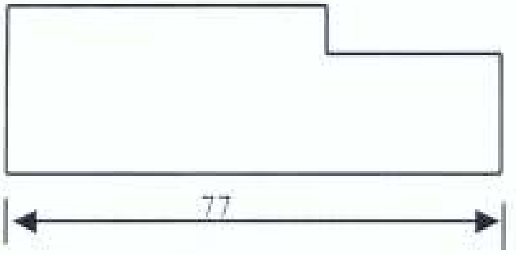


Fig. 32b

Dimension figures should be properly placed on the drawings. Fig. Fig. 32c

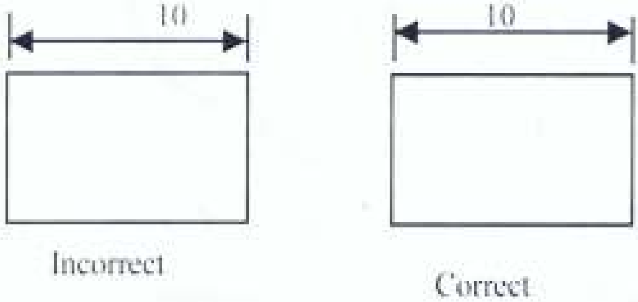


Fig. 32c

When dimensioning multiple features of an object, dimensions should be aligned uniformly and not staggered or randomly scattered about the object. Fig. 33

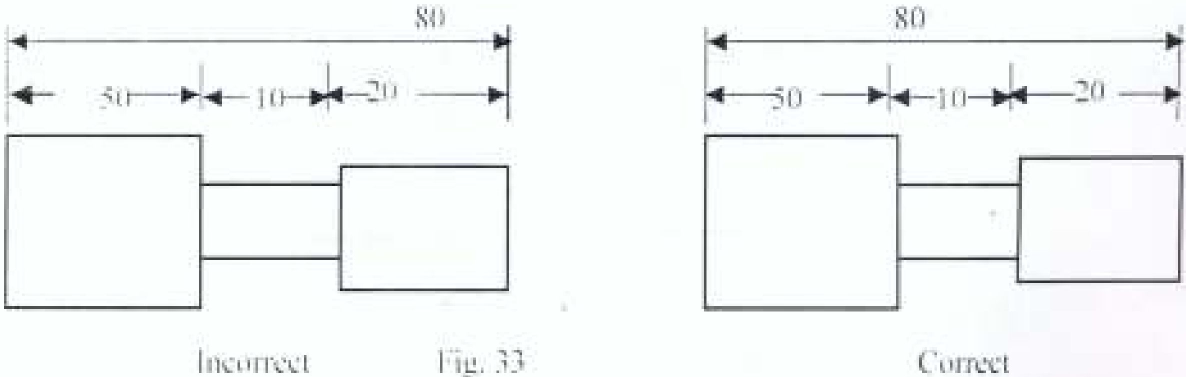


Fig. 33

Step 5

STEP 5: Join these marks with overlapping strokes. First from the right side of the circle from top to bottom, followed by the left side, the same way. Fig. 22e

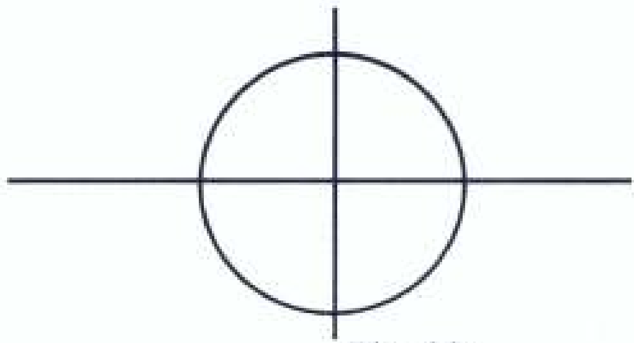


Fig. 22e

Step 5

ACTIVITY 4.5-1: SKETCHING OF ELLIPSE (Fig. 2.3a produce)

A similar technique for circle is used for sketching ellipses except that the square becomes a rectangle.

STEP I: Locate the centre lines of the ellipse by sketching the major and minor axes.

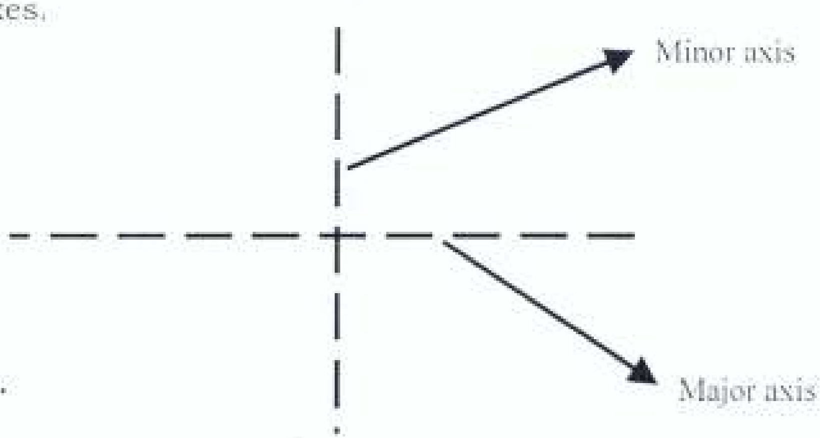


Fig. 23a.

STEP II: Draw the rectangle around the centre line. Fig. 23b

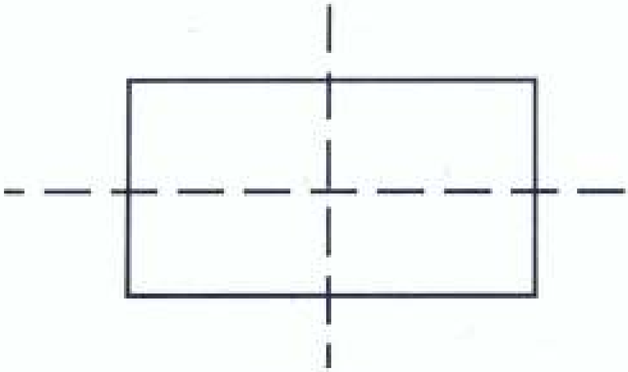


Fig. 23b

STEP III: Sketch arcs where the centre lines touches the box.

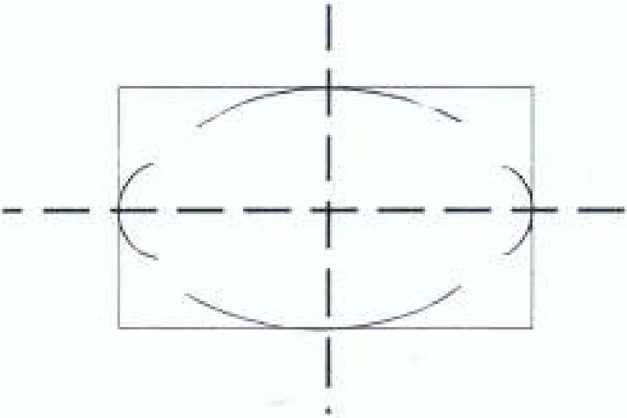


Fig. 23c

STEP IV: Sketch the ellipse by joining these arcs.

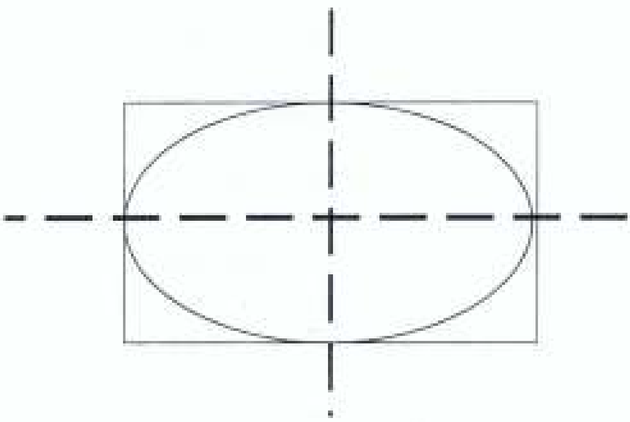


Fig. 23d

STEP VI: Darken all vertical lines to complete the drawing.

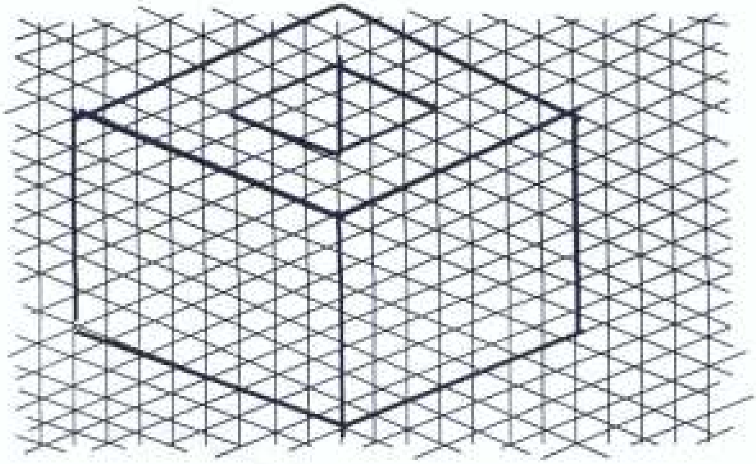


Figure 25d

Note: Circle in isometric sketching will appear elliptical.

ACTIVITY 4.10-1: TO DRAW A CYLINDER IN ISOMETRIC PROJECTION

STEP: Sketch a box and add the centerlines. The two ends should be squares drawn in isometric projection. Fig. 26a

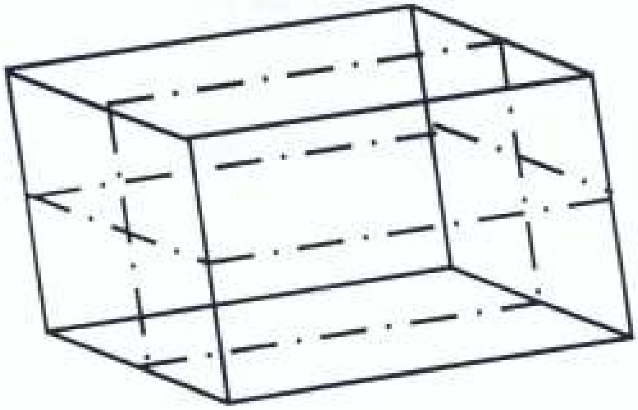
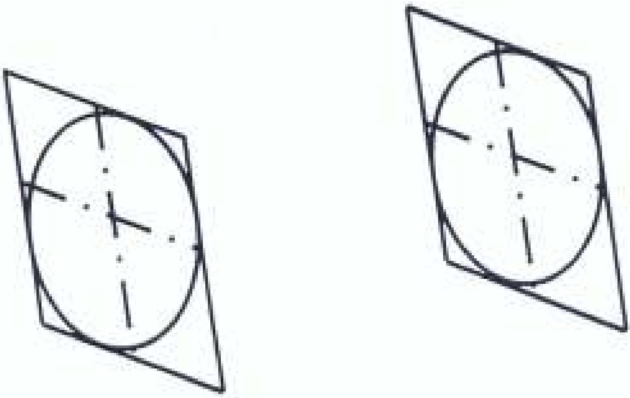


Fig. 26a: Isometric Box

STEP II: Sketch the circles at both ends. Fig. 26b



STEP III: Sketch in the sides so that they are tangential to the circles and clean off the square. Fig. 26c

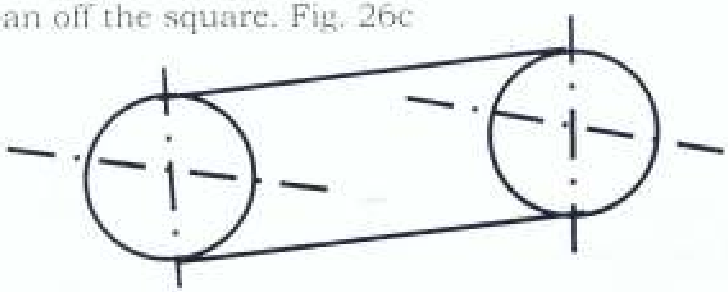


Fig. 26c: Isometric Cylinder

ACTIVITY 4.11-1: **OBLIQUE SKETCHING:** Involves a combination of a flat orthographic front surface with depth lines receding at an angle of 45^0.

Procedure: **STEP I:** Draw the horizontal, vertical and receding lines. Fig. 27a

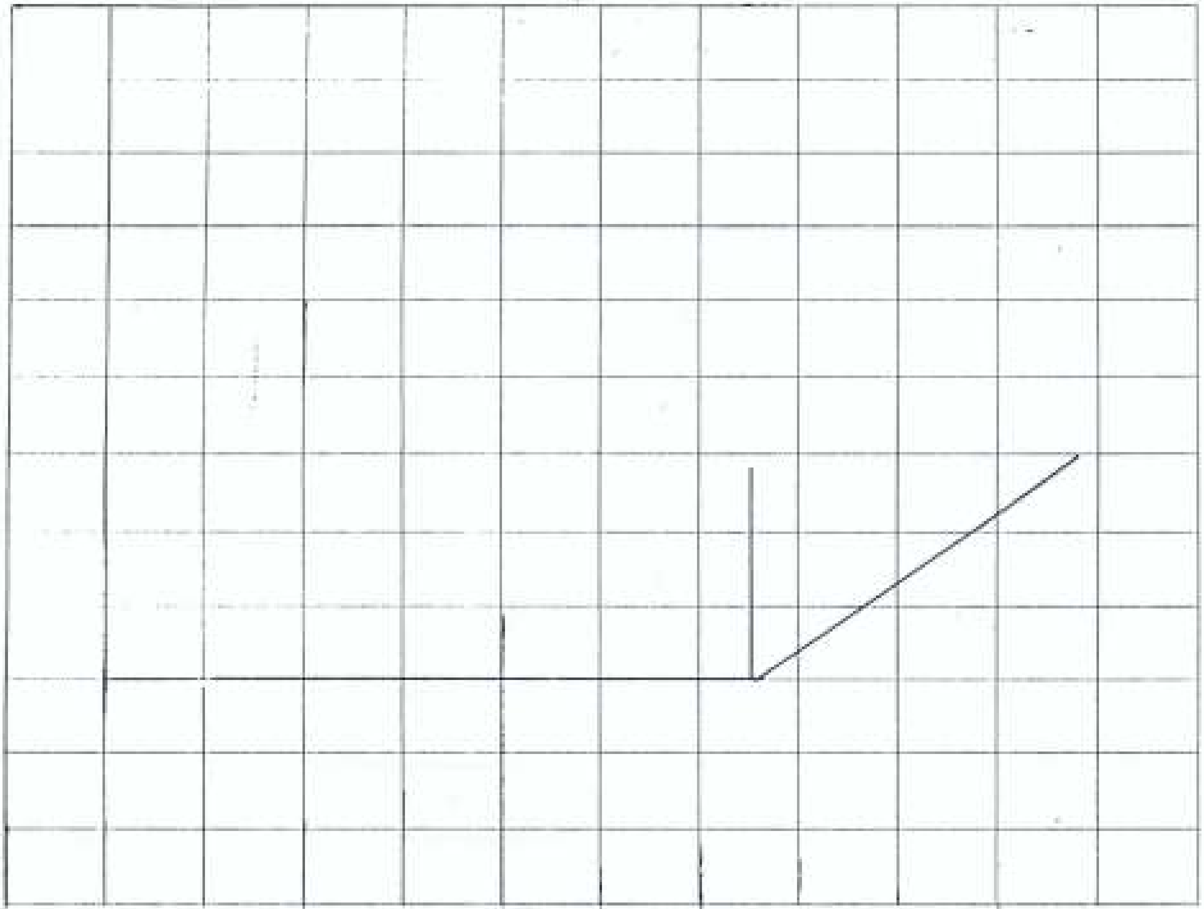
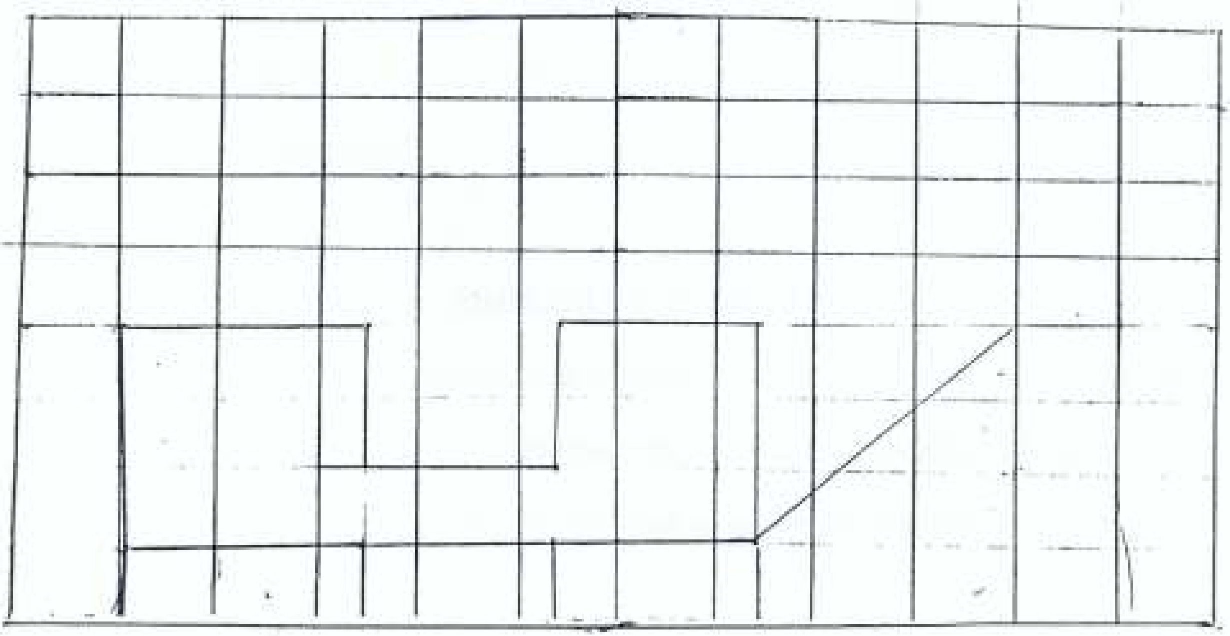


Fig. 27a Oblique Sketching

STEP II: layout the flat front surface of the object.



STEP III: Block in the depth by drawing parallel lines. Fig. 27b

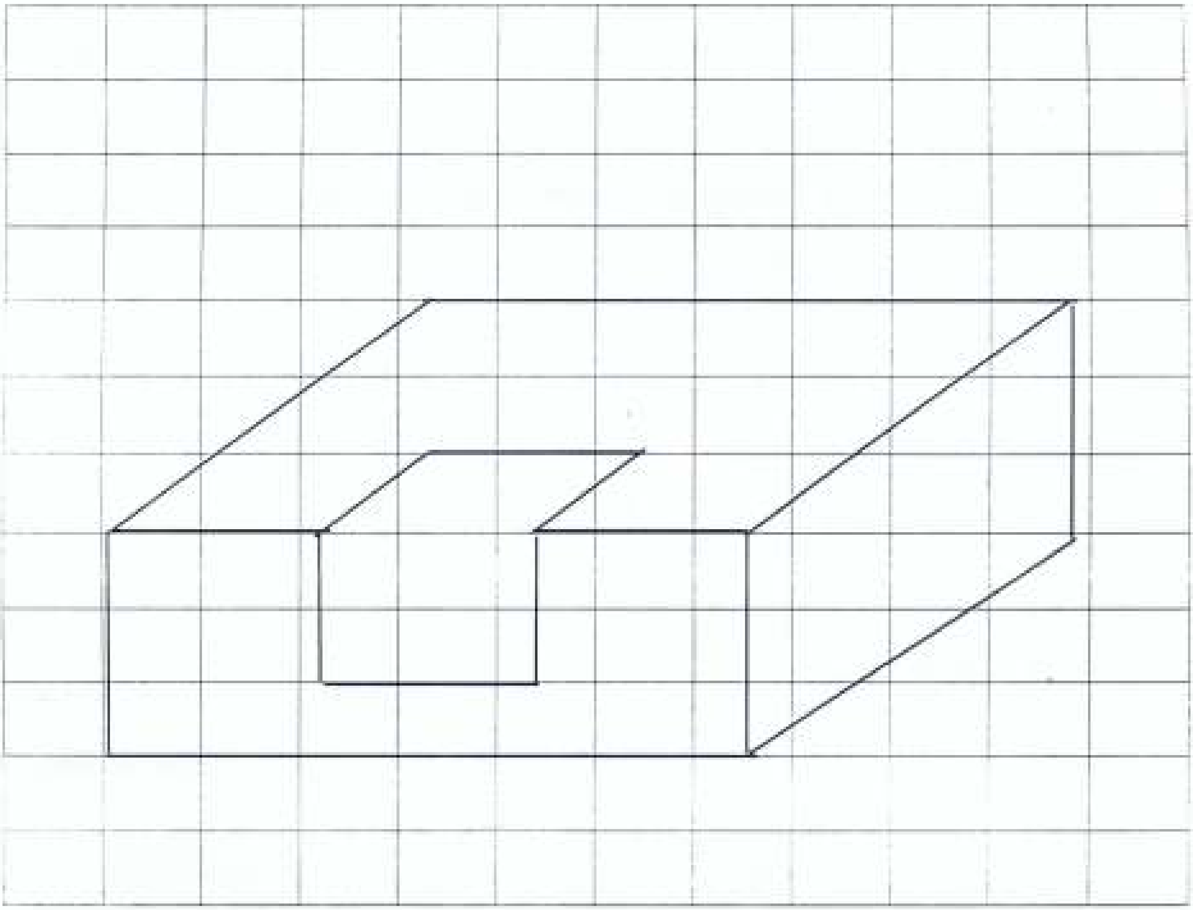


Figure fig. 27b Oblique Drawing

Oblique sketching allows round components to be drawn round rather than elliptical.

ACTIVITY 4.12-1: PERSPECTIVE DRAWINGS

Are the type of pictorial drawings that most nearly represent what is seen by the eye. In perspective drawings parallel lines tend to converge as they receed from persons view while parallel lines remains parallel in other pictorial drawings. The two common types are the "single point perspective" and the "Two point perspective"

ACTIVITY 4.13-1:Sketching perspective (single point)

STEP I: Draw the front surface of the object. Fig. 28a

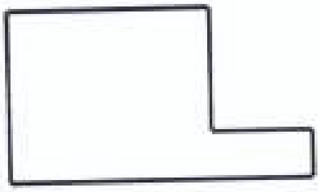


Fig. 28a

STEP II: Select and mark a single vanishing point (VP). Project all points on the font surface back to the vanishing point. Fig. 28b

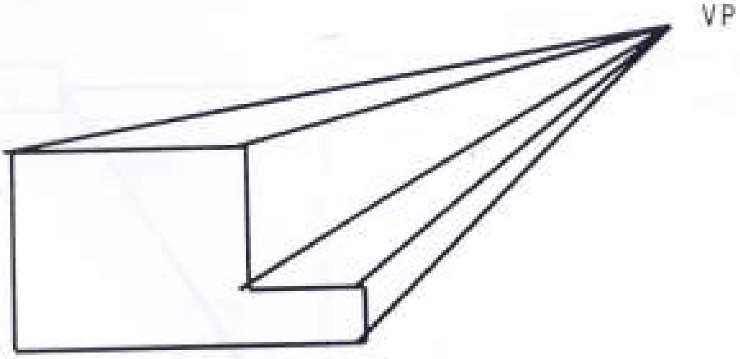


Fig. 28b

STEP III: Estimate the depth of the object and mark off on all line projected. Fig. 28c

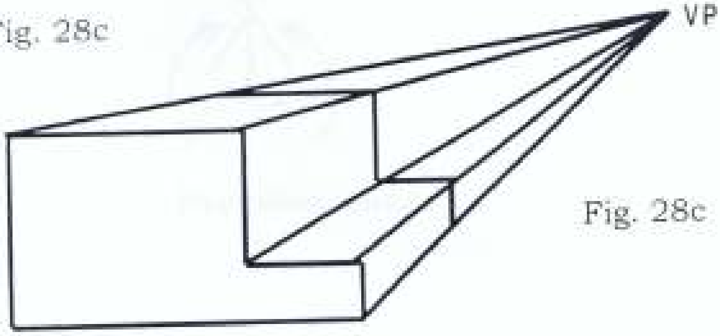


Fig. 28c

STEP IV: Complete the sketch by outlining the exposed profile of the rear surface. Fig. 28d

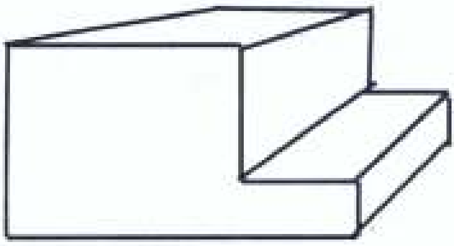


Fig. 28d

ACTIVITY 4.14-1: TWO POINT PERSPECTIVE

STEP I: Layout the two point perspective frame the two point vertical height and the two vanishing points (right and left) and the receding lines. Fig. 29a

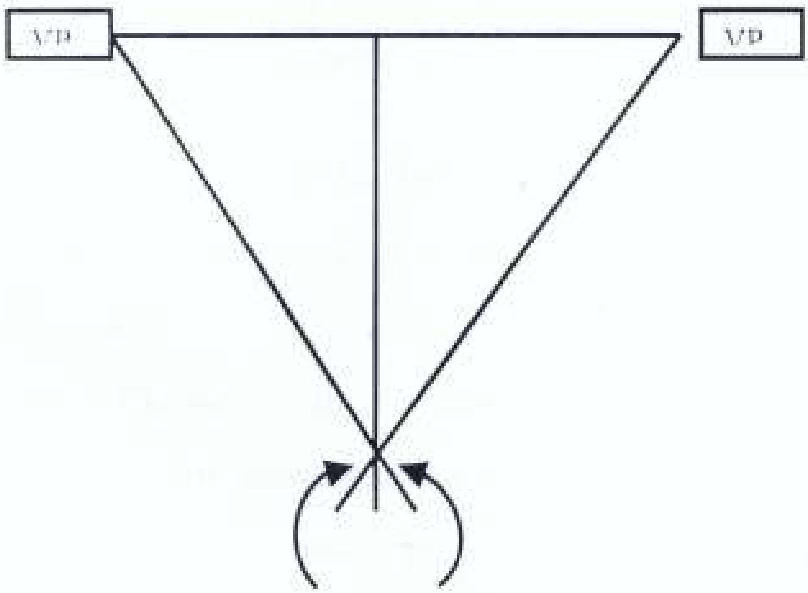


Fig. 29a: **Receding lines**

STEP II: Layout the details of the object. Fig. 29b

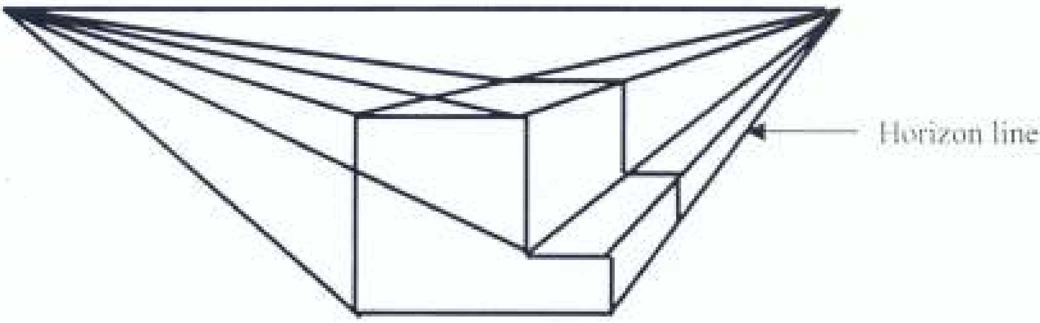


Fig. 29b

The horizon line when positioned below the view provides a view of the bottom of the object, and when positioned above shows the top.

ASSESSMENT QUESTIONS.

(1) The following are reasons for carrying out technical sketching except. ____________

(A) To quickly put an idea on paper

(B) To develop a series of ideas for refining are new product.

(C) To develop and analyze the best methods for making a product

(D) To determine the type of instrument to be used.

(2) Freehand sketching is a method of making a drawing using _________ only

(A) Crayon (B) Colours (C) Pencil (D) Ruler

(3) ________ are used as guides for sketching straight or curve lines

(A) Dashes or dots (B) Circles (C) Arcs (D) Rule

(4) The first step in sketching a circle is__________

(A) Marking off the radial distance of the circle

(B) Drawing a square through marked points

(C) Drawing a rectangle through marked points

(D) None of the above

(5) The two axes needed in sketching an ellipse are__________

(A) Upper and Lower axes (B) Upper and Middle axes

(C) Major and Upper axes (D) Major and Minor axes

(6) How many types of sketches do we have? __________

(A) 3 (2) 4 (C) 5 (D) 6

(7) The following are types of sketches except____________

(A) Orthographic (B) Axonometric (C) Oblique (D) Quadrilateral

(8) The following are principal views of orthographic sketch except__________

(A) Top (B) Front (C) Bottom left side (D) Flat side

(9) One of the following is not an axonometric projection ____________

(A) Isometric (B) Oblique (C) Diametric (D) Trimetric

(10) The size of isometric grid square used in sketching is ________

(A) 5mm (B) 8mmm (C) 10mm (D) 15mm

(11) An isometric circle will give _____ shape

(A) Perfect circle (B) Elliptical (C) Square (D) Rectangular

(12) The depth lines of an oblique sketching receed at an angle of _______

(A) 30^0 (B) 60^0 (C) 45^0 (D) 35^0

(13) The first step in oblique sketching is ___________

(A) _______ Layout the flat front surface of the object

(B) _______ Block in the depth by drawing parallel lines

(C) _______ Draw the horizontal, vertical and receeding lines

(D) _______ None of the above.

(14) The shape of round object in oblique sketching is ________

(A) Elliptical (B) Round (C) Square (D) Rectangle

(15) The two common types of perspective are _________

(A) _______ Single point and two point perspectives

(B) _______ Isometric and single point perspective

(C) _______ Two point and oblique point perspective

(D) _______ Five point and six point perspective

(16) When the horizon line in a two point perspective is positioned above the view, it provides a view of the ______ of the object.

(A) Top (B) Right (C) Left (D) Bottom

ANSWERS TO ASSESSMENT QUESTIONS

(1) D (2) C (3) A (4) C (5) D (6) B (7) D (8) D (9) B

(10) C (11) B (12) C (13) C (14) B (15) A (16) A

If you get at least 2/3 of the questions correctly go to the next module, if no re study the module.

3.1.5 Module 5-Dimensioning and notation

This module covers in depth the fundamentals of dimensioning and notation. The areas covered include: specifying the scale (measuring systems), dimension elements, dimensioning features for size, dimensioning features for position, rules for good dimensioning and notes.

OBJECTIVES

After studying this module you should be able to:

- Identify the various dimension elements and apply these elements in technical drawing.
- Identify the measuring systems and use them in technical drawing
- Dimension features for size and position.
- Identify the various dimensioning rules and apply them in technical drawing
- Put notes on drawings

HOW TO STUDY THIS MODULE

- Read through this module thoroughly. You should as you read, try to note the main and important ideas. When you find an unfamiliar word, try and look up the meanings of such unfamiliar word in Microsoft Word.
- You should study this module step by step as they have been arranged for you. You must do the exerise at the end of the module. Do not try to look at the answers before answering or attempting the questions.
- At the end of the module answer the review questions that covers the topic before proceeding to the next topic.

DEFINITION

Dimensioning is defined as the process of defining the size, form and location of geometric components on engineering drawings. Notation is the process whereby needed information not covered by dimensions is placed on a technical drawing.

ACTIVITY 5.0-1: TYPES OF DIMENSIONS -

There are two basic kinds of dimesions used on drawings: "Size dimension and Location dimensions".

ACTIVITY 5.1 – 1: SIZE DIMENSIONS: Are dimensions, which indicate the overall size of the object and the various features, which make the object. Parts are usually broken down into basic geometric shape for dimensioning. Fig.30

ACTIVITY 5.2-1: LOCATION DIMENSIONS

Are used to show the relative positions of the basic shapes of an object from some specified surface. Fig. 30

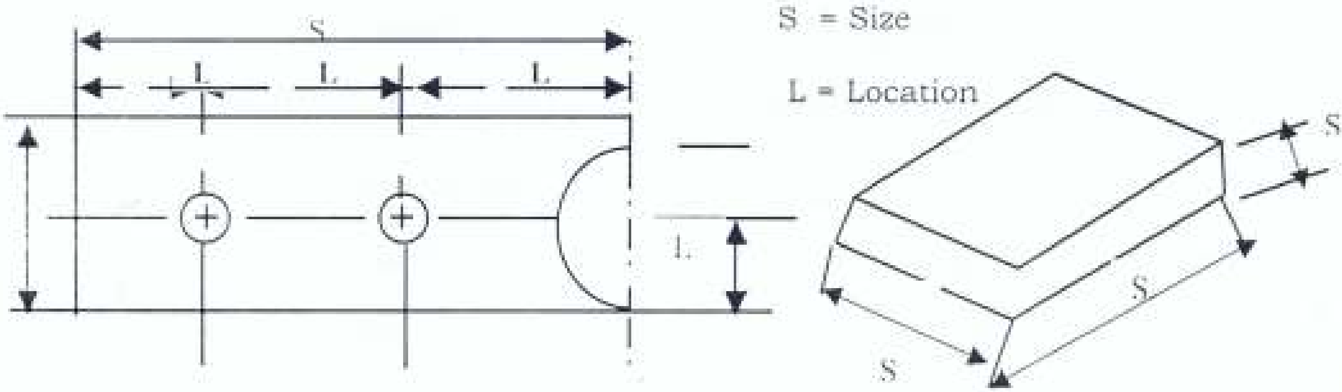


Fig. 30: showing Location and Size Dimensions

ACTIVITY 5.3-1: DIMENSIONING SYSTEM

The dimensioning systems used on technical drawings are the; Metric dimensioning, decimal inch dimensioning and fractional dimensioning. The metric system of dimensioning has been widely adopted and is gaining favour worldwide.

ACTIVITY 5.4-1: Metric Dimensioning: When the metric system is used, dimensions on drawings are given in millimeters, meters and micrometers. The millimeter is the standard metric unit of measurement on technical drawings.

ACTIVITY 5.5-1: **Metric Dimensioning Rules**

(i) Dimensions which are less than unity (less than 1mm) should be preceeded by zero "0". Fig. 31a

(ii) When a dimension is a whole number, neither the zero nor the decimal is required. Fig. 31b

(iii) Digits in metric dimensions are not to be separated into groups by use of commas or spaces. Fig. 31c

(iv) There should be consistency with the unit of measurement.

(v) When a metric dimension consists of a whole number and a decimal portion, the whole number is written first, followed by the decimal point and finally, the decimal part of the number. Fig 31d

(vi) The unit of the dimension should be indicated in the tile block or in a small rectangle below the part. e.g.

"ALL DIMENSIONS IN MM"

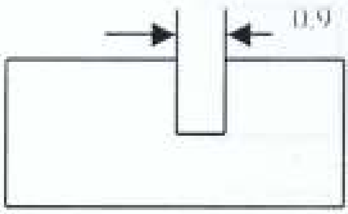


Fig. 31a

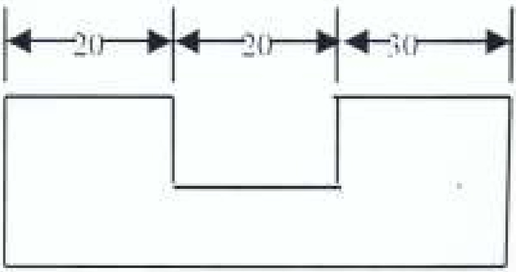


Fig. 31b

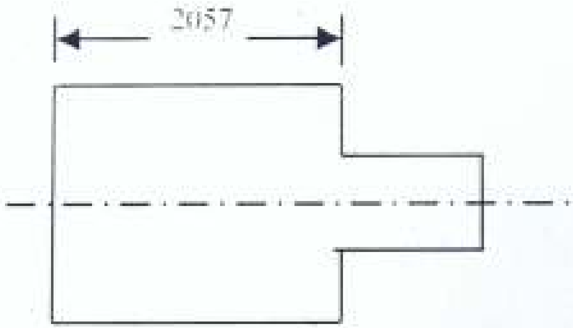


Fig. 31 c

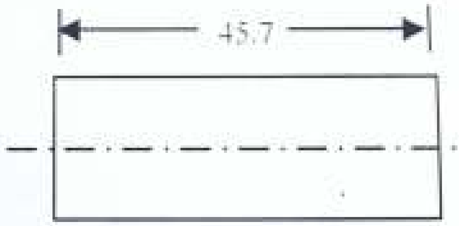


Fig. 31 d

ACTIVITY 5.6-1: DIMENSION ELEMENTS

A standard set of components are recommended for use on technical drawing. These components include dimension lines, extension lines, arrow heads, leaders and the real numbers or dimensions.

ACTIVITY 5.7-1: Dimension lines

Dimension lines are thin lines with arrow heads at each end used to indicate the distance being dimensioned. Dimensioning lines are drawn as thin lines using H or 2H.

Dimension lines may be broken for the placement of dimensions.

Fig. 32a

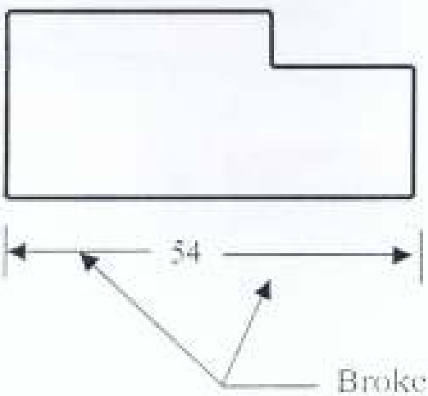


Fig. 32a

Broken dimension lines to allow for the placement of dimensions.

Where dimension line is not broken the dimensions are placed above the line. Fig. Fig. 32b

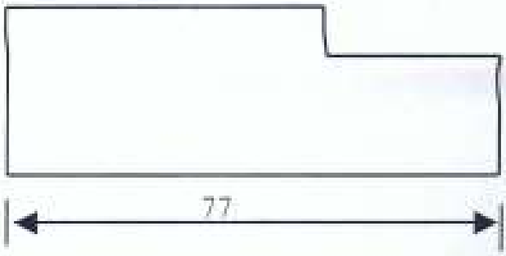


Fig. 32b

Dimension figures should be properly placed on the drawings. Fig. Fig. 32c

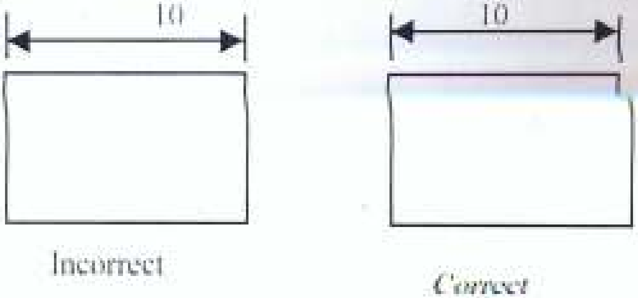
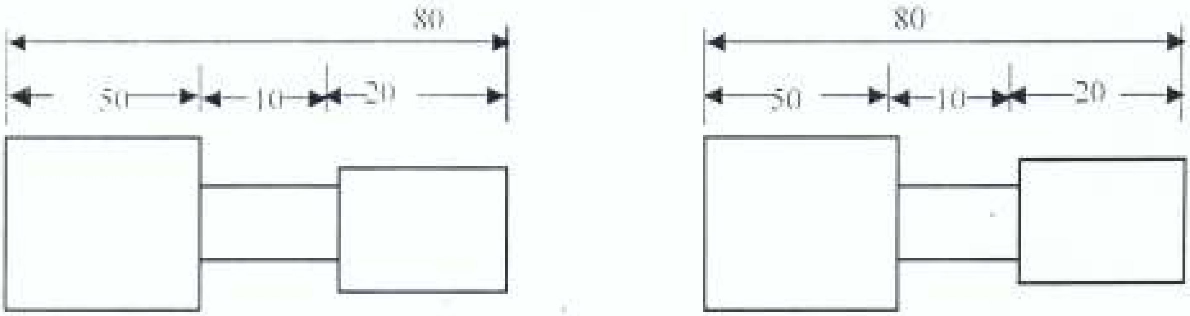


Fig. 32c

When dimensioning multiple features of an object, dimensions should be aligned uniformly and not staggered or randomly scattered about the object. Fig. 33



Incorrect Fig. 33 Correct

When several views of the same object are being dimensioned as in orthographic projection, dimensions should be placed between the views, with length, height depth and overall size of the object included. Fig. 34

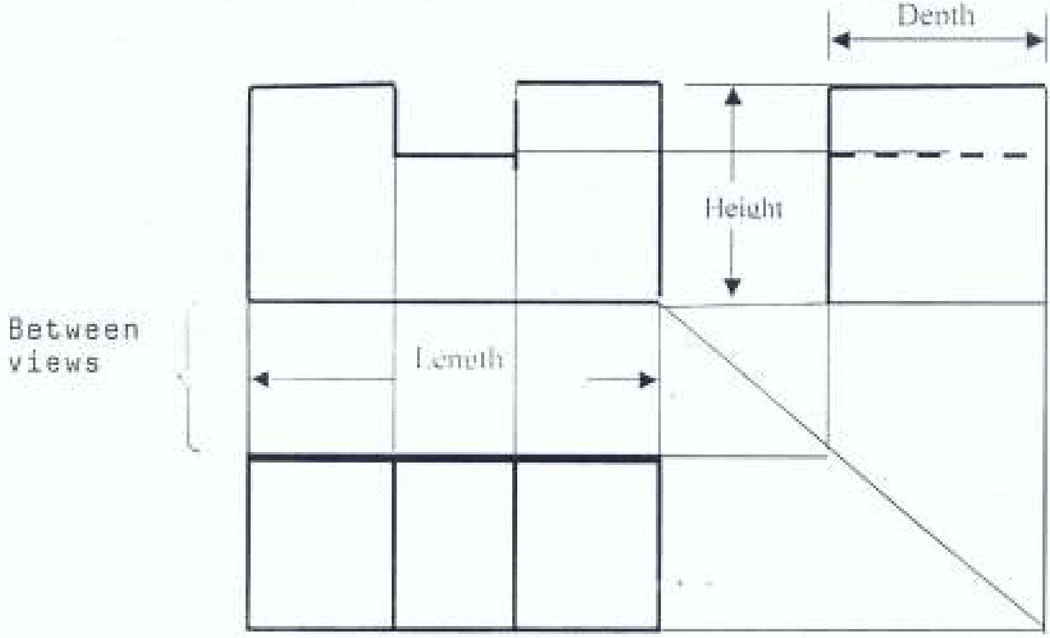


Fig. 34

There should be enough gap between the object and the dimension lines and between successive dimension lines. The first dimension line is usually spaced 10 to 25mm from the outline while successive dimension lines should have at least 5mm between them. Fig. 35a

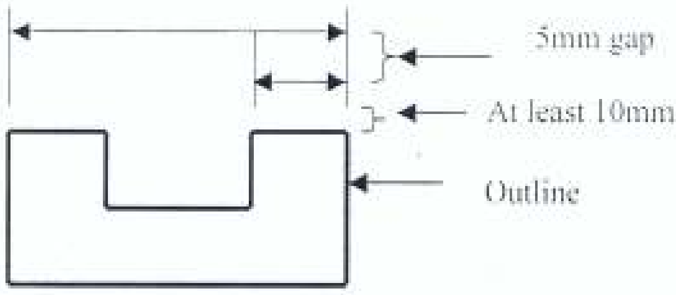


Fig. 35a

The shortest dimension should always be placed closed to the object. Fig. 35b

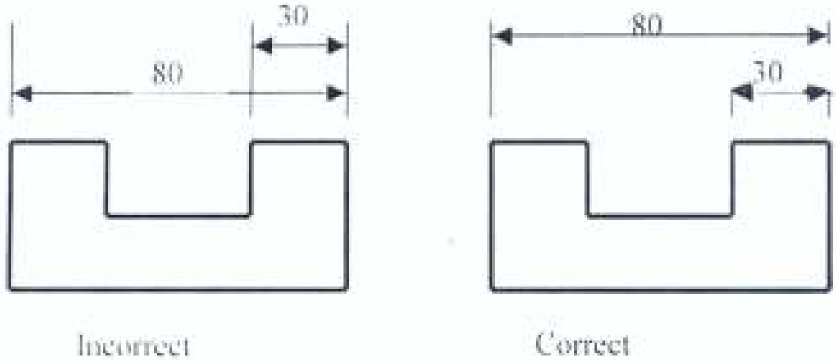


Fig. 35b

ACTIVITY 5.8-1: Arrow Heads

Arrow heads are used at the ends of dimension lines to show where a dimension begins and ends. Fig. 36. They are also used at the end of a lead or to show where a note or dimension applies to a drawing. Arrows heads can be open or solid.

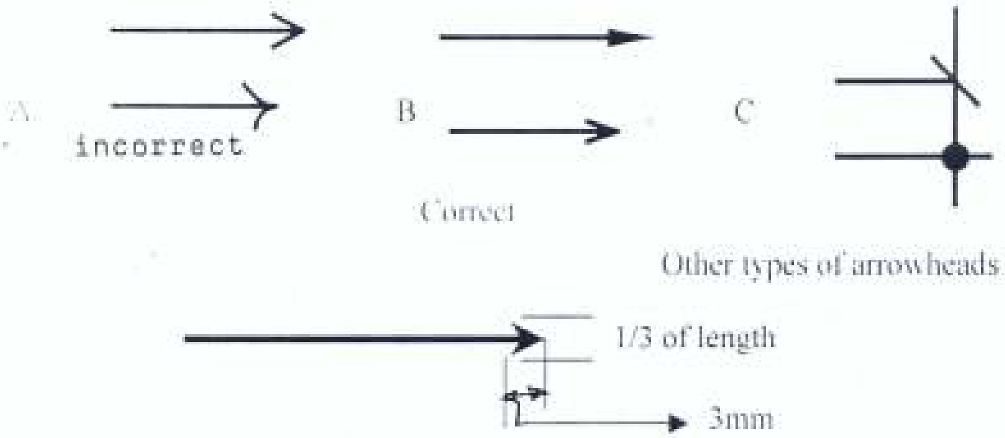


Fig. 36: Extension Lines

Extension lines are thin lines that extends from the outline of the object. They are used to locate center points and to provide space or dimension lines. Fig. 37

Extension lines should not touch the view because they are not part of the view. There should be a visible gap of 1 to 1.5mm between the object and the beginning of an extension line.

An extension line should extend about 3 - 4mm beyond the last dimension line

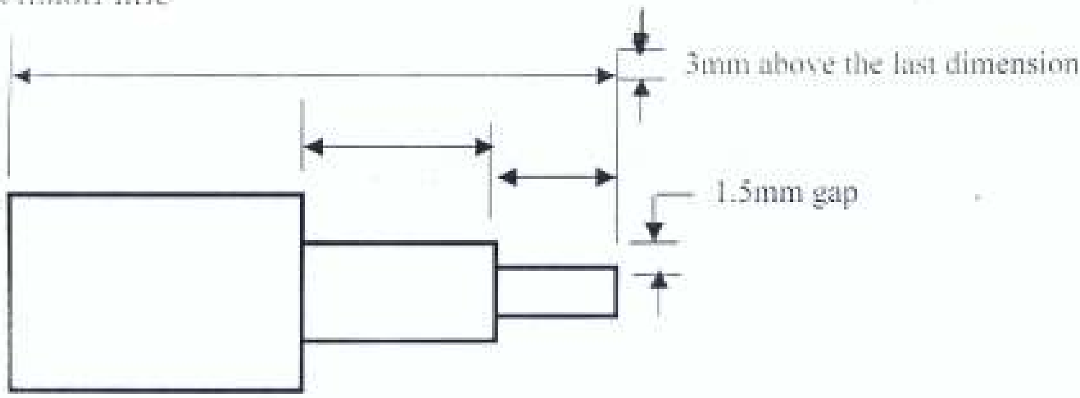


Fig. 37:- Extension lines

ACTIVITY 5.9-1: Leaders

Leaders are thin, straight lines that lead from a note or dimension to a feature on the drawing. Fig. 38a

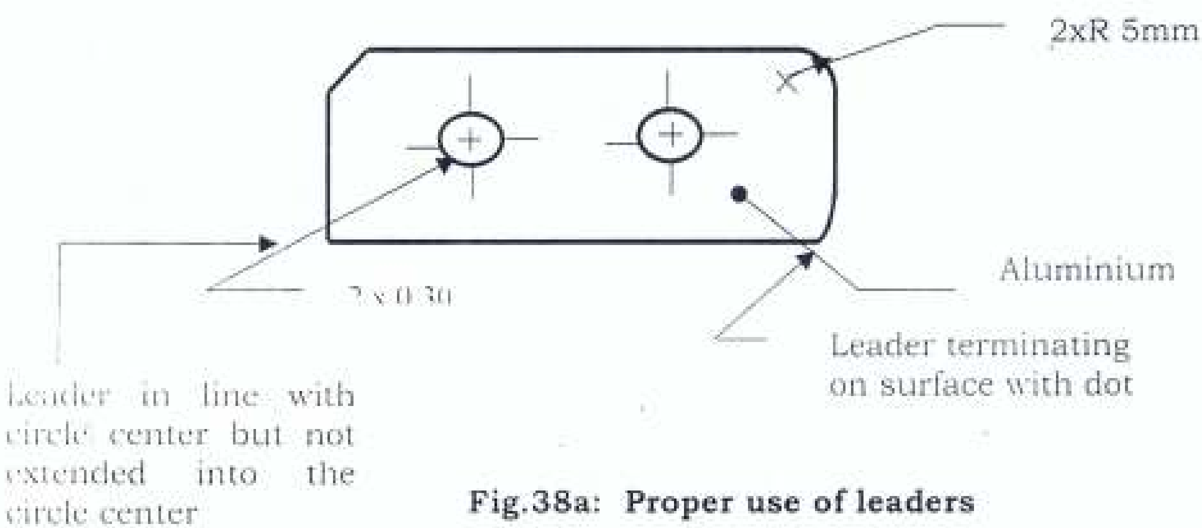


Fig.38a: Proper use of leaders

Leaders lines are drawn at an angle of between 30^0 and 60^0 Fig. 38b

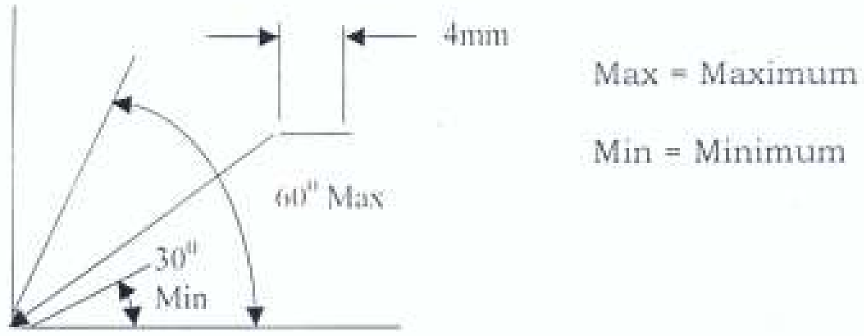


Fig. 38b: Angle of a leader line

Leader lines should not be drawn parallel to extension or dimension lines. When placing a dimension and / or note at the end of a leader, it is advisable to letter from the leader than into the leader. Fig. 38c

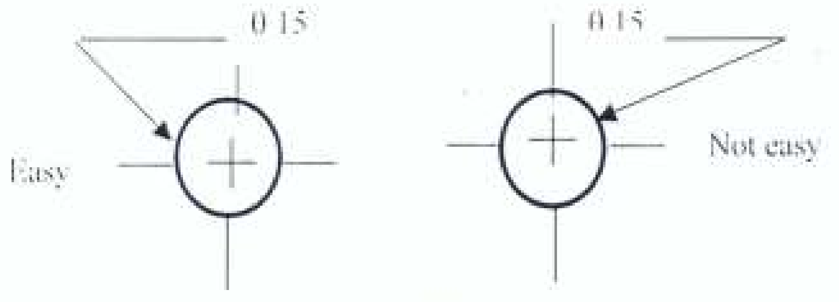


Fig 38c

Dimensional notes - These are notes used to describe size or form such as specifying holes, chamfers and threads. Fig. 38d

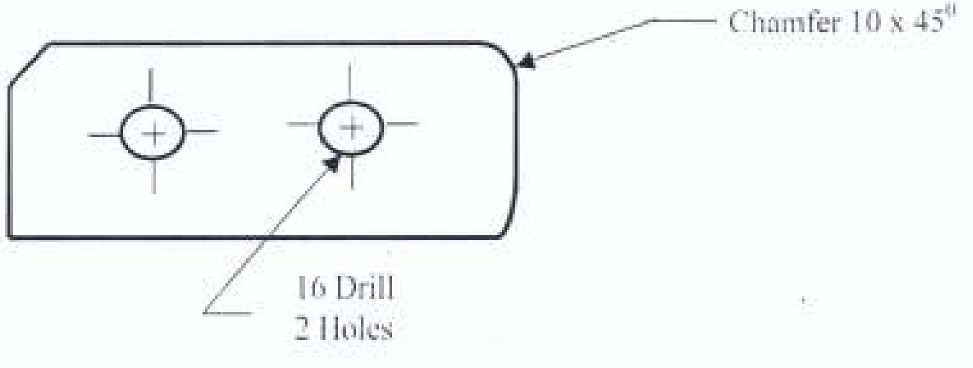


Fig. 38d: Dimensional notes with leaders are used to provide additional information not communicated elsewhere.

ACTIVITY 5.10-1: Dimension Figures: All lettering should be perfectly legible in order to save time and prevent costly mistakes.

- Guidelines may be used for beginners.
- Dimension figures should not be over crowded. Where there is limited space a practical and effective method is used. Fig. 39 a – e.

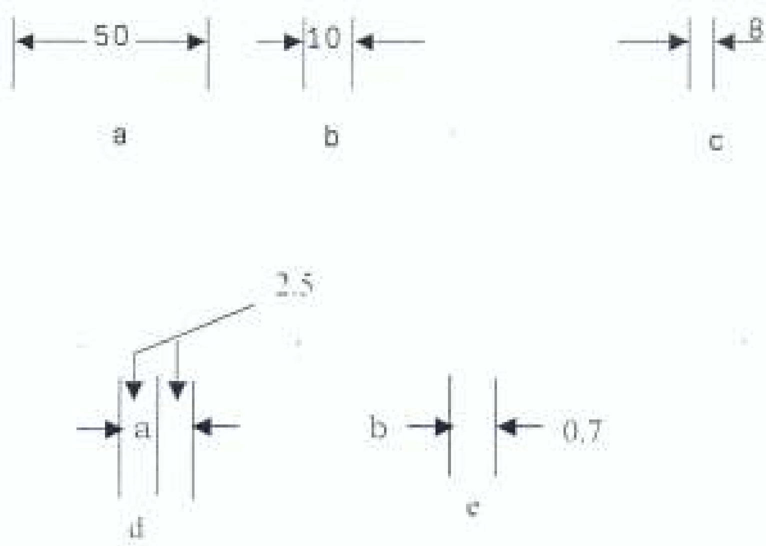


Fig. 39 Dimension figures. At "a". There is enough space.

- All numerals are 3mm high. Fig. 39(f)

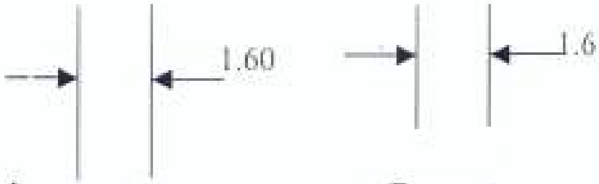
Fig. 39f

- All decimal points should be bold with enough space.

- Dimension figure less than zero should be preceded by zero e.g. 0.5.

- Where the dimension figure exceeds a whole number by fraction of a millimeter, the last digit to the right of the decimal point is not followed by zero except when expressing tolerances. Fig. 40a

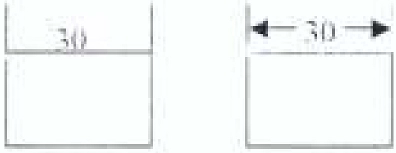
Example



Incorrect Correct

Fig. 40a

- Dimension figure should not be lettered over any outline on the drawing. Fig. 40b

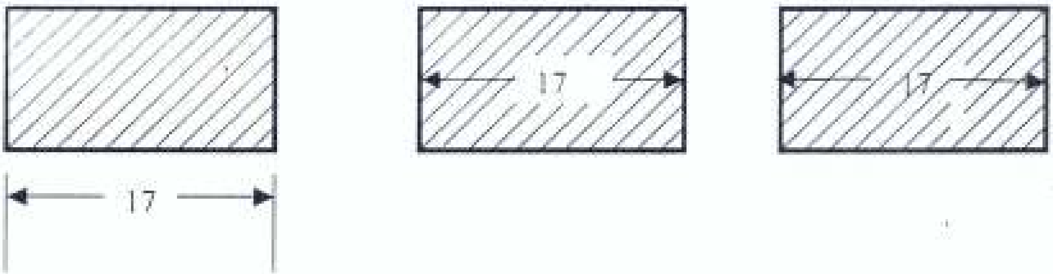


Wrong Correct

Fig. 40b

- Dimension figures should be placed outside a sectional area but if compulsory that it must be placed on a sectional area, an opening must be left in the section lining for the dimension figure. Figure 41

Best Acceptable Wrong



ACTIVITY 5.11-1: **Staggered Dimension**

In a group of parallel dimension lines, the numerals should not be stacked up on above the other. Figure 42 (a) but should be staggered as in (b)

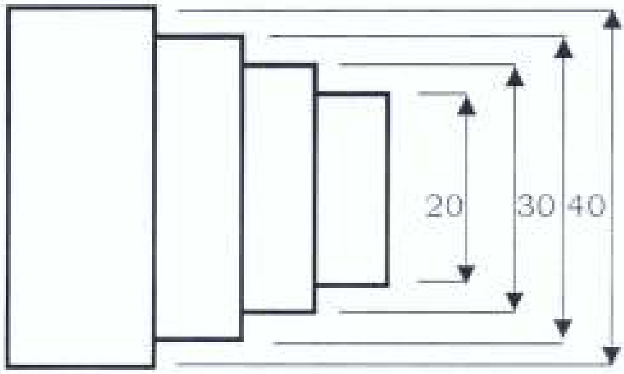


Fig. 42a (a) Wrong

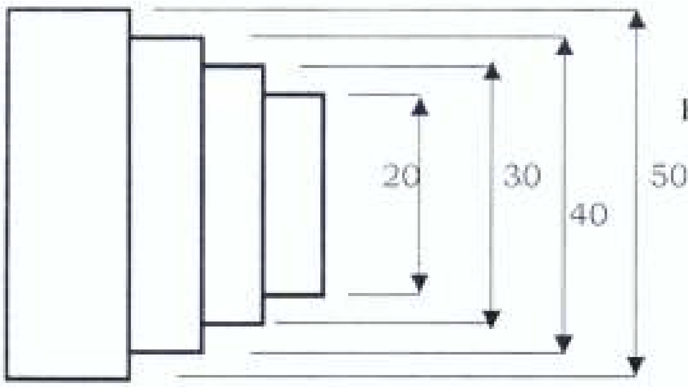


Figure 42b Staggered numerals.

(b) Correct

ACTIVITY 5.12-1: <u>Aligned or Unidirectional Dimensioning Systems</u>

The aligned dimensioning system figure 43a is a system in which the dimensions are aligned with the dimension lines so that they can be read either from the bottom of the drawing sheet or from the right hand side.

The aligned system is difficult to read and should be avoided if possible.

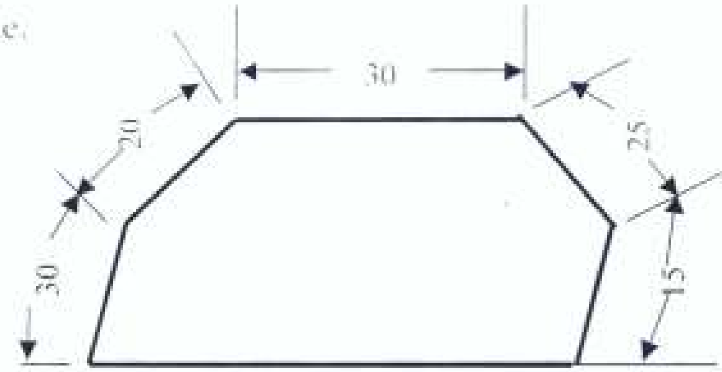


Figure 43a Aligned system

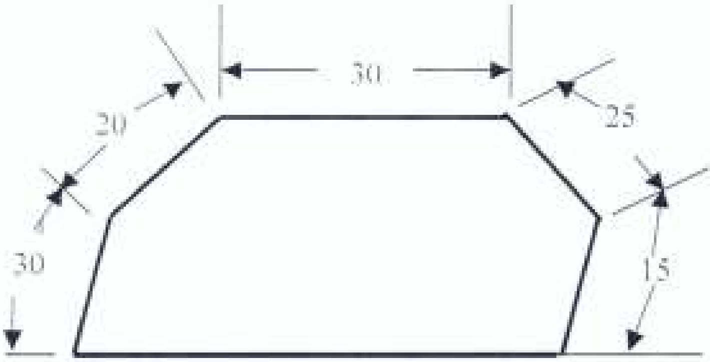


Figure 43b Unidirectional system

Unidirectional system figure 43b is a system in which all dimensions are written so that they can be read from the bottom of the drawing sheet.

Dimension lines that appear at unusual angles are best dimensioned using the unidirectional dimension system figure 43c

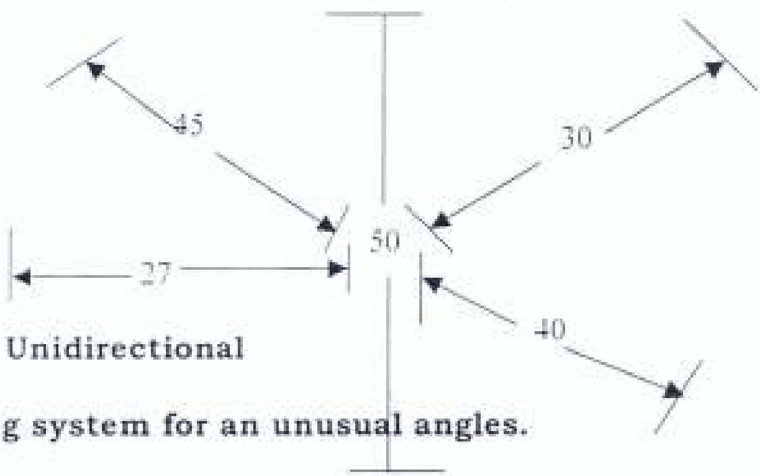


Figure 43c: Unidirectional dimensioning system for an unusual angles.

Activity 5.8-1 Specific dimensioning systems

Abbreviations and dimensioning symbols

Square (In a note)	SQ
Square (Before The Dimension)	□
Diameter (Before The Dimension)	⌀
Diameter (In A Note)	DIA
Number of Time Places	2X
Deep or Depth	↧
Radius (Before The Dimension)	R
Countersink	⌵
Counter Bore Or Spot Face	⌴
Centers	CRS
Material	MALT
Figure	FIG.
Counter bore	C'BORE
Pitch Circle Diameter	PCD
Across Flats	A/F
Across Corners	A/C
Round Head	RH
Spot Face	SF
Reference Dimension	( )
Slope	⌳
Conical Taper	⌲
Arc Length	

Spherical Radius	**RS**
Spherical Diameter	**SQ**
Hexagonal Head	**HEX HD**
Right Hand	**RH**
Left Hand	**LH**
Threads Per Inch	**TPI**
Outside Diameter	**O/D**
Inside Diameter	**I/D**
Number	**NO**
Center Line	**C**
Chamfered	**CHAM**
Counter Sink	**CSK**
Millimeter	**MM**
Centimeter	**CM**
Meter	**M**

NOTE: Full stop is not used for technical drawing abbreviations unless the abbreviation makes a word e.g. NO. or FIG.

Dimensioning Chords, Arcs and Angles

Chords. Arcs and angles are dimensioned in a similar way fig.

When dimensioning a chord. The dimension line should be perpendicular and the extension lines parallel to the chord. Figure 44a

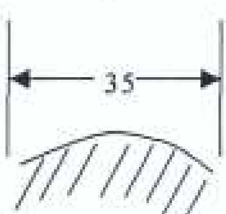


Figure 44a Chord dimensioning

- When dimensioning an arc the dimension line runs concurrent with the arc curve, while the extension lines are either vertical or horizontal. The arc symbol is placed above the dimension Fig. 44b

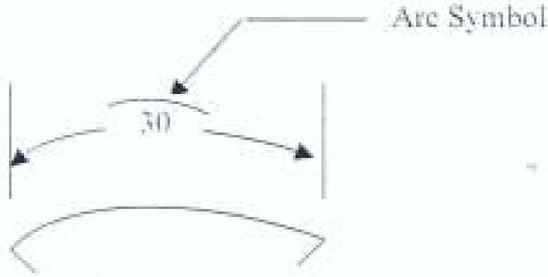


Figure: 44b Arc Dimensioning

When dimensioning an angle, the dimension line is a circular arc having its center on the point of the angle. Figure 44c. Angular dimensions are given in degrees, degrees and minutes or degrees, minutes and seconds depending on the accuracy required. Angle less than one degree should be preceded by O^0.

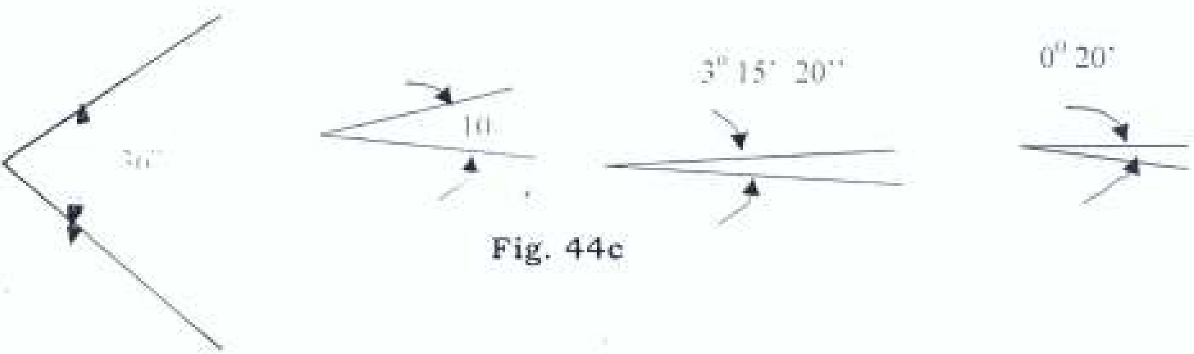


Fig. 44c

36^0	15'	20"
Degrees	Minutes	Seconds

NOTE: Angular measurements may also be stated in decimal form. All that is needed to know is that 60 seconds make 1 minute and 60 minutes make 1 degree.

ACTIVITY 5.14-1: **Dimensioning Circles**

Complete circles are dimensioned by their diameters. Figure 45 The dimension is preceded by the symbol ϕ meaning diameter. Circles must be shown with two center lines.

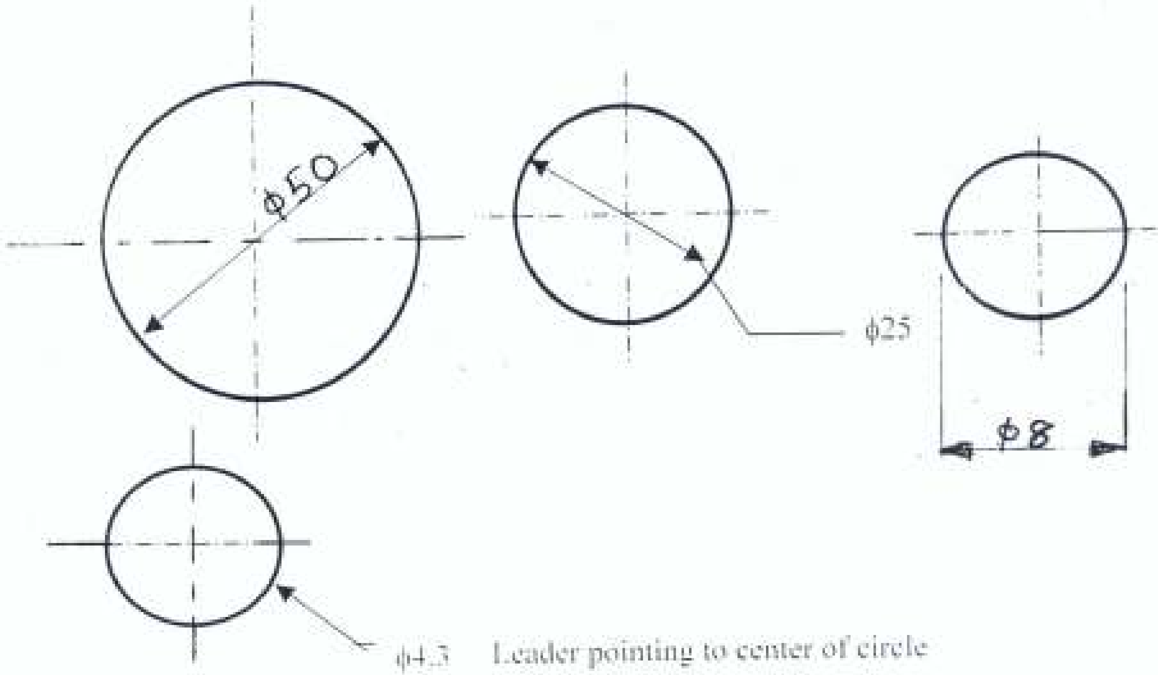
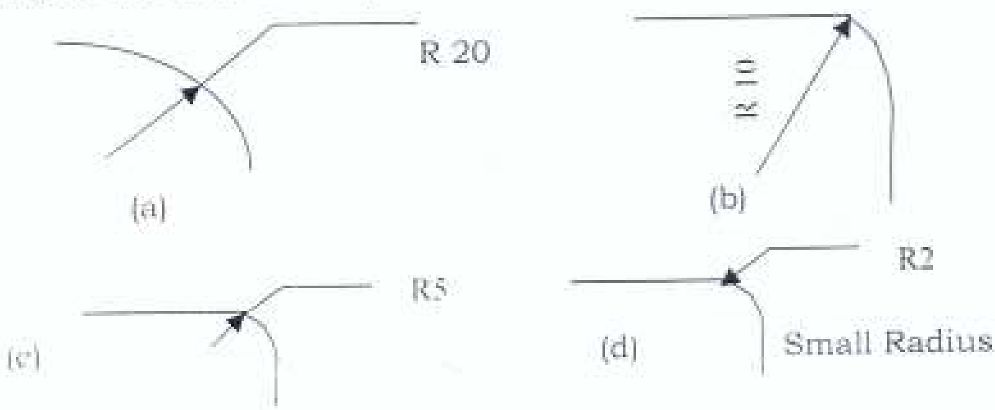


Fig. 45 : Dimentioning Circle.

ACTIVITY 5.15-1: **Dimensioning Radius**: Radius is dimensioned using a dimension line which passes through or is in line with the arc center. Figure 46a-e The dimension line carries one arrowhead only and are placed inside the Radius except for small radius.



(e)

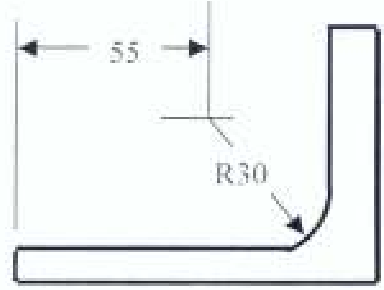


Fig 46 a – e: Dimensioning Radius

For small radius a note may be placed at the title block or bottom of the drawing thus:

Note: All Unspecified Radii = 2mm.

ACTIVITY 5.15a-1: Fillets and Corner Radii: Fillets and corner radii are dimensioned by a leader. Figure 47 or a small note where there are large number of fillets or rounded edges of the same size on a part.

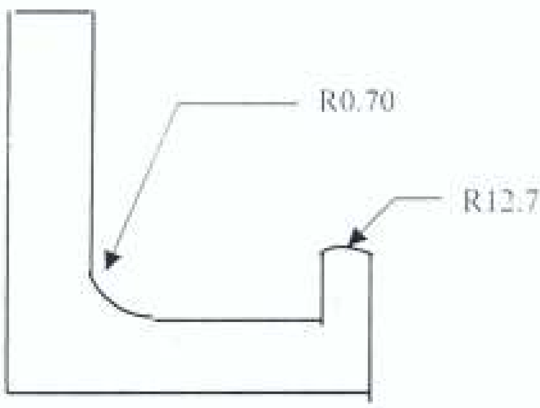


Fig. 47: Dimensioning fillets and corner radii

ACTIVITY 5.16-1: <u>**Hidden Features:**</u> Dimension line should not be drawn to hidden feature in a drawing except in an exceptional cases such as partial view where there may be no other view for dimensioning. A section view should be used. Figure 48

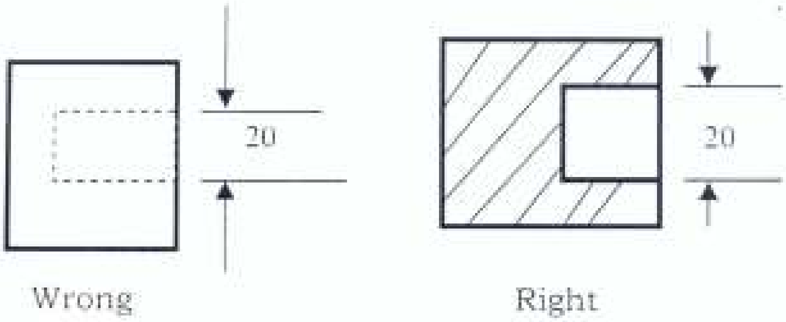


Fig.48 : Dimentioning Hidden Features

ACTIVITY 5.17-1: <u>Dimensioning Irregular Curves</u>

Irregular curves (especially symmetrical curves) may also be dimensioned using coordinate dimensions from a specified datum. Figure 49

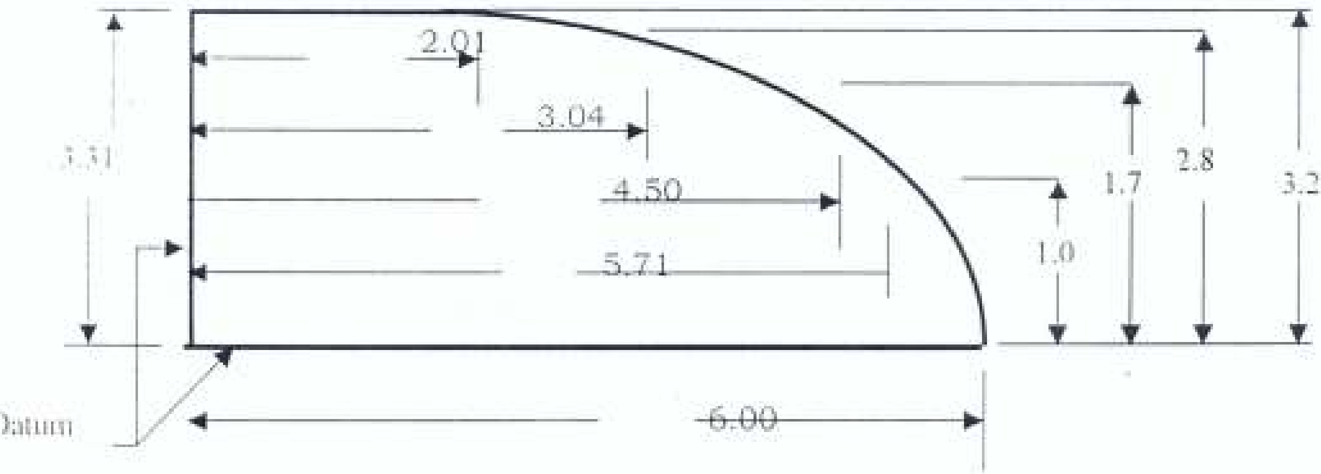


Figure 49: Dimensioning Irregular Curves.

ACTIVITY 5.18-1: <u>Dimensioning Chamfers</u>

Chamfers are dimensioned in a variety of ways depending on the location of the chamfer. Figure 50 (a – d)

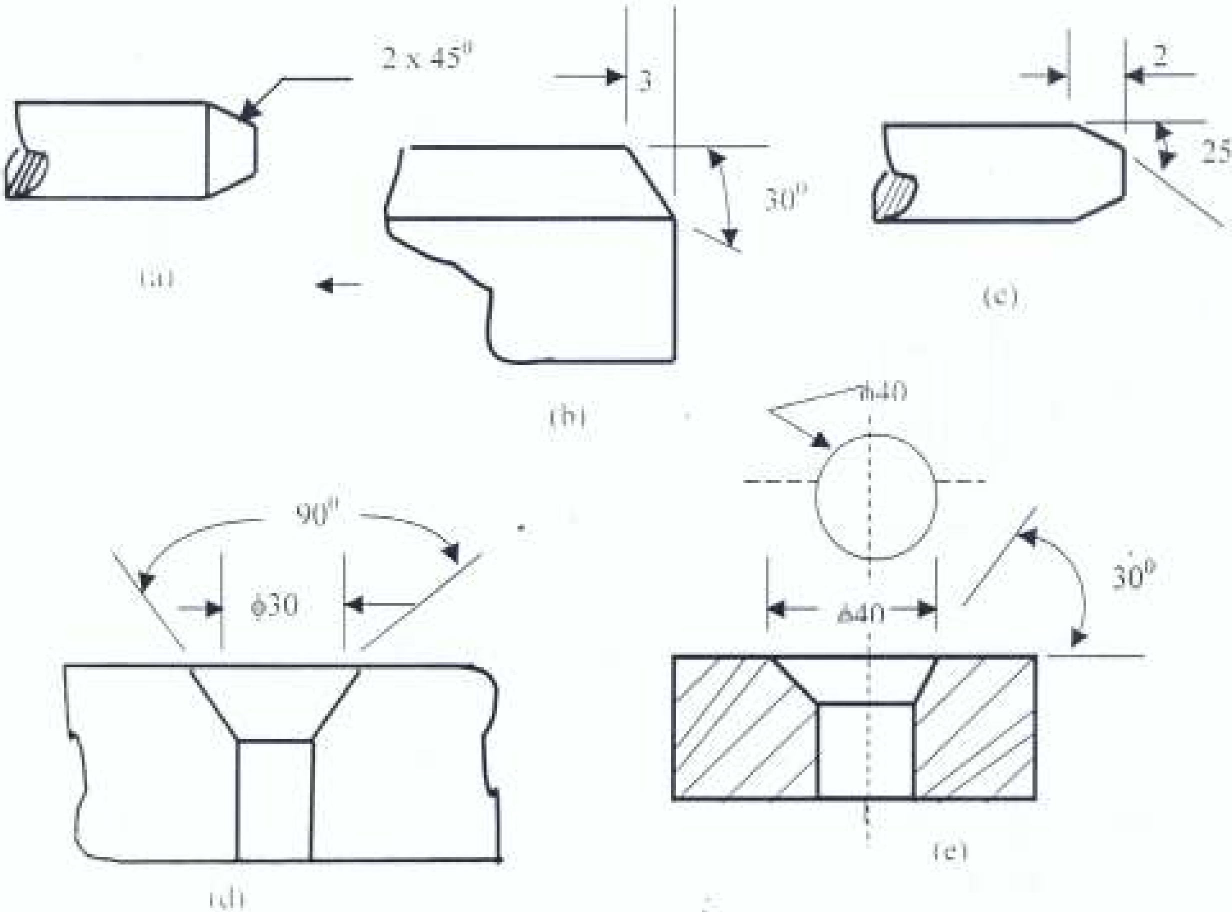


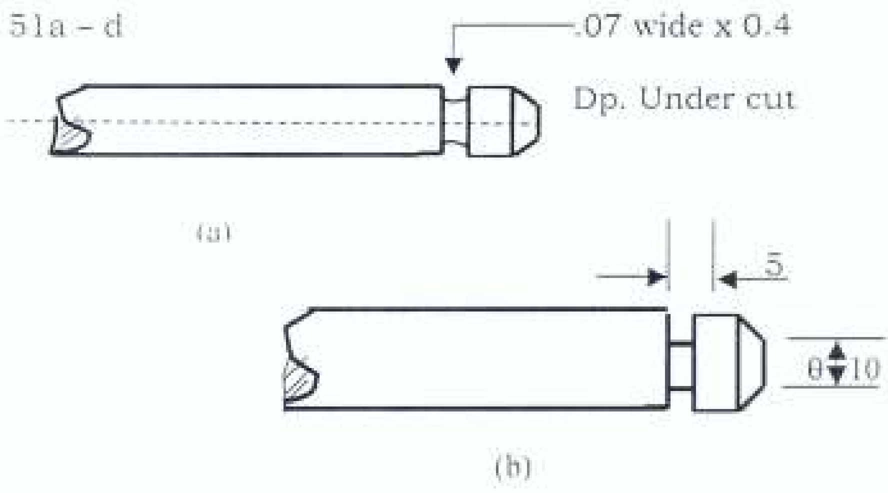
Figure 50 a –e: Dimensioning Chamfers (d & e Internal Chamfers)

Chamfers should never be dimensioned along their angular surfaces

ACTIVITY 5.19-1: Dimensioning Necks and Undercuts

Necks and undercuts are recessed cuts into cylindrical parts.

Figure 51a – d



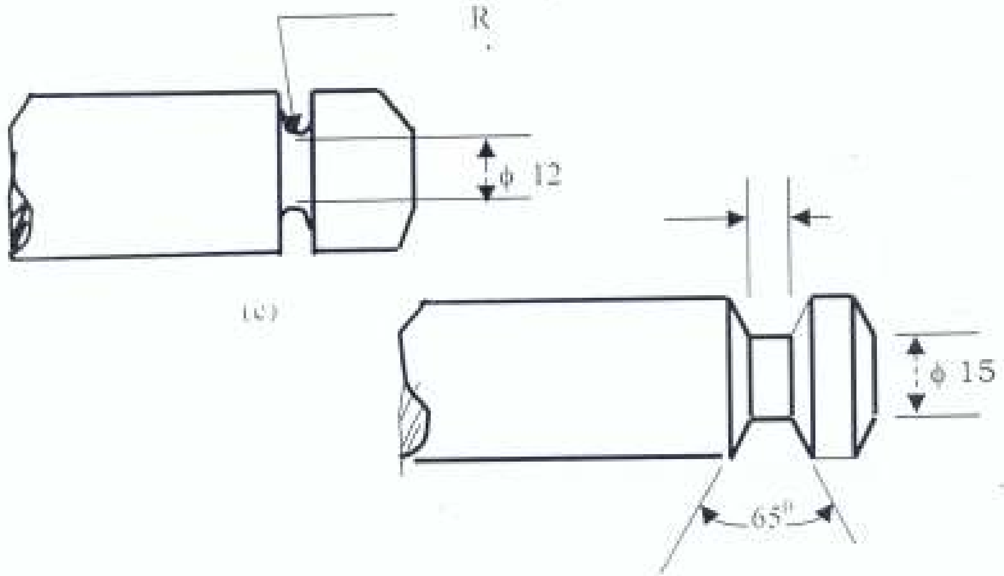
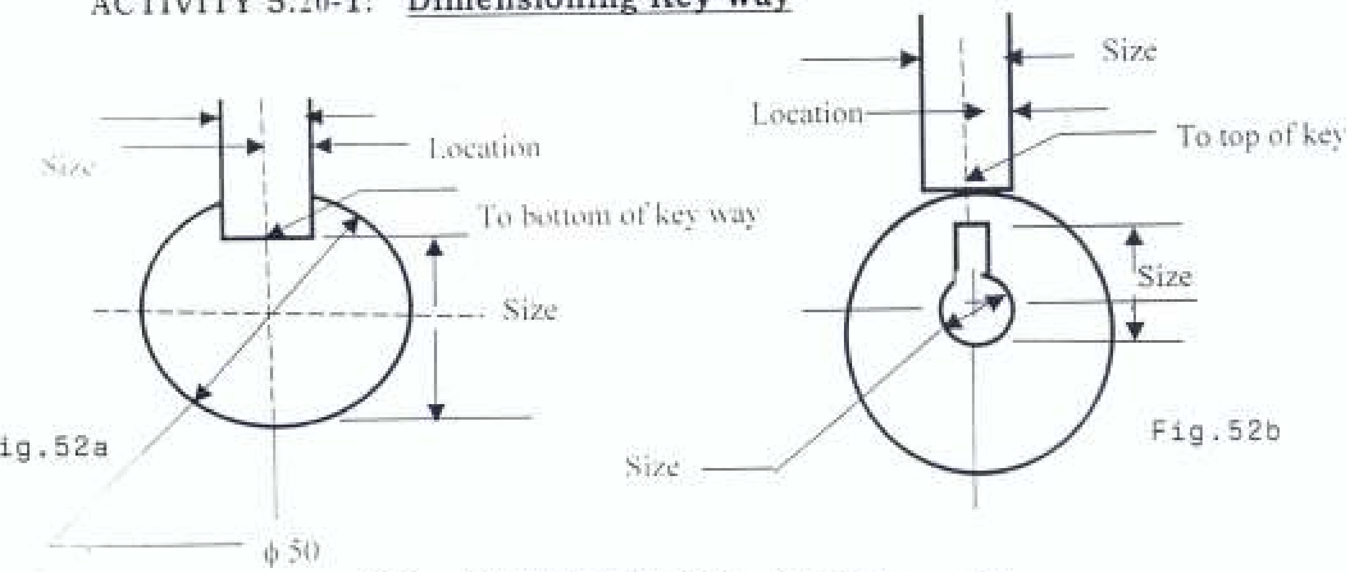


Fig. 51: Dimensioning neck and undercuts

ACTIVITY 5.20-1: **<u>Dimensioning Key Way</u>**

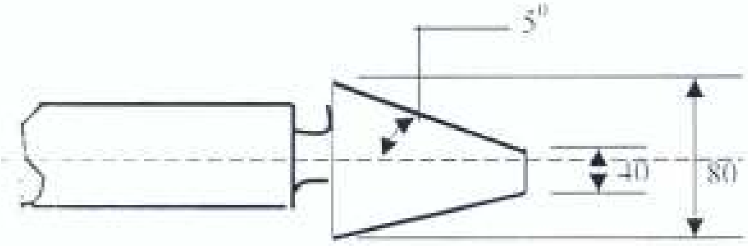


(a) Fig. 52 Dimentioning keyways (b)

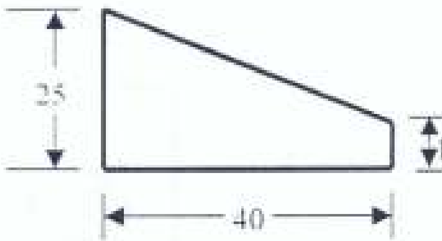
Exterior Size

Note that both size and location dimensioning are required to completely dimension a key way.

ACTIVITY 5.21-1: **<u>Dimensioning Tapers</u>** - Conical and Flat. Fig. 53



Dimensioning Round Tapers



Flat Tapers

Fig. 53

ACTIVITY 5.22-1: Dimensioning Features for Position

Position dimensions specify the location or distance relationship of one feature of a part with respect to another feature or datum.

(a) **Point to Point Dimensioning:** This is widely used for dimensioning locations usually for simple parts figure ....

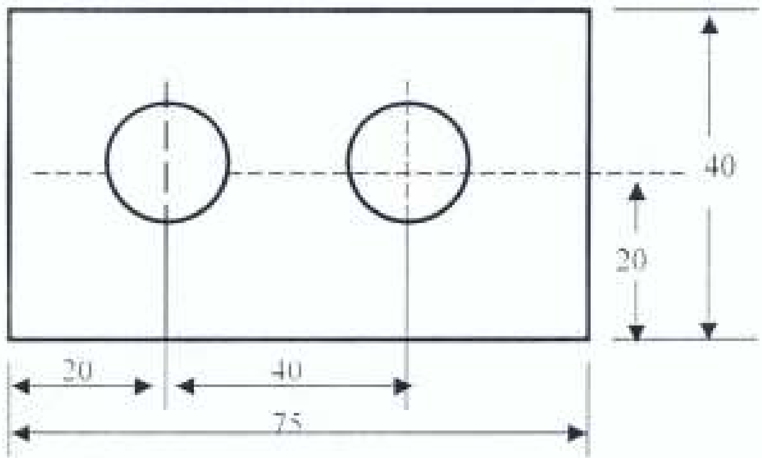


Figure 54: Point to Point Dimensioning.

(B) **Rectangular Coordinate Dimensioning**

Is used in locating holes and other features that lie in a rectangular or non-circular pattern. These dimensions are usually at right angle to each other and from a datum plane figure 55.

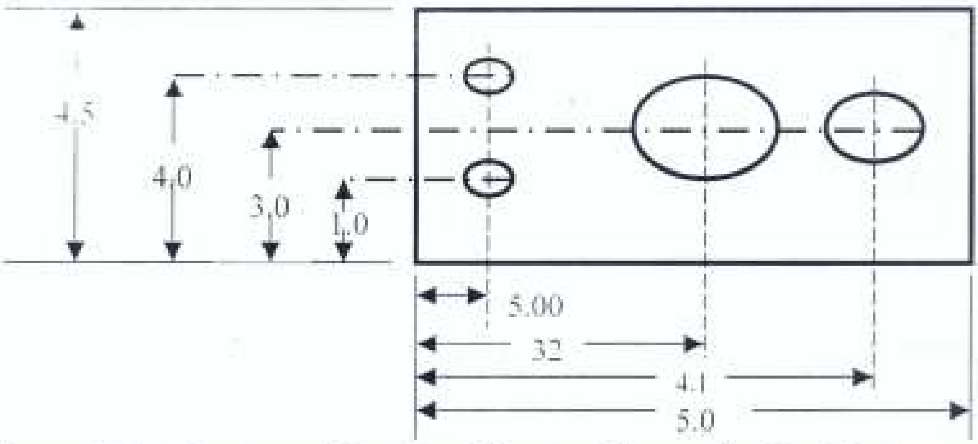


Figure 55: Rectangular Coordinate Dimensioning Datum and Centre Lines

(C) **Polar Coordinate Dimensioning**

Is used when holes or other features to be located lie in a circular or radial pattern. Figure 56. Both radial dimensions and datum planes can be used in polar coordinate dimensioning..

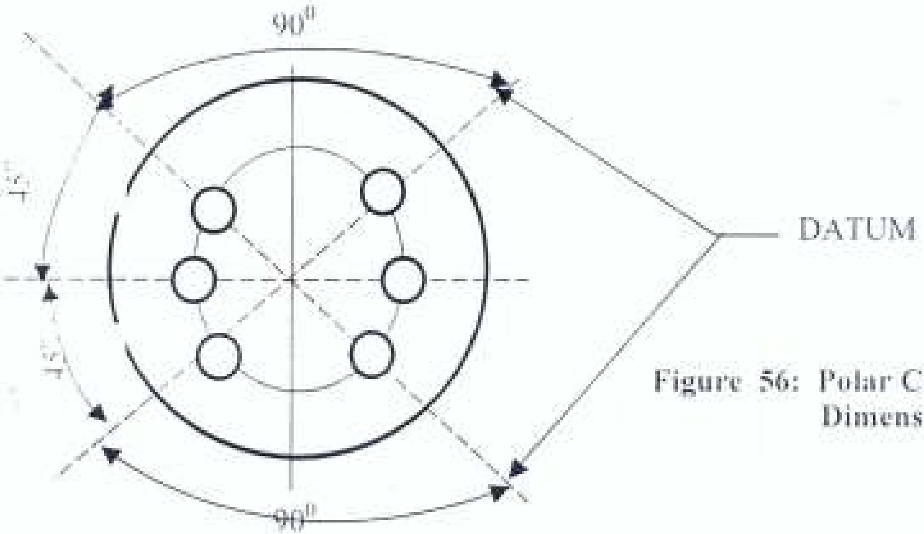


Figure 56: Polar Coordinate Dimensioning

ACTIVITY 5.23-1: Dimensioning Cylinder

There are two methods of dimensioning a cylinder. The first method is when the longitudinal view and the end view are given. Figure 57a. In this method the length is shown in the longitudinal view while the diameter is shown between the longitudinal view and the end view. In the second method the end view is left off. Therefore, the two dimensions are applied to the longitudinal view. Figure 57 (b)

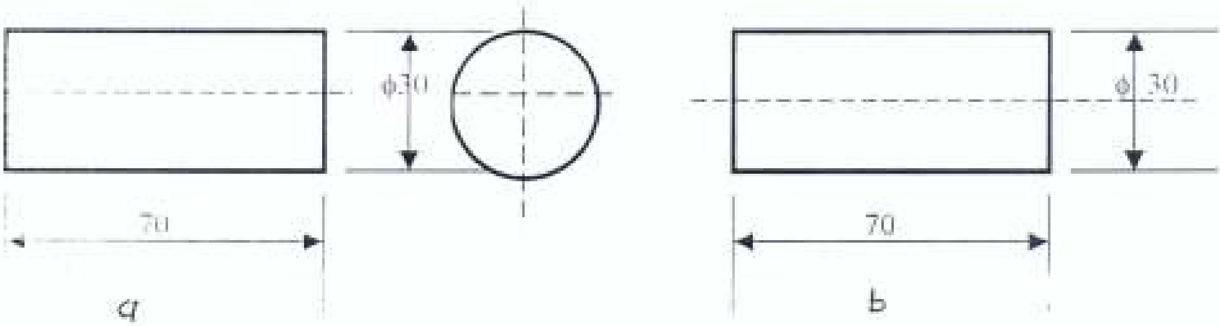


Figure 57: Dimensioning a Cylinder.

Note: The diameter is always specified and not radius when dimensioning a cylinder.

ACTIVITY 5.24-1: Dimensioning Square

The length dimension is applied to the longitudinal view while the height dimension is placed between the longitudinal view and the end view and preceded by the square symbol. Figure 58

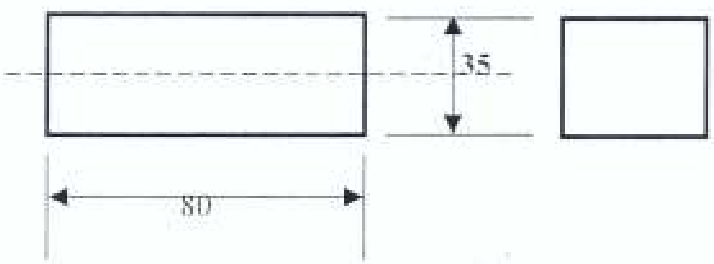
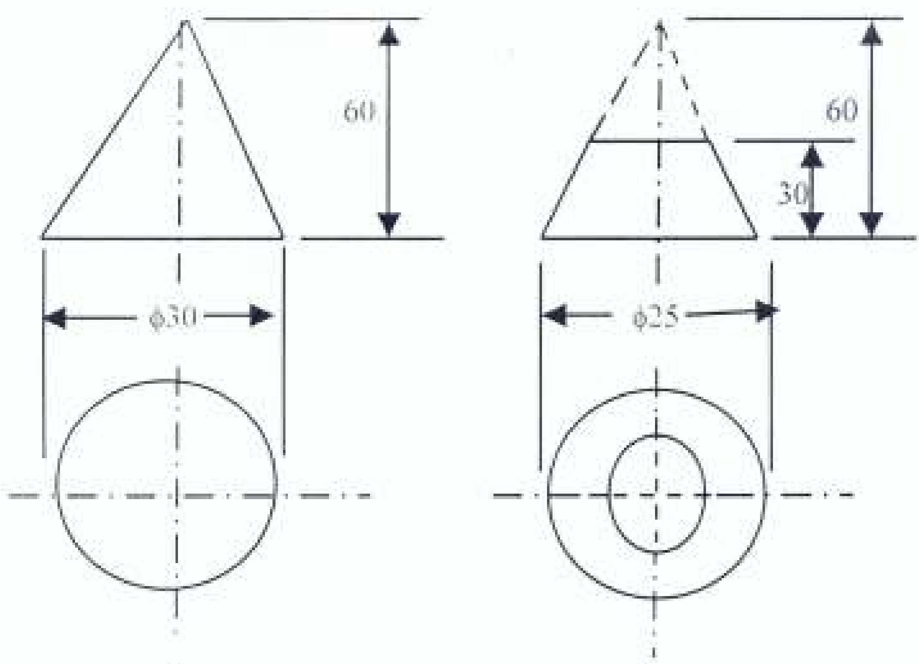


Figure 58: Dimensioning a Square

ACTIVITY 5.25-1: Dimensioning Cone

A cone is dimensioned by showing its altitude in the view where the cone appears as a triangle and showing the diameter of the base between the top view and front view. The frustum of a cone is dimensioned by giving the diameter between the top and front view, and both heights in the front view where the cone would appear as a triangle. Figure 59a shows the various dimensioning of a cone.

Figure 59b shows the dimensioning of the frustum of a cone while fig 59c illustrate how to dimension a cone that is cut-off at an angle.



a b

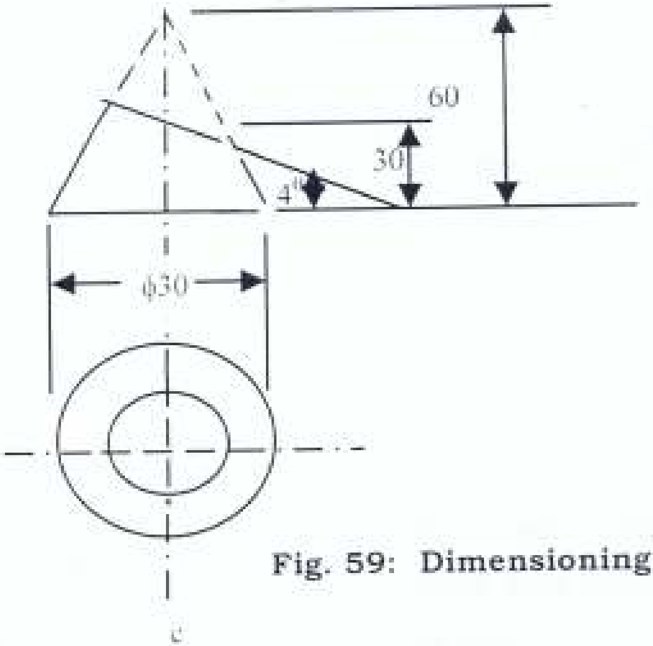


Fig. 59: Dimensioning cone

ACTIVITY 5.26-1: **Dimensioning Prisms**

A prism is usually dimensioned in two or more places depending on the type. Fig. 60

W = Width

D = Depth

H = Height

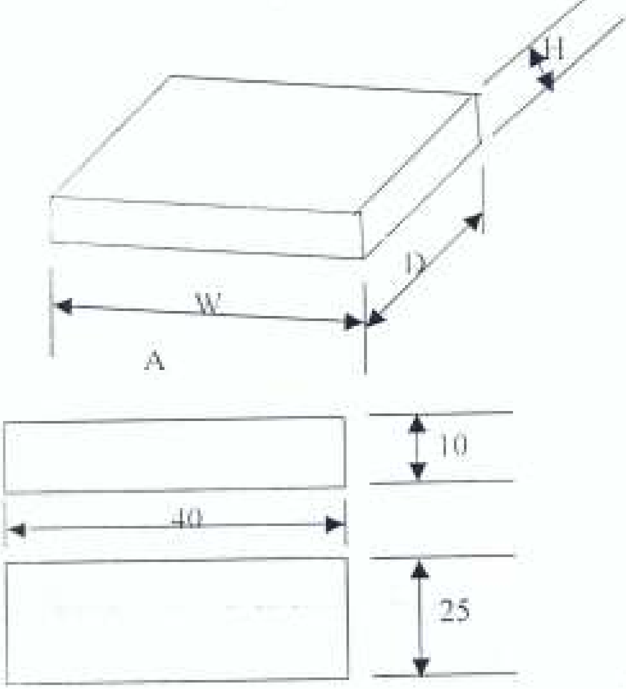


Figure 60a: **Rectangular Prisms.**

A rectangular Prism need 3 dimensions

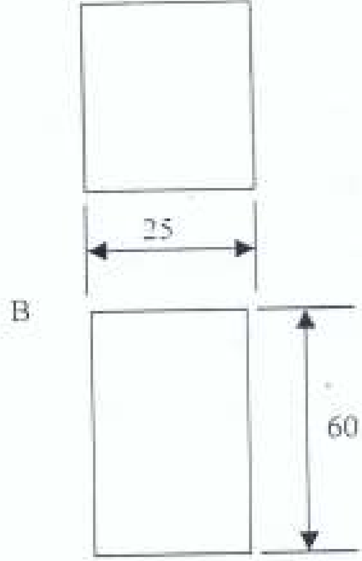


Fig. 60b Square Prism. Only two dimensions are needed

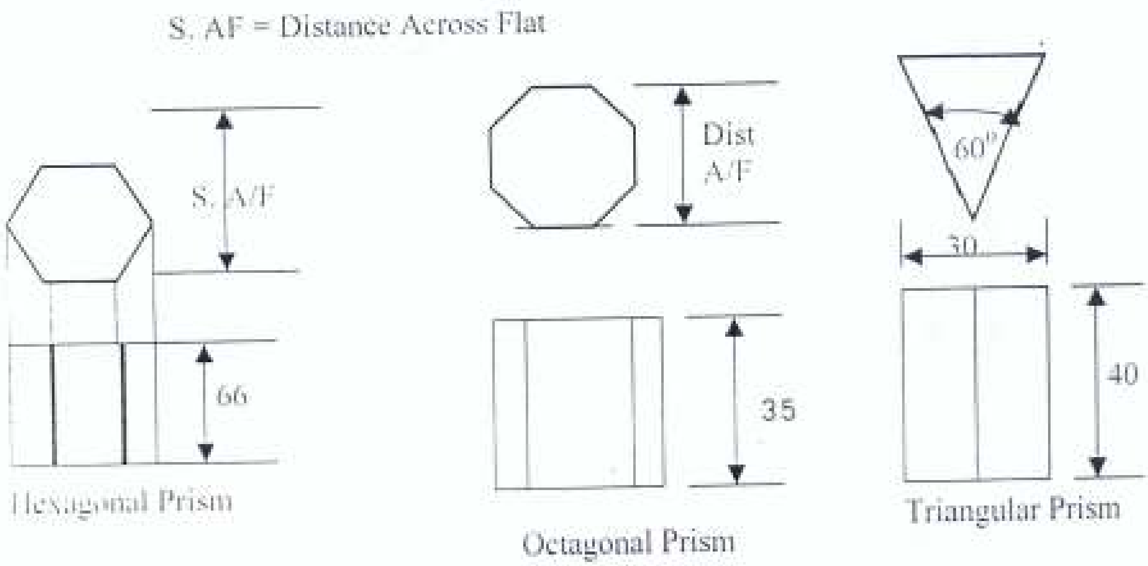


Fig 61: Dimensioning prisms

ACTIVITY 5.27-1: Dimensioning pyramids

A pyramid is dimensioned by showing the height in the front view and the dimensions of the base and the center of the vertex in the top view figure 62a. If it is a square base pyramid it is only necessary to show the base dimension on one side of the base in the top view and to indicate that the base is square by using the appropriate symbol. Fig. 62b.

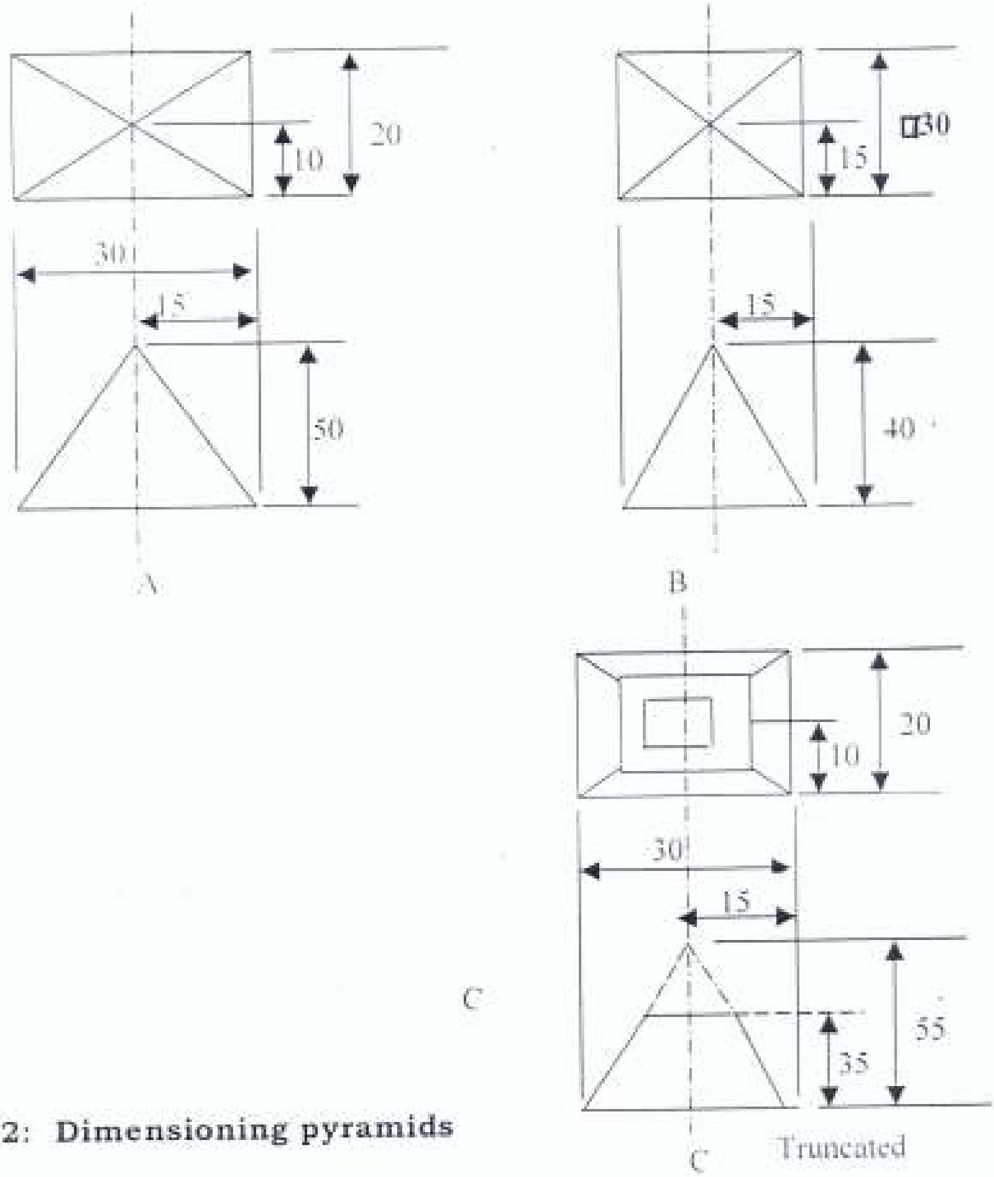
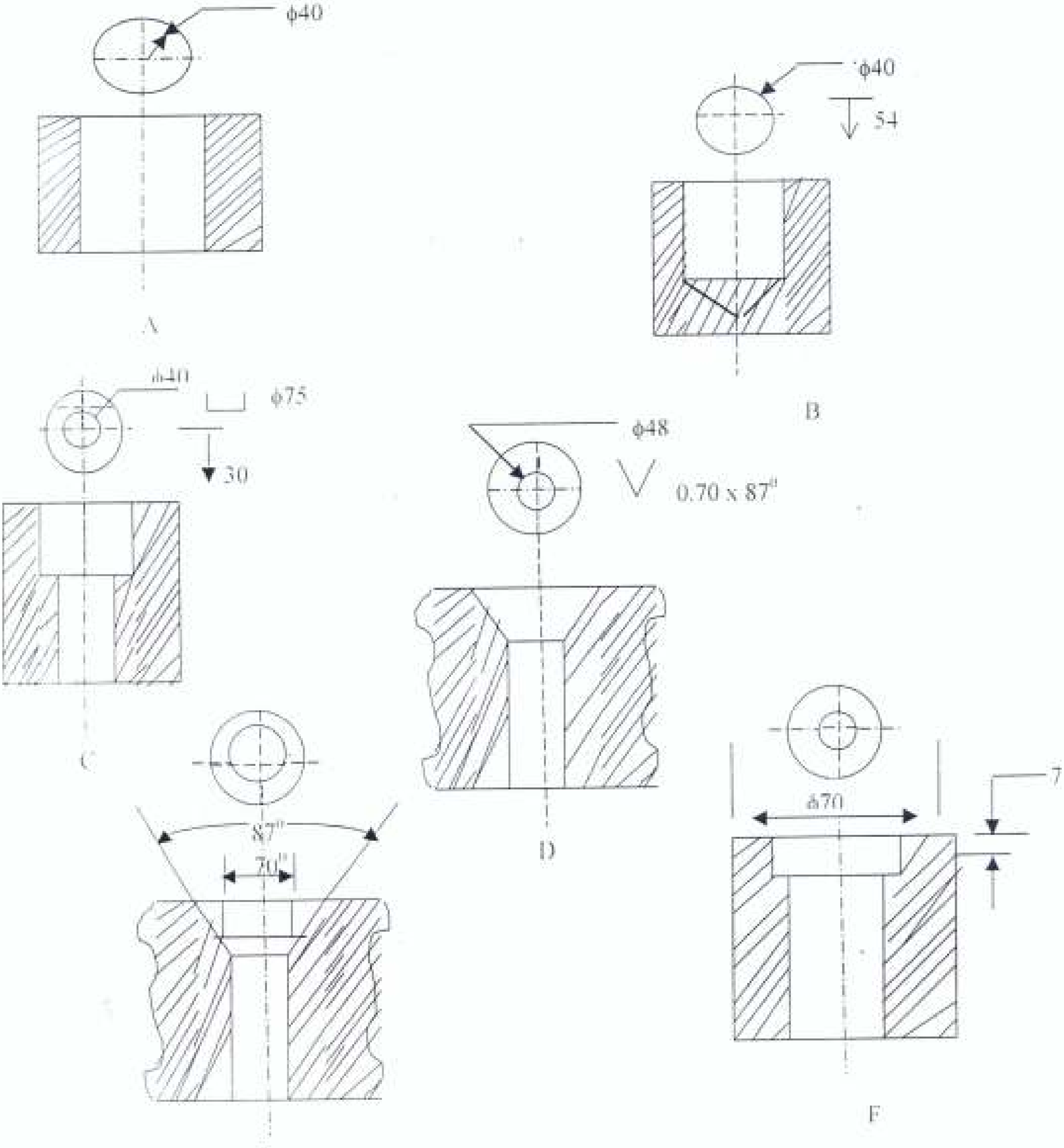


Fig. 62: Dimensioning pyramids

ACTIVITY 5.28-1: <u>Dimensioning for Holes</u>

Figure 63: Dimensioning for Holes. These are various holes produced during drilling, reaming, counter boring or spot facing operations.



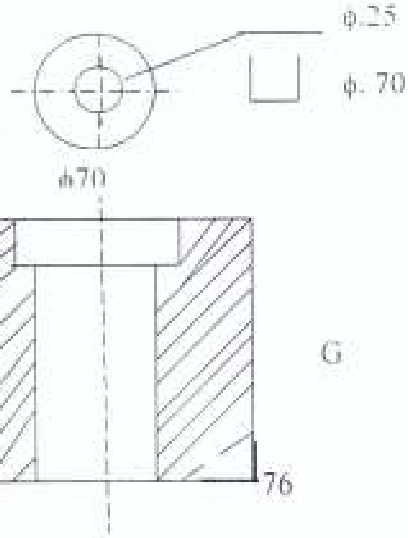


Fig. 63: Dimensioning Holes

ACTIVITY 5.29-1: **DIMENSIONING CONCENTRIC AND NON CONCENTRIC SHAFTS**

The three methods used for dimensioning concentric and non-concentric shafts are:

(i) Chain Dimensioning. Figure 64a

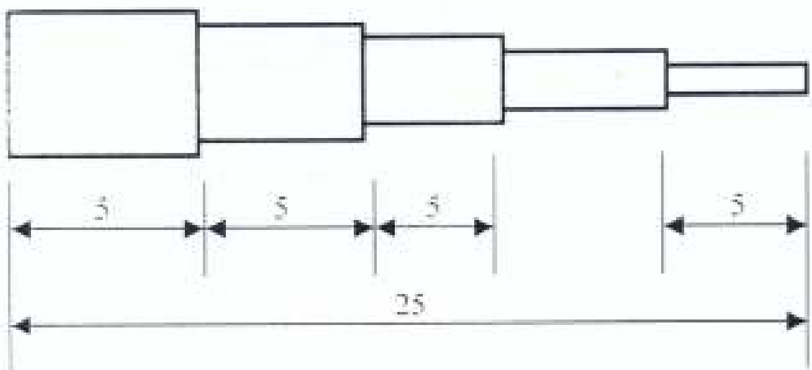


Fig. 64a

(ii) Datum or base line dimensioning Fig. 64b

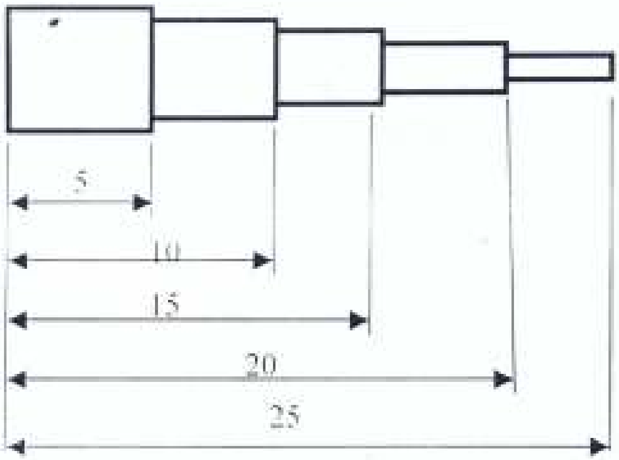


Fig. 64b

(i) Datum dimensioning combined with a reference dimension.

Fig. 64c

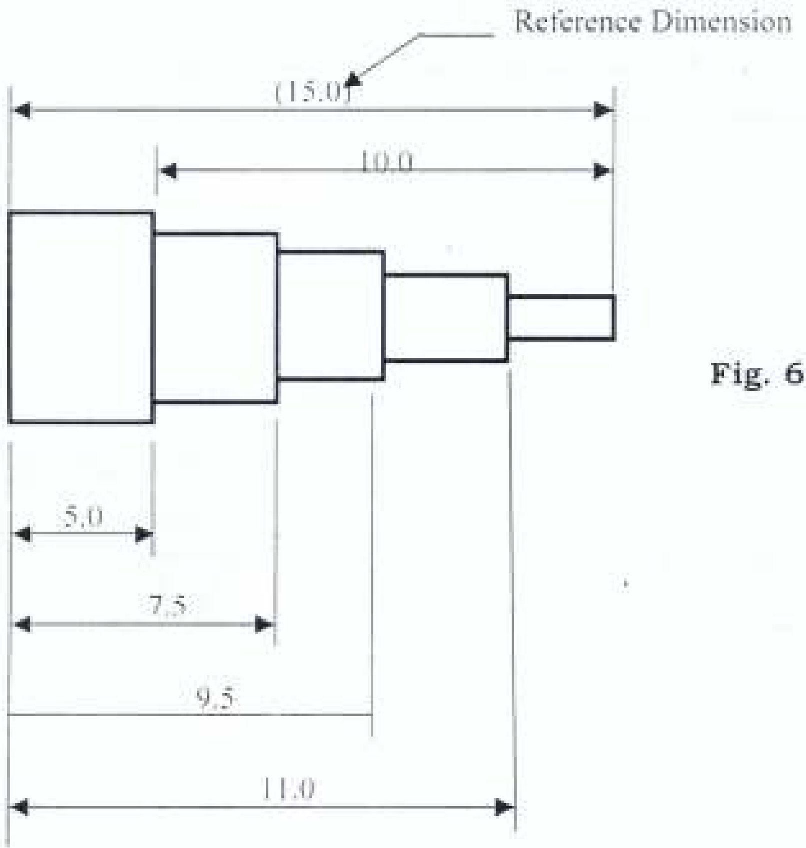


Fig. 64c

Figure. 64: **Dimensioning Concentric and Non Concentric Shafts**

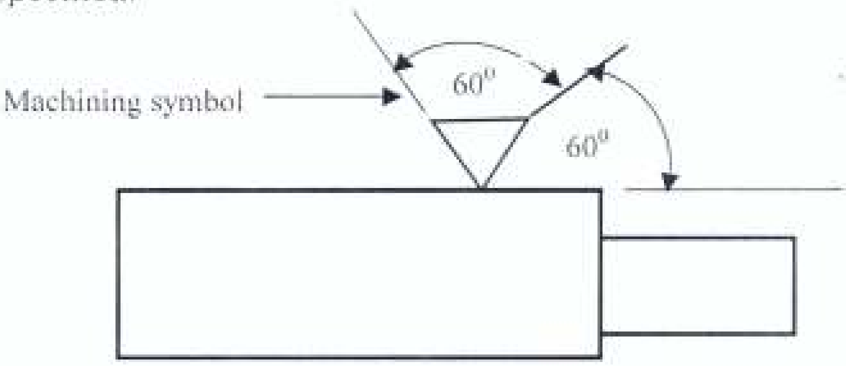
Reference dimensions are indicated on a drawing by enclosing in parentheses.

ACTIVITY 5.30-1: __Machining Symbols__

Machining symbols are used for specifying the type of surface finish to be applied to any machined surface. Figure 65a-e.

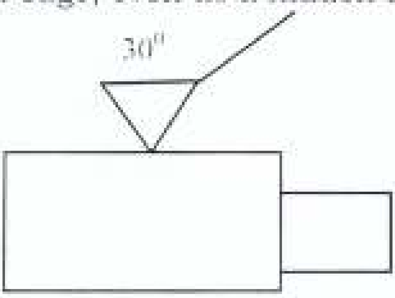
The small tick in 65b only indicates that the particular face has to be machined. The degree of smoothness is not specified.

In 65c both the finish mark and the special process to produce the surface are specified.

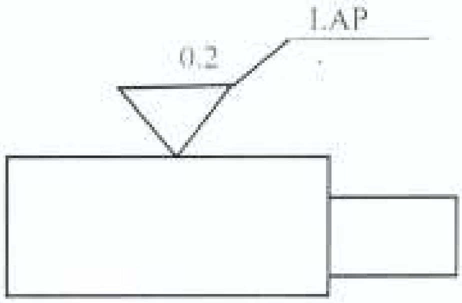


(a)

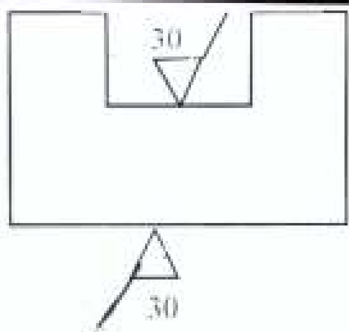
Note: Finish mark must be repeated in every view where the surface appears as an edge, even as a hidden line



(b)



(c)



d

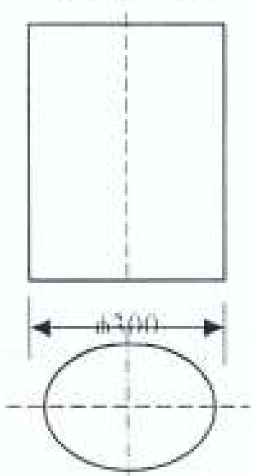
e

Fig. 65: Machining Symbol

ACTIVITY 5.31-1: TOLERANCING

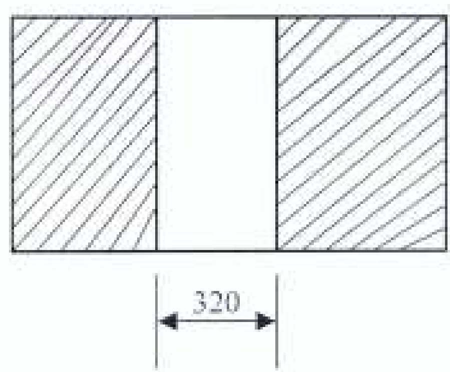
A tolerance is the total amount of variation permitted from the design size of a part. Tolerances may be expressed as limits (upper and lower limits). The upper and lower limits are calculated by adding or subtracting the allowable tolerance to or from the nominal size as the case may be fig. 66

(a) Shaft limit



Allowable tolerance ± 310 upper limit 290 lower limit

(b) Hole limit



Allowable tolerance ± 10 upper limit 330 Lower limit 310

Fig 66: Tolerance Design of a Size Part

FITS are the degrees of tightness or looseness between mating parts.

ACTIVITY 5.32-1: <u>Types of Fits</u>

(i) **Clearance Fit:-** Is the one in which there is space remaining after mating parts have been assembled(positive allowance).

(ii) **<u>Interference Fit:</u>** Is the fit in which the internal member is lager than the external member.

(iii) **<u>Transition Fit:</u>** Is the fit in which the result might be either a clearance or an interference fit after mating parts have been assembled.

ACTIVITY 5.33-1: DIMENSIONING RULES

(1) Apply dimensions in a way they will not be misinterpreted

(2) Dimension lines should be drawn in thin line.

(3) Dimension should be placed on visible outlines rather than hidden lines.

(4) Dimensions should be placed between the views to which they relate and outside the outline of the part.

(5) A gap of 1.5mm should be left between the object and extension line. The extension line should also extend beyond the dimension line approximately 3mm.

(6) Avoid crossing dimension lines with extension lines or leaders whenever possible.

(7) Dimensions should not be duplicated

(8) Each dimension should be stated clearly for easy interpretation in one way.

(9) Avoid placing dimensions on the part itself

(10) Crowding of dimension lines should be avoided. The gap between the first dimension line and the outline should be at least 10mm and 6mm for successive lines.

(11) Always dimension from a finished surface and not from a rough surface

(12) Show dimensions between surfaces or points that have a functional relationship.

(13) A centerline may be used as an extension line.

(14) Centerlines should not extend from view to view.

(15) Leader lines should point to the center of a hole or circular feature.

(16) Leader lines should be straight and broken at precise angles. They should never curve.

(17) Avoid unnecessary or redundant dimensions.

ACTIVITY 5.34-1: NOTATION

When all the information needed in a particular drawing cannot be communicated graphically notes are used to communicate or clarify the designers' interest.

Notes are brief carefully worded statements placed on drawings to convey information not covered or not adequately explained using drawings.

ACTIVITY 5.35-1: RULES FOR APPLYING NOTES ON DRAWINGS

- Notes should be placed horizontally on the drawing sheet.

Figure 67

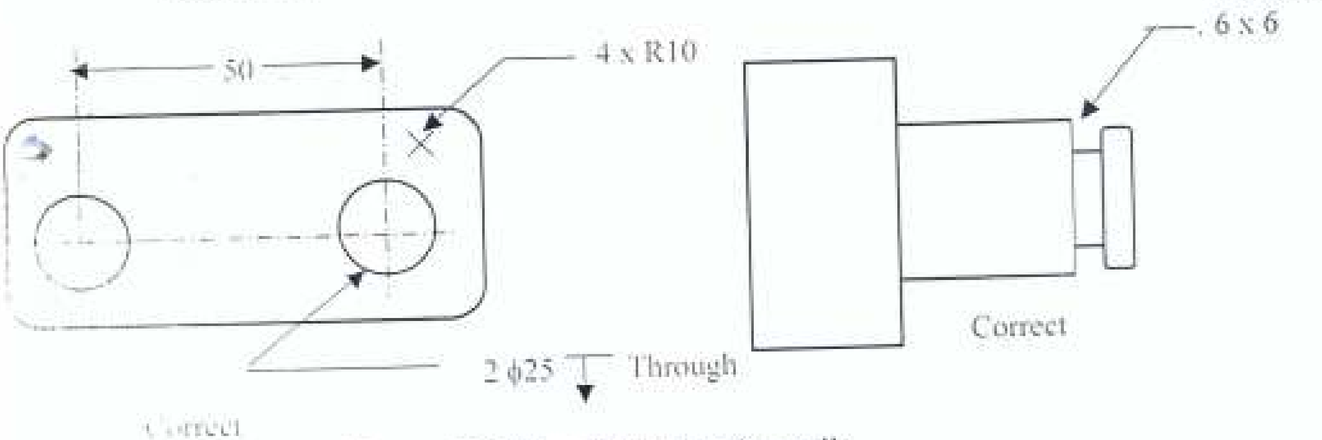
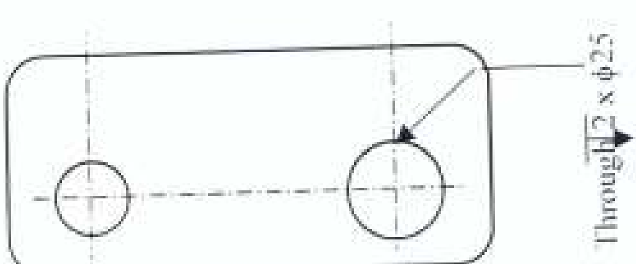


Figure 67: Notes Placed Horizontally



Wrong: Note wrongly placed

Fig. 67: Methods of Applying Notes on Drawings

General notes should be placed directly above the title block with the first note placed directly above.

The title block followed by the first, second, third etc. Table 2 Starting the numbering from the bottom will allow additional information to be added when necessary.

4		
3		
2		
1		
NO	DESCRIPTION	QUANTITY
NAME		
SCHOOL		
TYPE OF DRAWING		
SCALE	DATE	

FOR NOTES

TITLE BLOCK

- Detail notes should be located as close as possible to the detail they are describing and connected to it by a leader line.
- Notes should be applied to drawings when all drawings have been completed. This prevents notes and drawings from overlapping and minimize other errors on the drawing.

ACTIVITY 5.36-1: TYPES OF NOTES

The two basic types of notes use in Technical Drawing are:

(i) **General Notes**: Are broad items of information which have a project wide application rather than relating to just one single element of a project or part. They are usually placed immediately above the title block and numbered sequentially. The type of information placed in general notes are information like finish specifications,standard sizes of fillets, rounds and radii, hardness testing instructions,etc.

(ii) **Detail Notes:** Are specific notes that pertain to one particular element of a part. They are placed as near as possible to the element to which they apply and are connected using a leader line. Detail notes should not be placed on views. Figure 68.

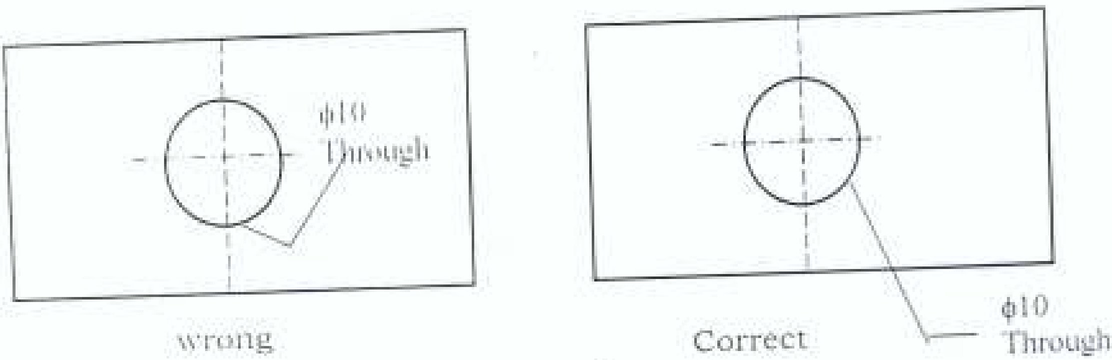


Fig. 68a: Detail notes

The most widely used lettering for notes is gothic upper case (capital lettering) e.g. **NOTE ALL DIMENSIONS IN MM**.

- Abbreviations should be clearly stated in a legend to ensure that all readers can interpretes the abbreviations constitientely and correctly. e.g.

SF - Spot faced

FAB - Fabricate

ASSY - Assembly

FAO - Finish All Over

Notes containing more than one sentence should be punctuated to show where a sentence ends and where another begins.

Notes should be jotted down first and properly verified before they are placed on drawings.

Sample Notes

- All unspecified radii R4mm.
- 45 degree chamfer all edges
- All Fillets and rounds R3mm
- 6 notes equally spaced.
- Heat treat
- CBORE from bottom.

ACTIVITY 5.38-1: CONSTRUCTION AND READING OF PLAIN AND DIAGONAL SCALES

Drawings are usually made full size, but when this is not possible the drawing must be made to a uniform scale. If the size of the object is larger than the drawing paper a reduced scale has to be used so that the finished drawings will be in proportion to the object. When the size of the object is so small and enlarged scale is used.

The scale used in a drawing is usually in the title block as a ratio or representaive fraction (RF).

$$(RF) = \frac{\text{distance drawn}}{\text{Distance represented}}$$

For example a scale of 50mm to 1m simply means that a line of 50mm long will represent 1m on the object to be drawn

$$R.f = \frac{\text{distance drawn}}{\text{Distance represented}} = \frac{5\Phi}{100\Phi} - \frac{1}{20}$$

The ration is 1:20

Enalargement scale	Full size	Reduced size
2:1 twice	1:1 full size	1:2 half full size
5:1 five times full size		1:5 one fifth full size
10:1 ten times full size		1:10 one tenth full size
15:1 fifteen times full size		1:15 one fifteenth full size
20:1 twenty times full size		1:20 one twentieth full size

When an object is easy to draw, the scaling is often done by calculation. If the object is not an easy one to produce on the paper, it is quicker to use a scale ruler or to construct a scale for the purpose of reducing or enlarging the dimension.

There are two types of scales.

(i) Plain scale

(ii) Diagonal scale

Each of these can be a reduced, full size or enalrged scale.

ACTIVITY 5.38a-1: PLAIN SCALE

This type of scale has two units of measurements e.g. centimeters and metres.

Fig. 68b: To construct a scale of 50mm equals 1m to read up to 6m in Centimeters.

PROCEDURE

- Draw a horizontal line to the required length in this case it is $50 \times 6 = 300$mm.
- Divide the line into 6 equal parts
- Draw vertical lines from each of these points and complete the rectangle as shown in fig 68b. The length of the sclae can be any convenient height.
- Divide the first or end division on the left into ten equal parts in order to show parts of a metre in portions equivalent to 10cm (0.1m)

- Write "O" at the end of the first division as shown in figure 68b

- Number the metres in this case 1 – 5 in large figure

- Number the decimal parts with small figures as 25cm (0.25cm) 50cm, (0.5m), 75cm (0.75m)

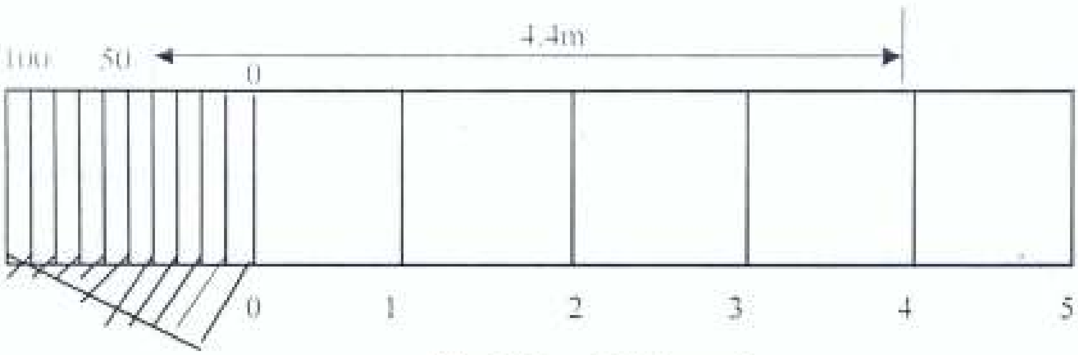


Fig 68b: Plain scale

Note ... w a rec ... The whole number is counted to the right of zero while the decimal part is counted to the left.

Another thing to note is that the scale can be constructed in other units such as decimeters and metres, centimeters and decimeters, etc.

ACTIVITY 5.38b-1: DIAGONAL SCALE

The advantage of diagonal scale over the plain scale is that the diagonal scale can be used to much finer limits than plain scale, but take longer time to construct and must be drawn to accuracy.

Fig. **68c:** To construct a diagonal scale of 4 centimetres. Equal 1 metre to read up to 5 metres in decimeters and centimeters

PROCEDURE

- Draw AB 20 centimetres (4 x 5) long and divide it into 5 equal parts.
- Draw vertical from each of these points and complete the rectangle
- Divide the first unit into 10 equal parts.

  Divide the perpendicular AC into 10 equal parts. Draw horizontal lines from these units equal in length to the full length of the scale. The horizontal space must be equal
- Transfer the 10 divisions of the first unit on AB to the top line and draw diagonals of one unit slope.

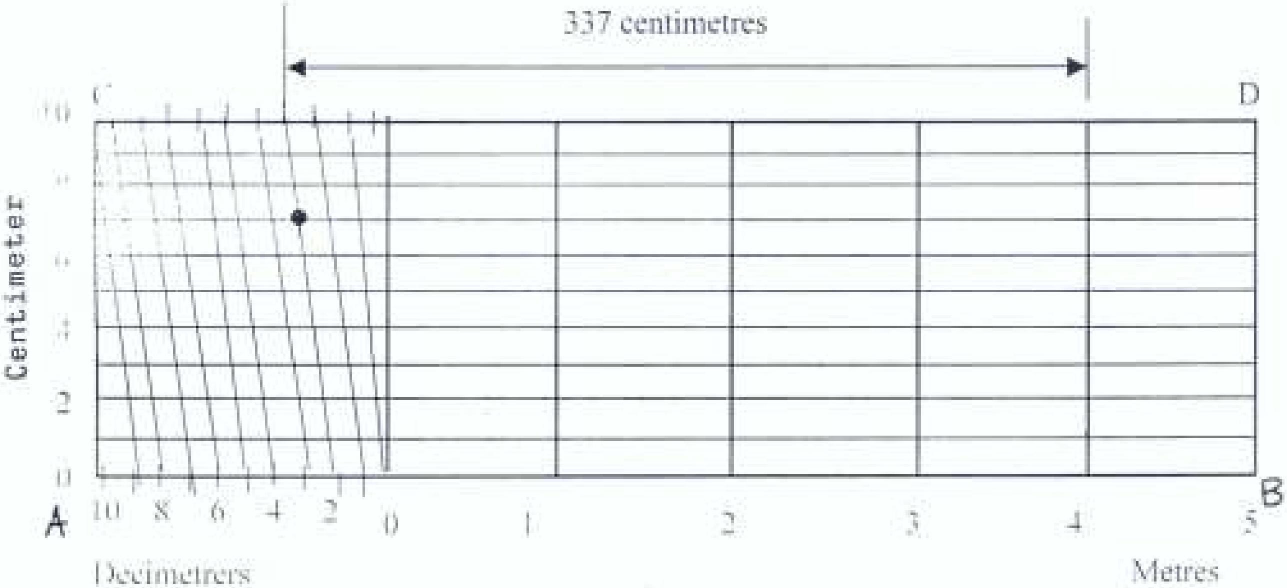


Fig. 68c: Diagonal scale

Note that the reading is taken from the right hand side to the left hand side on the horizontal dimensions while it is from the bottom to the top on the vertical dimensions.

- Always remember that the vertical height of any scale, plain or diagonal does not affect the horizontal dimensions.

ASSESSMENT QUESTIONS

1. _______ is the line used to show where a line begins and ends

   (A) Note line (B) Dimension line (c) Location line

   (D) Symbols

2. Another name for size description is _________

   (A) Symbols (B) Note (C) Dimensioning (D) Alignment

3. The dimensioning system in which the numerals are placed in line with the dimension lines is called 84 _______ system.

   (A) Unidirectional (B) Aligned (C) Co-ordinate (D) Metric

4. The two basic kinds of dimensions are ________ and ________

   (A) Metric, Inches (B) Size, Location (C) Size, Inches

   (B) Location, Metric.

5. Angles may be dimensioned by degrees minutes, and seconds or by ________ angles

   (A) Metric (B) Inches (C) notes read from the Decimal (D) Aligned

6. When all dimensions are read from the bottom of the sheet, the ________ dimensioning system is used

   (A) Aligned (B) Location (C) Metric (D) Unidirectional

7. The symbol for diameter is _______ (A) A (B) ϕ (C) K (D) □

8. The dimensioning symbol for counter bore is_____

(A) V (B) θ (C)⊔ (D)

9. The abbreviation for counter sink is ____ (A) (B) θ (C)⊔ (D) CSK

10. The amount by which the accuracy of a part may vary from the absolute measurement is called __________

(A) Datum (B) Reference (C) Tolerance (D) Expansion

ANSWERS TO ASSESSEMENT QUESTIONS

(1) B (2) C (3) B (4) B (5) C (6) D (7) B (8) C (9) A (10) C

PROBLEMS

(1a) State the function of the following drawing instruments and materials.

(A) Compass (B) Protractor (C) French curve (D) Divider (E) Cellotape

(1b) Sketch the following drawing instruments (i) French curve (ii) Tee-square (iii) Adjustable triangle (set square)

(2a) Letter the alphabet in capital letter in 3mm and 6mm characters. Use guide lines and keep character width and spacing consistent.

(2b) Letter the following dimensions in 6mm figures

0.55 4.27 543 2280

(2c) Letter the figures up to 9 in 3mm, 6mm and 10mm characters.

(3) On 'A' size plain paper draw:

(i) Boarder line

(ii) Title block corner or full-length title block with the following information: Name, School, Type of Drawing, Scale and Date.

(4) Divide the plain sheet in question one above into 4 equal rectangles and sketch the following:

Rectangle no 1

a (i) Horizontal and vertical lines (5cm long)

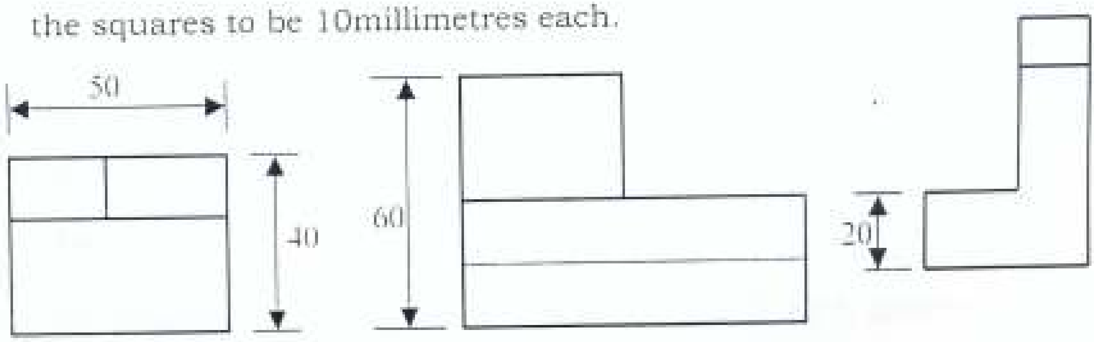
(ii) Circles of radii 20m and 30mm

Rectangle no 2

b. Ellipse with major axis 100mm and minor axis 75mm

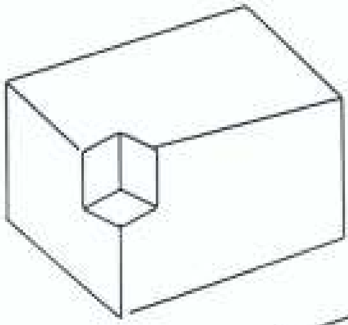
Rectangle no 3

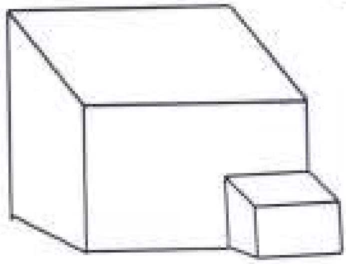
c. Sketch the following views using square method, assuming the squares to be 10millimetres each.

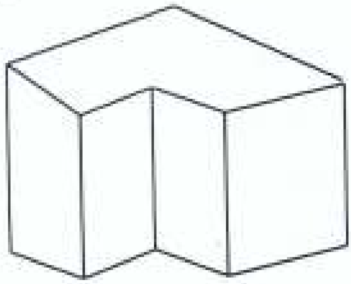


Rectangular no 4

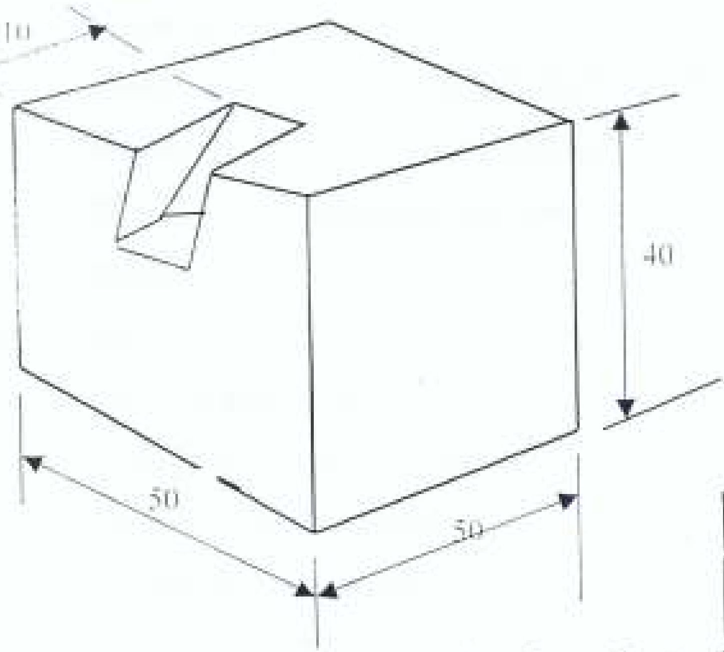
d. Sketch the blocks shown below in isometric projection on an isometric grid, assuming the isometric squares to be10millimeters each.

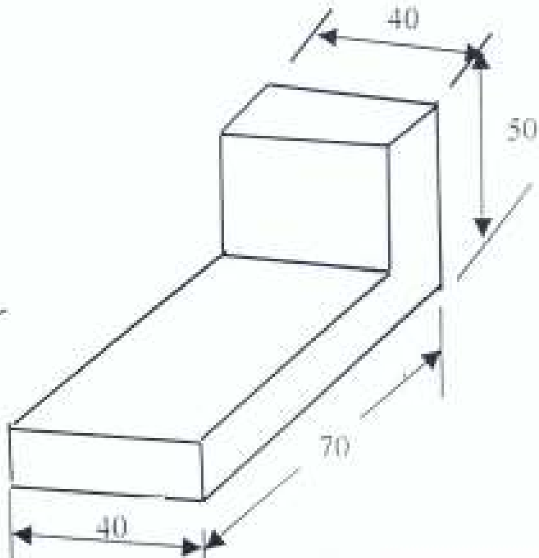




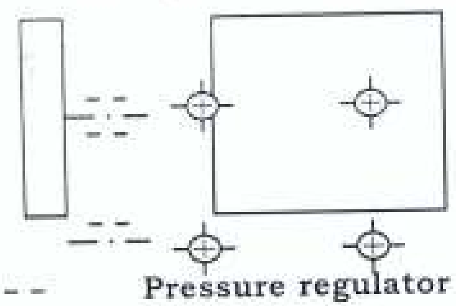


Make an oblique sketch of the following blocks using squared method

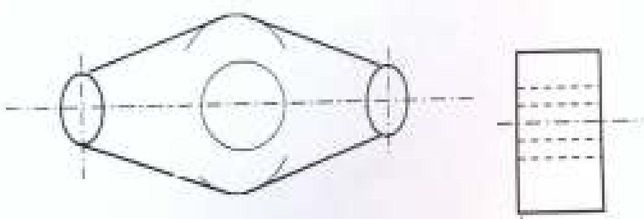




5. Draw and dimension the objects shown below, check each drawing against the rules for good dimensioning. Letter the title of each object below the object. Assume appropriate dimension



Pressure regulator



Flange, Water inlet

3.2 Lesson Two – Geometry

This topic discuss in detail the technique associated with geometric construction, which must be thoroughly mastered. The various procedures in this topic are used in solving all drawing problems. The topic covers both the plane and solid geometry. It is grouped under 8 modules. Review questions are presented at the end of each module as self-assessment questions for the students.

These modules are;

Module 1: points, lines, angles and triangles

Module 2: arcs, circles and tangents.

Module 3: quadrilaterals, polygons and areas of plane figures

Module 4: loci part 1 (ellipse parabola and hyperbola)

Module 5: loci part 2 (cycloid, hypocycloid, epicycloids, involutes and Archimedean spiral)

Module 6: loci part 3 (Link mechanism and helix)

Module 7: development

Module 8: intersections

HOW TO STUDY THIS TOPIC

* Study each module separately
* Read the module you have chosen thorough quickly to get the main idea.
* As you read through the module underline in pencil any word you find difficult.
* Write down the appropriate meaning of the underlined words in your notebook.
* Study the module by carefully reading though it step by step.
* Make sure you practice each drawing using the drawing board
* Remember to answer the questions for each module as you read along
* Do not move on to the next module unless you have attempted the self-assessment question at the end of the chosen module.

Geometrical Construction

Geometry is study of the size and shape of things. Geometric constructions are made of individual lines and points drawn in proper relationship to another.

Geometric construction is very important to nearly everyone in technical fields (Engineers, surveyors, architects, designers mathematicians, scientists etc). These set of people regularly apply the principle of geometry to the solution of technical problems such as the design of machine parts, architectural structures etc. Therefore technical student require a good knowledge of geometrical construction to be able to apply it to the solution of technical problem.

Geometrical construction is divided into two groups; plane geometry and solid geometry.

Plane geometry: these are two-dimensional geometry with length and breadth only without thickness examples are polygons quadrilaterals, circles and semi-circles ellipse angles simple triangles etc

Solid geometry: These are three-dimensional geometry with length breadth and thickness. Examples are pyramids, prisms, cubes, cones, sphere, tours, ovoid, helices, etc.

3.2.1 Module 1-Points, lines, angles and triangles

The basic techniques associated with geometric construction must be thoroughly mastered. The various procedures discussed in this module are used in solving drawing problems in technical drawing. To be truly proficient in the layout of both simple and complex drawings the drafter must know and fully understand the many geometric construction used.

OBJECTIVES

At the end of this module student should be able to:

- Define the following: points, lines angles and triangles.
- Represent points on drawing
- Draw different types of lines
- Bisect lines
- Draw lines perpendicular to a given line
- Draw parallel lines

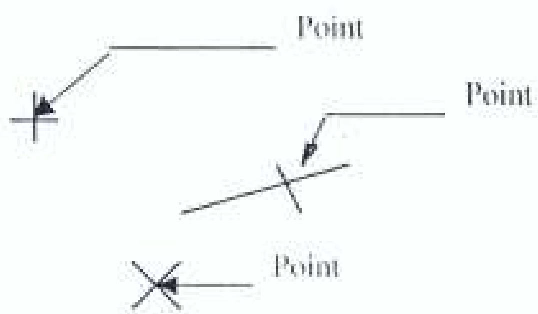
Construct different types of angles and triangles.

HOW TO STUDY THIS MODULE
- Read the whole mmodule through quickly to get the main ideas
- As you read this module, underline in pencil any word you find difficult and check for the meaning in the microsoftword.
- Study the module by carefully reading it through step by step.
- Make sure you try and practice the activities on your own.

ACTIVITY 1.0-2: **Points and Lines**

Points

A point is a location in space or on a drawing and has no width, height or depth. A point can be represented by any of the following:



(a) A small cross

(b) A short crossbar on a line

(c) Intersection of two lines

Simple dot (•) should not be used to represent a point.

Lines

A line is that which has length without breadth. There are different types of lines: they are as follows:

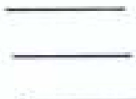
(a) **Straight line:** A straight line is defined as the shortest distance between two points.

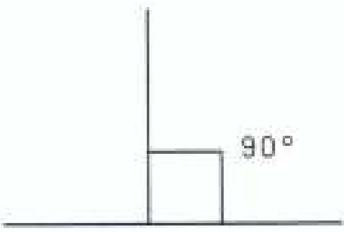
Straight line (indefinite length)

Straight line with fixed end points (definite length)

(b) Horizontal line

(c) Vertical line

(d)  or  Parallel lines: They are lines which maintains the same distance apart.

(e) 

Perpendicular is a straight line, which forms an angle of 90^0 to horizontal lines. A perpendicular is a straight line touching a horizontal line at 90^0

(f)  Curve line

(g)  An arc

ACTIVITY 1.1-2: <u>Bisecting Lines</u>

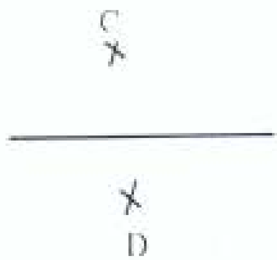
Bisect means to divide into two equal parts.

ACTIVITY 1.1a-2: Fig. 69: To bisect a given straight line (AB) by the compass method

Step 1

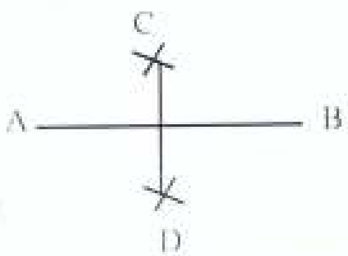
Draw the given line AB.

Step 2



Using A and B as centers, strikes arcs with equal radii greater than half the length AB above and below the line to interest at points C and D

Step 3



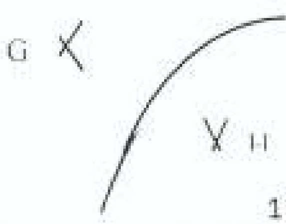
Draw a straight line from C to D. This line is the perpendicular bisector of line AB

Fig. 69: Bisecting a Straight Line

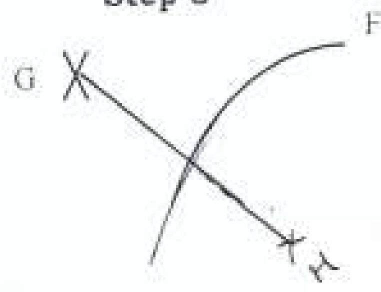
ACTIVITY 1.1b-2: Fig. 70: To bisect a given arc (EF)

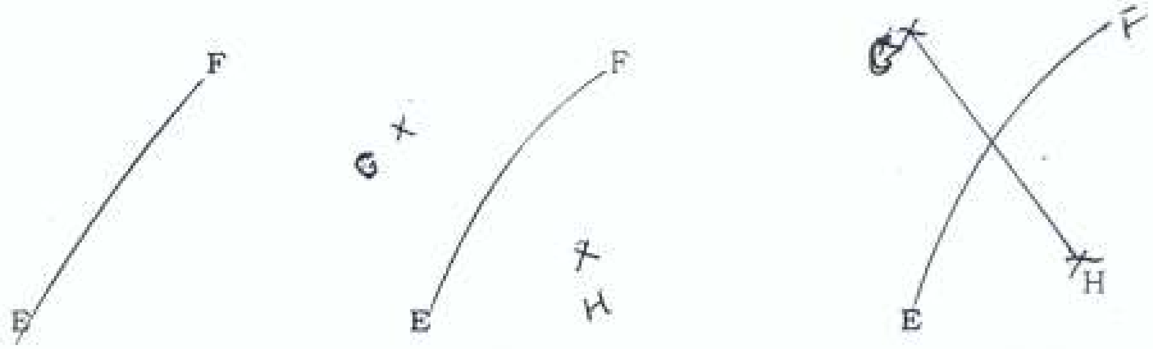
Step 1

Step 2



Step 3



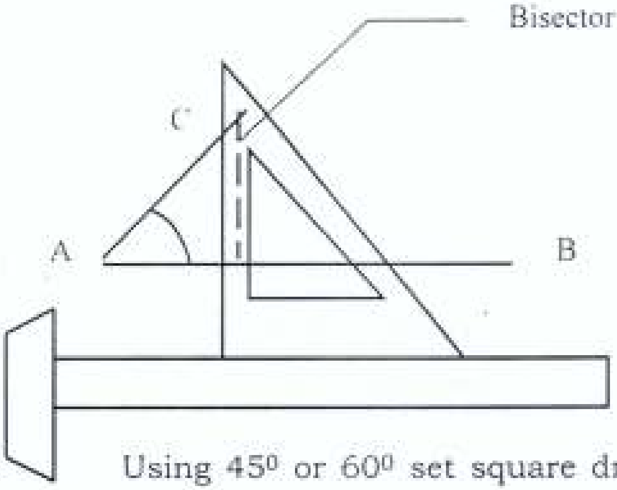


ACTIVITY 1.1c-2: Fig. 71: To bisect a line by the triangle and T-square method.

Step 1

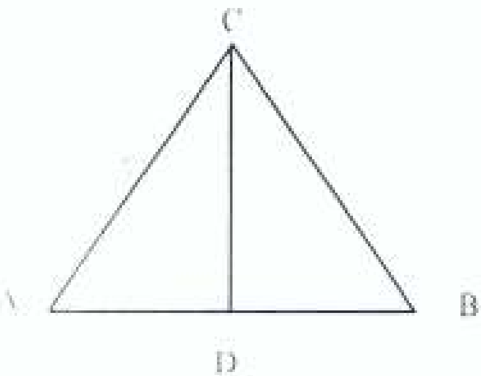
Draw the given line AB

Step 2



Using 45^0 or 60^0 set square draw lin
AC and BC at 45^0or 60^0 (depending
the set square used).

Step 3



A line CD drawn perpendicular to line AB is the besector of line AB.

ACTIVITY 1.2-2: Fig. 72: To construct a perpendicular at the end of a given line.

Step 1

Draw the given line EF

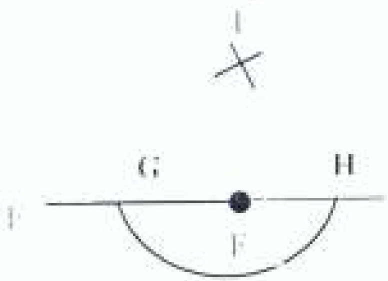
Step 2

With a thin line, extend line EF outwards from F

Step 3

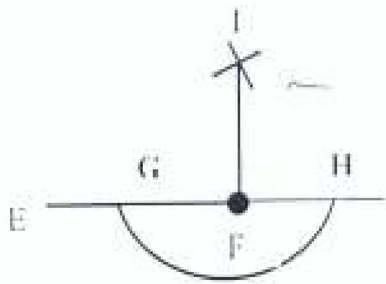
Using center F and any convenient radius draw the semi-circle GH

Step IV



Using G and H as centers, strike, arc arcs with equal radii greater than half the length of GH to intersect at i

Step V



A line drawn through the intersection of the arcs to point F is the required perpendicular.

ACTIVITY 1.3-2:, Fig. 73: To construct a perpendicular with the compass at a given point on a given line.

Step 1

Draw the given line AB and mark the given point say O.

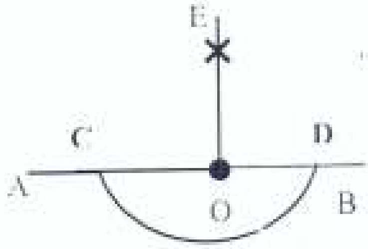
Step 2

Using O as center and any convenient radius draw semicircle CD.

Step 3

Using C and D as centers, and any convenient radius greater than half-length CD, strike arcs to intersect at E.

Step 4



Draw a line through the intersections of the arcs to point "O" to give the required perpendicular.

point outside the line.

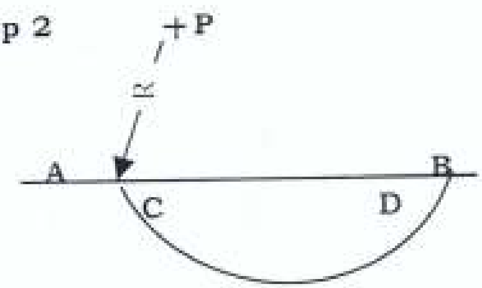
Activity 1.4 Fig.73a - To draw a perpendicular to a given line from a point 'P' outside the given line.

Given: Line AB

Step 1

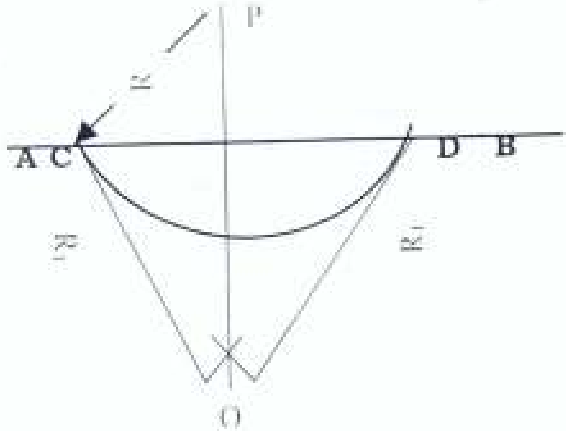
Draw the given line AB and locate point P outside the given line

Step 2



With P as the centre, draw an arc with radius R long enough to intersect line AB to locate points C and D.

Step 3

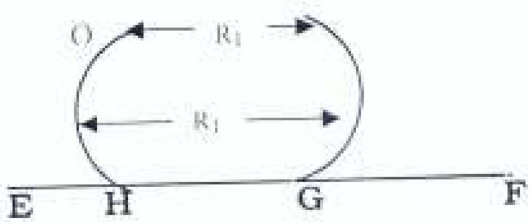


With C and D as centres and radius R_1 greater than half of CD draw intersecting arcs to locate point O. A line drawn through points P and O is the perpendicular line.

ACTIVITY 1.5-2: Fig. 74: To draw a line parallel to a given line EF through a point "O".

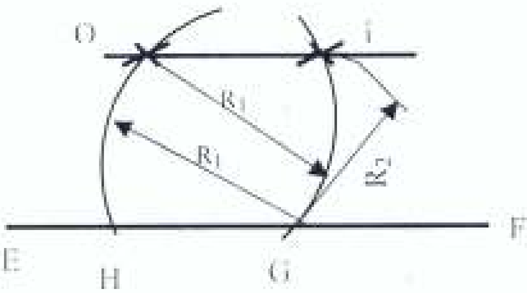
Step 1

Draw the given line EF and locate the point O.



With point o as the center and any convenient radius R_1 draw an arc cutting line EF to locate point G. (With point G as the center and the previous radius R_1).

Step 3.



With G as the center and radius R_2 equal to chord OH draw an arc to locate point i.

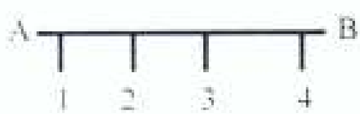
Draw a line through points O and i to give the required parallel line to line AB.

ACTIVITY 1.6-2: Fig. 75: To draw a parallel line to a given line AB at a distance from AB.

Step 1

Draw the given line AB

Step 2

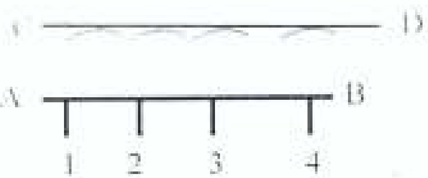


Mark points 1 – 4 at any convenient distances on line AB with points 1and 4 very close to the ends

Step 3

With centers 1,2,3, 4, and a radius equal to the distance away from the required parallel line draw arcs.

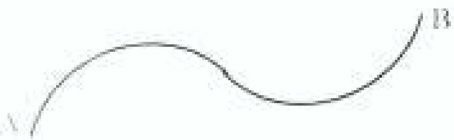
Step 4



Draw a line (CD) tangential to the arcs to give the required parallel line

ACTIVITY 1.6a-2: Fig. 75: To draw a line parallel to a given curved line at a given distance

Step 1

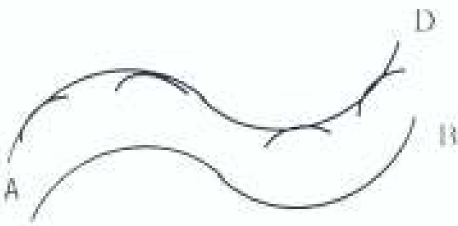


Draw the given curve AB

Step 2

With a radius equal to the distance away of the required parallel curve place the point of the compass on the given line and draw series of light arcs.

Step 3



Using a French curve, draw a line CD tangential to the arcs to give the required parallel

Curve.

NOTE: Parallel lines can also be drawn using the two triangles or a triangle with T-square (see board practice).

ACTIVITY 1.7-2: Fig. 76: To divide a line (EF) into a given number of equal parts.

Step 1

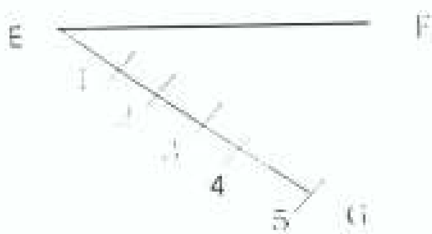
Draw the given line EF

Step 2.

Draw line EG at any

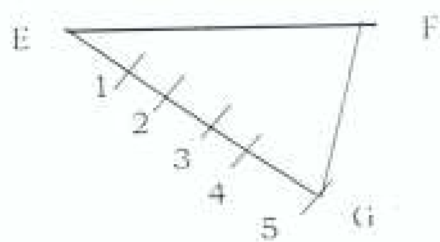
Convenient angle to EF.

Step 3



With a divider lay off the number of the required divisions above E.G. These may be of any convenient length but equal.

Step 4



Join the last point on line EG to F.

Step 5

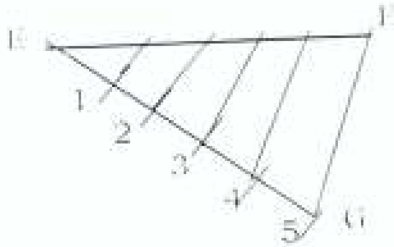


Fig. 76

With the aid of your setsquare. Draw lines parallel to the first line from the other numbers. These will divide EF into the required number.

ACTIVITY 1.8-2: ANGLES AND TRIANGLES

An angle is formed when two lines intersect or are inclined to each other. The common symbols for angles and angular constructions are;

< = Angle (singular), < s (plural), Δ = triangle

$\perp$ = Perpendicular.

Angles are measured in degrees, minutes and seconds.

There are 360^0 in a complete circle. A degree is divided into 60 minutes (60') and a minute is divided into 60 seconds (60").

When minutes alone are indicated, the number should be preceded by 0^0 e.g. $0^0 40'$

ACTIVITY 1.9-2: TYPES OF ANGLES

The different types of angles are illustrated in fig. 77 a-g below

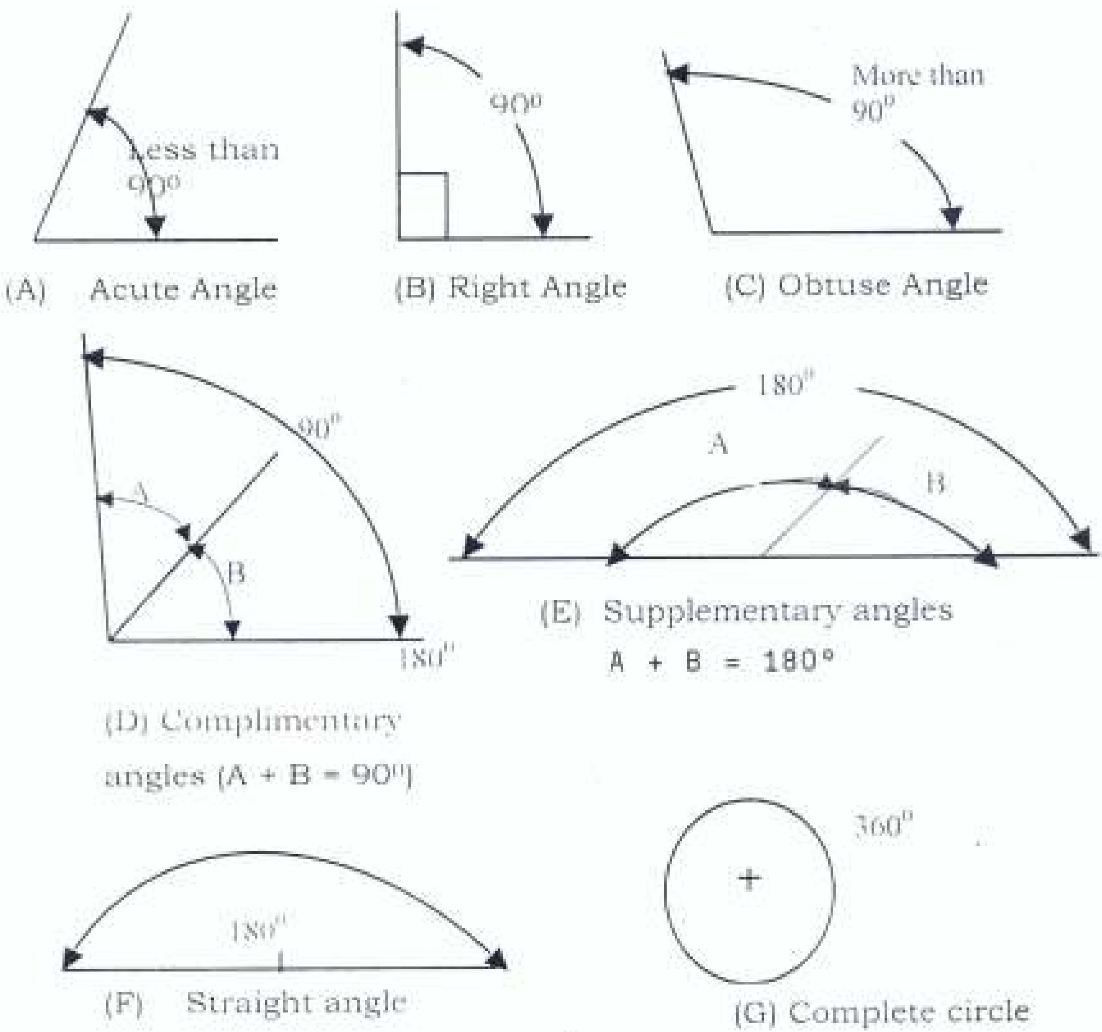


Fig. 77 a – g

CONSTRUCTION OF ANGLES

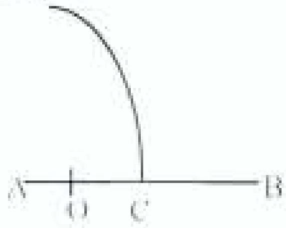
ACTIVITY 1.10-2: Fig. 78: To construct an angle of 60° at a point O on line AB.

Given: Line AB:

Step 1

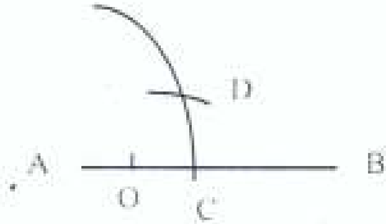
Draw line AB and mark point O on the line

Step 2

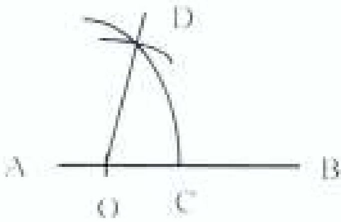


Using center O and any convenient radius draw an arc to touch AB at C

Step 3



With center C and the same radius draw an arc to intersect the first arc at D



Draw a line from O through D. < DOB is the required 60^0 angle .

Fig. 78

ACTIVITY 1.11-2: fig. 79: To construct an angle of 90^0 at point on line AB say point A

Step 1

Draw the given line AB

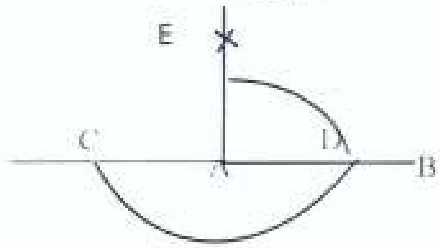
Step 2

Extend a construction line outwards from A

Step 3

With center A and any convenient radius draw a semicircle CD.

Step 4

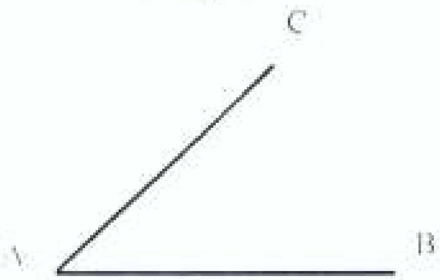


With centers C and D and any convenient radius greater than half-length CD draw arcs to intersect at E. Draw a line from point A through the intersection of the arcs. < EAB is the required angle.

ACTIVITY 1.12-2: **Bisecting Angles**

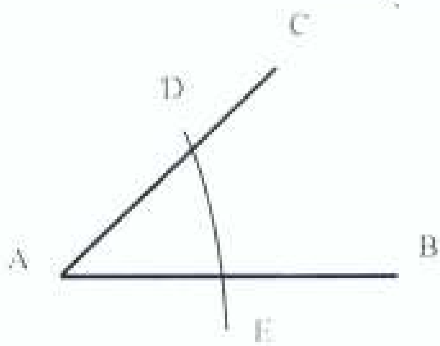
ACTIVITY 1.12a-2: To bisect an angle

Step 1



Draw the given angle <CAB

Step 2



With point A as the center and any convenient radius, draw an arc to intersect with AC and AB at D and E

Step 3

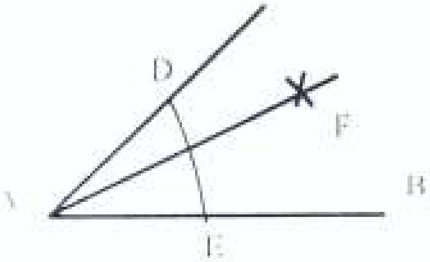


Fig. 80

With D and E as centres and any radius greater than half of arc DE, draw arcs to intersect, locating point F. Draw a line from point A through F to bisect < CAB. Angles 45^0, 30^0, 15^0 can be constructed by bisecting angles 90^0, 60^0 and 30^0 respectively.

ACTIVITY 1.13-2: TRIANGLES

-A triagnle is a plane with three straight sides and three angles. Fig. 81

-The sum of the interior angles in a triangle is equal to 180^0.

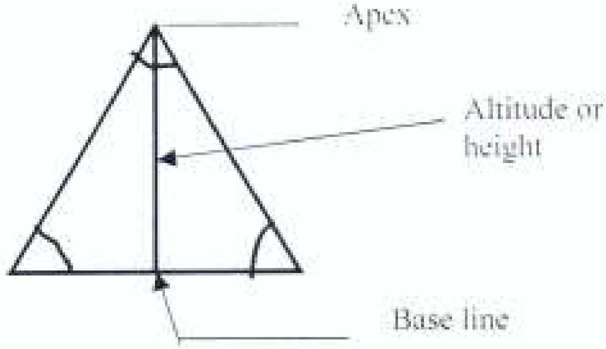
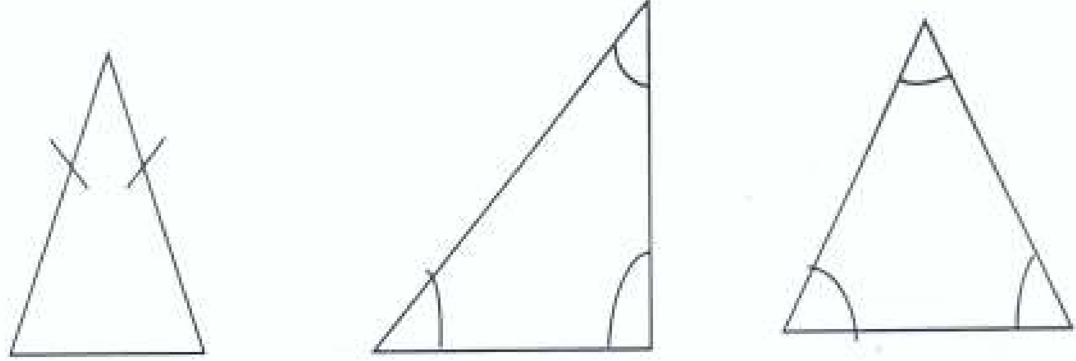


Fig. 81: A triangle

ACTIVITY 1.14-2: TYPES OF TRIANGLES

Triangles are identified by their lengths of sides or angle sizes

(i) Triangles identified by their lengths of sides. Fig 8 a - c



(a) **Isosceles triangle**

Two sides equal two angles equal and the base angles form by the two equal side, are equal.

(b) **Scalene triangle**

No sides or angles equal

(c) **Equilateral triangle**

All sides. All angles equal

Triangles Identified by their angle sizes Fig 83 a - c.

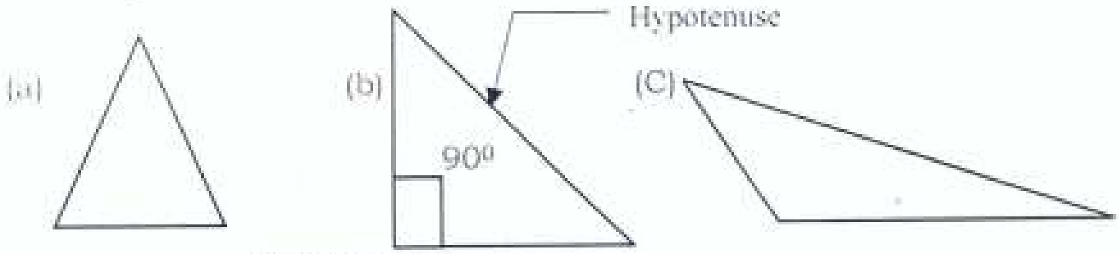


Fig. 83 a – c

Acute-angled triangle

each angle less than 90^0

Right-angled triangle

One 90^0 angle. The side directly opposite the 90^0 angle is called the hypotenuse

Obtuse angled triangle

One angle greater than 90^0

ACTIVITY 1.15-2: CONSTRUCTING TRIANGLES

ACTIVITY 1.15a-2: Fig. 84: To construct a traingle ABC when given the lengths of the three sides.

Let lengths of sides AB = 50mm, AC = 41mm and BC = 35mm.

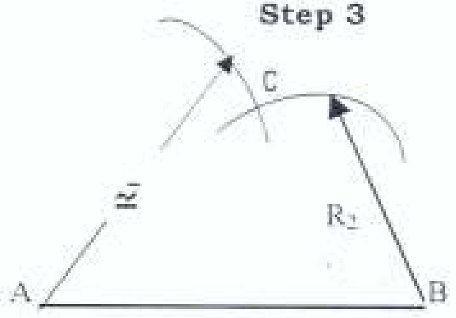
Step 1

Draw the longest side AB = 50mm

Step 2

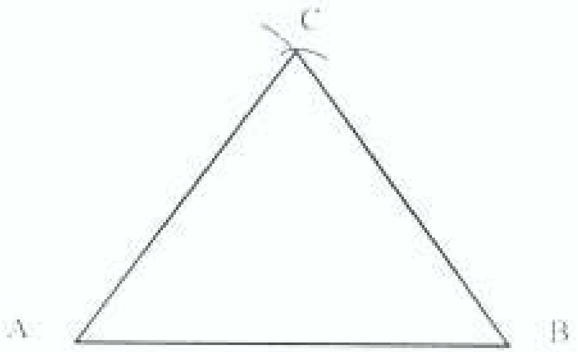
Swing an arc R_1 from point A whose radius is equal to AC = 41

Step 3



Swing another arc R_2 from point B whose radius is equal to BC to intersect the arc swing from point A at point C

Step 4



Connect A to C and B to C to complete the triangle

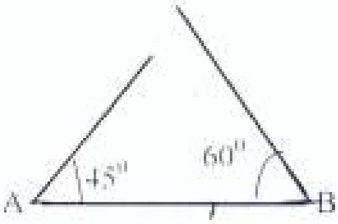
Fig. 84

ACTIVITY 1.15b-2: Fig. 85: To construct a triangle ABC with two angles and included side length given: $\angle A = 45^0$, $\angle B = 60^0$ $\angle AB$ = 50mm.

Step 1

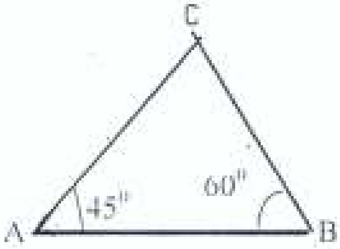
Draw the given line

Step 2



Construct the two angles A and B at opposite ends of line AB

Step 3



Extend the sides of angles A and B to intersect at point C. Δ ABC is the required triangle.

ACTIVITY 1.15c-2: Fig. 86: To construct a triangle ABC when two side lengths and the included angle are given:

Given: AB = 57mm, AC = 47, $\angle$ A = 60^0

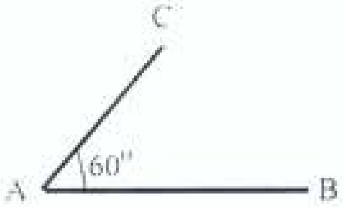
Step 1

Step 3

Draw the given side AB

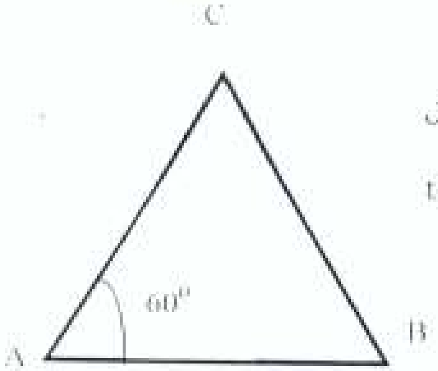
Step 2

Construct the given angle at point A



Lay off the other side AC at this angle

Step 4



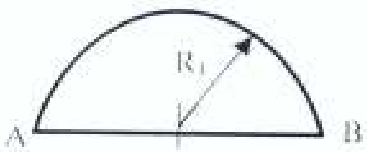
Join the end points of two given lines to form the required triangle.

ACTIVITY 1.15d-2: Fig. 87: To construct a right angled triangle when given the length of the hypotenuse and one other side. Let say AB (hypotenuse) = 55mm, AC = 40mm

Step 1

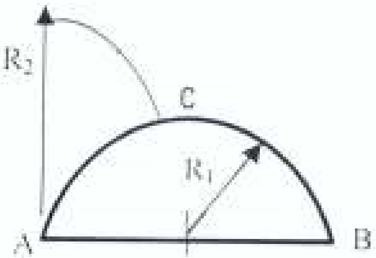
Draw the given hypotenuse AB

Step 2



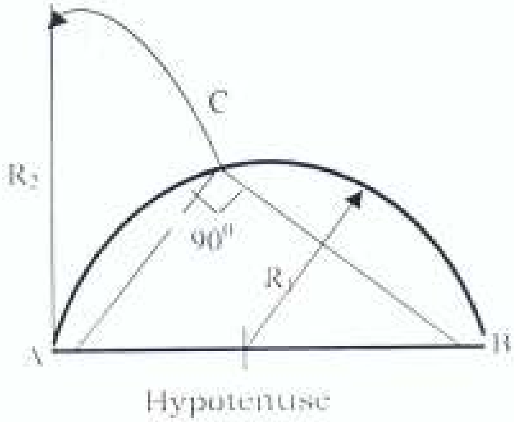
Draw a semicircle with radius (R_1) equal to half the length of the hypotenuse AB.

Step 3



With a compass, scribe arc AC equal to the length of the other given side R_2 from point A.

Step 4



Join A to C, and B to C. The triangle ABC is the required triangle.

Fig. 87: Construction of Right Angled Triangle

SELF-ASSESSMENT QUESTIONS

1 The following can be used to represent a point except

A + Small cross

B  Short cross bar on a line

C  Intersection of two lines

D • Dot

2 The shortest distance between two points is called

A straight line B curved lines C parallel line

D zigzag line

3 The angle formed by a perpendicular line is ______

A 70° B 80° C 90° D 45°

4 What kind of triangles has one right angle (90°)?

A isosceles triangle B sculene triangle C acute angle triangle

D right-angled triangle

5 What is angle greater than 90° but less than 180° called?

A acute angle B right angle C obtuse angle

D complimentary angle

6 What is the name given to a triangle with all three sides of equal length A isosceles triangles B equilateral triangles

C acute angle triangles D obtuse triangles

Answers

(1) D (2) A (3) C (4) D (5) C (6) B.

LESSON TWO

MODULE 2

ARCS, CIRLES AND TANGENTS

The major areas covered in this module are; circles, arcs and tangents. Circles and arcs are geometric objects constructed with curved lines while tangent is a line or curve that touches the surface of an arc or circle at only one point.

OBJECTIVES

By the end of this module student should be able to:

- Define arcs, circles and tangents
- Identity the various parts of a circle
- Draw arcs and circles
- Draw lines tangent to a circle
- Draw an inscribe circle to a given triangle
- Circumscribe a circle to a given triangle

HOW TO STUDY THIS MODULE

- You should before you read through this module study module 1
- Read though this module once, when you find a word whose meaning is not known to you try and look up such word in the dictionary.

*Study this module step by step just as they have been arranged for you. You must answer the self-assessment question at the end of the module before you proceed to another module.

CIRCLES AND ARCS

ACTIVITY 2.0-2: **Circle:** A circle is a plane figure bounded by a curved line called the circumference.

ACTIVITY 2.1-2: **Part of a circle Fig. 88**

An Arc: Is any part of the circumference.

A diameter: Is the distance across a circle passing through the centre.

Radius: Is a straight line drawn from the center to the circumference of a circle and is ½ the diameter.

A Chord: A chord is a straight line drawn across the circle, touching the circumference at both ends.

A Segment: Is part of a circle bounded by a chord and an arc.

A Sector: Is part of a circle bounded by an arc and two radii.

A Quadrant: Is part of a circle bounded by two radii at right angle to each other and an arc. It is ¼ of a circle.

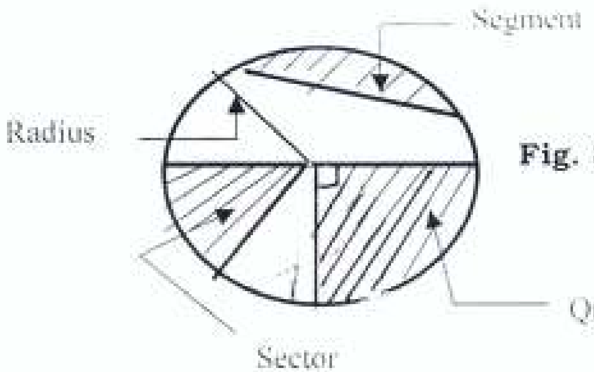
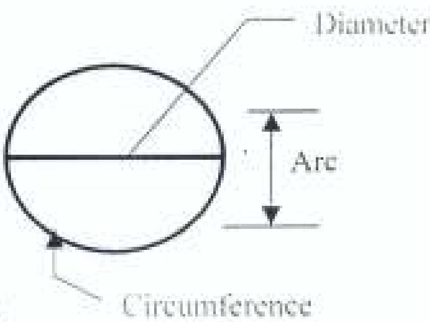
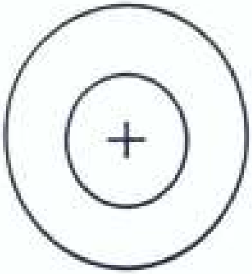


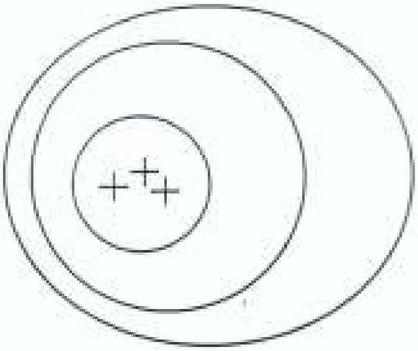
Fig. 88





Concentric circles

A concentric circles have the same center but different radii.



Eccentric circles

Eccentric circles have different centers

Fig. 89

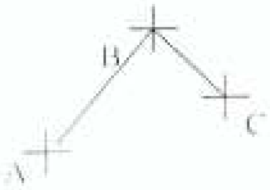
ACTIVITY 2.2-2: CONSTRUCTING CIRCLES

ACTIVITY 2.2a-2: fig. 90: To construct a circle through three given points A, B and C.

Step 1

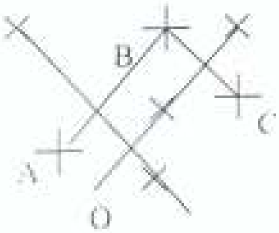
Given points

Step 2



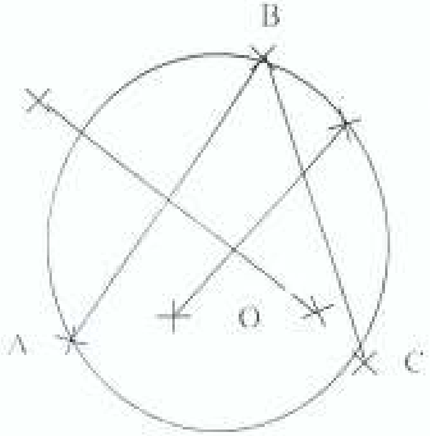
Draw lines between the three points as shown.

Step 3



Bisect each line

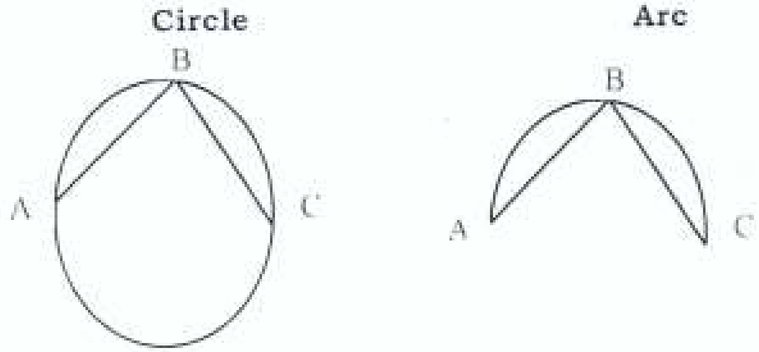
Step 4



The center O, where the two bisecting lines met is the center

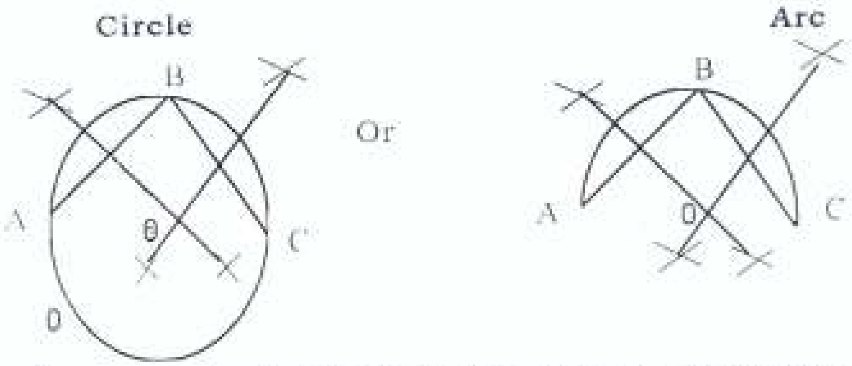
ACTIVITY 2.2b-2:fig. 91: To locate the center of a given circle or arc

Step 1



Draw two chords AB and BC

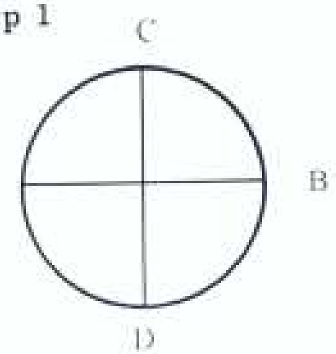
Step 2

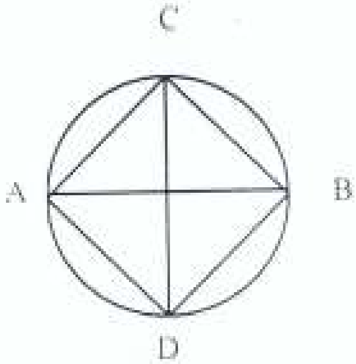


Construct the perpendicular bisector of each chord. The point of intersection "O" of the bisectors is the center of the circle or arc.

ACTIVITY 2.3-2: **Fig. 92:** To inscribe a square in a given circle

Step 1



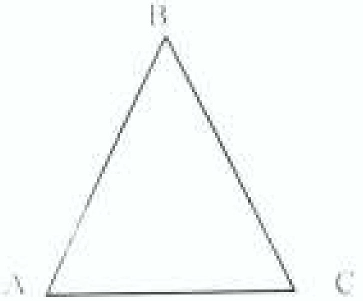


Draw the given circle and the two diameters AB and CD

Join the points A, B, C, and D with straight lines to complete the square

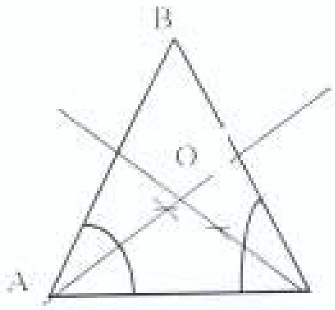
ACTIVITY 2.4-2:, Fig. 93: To inscribe a circle in a given triangle ABC.

Step 1



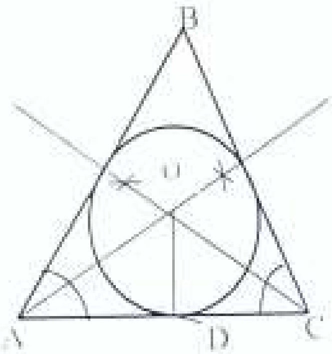
Draw the given triangle

Step 2



Bisect any two angles and produce the bisectors to intersect at O

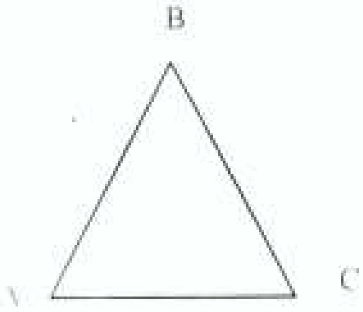
Step 3



Draw a perpendicular (OD) to any of the sides from point O. With center O and radius OD, draw the required circle.

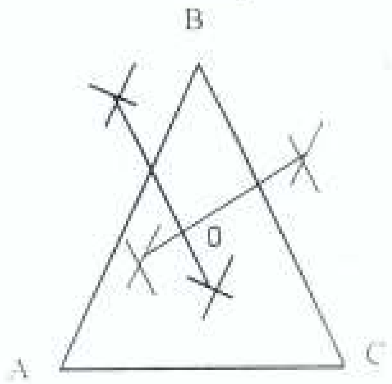
ACTIVITY 2.5-2: To draw the circumscribing circle of a given triangle ABC. Fig. 94

Step 1



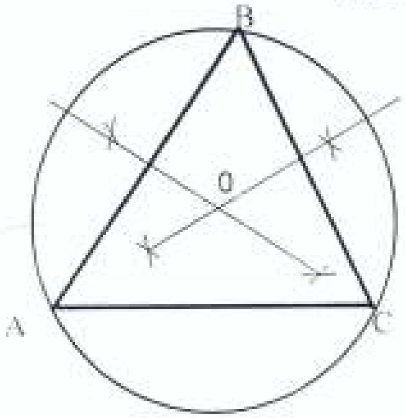
Draw the given triangle ABC

Step 2



Bisect any two of the sides and produce the bisectors to intersect at O

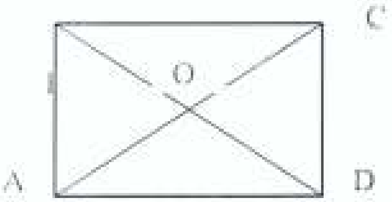
Step 3



With center O and radius OA or OB or DC draw the circle to pass through the three points A, B and C.

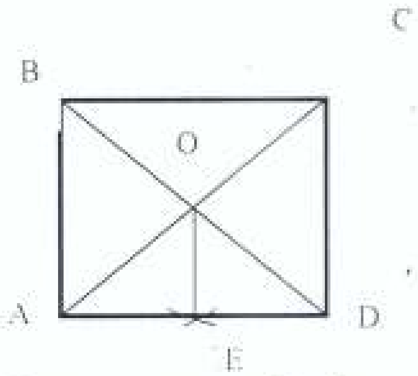
ACTIVITY 2.6-2: Fig. 95: To construct a circle within a given square ABCD

Step 1



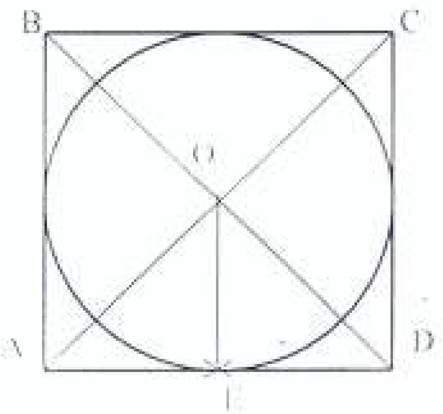
Draw the diagonals AC and CD to locate center of the square O

Step 2



Draw a perpendicular (OE) bisector to any side of the square

Step 3



With center O and radius OE draw the required circle.

ACTIVITY 2.7-2: TANGENTS

DEFINITION

A tangent is a line or curve that touches the surface of an arc or circle at only one point.

ACTIVITY 2.7a-2: PRINCIPLES OF TANGENCY

There are three principles of tangency:

(i) The first principle is joining an arc with a straight line.

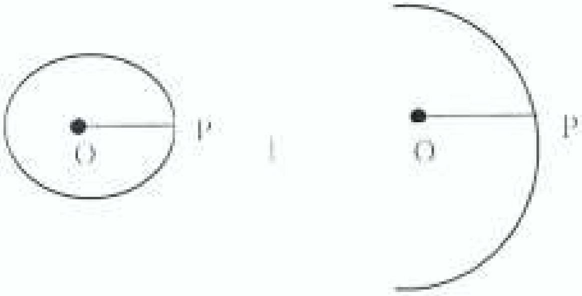
(ii) The second principle is joining two arcs externally.

(iii) The third principle is joining two arcs internally.

It should be noted that in all tangency problems the points of tangency should be located before the arc is drawn to enable the arc to be drawn perfectly thereby ensuring accuracy.

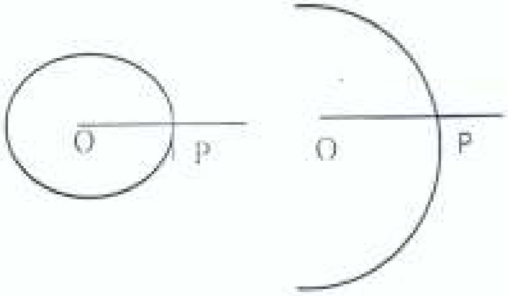
ACTIVITY 2.8-2: Fig. 96: To construct a Tangent to a given circle or arc at a given point

Step 1

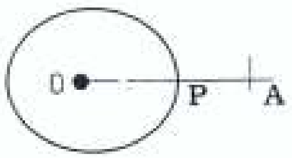


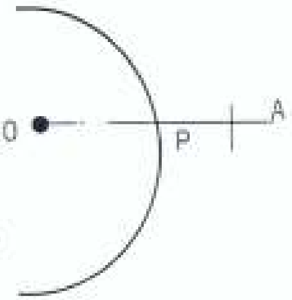
Draw the circle or arc with given center O. Indicate the given point P

Step 2



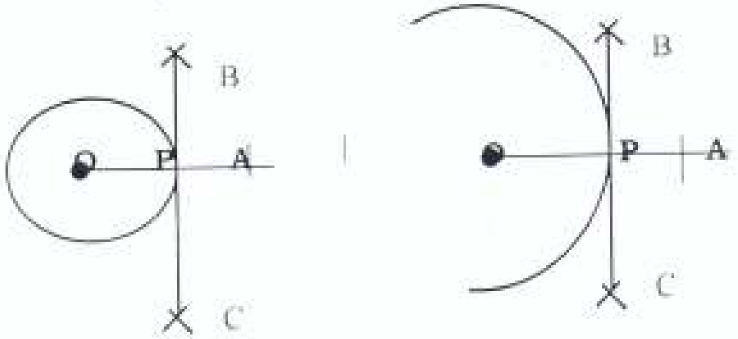
Extend the line OP outwards.



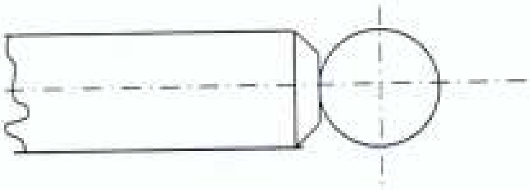


With P as center and radius OP draw an arc to cut the extended line at A

Step 4



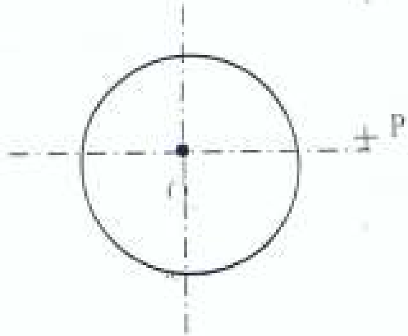
Bisect OA, the bisector BC is the required tangent tangent



APPLICATION

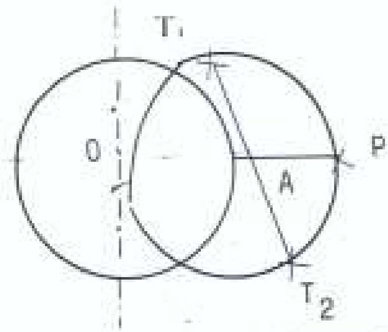
ACTIVITY 2.9-2: Fig. 97: To draw a tangent to a circle from a point outside the circle.

Step 1



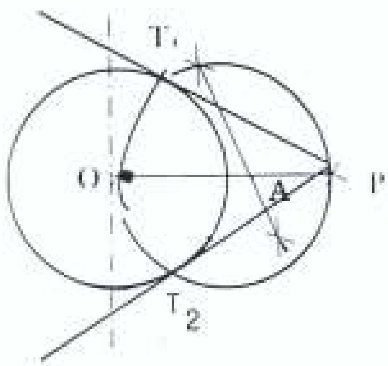
Draw the given circle with center O and locate the given point P outside the circle

Step 2



Draw line OP and bisect it to locate point A. Draw a circle with center "A" and radius AO = AP to locate tangent points T_1 and T_2

Step 3



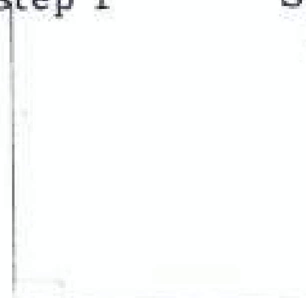
Draw PT_1 and PT_2.

These lines are tangent to the circle.

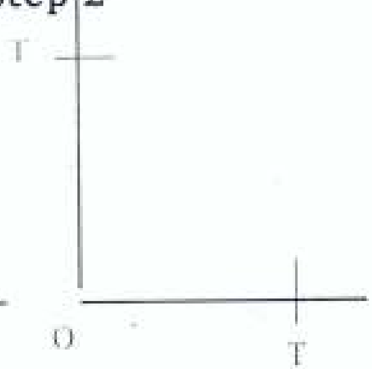
ACTIVITY 2.10-2 JOINING ARC WITH STRAIGHT LINE

ACTIVITY 2.10a-2 Fig. 98: To draw an arc Tangent to two given lines at right angles from a given radius.

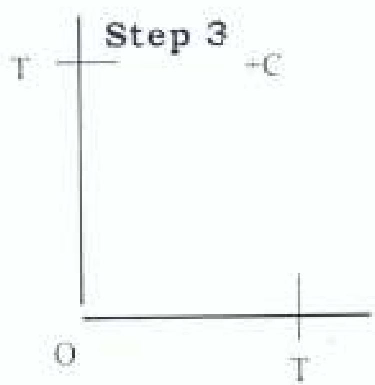
Step 1



Step 2



Step 3

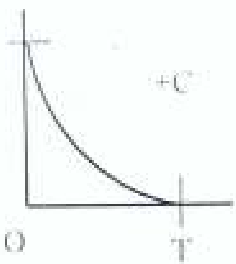


Draw the two lines at right angle to each other

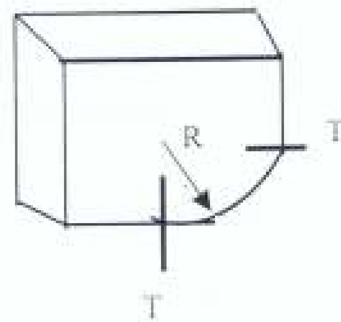
With given radius R, strike arcs intersecting the given lines to locate the tangency points (T) OT = R

With given radius R again and with point T as centers strike arcs intersecting at C

Step 4



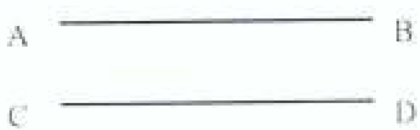
With C as center and the given radius R, draw the required tangent arc.



APPLICATION

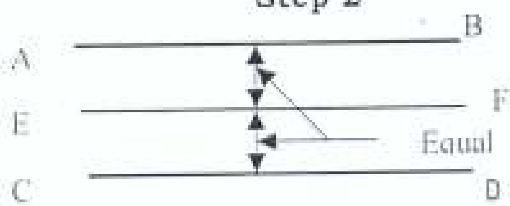
ACTIVITY 2.10b-2 **Fig. 99:** To construct arc tangent to two given parallel lines

Step 1



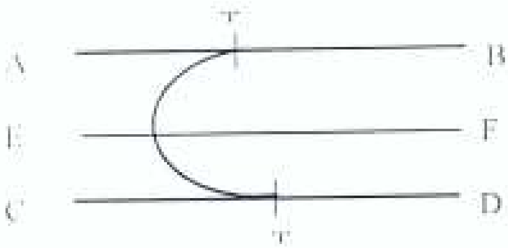
Draw the two parallel lines AB and CD

Step 2

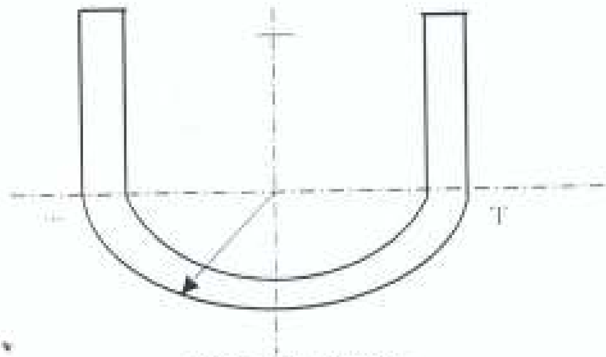


Draw line EF equidistant between AB and CD

Step 3



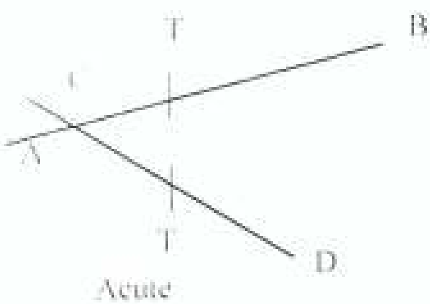
Using line EF as centre pick radius equal to the distance from line AB or CD to line EF and draw the arc

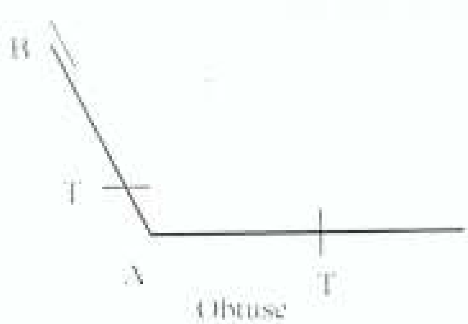


APPLICATION

ACTIVITY 2.10c-2 Fig. 100: To construct an arc of a given radius R and tangent to two given non-parallel lines at Acute or obtuse angles.

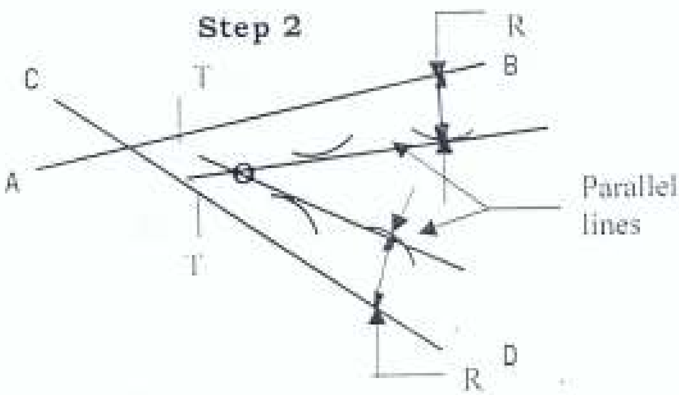
Step 1

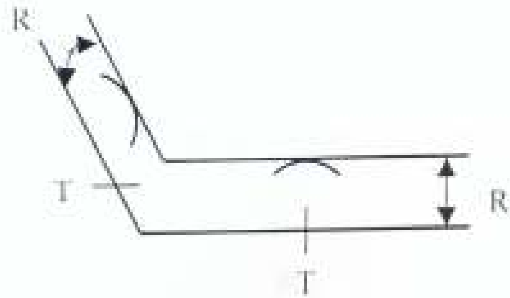




Draw the two lines to form the angles

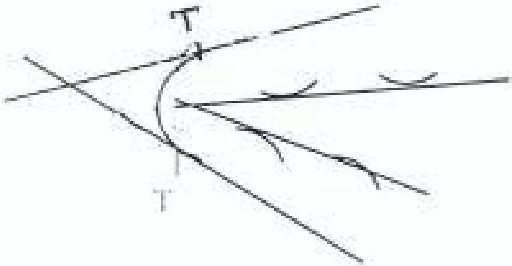
Step 2

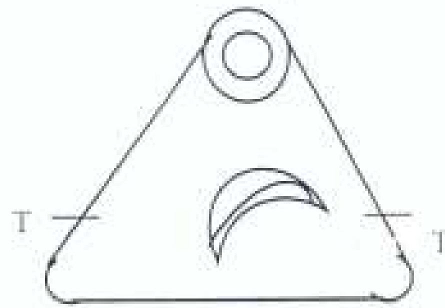




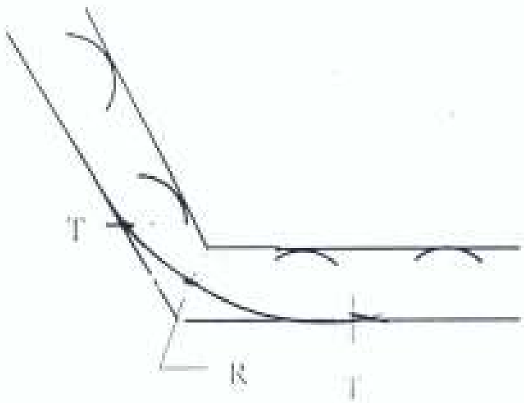
At a distance of R, construct lines parallel to the given lines.

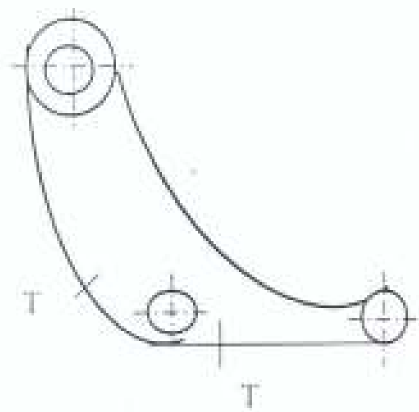
Step 3





APPLICATION





APPLICATION

With the intersection of the two parallel lines O as center and with given radius draw the required tangent arc between the points of tangency

ACTIVITY 2.11-2: JOINING TWO ARCS EXTERNALLY

(an arc tangent to two radii)

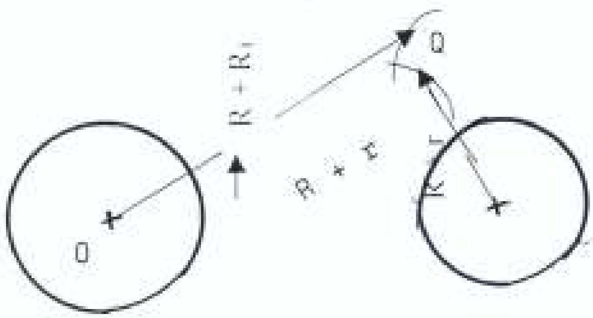
ACTIVITY 2.11a-2: **Fig. 101:** To draw an arc tangent to two circles externally.

Given: Radii of the two circles R and r. Radius of the arc $\mathbf{R_1}$. Distance between circle centers.

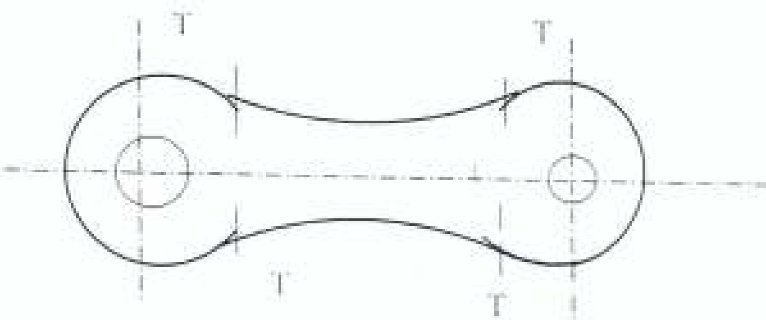
Step 1

Draw the two circles of radius R and r respectively

Step 2



From the centers O and P of the circles draw arcs of radii R + R_1 and r + R_1 respectively to intersect at a point Q



Set the compass at the given radius R_1 and from center Q draw the required arc to touch the two circles at tangent points (T). Repeat the steps to obtain the second arc if necessary.

ACTIVITY 2.12-2: **JOINING TWO ARCS INTERNALLY**

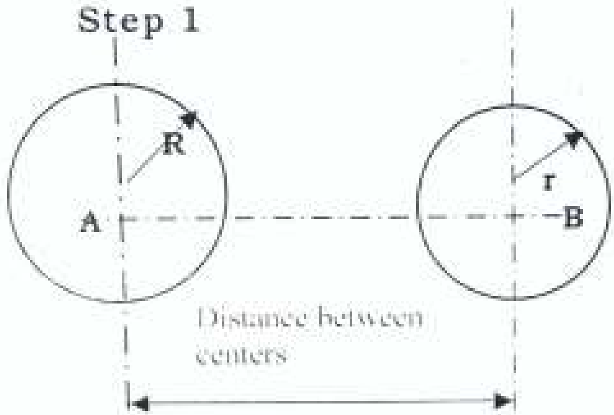
ACTIVITY 2.12a-2: Fig. 102: To draw an arc Tangent to two circles internally.

Given: Radii of the two circles R and r

Radius of the arc R_1

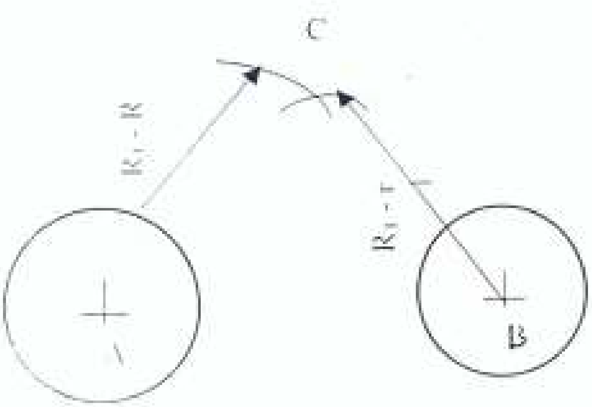
Distance between circle centers

Step 1



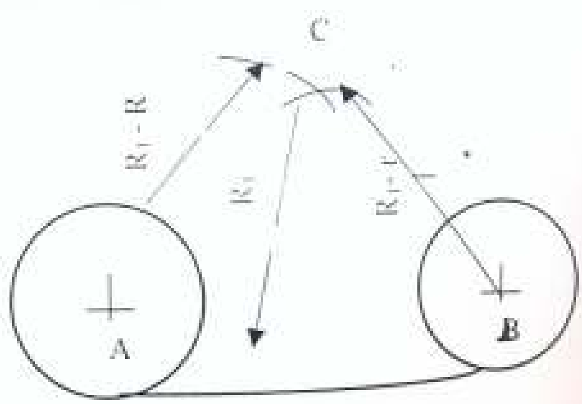
Draw the given circles of Radii R and r respectively.

Step 2

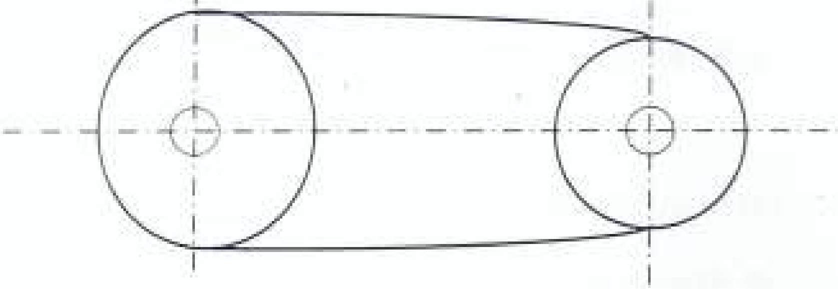


To find the center of the arc "C" draw arc of radii $R_1 - R$ and $R_1 - r$ from the circle centers A and B respectively

Step 3



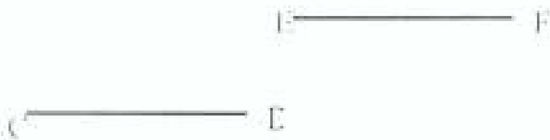
The point of intersection of the two arcs point "C" is the center for the given arc R_1. For the second arc, repeat the steps illustrated above.



ACTIVITY 2.13-2: **Fig. 103:** To draw an Ogee curve connecting two parallel lines.

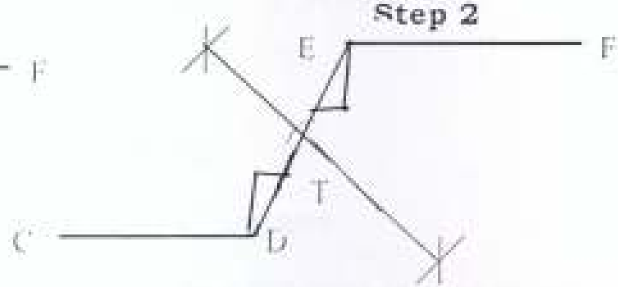
Given: Line CD and EF, and radius.

Step 1



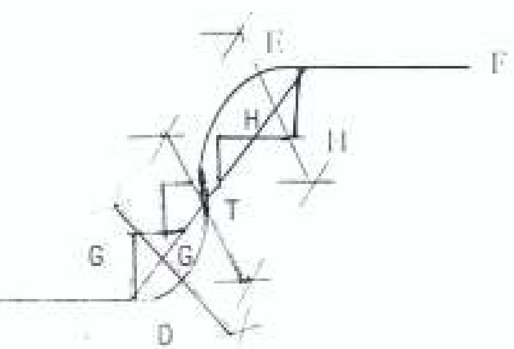
Draw the two given parallel lines CD and EF.

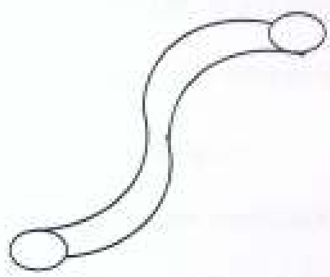
Step 2



Draw DE and determine the inflection point T (at mid point if equal arcs are desired).

Step 3





APPLICATION

At D and E erect perpendiculars and Draw perpendicular bisectors of DT and ET. The intersections G and H of these bisectors and the perpendiculars, respectively, are the centers of the required arcs.

SELF ASSESSMENT QUESTION

1 what is an arc?

A is a line drawn from the centre of the circle to the circumference.

B is the distance across a circle passing though the centre

C is any part of the circumference of a circle

D it is the diameter of the circle

2. A circle is defined as a plane figure bounded by --------------

A The circumference B Straight line C Parallel line

D Perpendicular line

3. The following are part of a circle except

A chord B radius C arc D polygon

4. The circle that have the same centre but different radius is called

A concentric circle B eccentric circles C tangential circles

D quadrant circles

5. Must be done to locate the centre of an inscribe circle to given triangle A bisect one angle only B bisect one side only C bisect any two sides D bisect any two angles

6. What is the name of the point at which a line touches an arc or a circle? A quadrilateral B polygon C tangent D triangle

Answer

(1) C (2) B (3) D (4) A (5) D (6) D

3.2.3 Module 3 – Quadrilaterals, polygons and areas of plane figures

The major topics covered in this module include Quadrilaterals, polygons and Areas of plane figures. Quadrilaterals and polygons are geometric objects enclosed with straight lines.

OBJECTIVES

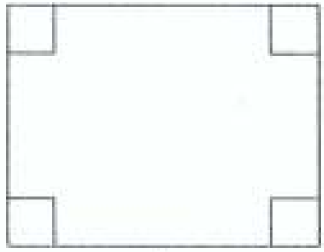
At the end of this module student should be able to:

- Define quadrilaterals
- Define polygons
- List the different types of quadrilaterals and polygons
- Construct/draw different types of quadrilaterals
- Construct/draw different types of polygons
- Draw figure equal in area to a given figure
- Enlarge or reduce plane figures in a given ratio

HOW TO STUDY THIS MODULE

- Read though this module noting the main idea and the unfamiliar words look up the meaning of this unfamiliar word in Microsoft Word.
- Study the module step by step in order, which the steps are arranged.
- Attempt all the self- assessment questions given at the end of the module.
- Do not look at the answer before writing your answer to the questions.
- To get the best out of studying this unit obeys all instructions and observes all rules.

ACTIVITY 3. 0-2: Quadrilaterals. Fig. 104a-h: are plane figures with four sides and four interior angels.



A

Square

Has four equal sides. All its four angels are right angles (90^0).

B

Rectangle

Has its opposite sides equal, and all its four angles are right angles (90^0).

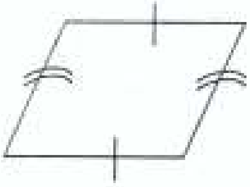
C

Rhombus

Has all sides equal. Its angles are not at right angles.

Rhomboid

Has opposite sides equal.



D

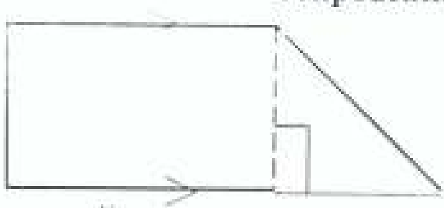
Parallelogram

Opposite sides equal. Its angles not at right angles

E

Trapezium

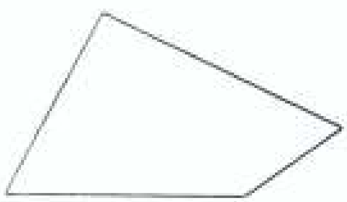
Has two opposite sides parallel.



F

Trapezoid

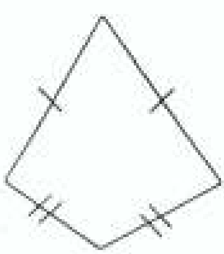
It has four unequal sides and angles



G

Deltoid or kite

Its adjacent pairs of sides are equal.



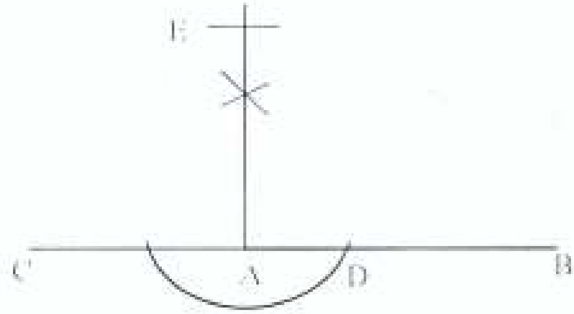
H

ACTIVITY 3.1-2: Fig. 105: To construct a square when given the length of the side.

Step 1

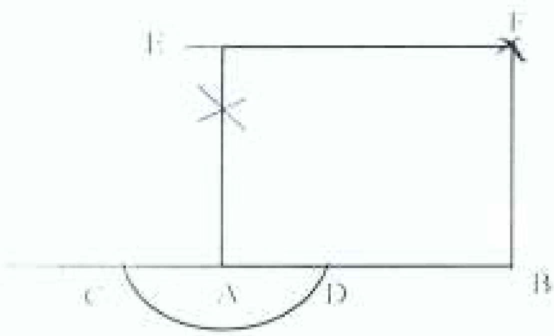
Draw line AB equal to the length of the given side

Step 2



Construct a perpendicular to line AB at point A (see activity 4 module 4). Set the compass for the given length and mark off this length on the perpendicular line to give point E.

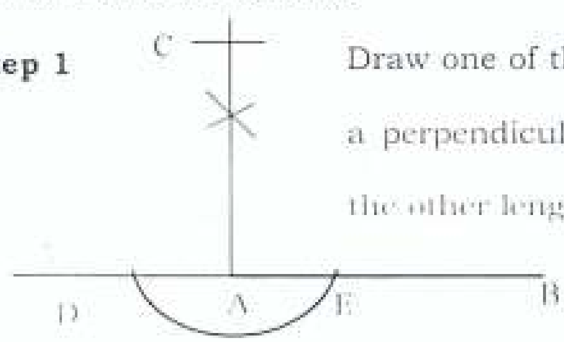
Step 3



From points E and B, using the same compass length AB, lay off intersecting arcs BF and EF, ABEF is the required square.

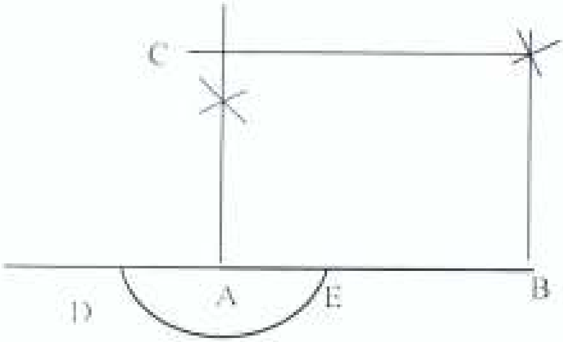
ACTIVITY 3.2-2 Fig. 106: To construct a rectangle given the length of the two sides AB and AC.

Step 1



Draw one of the given line AB. Construct a perpendicular at point A and mark off the other length AC.

Step 2



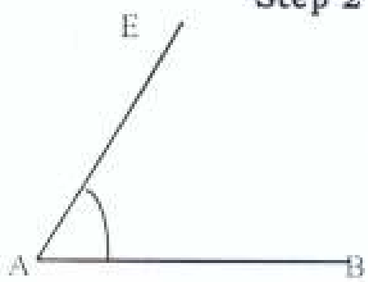
With center C and radius AB strike an arc. With center B and radius AC strike another arc to intersect the other arc locating point F. Join C to F and B to F. ABCF is the required rectangle.

ACTIVITY 3.3-2: Fig. 107: To construct a parallelogram given the length of the two sides and one angle.

Step 1

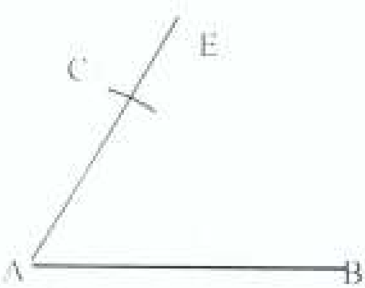
Draw one of the given sides AB

Step 2



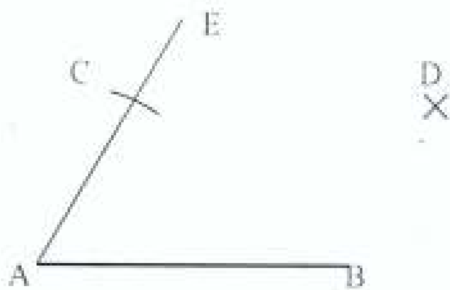
Construct the given angle BAE

Step 3



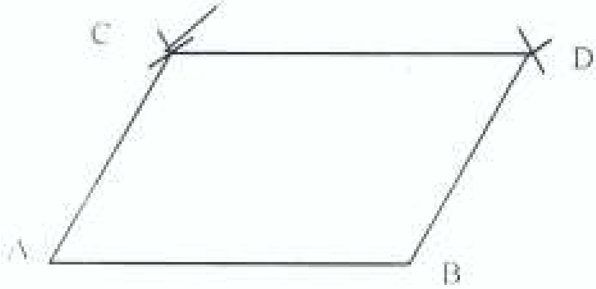
With center A and radius of the other side draw an arc to cut AE at C

Step 4



With center C and radius AB strike an arc. With center B and radius AC strike another arc to intersect the former arc at D

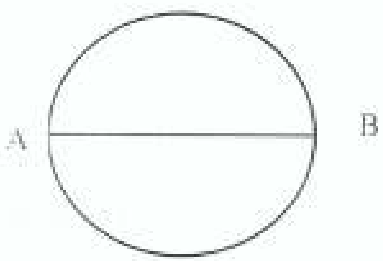
Step 5



Join C to D and B to D to obtain the required parallelogram.

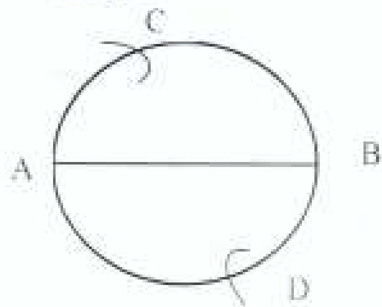
ACTIVITY 3.4-2: Fig. 108: To construct a Rectangle given the length of the diagonal and one side.

Step 1



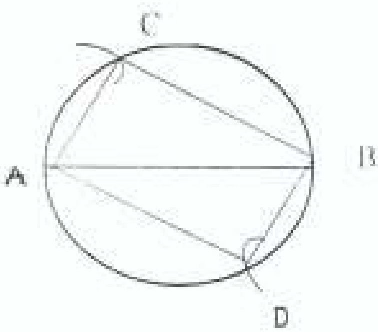
Draw a circle equal in diameter to the given diagonal

Step 2



With centers A and B in turn and a radius equal to the given side, strike an arc to cut the circumference at C and D respectively.

Step 3

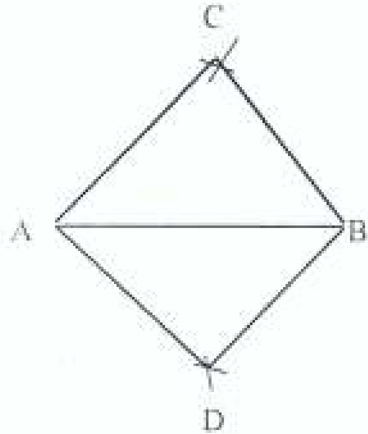


Join the points A, B, C and D to complete the required triangle.

ACTIVITY 3.5-2: Fig. 109: To construct a Rhombus when given the length of the diagonal and side.

Step 1

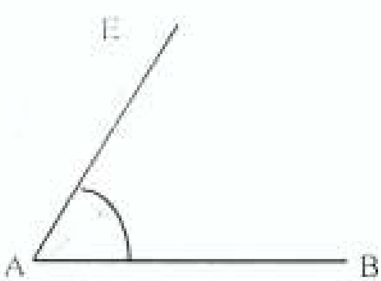
Draw the given diagonal AB



With radius of the given side and centers A and B in turn draw arcs above and below line AB to intersect at C and D respectively. ABCD is the required rhombus.

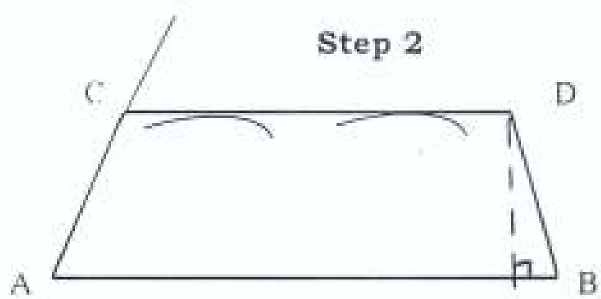
ACTIVITY 3.6-2: Fig. 110: To construct a trapezium given the parallel and the perpendicular distance between them, and one angle.

Step 1



Draw one of the given parallels AB and construct the given angle BAE

Step 2



Using the distance between the parallel lines strike arcs for the second parallel line. Draw the second parallel line to touch the projected line from A. Join BOD to complete the required trapezium.

ACTIVITY 3.7-2: POLYGONS

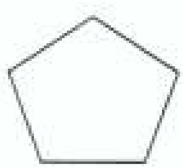
INTRODUCTION

Polygons are plane figures with more than four (4) sides.

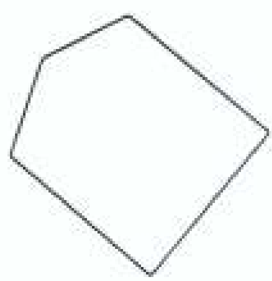
- A polygon may be a regular or irregular polygon
- Regular polygons; are polygons having equal sides and angles
- Irregular polygons; are polygons with unequal sides and angles.

ACTIVITY 3.8-2: TYPES OF POLYGONS

Pentagon polygon	5 sides
Hexagon polygon	6 sides
Heptagon polygon	7 sides
Octagon polygon	8 sides
Nonagon polygon	9 sides
Decagon polygon	10 sides
Dodecagon polygon	12 sides



Regular polygon



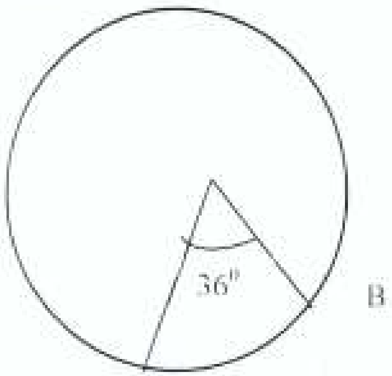
Irregular polygon

ACTIVITY 3.9-2: POLYGON CONSTRUCTION

ACTIVITY 3.9a-2: Fig. 111 To draw a pentagon polygon in a given circle using the protractor.

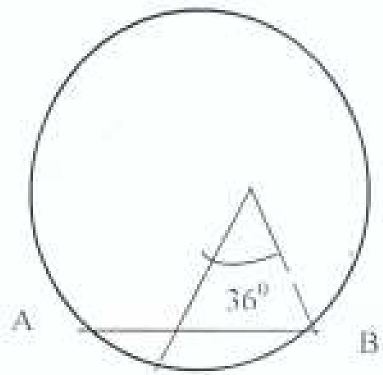
A regular pentagon is made up of five isosceles triangles, each of the vertical angles being 72⁰.

Step 1



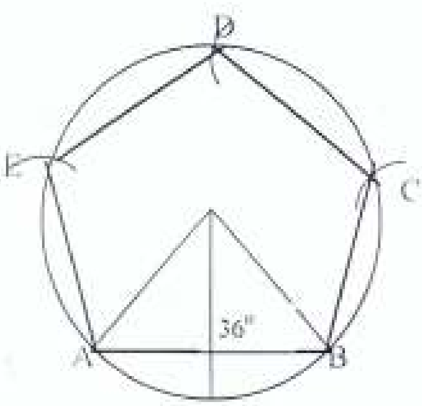
From the center of the circle, measure 36⁰ with your protractor and produce this line to touch the circle at B.

Step 2



With the aid of the T-square, draw a line from this point B to cut the other side of the circle. This will produce one side of the pentagon.

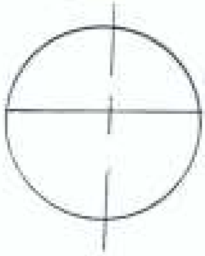
Step 3



With the compass and radius AB, mark off the remaining sides on the circle, and join them to produce the required pentagon.

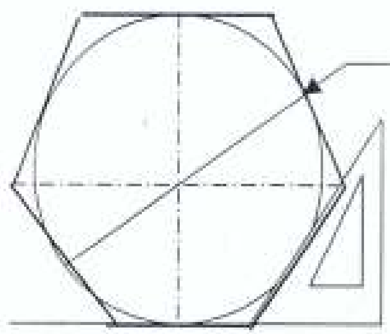
ACTIVITY 3.9b-2: **Fig. 112:** To draw a regular hexagon given the distance across flats.

Step 1



Draw a circle having a diameter equal to the distance across flats.

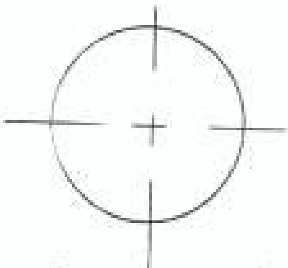
Step 2



Draw tangents to the circle with a 60° Setsquare to produce the hexagon.

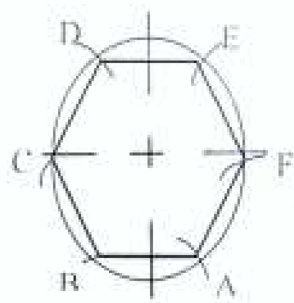
ACTIVITY 3.9c-2: Fig. 113: To draw a regular hexagon given the distance across corners.

Step 1



Draw a circle having a diameter equal to the distance across corners.

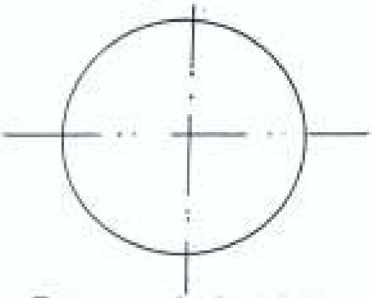
Step 2



From a point A on the circumference of the circle step off the radius round it to give six equally spaced points (A, B, C, D, E and F). Join these points to form the hexagon.

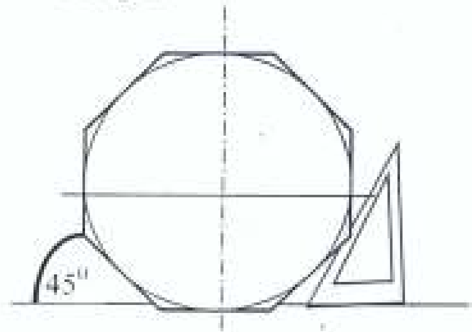
ACTIVITY 3.9d-2: **Fig. 114**: To draw a regular octagon given the distance across flats (A/F).

Step 1



Draw a circle with a diameter equal to the given distance

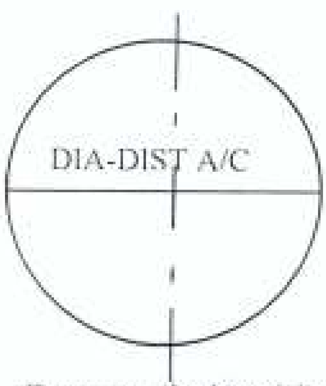
Step 2



Draw tangents to the circle with 45⁰ set square to produce the required octagon.

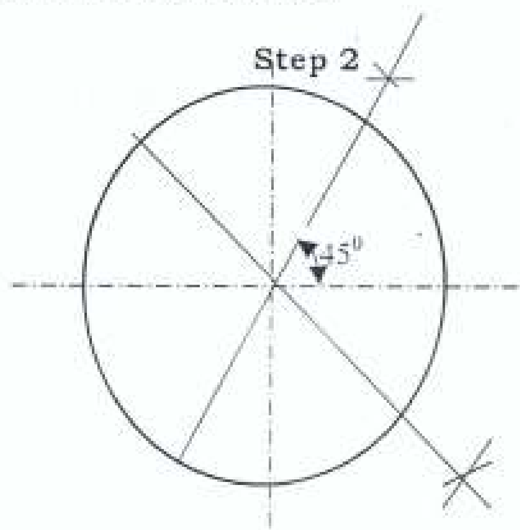
To draw a regular octagon given the distance across corners.

Step 1



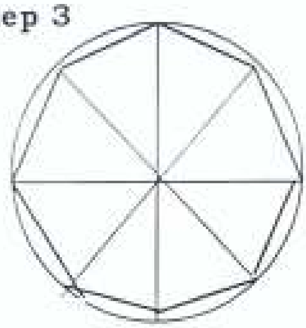
Draw a circle with diameter equal to the given distance across corners.

Step 2



Draw vertical and horizontal diameters of this circle. Bisect the angles to obtain 45⁰ each and produce the bisectors to touch the circumference of the circle.

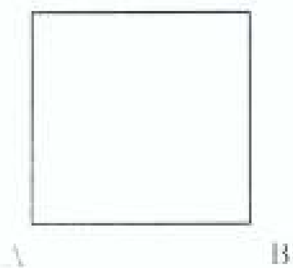
Step 3



Join these points where the lines touches the circumference to produce the required octagon.

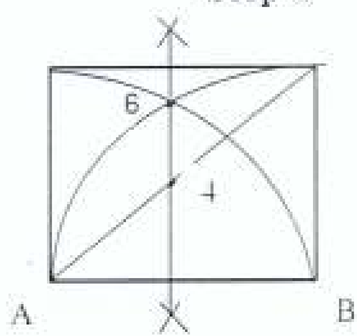
ACTIVITY 3.9e-2: Fig. 115: To draw any regular polygon given the length of the side (AB) using square method

Step 1



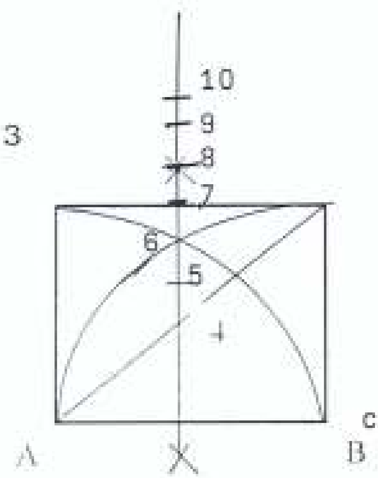
Draw the given length AB and construct a square on it.

Step 2



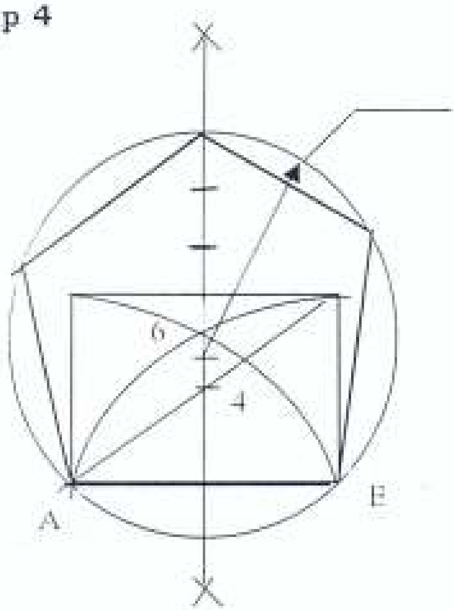
Bisect AB. Draw a diagonal on the square to cut the bisector of AB at 4. With A and B in turn and radius AB. Draw arcs to intersect at 6.

Step 3



Bisect 4-6 to obtain point 5. Take the distance 4-5 and step it off from point 6 to obtain 7, 8, 9, 10 etc as the circle centres for circumscribing circles of the regular polygons.

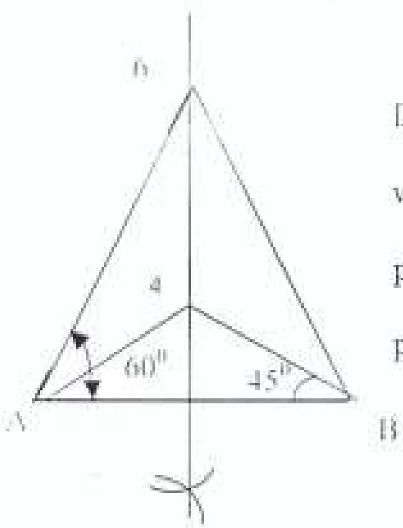
Step 4



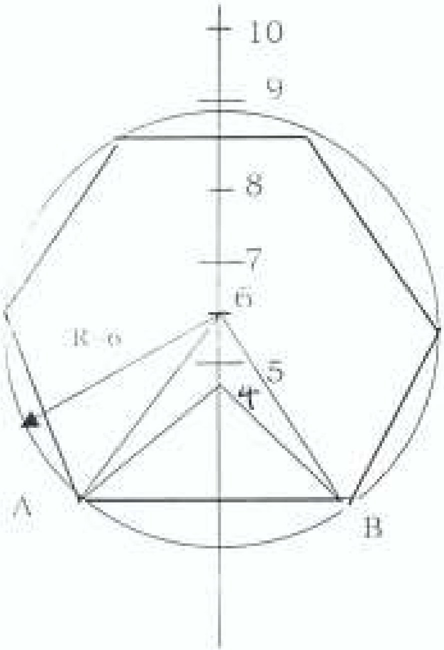
To draw any polygon, set the compass on the number corresponding to the number of sides of the polygon and extend it to A and draw the circumscribing circle. Step AB round the number of sides and join the points.

ACTIVITY 3.9f-2: Fig. 116a: Two triangles method

Step 1



Draw the given side AB. Construct two triangles with base angles 45^0 and 60^0 respectively. Mark points 4 and 6 where these triangles touches the perpendicular bisector of AB



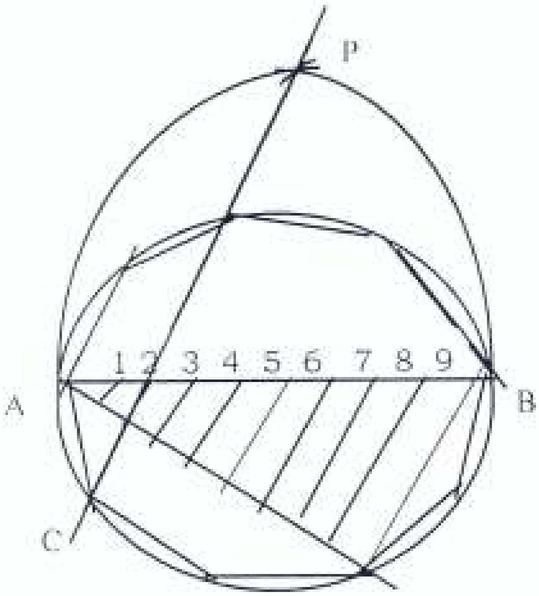
Bisect the space between 4 and 6 to locate point 5. The points 4, 5 and 6 are the centers for circumscribing circle of regular polygons with four, five and six sides of length AB. For any other polygon step off the distance 4 – 5 to obtain the circumscribing center. To draw any polygon follow step 4 in method 1 (square method) above.

ACTIVITY 3.9g-2: Fig. 116b: To construct any polygon in a given circle

Given: Diameter of the circle

Procedure

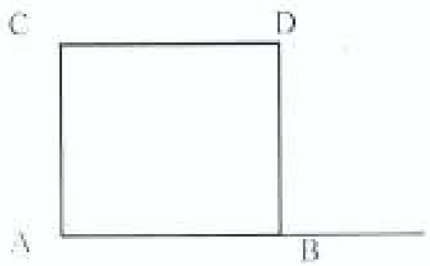
- Draw the given circle
- Divide the diameter AB into the same number of equal parts as the required polygon has side.
- With centres A and B in turn and radius AB draw arcs to intersent at P.
- Draw a line from P through 2 to touch the circle at C.
- Joint AC to give one side of the polygon
- Step AC round the circle to obtain the other sides of the polygon.



ACTIVITY 3.10-2: AREAS OF FIGURES

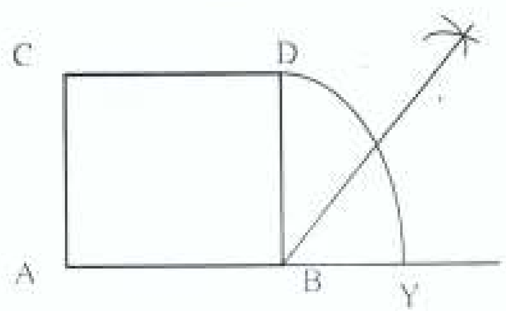
ACTIVITY 3.10a-2: Fig. 117: To draw a square double the area of a given square ABCD

Step 1



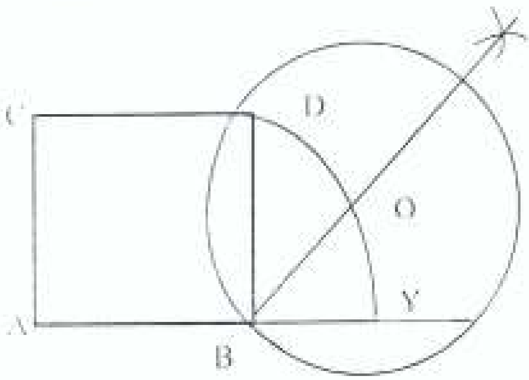
Draw the given square and extend the base AB to the right.

Step 2

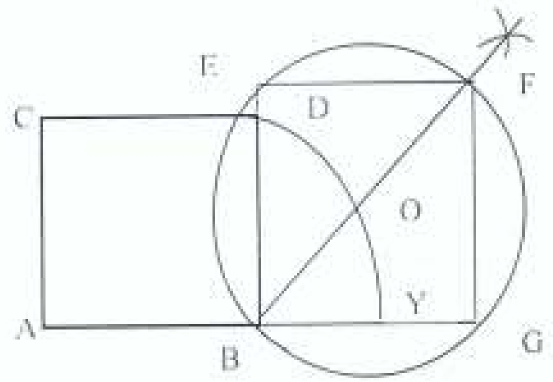


With radius BD and center B draw an arc DY. Bisect angle DBY.

Step 3



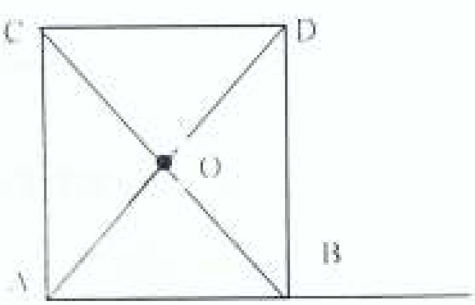
The intersection at O is the center of a circle, which contains the square. Draw the circle with center "O" and radius OD.



Draw through DB to touch the circle at E. BE is one side of the required square. Complete the square BEFG.

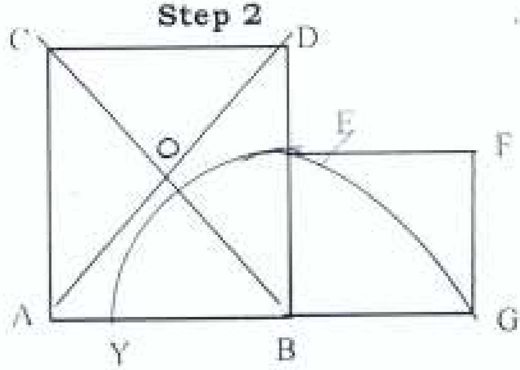
ACTIVITY 3.10b-2: Fig. 118: To draw a square half the size of a given square ABCD.

Step 1



Draw the given square and extend the base line AB to the right and produce the diagonals to meet at O

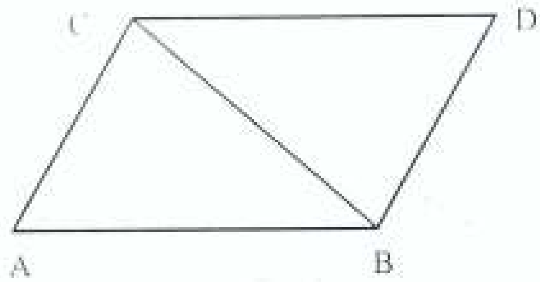
Step 2



With B as center and radius BO draw an arc touching BD at E and AB extended at G. Line BE and BG are two sides of the square. Complete the square. BEFG.

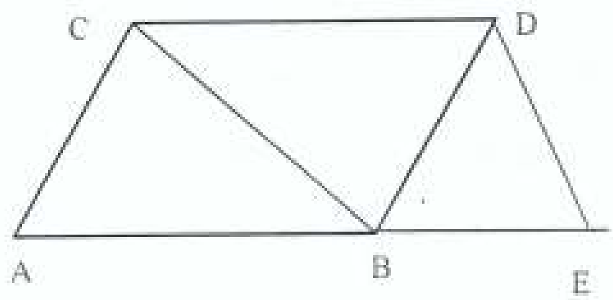
ACTIVITY 3.10c-2: Fig. 119: To draw a triangle equal in area to a given parallelogram.

Step 1



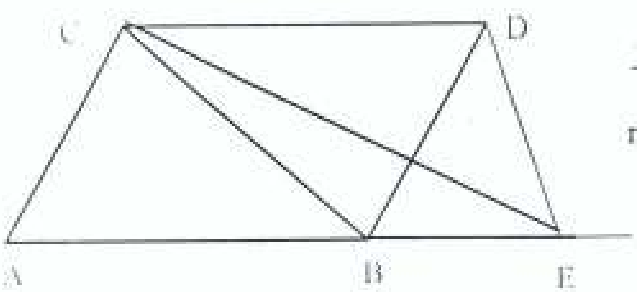
Draw the given parallelogram ABCD and join B to C

Step 2



Extend the base line AB. Draw DE parallel to BC from D.

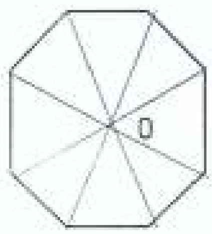
Step 3



Join E to C. EBC is the required triangle.

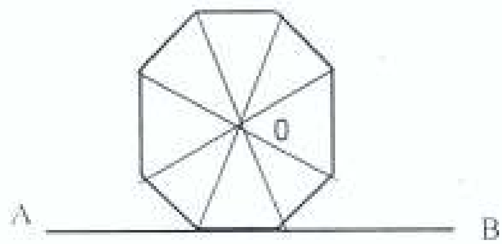
ACTIVITY 3.10d-2: Fig. 120: To draw a triangle equal in area to any regular polygon.

Step 1



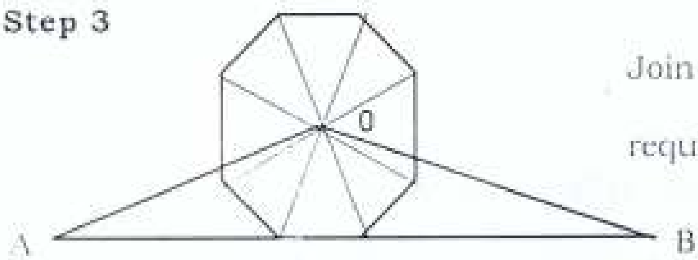
Draw the regular polygon and draw the diagonal to intersect at the center O. in this example an octagon is drawn.

Step 2



Draw AB equal in length to length of side X number of sides e.g. if the length of side is 15mm, AB is equal to 15 x 8 (octagon polygon) = 120mm.

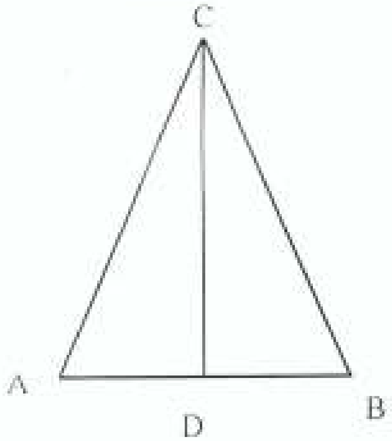
Step 3



Join O to A and O to B. ABO is the required triangle

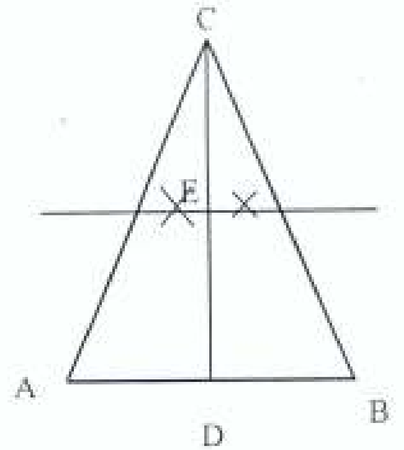
ACTIVITY 3.10e-2: Fig. 121: To draw a rectangle equal in area to a given triangle.

Step 1

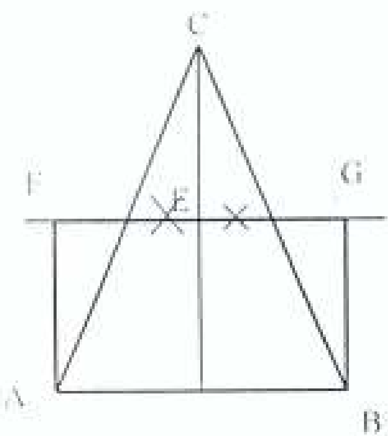


Draw the given triangle and draw a perpendicular to AB from C to give point D.

Step 2



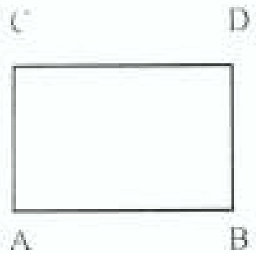
Bisect CD to give point E.



Draw a parallel line to AB through E. Draw perpendiculars at A and B to touch the parallel line-to-line AB at F and G. ABGF is the required rectangle.

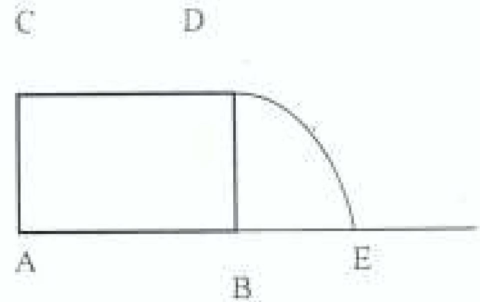
ACTIVITY 3.10f-2: Fig. 122: To draw a square equal in area to a given rectangle.

Step 1



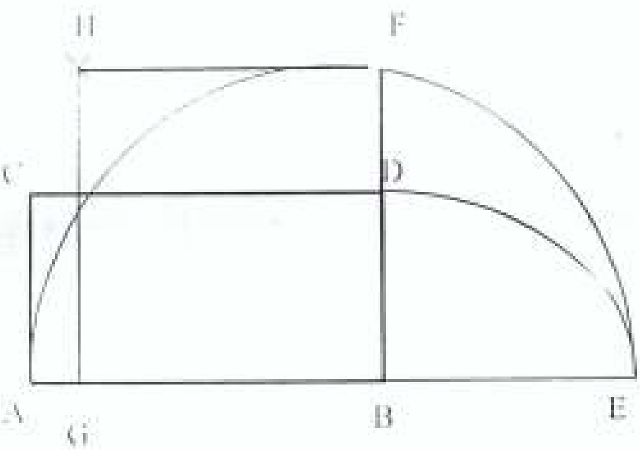
Draw the given rectangle ABCD

Step 2



Extend line AB to the right and draw an arc with radius BD to touch AB extended at E.

Step 3

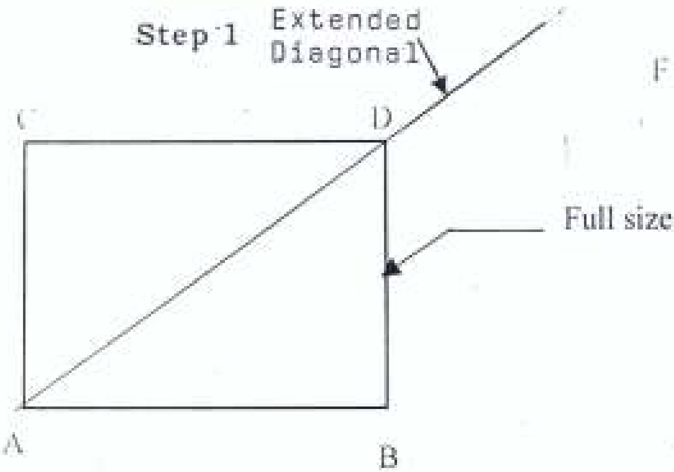


Draw a semicircle on AE. Extend BD to touch the semicircle at F. BF is a side of the square. Mark G on AB equal to BF **with radius BF and centres G and F in** turn draw arcs to intersect at H. Join H to G and H to F to obtain the require square BFGH.

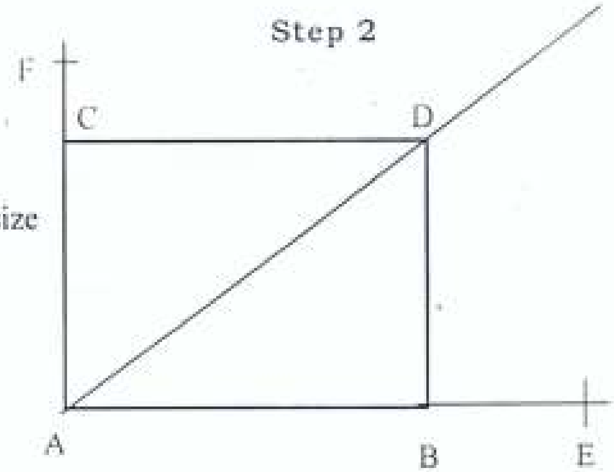
ACTIVITY 3.11-2: ENLARGEMENT AND REDUCTION OF PLANE FIGURES

ACTIVITY 3.11a-2: Fig. 123: To enlarge or reduce the size of a given plane figure. In this exercise a rectangle is given.

(a) Enlargement

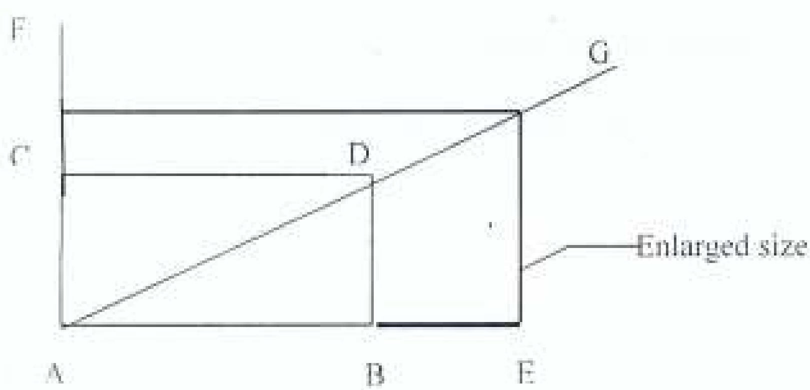


Draw the given rectangle ABCD and extend the diagonal



With radius equal to the length of the required rectangle locate points E and F on lines AB and AC respectively.

Step 3

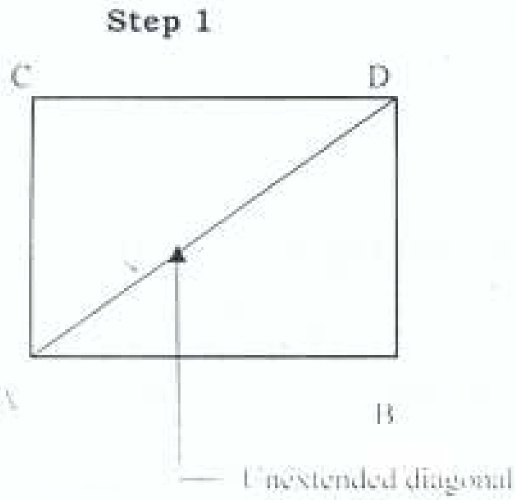


From points E and F draw parallel lines to lines BD and CD to locate on the extended diagonal at point G. AEFG is the enlarged triangle.

ACTIVITY 3.11b-2: 124 **REDUCTION**

STEP 1

To reduce the size proportionately the vertical and horizontal lines are located on the unextended diagonal as show below: Fig. 124



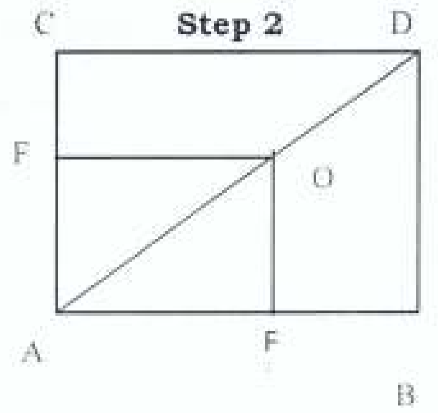


Fig. 124

STEP 2

Mark the points for the reduced rectangle on lines AB and AC, which are E and F respectively. From these points E and F draw parallel lines to lines AB and AC to locate on the diagonal at point O. Rectangle AEFO is the reduced rectangle.

ACTIVITY 3.11c-2: **Fig. 125:** to reduce a plane figure to a similar figure in a given ratio.

Given: An irregular hexagon polygon to be reduced in the ratio 3:2.

PROCEDURE

- Draw the given irregular hexagon polygon ABCDEF with AB as base.
- Draw line BG at any convenient angle.

* Divide line BG into the number of parts corresponding with the largest number of the given ratio (3).
* Drop verticals afrom these points to the extended line from the base line. Point 3 to locate H and point 2 to locate i.
* Bisect AH to give point j and draw a semicircle of radius HJ from point j.
* Bisect Ai to give point k and draw a semicircle of radius ki from point k.
* Draw a vertical line from B to touch the semicircles at L and M.
* Join M to A.
* Draw a line parallel to line AM from point L to touch line AB at "a". Draw af parallel to AF, fe parallel to FE, etc.
* The shaded portion "BafedC" is the reduced hexagon polygon.

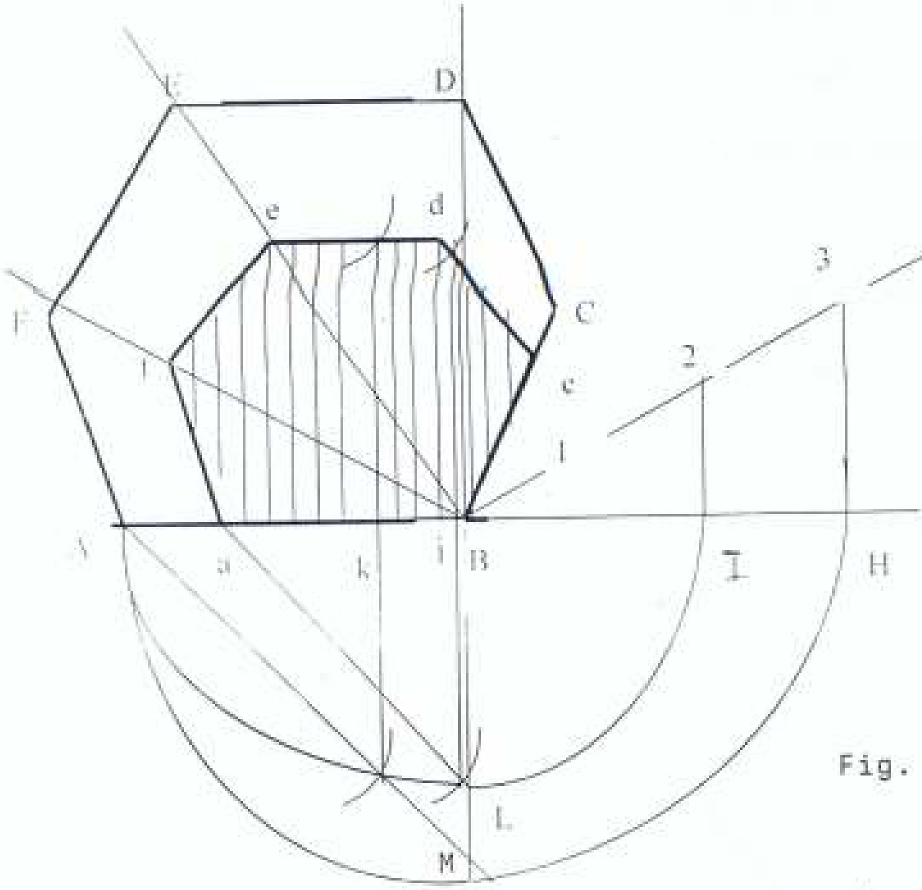


Fig. 125 : Reduction of a plane figure.

ACTIVITY 3.12-2: Fig. 126 : To enlarge a plane figure to a similar figure in a given area ratio.

Given: An irregular hexagon polygon to be enlarged in the ratio 2:3.

PROCEDURE

* Draw the irregular hexagon polygon ABCDEF with AB as the base.
* At any convenient angle draw line BG .
* Divide line BG into the number of parts corresponding with the largest number of the given ration (3).
* Drop verticals from these points to the extended line from the base line. Point 3 to locate H and point 2 to locate i.

* Bisect AH at J and draw a semicircle of radius HJ from point J.
* Bisect AI at k and draw a semicircle of radius ki from point k.
* Draw a vertical line from B to touch the semicircles at L and M.
* Draw a line parallel to line AL to touch the base line at 'a'.
* Extend the diagonals BF, BE, BD and BC to give Bf, Be, Bd and Bc
* Draw af parallel to AF, fe parallel to FE, etc. to touch the diagonals respectively.
* The shaded portion Bafedc is the enlarged polygon.

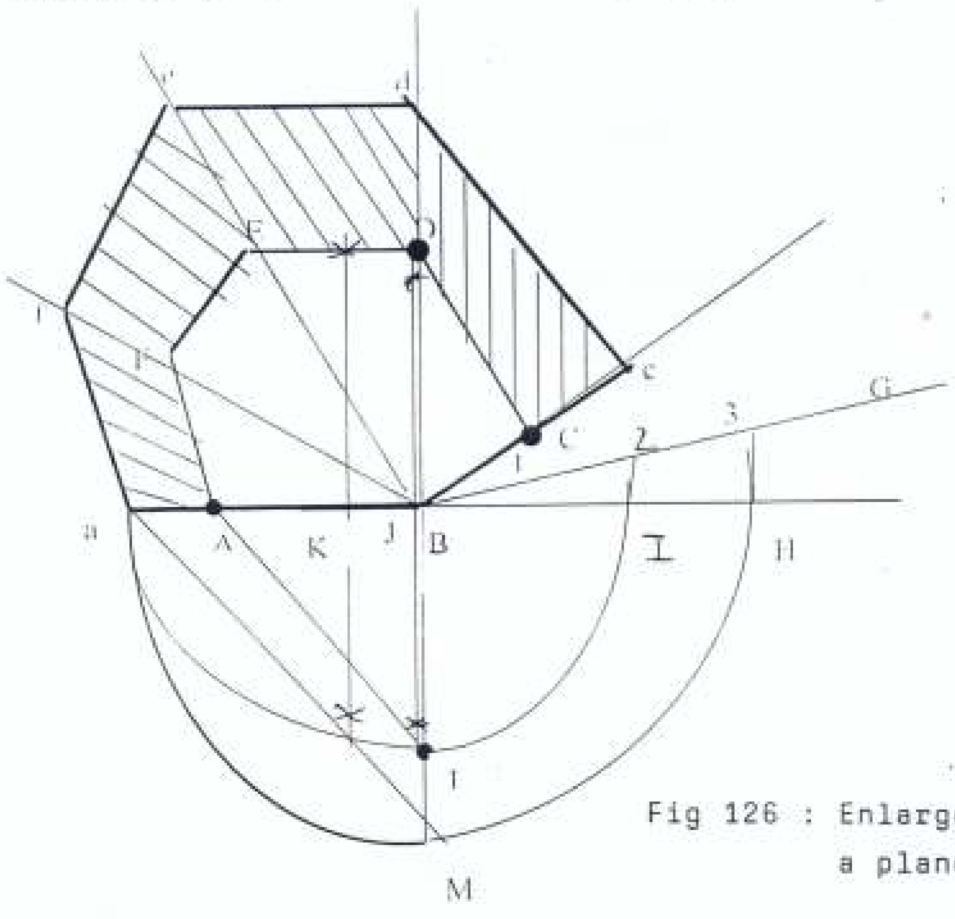


Fig 126 : Enlargement of a plane figure.

SELF ASSESSMENT QUESTIONS.

1 What name is given to a plane figure with four sides and four interior angles? A involutes B triangles

C quadrilaterals D helix

2 what is the name given to a plane figure with four equal sides

A rectangle B square C kite D involutes

3 A hexagon has how many sides.

A 5 sides B 6 sides C 7 sides D 8 sides

4. A 45° set square is used to draw _______ polygon

A nonagon B octagon C heptagon D hexagon

5. What name is given to polygons with all sides of equal length

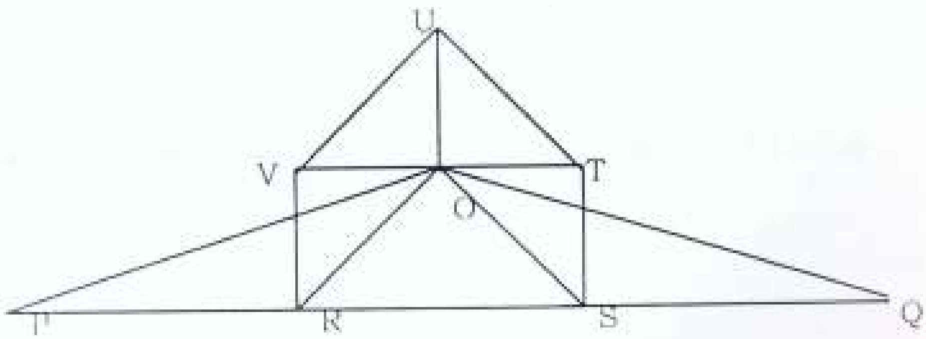
A Irregular polygon B unequal polygon

C uneven polygon D regular polygon

6. The following are polygons except

A hexagon B pentagon C involutes D octagon

Use the figure below for questions 7 and 8. The figure shows a regular pentagon on a triangles OPQ. The base of the triangle is 5 times the side of the pentagon.



7 What is the relationship between the areas of ΔPOQ and the pentagon RSTUV?

A the two figure are equal in area

B the triangle is 5 times the area of the pentagon

C the pentagon is 5 times the area of the triangle

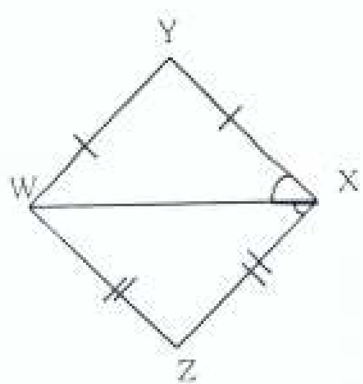
D the triangle is $^{3}/_{5}$ of the area of the pentagon

8 What kind of triangle is ΔOPQ

A acute angled B right angled C Isosceles D Scalene

8. Use the figure below for question 9 and 10

$< WXY = 72°$ and $< WXZ = 31°$



9 Calculate $\angle WZX$ A 118° B 144° C 175° D 178°

10 What is the name of the quadrilateral?

A square B rhombus C parallelogram D kite

Answers

(1) C (2) B (3) B (4) B (5) D (6) C (7) A (8) C (9) A (10) D.

3.2.4 Module 4 - Loci part 1: ellipse, parabola and hyperbola

Covered in this module are the various conic sections produced when a plane passes through a right circular cone. These shapes are ellipse, parabola and hyperbola. They are geometric curves used in drafting.

Definition: A locus (*Singular of loci*) is the path traced by a point which is governed by certain laws or rules.

OBJECTIVES

At the end of this modules students should be able to

- Define locus
- Identify and draw different conic sections
- Construct the different curves (ellipse, parabola and hyperbola when given the focus to the directory and the eccentricity)
- State the applications of the different curves mentioned above.

HOW TO STUDY THIS MODULE.

* Read through the module once noting the main idea
* Study the module step by step as it has been arranged for you
* Practice the drawing in the examples.
* Practice the drawing in the example.
* Do the self- assessment question at the end of the module.
* Do not look at the answer before answering the questions at the end of the module.

ACTIVITY 4.0-2: CONIC SECTIONS: Conic sections are shapes produced when a plane intersects a right circular cone. Five types of shapes are produced. These shapes are circle, ellipse, parabola hyperbola and triangle.

The type of shape produced depends on the position of the cutting plane. These are illustrated in the figure below:

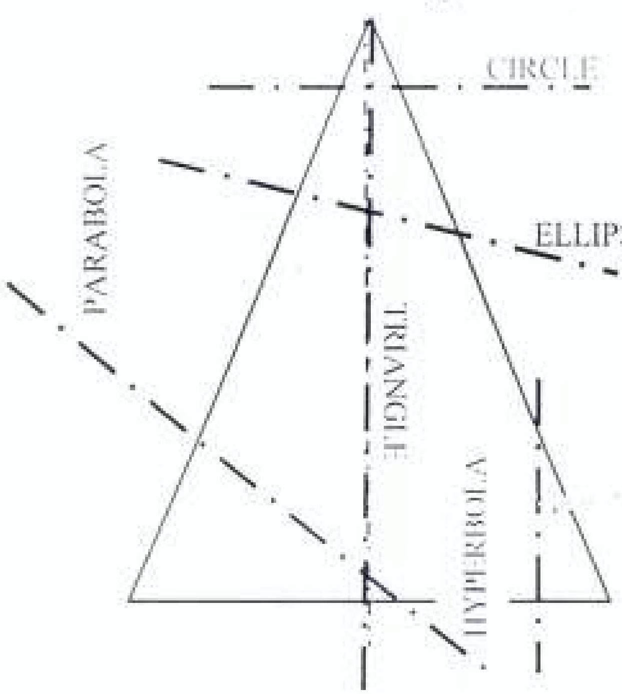


Fig. 127: Conic Sections

ACTIVITY 4.0a-2: **Circle:** A circle is produced when the plane is at right angle to the axis and cuts all the element on one side of the apex fig. 128

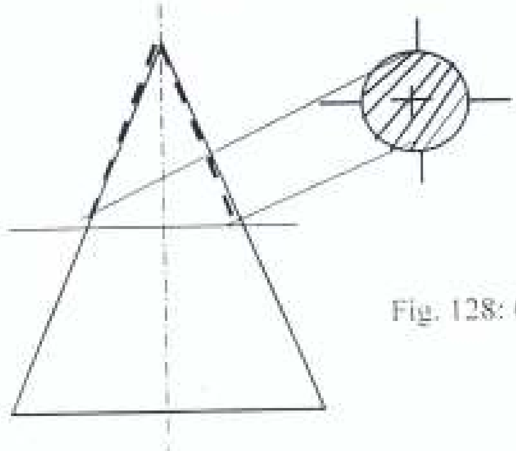


Fig. 128: Circle section

ACTIVITY 4.0b-2: **Ellipse:** This curve results when a plane passes through the cone inclined to the axis. Fig. 129

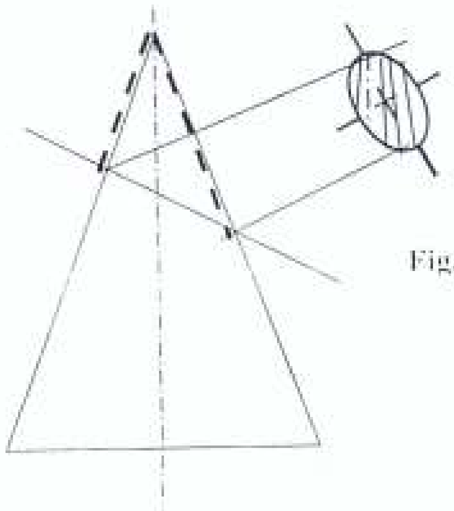


Fig. 129. Ellipse section

ACTIVITY 4.0c-2: **Parabola:** This curve is produced when the cutting plane passes through the cone parallel to one element. Fig. 130 .

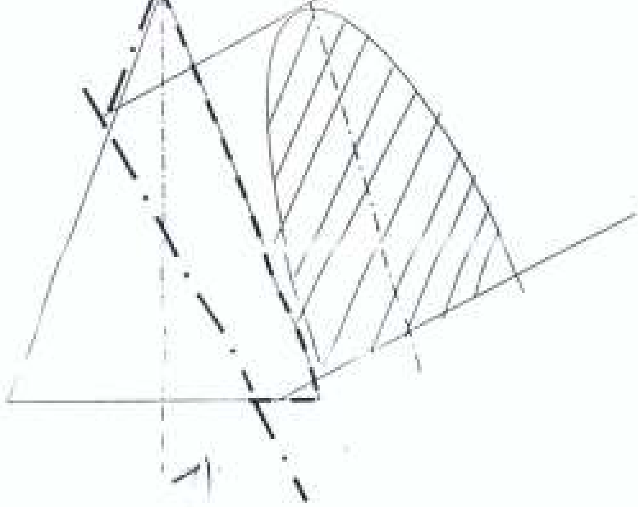


Fig. 130 Parabola section.

ACTIVITY 4.0d-Z, Fig. 131 : Hyperbola section occurs when a plane passes through the cone parallel with the axis of the cone.

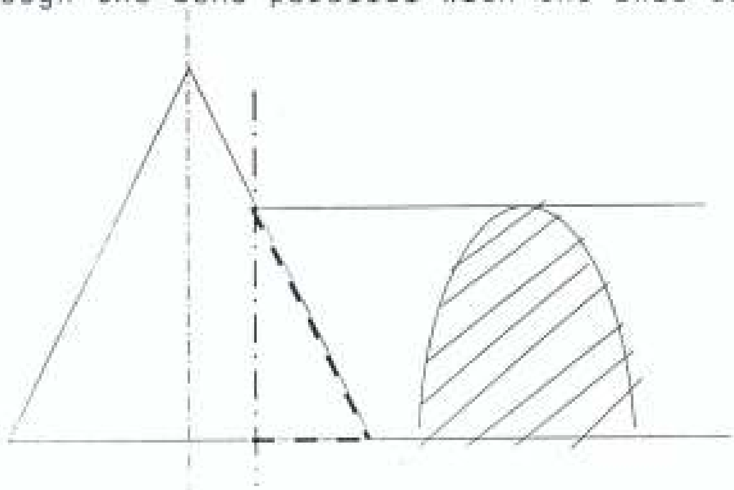


Fig. 131: Hyperbola section

Another shape that can be produced from conic section is triangle. Triangle is produced when a plane passes through *the axis of the cone*. Fig. 132.

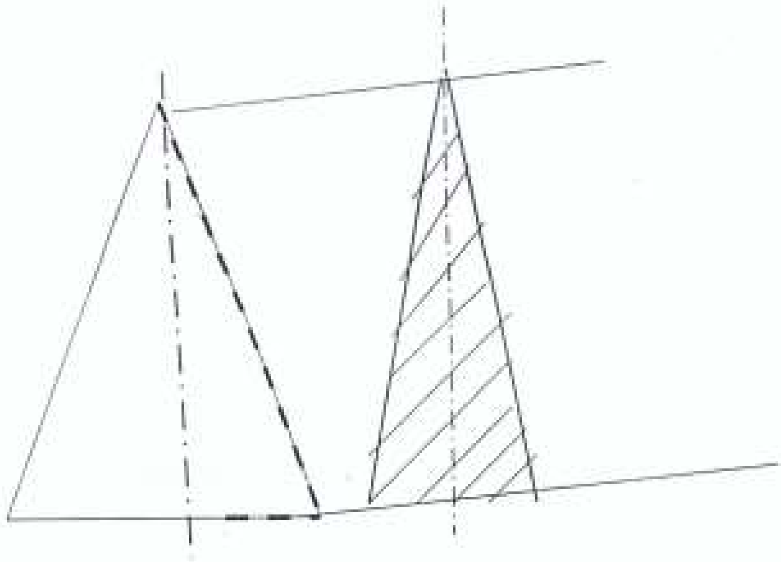


Fig. 132: Triangle section

Apart from the conic sections one of the ways of constructing these curves is to be given the focus to the directrix and the eccentricity. Figure 133 (a – c)

The ratio PF:OP which is equal to unity or one is the eccentricity

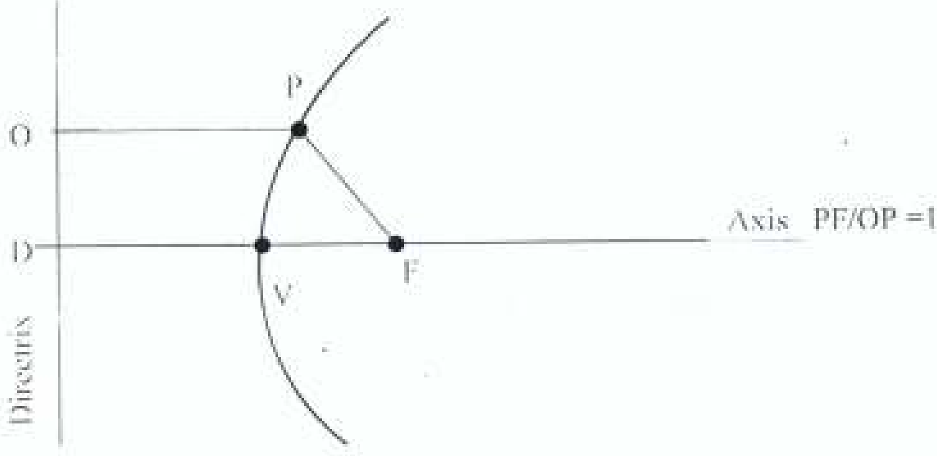
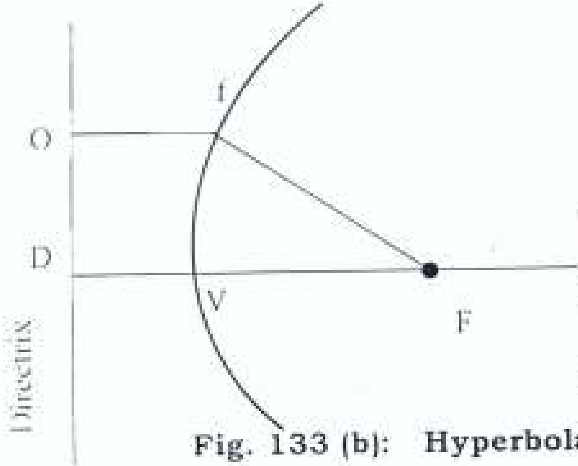
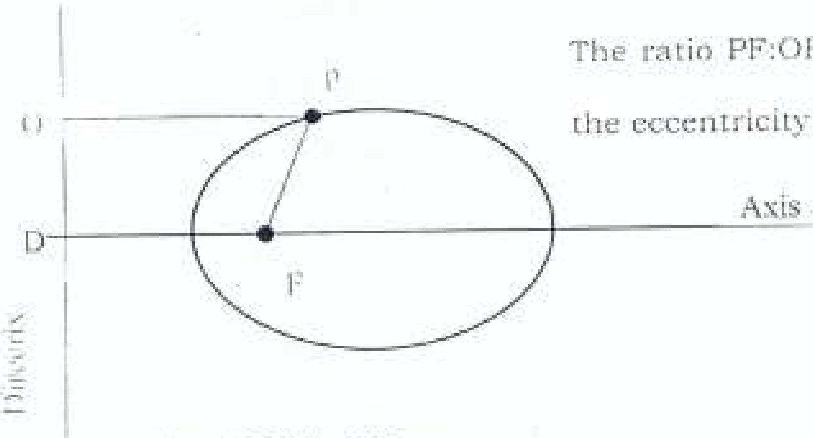


Fig. 133(a): Parabola



The ratio PF:OP which is greater than one is the eccentricity (PF/OP >1)

Fig. 133 (b): Hyperbola



The ratio PF:OP is less than one is the eccentricity

Axis PF/OP <1

Fig. 133(c): Ellipse

F = Focus

V = Vertex

D = Directrix

Line OP is always at right angles to the direstrix

ACTIVITY 4.1-2: Ellipse

Ellipse: An ellipse is a curve formed by a point moving in a plane so that the sum of the distances from two fixed points is constant and equal to the major axis. It consists of two axes which bisects at right angles. These axes are known as **major axis** (longest diameter) and minor axis [shortest diameter] while the curved line which bounded this plane figure is called **the circumference.**

ACTIVITY 4.1a-2: Applications of Ellipse: Ellipse have a wide range of applications in the design of some home decorations such as trays and plates and also in some automobile spare parts such as the gasket.

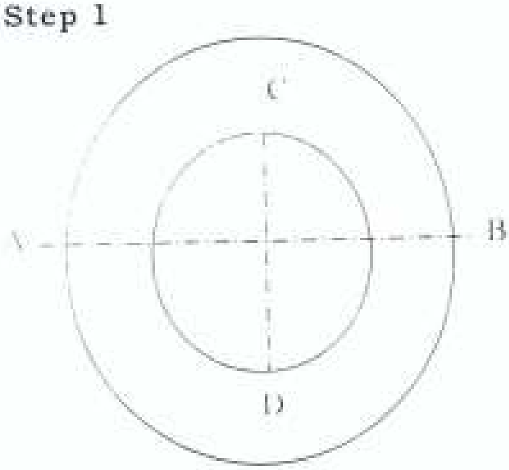
ACTIVITY 4.2-2: CONSTRUCTION OF ELLIPSE

ACTIVITY 4.2a-2: Fig. 134: Auxiliary or concentric circles method

Given: Diameter of major axis

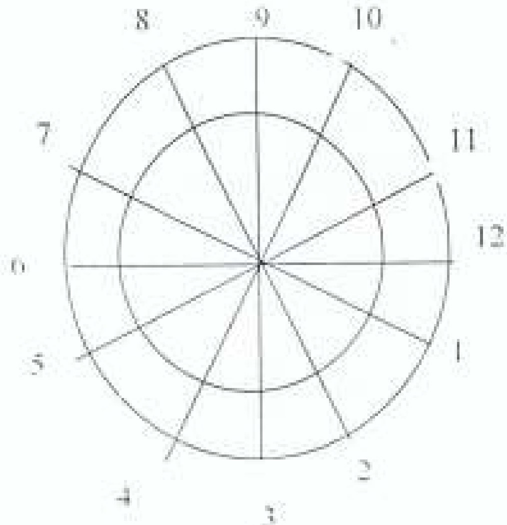
Diameter of minor axis.

Step 1



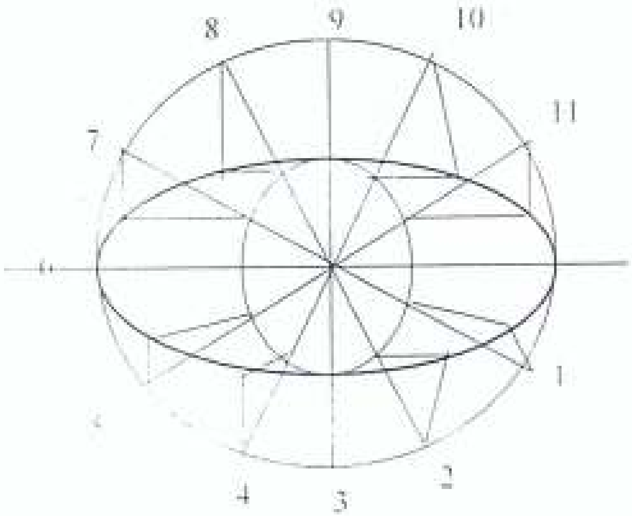
(1) Draw two circles equal in diameter to the major and minor axes AB and CD respectively.

Step 2



Divide the circles into 12 equal parts

Step 3



Drop perpendiculars from the points where the lines touches major axis circle, and draw horizontals from the points where the radiating lines cut the inner circle to intersect the verticals. These intersectors are points on the ellipse.

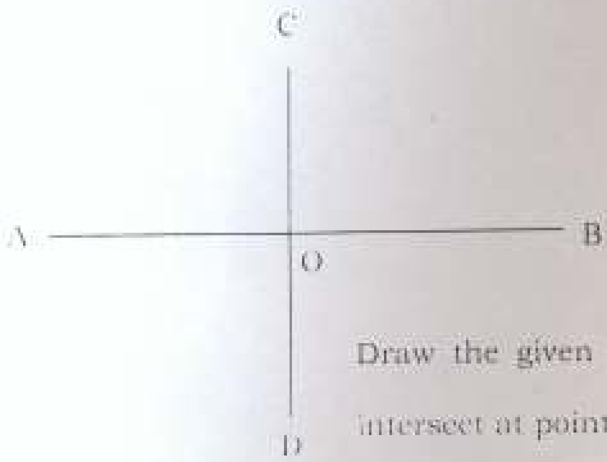
Fig. 134: Auxilliary or Concentric Circles Method.

ACTIVITY 4.2b-2: Fig. 135: Trammel methods

Given: Major axis AB

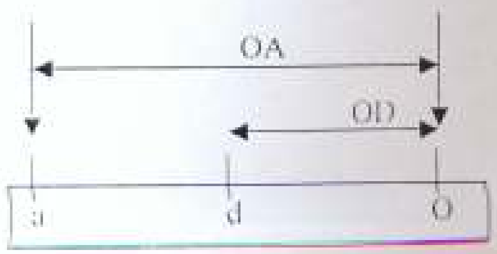
Minor axis CD

Step 1



Draw the given major and minor axes to intersect at point O.

Step 2

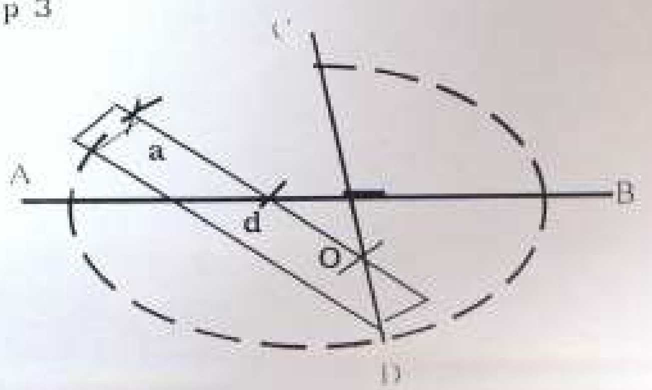


OA = ½ major axis

OD = ½ minor axis

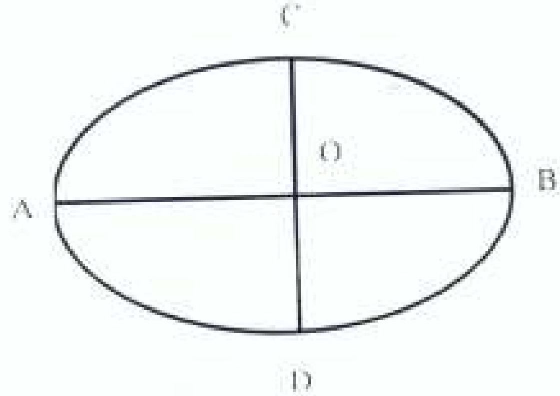
Cut a strip of paper (trammel), and mark off the distances AO (half major axis) and OD (1/2 minor axis) on it

Step 3



Place the trammel on the axes with point O moving along line CD (minor axis), point 'd' along line AB (major axis) and mark the ellipse points at 'a'.

Step 4



Join the marked points with a French curve

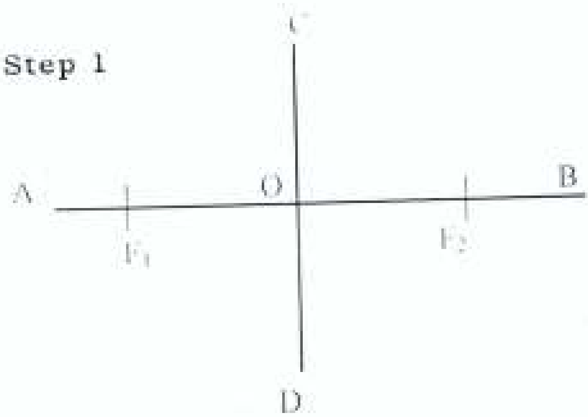
Fig. 135: **Trammel Method**

ACTIVITY 4.2c-2: Fig. 136: Focal Point Method

Definition : Focal point is when a point moves so that the sum of tis distance from two fixed points, called focal points or foci, is constant.

Given: Major axis AB
Minor axis CD

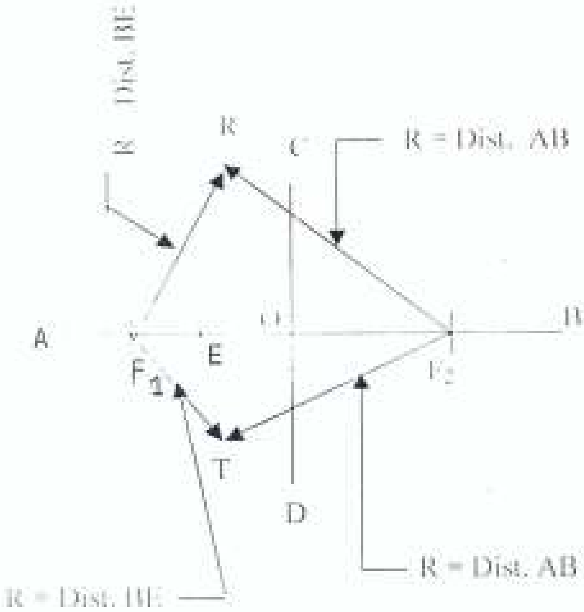
Step 1



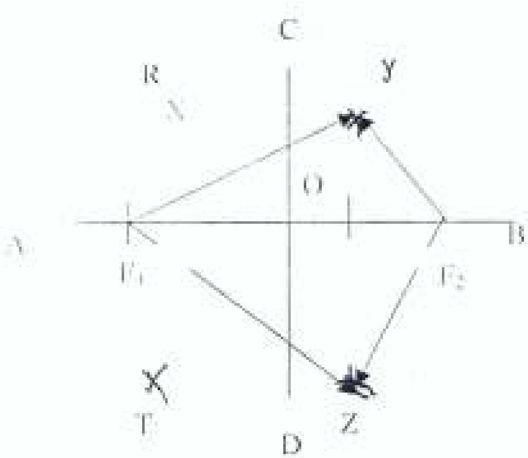
Draw the major and minor axes to intersect at O. locate the focal Points with radius equal to the semi-major axis AO or OB centred at C or D.

The points F_1 and F_2 where these arcs cut the major axis are the focal points.

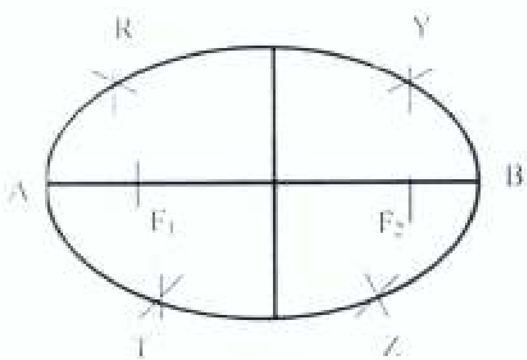
$CF_1 + CF_2 = AB$.



To find the points on the ellipse such as R & T, locate a point E between F, and O, using points F_1 and F_2 as centers, and radii equal to the distance from point A to points B, and from point B to E strike intersecting arcs at R and T.



Repeat the same procedure to locate other points Y & Z on the other two quadrants.



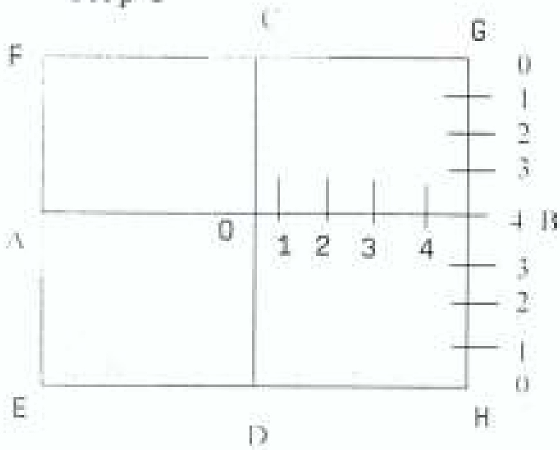
Join the marked points with the aid of the French curve

Fig. 136: Focal Point Method

ACTIVITY 4.2d-2: **Fig. 137:** Rectangular method.

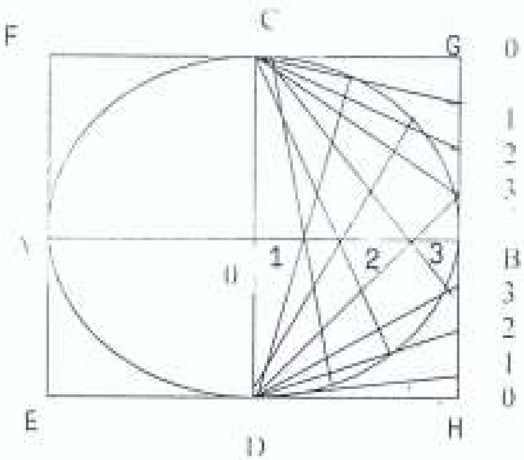
Given: Major and Minor axes AB and CD respectively.

Step 1



Draw a rectangle equal in length and breadth to the major and minor axes respectively.

Divide lines OB, and into the same number of units (Maximum of four). All the units on a line should be of equal length.



Draw lines from point C to the points on line BG.

Draw lines from point D to the points on BH.

Fig. 137: Rectangular Method

From point C draw through positions 1, 2, and 3 on the major axis to meet radiating lines 1, 2 & 3 from D. From point D draw through positions 1, 2 and 3 on the major axis to meet radiating lines 1, 2 and 3 from C. Join the point of intersections to obtain one half of the ellipse. Locate points in the remaining quadrants in a similar way.

NOTE: If the conjugate diameters are given the method of construction is exactly the same as the diameter method. Conjugate in this regard means that two diameters are conjugates when each is parallel to the tangents at the extremities of each other.

ACTIVITY 4.3-2: PARABOLA

Parabola is the locus of a point, which moves so that its distances from a fixed point, the focus and a fixed straight line, the directrix are always equal.

ACTIVITY 4.3a-2: APPLICATION

The parabolic curve is used in engineering in the design of bridge, arches and dams, it is also used in forming the shape of reflectors for sound and light because it possess the property that if a source of light, heat or sound is placed at the focus, rays reflected from the parabola form a parallel beam (e.g. hand torches, car head lamps and electric lamps). Equally, rays falling on the parabola from outside will be reflected to the focus (e.g. radar and radio dishes).

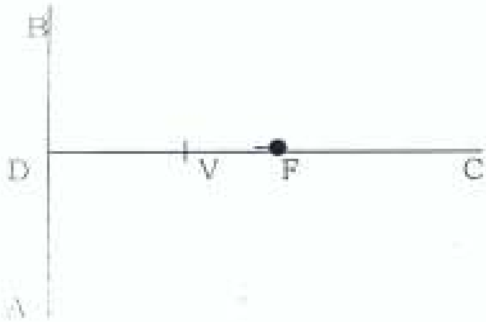
It is also used in the aspect of physics called **kinematics** as graph of displacement against time for a body moving with uniform acceleration in a straight line.

ACTIVITY 4.4-2: **CONSTRUCTION OF PARABOLA**

ACTIVITY 4.4a-2: **LOCUS METHOD, FIG. 138**

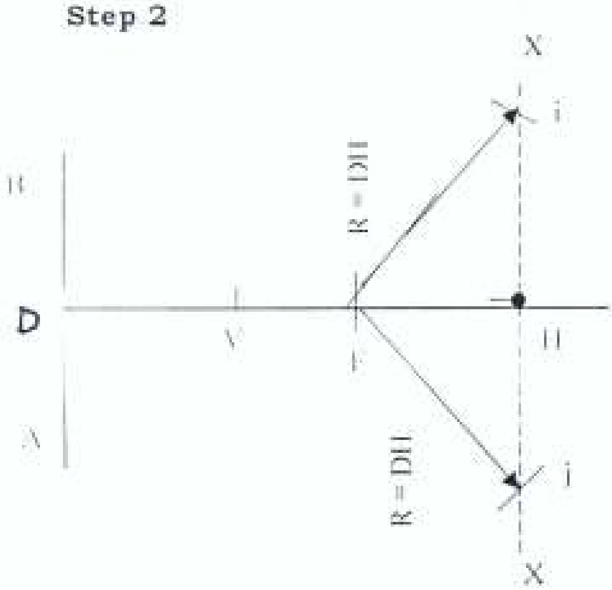
Given: The directrix to focus.

NOTE: DV = VF



Position the Directrix (AB) and draw a line DC perpendicular to the directrix at point D. Locate the Focus (F). Bisect DF to give the vertex V.

Step 2

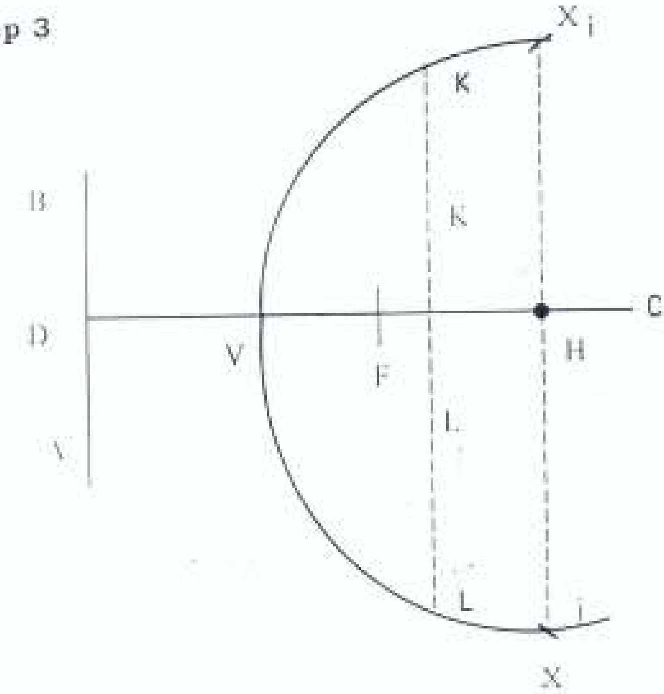


Draw line X-X parallel to the directrix at any convenient distance from F to cross the centre line or axis at point H.

With radius DH and centre F draw an arc to cut XX at I and j, which gives points on the parabola.

In a similar way locate as many points as necessary to draw the parabola.

Step 3



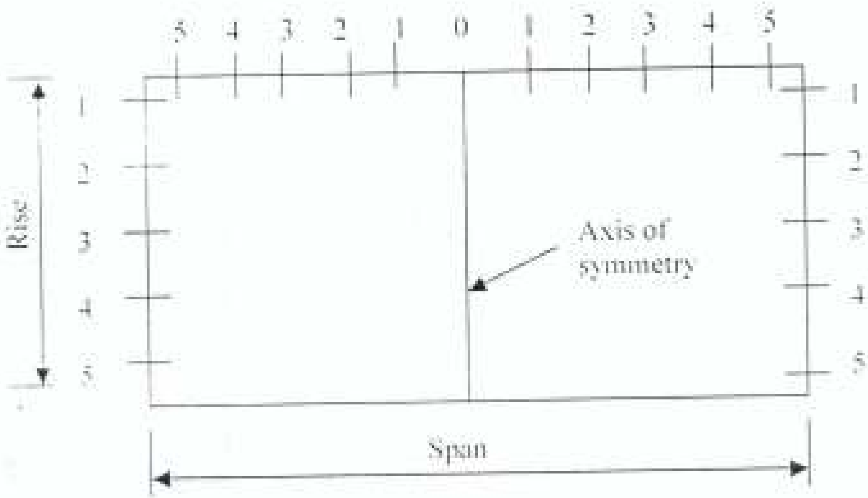
Join the points with a French curve to pass through the vertex V. At the vertex (V) the parabola crosses the axis at 90^0.

Fig. 138

ACTIVITY 4.4b-2: Circumscribing rectangle method

To construct a parabola within a given rectangle, Fig 139

Given: Rise AB and span AC.



Layout a rectangle using the span and rise.

Divide the rectangle into two equal parts by the axis of symmetry.

Divide each half of the rectangle into any equal number of parts (say 5).

The divisions on the rise and span may not be equal in size.

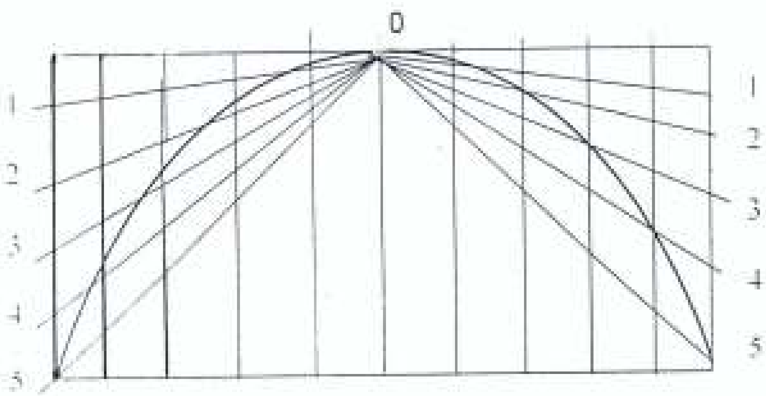


Fig 139

Draw verticals parallel to the axis through one set of division and join each of the other divisions to O. Where these verticals meet the radiating lines from O for each number is a point. Join the points.

ACTIVITY 4.4c-2: To draw a tangent and normal to a parabola and to determine the focus and directrix. Fig. 140

Step 1

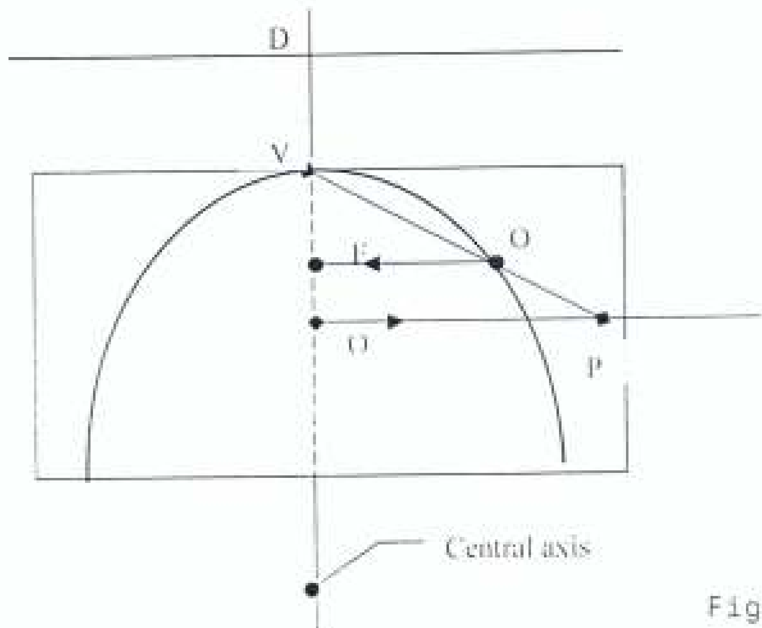


Fig. 140a

Draw the parabola using the circumscribing rectangle method.

Mark off point O anywhere along the central axis.

From O draw a line at right angle to the central axis equal to twice VO and produce

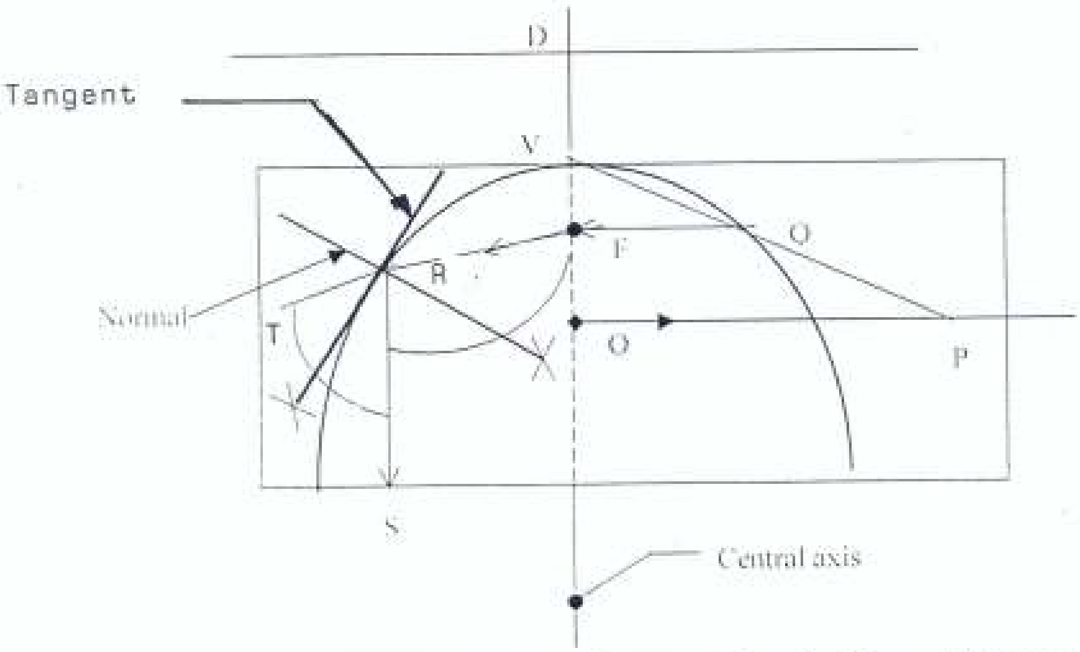
OP

Join P to V where this line crosses the curve mark off point Q. Draw a straight line

with a T-square from Q to touch the central axis at F. Point F is the required focus.

With radius equal to FV and from point V on the central axis mark off point D to

locate the directrix DV = VF (eccentricity is unity).



To draw a tangent and normal on . point R. From F (focus) draw

through R and produce FT.

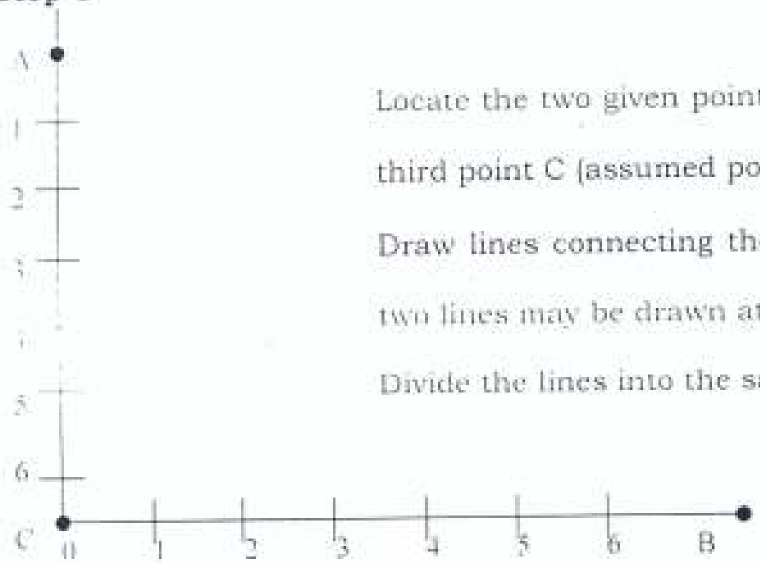
Draw vertical line from R to produce S. Bisect $\hat{FRS}$ and produce

the normal.

Bisect SRT to produce the tangent.

To construct a parabolic curve through two given points A and B. fig. 141

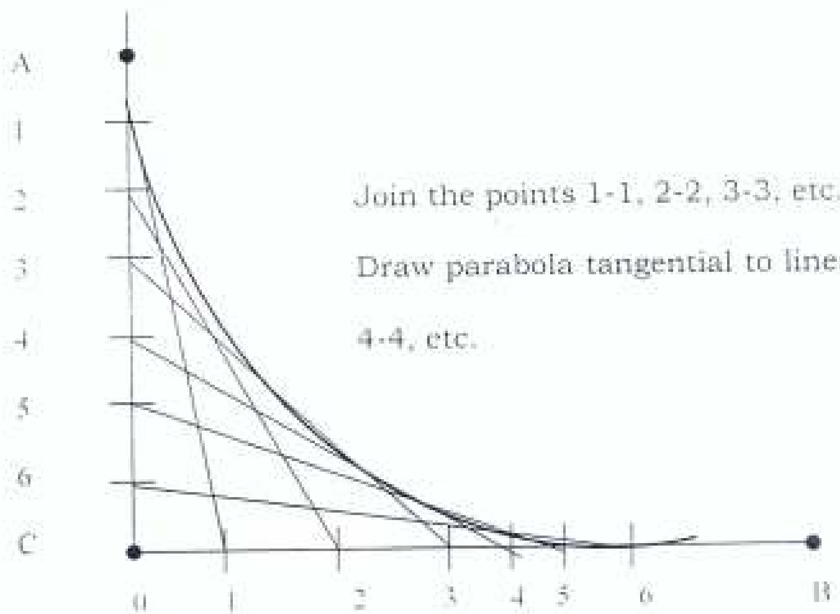
Step 1



Locate the two given points A and B and choose the third point C (assumed point).

Draw lines connecting the points AC and CB. The two lines may be drawn at any angle to each other.

Divide the lines into the same number of parts.



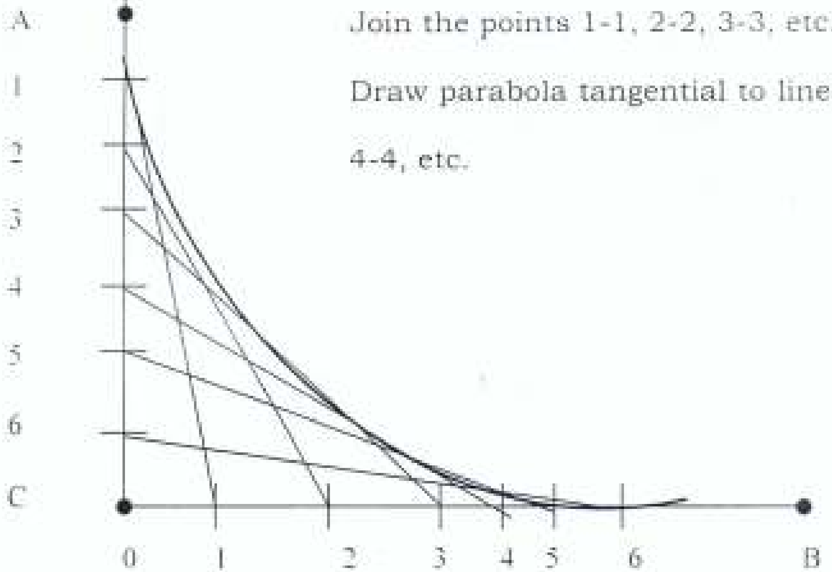
Join the points 1-1, 2-2, 3-3, etc.

Draw parabola tangential to lines 1-1-, 2-2, 3-3-, 4-4, etc.

Fig. 141 Parabola Curve.

Join the points 1-1, 2-2, 3-3, etc.

Draw parabola tangential to lines 1-1-, 2-2, 3-3-, 4-4, etc.



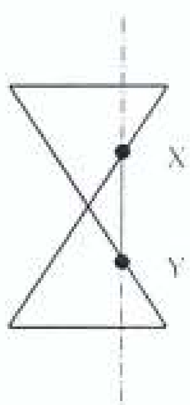
ACTIVITY 4.5-2: HYPERBOLA

Hyperbola is the locus of a point which moves so that the ratio of its distances from the focus and directrix is constant and greater than 1. Mathematically, a hyperbola is defined as a plane curve traced by a point moving so that the difference of its distance from two fixed points (the foci) is a constant equal to the transverse axis.

Transverse axis: Is the distance between the vertices of the two curves.

ACTIVITY 4.5a-2: Application

Hyperbolic curves are used in space probes. It can also be used to indicate varying pressure of gas as the volume varies.



XY = transverse axis

ACTIVITY 4.5b-2: To draw a hyperbola for a given ratio (in this case 5/3 or 1:1.67). directrix/vertex dimension is 12mm. Fig. 142

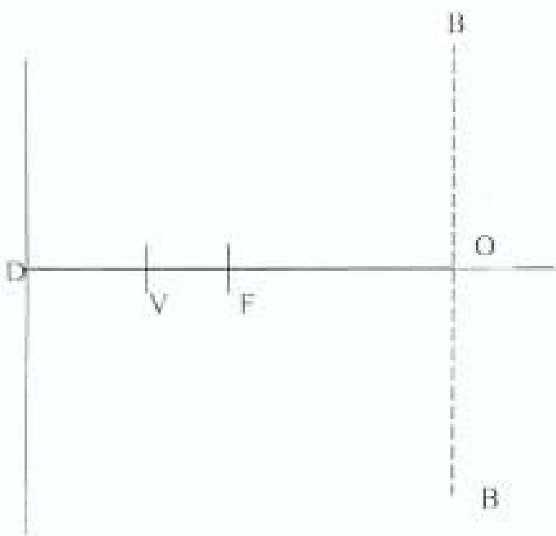
The ratio 1:1.67 means that the distance from the focus to a point on the curve is 1.67 times greater than the distance from the point on the curve to the directrix.

To obtain the vertex/focus dimension multiply 1.67 with the D/V dimension.

D/V = 12mm

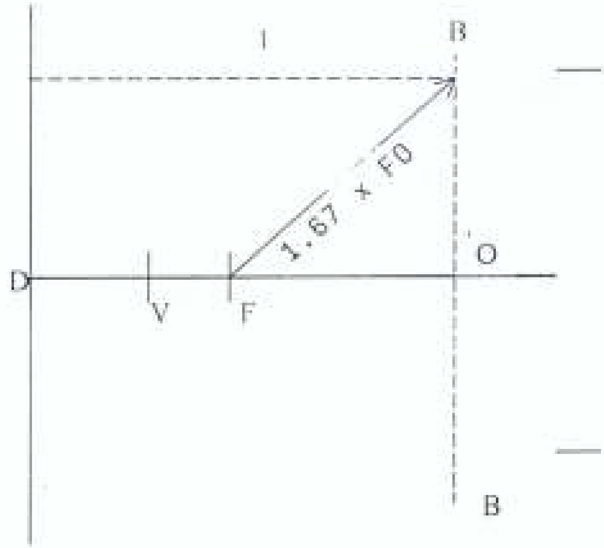
VF = 12 x 1.67 = 20mm.

Step 1



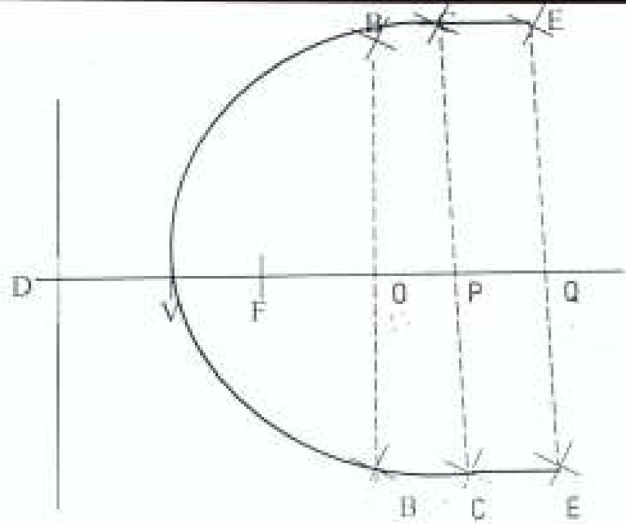
Position the focus, vertex and directrix. On the centre axis draw line BB parallel to the directrix to give point on the axis.

Step 2



With centre F and radius FO times the eccentricity draw arcs to cut BB above and below the axis

Step 3



Other points on the curve are fixed in the same way by taking the distance FPX the eccentricity for line CC. FQ times the eccentricity for line EE etc.

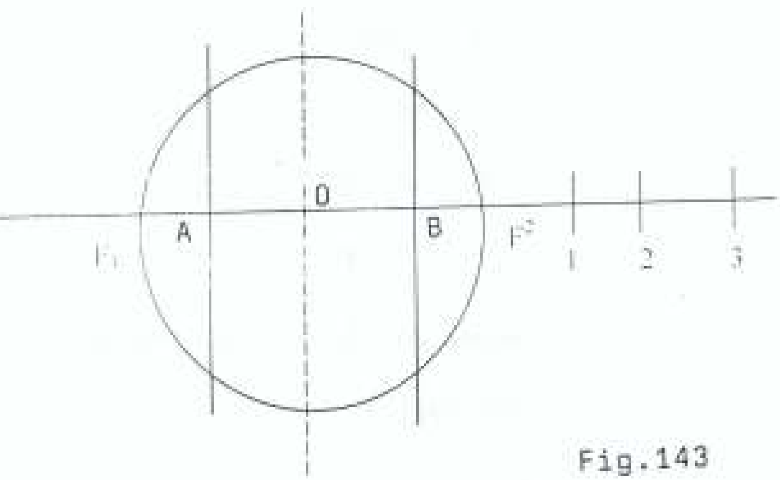
Fig. 142

ACTIVITY 4.5c-2: To construct a hyperbola using the foci method.

Fig. 143

Given: The foci F_1 and F_2, and the transverse axis AB.

Step 1



Draw the given foci F_1F_2 and the transverse axis AB. Bisect F_1F_2 and draw a circle with centre O passing through F_1 & F_2 as shown in the drawing above..

Lay off a convenient number of points on line F_1F_2 extended (in this case 3 pts).

Fig.143

Step 2

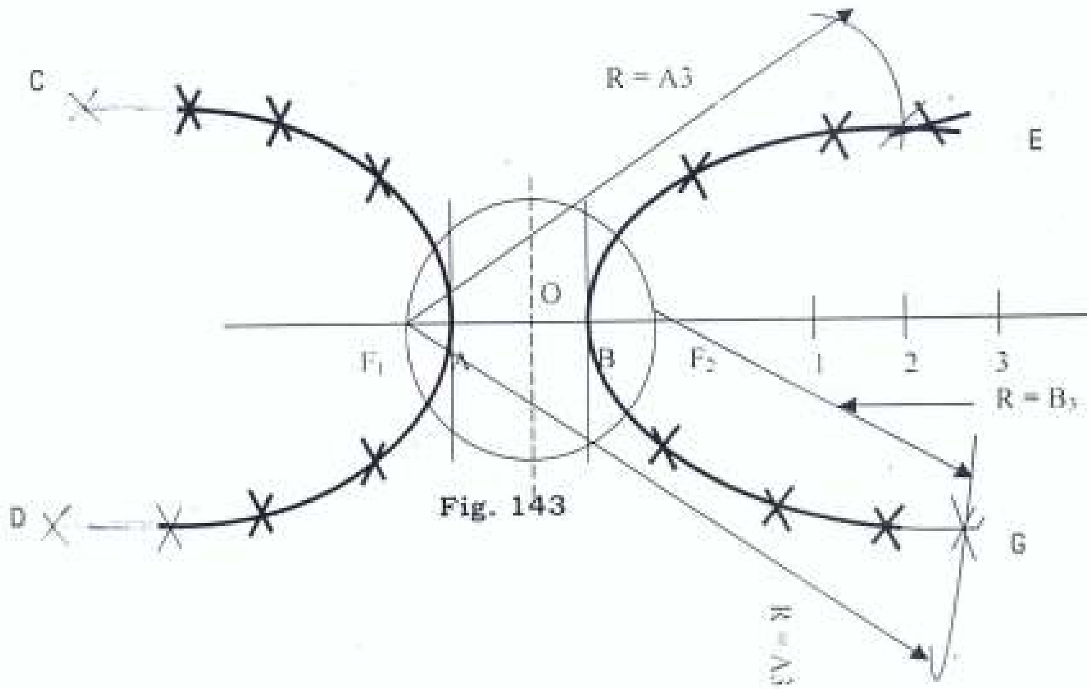


Fig. 143

With points F_1 and F_2 as centers and radius A3 draw arcs C, D, E and G.

With points F_1 and F_2 as centres and radius B3 draw arcs to intersect the arcs at C, D, E and G to give points on the curve.

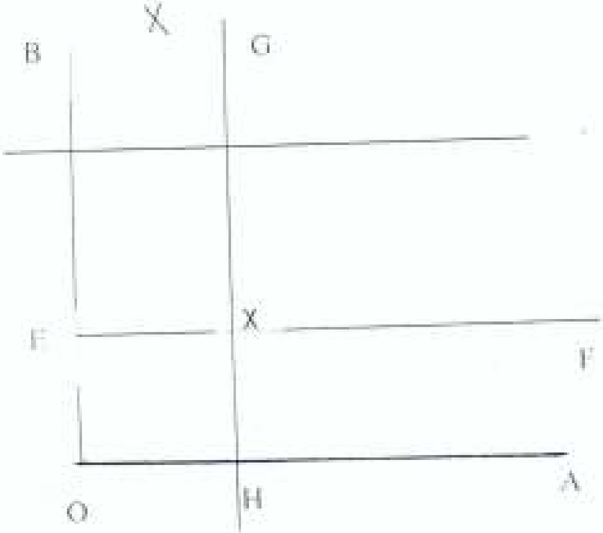
For more points lay off more intersecting arcs using radii of A_2 and B_2, A_1 and B_1

Join the points with french curve.

ACTIVITY 4.5d-2: To construct a hyperbola with the asymptotes and one point on the curve given. Fig. 144

Definition

Asymptotes are lines, which are tangents to the hyperbola at infinity.



Draw the given asymptotes OA and OB and locate the given point on the curve X.

Through point X draw lines EF and GH parallel to the asymptotes.

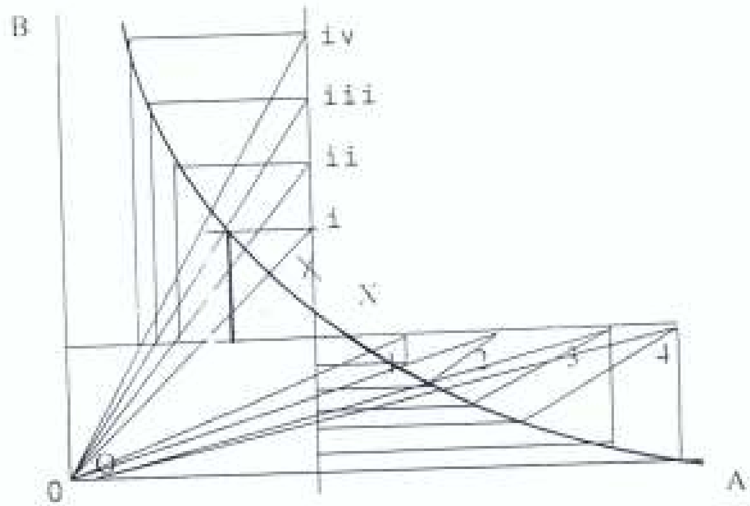


Fig. 144

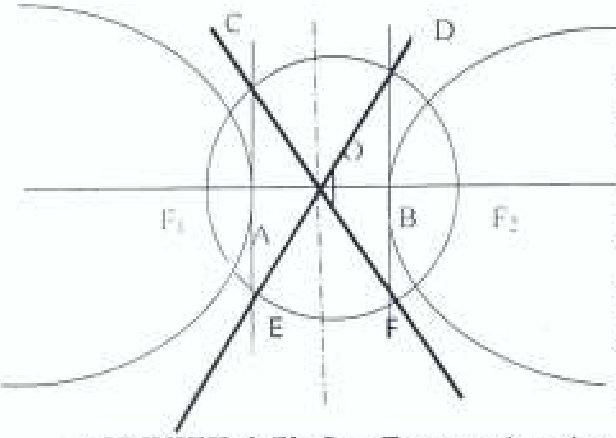
From point O draw a number of radial lines intersecting GH at points i, ii, iii and iv and EF at points 1, 2, 3,4 (at any convenient distant).

Draw lines parallel to the asymptotes at points 1 and i, 2 and ii, etc.

Join the intersection of these lines with a French curve to produce the curve.

ACTIVITY 4.5c-2: To locate the asymptotes of a hyperbola. Fig. 145

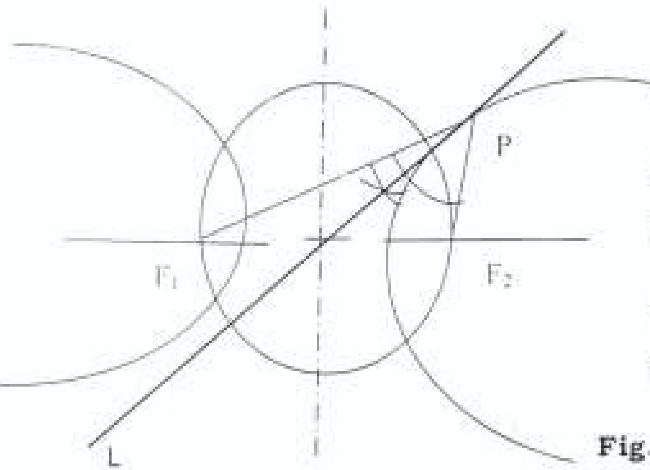
Given: The hyperbola, foci and transverse axis.



Draw the given hyperbola, foci and transverse axis.
With center o and radius OF_1 draw a circle.
Draw perpendiculars to the transverse axis at points A and B (vertices of the hyperbola.)
Lines drawn passing through the points C, D, E and F. Where the perpendiculars intersect the circle are the Asymptotes.

ACTIVITY 4.5b-2: To construct a tangent to a hyperbola. Fig. 146

Given: The hyperbola and the point of tangency P.



Draw the given hyperbola and

locate the position P.

Draw lines from P to F_1 and F_2.

Bisect angle F_1PF_2.

The bisector LP is the required tangent.

Fig. 146

SELF-ASSESSMENT QUESTIONS

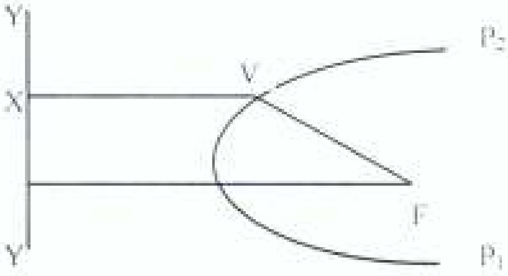
1 The total of all the positions occupied by a point which varies its position according to a given law is its:

A line B locus C curve D plane

2 Which of the following is not a conic section?

A A frustum B A circle C An ellipse D A triangle

3 The diagram below is an incomplete construction of the locus of a point 'P' measuring relative to a focus F and a directrix Y-Y. If the ratio VF/VX is less than unity, then the locus is a part of:



A A circle B A ellipse C A parabola D A hyperbola

4 Which of the following information will be required in constructing an ellipse using the concentric circle method

A Focus and directrix B Major axis and focus

C Minor axis and directrix D Major and minor axis

5 The eccentricity of a parabola is

(A) Zero (B) Unity (C) Greater than unity (D) less than unity

6 The locus of a point, which moves so that its distance from the focus equals its perpendicular distance from the directrix is:

(A) Hyperbola (B) Parabola (C) Ellipse (D) Cycloid

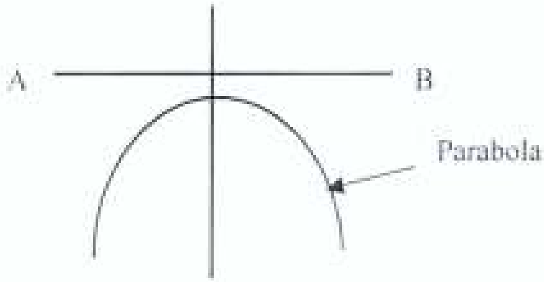
7 Line AB in the figure below is called the?

(A) Ordinate

B Directrix

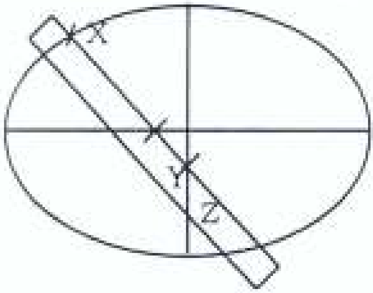
C Asymptote

D Normal



8 Which of the following is not applicable in the construction of hyperbola?

(A) Asymptote (B) Abscissa (C) Directrix (D) Minor axis



Use the figure above to answer questions 9 and 10

9 What method of ellipse construction is shown?

(A) Rectangular method (B) Auxiliary method

(C) Focal point method (D) Trammel method

10 The distance X Z represents the

(A) Minor axis (B) Major axis

(C) Half minor axis (D) Half major axis

Answers

(1) B (2) A (3) B (4) D (5) B (6) B (7) B (8) D (9) D (10) D.

3.2.5 Module 5 – Loci part II: cycloid, hypocycloid epicycloids, involutes curves and Archimedean spiral

OBJECTIVES

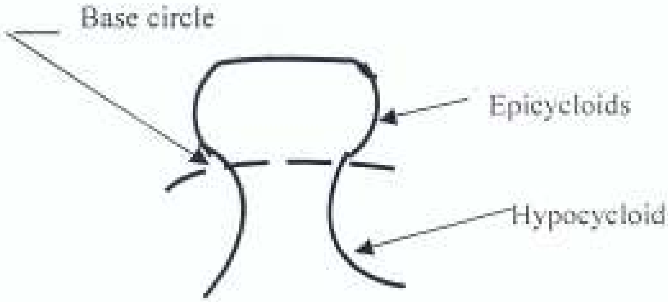
By the end of this module student should be able to:

- Define cycloid, hypocycloid, epicycloids involutes and archimedean spiral
- State the application of these drawings in engineering
- Construct the different curves.

The cycloid, hypocycloid, epicycloids and involutes curves are the basic forms used for gear teeth.

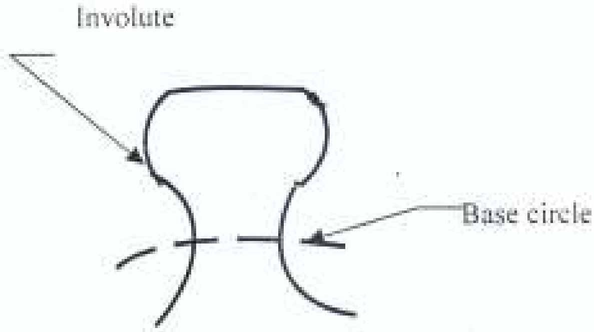
In the cycloid gear tooth profile, fig. 147a the upper part of the base line consists of parts of an epicycloids while the lower part of the base line consists of parts of the hypocycloid.

In the involutes gear tooth profiles, fig. 147b the part above the base circle is an involutes.



Cycloid tooth

Fig. 147a



Involute tooth (the rack teeth is a straight profile)

Involute tooth

Fig. 147b

ACTIVITY 5.0-2: CYCLOID

A cycloid is the locus of a point located on the circumference of a circle, which rolls on a straight line without slipping.

ACTIVITY 5.1-2: CONSTRUCTION OF A CYCLOID CURVE, Fig. 148

Given: The span of cycloid AB.

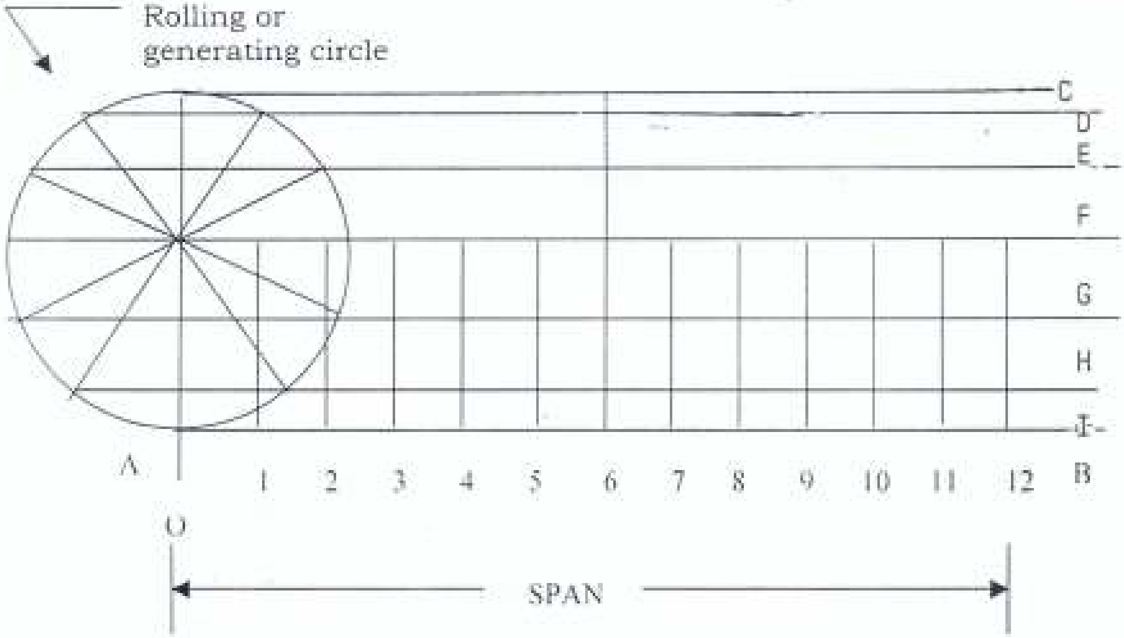
Step 1: Divide the span length AB by Pi (Π) to get the required diameter of the generating circle.

Step 2: Draw the generating circle and the span AB tangential to the circle.

Step 3: Divide the circle and the tangent line AB into an equal number of divisions. (Twelve for convenience).

Step 4: Through the points on the rolling or generating circle circumference draw parallel lines CDEFGH to the fixed line AB.

Step 5: Project perpendicular lines on the division points on the fixed line AB to the centre line of the circle (in this case line F).



Step 6: At the intersections of the perpendiculars with the centre line F. Draw circles of diameters equal to the rolling circle representing the various position of the rolling circle as it moves to the right.

Step 7: Mark the point of tangency (0/12) between the rolling circle and the span as p.

Step 8: Mark points P_1, P_2, P_3, ... P_{12} with a cross where each of the circle cuts the corresponding horizontal line i.e. circle with centre perpendicular 1 cuts horizontal line 1 (line H) at p_1, circle with centre perpendicular 2 cuts horizontal line 2 (line G at P_2, circle with centre perpendicular 3 cuts horizontal line 3 (line F) at P_3 etc. Connect all the points P_1, P_2, P_3, ... P_{12} with a smooth curve to complete the cycloidal curve.

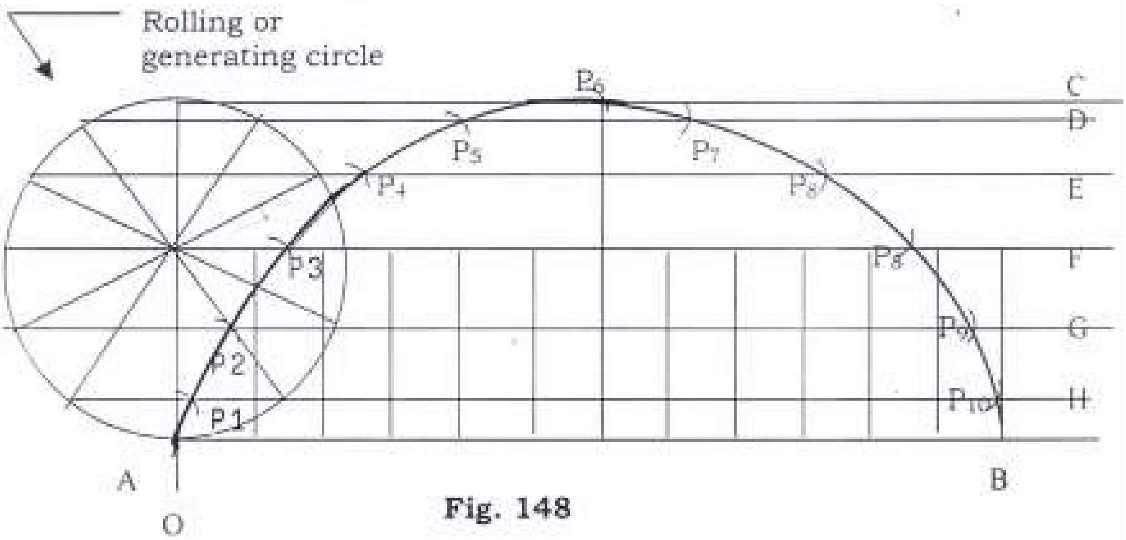


Fig. 148

Note: The span AB = 2ΠR or ΠD (circumference of the rolling circle). Therefore the span can equally be determined when given the rolling circle radius or diameter.

The span represents the rolling distance of one revolution of a diameter. The locus may be continued, but repeats itself for each complete revolution of the rolling circle.

ACTIVITY 5.2-2: HYPOCYCLOID

An hypocycloid is the locus of a point on the circumference of a rolling circle which rolls without slipping round the inside of a fixed circle called the base circle.

ACTIVITY 5.3-2: To construct an hypocycloid, fig. 149: The construction of an hypocycloid is similar to that of cycloid except that the generating circle (rolling circle) rolls on a curve line instead of a straight line.

Given: Base circle diameter, generating circle (rolling circle) diameter.

Step 1: Determine θ using the formula θ = 360 x d/D.

Where d = Diameter of rolling circle

D = Diameter of base circle

θ = The angle subtended at the centre of the base circle.

Step 2: Draw line AO equal to the radius of the given base circle.

Step 3: Using point O as centre and radius AO draw an arc OB subtending angle θ. Join B to O. (**Note:** The length of the arc AB = the circumference of the rolling circle Πd).

Step 4: On line AO, draw the generating circle tangential to arc AB on the inner side at point A. Divide the generating circle into twelve equal parts.

Step 5: Divide the generating circle into twelve equal parts and draw an arc from each point on the circle including the centre point C to touch line OB.

Step 6: Transfer the twelve divisions on the rolling circle to the arc AB. After this draw lines from the 12 points on the arc AB to the arc centre O.

Step 7: Where these lines intersects the centre line arc C, draw circles of diameter equal to the rolling circle representing the various position of the rolling circle as it moves to the right.

Step 8: Mark points P_1, P_2, P_3, ... P_{12} with a cross where each of the circle cuts the corresponding arc i.e. circle with radial line 1 cuts arc 1 at P_1, circle with radial line 2 cuts arc 2 at P_2 ... circle with radial line 12 cuts arc 12 at point 12.

Step 9: Join these points P_1, P_2, P_3 to P_{12} with a perfect curve to produce the required hypocycloid.

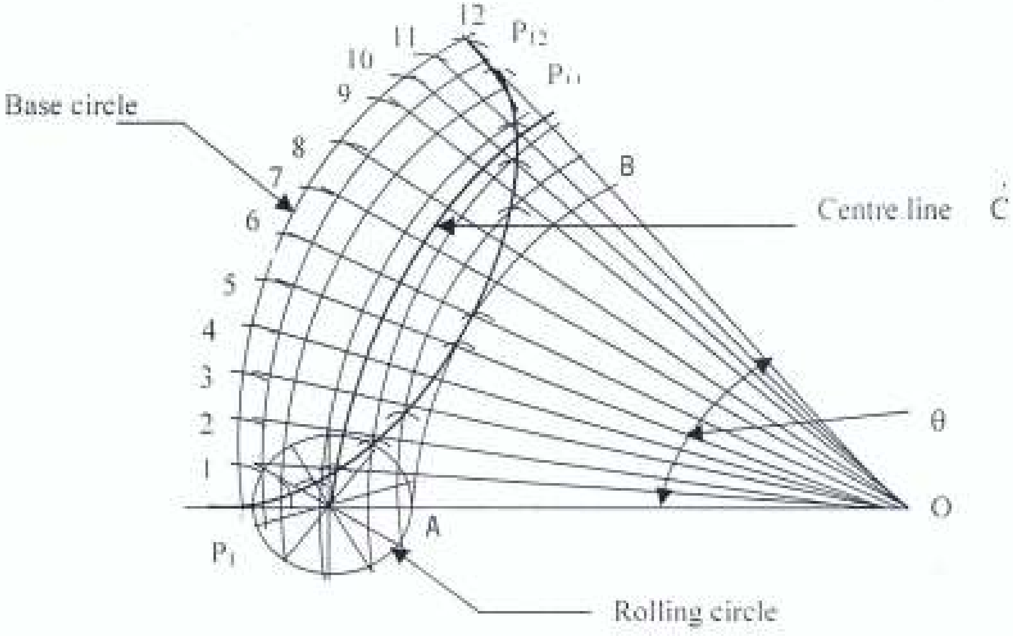


Fig.149: Hypocycloid

ACTIVITY 5.3-2: EPICYCLOIDS

An epicycloid is the locus of a point on the circumference of rolling circle which rolls without slipping round the outside of a fixed circle called the base circle.

ACTIVITY 5.4-2: CONSTRUCTION OF EPICYCLOIDS, fig. 150

The method of constructing epicycloids is similar to that of hypocycloid except that the generating circle rolls n the outside of a curved line.

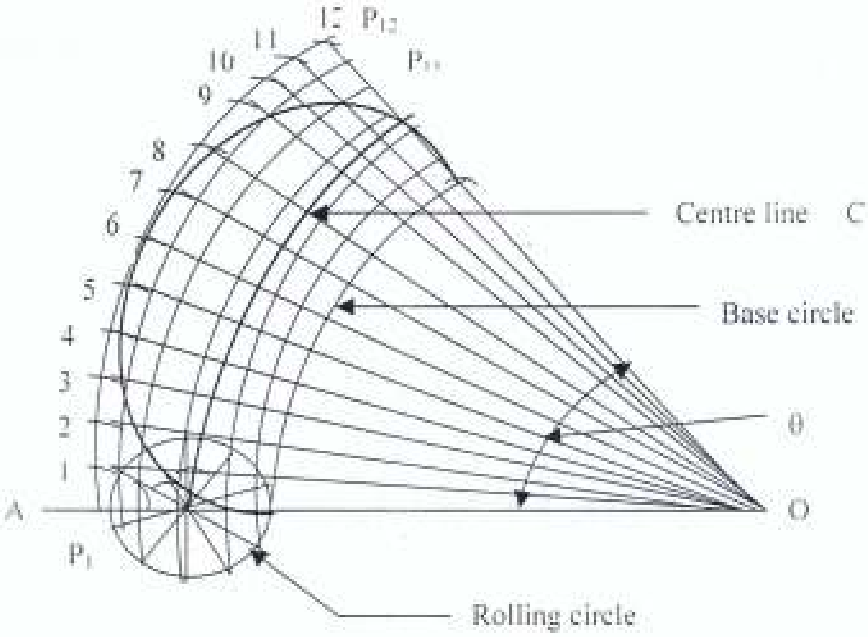


Fig. 150: Epicycloid

ACTIVITY 5.5-2: THE ARCHIMEDIAN SPIRAL

The archimedian spiral is the locus of a point moving uniformly around and away from a fixed point.

ACTIVITY 5.5a-2: APPLICATION: It is used in design of cams to change uniform rotary motion into uniform reciprocal (straight line) motion.

ACTIVITY 5.6-2: CONSTRUCTION OF ARCHIMEDIAN SPIRAL, fig. 151

Given: CB (The rise of one revolution)

Step 1: Locate the centre C. Draw CA and CB equal to the given rise.

Step 2: Divide CB into equal number of parts say eight (8) for convenience.

Step 3: With point C as the centre and radius CB draw a circle.

Step 4: Divide the circle into the same number of equal parts as line CB (in this example 8). Number the radial lines, starting with first line after line CB.

Step 5: Using centre C and radius C_1 draw an arc to cut radial 1. With C as the centre repeat for radials 2 to 8.

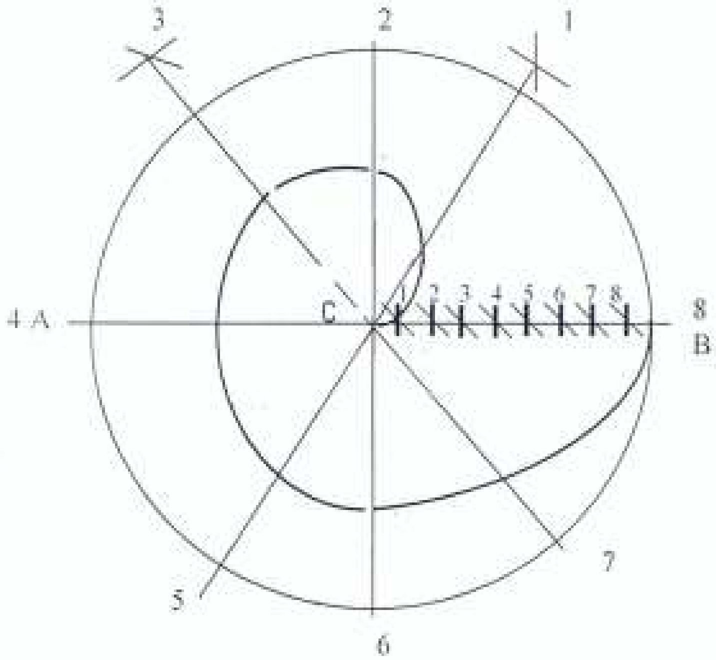


Fig. 151: The Archimedian Spiral

Note: It does not have to finish at the actual centre of the circle; it can finish at the radius of a smaller circle.

ACTIVITY 5.7-2: INVOLUTE

The involute of a circle is the path formed or traced by the free end of a string as it is unwound from the circle or polygon.

ACTIVITY 5.7a-2: APPLICATION: AS earlier stated the involute is used in the design of involute gear teeth.

ACTIVITY 5.8-2: TO DRAW AN INVOLUTE OF A CIRCLE, fig. 152

Given: The circle with centre O

: The starting point P

Step 1: Draw the circle and divide it into a number of equal parts say eight (8).

Step 2: Mark the first division on the circumference of the circle as point P.

Step 3: Draw tangents at P, 1, 2, 3, --- 7. On the tangent drawn at point P, step off the same number of equal spaces as the number of division on the circumference of the circle in this case (8).

Step 4: On tangent 1 lay off a distance equal to the length of P – 1. From the horizontal on tangent P, lay off a distance equal to the length of the distance P – 2, from the horizontal division, and so on until the distance on the final tangent has been set off.

Step 5: Draw a curve line through these points on the tangents to give the required involute.

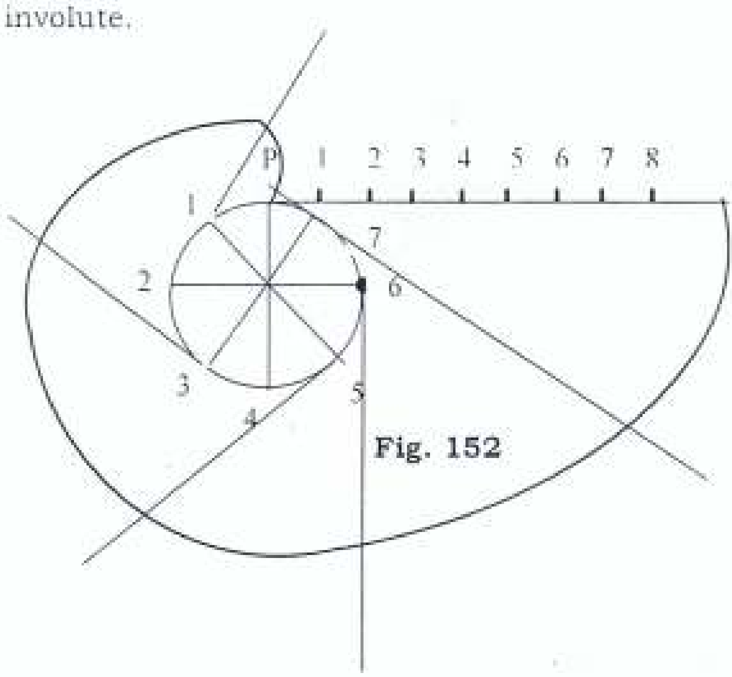


Fig. 152

ACTIVITY 5.9-2: TO DRAW AN INVOLUTE OF A SQUARE, fig. 153

Given: Square ABCD

Starting point O.

Step 1: Draw the given square

Step 2: Extend straight lines from points ABCD to an approximate location of points. Mark the starting point O on any of the extended line (in this case line DH) at any convenient radius to point O but far away from D.

Step 3: Using point A as the centre and a radius of AO draw an arc from point O to touch the extended line from A at point B. Using B as centre and radius BF draw an arc from E to touch the extended line from B at F.

Step 4: Using C as centre and radius CF draw an arc from F to touch the extended line from C at point G.

Step 5: Continue in the same manner around the square until the required involute is completed.

Diagram

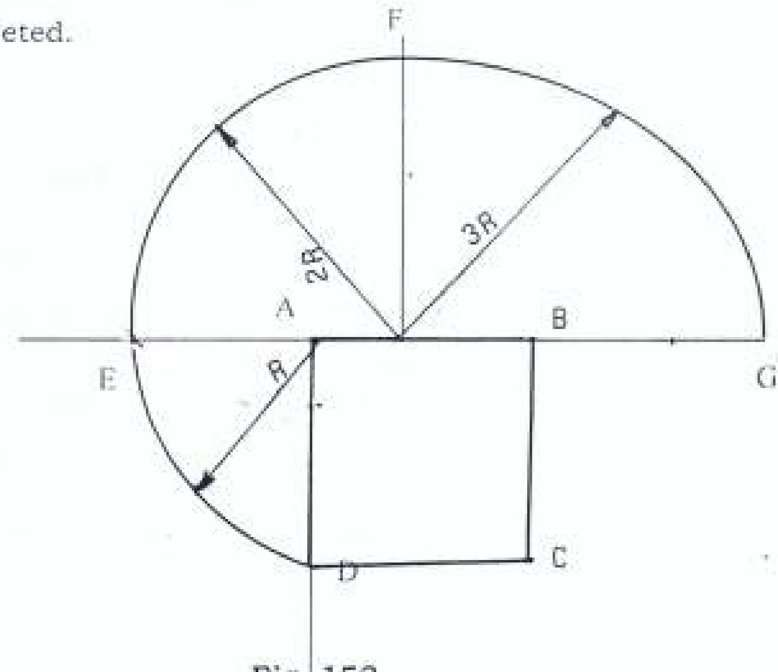


Fig. 153

ACTIVITY 5.10-2: CONSTRUCTION OF AN INVOLUTE OF A TRIANGLE

The construction of an involute of a triangle (usually equilateral triangle) is similar to that for the involute of a square except that the number of sides will be three instead of four.

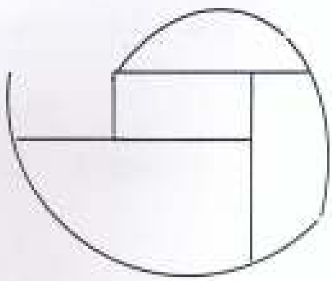
SELF-ASSESSMENT QUESTIONS

(1) The term epicycloid is defined as the path traced out by a point on a circle rolling without slipping on

(a) A straight line (b) The outside of a base circle

(c) The inside of a base circle (d) A parabola

(2)



The curve shown in the figure above is

(a) An epicycloids (b) An ellipse

(c) An archimedean spiral (d) An involute

(3) The locus of a point on the circumference of a circle as it rolls without slipping around the inside of a larger circle is

(a) Cycloid (b) An involute

(c) An epicycloid (d) A hypocycloid

(4) In which of the following is the involute of a circle practically applied

(a) Circular profiles (b) Cylindrical solids

(c) Gear teeth (d) Round objects

(5) The locus of a point moving uniformly around and away from a fixed point is

(a) Archimedian spiral (b) Epicycloid

(c) Hypocycloid (d) Cycloid

(6) ____________ is used in the design of cams to change uniform rotary motion into uniform reciprocal (straight line) motion

(a) Involute (b) Ellipse (c) Cycloid (d) Archimedean spiral

(7) The locus of a point located on the circumference of a circle which rolls on a straight line without slipping is

(a) An involute (b) A cycloid

(c) Epicycloid (d) Hypocycloid

(8) The path traced by the free end of a string, as it is unwound from a circle or polygon is

(a) An ellipse (b) A cycloid (c) An involute (d) A cylinder

ANSWERS

(1)	B	(2)	D	(3)	D	(4)	C
(5)	A	(6)	D	(7)	B	(8)	C

3.2.6 Module 6 – Loci part III: link mechanism and helix

OBJECTIVES

By the end of this module students should be able to:

- Define link mechanism and state it application in engineering.
- Define helix and state its application in engineering.
- Construct various types of link mechanisms
- Draw different types of helices.

HOW TO STUDY THIS MODULE

* Read through the module step by step
* Perform the activity presented as examples in the module.
* Do the self-assessment questions at the end of the module without referring to the module.

In machine designs link mechanisms have a very wide application, especially in machines with a reciprocating action such as automobile engines like motor cycle, motor cars etc. In the design of mechanism it is important to trace the movement of the parts (the locus) so that the forces present can be found and clearances checked by providing suitable guard. The connecting rod and piston in a motorcar engine is an example of link mechanism. Figure 154

OA is the crank and the locus of A is a circle

AB is the connecting rod

C is the piston.

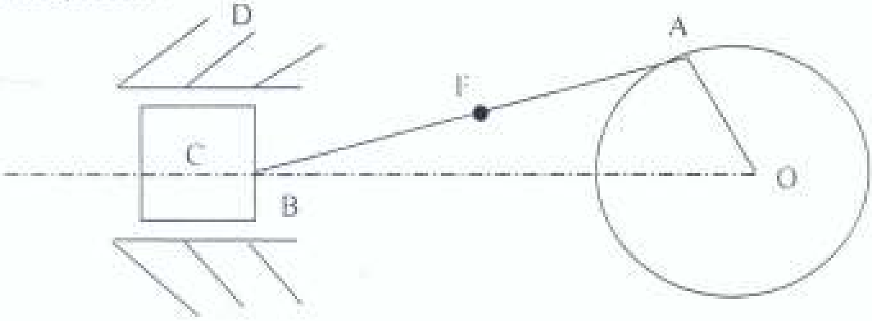
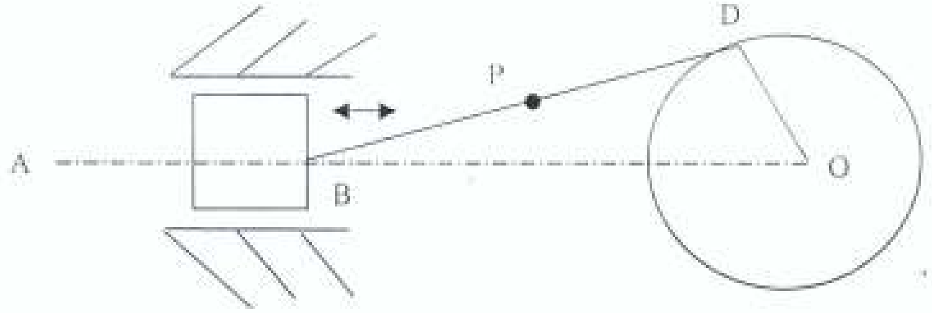


Figure 154: Link Mechanism

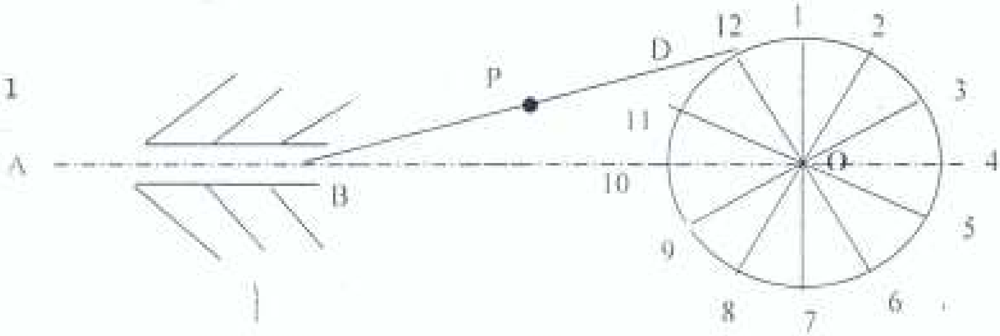
D The guide is called the cylinder in a motorcar engine.

ACTIVITY 6.1-2: The crank OD rotates about a fixed centre O. The rod is pin jointed at D and is fixed to the slide (B) at the other end. The end B of the connecting rod is constrained to move in an east to west direction along the line AO. Plot the locus of P when the crank OD makes one complete revolution.



To plot the locus the mechanism is drawn in several positions with the position of the tracing point on each marked. A curve drawn through these points will give the required locus. Fig. 155

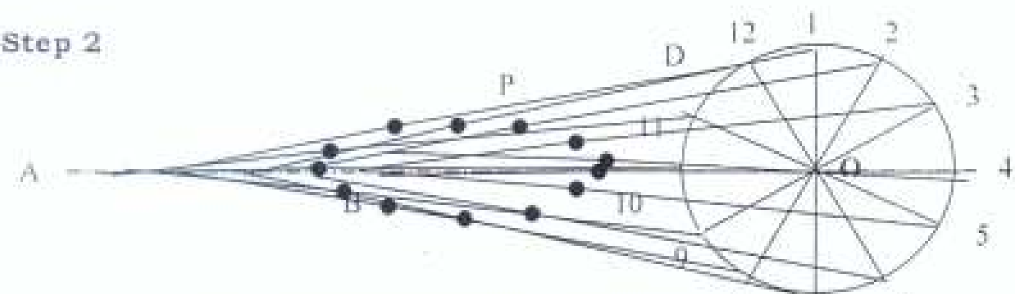
Step 1



Divide the circle through D into a number of equal parts. (8 or 12 parts) in this case 12 parts.

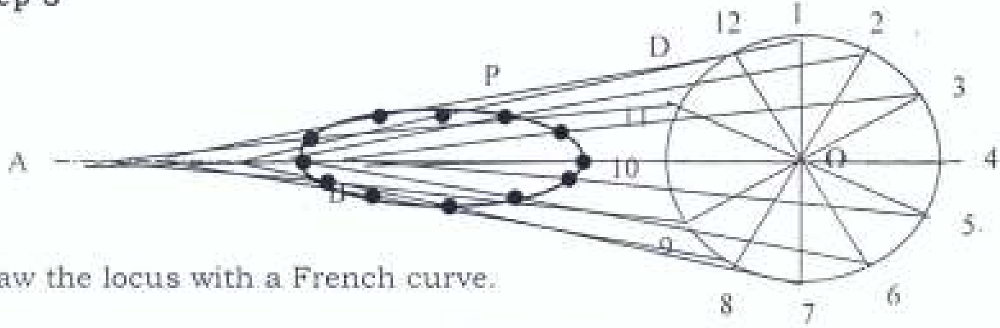
Note: The radius of the circle is equal to OD (crank radius).

Step 2



Plot P on each position of BD.

Step 3



Draw the locus with a French curve.

Fig. 155

ACTIVITY 6.2-2: In the figure 156 below, the crank AB revolves anticlockwise about A. The rod CD is pin jointed at B and is also pivoted at P. Plot;

(i) The locus of the point C as the crank AB makes one revolution.

(ii) The locus of point D as the crank AB makes one revolution.

Given: AB = 30mm, CD = 120, BD = 20

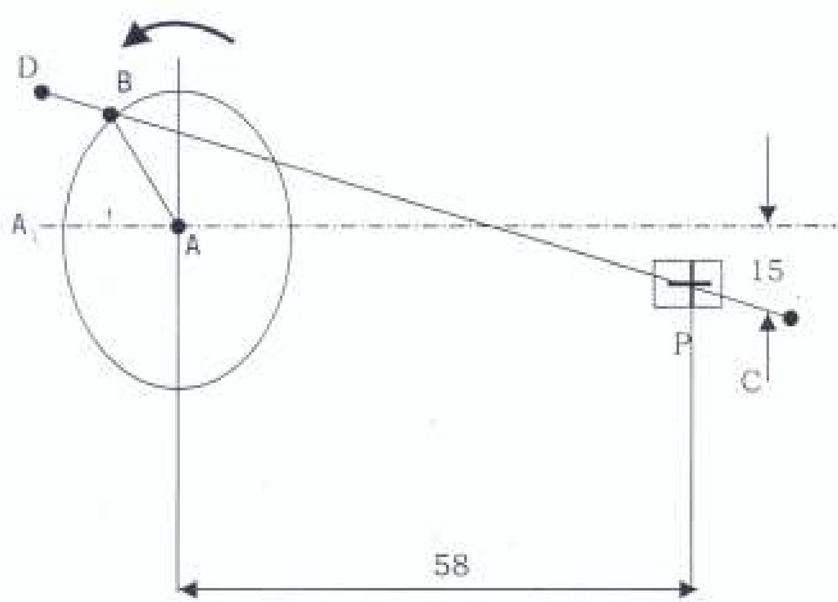


Fig. 156

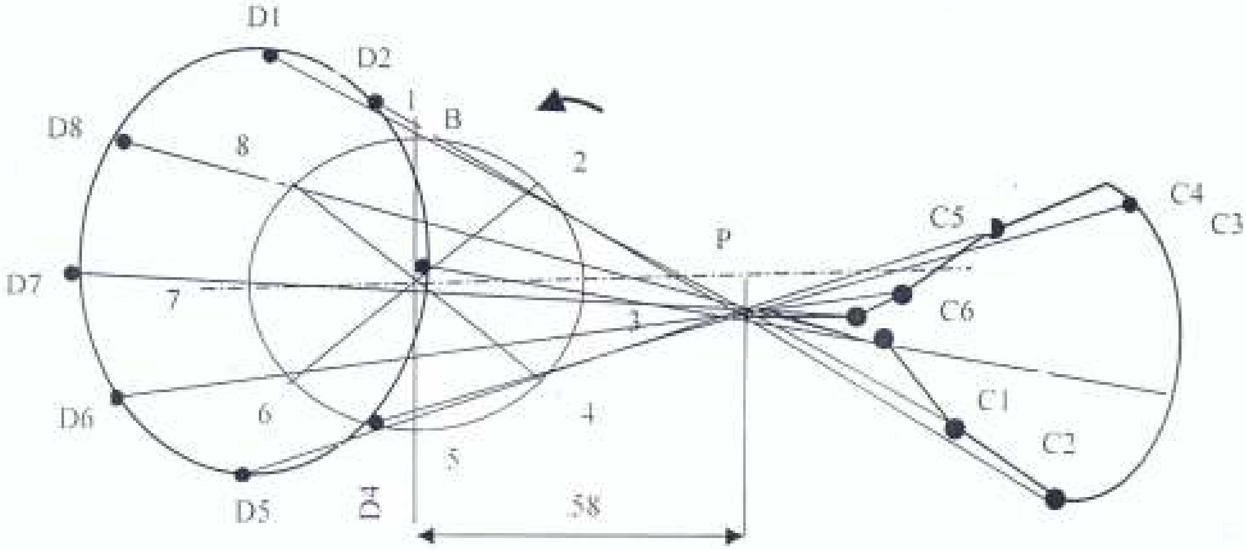


Fig. 156

PROCEDURE

Step 1: Draw the given figure and divide the circle through B into a number of equal parts, eight or twelve for convenience.

Step 2: From each point on the circle plot a corresponding position for C through P, and draw CD in eight positions.

Step 3: Join the eight positions of C (C_1, C_2, C_3 ------ C_8) with French curve to give the locus of point C.

Step iv: For the positions of the locus at D, extend each of the eight lines CB to the left to produce BD = 20mm (given).

Step v: Join the points (D_1, D_2, D_3 ------ D_8) with a French to give the locus of point D.

Note: When cranks of different radius rotates only the small crank can make a complete revolution. If they are equal they, will both make complete revolution.

ACTIVITY 6.3-2: SOLID GEOMETRY

SOLID GEOMETRY: A three –Dimensional solid object that has length, width and thickness.

ACTIVITY 6.4-2: HELIX

Definition

A helix is the locus of a point moving around the circumference of a cylinder at a uniform rate while moving parallel to the axis at uniform rate. A helix is a three dimensional figure. The axial movement during one revolution is called the lead or pitch.

A helix may be right handed or left-handed. A right-handed helix moves into the mating part when turned clockwise (left to right) while a left-handed helix moves into the mating part when turned anticlockwise (right to left).

APPLICATION: Typical Application of helix are springs, bolt and screw thread, gears (worm of helical), cylindrical cams, flutes on drills, auger bits used in wood work, etc.

ACTIVITY 6.5-2: CONSTRUCTION OF AN HELIX, fig. 157

Given: Diameter of the cylinder, the lead or pitch

Step 1: Draw the two views of the cylinder given. The end view equal to the diameter of the cylinder and the front view equal to the lead or pitch. Both of them must maintain the same centre line.

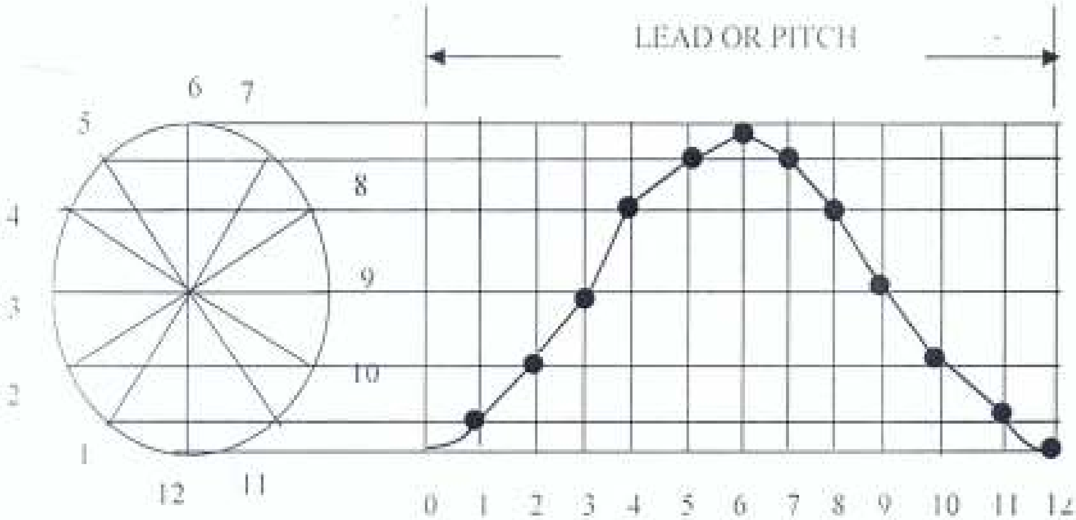
Step 2: Divide the end view into an equal number of parts (in this case 12 parts).

Step 3: Divide the lead or front view along the axis into the same number of equal parts as for the end view and project vertical lines equal to the given diameter from these points.

Step 4: Project horizontal lines from the points 1, 2, 3, --- 12 on the end elevation to terminate on the last vertical line on the lead.

Step 5: Mark the point of intersection of the vertical lines with the corresponding horizontal line, thus marking the curve points.

Step 6: Join these points with a curve line to produce locus of the point.



End view **Front view**

Fig. 157 Helix Construction

Helix may be single start thread or multi-start threads. In the single start thread the lead is equal to the pitch while in the multi start thread the lead is always greater than the pitch. For example, with a double start thread the pitch is half the lead; with a triple start thread it is a third of the lead, etc.

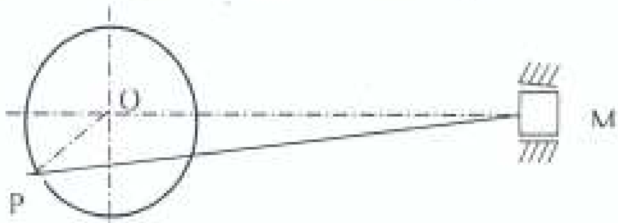
Hidden details are generally omitted on helix drawings to avoid confusion.

SELF ASSESSMENT QUESTIONS

(1) Which of the following is not a practical application of the helix

(a) Screw thread (b) Coil spring (c) Twist drills (d) Parabola

use the link mechanism in the figure below to answer questions 2, 3 and 4.



Given that OP = 80MM, PM = 250MM and OM is horizontal

(2) What is horizontal maximum displacement (stroke) of M.

(a) 125mm (b) 160mm (c) 170mm (d) 330mm

(3) PO in the mechanism is referred to as the

(a) Connecting rod (b) Piston (c) Sleeves (d) Crank

(4) Which of the following does not use the principle of the above mechanism?

(a) Automobile engine (b) Power hacksaw

(c) Sewing machine (d) Circular saw

(5) The type of curve applied in the manufacture of springs, screw threads and propellers is the;

(a) Helix (b) Cycloid (c) Ellipse (d) Parabola

(6) What is the path traced by a mouse running at a constant speed round a circle marked on the floor of a lift which rises at a constant speed from the pyramid to the tenth floor of a building?

(a) Circle (b) Cycloid (c) Ellipse (d) Helix

(7) In a triple start thread the;

(a) Pitch is thrice the head (b) Lead is thrice the pitch

(c) Root is thrice the pitch (d) Root is thrice the minor diameter.

ANSWERS

(1) D (2) D (3) D (4) D (5) A (6) D (7) B

3.2.7 Module 7 - Developments

OBJECTIVES

At the end of this module students should be able to:

- Define development and state its application in engineering
- State the two classes of surface development "rule and double curve surfaces"
- Identify different types of ruled surfaces
- Identify different types of curved surfaces
- Differentiate between right angle object and oblique object
- State reason (s) why certain surfaces are developable and some are not developable
- Identify the three methods of pattern development
- Develop different surfaces using the different methods of surface development.

HOW TO STUDY THIS MODULE

- Read though the module step by step
- Perform the activities presented as examples in the module
- Do the self-assessment questions at the end of the module without referring to the module.

- An object to be developed may be right angle object or oblique object.
- Right angle objects are developed by laying out the true length lines on a stretch out line or girth.
- Oblique object development requires auxiliary projection to find the true length lines.
- The development of truncated objects is the same as if the object was not truncated except that the truncated portion must be located too.
- In sheet metal development extra material must be provided for laps or seams, bends and for finishing raw edges by hems.
- In development the shortest seam or joint line is used because of the economy of time and material achieved in making the joint.

DEVELOPMENT: Development is the layout of a pattern of a shape in a single flat plain in readiness for folding to a desired shape. Surface development is applied in many engineering products such as (boxes e.g. tool box and nail boxes) buckets, air conditioning duct, funnel or hopper, etc. Development is used for manufacturing products that requires folding or rolling of sheet metals.

Surface development is classified into two:

(i) Ruled surfaces

(ii) Double curved surfaces

The ruled surfaces are further classified as; "plane surface, single curved surfaces", "warped surfaces"

The single curved surface is produced when the generating line touches a curve and moves so that any two successive positions either intersect (conical surface) or are parallel (cylindrical surface). The plane and single curved surfaces can easily be developed. The warped surfaces comprise those ruled surfaces for which successive positions of the generating line neither intersect nor are parallel e.g. automobile fender which is usually pressed into shape.

Double curved surface is an object that is fully formed by curved lines without straight lines. An example of double curved surface is the sphere.

Warped and double-curved surfaces are not developable unless they are divided into small sections, which are developable.

ACTIVITY 7.0-2: METHODS OF PATTERN DEVELOPMENT

There are three methods of pattern development:

(i) Parallel line method.

(ii) Radial line method

(iii) Triangulation method.

ACTIVITY 7.1-2: PARALLEL LINE DEVELOPMENT

In this method all fold lines are parallel. It is used for object with constant cross-section throughout their length. Fig. 158

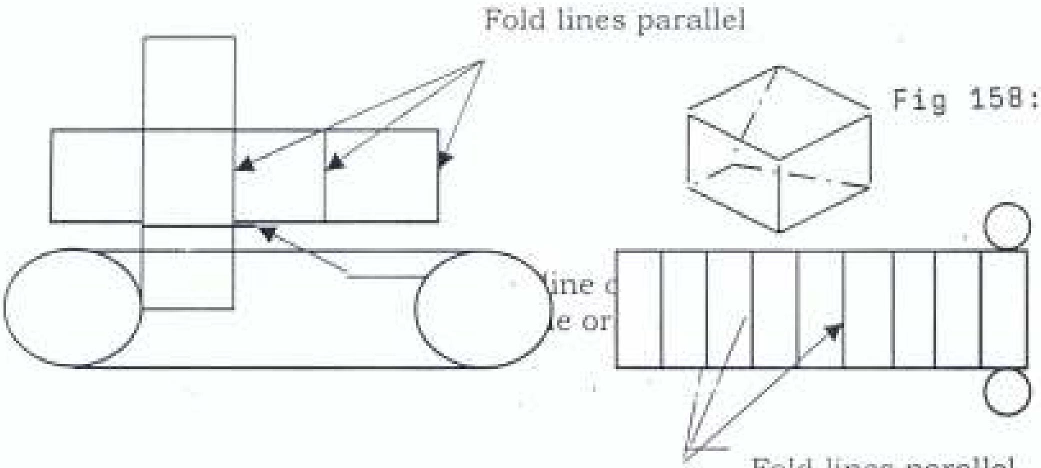


Fig 158: Cube.

Fig. 159 Cylinder

ACTIVITY 7.2-2: PRISMS, Fig 160

A prisms is named according to the shape of its base. The edges are parallel to one another

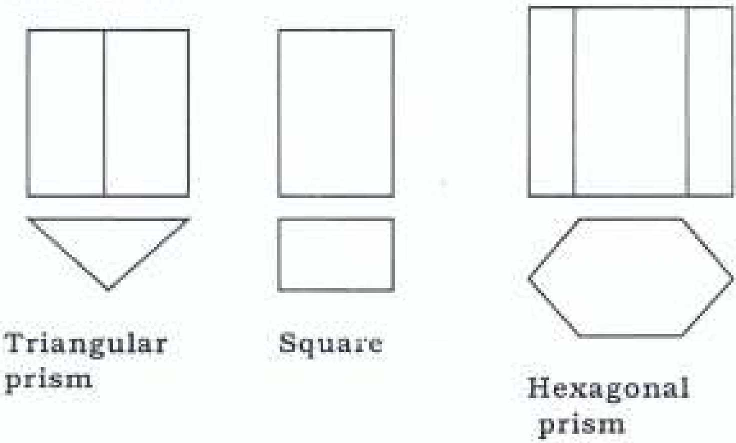


Fig.166.

ACTIVITY 7.3-2: TO DRAW THE DEVELOPMENT OF A SQUARE PRISM, fig. 161

Given: Front elevation ABCD and the plan

STEP 1: Draw the front elevation ABCD and the plan 1,2,3,4.

STEP 2: Project lines from the top and bottom part of the elevation equal to the length of the four sides of the plan

STEP 3: On the projected lines from the front elevation mark the distances 1 – 2, 2 – 3, 3- 4, 4 – 1 from the plan.

STEP 4: Draw verticals on the points to maintain the height of the elevation.

STEP 5: Add a square equal to the given plan to the last division 4-1 at the top and bottom.

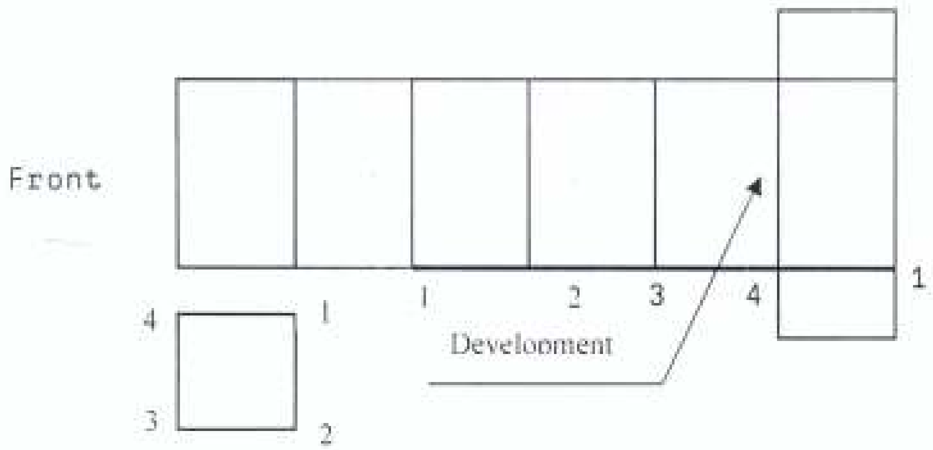


Fig. 161

ACTIVITY 7.4-2: TO DRAW THE DEVELOPMENT OF THE FRUSTUM OF RIGHT CYLINDER AND THE CIRCULAR PLAN OF THE CYLINDER, fig. 162

STEP 1: Draw the given truncated cylinder ABCD and the given plan

STEP 2: Divide the circumference of the plan into 12 equal parts and project lines from the points to touch line AB on the truncated front elevation.

STEP 3: Project horizontal lines from the elevation where the lines from the plan touches AB. Also project line DC equal to the circumference of the given plan by stepping off the 12 divisions from the plan.

STEP 4: Draw vertical lines from the 12 units on DC extension to intersect the projection lines from line AB to obtain the curve points.

STEP 5: Join these points with perfect curve to obtain the development of the frustum of the cylinder.

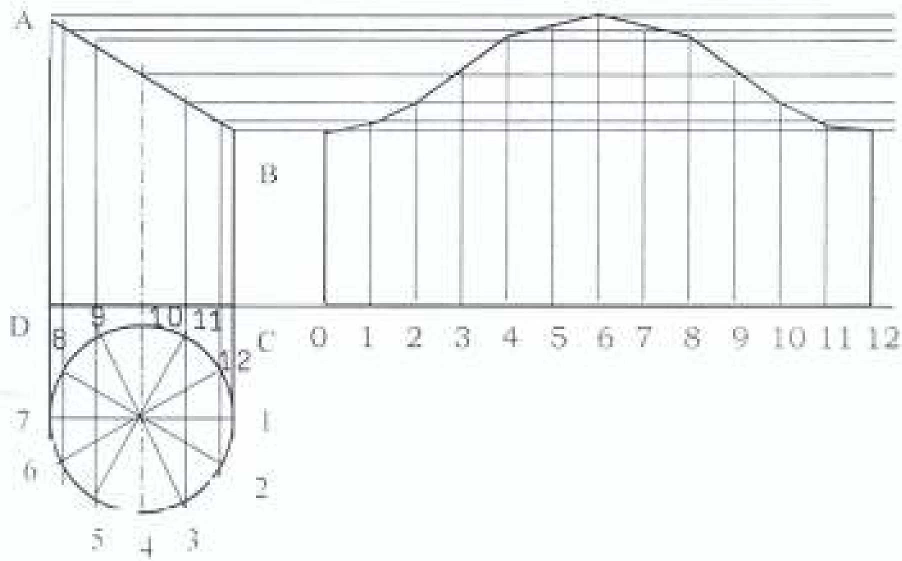


Fig. 162

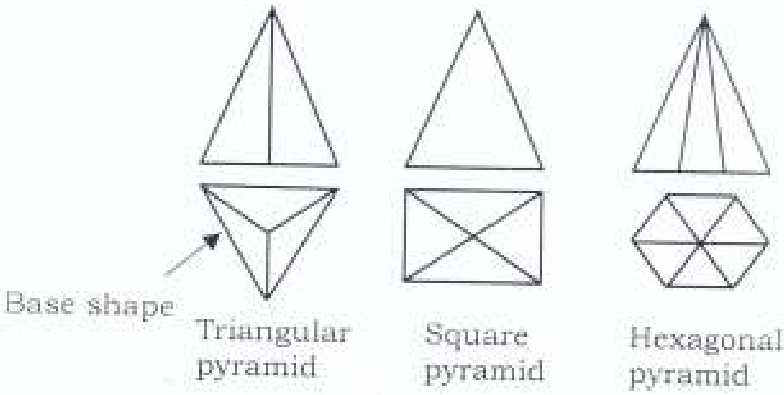
ACTIVITY 7.5-2: DEVELOPMENT OF AN OBLIQUE CYLINDER

The development of an oblique cylinder is similar to that for the truncated cylinder except that the true lengths must be found in an auxiliary view while the end covers if needed, are developed from a secondary auxiliary.

RADIAL LINE DEVELOPMENT.

ACTIVITY 7.6-2: PYRAMIDS, fig. 163

A pyramid is also named according to the shape of its base. The sloping sides meets at the apex while the axis passes through the centre of the base and the apex.



ACTIVITY 7.7-2: TO DRAW THE DEVELOPMENT OF A PYRAMID, fig. 164

Given: The elevation ABC and the plan.

STEP 1: Draw the triangular front elevation and the hexagonal plan with both maintaining the same centre line.

STEP 2: Draw diagonals across the corners of the plan and number them from 1-6.

STEP 3: Project these points vertically to touch the base BC of the front elevation end.

STEP 4: Draw lines from these points on line BC to touch the apex of the elevation.

STEP 5: With apex A as a centre and radius of the slant height AB. Draw an arc from B large enough to accommodate the chords on the plan.

STEP 6: Step off the units 1-6 from the plan on the arc with B as point O.

STEP 7: Join these points with straight lines i.e. 0 – 1, 1 – 2, etc to obtain the development.

STEP 8: Draw a straight line from these points to the apex A.

RESULT

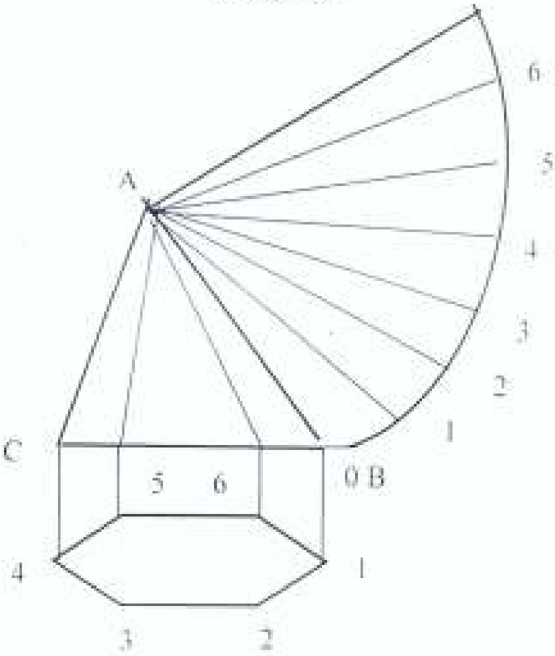
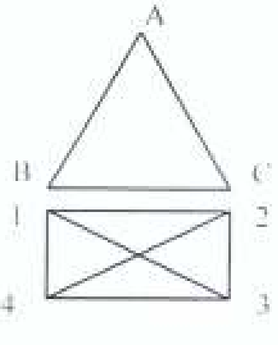


Fig. 164

ACTIVITY 7.8-2: DEVELOPMENT OF A PYRAMID WHEN THE TRUE LENGTH IS NOT KNOWN IN THE ELEVATION, fig. 165 a

Given: The front elevation and the top views of a right pyramid

STEP 1: Draw the given views

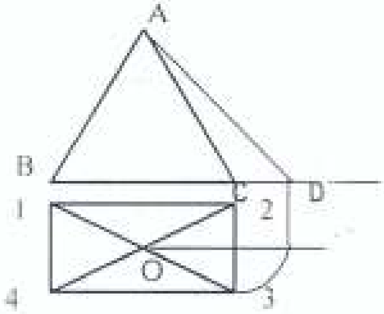


STEP 2: Project the base of the elevation to the right.

STEP 3: Locate the true length of the corner lines of the pyramid, by rotating line 03 to a horizontal position in the plan. Then project the point D. Join A to D. This is the true length of the pyramid.

STEP 4: Using the length AD (true length) as radius and centre P draw an arc EF for the stretch out line of the pyramid.

STEP 5: Lay off the length 1- 2, 2-3, 3 – 4, and 4 – 1 as a chord on the arc EF, join the end points with P to form triangles



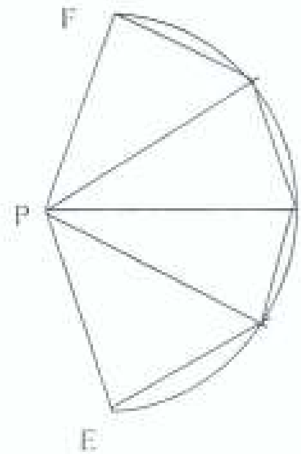


Fig. 165a

ACTIVITY 7.9-2: TO DRAW THE DEVELOPMENT OF A CONE, 165 b

GIVEN: The elevation ABC and the plan.

STEP 1: Draw the elevation ABC and the plan equal in diameter with the base of the elevation BC with both maintaining the same centre line.

STEP 2: Divide the circumference of the plan into twelve equal parts.

STEP 3: With centre A and radius AB draw an arc from B equal to the circumference of the plan.

STEP 4: Step off units 1-12 along the arc.

STEP 5: Join 12 to the apex to complete the development of the cone.

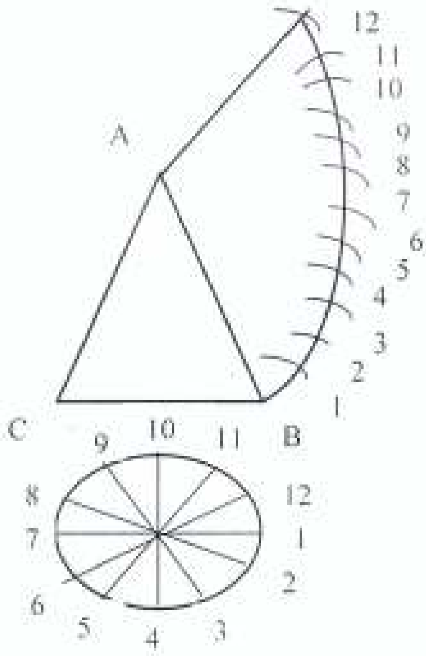


Fig. 165

ACTIVITY 7.10-2: TO DRAW THE DEVELOPMENT OF A TRUNCATED RIGHT CONE, fig. 166

Given: The front elevation and the base circle.

STEP 1: Draw the given elevation and plan.

STEP 2: Divide the circular base (plan) into a number of equal parts. Project these points vertically to the base line in the front elevation.

STEP 3: Project these points on the elevation base line to the apex of the cone.

STEP 4: Where the radiating lines cut the section DE project them horizontally to touch AB.

STEP 5: With centre A and each of the points on AB (including point B) as radius draw arcs.

STEP 5: Mark off the plan units 1 – 12 on the arc from B and connect them to A.

STEP 7: Mark off the intersection of the connecting lines from A and the arcs and join them with curve line to produce the top shape.

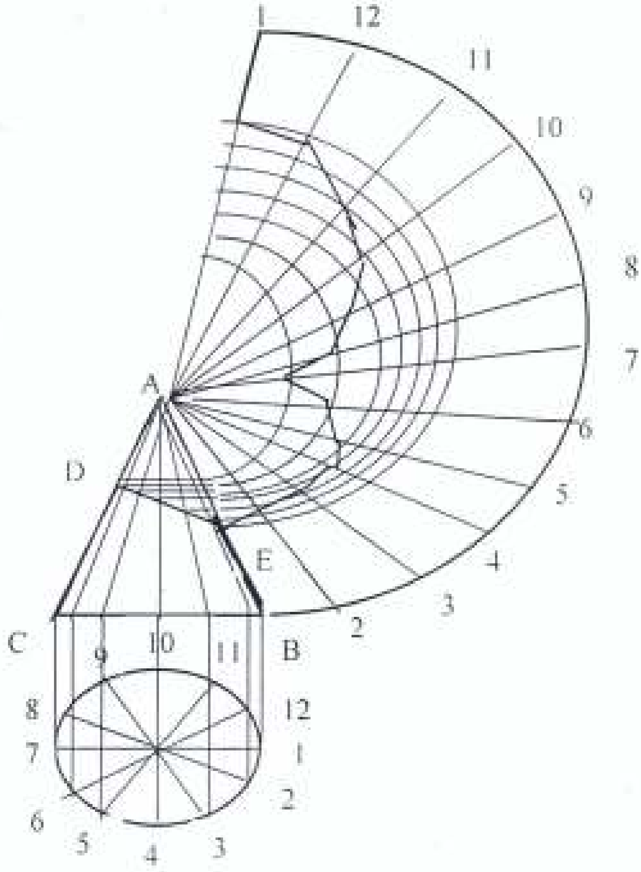


Fig. 166

ACTIVITY 7.11-2: OBLIQUE CONE

An oblique cone has its axis inclined to its base rather than perpendicular and because of this radial surface lines are not all the same true length. The cone is divided into a number of triangles instead of a sector as in right cone development. The development involves finding the true lengths of the sides of the triangles and drawn out side by side.

ACTIVITY 7.12-2: TO DRAW THE DEVELOPMENT OF OBLIQUE CONES, fig. 167

Given: The elevation.

STEP 1: Draw the given elevation and the circular base of the cone. Divide the circular base into 12 equal parts.

STEP 2: Project the points on the circular base to the base line of the elevation and from these points radiate lines to the apex A.

STEP 3: Extend the base line of the cone to the right and draw a perpendicular to this line from the apex A (AA^1).

STEP 4: From point A Rabate points 0 to 6 to the base line extended to give points 0^1 to 6^1. Join these lines to the apex A. These lines are the true lengths of the generators shown.

STEP 5: Start the development by positioning A – 6^1 in the centre. From point 6^1 strike arcs equal to one of the units on the base circle on each arcs of length or radius A – 5^1. Join the points of intersection of these arcs to point A to give the first two triangles $A5^1 6^1$ on the development.

STEP 6: To draw the next two triangles $A4^1 5^1$ with 5^1 and radius equal to one of the units on the base circle strike arcs. Intersect these arcs with arcs of radius $A4^1$. Join these points to the Apex A to give triangles. Determine other points in similar manner.

Note: Lines A – 0 and A – 6 are already in their true lengths.

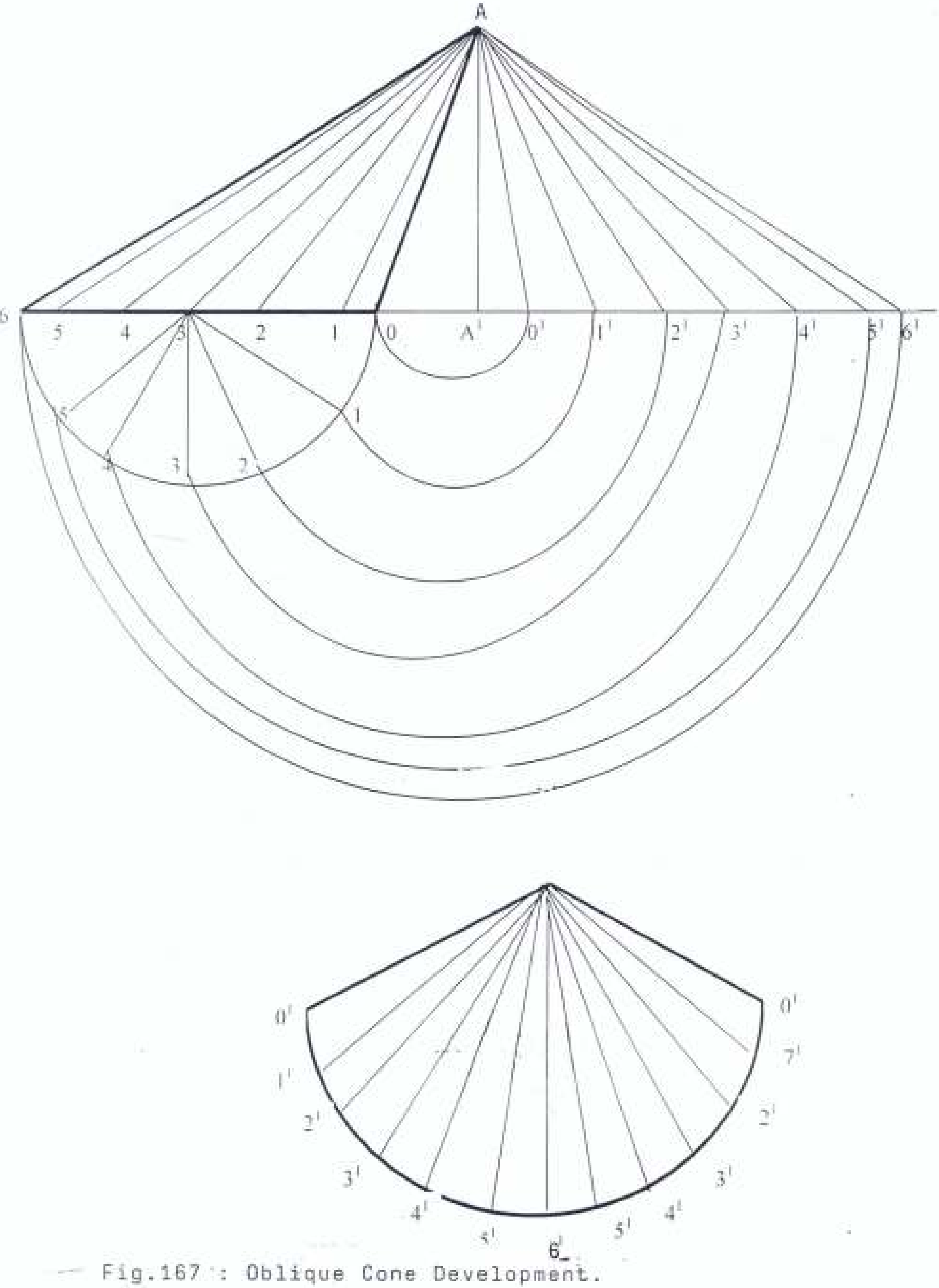


Fig.167 : Oblique Cone Development.

TRIANGULATION METHOD

Triangulation is another major method used to lay out a surface development. The development involves dividing the surface into a number of triangles.

The true length and true sizes of the triangles are found and transferred to a stretch-out.

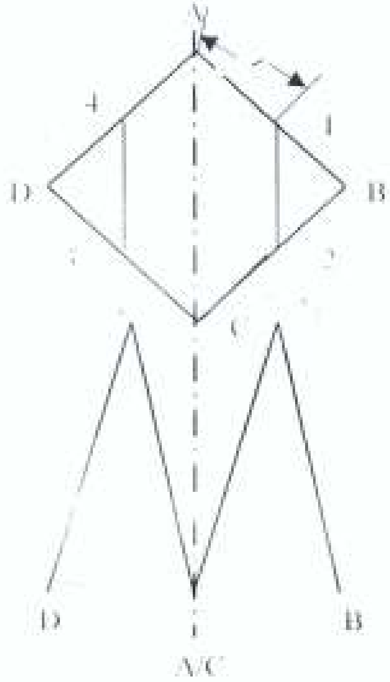
Transition pieces are used to join pipes or ducts of different cross section shapes e.g. square duct to a round one.

In order to determine the true length in a transitional pieces using triangulation method two views are needed. These are the top view and the front elevation.

Activity 7.13-2 To develop a transitional piece using triangulation method. Fig. 168

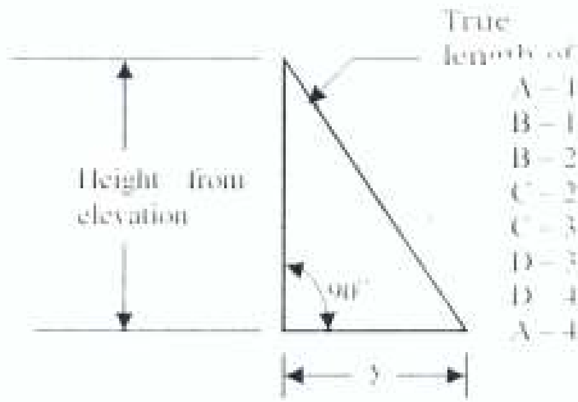
Given: Top view and front view

STEP 1: Draw the given views and determine the true length and true distance as shown below. The height between points A and I is projected from the front view to the true length while the distance y between corresponding line end points A – I is found in the top view and transferred to the true length diagram. The true lengths are the same for all the edges since all the heights and top view distances are the same.



Front view

True length is obtained by placing plan length at right angle to their vertical height. The hypotenuse so formed is the true length.

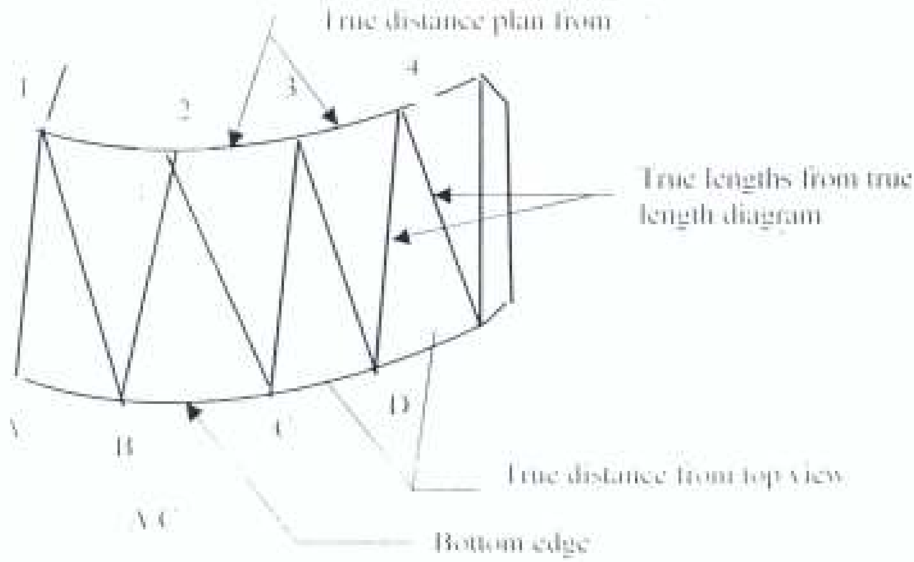


From top view

True length diagram

STEP 2

Using true lengths and true distances and starting from A – 1 draw each triangle representing a surface of the object as shown in fig. 168



Pattern development

SELF-ASSESSMENT QUESTIONS

(1) The following are methods for surface development except

(a) Parallel method (b) Radial method

(c) Surface method (d) Triangulation method

(2) The following are ruled surfaces except

(a) Parabolic surface (b) Plane surface

(c) Single surface (d) Warped surface

(3) Name the two general classes of surfaces

(a) Sphere and Radial surfaces

(b) Ruled and double curved surfaces

(c) Oblique and triangulation surfaces

(d) Parabolic and orthographic surfaces

(4) A sphere has a ___________ curved surface

(a) Single (b) Plane (c) Double (d) Radial

(5) A development that goes from square to round is called ________ piece (a) Radial (b) Parallel (c) Double (d) Transition

(6) Lines on a stretch out that show where to make a fold are called ___________lines.

(a) Curved (b) Straight (c) B and (d) pattern

(7) Using a series of triangles to develop pattern is called ___________

(a) Triangulation method (b) Radial method

(b) Parallel method (d) Double method

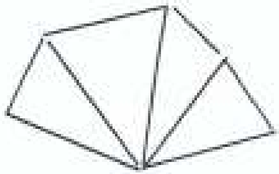
(8) Cone shapes are produced by using __________ line development.

(a) Warped (b) Radial (c) Parallel (d) Triangulation

(9) If a semicircle is made to rotate about its diameter the solid generated is

(a) A cone (b) A pyramid (c) A sphere (d) A cylinder

(10)



The surface development above is that of a

(a) Triangular pyramid (b) Rectangular pyramid

(c) Square pyramid (d) Pentagonal pyramid

ANSWERS

(1)	C	(2)	A	(3)	B	(4)	C	(5)	D
(6)	C	(7)	A	(8)	B	(9)	C	(10)	C

3.2.8 Module 8 - Intersections

Intersections are lines formed at the junction of surfaces where two or more objects join or pass through each other.

Example is a cone passing through a cylinder.

Intersections are common in the engineering and related fields. For instance the automotive and aerospace industries, a lot of design works such as panel, body section, wings, etc involve various intersections, which must be correctly defined. The design and specifications of buildings require architects and engineers to define the intersection of surfaces.

TYPES OF INTERSECTIONS

Intersections are classified on the basis of the types of geometrical surfaces involved. Geometrical surfaces are classified as;

(i) Ruled geometrical surfaces

(ii) Double curved geometrical surfaces

RULED GEOMETRICAL SURFACES

Rule geometrical surfaces are surfaces generated by moving a straight line. There are three types of geometrical surfaces; plane, single-curved, and warped surfaces. Fig. 170. Both the plane and single curved surfaces can be developed while the warped surface can not be developed (unrolled into a single plane) because they are usually formed by peening, stamping or expose process (e.g. tanker truck). Warped surface can only be developed if it is divided into sections

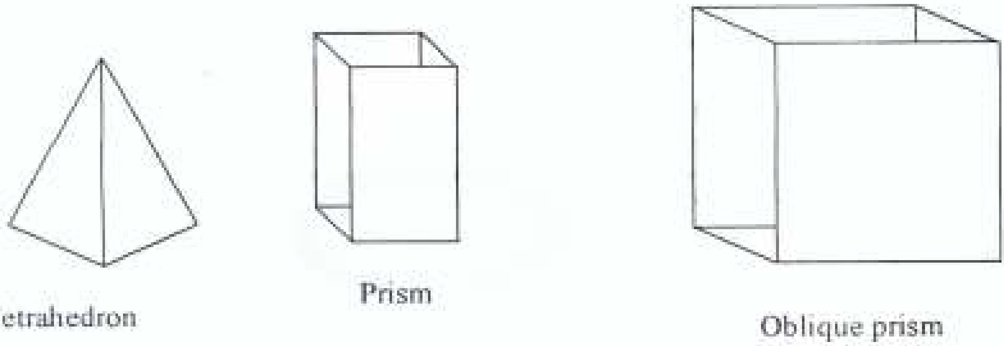


Fig. 170 (a) plan Surfaces (Developable)

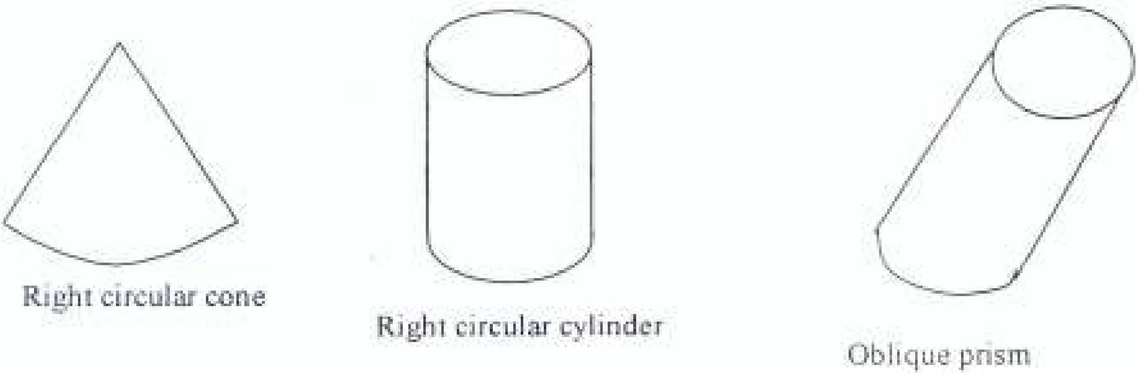


Fig. 170 (b): Ruled Surfaces (Developable)

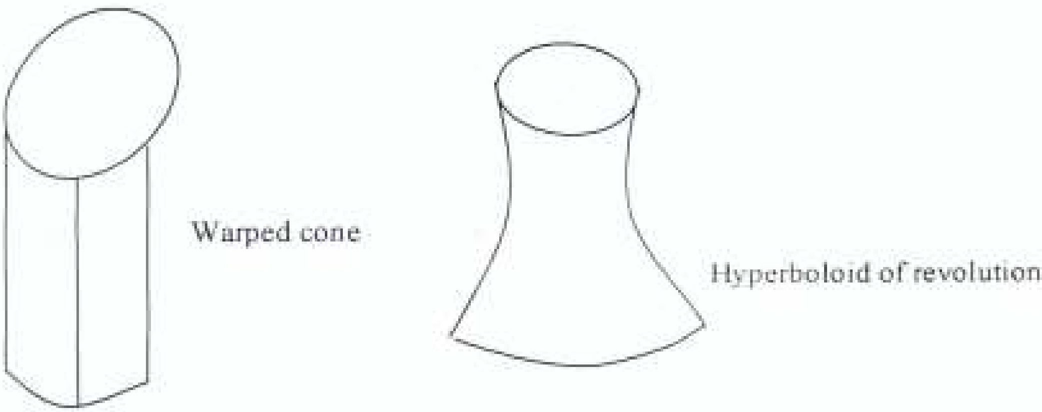


Fig. 170 (c): Warped Surfaces (Non-developable)

DOUBLE-CURVED SURFACES

Double-curved geometrical surfaces are surfaces generated by a curve line revolving around a straight line in the plane of the curve. Fig 171. double curved surface cannot be developed into single plane surface.

Fig. 171. Double Curved Geometrical Surfaces

DRAWING CURVES OF INTERSECTION

Activity 7.14-2 How to draw the curve of intersection of two cylindrical pipes of equal diameter joined at right angles. Fig. 172

Given: The plan and the elevation.

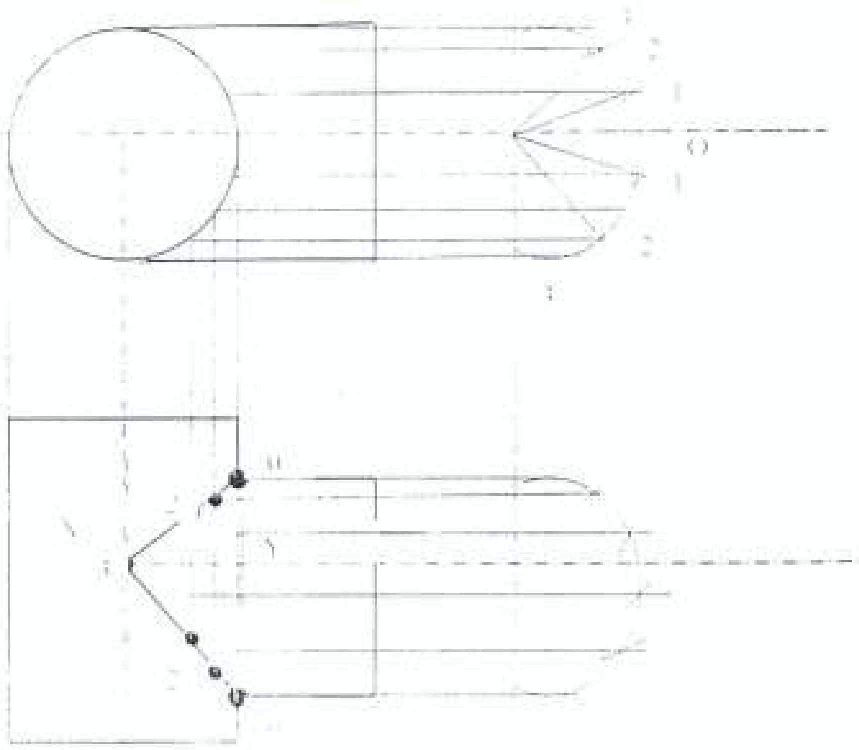
Step 1: Draw the given plan and elevation

Step 2: At any convenient distance away from the plan and elevation draw semi circles and divide them into 6 equal parts.

Step: 3 Project horizontal lines from the points on the plan semi circle to touch the plan of pipe X and project these points vertically to the elevation.

Step: 4 From the points on the elevation semicircle project horizontal lines to intersect corresponding vertical lines in step 3, to produce the points of intersection.

Step: 5 Join these points to give the curve of intersection.



Note: The lines of intersection for two cylinders of equal diameters are always straight line.

The same procedure is used to draw the line of intersection of two cylindrical pipes of unequal diameter joined at right angles. The only difference is the line of intersection, which is always a curve as against a straight line in two cylinders of the same diameter joined at right angle.

Activity 7.15-2 Curve of intersection for cylindrical pipes of unequal diameter joined at an angle other than 90°. Fig. 173

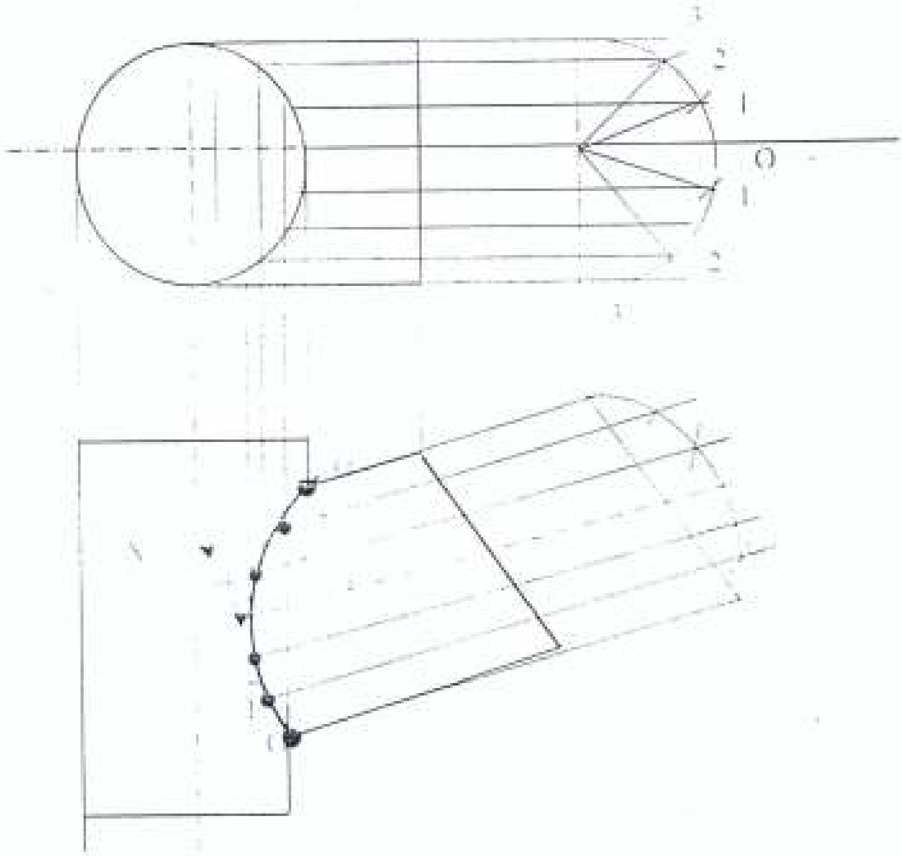
Given: The plan and the elevation.

Step 1: Draw the given plan and elevation with the views inclined at a specific angle θ (Ref. Fig.174)

Step 2: Draw a semicircle at any convenient distance away from the plan and elevation and divide them into 6 equal parts.

Step 3: Project horizontal lines from the points on the plan semicircle to touch the plan of pipe X and project these points vertically to the elevation.

Step 4: Project lines parallel to pipe Y from the points on the elevation semicircle to intersect the corresponding vertical projections lines, to mark the line of intersection.


3
2
1
O
1
2
3

Activity 16.3-2 Drawing curve of intersection of a cylinder intersecting a cone

Given: The front elevation and the plan.

Step 1: Draw the given elevation and plan. Draw the semicircle as usual.

Step 2: From the points on the elevation semicircle draw the horizontal lines IL, 2M, 3N, 0O, 3P, 2Q, 2R.

Step: 3 Draw vertical lines from the points L, M, N, O, P, Q, R to the center line of the plan.

Step 4: Draw the circular cone sections on the plan with each radius equal to the distance between the circle center and the points made by the vertical lines from step three on the center line.

Step 5: Mark the intersection of the cone sections with their corresponding cylinder sections to give the points for the curve on the plan.

Step 6: Project the points for the curve on the plan vertically to their corresponding lines on the front elevation, to produce the curve points on the front elevation.

CHAPTER FOUR

SYSTEMS DESIGN AND IMPLEMENTATION

4.1 Systems Design

Cornell (1997) defined system design as the process of developing a plan for implementing the set of functional hardware and software systems. It is the creative ability of combining the theoretical ideas with the available resources to achieve a desired output or goal, that is, the objectives of the system to be developed.

This idea was employed in development/design of "DEVELOPMENT OF COMPUTERIZED TECHNICAL DRAWING LEARNING DESK FOR SECONDARY SCHOOLS."

Henceforth, the system shall be called T.D:BASICS, acronym for development of Computerized Learning Desk in Technical Drawing for Secondary Schools.

4.2 Development of The Learning Software

Basically, T.D:BASICS was developed with visual Basic programming language a programming language designed for the Microsoft windows environment. Although there exists some other high level programming language such as COBOL, FORTRAN, ALGOL, PASCAL etc, but visual Basic was selected because it is considered to be the easiest language to learn as it was originally designed as a beginner's language, it is user friendly and readily compatible with Microsoft Windows environment.

Therefore T.D:BASICS supports most standard features of the Microsoft Windows graphical user interface. This makes acquisition user friendly, menu-driven and also supports the use of mouse as an additional in put device for activating manus, command buttons and making selection in a list of options.

4.3 Features of T.D.BASICS

T.D.BASICS is able to carry out the following activities:

i Help the student to know the expected learning Outcome through the outlined objectives.

ii Give instruction on how to study each module.

iii Impart technical drawing knowledge in students .

iv Present technical drawing lessons in a modular form.

v Make student progress through technical drawing curriculum at his or her own speed without interference form the teacher/instructor.

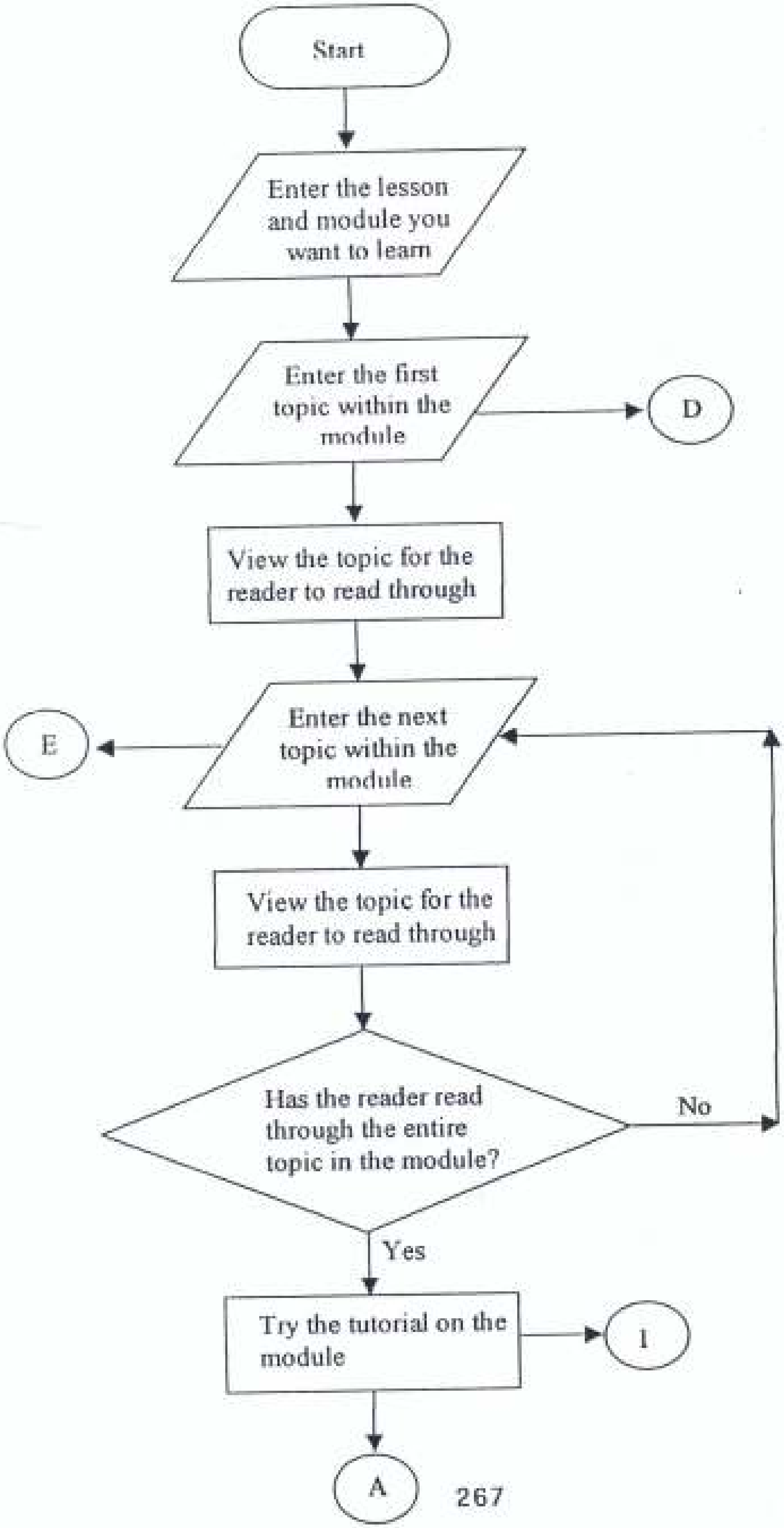
vi Evaluate the student on every module studied

vii Process the result after evaluation and direct the student on what next to do based on the result.

viii Decide on whether to supply the answers or not to any studied module based on the score.

4.4 Flowchart Development

A flowchart relating the learning activities involved in T.D.BASICS was developed to provide a diagrammatic representation of the learning process. The flowchart is shown in figure 4.1. The figure represents the steps involved in the learning of the developed technical drawing software. It shows the interaction between the user and the software.


Start
Enter the lesson and module you want to learn
Enter the first topic within the module
D
View the topic for the reader to read through
Enter the next topic within the module
E
View the topic for the reader to read through
Has the reader read through the entire topic in the module?
No
Yes
Try the tutorial on the module
I
A

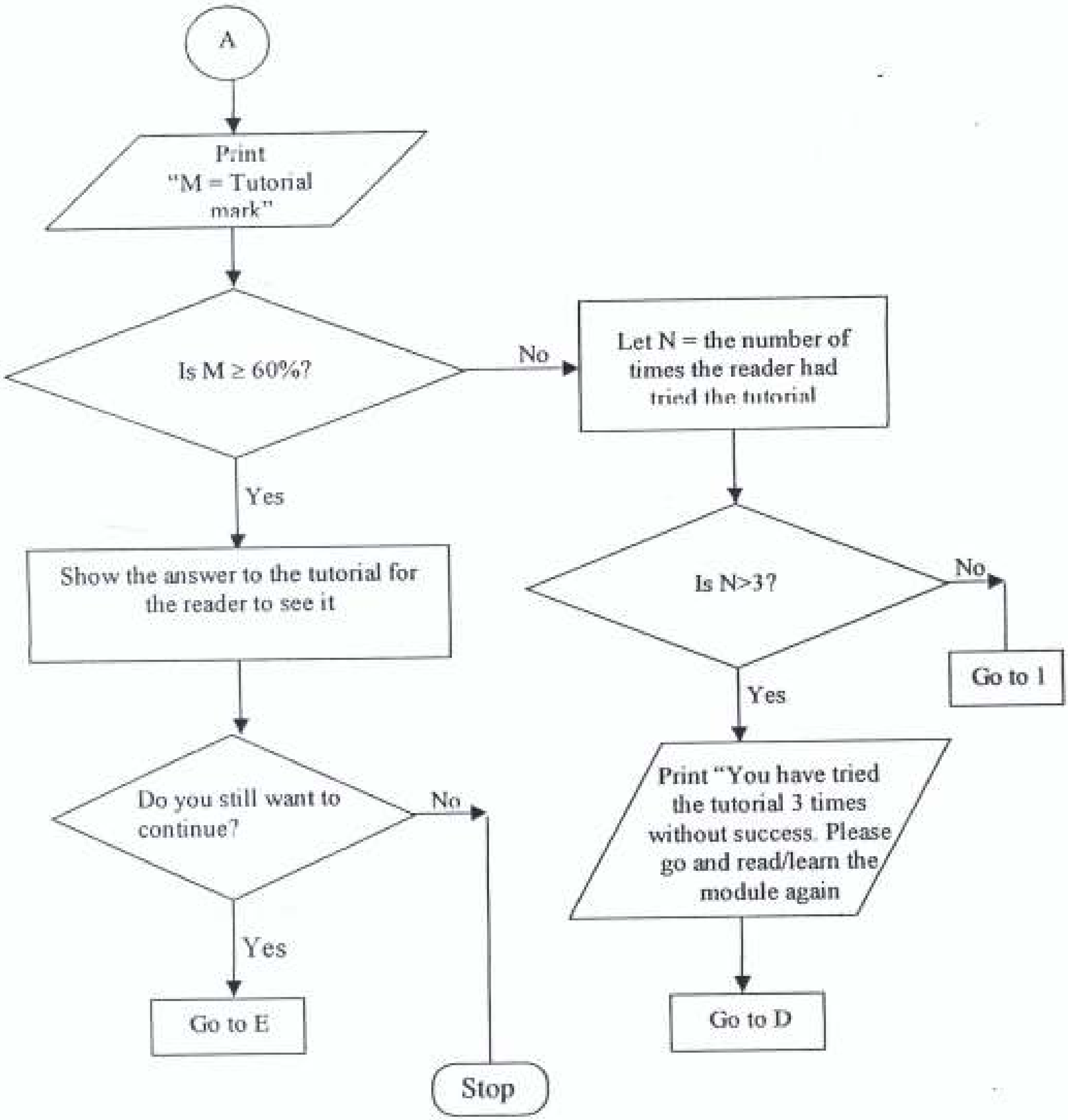


Fig 4.1 Flowchart of the system for each of the module

4.5 Writing Code

The codes otherwise known as program are the set of instruction/set of program written to execute the teaching/learning tasks. The code consists of language statements constants and declarations arranged in a logical manner. The order in which the code executes depends on the user that is the user is in charge and the code responds. The code for T.D.BASICS is as shown in Appendix A

4.6 Ease of Use

This relates to the user interface. T.D.BASICS was developed with visual Basic programming language, a programming language designed for the Microsoft windows environment. Thus, T.D.BASICS supports most standard features of the Microsoft windows graphical user interface. This means that T.D.BASICS is user friendly, menu driven and also supports the use of mouse as an additional input device for activating menus, command buttons and selecting options from a list box.

4.7 Systems Implementation

The systems implementation presents the hardware and software requirements of T.D.BASICS. It also describes the installation procedure for setting up the system, the user's guide, which guides the user on how to use the system.

4.6.1. Hardware requirements.

The hardware requirement of T.D.BASICS is a personal computer (Pc) with the following minimum configuration.

- Pentium 133 or higher processor

- Minimum of 32 Mb of RAM
- 14" VGA colour monitor
- 10 Mb free Hard Disk
- 3.5" Floppy Disk Drive
- A mouse and other suitable pointing devices

4.7.2 Software requirements

Microsoft Windows 95 operating system or later versions.

4.7.3 Installation procedure

T.D.BASICS is stored in installation diskettes/disc, the installation procedures is as follows;

(a) Insert the installation diskettes in the floppy drive

(b) Copy all the packaged application from the diskettes completely into a folder

(c) Open the folder and double click on the set up icon to run the set up. Follow the instruction of the system until the software has been completely installed. The computer will prompt you after the package has been successfully installed.

(d) You can now access T.D.BASICS from your explorer.

4.7.4 Users' guide.

As shown in figure 4.2 T.D.BASICS starts with a main entry screen showing a logo, version number and horizontal menus on the task bar where all the features of the software can be accessed.

Fig. 4.2: T.D. BASICS Main entry screen.

The T.D.BASICS main menu globe was designed to use the standard window pull down menu style; that is by clicking any of the horizontal menus displayed, a vertical menu is pulled down.

The main menu for T.D.BASICS has four horizontal bar menus: These are:

- Learning T. D
- Tutorials
- About
- Quit

- ➢ Click on the "Learning T. D" menu to display the two technical drawing lessons under the menu.
- ➢ Click on the lesson to be learnt or studied and move the cursor to the right to display the various modules under the lesson. Fig 4.3

Fig. 4.3: Main screen of the software showing the list of Modules.

➢ Select a module of your choice and click on it to present the user interface for that module figure 4.4 where all the features of the module can be accessed. Click on the users interface combo for the selected module to present all the learning activities in the module from where one can now select the activity to be studied.

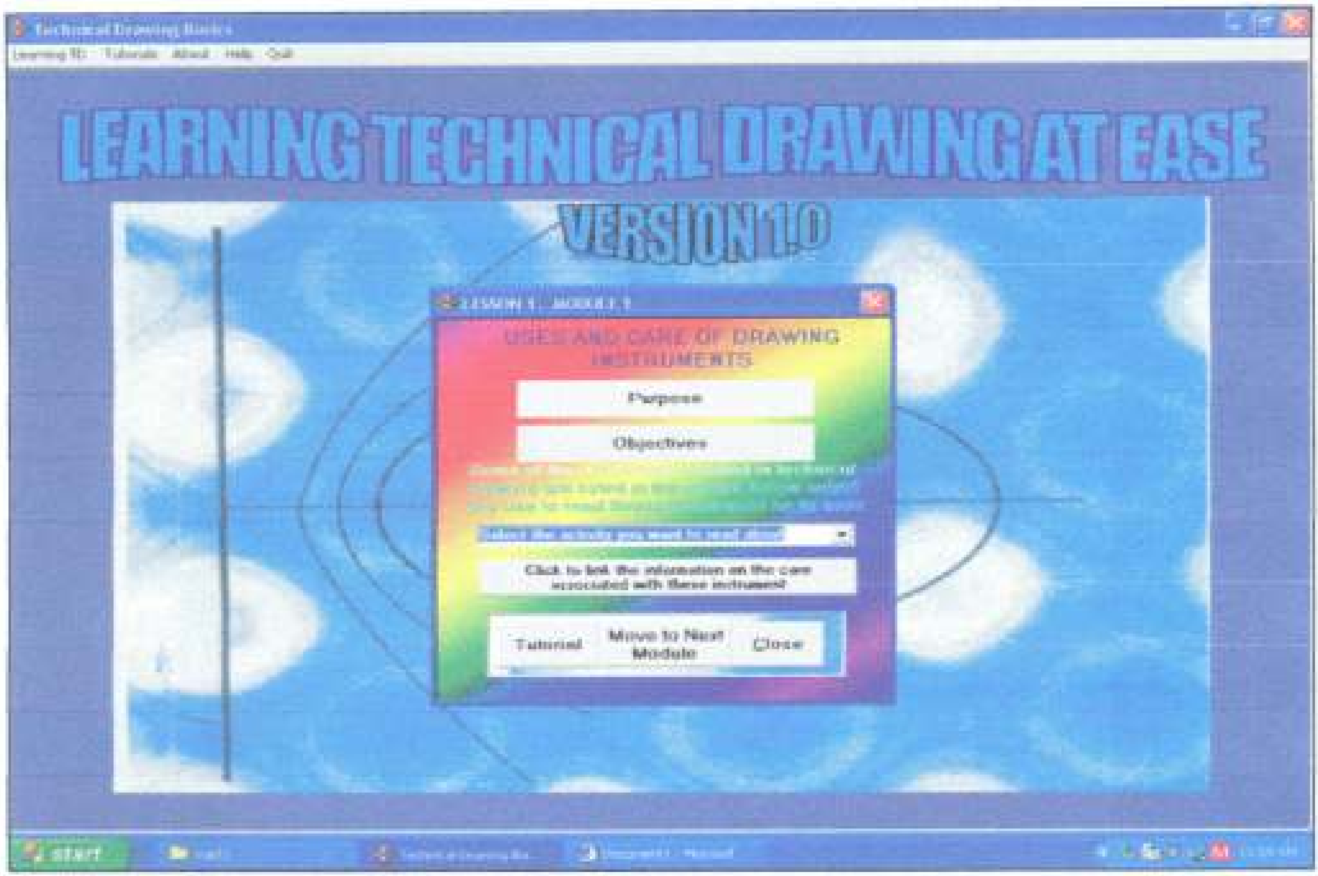


Fig. 4.4: User interface for lesson one module one

- A click on the activities to be studied will present the learning window for that activity as shown in figure 4.5a and 4.5b

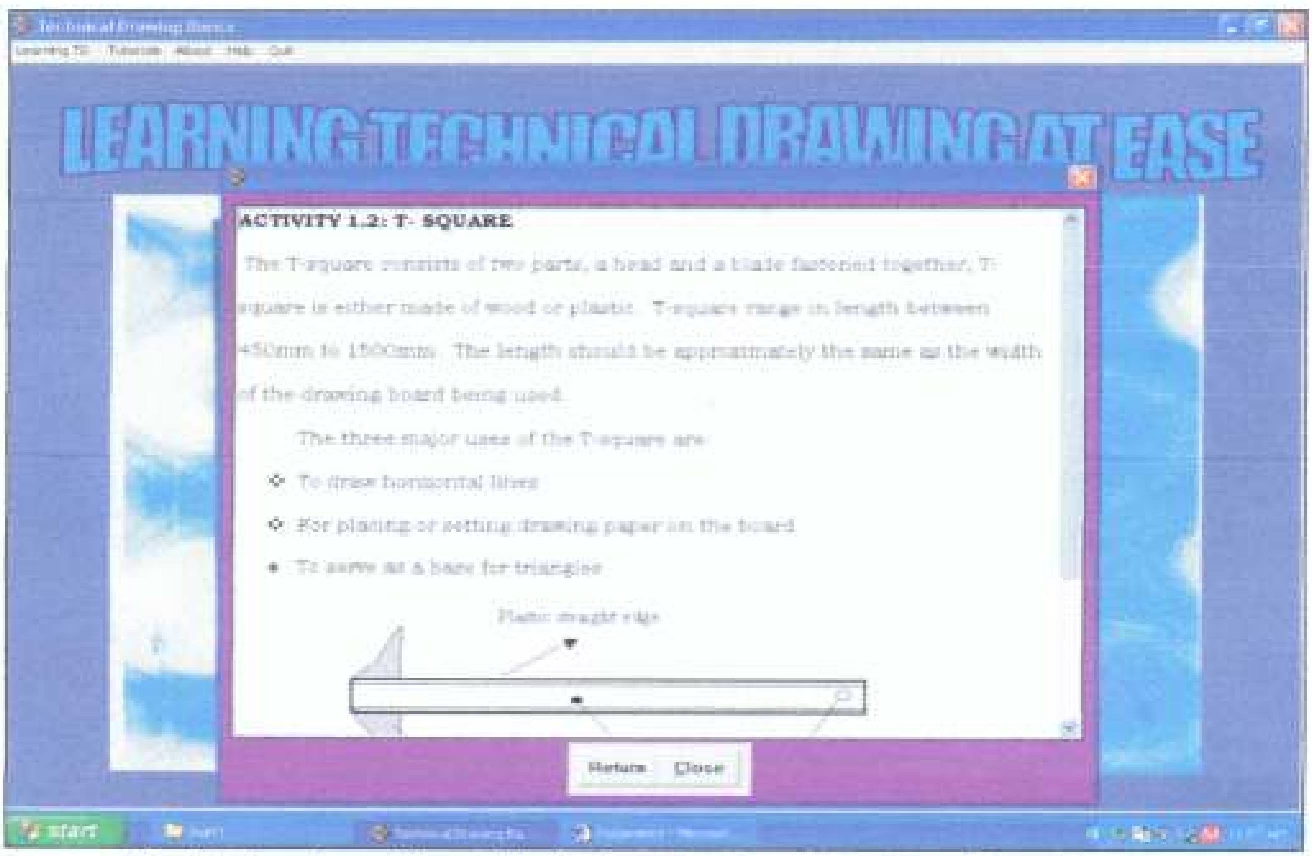


Fig. 4.5: Learning window giving information about T-Square and its care.

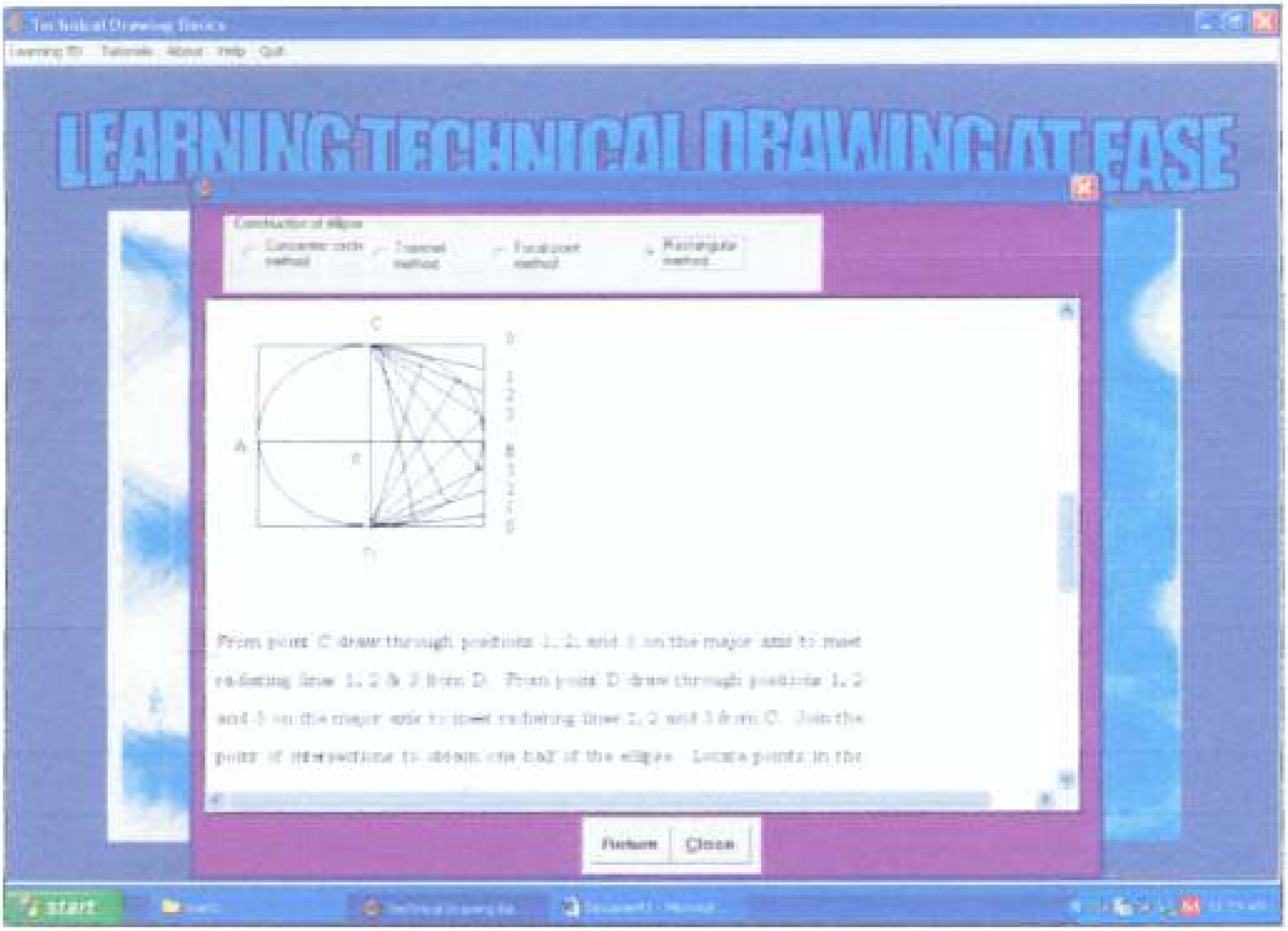


Fig. 4.5b : Learning window giving information about construction of ellipse using the rectangular method

- The tutorials can be accessed either from the horizontal bar (task bar) or from the user interface of each module.
- A click on the task bar tutorial will present a list of tutorials for all the modules from where the particular tutorial to be answered will be selected.
- Click on the selected tutorial to display the tutorial interface for that lesson fig 4.6. The answers can now be supplied in the empty boxes provided.

- The "About: menu provide information about the developers.
- To exit the system, click quit on the T.D. BASICS main menu globe followed by click on exit.

CHAPTER FIVE

RESULTS AND DISCUSSIONS

5.1 Results

The purpose of this project which is to develop a technical drawing software for the teaching and learning of technical drawing in secondary schools was achieved. The study has developed useful tool for teaching and learning technical drawing, a subject considered to be difficult for many students. The developed software presents concise explanations of the subjects general principle, and uses worked examples freely to expand the software. Each example shows the method of obtaining the solution and includes additional explanatory notes. For some topics, where it would have been difficult to understand a solution given on a single drawing, the solution has been drawn in step-by step form.

The modular approach, interactive procedures and graduated test will promote easy learning of the subject, user friendly, menu driven, portable and runs on Microsoft windows operating system. The set of programs written to achieve the objective of this study is given in appendix A

The design result was found to be reliable, accurate and result oriented than the existing methods of teaching and learning the subject. The drawings produced are better than the manually prepared drawings. There is more standardization and greater legibility of the drawings.

Another result achieved from the developed soft ware is the high quality of the physical features in terms of attractiveness, durability size and clarity of the resources. Also achieved are accuracy, clarity and usefulness of illustrations, drawings and weight of material for ease of handling and storage.

The resulting software helps to facilitate learning, help to save teaching and learning process from being merely the talk and chalk approach. It facilitates teaching – learning process if properly used.

Other specific results achieved through the developed software include:

Stimulation of interest. In teaching and learning situation, there is the need to generate or arouse and maintain students interest. Once interest is built up, effective learning will definitely take place. This technical drawing soft ware has the ability to awaken student interests and thus arouse their curiosity to learn and know more. The use of this soft ware enables the learner to be more alert and attentive. With interest developed in addition to being alert and attentive, students would like to follow explanations, procedures or exercises sequentially and faithfully so as to comprehend the whole learning episode.

Making technical drawing teaching to be more productive. The use of the software makes technical drawing teaching/ learning more productive since it helps to speed up the rate of students learning. In addition to making students learn faster or promote greater acquisition of knowledge, the software also makes them to understand deeper, retain longer and apply accurately what has been learned as compared with other approaches.

Providing Meaningful sources of information to learners. This development helps the classroom teacher provide his learners with meaningful sources of information. Teachers can guide learners to easily understand information in various forms. Teachers and students can easily turn to any topic or subtopic, diagram and exercise with ease thereby enhancing and, promoting clarity of communication and increase the degree or rate of comprehension and assimilation.

Help to overcome physical limitations in the Teaching – learning environment or situation – There are many types of communication problems that can face a technical drawing teacher in actual teaching – learning situations. Students in a class may not be able to observe closely teacher demonstrations. There might be the problem of how the teacher can show a small drawing or printed diagram to the class as a group or reveal a particular information, there could also be the problem of how to avoid wasting much time each year (or from one class to another) re – doing complex chalk board diagrams or illustrations or drawings. These and other similar problems are solved through effective utilization of this research work.

Making learning become more concrete, real, immediate and permanent. The use of this research work creates impression that are so vivid and powerful that learners hardly forget experiences they are exposed to through the media (such as the computer).

Stimulation of problem solving. The student tends to learn more and like better if they are opportune to be engaged in significant and appealing activities. When students are actively participating in the teaching learning process, their interest is maintained and there is increase in learning. Students develop skills necessary in problem solving when they are involved individually in a learning process making use of instructional material like the computer.

Finally, the developed software helps to individualize instruction. Individualized instruction refers to a situation where all the students proceed through the same curriculum but at their own individual rates. Instruction is individualized in the sense that the teaching is so planned to suit the specific needs, ability and problems facing a particular student or a small group of student. The primary purpose of this type of instruction is to assist a student who is working independently to achieve clearly specified instructional objectives of a programmed of instruction. It has the potentiality of promoting students ability to work independently over a period of time.

With this research work individual students now have besides the teacher other avenues for learning technical drawing. He can now proceed at his own pace and time in the process of learning technical drawing.

5.2 Discussions

The software will serve as a good guide to beginners in technical drawing. It is well prepared to suit the specific needs of the beginners. It contains much of the knowledge and experience needed for proceeding on advanced studies in technical drawing.

While the software will be highly valuable for the beginning higher institution students by serving as learning software in technical drawing course in engineering and technology, it has been developed primarily for the secondary school students, covering the geometrical drawing syllabus for senior secondary school certificate.

The software is programmed in a logical step by step order, from simple to complex, for use at all levels of the educational setting.

The step-by-step procedure adopted in the preparation of the software makes it useful for all levels of users. Selected aspects can be successfully used at the Junior secondary school. (JSS) level with the assistance and guidance of the teacher. It is hoped that the brief explanation to each chapter will be helpful to the guiding teachers or individual learners.

The areas covered in this software are;

Lesson 1 Technical drawing Basics

Lesson 2 Geometry

Each lesson is further divided into a number of modules programmed in a logical step by step order from simple to complex for use at all levels of the secondary school educational setting (JSS1 – SSS 3).

The objectives for each module are outlined at the beginning of the module to give an insight into the expected outcome. Next to the objectives is the instruction that provides a good guide to the student on how to study the chosen module.

In order to help the students questions have been provided at the end of each module. These questions are designed to test the student's understanding of the Module.

Every attempt has been made in the preparation of this work to employ examples and illustrations that are familiar with the environment and background of the children.

All dimensions are in S.I unit.

5.1.1 Lesson one – Technical drawing basics.

This topic presents a checklists of what students of technical drawing should learn for effective drawing.

Module 1 Uses and care of drawing instruments

Module 2 Lines and lettering

Module 3 Board practice

Module 4 Technical sketching

Module 5 Dimensioning and Notation

Lesson 1 Module 1 – Uses and care of drawing instruments

In learning to read and write the drafting language, student must learn which instrument to use on a particular drawing. He needs to know how to use drafting equipment skillfully, accurately and quickly. This module exposes student to the basic drawing instruments used in technical drawing, their uses and materials which they are made of. Some of these instruments are drawing board, T-square, Triangles, protractors, French curves, Pencils, erasers, pair of compasses, Dividers, etc.

Lesson 1 Module 2 – Lines and lettering techniques

Different basic types of lines are used in manual drafting with each having its own individual characteristics. Simple freehand lettering, quickly made and perfectly legible is important to engineering. Lettering is used to tell the kinds of material, sizes, distances and amounts; to identify units; and to give other necessary information. This module covers two of the basics that are needed in preparing all types of technical drawings. The major topics covered in this module are lines and lettering techniques.

Lesson 1 Module 3 – Board practice

Drawing board practice involves the correct use of drawing board and drawing instruments to produce good and accurate technical drawings.

Activities such as;

- Drawing of title block
- Fasten of drawing paper on the drawing board with the aid of the T-square
- Drawing different types of lines like horizontal, vertical, inclined parallel, boarder lines, etc.

Lesson 1 Module 4 – Freehand sketching

Freehand sketching is a method of making a drawing without the use of instruments except drawing pen or pencil. It is one of the first steps in communicating ideas for a design and it is used in every step thereafter.

The learning activities covered in this module are;

- Sketching different types of lines and curves
- Sketching arcs, circles and semicircles.
- Orthographic, axonometric, oblique and perspective sketching.

Lesson 1 Module 5 – Dimensioning and notation

The module covers in depth the fundamentals of dimensioning and notation. The areas covered include: specifying the scale (measuring systems), dimension elements, dimensioning features for size, dimensioning features for position, rules for good dimensioning and notes.

5.1.2 Lesson Two - Geometry

This topic discuss in detail the basic technique associated with geometric construction, which must be thoroughly mastered. The various procedures in this are used in solving all drawing problems. The topic covers both the plane and solid geometry. It is grouped under 8 modules.

Review questions are presented at the end of each module as self-assessment questions for the students. These modules are:

Module 1: points, lines, angles and triangles

Module 2: arcs, circles and tangents

Module 3: quadrilaterals, polygons and areas of plane figures

Module 4: loci part 1 (ellipse, parabola and hyperbola)

Module 5: loci part 2 (cycloid, hypocycloid, epicycloids, involutes and Archimedean spiral)

Module 6: loci part 3 (link mechanism and helix)

Module 7: development

Module 8: intersections

Geometrical Construction

Geometry is the study of the size and shape of things. Geometric constructions are made of individual lines and points drawn in proper relationship to another.

Geometric construction is very important to nearly everyone in technical fields (Engineers, surveyors, architects, designers mathematicians, scientists, etc). These set of people regularly apply the principle of geometry to the solution of technical problems such as the design of machine parts, architectural structures etc. therefore technical student require a good knowledge of geometrical construction to be able to apply it to the solution of technical problems.

Geometrical construction is divided into two groups: plane geometry and solid geometry.

Plane Geometry: these are two-dimensional geometry with length and breadth only without thickness examples are polygons, quadrilaterals, circles and semi-circles, ellipse, angles, simple triangles etc

Solid Geometry: These are three-dimensional geometry with length breadth and thickness. Examples are pyramids, prisms, cubes, cones, sphere, torus, ovoid, helices, etc.

Lesson 2 Module 1 – Points, lines, angles and triangles.

The basic techniques associated with geometric construction must be thoroughly mastered. The various procedures discussed in this module are used in solving drawing problems in technical drawing. To be truly proficient in the layout of both simple and complex drawings the student must know and fully understand the many geometric construction use.

The areas covered in this module are points, lines, angles and triangles

Lesson 2 Module 2 – Arcs, circles and tangents.

The major areas covered in this module are circles, arcs and tangents.

Circles and arcs are geometric objects constructed with curved lines while target is a line or curve that touches the surface of an arc of circle at only one point.

Lesson 2 Module 3–Quadrilateral, polygons and areas of plane figures.

The major topics covered in this module include quadrilaterals, polygons and areas of plane figures. Quadrilaterals and polygons are geometric objects enclosed with straight lines. At the end of this module students will be able to:

- Define quadrilateral
- Define Polygon
- List the different types of quadrilaterals and polygons
- Construct different types of quadrilaterals and polygons.
- Enlarge or reduce plane figures in a given ratio.

Lesson 2 module 4 – (loci part 1) ellipse, parabola and hyperbola

Locus (singular) is the path traced by a point, which is governed by certain laws or rules.

passes through a right circular cone. These shapes are ellipse, parabola and hyperbola. They are geometric curves used in drafting.

Lesson 2 Module 5-Loci Part II: Cycloid, hypocycloid, epicycloids involutes curves and archimedean spiral.

The major areas covered in this module are cycloid, hypocycloid, Epicycloids involutes curves and Archimedean spiral. The cycloid Hypocycloid, epicycloids and involutes curves are the basic forms used for gear teeth while the Archimedean spiral is used in the design of cams to change uniform motion into uniform reciprocal (straight line) motion.

Lesson 2 module 6-Loci Part III: Link mechanism and helix

In machine designs link mechanism have a very wide application especially in machines with a reciprocating action such as automobile engines like motorcycle, motorcars, e.t.c. in the design of mechanism, it is important to trace the movement of the parts (the locus) so that the forces present can be found and clearances checked by providing suitable guard.

The connecting rod and the piston in motorcar engine is an example of link mechanism.

A helix is the locus of a point moving around the circumference of a cylinder at a uniform rate while moving parallel to the axis at a uniform rate.

A helix is a three-dimensional figure. A helix may be right handed or left-handed. Application: Typical application of helix are springs, blot and screw thread, gears (worm or helical), cylindrical cams, flutes on drills, auger bits used in wood, etc.

Lesson 2 Module 7 – Development

Development is the layout of a pattern of a shape in a single flat plane in readiness for folding to a desired shape. Surface development is applied in many engineering products such as boxes, buckets, air conditioning duct, funnel or hopper, etc.

In this module the different types of surface were discussed. Also discussed are the various methods of pattern development these methods of pattern development are:

- Parallel line method
- Radial line method
- Triangulation method

Lesson 2 Module 8 – Intersections

Intersections are lines formed at the junction of surfaces where two or more objects join or pass through each other. Intersections are common in the engineering and related fields. For instance in the automotive and aerospace industries, a lot of design works such as panel, body section, wings, etc. involves various intersections, which must be correctly defined. The design and specification of buildings require architects and engineers to define the intersection of surfaces.

This module covers the two types of surfaces involved in intersections. The various methods of drawing the curve of intersections for different objects were outlined.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The conclusion that can be drawn from this study is that lack of adequate instructional materials in the teaching and learning of technical drawing has been a major hindrance towards imparting the knowledge of the subject at secondary school level. Therefore, the study was able to solve these problems by developing a technical drawing software T.D.BASICS. The T.D.BASICS developed became a veritable tool (instructional material) for the teaching of the subject. The modular approach, interactive procedures and graduated test will promote easy learning of the subject matter. The approach adopted is sound and if followed logically student offering technical drawing will find the work progressive. An extensive cover of all aspects a student will need in the area of plane and solid geometry has been produced, which if properly assimilated will give on excellent knowledge of the subject. The course has been planned and programmed in a logical sequence and the diagrams have been kept as simple as the subject will allow so that the researcher feels in the light of considerable experience in secondary schools, many of the exercises included are within the capacity of slower groups. However the only limitation of the study is the lack of audio.

Generally, within the scope of the study T.D.BASICS is and effective software for the teaching and learning of technical drawing.

6.2 Recommendations

Based on the result of this study the recommendation below become necessary:

(a) For the giant result achieved though this research work to materialize, a lot of efforts and resources both material and financial must be put in place by the authorities concerned (federal, state governments and other educational agencies) so that schools and colleges can have access to a well equipped instructional resource centers. Efforts should be made by these various authorities to acquire enough computer systems for schools and colleges. By so doing a lot of success would be achieved through the use of the developed software in technical drawing teaching.

(b) Schools and Parents should acquire the software for the training of the students both in the school and at home, encourage rather than discourage their children from offering technical drawing.

Every technical drawing students must be computer literate.

(c) Government (State and Federal) should intensity their efforts in the on going rural electrification projects so that secondary schools in these areas can make maximum use of the soft ware.

(d) Technical drawing should be made compulsory for all science students in the secondary schools and a prerequisite for admission into any Engineering course either in the polytechnic or university.

(e) Examination bodies like JAMB should introduce technical drawing in their Examinations.

(f) T.D.BASICS is recommended for use in our various technical training institutes across the country.

(g) The software is also recommended for training and research purposes in higher institutions across the country.

(h) The resulting software is recommended for commercialization so that the feed back from the users can help in identifying hidden limitation of the work for improvement.

(i) Computer Training programs should be organized for Technical drawing teachers (who will in turn train the students) on regular basis.

There should be welfare package (special allowance) on a continuous basis for the technical teachers so as to encourage them in the discharge of their duties effectively.

(j) Further research work should be carried out to cover other areas of technical drawing such as Engineering drawing (Mechanical drawing and related technology)

(k) Finally, Experts in the various Fields of Technical Education including our Engineers should Emulate the examples of the scientists in carrying out more research in the development of appropriate had- ware / software for the teaching and learning of technical education in our various secondary schools, rather than relying on reproducing the existing hard wares.

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APPENDIX

T.D BASICS Computer Programs

```
Global nest As Integer
Global c As Integer

Public Sub dallow(frm As Form)
If frm.lbldetc.Caption > 3 Then
MsgBox (" You have made three trials without success. you should go and learn the
module again. Best of luck in your study"), vbInformation, "TDware Notification"
Stop
Else
Exit Sub
End If
Stop
End Sub

Sub LoadCommandImages(frm As Form)
'On Error Resume Next
'frm.CmdFirst.Picture = LoadPicture(App.Path & "\first.ico")
'frm.cmdLast.Picture = LoadPicture(App.Path & "\Last.ico")
frm.cmdPrev.Picture = LoadPicture(App.Path & "\first.ico")
frm.CmdNext.Picture = LoadPicture(App.Path & "\last.ico")
End Sub

Private Sub Command2_Click()
Unload Me
Me.Hide
frmod5.Show
End Sub


Private Sub Form_Load()
Me.Height = 5655
Me.Width = 5475
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
With cmb11
.AddItem "Points and lines"
.AddItem "Bisecting lines"
.AddItem "Construction of perpendicular lines"
.AddItem "Construction of parallel lines"
.AddItem "Dividing a line into a given number of part"
.AddItem "Angles and triangles"
.AddItem "Construction of angles"
.AddItem "Bisecting of angles"
.AddItem "Construction of triangles"
End With
End Sub

Private Sub Label2_Click()
frmply1.RTB.FileName = App.Path & "\2mode1\obj.rtf"
frmply1.Show
End Sub
```

```
Private Sub Command2_Click()
Unload Me
Me.Hide
frm21.Show
End Sub

Private Sub Form_Load()
Me.Height = 5655
Me.Width = 5475
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
With cmb11
.AddItem "Quaudrilaterals"
.AddItem "Polygons"
.AddItem "Area of figures"
.AddItem "Enlargement and reduction of plane figures"
End With
End Sub

Private Sub cmdnextm_Click()
Unload Me
frm24.Show
frmply3.Hide
Me.Hide
End Sub
Private Sub cmdtut_Click()
Unload Me
Unload frmass23
frmass23.Show
detc = 1
frmass23.lbldetc.Caption = detc
frmply3.Hide
Me.Hide
End Sub

Private Sub Label2_Click()
frmply3.RTB.FileName = App.Path & "\2mode3\obj.rtf"
frmply3.Show
End Sub


Private Sub cmb11_Click()
With cmb11
frmply4.RTB.Refresh
If cmb11.Text = "Ellipse" Then
frmply4.RTB.FileName = App.Path & "\2mode4\ellipse.rtf"
frmply4.framellipse.Visible = True
ElseIf cmb11.Text = "Parabola" Then
frmply4.RTB.FileName = App.Path & "\2mode4\parabola.rtf"
frmply4.frmpara.Visible = True
ElseIf cmb11.Text = "Hyperbola" Then
```

```
frmply4.RTB.FileName = App.Path & "\2mode4\hyperbola.rtf"
frmply4.framehyper.Visible = True
End If
End With
Me.Hide
frmply4.Show
End Sub

Private Sub cmdnextm_Click()
Unload Me
frm25.Show
frmply4.Hide
Me.Hide
End Sub
Private Sub cmdtut_Click()
Unload Me
Unload frmass24
frmass24.Show
detc = 1
frmass24.lbldetc.Caption = detc
frmply4.Hide
Me.Hide
End Sub


Private Sub Command1_Click()
frmply4.RTB.Refresh
frmply4.RTB.FileName = App.Path & "\2mode4\\conics.rtf"
frmply4.Show
End Sub


Private Sub Command2_Click()
Unload Me
Me.Hide
frm23.Show
End Sub

Private Sub Command3_Click()
Unload Me
Me.Hide
End Sub

Private Sub Form_Load()
Me.Height = 5655
Me.Width = 5475
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
With cmb11
 .AddItem "Ellipse"
```

```
.AddItem "Parabola"
.AddItem "Hyperbola"
End With
End Sub


Private Sub Label2_Click()
frmply4.RTB.Refresh
frmply4.RTB.FileName = App.Path & "\2mode4\\obj.rtf"
frmply4.Show
End Sub


Private Sub cmb11_Click()
With cmb11
frmply5.RTB.Refresh
If cmb11.Text = "Cycloid" Then
frmply5.RTB.FileName = App.Path & "\2mode5\cycloidcon.rtf"
ElseIf cmb11.Text = "Hypocycloid" Then
frmply5.RTB.FileName = App.Path & "\2mode5\hypocon.rtf"
ElseIf cmb11.Text = "Epycycloid" Then
frmply5.RTB.FileName = App.Path & "\2mode5\epycon.rtf"
ElseIf cmb11.Text = "Helix" Then
frmply5.RTB.FileName = App.Path & "\2mode6\helixcon.rtf"
'frmply5.CmdNext.Visible = True
ElseIf cmb11.Text = "Involute curves" Then
frmply5.RTB.FileName = App.Path & "\2mode5\cyinvolute.rtf"
frmply5.Command1.Visible = True: frmply5.Command2.Visible = True:
frmply5.Command3.Visible = True
ElseIf cmb11.Text = "Archimedian spiral" Then
frmply5.RTB.FileName = App.Path & "\2mode5\spiralcon.rtf"
ElseIf cmb11.Text = "Link mechanism" Then
frmply5.RTB.FileName = App.Path & "\2mode6\link.rtf"
frmply5.Command4.Visible = True: frmply5.Command5.Visible = True
End If
End With
Me.Hide
frmply5.Show
End Sub


Private Sub Command1_Click()
Unload Me
Me.Hide
End Sub

Private Sub Command2_Click()
Unload Me
Me.Hide
frm24.Show
```

```
End Sub


Private Sub Frame1_Click()
frmply5.RTB.Refresh
frmply5.RTB.FileName = App.Path & "\2mode5\The cycloid.rtf"
frmply5.Show
End Sub

Private Sub Label1_Click()
frmply5.RTB.Refresh
frmply5.RTB.FileName = App.Path & "\2mode5\The cycloid.rtf"
frmply5.Show
End Sub

Private Sub cmdnextm_Click()
Unload Me
frm26.Show
frmply5.Hide
Me.Hide
End Sub
Private Sub cmdtut_Click()
Unload Me
Unload frmass25
frmass25.Show
detc = 1
frmass25.lbldetc.Caption = detc
frmply5.Hide
Me.Hide
End Sub


Private Sub Form_Load()
Me.Height = 5655
Me.Width = 5475
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
With cmb11
.AddItem "Cycloid"
.AddItem "Hypocycloid"
.AddItem "Epicycloid"
.AddItem "Involute curves"
.AddItem "Archimedian spiral"
.AddItem "Helix"
.AddItem "Link mechanism"
End With
End Sub

Private Sub Label3_Click()
frmply5.RTB.Refresh
frmply5.RTB.FileName = App.Path & "\2mode5\obj.rtf"
```

```
frmply5.Show
End Sub


Private Sub cmb11_Click()
With cmb11
frmply6.RTB.Refresh
If cmb11.Text = "Square prism" Then
frmply6.RTB.FileName = App.Path & "\2mode7\devsquare.rtf"
ElseIf cmb11.Text = "Cylinder" Then
frmply6.RTB.FileName = App.Path & "\2mode7\devcylinder.rtf"
frmply6.CmdNext.Visible = True
'ElseIf cmb11.Text = "Oblique cylinder" Then
'frmply6.RTB.FileName = App.Path & "\2mode7\area.rtf"
ElseIf cmb11.Text = "Pyramid" Then
frmply6.RTB.FileName = App.Path & "\2mode7\devpyra.rtf"
ElseIf cmb11.Text = "Cone" Then
frmply6.RTB.FileName = App.Path & "\2mode7\conedev.rtf"
frmply6.Command1.Visible = True: frmply6.Command5.Visible = True
'ElseIf cmb11.Text = "Oblique cylinder" Then
'frmply6.RTB.FileName = App.Path & "\2mode7\area.rtf"
'ElseIf cmb11.Text = "Pyramid" Then
'frmply6.RTB.FileName = App.Path & "\2mode7\largered.rtf"
ElseIf cmb11.Text = "Triangulation" Then
frmply6.RTB.FileName = App.Path & "\2mode7\triangulation.rtf"
End If
End With
Me.Hide
frmply6.Show
End Sub

Private Sub cmdnextm_Click()
Unload Me
frm27.Show
frmply5.Hide
Me.Hide
End Sub

'Private Sub cmdnextm_Click()
'Unload Me
'frm22.Show
'frmply1.Hide
'Me.Hide
'End Sub
Private Sub cmdtut_Click()
Unload Me
Unload frmass26
frmass26.Show
detc = 1
frmass26.lbldetc.Caption = detc
```

```
frmply6.Hide
Me.Hide
End Sub

Private Sub Command1_Click()
frmply6.RTB.Refresh
frmply6.RTB.FileName = App.Path & "\2mode7\development.rtf"
frmply6.Show
End Sub

Private Sub Command2_Click()
Unload Me
Me.Hide
frm25.Show
End Sub

Private Sub Command3_Click()
Unload Me
Me.Hide
End Sub
Private Sub Form_Load()

Me.Height = 5655
Me.Width = 5475
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
With cmb11
.AddItem "Square prism"
.AddItem "Cylinder"
'.AddItem "Oblique cylinder"
.AddItem "Pyramid"
.AddItem "Cone"
'.AddItem "Truncated right cone"
'.AddItem "Oblique cone"
.AddItem "Triangulation"
End With
End Sub


Private Sub Label2_Click()
frmply6.RTB.Refresh
frmply6.RTB.FileName = App.Path & "\2mode6\obj.rtf"
frmply6.Show
End Sub

Private Sub cmdtut_Click()
MsgBox "No Tutorial"

End Sub

Private Sub Command1_Click()
```

```
frmply7.RTB.FileName = App.Path & "\2mode8\INTERSECTIONS.rtf"
frmply7.Show
Me.Hide
End Sub

Private Sub Command2_Click()
Unload Me
Me.Hide
frm26.Show
End Sub

Private Sub Command3_Click()
Unload Me
Me.Hide
End Sub

Private Sub Command4_Click()
Me.Hide
frmply7.RTB.FileName = App.Path & "\2mode8\inter.rtf"
frmply7.Show
End Sub

Private Sub Form_Load()
Me.Height = 3660
Me.Width = 4650
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2

End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 9345
Me.Width = 10530
'RTB.FileName = App.Path & "\activity193.rtf"
End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "C" Then
  Text1.Text = "c"
   Else
  Text1.Text = ""
End If
If UCase(Text2.Text) = "B" Then
    Text2.Text = "b"
   Else
  Text2.Text = ""
End If
If UCase(Text3.Text) = "A" Then
   Text3.Text = "a"
   Else
  Text3.Text = ""
```

```
End If
If UCase(Text4.Text) = "B" Then
    Text4.Text = "b"
   Else
  Text4.Text = ""
End If
If UCase(Text5.Text) = "A" Then
   Text5.Text = "a"
   Else
  Text5.Text = ""
End If
If UCase(Text6.Text) = "D" Then
   Text6.Text = "d"
   Else
  Text6.Text = ""
End If
If UCase(Text7.Text) = "C" Then
   Text7.Text = "c"
   Else
  Text7.Text = ""
End If
If UCase(Text8.Text) = "D" Then
    Text8.Text = "d"
   Else
  Text8.Text = ""
End If
If UCase(Text9.Text) = "A" Then
    Text9.Text = "a"
   Else
  Text9.Text = ""
End If
If UCase(Text10.Text) = "B" Then
   Text10.Text = "b"
   Else
  Text10.Text = ""
End If
If UCase(Text11.Text) = "A" Then
    Text11.Text = "a"
   Else
  Text11.Text = ""
End If
If UCase(Text12.Text) = "B" Then
    Text12.Text = "b"
   Else
  Text12.Text = ""
End If
If UCase(Text13.Text) = "B" Then
   Text13.Text = "b"
   Else
  Text13.Text = ""
```

```
End If
If UCase(Text14.Text) = "B" Then
    Text14.Text = "b"
    Else
  Text14.Text = ""
End If
If UCase(Text15.Text) = "A" Then
   Text15.Text = "a"
   Else
  Text15.Text = ""
End If
End Sub


Private Sub CmdNext_Click()
Me.Hide
FrmLessonOneModule3.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity22.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "D" Then
    a = 1
   Else
  a = 0
End If
If UCase(Text2.Text) = "D" Then
    b = 1
   Else
  b = 0
End If
If UCase(Text3.Text) = "D" Then
   c = 1
   Else
 c = 0
End If
If UCase(Text4.Text) = "A" Then
```

```
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "C" Then
    f = 1
   Else
  f = 0
End If
If UCase(Text6.Text) = "C" Then
   g = 1
   Else
  g = 0
End If
If UCase(Text7.Text) = "D" Then
    h = 1
   Else
  h = 0
End If
If UCase(Text8.Text) = "B" Then
    i = 1
   Else
  i = 0
End If
Tot = a + b + c + e + f + g + h + i
pec = (Tot / 8) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 12
Me.Hide
frmmsg.Show

End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "D" Then
   Text1.Text = "d"
   Else
  Text1.Text = ""
End If
If UCase(Text2.Text) = "D" Then
    Text2.Text = "d"
   Else
  Text2.Text = ""
End If
If UCase(Text3.Text) = "D" Then
  Text3.Text = "d"
   Else
  Text3.Text = ""
```

```
End If
If UCase(Text4.Text) = "A" Then
    Text4.Text = "a"
    Else
   Text4.Text = ""
End If
If UCase(Text5.Text) = "C" Then
      Text5.Text = "c"
    Else
   Text5.Text = ""
End If
If UCase(Text6.Text) = "C" Then
     Text6.Text = "c"
    Else
   Text6.Text = ""
End If
If UCase(Text7.Text) = "D" Then
      Text7.Text = "d"
    Else
   Text7.Text = ""
End If
If UCase(Text8.Text) = "B" Then
      Text8.Text = "b"
    Else
   Text8.Text = ""
End If
End Sub


Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 7230
Me.Width = 10875
'RTB.FileName = App.Path & "\assessment2.rtf"
End Sub


Private Sub CmdNext_Click()
Me.Hide

FrmLessonOneModule4.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity36.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
```

```
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed. You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "A" Then
    a = 1
   Else
  a = 0
End If
If UCase(Text2.Text) = "D" Then
    b = 1
   Else
  b = 0
End If
If UCase(Text3.Text) = "B" Then
   c = 1
   Else
 c = 0
End If
If UCase(Text4.Text) = "D" Then
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "A" Then
    f = 1
   Else
  f = 0
End If
If UCase(Text6.Text) = "D" Then
   g = 1
   Else
  g = 0
End If
If UCase(Text7.Text) = "B" Then
    h = 1
   Else
  h = 0
End If
If UCase(Text8.Text) = "D" Then
   i = 1
   Else
 i = 0
End If
If UCase(Text9.Text) = "C" Then
   j = 1
```

```
   Else
  j = 0
End If
If UCase(Text10.Text) = "C" Then
    k = 1
   Else
  k = 0
End If
If UCase(Text11.Text) = "A" Then
    l = 1
   Else
  l = 0
End If
If UCase(Text12.Text) = "D" Then
    m = 1
   Else
  m = 0
End If
If UCase(Text13.Text) = "D" Then
    n = 1
   Else
  n = 0
End If
If UCase(Text14.Text) = "A" Then
    p = 1
   Else
  p = 0
End If
Tot = a + b + c + e + f + g + h + i + j + k + l + m + n + p
pec = (Tot / 14) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 13
Me.Hide
frmmsg.Show
End Sub

Private Sub Command2_Click()
frmassup.RTB.Refresh
frmassup.RTB.FileName = App.Path & "\ass\\french.rtf"
frmassup.Show
End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
'RTB.FileName = App.Path & "\Assessment3.rtf"
End Sub
Sub checkwatdid()
```

```
If UCase(Text1.Text) = "A" Then
  Text1.Text = "a"
   Else
  Text1.Text = ""
End If
If UCase(Text2.Text) = "D" Then
    Text2.Text = "d"
   Else
  Text2.Text = ""
End If
If UCase(Text3.Text) = "B" Then
    Text3.Text = "b"
   Else
  Text3.Text = ""
End If
If UCase(Text4.Text) = "D" Then
    Text4.Text = "d"
   Else
  Text4.Text = ""
End If
If UCase(Text5.Text) = "A" Then
    Text5.Text = "a"
   Else
  Text5.Text = ""
End If
If UCase(Text6.Text) = "D" Then
    Text6.Text = "d"
   Else
  Text6.Text = ""
End If
If UCase(Text7.Text) = "B" Then
    Text7.Text = "b"
   Else
  Text7.Text = ""
End If
If UCase(Text8.Text) = "D" Then
    Text8.Text = "d"
   Else
  Text8.Text = ""
End If
If UCase(Text9.Text) = "C" Then
    Text9.Text = "c"
   Else
  Text9.Text = ""
End If
If UCase(Text10.Text) = "C" Then
    Text10.Text = "c"
   Else
  Text10.Text = ""
End If
```

```
If UCase(Text11.Text) = "A" Then
    Text11.Text = "a"
   Else
  Text11.Text = ""
End If
If UCase(Text12.Text) = "D" Then
    Text12.Text = "d"
   Else
  Text12.Text = ""
End If
If UCase(Text13.Text) = "D" Then
   Text13.Text = "d"
   Else
  Text13.Text = ""
End If
If UCase(Text14.Text) = "A" Then
    Text14.Text = "a"
   Else
  Text14.Text = ""
End If
End Sub


Private Sub CmdNext_Click()
Me.Hide

FrmLessonOneModule5.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity49.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"

End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "D" Then
    a = 1
   Else
  a = 0
End If
```

```
If UCase(Text2.Text) = "C" Then
    b = 1
   Else
  b = 0
End If
If UCase(Text3.Text) = "A" Then
   c = 1
   Else
 c = 0
End If
If UCase(Text4.Text) = "C" Then
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "D" Then
    f = 1
   Else
  f = 0
End If
If UCase(Text6.Text) = "B" Then
   g = 1
   Else
  g = 0
End If
If UCase(Text7.Text) = "D" Then
    h = 1
   Else
  h = 0
End If
If UCase(Text8.Text) = "D" Then
    i = 1
   Else
  i = 0
End If
If UCase(Text9.Text) = "B" Then
    j = 1
   Else
  j = 0
End If
If UCase(Text10.Text) = "C" Then
    k = 1
   Else
  k = 0
End If
If UCase(Text11.Text) = "B" Then
    l = 1
   Else
  l = 0
End If
```

```
If UCase(Text12.Text) = "C" Then
    m = 1
   Else
  m = 0
End If
If UCase(Text13.Text) = "C" Then
    n = 1
   Else
  n = 0
End If
If UCase(Text14.Text) = "B" Then
    p = 1
   Else
  p = 0
End If
If UCase(Text15.Text) = "A" Then
    q = 1
   Else
  q = 0
End If
If UCase(Text17.Text) = "A" Then
    r = 1
   Else
  r = 0
End If
Tot = a + b + c + e + f + g + h + i + j + k + l + m + n + p + q + r
pec = (Tot / 16) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 14
Me.Hide
frmmsg.Show
End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 10620
Me.Width = 10965
'RTB.FileName = App.Path & "\Assessment4.rtf"
End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "D" Then
   Text1.Text = "d"
    Else
   Text1.Text = ""
End If
If UCase(Text2.Text) = "C" Then
     Text2.Text = "c"
```

```
    Else
   Text2.Text = ""
End If
If UCase(Text3.Text) = "A" Then
    Text3.Text = "a"
    Else
   Text3.Text = ""
End If
If UCase(Text4.Text) = "C" Then
     Text4.Text = "c"
    Else
   Text4.Text = ""
End If
If UCase(Text5.Text) = "D" Then
    Text5.Text = "d"
    Else
   Text5.Text = ""
End If
If UCase(Text6.Text) = "B" Then
    Text6.Text = "b"
    Else
   Text6.Text = ""
End If
If UCase(Text7.Text) = "D" Then
    Text7.Text = "d"
    Else
   Text7.Text = ""
End If
If UCase(Text8.Text) = "D" Then
     Text8.Text = "d"
    Else
   Text8.Text = ""
End If
If UCase(Text9.Text) = "B" Then
     Text9.Text = "b"
    Else
   Text9.Text = ""
End If
If UCase(Text10.Text) = "C" Then
    Text10.Text = "c"
    Else
   Text10.Text = ""
End If
If UCase(Text11.Text) = "B" Then
     Text11.Text = "b"
    Else
   Text11.Text = ""
End If
If UCase(Text12.Text) = "C" Then
     Text12.Text = "c"
```

```
  Else
  Text12.Text = ""
 End If
 If UCase(Text13.Text) = "C" Then
   Text13.Text = "c"
   Else
  Text13.Text = ""
 End If
 If UCase(Text14.Text) = "B" Then
   Text14.Text = "b"
   Else
  Text14.Text = ""
 End If
 If UCase(Text15.Text) = "A" Then
   Text15.Text = "a"
   Else
  Text15.Text = ""
 End If
 If UCase(Text17.Text) = "A" Then
   Text17.Text = "a"
   Else
  Text17.Text = ""
 End If
 End Sub

Private Sub CmdNext_Click()
Me.Hide
FrmActivity196.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity193.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "B" Then
  a = 1
  Else
 a = 0
End If
```

```
If UCase(Text2.Text) = "C" Then
    b = 1
   Else
  b = 0
End If
If UCase(Text3.Text) = "B" Then
    c = 1
   Else
  c = 0
End If
If UCase(Text4.Text) = "B" Then
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "C" Then
    f = 1
   Else
  f = 0
End If
If UCase(Text6.Text) = "D" Then
    g = 1
   Else
  g = 0
End If
If UCase(Text7.Text) = "B" Then
    h = 1
   Else
  h = 0
End If
If UCase(Text8.Text) = "C" Then
    i = 1
   Else
  i = 0
End If
If UCase(Text9.Text) = "A" Then
    j = 1
   Else
  j = 0
End If
If UCase(Text10.Text) = "C" Then
    k = 1
   Else
  k = 0
End If
Tot = a + b + c + e + f + g + h + i + j + k
pec = (Tot / 10) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
```

```
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 15
Me.Hide
frmmsg.Show
End Sub

Private Sub Form_Load()
Me.Height = 8115
Me.Width = 10545
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
'RTB.FileName = App.Path & "\activity194.rtf"
End Sub

Sub checkwatdid()
If UCase(Text1.Text) = "B" Then
   Text1.Text = "b"
    Else
   Text1.Text = ""
End If
If UCase(Text2.Text) = "C" Then
     Text2.Text = "c"
    Else
   Text2.Text = ""
End If
If UCase(Text3.Text) = "B" Then
    Text3.Text = "b"
    Else
   Text3.Text = ""
End If
If UCase(Text4.Text) = "B" Then
     Text4.Text = "b"
    Else
   Text4.Text = ""
End If
If UCase(Text5.Text) = "C" Then
    Text5.Text = "c"
    Else
   Text5.Text = ""
End If
If UCase(Text6.Text) = "D" Then
    Text6.Text = "d"
    Else
   Text6.Text = ""
End If
If UCase(Text7.Text) = "B" Then
    Text7.Text = "b"
    Else
   Text7.Text = ""
End If
If UCase(Text8.Text) = "C" Then
```

```
    Text8.Text = "c"
   Else
  Text8.Text = ""
End If
If UCase(Text9.Text) = "A" Then
    Text9.Text = "a"
   Else
  Text9.Text = ""
End If
If UCase(Text10.Text) = "C" Then
    Text10.Text = "c"
   Else
  Text10.Text = ""
End If
End Sub

Private Sub CmdNext_Click()
Me.Hide
FrmActivity197.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity195.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "D" Then
    a = 1
   Else
  a = 0
End If
If UCase(Text2.Text) = "A" Then
    b = 1
   Else
  b = 0
End If
If UCase(Text3.Text) = "C" Then
    c = 1
   Else
  c = 0
```

```
End If
If UCase(Text4.Text) = "D" Then
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "C" Then
    f = 1
   Else
  f = 0
End If
If UCase(Text6.Text) = "B" Then
   g = 1
   Else
  g = 0
End If
Tot = a + b + c + e + f + g
pec = (Tot / 6) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 21
Me.Hide
frmmsg.Show
End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 5850
Me.Width = 10500
'RTB.FileName = App.Path & "\activity196.rtf"
End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "D" Then
   Text1.Text = "d"
   Else
  Text1.Text = ""
End If
If UCase(Text2.Text) = "A" Then
     Text2.Text = "a"
   Else
  Text2.Text = ""
End If
If UCase(Text3.Text) = "C" Then
    Text3.Text = "c"
   Else
  Text3.Text = ""
End If
If UCase(Text4.Text) = "D" Then
```

```
  Text4.Text = "d"
  Else
 Text4.Text = ""
End If
If UCase(Text5.Text) = "C" Then
  Text5.Text = "c"
  Else
 Text5.Text = ""
End If
If UCase(Text6.Text) = "B" Then
  Text6.Text = "b"
  Else
 Text6.Text = ""
End If
End Sub


Private Sub CmdNext_Click()
Me.Hide
FrmAssessment1.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity195.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "C" Then
   a = 1
  Else
 a = 0
End If
If UCase(Text2.Text) = "B" Then
   b = 1
  Else
 b = 0
End If
If UCase(Text3.Text) = "D" Then
  c = 1
  Else
```

```
  c = 0
 End If
 If UCase(Text4.Text) = "A" Then
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "D" Then
   f = 1
  Else
 f = 0
End If
If UCase(Text6.Text) = "D" Then
  g = 1
  Else
 g = 0
End If
Tot = a + b + c + e + f + g
pec = (Tot / 6) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 22
Me.Hide
frmmsg.Show
End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 6315
Me.Width = 10545
'RTB.FileName = App.Path & "\activity197.rtf"
End Sub

Sub checkwatdid()
If UCase(Text1.Text) = "C" Then
  Text1.Text = "c"
   Else
  Text1.Text = ""
End If
If UCase(Text2.Text) = "B" Then
    Text2.Text = "b"
   Else
  Text2.Text = ""
End If
If UCase(Text3.Text) = "D" Then
   Text3.Text = "d"
   Else
  Text3.Text = ""
```

```
End If
If UCase(Text4.Text) = "A" Then
    Text4.Text = "a"
   Else
  Text4.Text = ""
End If
If UCase(Text5.Text) = "D" Then
   Text5.Text = "d"
   Else
  Text5.Text = ""
End If
If UCase(Text6.Text) = "D" Then
   Text6.Text = "d"
   Else
  Text6.Text = ""
End If
End Sub

Private Sub CmdNext_Click()
Me.Hide
FrmActivity22.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmLessonOneModule2.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "C" Then
    a = 1
   Else
  a = 0
End If
If UCase(Text2.Text) = "B" Then
    b = 1
   Else
  b = 0
End If
If UCase(Text3.Text) = "B" Then
   c = 1
```

```
   Else
  c = 0
End If
If UCase(Text4.Text) = "B" Then
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "D" Then
    f = 1
   Else
  f = 0
End If
If UCase(Text6.Text) = "C" Then
   g = 1
   Else
  g = 0
End If
If UCase(Text7.Text) = "A" Then
    h = 1
   Else
  h = 0
End If
If UCase(Text8.Text) = "C" Then
    i = 1
   Else
  i = 0
End If
If UCase(Text9.Text) = "A" Then
    j = 1
   Else
  j = 0
End If
If UCase(Text10.Text) = "D" Then
    k = 1
   Else
  k = 0
End If
Tot = a + b + c + e + f + g + h + i + j + k
pec = (Tot / 10) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 23
Me.Hide
frmmsg.Show
End Sub

Private Sub Form_Load()
```

```
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 6315
Me.Width = 10545
'RTB.FileName = App.Path & "\activity21.rtf"
End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "C" Then
   Text1.Text = "c"
    Else
   Text1.Text = ""
End If
If UCase(Text2.Text) = "B" Then
    Text2.Text = "b"
    Else
   Text2.Text = ""
End If
If UCase(Text3.Text) = "B" Then
    Text3.Text = "b"
    Else
   Text3.Text = ""
End If
If UCase(Text4.Text) = "B" Then
    Text4.Text = "b"
    Else
   Text4.Text = ""
End If
If UCase(Text5.Text) = "D" Then
    Text5.Text = "d"
    Else
   Text5.Text = ""
End If
If UCase(Text6.Text) = "C" Then
    Text6.Text = "c"
    Else
   Text6.Text = ""
End If
If UCase(Text7.Text) = "A" Then
    Text7.Text = "a"
    Else
   Text7.Text = ""
End If
If UCase(Text8.Text) = "C" Then
    Text8.Text = "c"
    Else
   Text8.Text = ""
End If
If UCase(Text9.Text) = "A" Then
    Text9.Text = "a"
    Else
   Text9.Text = ""
```

```
End If
If UCase(Text10.Text) = "D" Then
    Text10.Text = "d"
    Else
   Text10.Text = ""
End If
End Sub

Private Sub CmdNext_Click()
Me.Hide
fRMASSESSMENT2.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity21.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "B" Then
     a = 1
    Else
   a = 0
End If
If UCase(Text2.Text) = "A" Then
     b = 1
    Else
   b = 0
End If
If UCase(Text3.Text) = "B" Then
    c = 1
    Else
  c = 0
End If
If UCase(Text4.Text) = "D" Then
     e = 1
    Else
   e = 0
End If
If UCase(Text5.Text) = "B" Then
     f = 1
```

```
  Else
  f = 0
End If
If UCase(Text6.Text) = "B" Then
  g = 1
  Else
  g = 0
End If
If UCase(Text7.Text) = "B" Then
   h = 1
  Else
  h = 0
End If
If UCase(Text8.Text) = "D" Then
   i = 1
  Else
  i = 0
End If
If UCase(Text9.Text) = "D" Then
   j = 1
  Else
  j = 0
End If
If UCase(Text10.Text) = "D" Then
   k = 1
  Else
  k = 0
End If
Tot = a + b + c + e + f + g + h + i + j + k
pec = (Tot / 10) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 24
Me.Hide
frmmsg.Show
End Sub

Private Sub Command2_Click()
frmassup24.RTB.Refresh
frmassup24.RTB.FileName = App.Path & "\ass\\2-4-3.rtf"
frmassup24.Show
End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "B" Then
  Text1.Text = "b"
   Else
  Text1.Text = ""
End If
```

```
If UCase(Text2.Text) = "A" Then
    Text2.Text = "a"
   Else
  Text2.Text = ""
End If
If UCase(Text3.Text) = "B" Then
   Text3.Text = "b"
   Else
  Text3.Text = ""
End If
If UCase(Text4.Text) = "D" Then
    Text4.Text = "d"
   Else
  Text4.Text = ""
End If
If UCase(Text5.Text) = "B" Then
   Text5.Text = "b"
   Else
  Text5.Text = ""
End If
If UCase(Text6.Text) = "B" Then
   Text6.Text = "b"
   Else
  Text6.Text = ""
End If
If UCase(Text7.Text) = "B" Then
   Text7.Text = "b"
   Else
  Text7.Text = ""
End If
If UCase(Text8.Text) = "D" Then
    Text8.Text = "d"
   Else
  Text8.Text = ""
End If
If UCase(Text9.Text) = "D" Then
    Text9.Text = "d"
   Else
  Text9.Text = ""
End If
If UCase(Text10.Text) = "D" Then
   Text10.Text = "d"
   Else
  Text10.Text = ""
End If
End Sub


Private Sub Command3_Click()
frmassup24.RTB.Refresh
```

```
frmassup24.RTB.FileName = App.Path & "\ass\\2-4-7.rtf"
frmassup24.Show
End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 11235
Me.Width = 10035
'Text1.SetFocus
'RTB.FileName = App.Path & "\activity22.rtf"
End Sub

Private Sub CmdNext_Click()
Me.Hide
FrmActivity34.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity31.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "B" Then
     a = 1
    Else
   a = 0
End If
If UCase(Text2.Text) = "D" Then
     b = 1
    Else
   b = 0
End If
If UCase(Text3.Text) = "D" Then
    c = 1
    Else
  c = 0
End If
If UCase(Text4.Text) = "C" Then
     e = 1
     Else
```

```
e = 0
End If
If UCase(Text5.Text) = "A" Then
   f = 1
  Else
 f = 0
End If
If UCase(Text6.Text) = "D" Then
   g = 1
  Else
 g = 0
End If
If UCase(Text7.Text) = "B" Then
   h = 1
  Else
 h = 0
End If
If UCase(Text8.Text) = "C" Then
   i = 1
  Else
 i = 0
End If
If UCase(Text9.Text) = "D" Then
   j = 1
  Else
 j = 0
End If
If UCase(Text10.Text) = "D" Then
   k = 1
  Else
 k = 0
End If
If UCase(Text11.Text) = "D" Then
   l = 1
  Else
 l = 0
End If
If UCase(Text12.Text) = "D" Then
   m = 1
  Else
 m = 0
End If
If UCase(Text13.Text) = "A" Then
   n = 1
  Else
 n = 0
End If
If UCase(Text14.Text) = "D" Then
   p = 1
  Else
```

```
  p = 0
End If
If UCase(Text15.Text) = "B" Then
    q = 1
   Else
  q = 0
End If
Tot = a + b + c + e + f + g + h + i + j + k + l + m + n + p + q
pec = (Tot / 15) * 100
pect = CInt(pec)
Text16.Text = pect
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 25
Me.Hide
frmmsg.Show
End Sub

Private Sub Command2_Click()
frmassup24.RTB.Refresh
frmassup24.RTB.FileName = App.Path & "\ass\\2-5-1.rtf"
frmassup24.Show
End Sub

Private Sub Command3_Click()
frmassup24.RTB.Refresh
frmassup24.RTB.FileName = App.Path & "\ass\\2-5-2.rtf"
frmassup24.Show
End Sub

Private Sub Command4_Click()
frmassup24.RTB.Refresh
frmassup24.RTB.FileName = App.Path & "\ass\\2-5-2.rtf"
frmassup24.Show
End Sub

Private Sub Command5_Click()
frmassup24.RTB.Refresh
frmassup24.RTB.FileName = App.Path & "\ass\\2-5-2.rtf"
frmassup24.Show
End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 11115
Me.Width = 10020
'RTB.FileName = App.Path & "\activity33.rtf"
End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "B" Then
```

```
Text1.Text = "b"
 Else
Text1.Text = ""
End If
If UCase(Text2.Text) = "D" Then
  Text2.Text = "d"
 Else
Text2.Text = ""
End If
If UCase(Text3.Text) = "D" Then
  Text3.Text = "d"
 Else
Text3.Text = ""
End If
If UCase(Text4.Text) = "C" Then
  Text4.Text = "c"
 Else
Text4.Text = ""
End If
If UCase(Text5.Text) = "A" Then
  Text5.Text = "a"
 Else
Text5.Text = ""
End If
If UCase(Text6.Text) = "D" Then
  Text6.Text = "d"
 Else
Text6.Text = ""
End If
If UCase(Text7.Text) = "B" Then
  Text7.Text = "b"
 Else
Text7.Text = ""
End If
If UCase(Text8.Text) = "C" Then
  Text8.Text = "c"
 Else
Text8.Text = ""
End If
If UCase(Text9.Text) = "D" Then
  Text9.Text = "d"
 Else
Text9.Text = ""
End If
If UCase(Text10.Text) = "D" Then
  Text10.Text = "d"
 Else
Text10.Text = ""
End If
If UCase(Text11.Text) = "D" Then
```

```
Text11.Text = "d"
Else
Text11.Text = ""
End If
If UCase(Text12.Text) = "D" Then
Text12.Text = "d"
Else
Text12.Text = ""
End If
If UCase(Text13.Text) = "A" Then
Text13.Text = "a"
Else
Text13.Text = ""
End If
If UCase(Text14.Text) = "D" Then
Text14.Text = "d"
Else
Text14.Text = ""
End If
If UCase(Text15.Text) = "B" Then
Text15.Text = "b"
Else
Text15.Text = ""
End If
End Sub

Private Sub CmdNext_Click()
Me.Hide
FrmActivity35.Show
End Sub

Private Sub cmdPrev_Click()
Me.Hide
FrmActivity33.Show
End Sub

Private Sub cmdswme_Click()
checkwatdid
cmdswme.Visible = False
MsgBox (" The question(s) whom/whose answer box are empty are those you missed.
You should try and attempt them again.") ', vbInformation, "TDware Notification"
End Sub

Private Sub Command1_Click()
detcc = lbldetc.Caption
frmmsg.lbldetc.Caption = detcc
If UCase(Text1.Text) = "C" Then
a = 1
Else
a = 0
```

```
End If
If UCase(Text2.Text) = "A" Then
    b = 1
   Else
  b = 0
End If
If UCase(Text3.Text) = "B" Then
   c = 1
   Else
 c = 0
End If
If UCase(Text4.Text) = "C" Then
    e = 1
   Else
  e = 0
End If
If UCase(Text5.Text) = "D" Then
    f = 1
   Else
  f = 0
End If
If UCase(Text6.Text) = "C" Then
   g = 1
   Else
  g = 0
End If
If UCase(Text7.Text) = "A" Then
    h = 1
   Else
  h = 0
End If
If UCase(Text8.Text) = "B" Then
    i = 1
   Else
  i = 0
End If
If UCase(Text9.Text) = "C" Then
    j = 1
   Else
  j = 0
End If
If UCase(Text10.Text) = "C" Then
    k = 1
   Else
  k = 0
End If
Tot = a + b + c + e + f + g + h + i + j + k
pec = (Tot / 10) * 100
pect = CInt(pec)
Text16.Text = pect
```

```
Unload Me
frmmsg.Text16 = pect & "%"
frmmsg.lbltest.Caption = 26
Me.Hide
frmmsg.Show
End Sub

Private Sub Form_Load()
Me.Move (Screen.Width - Me.Width) / 2, (Screen.Height - Me.Height) / 2
Me.Height = 9285
Me.Width = 10035
'RTB.FileName = App.Path & "\activity34.rtf"
End Sub
Sub checkwatdid()
If UCase(Text1.Text) = "C" Then
   Text1.Text = "c"
    Else
   Text1.Text = ""
End If
If UCase(Text2.Text) = "A" Then
     Text2.Text = "a"
    Else
   Text2.Text = ""
End If
If UCase(Text3.Text) = "B" Then
    Text3.Text = "b"
    Else
   Text3.Text = ""
End If
If UCase(Text4.Text) = "C" Then
     Text4.Text = "c"
    Else
   Text4.Text = ""
End If
If UCase(Text5.Text) = "D" Then
     Text5.Text = "d"
     Else
    Text5.Text = ""
 End If
 If UCase(Text6.Text) = "C" Then
     Text6.Text = "c"
     Else
    Text6.Text = ""
 End If
 If UCase(Text7.Text) = "A" Then
     Text7.Text = "a"
     Else
    Text7.Text = ""
 End If
 If UCase(Text8.Text) = "B" Then
```

```
    Text8.Text = "b"
   Else
  Text8.Text = ""
End If
If UCase(Text9.Text) = "C" Then
    Text9.Text = "c"
   Else
  Text9.Text = ""
End If
If UCase(Text10.Text) = "C" Then
   Text10.Text = "c"
   Else
  Text10.Text = ""
End If
End Sub
```