PROTOTYPE

NCDC
NATIONAL CURRICULUM DEVELOPMENT CENTRE

# TECHNOLOGY AND DESIGN TEXTBOOK

## SENIOR ONE

LOWER SECONDARY CURRICULUM

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# TECHNOLOGY AND DESIGN TEXTBOOK

## SENIOR ONE

LOWER SECONDARY CURRICULUM

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This material has been developed as a prototype for implementation of the revised Lower Secondary Curriculum and as a support for other textbook development interests.



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# Contents

# Preface

This *Technology and Design*, *Learner's Textbook* has been written following the new syllabus. The knowledge, skills and values required to produce a learner competent to solve emerging community problems in the 21st century world of work have been incorporated in this book. To do this, a range of real-life community problem-solving activities have been developed and incorporated. These are set to be conducted within the school environment, both in and outside the classroom setting.

The activities have been developed in a way that the learner will work individually and also collaboratively. This will build his/her generic skills and prepare him/her to work in any environment.

The content of this book guides the learner to solve a range of technical problems that are electrical, environmental, construction-related, mechanical and agricultural.

Therefore, this book will be able to guide the learner to understand the content in the *Technology and Design* syllabus and acquire the knowledge and skills developed therein.

**Associate Professor Betty Ezati**

Chairperson, NCDC Governing Council

# Acknowledgements

National Curriculum Development Centre (NCDC) would like to express its appreciation to all those who worked tirelessly towards the production of this *Learner's Book.*

Our gratitude goes to the various institutions which provided staff who worked as a panel, the Subject Specialist who initiated the work and the Production Unit at NCDC which ensured that the work produced meets the required standards. Our thanks go to ***Enabel*** which provided technical support in textbook development.

The Centre is indebted to the learners and teachers who worked with the NCDC Specialist and consultants from Cambridge Education and Curriculum Foundation.

Last but not least, NCDC would like to acknowledge all those behind the scenes who formed part of the team that worked hard to finalise the work on this Learner's Book.

NCDC is strives at upholding the standards, ethics and values of publishing. In developing this material, several sources have been referred to which we might not fully acknowledge.

We welcome any suggestions for improvement to continue making our service delivery better. Please get to us through P. O. Box 7002 Kampala or email us through admin@ncdc.go.ug.

**Grace K. Baguma**

Director, National Curriculum Development Centre

# Introduction

*Technology and Design* curriculum aims to develop creative activities where its graduates interact with their environment to bring about change in response to societal needs, wants and opportunities. This book is prepared for learners of Senior One, based on the need to champion the concept of creative learning.

The learning experience is segmented and planned to unfold in three complimentary domains of Design Appreciation, Design & Drawing, and Technology in the making.

i) Design Appreciation is intended to give the learner knowledge on the basic principles of design and to arouse his/her interest in design.

ii) Design & Drawing equips the learner with the basic procedures of communicating design ideas through drawing.

iii) Technology in the making enables the learner to put into action the generated and communicated ideas.

These learning domains are intended to inspire the learner to design in different areas of speciality.

The learning domains are meant to develop the cognitive and vocational skills of the learner to match the 21st century values of critical thinking and problem-solving, creativity, collaboration and communication.

## Aims and Objectives

Technology and Design intends to enable the learner:

i) acquire basic knowledge on design.
ii) practise basic, creative techniques.
iii) appreciate his/her immediate environment as a source of materials for production of engineering articles.
iv) acquire skills of proper use of tools, equipment and materials.
v) comprehend works of the made world.
vi) be aware of different roles, functions, audiences and consumers of design products.
vii) relate the usefulness of design in other subject areas.
viii) identify, research and produce personal technology and design works and projects; develop interest for future vocation in technology and design for self and national development.

# Technology and Design Themes

## Theme One: Design Application

The learner will develop knowledge and skills by:

i) demonstrating ability to analyse the community needs regarding design of a particular resource/facility and the correct use of tools and materials.

ii) making appropriate design decisions.

iii) using exploration/experimentation, reflection and revision when producing a variety of models or mock-ups

## Theme Two: Design and Drawing

The learner will develop knowledge and skills by:

i) examining the basic items of engineering design equipment and also using them.

ii) using basic drawing equipment and properly lay out drawing paper.

iii) identifying common shapes and their features as used in design.

iv) constructing different shapes used in design and making models/mock-ups of shapes used in design.

## Theme Three: Technology in the Making

The learner will develop knowledge, skills and good attitude by:

i) observing and applying health and safety rules associated with the use of materials, tools, and machines in design while making a product in a workplace, and show responsibility in terms of respect for the environment.

ii) demonstrating how to give first aid in relation to accidents on different parts of the body.

iii) analysing how the production of different designs can affect the environment

iv) applying environmentally responsible practices.

# Chapter 1: Introduction to Design

**Key Words**

- design
- technology
- appreciation
- design function
- elements of design
- principles of design
- design features
- environmental awareness
- sustainable material use
- production
- after-use disposal
- societal and cultural influences

**You will need:**

1. notebook, pencil, pens
2. engineering articles
3. colours
4. drawing instruments

After studying this chapter and practising its activities, you should be able to:

1. develop appreciation of function in the design world.
2. use basic elements and principles of design.
3. demonstrate awareness of environmental considerations related to sustainable material use, production methods and after-use disposal.

## Introduction

This chapter introduces you to the basic concepts of technology and design. The concepts include design features, elements, principles and materials required.

Studying this chapter will enable you to appreciate the usefulness of technology and design in your environment. This will give you knowledge why many structures in your environment are constructed in different shapes, designs and orientation.

This section will further guide you in analysing the environmental, cultural and social influences on technology and design.

## Activity 1: Familiarising with design terminologies and aspects

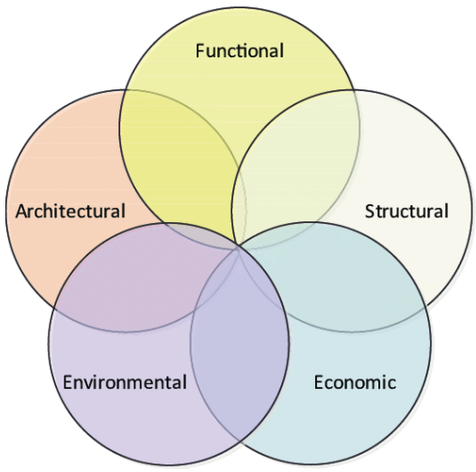
1.1 In smaller groups, brainstorm the meaning of the following terms: design, technology, design technology, design aspects/features, design elements and design principles, sustainability, environmental conservation.

1.2 Identify the objects that require design in your environment.

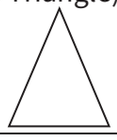
1.3 Choose one of the identified object and create a chart to relate/explain the design features/aspects with their functions in the environment, example: a cup.

| S/N | Feature | Function |
|---|---|---|
| | Handle | Accommodates the fingers to hold the cup |
| | Body | Contains the contents of the cup |
| | Base | Supports the cup to rest on a surface |
| | Mouth | Lets out contents of the cup |

1.4 Collaborate with your classmates and discuss the design principles in your immediate environment, example: functional: the purpose to which the design is made, or the problem to be solved by the design.




1.5 Identify and state the role of the basic design elements, example: lines, shapes.

| **Design element** | **Role** |
|---|---|
| Line ———— | Defines the boundary of a design. |
| Shape (e.g. Triangle)  | Specifies the particular form of outline of a design. |

1.6 In pairs, identify and describe the different materials used in design and state their sources, example: wood.

| **Material** | **Description** | **Source** |
|---|---|---|
| Wood | A hard fibrous material from the main substance of the trunk or branches of a plant. | 1. Trees<br>2. Shrubs |
| | | |
| | | |

1.7 State the reasons for the different choices of materials in design, example: wood. The material is:

i) readily available
ii) less costly
iii) ease to work
iv) warm to touch
v) strong in structural form
vi) rigid in structural application
vii) light in weight
viii) resistant to wear
ix) good in texture
x) bright in appearance

1.8 Explain the cultural/societal influences on design in relation to the different materials, example: wood. Some cultures like the Karamojong prefer wood for their stools as compared to other materials.

1.9 Suggest practices that promote continuous availability of the different design materials for example, wood materials.

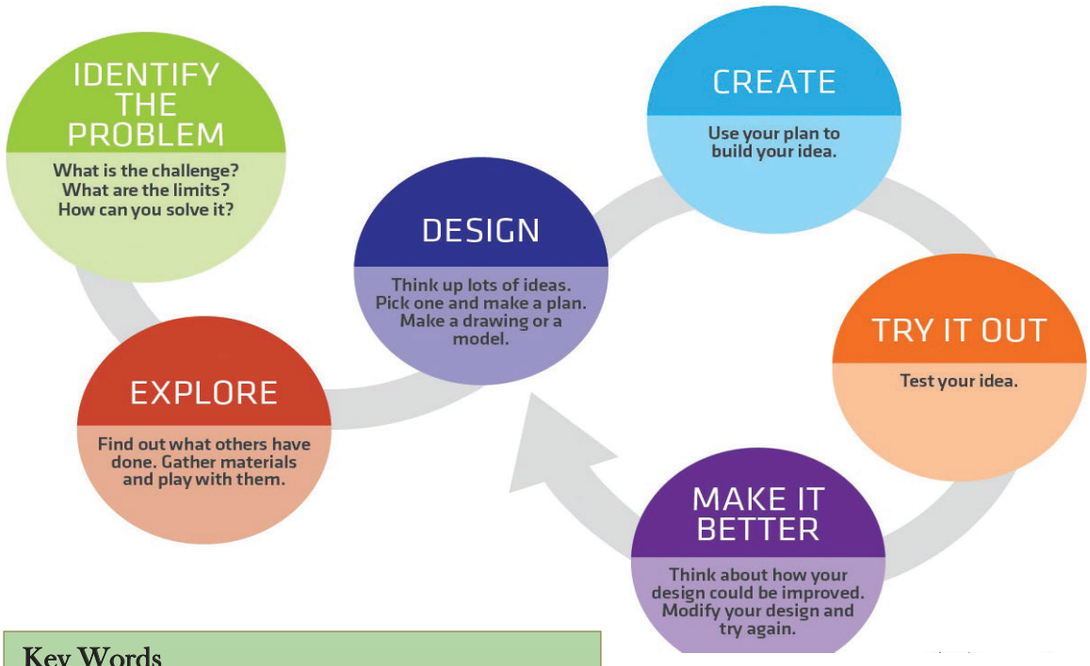
i) Continuous afforestation and reforestation
ii) Planting fast growing timber lot trees
iii) Recycling waste into reusable forms of wood
iv) Adopting modern cost effective methods of wood conversion

1.10 In groups, suggest the safe environmental practices of different design materials listed in (6) above: for example, wood.

i) Promoting afforestation and reforestation
ii) Adopting clean energy cooking technologies
iii) Recycling all waste wood
iv) Substituting wood with other materials where possible
v) Combining or and reinforcing wood with other materials to limit its use.
vi) Adopting and promoting natural methods of wood preservation.

1.11 Write individual reports indicating the key points learnt in this chapter.

# Chapter 2: The Design Process




**Key Words**

- design
- design process
- design need
- facility
- resource
- design brief
- design factor
- design idea
- design specifications
- sketch
- investigation
- model/mock-up
- suitability

**You will need:**

1. notebook, pencil, pens
2. engineering articles
3. sample models
4. colours
5. drawing instruments
6. essential tools
7. materials from the environment

At the end of this chapter and after practising its activities, you should be able to:

1. identify the community needs to design a particular resource/facility (e.g. bus shelter, library, water station, market, recycling centre).
2. make appropriate design decisions.
3. use exploration/experimentation, reflection and revision when producing a variety of models or mock-ups.

## Introduction

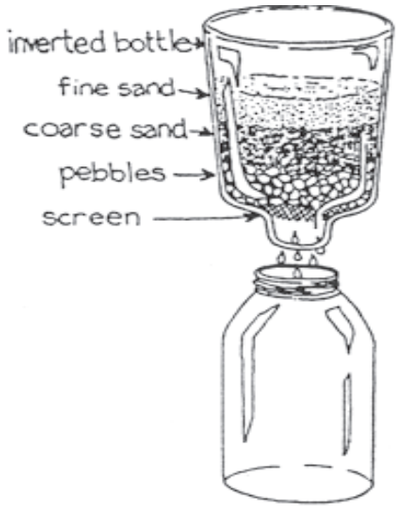
This chapter introduces you to the basic design techniques required to generate ideas and actions necessary to satisfy identified community need(s). You will be able to use the essential tools and materials to design and produce the article(s) required to solve community challenges.

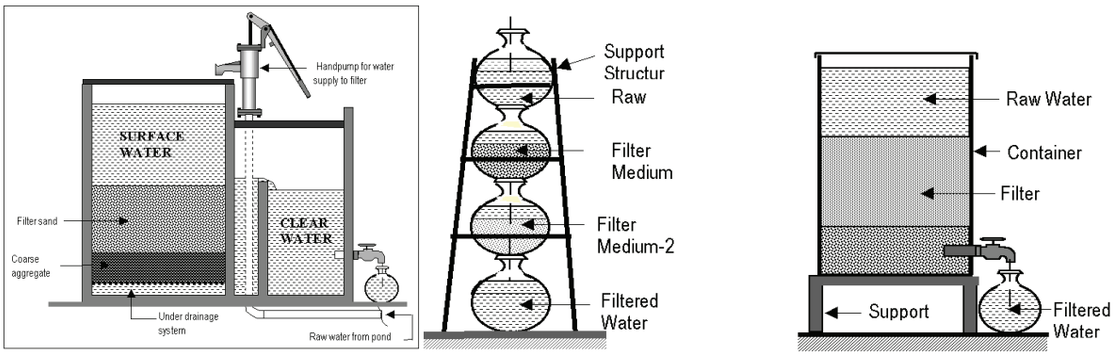
## Activity 2: Practising the design process

2.1 In groups:

a. identify the challenges in your community; for example, poor accommodation, lack of safe drinking water.
b. select the most pressing challenge; for example, lack of safe drinking water.

c. identify and illustrate with neat sketches the possible solutions required to solve the pressing challenge; for example, sand water purifying equipment/facility to provide the community with safe drinking water, or a shadoof.




d. choose one solution from the ones identified in 2.1(c) above and explain the factors that affect the design of the solution you have chosen, putting into consideration the community needs.

**Choosing the sand water purifying equipment/facility**

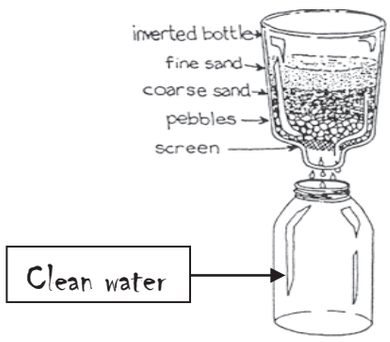
Factors that influence the design are:

- Cost of construction
- Availability of materials
- Ease with which to make
- Maintenance costs
- Reliability technology
- Durability
- Size of community
- Filter

e. Write individual report to state the components and materials required to make the equipment identified in 2.1(c), such as:

- Purifying container
- Water collection container
- Sands (fine and coarse)
- Pebbles
- Loam and clay soil
- Water pump

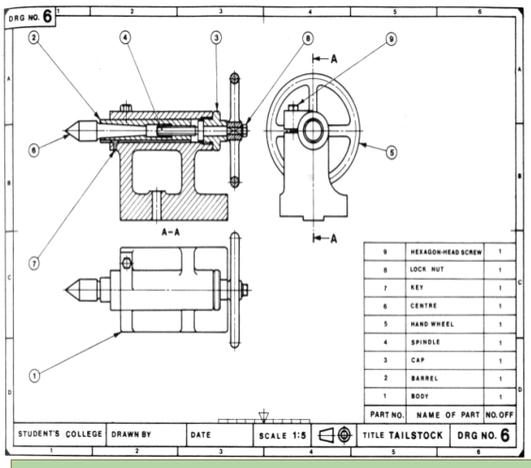
f. Individually, make a prototype (model) of the technology and write a report evaluating the model against design specifications.

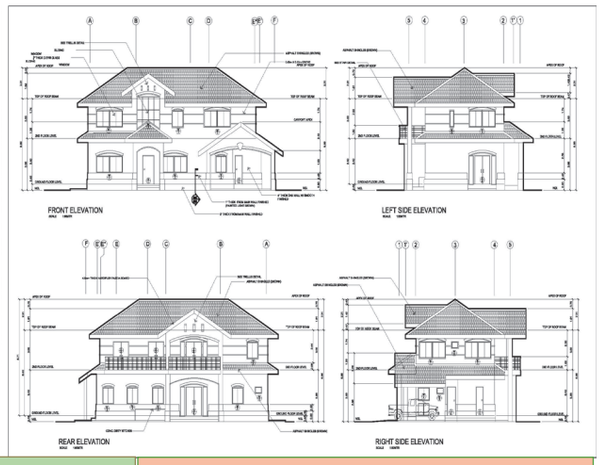



g. Individually, identify any improvements that can be added to the model for proper functioning, such as:
   - Larger purification container
   - Large clean water collection container
   - Clean water outlet
   - Row water supply pump

h. Individually, use the model to test ideas in the design brief; for example, obtain clean water from the model test.

# Chapter 3: Introduction to Drawing




**Key Words**

- drawing
- engineering drawing
- engineering design
- drawing equipment
- drawing techniques
- lines
- primary angles
- secondary angles
- paper layout

**You will need:**

1. notebook, drawing pencils (HB, 2H), pens
2. drawing equipment
3. drawing set
4. engineering articles

After practising activities in this chapter, you should be able to:

1. use basic drawing equipment and properly lay out drawing paper.
2. use lines to construct primary and secondary angles.

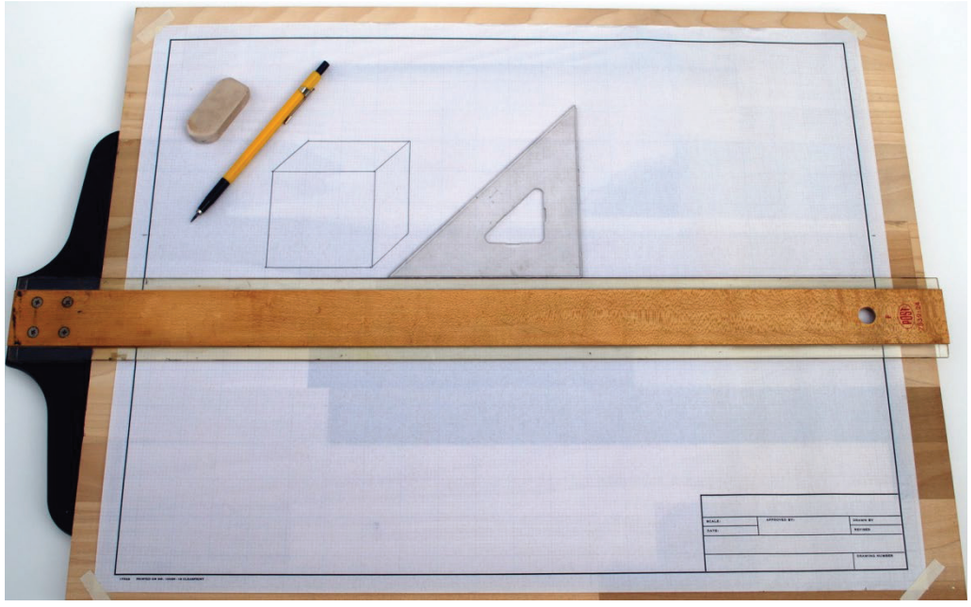
## Introduction

This chapter introduces you to the basic drawing equipment and techniques for engineering design. After studying this chapter, you will be able to use the essential equipment and materials to layout drawing paper and graphically produce different engineering article(s).

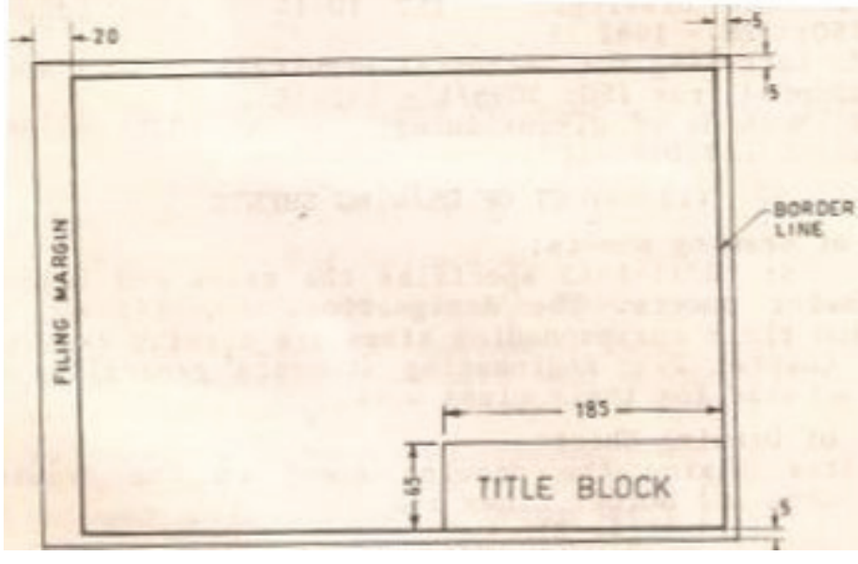
## Activity 3: Familiarising with drawing equipment and basic concepts of drawing

3.1 In groups:

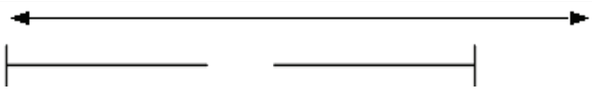
a. brainstorm and list the different drawing instruments. I.E Drawing board, TEE-square.
b. practise the techniques of using the listed instruments in (a) above.



c. lay out the drawing paper to include the title block.

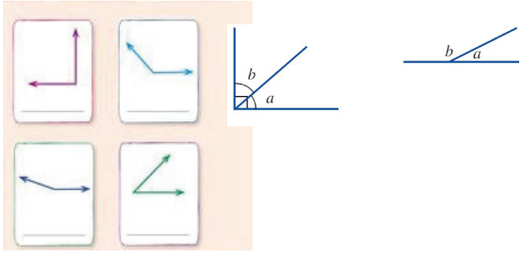



d. brainstorm the different types of lines used in engineering drawing; for example, dimension line, construction line etc.

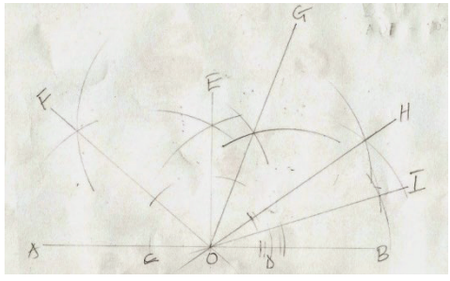
| S/N | Type of line | Illustration |
|---|---|---|
| 1. | Dimension lines (Thin) |  |
| 2. | Construction line (Thin) |  |
| | | |

e. Individually, produce a drawing to illustrate the application of different types of lines.

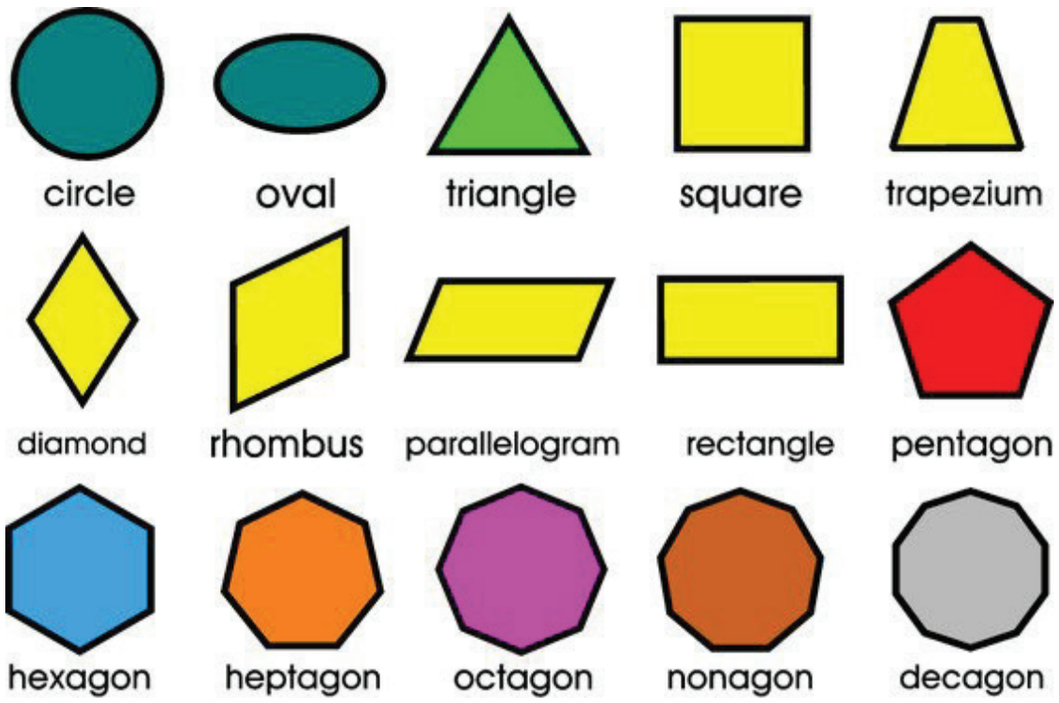
f. discuss the different types of angles, including:
   i) Primary angles
   ii) Secondary angles
   iii) Complementary angles
   iv) Supplementary angles




g. Individually, construct the following angles:
   i) Primary angles
   ii) Secondary angles



# Chapter 4: Basic Shapes




**Key Words**

- shapes
- features
- quadrilaterals
- polygons
- circles
- triangles
- models/mock-ups

**You will need:**

1. notebook, drawing pencils (HB, 2H) and pens
2. drawing equipment
3. drawing set
4. engineering articles

After practising activities in this chapter, you will be able to:

1. appreciate common shapes and their features as used in design (k, u).
2. construct different shapes used in design.
3. make models/mock-ups of shapes used in design.

## Introduction

This chapter will introduce you to the basic geometrical shapes and their application in design. After studying this chapter, you will be able to use the shapes to design and make models.

## Activity 4: Practising the application of basic shapes

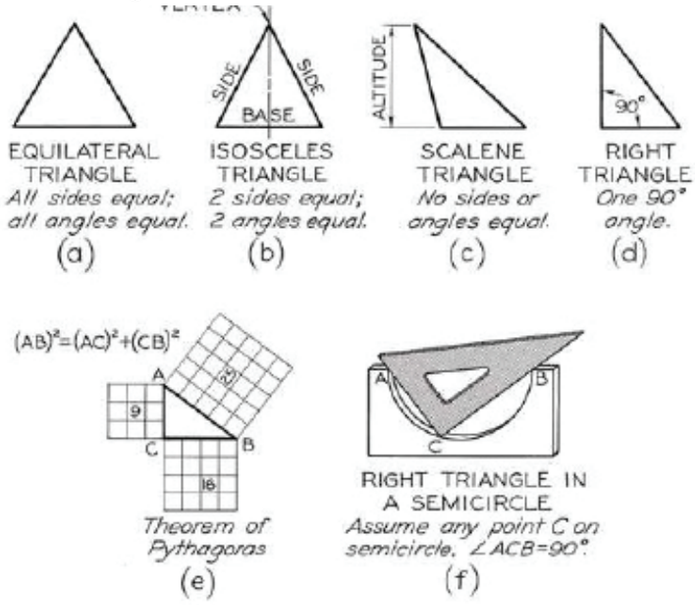
4.1 In groups:

a. discuss the basic geometrical shapes used in design.
b. discuss the different types of triangles.

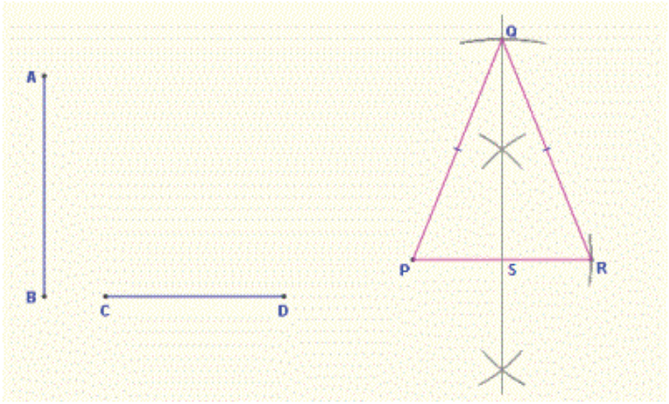
A triangle is a plane figure bounded by three straight sides.

The sum of the interior angles is always

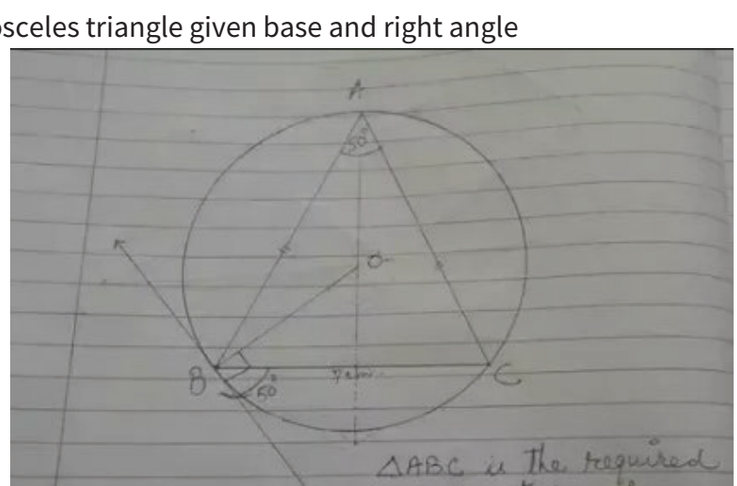
Any triangle inscribed in a semicircle is a right triangle if the hypotenuse coincides with the diameter.




c. Individually, practise drawing of triangles.
   i) Given Base and Altitude

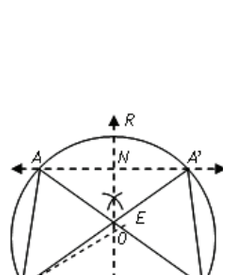


ii) Isosceles triangle given base and right angle

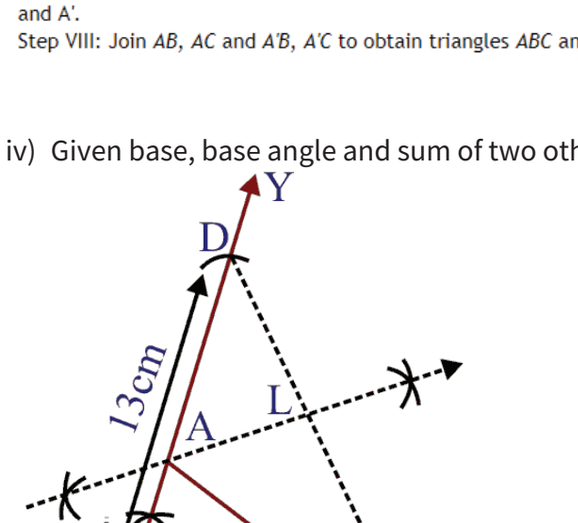



iii) Given base, vertical angle and altitude

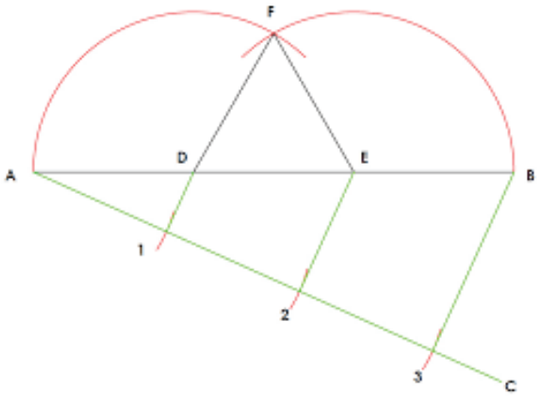
Step I: Draw a line segment equal to the base *BC* (say).
Step II: Below BC, make an ∠*CBP* at *B* equal to the vertical angle of the triangle.
Step III: Draw a line *BE*⊥ *BP* at the point *B*.
Step IV: Draw the right bisector *QR* of *BC* meeting line *BE* at *O* and *BC* at *M*.
Step V: With *O* as centre and *OB* as radius draw a circle.
Step VI: Take a point *N* on *QR* such that *MN* is equal to the altitude of the triangle.
Step VII: Draw a line parallel to *BC* through point *N*, intersecting circle drawn in step V at *A* and A'.
Step VIII: Join *AB*, *AC* and *A'B*, *A'C* to obtain triangles *ABC* and *A'BC* as the required triangles.

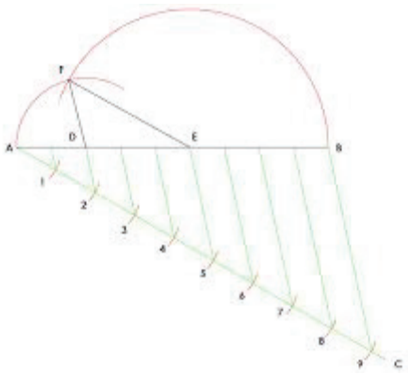



iv) Given base, base angle and sum of two other sides

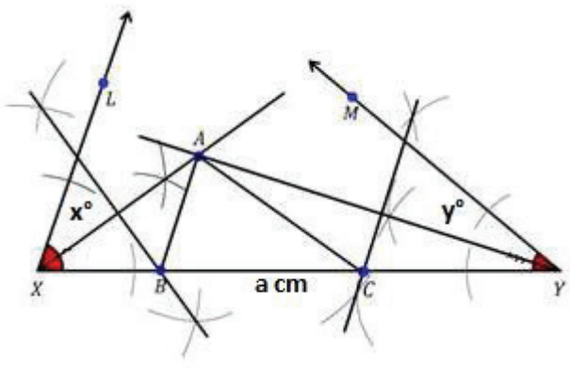



v) Given the perimeter and ration of sides as 2:3:4

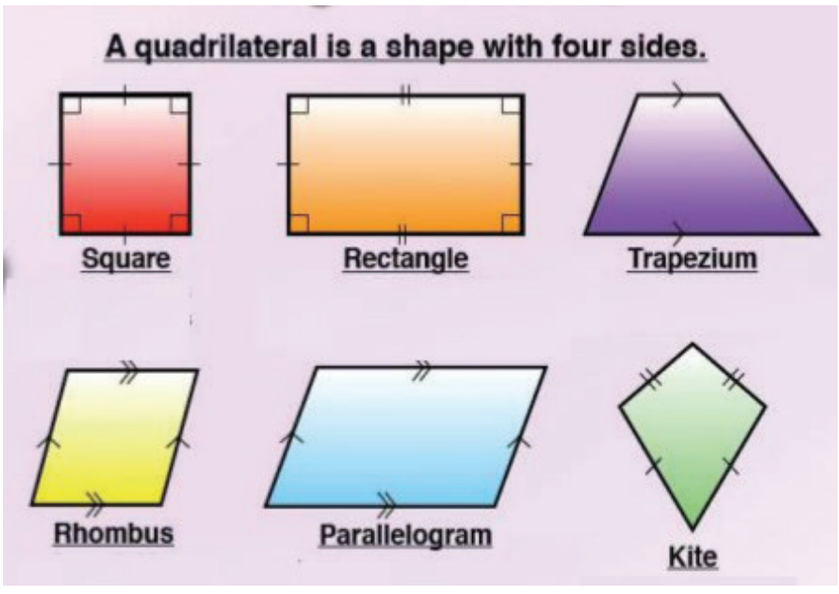


vi) Given perimeter and two base angles

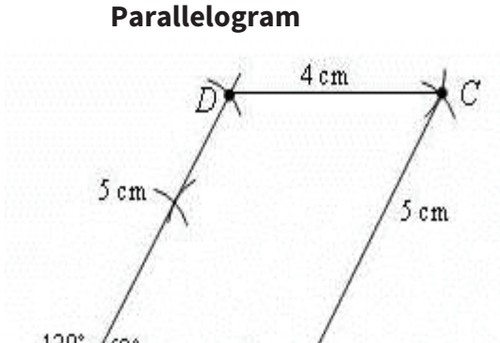



d. In groups, discuss the different types of quadrilaterals.

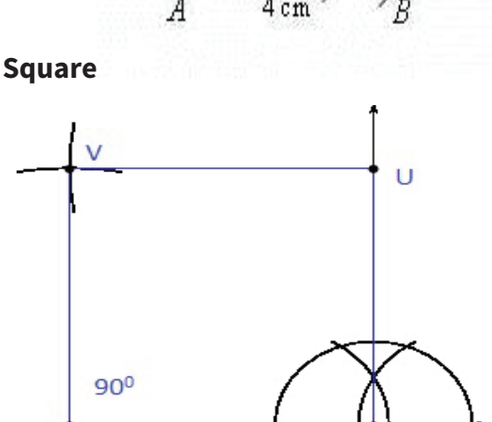


e. Individually, practise construction of different types of quadrilaterals.

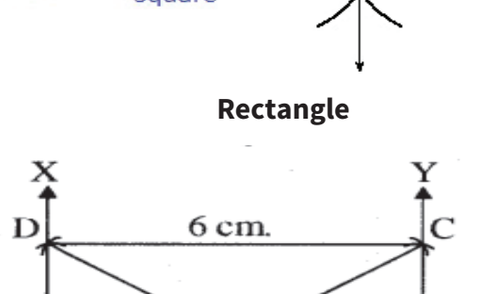
**Parallelogram**



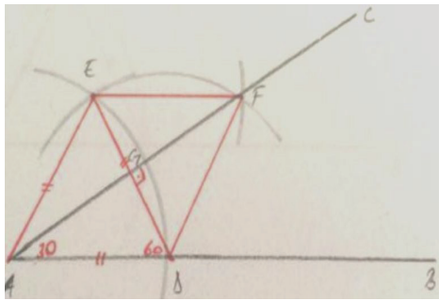

**Square**



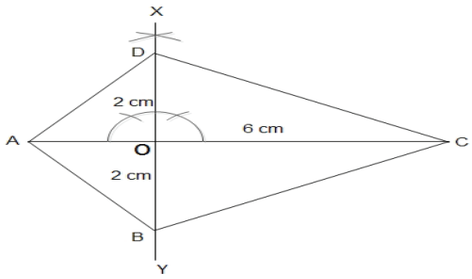

**Rectangle**



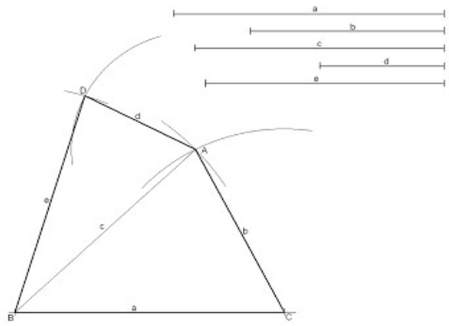
**Rhombus**



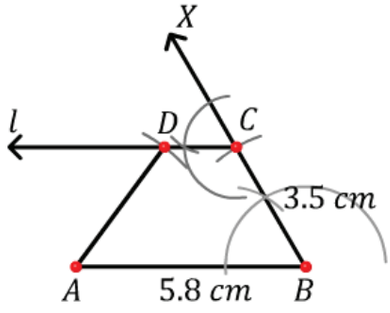

**Kite/Trapezion**



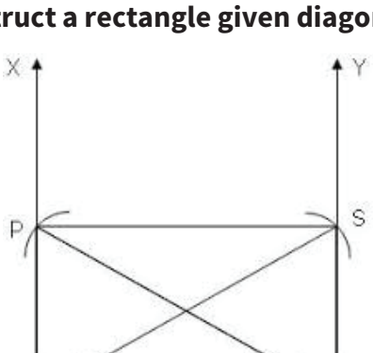

**Trapezoid**



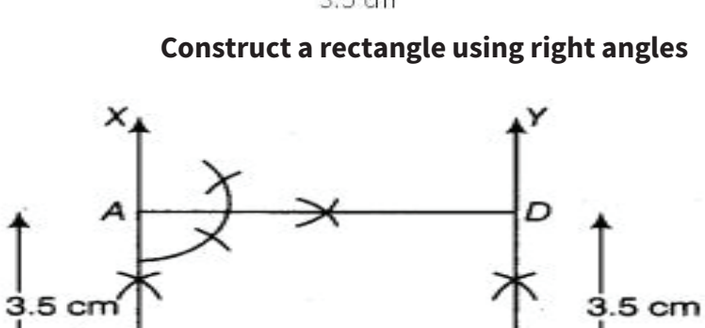
**Trapezium**



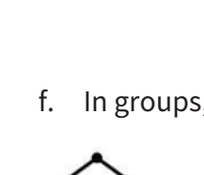
**Construct a rectangle given diagonal and one side**



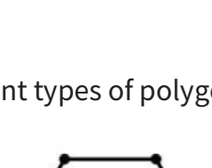

**Construct a rectangle using right angles**



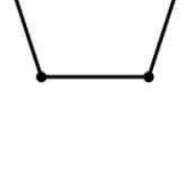

f. In groups, discuss the different types of polygons.



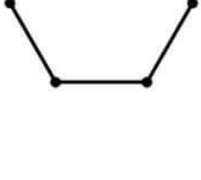
regular pentagon
sum of angles = 540°
each angle
= 540/5 = 108°



regular hexagon
sum of angles = 720°
each angle
= 720/6 = 120°



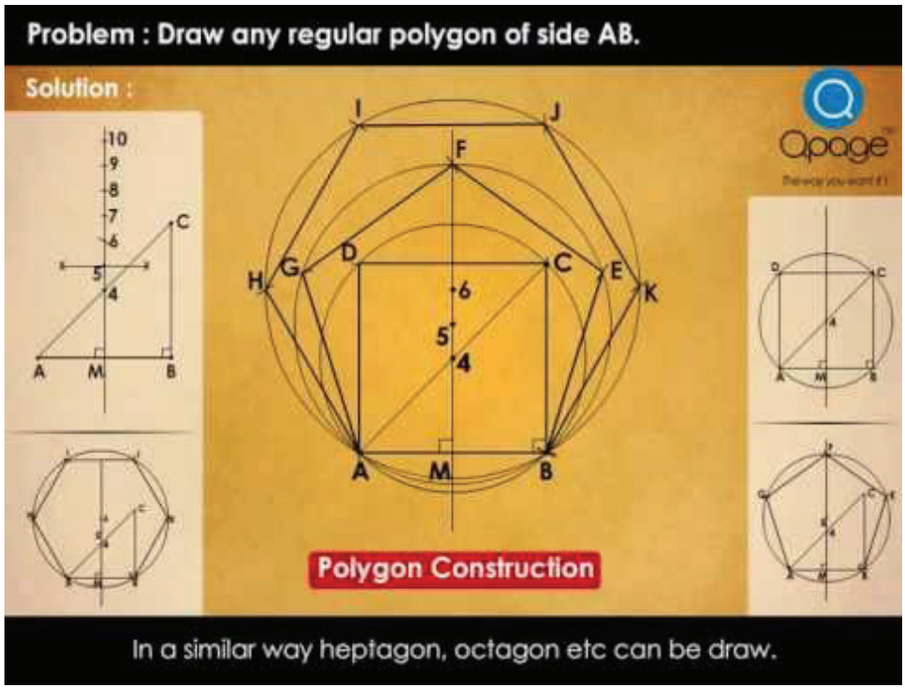
regular octagon
sum of angles = 1080°
each angle
= 1080/8 = 135°



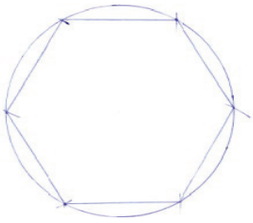
regular decagon
sum of angles = 1440°
each angle
= 1440/10 = 144°

g. Individually, practise the construction of different types of polygons.

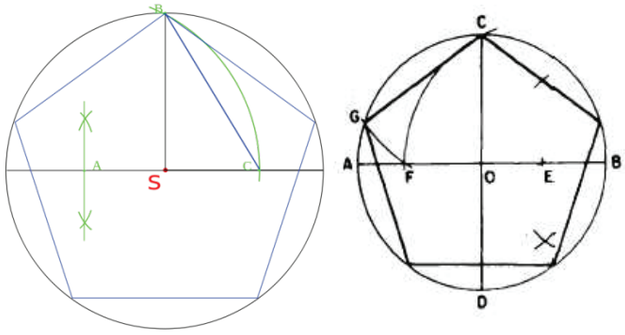
i) Regular polygons given one side



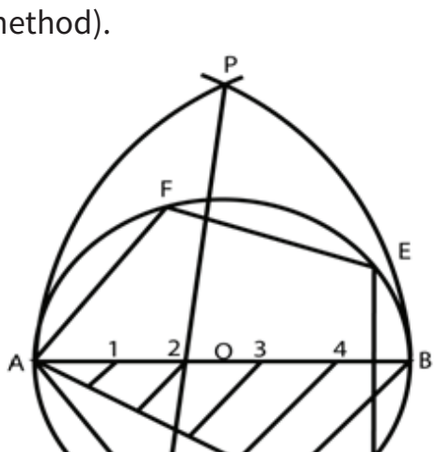

ii) Hexagon given length of one side/radius of the circle



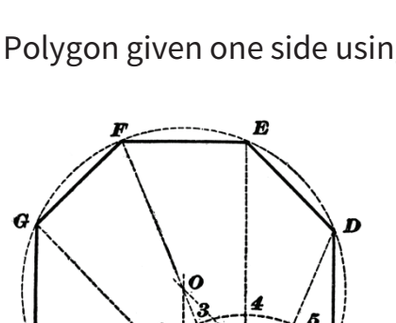
iii) Pentagon given diameter of the circumscribing circle



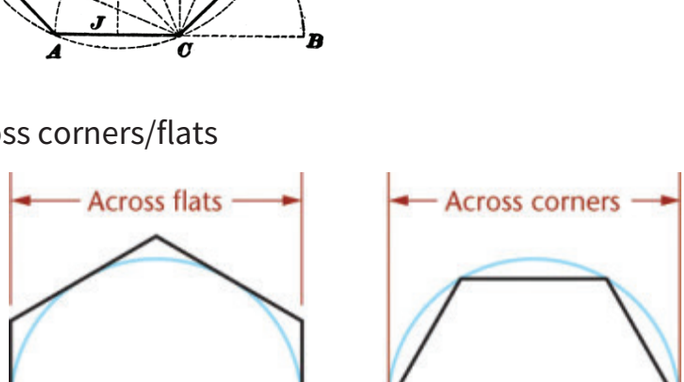
iv) Regular polygons given diameter of the circumscribing circle (General method).



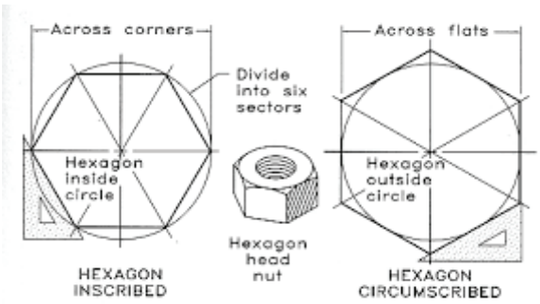

v) Polygon given one side using semi-circle method



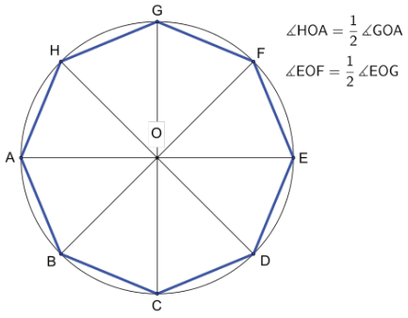

vi) Across corners/flats



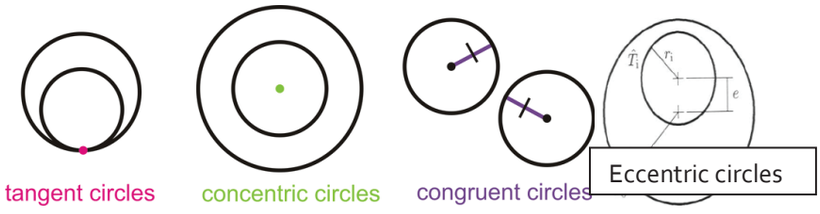
**Hexagon across corners/flats**

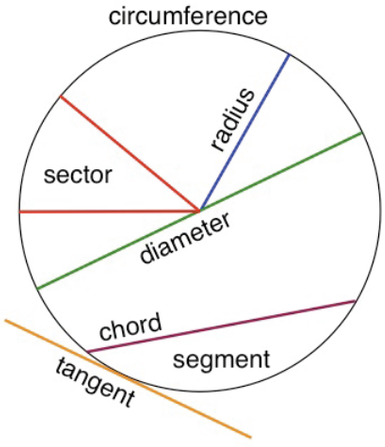


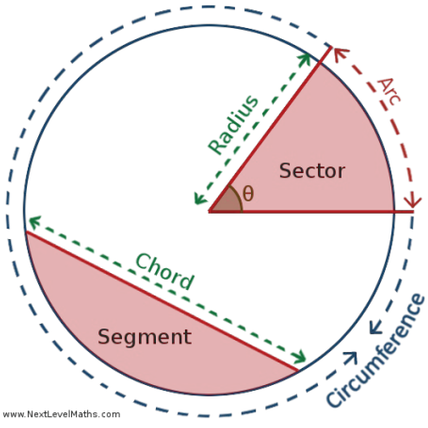

**Octagon across corners**



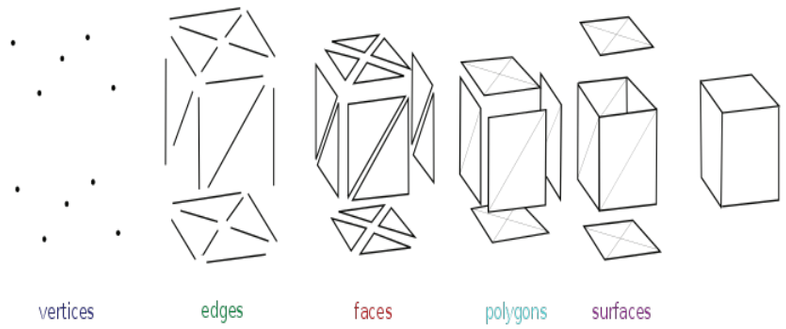

h. In groups, discuss the different types and features of circles.



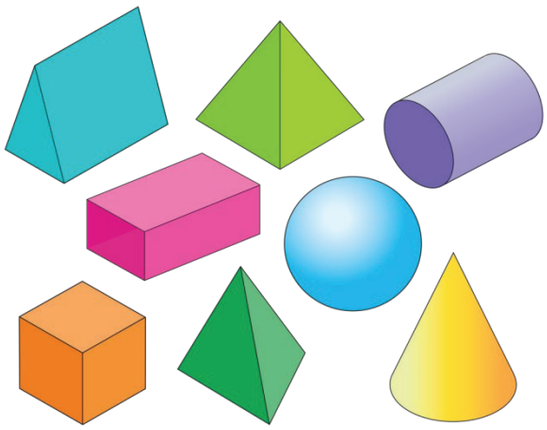



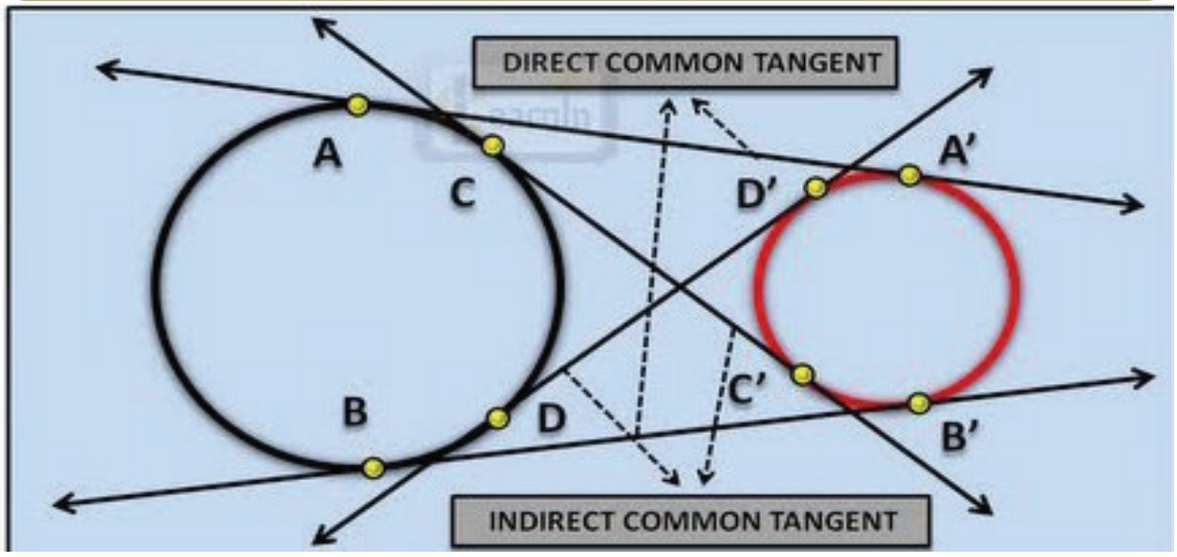
i. Individually, combine different shapes to form a model.




j. Individually, use the available materials to produce the designed models.



# Chapter 5: Tangents to Circles




**Key Words**

- Tangent
- Normal
- Tangency/point of contact
- Direct common tangent
- Transverse/Indirect common tangent

**You will need:**

- notebook, pencil, pens
- engineering articles
- colours
- drawing instruments

After studying this chapter and practising its activities, you should be able to:

1. identify tangents used in design.
2. construct different tangents.
3. make models/mock-ups to show how tangents are applied in design in day-to-day life.

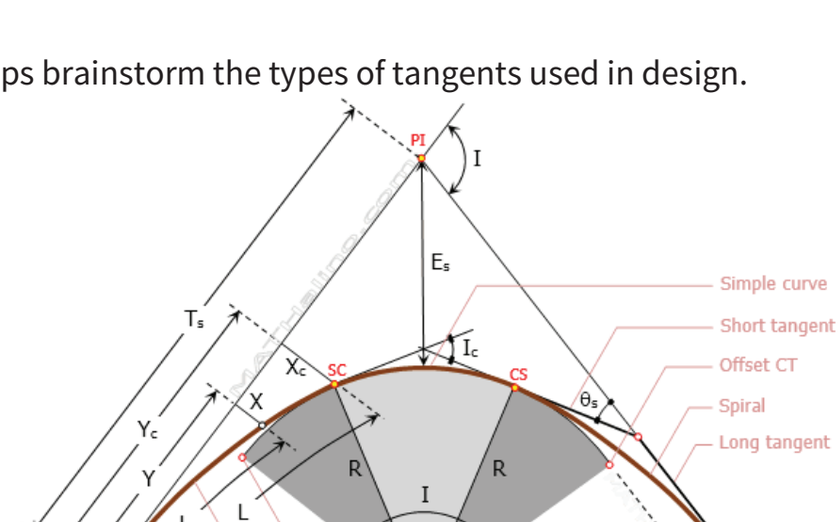
## Introduction

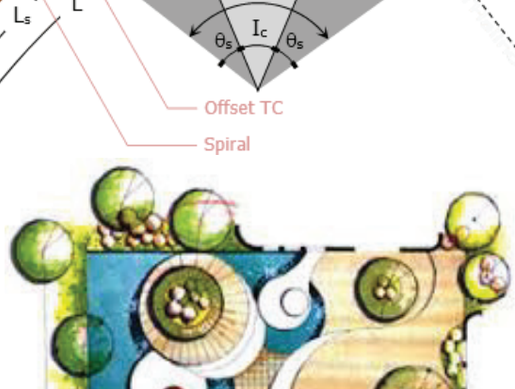
This chapter introduces you to the different types of tangents, their construction and application in design.

By studying this chapter, you will be equipped with knowledge and skills to apply the different principles of tangency in making models and different engineering designs.

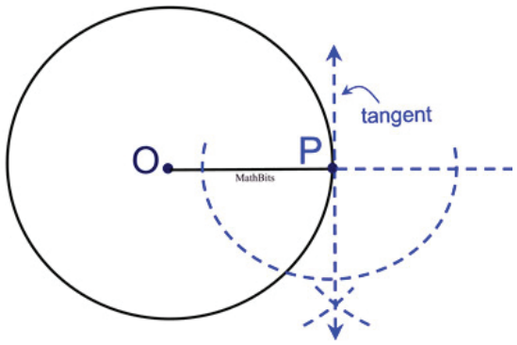
## Activity 6: Observe health, safety, security and environmental rules and regulations

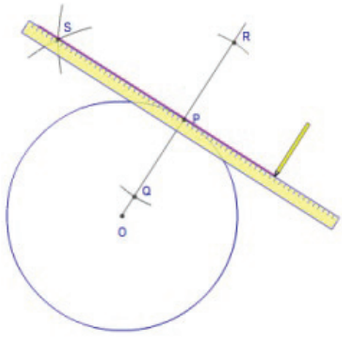
5.1 In groups brainstorm the types of tangents used in design.



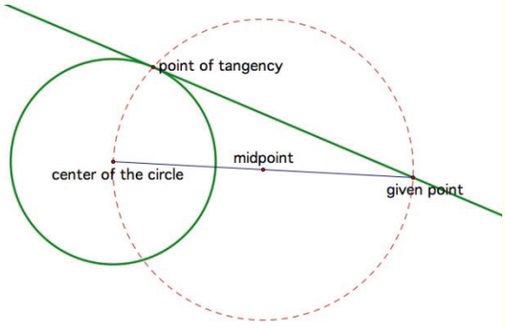



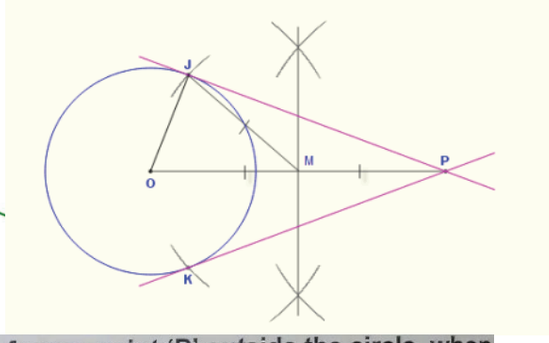
5.2 Individually, construct a tangent to a circle from a point on the circumference of the circle.

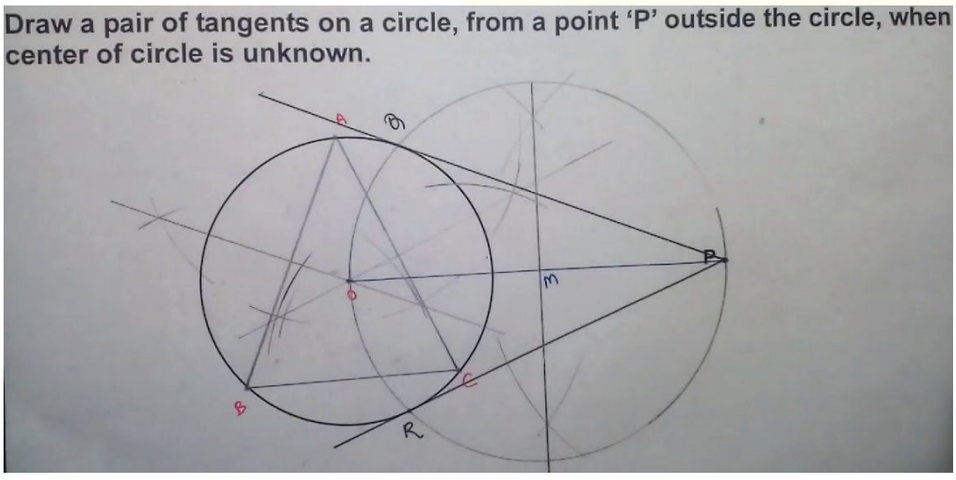



5.3 Individually, construct a tangent to a circle from a point outside the circle.

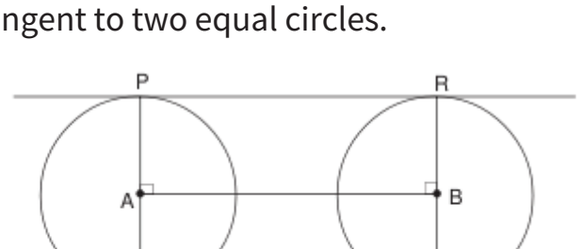


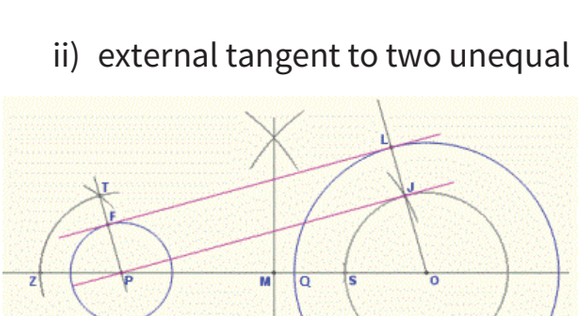



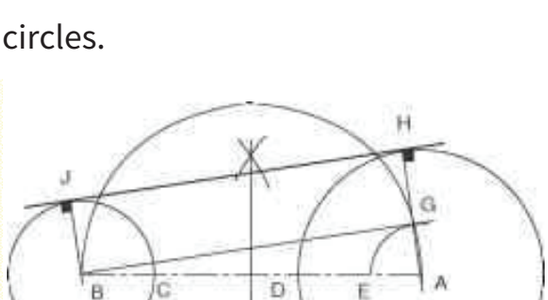
5.4 Individually, construct a common:

i) external tangent to two equal circles.



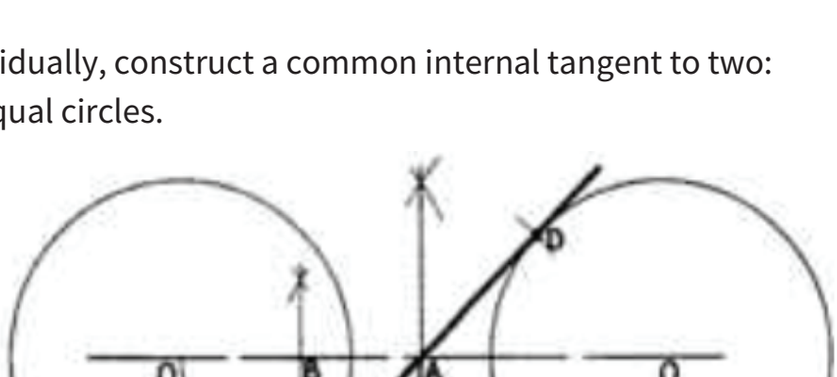

ii) external tangent to two unequal circles.



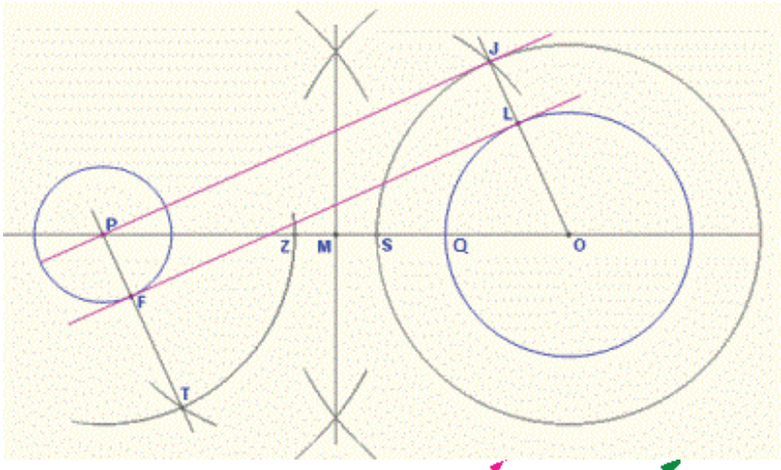



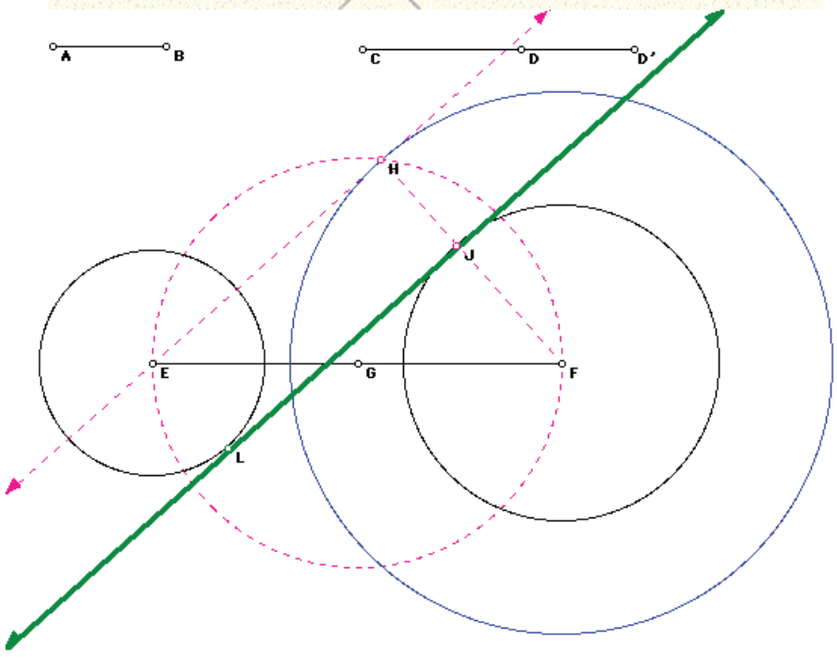

5.5 Individually, construct a common internal tangent to two:

i) equal circles.

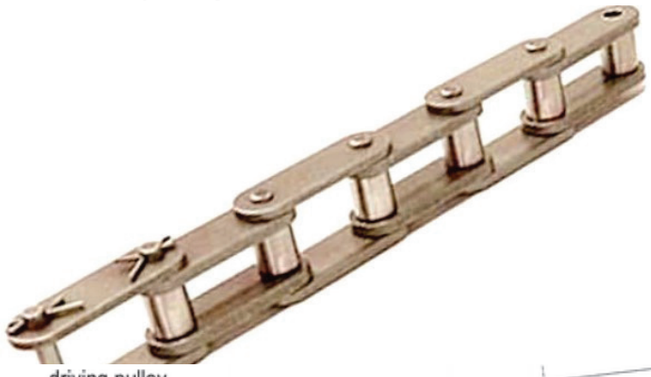


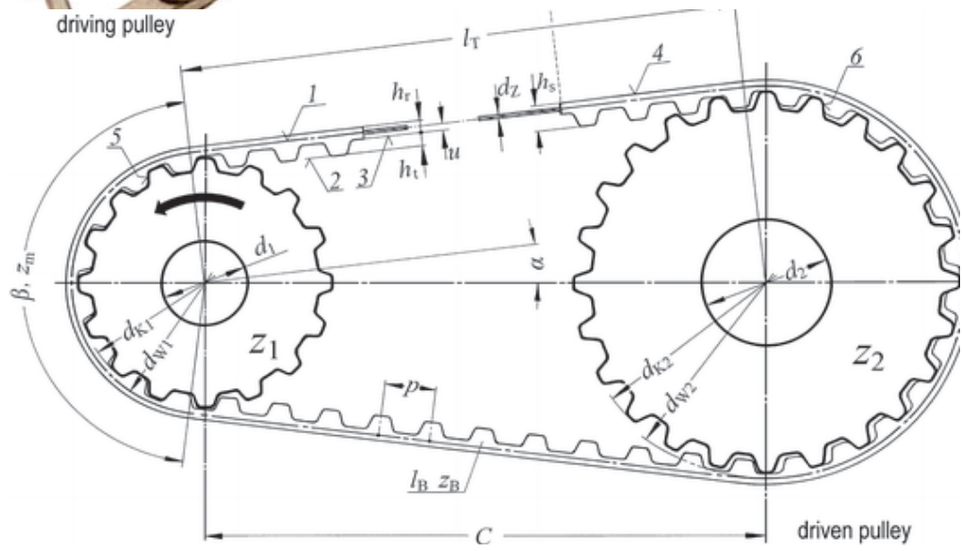
ii) unequal circles.

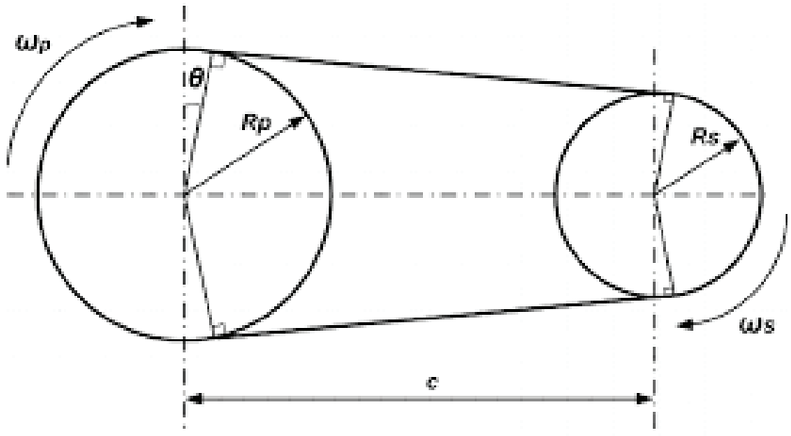


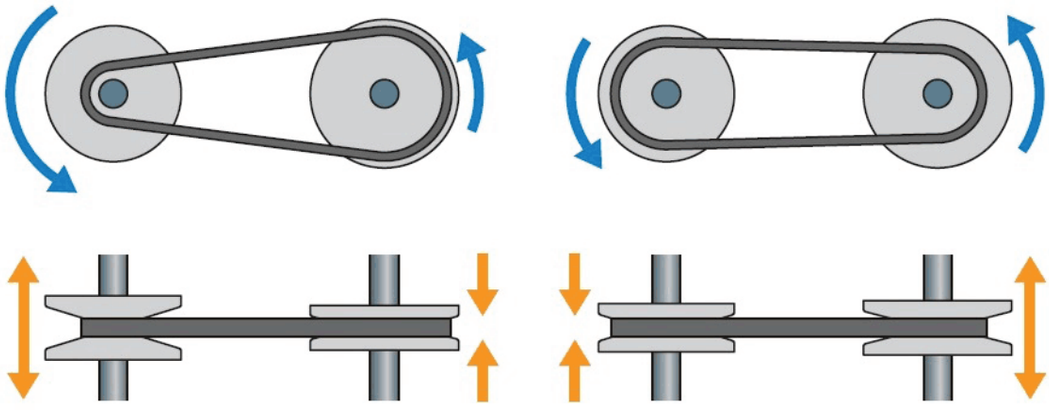



5.6 In pairs, use the principles of tangency to design models e.g. bicycle chain links and pulleys.

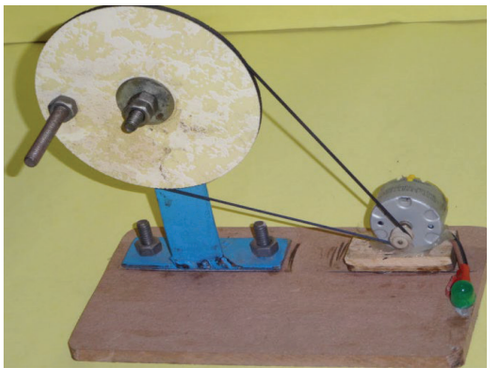






5.7 In pairs, use appropriate materials to make models of the designed articles using local materials available in the environment.

# Chapter 6: Health, Safety, Security and Environment

**Key Words**

- health
- safety
- security
- environment
- first aid
- accident
- annotation
- gadgets
- rules
- regulations
- protective wear
- recycling
- disposal

**You will need:**

1. notebook, pencil, pens
2. engineering articles
3. colours
4. drawing instruments

After studying this chapter and practising its activities, you should be able to:

1. demonstrate good practice of health and safety associated with the use of materials, tools, and machines in design.
2. demonstrate correct procedure of how to give first aid in relation to accidents affecting different parts of the body.
3. analyse how the production of design works can affect the environment and apply environmentally responsible practices.

## Introduction

This chapter introduces you to the safety and health regulations to be observed during design.

By studying this chapter, you will be equipped with knowledge and skills to protect yourself, materials, tools, equipment and environment during design and the making of engineering articles.

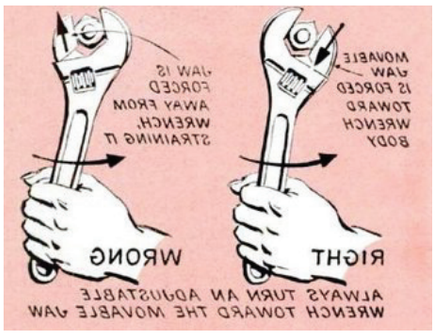
## Activity 6: Observe health, safety, security and environmental rules and regulations

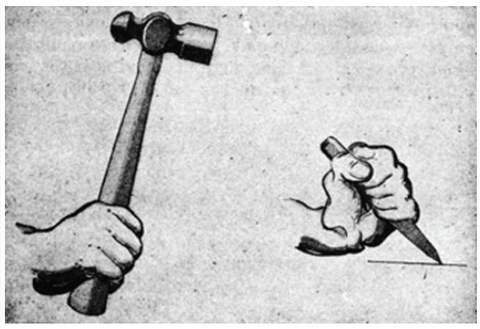
6.1 In groups, brainstorm the meaning of the following terms: health, safety, security, environment, rules and regulations.

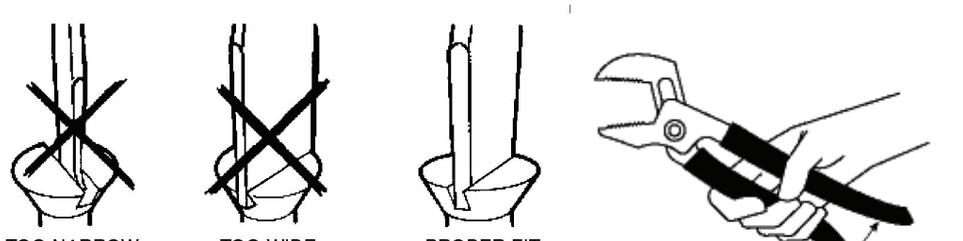
6.2 In small groups discuss:

i) different personal and environmental health practices to be adhered to during design and making of engineering articles.
ii) safety rules and regulations for personnel and handling of materials, and tools equipment during design and making of engineering articles.
iii) security of personnel, materials, tools and equipment during design and making of engineering articles.
iv) impact of designing and making engineering articles on the environmental, such as waste disposal, pollution (noise, air, water), destruction of the ecosystem, climate change due to Green House Gases (GHGs).
v) different environmental considerations to be observed during design and making of engineering articles.

6.3 In groups, practise the correct use of tools and machines in the process of design.



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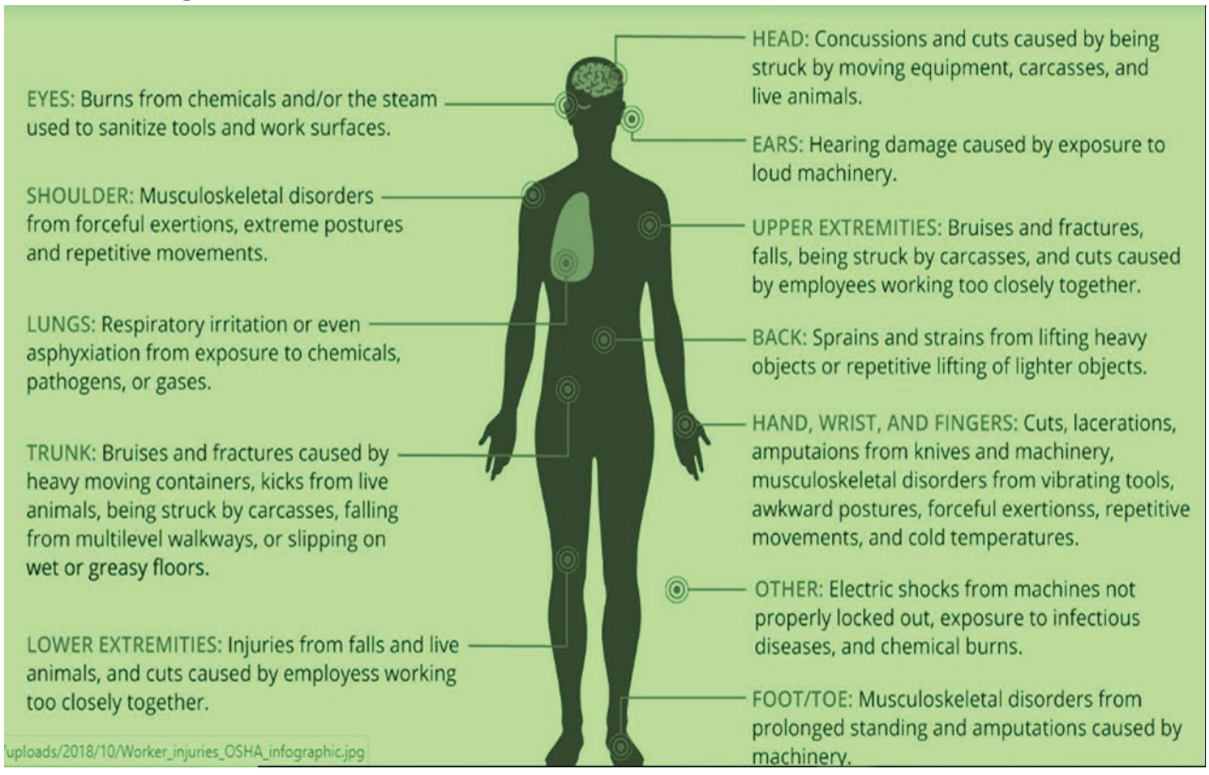
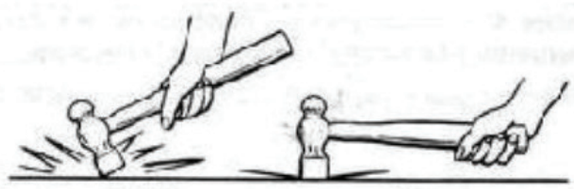
6.4 In pairs, sketch a human figure, annotating it to show areas that need protection while working.



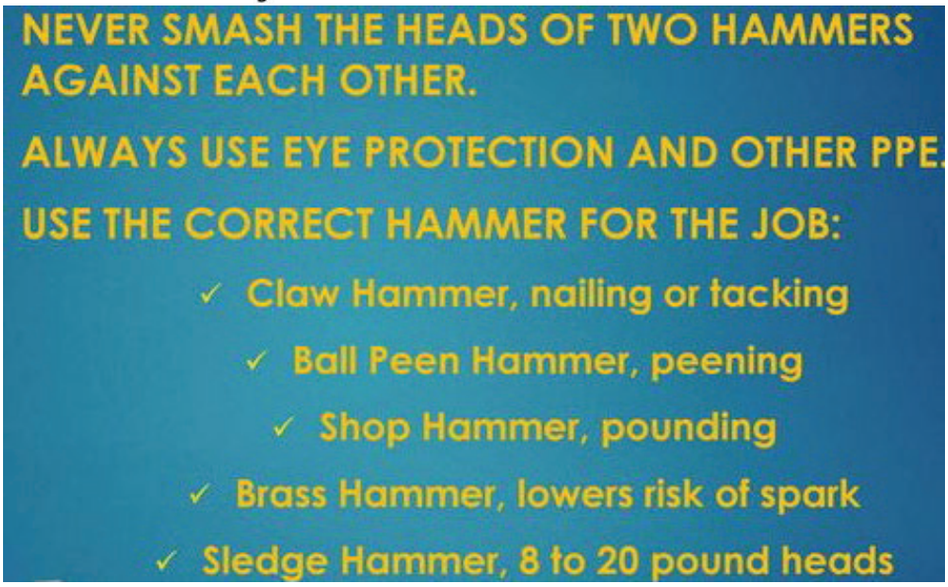

6.5 In pairs, name the basic gadgets and tools required in design and making of articles and the safety regulations associated with each, detailing their proper use in a report; for example, hammer, screw driver, cutting saws, machete, knife.

# HAMMERS

When using a hammer, always grasp it at the **end of the handle** to provide **balance** and **striking force**.



Wrong Correct




- Do not use a hammer if the handle is damaged or loose.
- Never weld, heat, or regrind a hammer head.
- Remove from service any hammer exhibiting signs of excessive wear, such as cracks, chips, or a mushroomed head.
- Sledgehammers with hardened heads are prohibited (refer to prohibited items register).
- Do not strike the surface at an angle. The hammer face should contact the striking surface squarely. Glancing blows made with a hammer often lead to injury.

## Screwdrivers


Do not hold the work piece against your body while using the screwdriver

Do not use a screwdriver as a punch, chisel, pry bar or nail puller

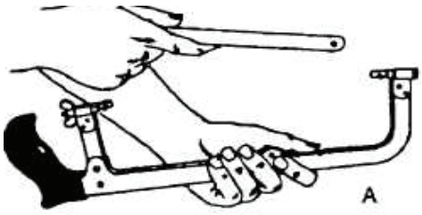
**Do not use a screwdriver to make a starting hole for screws**

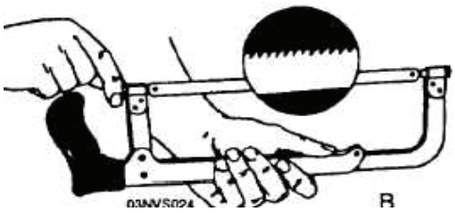
- Never use a screwdriver as a pry bar, chisel, punch, stirrer, or scraper.
- Always use a screwdriver tip that properly fits the slot of the screw.
- Throw away screwdrivers with broken or worn handles.
- Use magnetic or screw-holding screwdrivers to start fasteners in tight areas.
- Never use pliers on a screwdriver for extra leverage. Only use a spanner on screwdrivers specifically designed to accept them.
- For electrical work specialised insulated screwdrivers shall be used.

## Cutting saws

1. Hold the hacksaw properly at an **angle of 30°**
2. When cutting, **move your body** rather than just your arms.
3. Apply **pressure only during the forward stroke** (cutting stroke).
4. Use the **entire length** of the blade in each cutting stroke.
5. The usual cutting speed is from **40 to 50 strokes per minute**

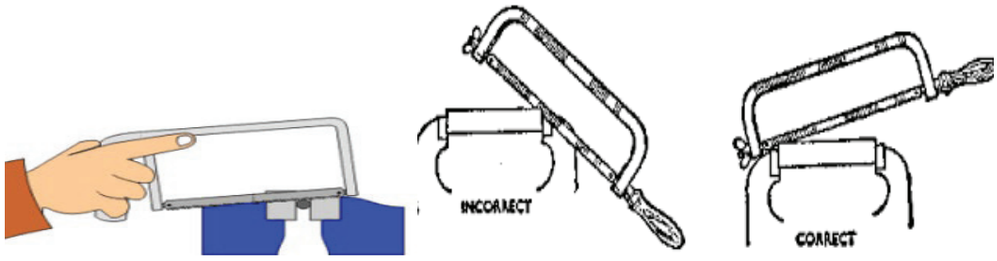

6. Choose the correct blade for the material being cut.
7. Secure the blade with the teeth pointing forward.




8. Keep the blade rigid and the frame properly aligned.

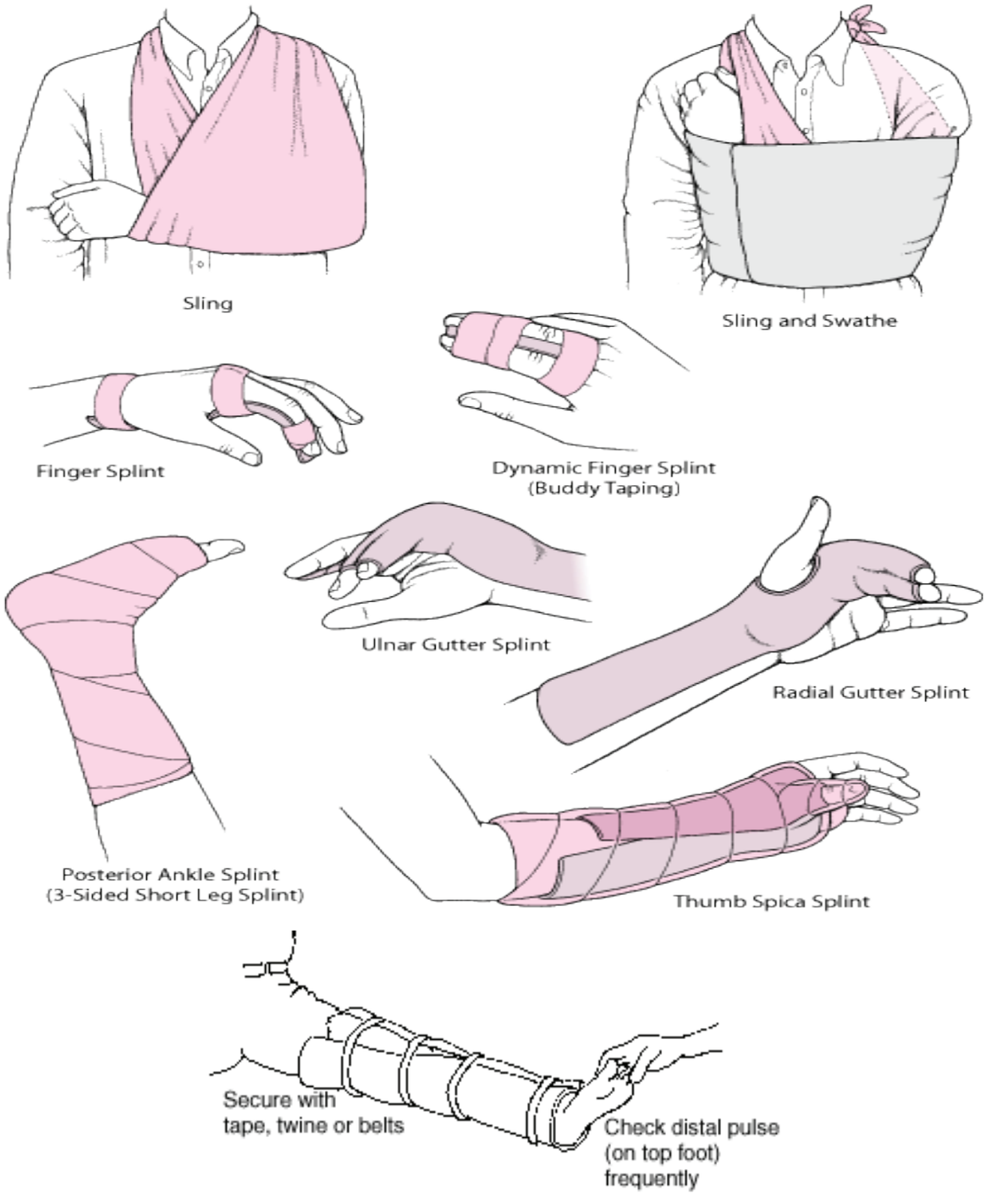
9. Cut using strong, steady strokes directed away from you.

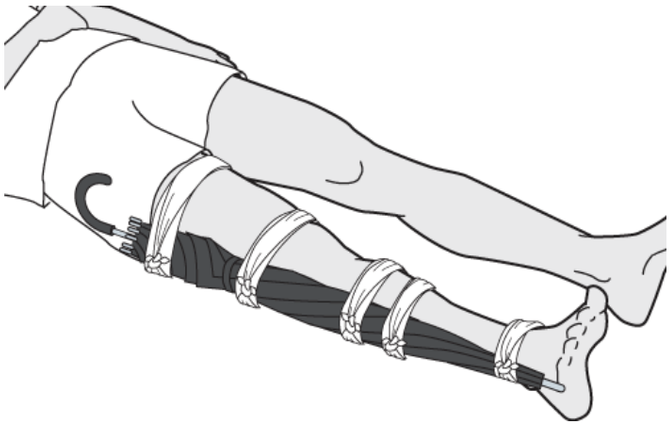


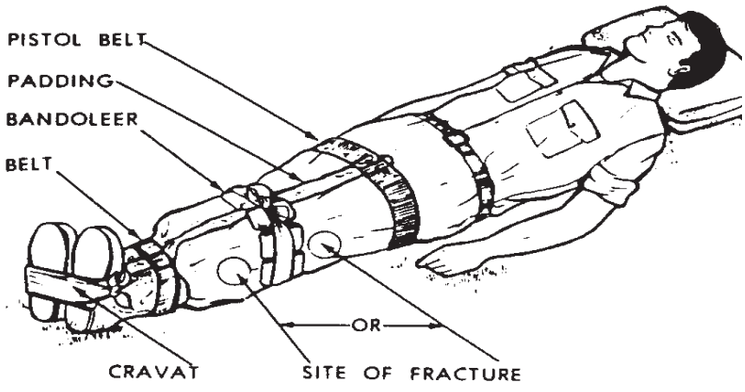

6.6 The learner should practise the proper use of protective wear when using the gadgets/tools.


PERSONAL PROTECTIVE EQUIPMENT(PPE)
EAR PROTECTION
USE IN NOISY AREAS TO AVOID HEARING LOSS
WEAR EAR PROTECTION
SAFETY HELMET
USE TO PROTECT YOUR HEAD FROM FALLING OBJECTS
WEAR HEAD PROTECTION
RESPIRATORY EQUIPMENT
USE TO PROTECT FROM INHALING DUST AND OTHER CONTAMINANTS
WEAR HEAD SHIELD
WEAR A FACE MASK
WEAR EYE PROTECTION
SAFETY GLASSES
USE TO PROTECT EYES FROM FLYING PARTICLES
SAFETY GLOVES
USE TO PROTECT YOUR HANDS FROM INJURY
WEAR HAND PROTECTION
WEAR REFLECTIVE CLOTHING
SAFETY SHOES
USE TO PROTECT YOUR FEET FROM FALLING OR ROLLING OBJECTS
REFLECTIVE CLOTHING
USE TO MAKE SURE YOU ARE HIGHLY VISIBLE TO OTHER PERSONNEL
WEAR FOOT PROTECTION
YOU ONLY HAVE ONE BODY!

6.7 In pairs, the learners research and participate in a demonstration of how first aid is applied when an accident occurs.








6.8 In pairs, the learners produce a chart describing the proper and safe use of materials in the environment and apply safety rules/regulations while working, such as shown in the table below.

| Material | Safety risks | Safe use/safety regulations |
|---|---|---|
| ***Clay materials*** | Can cause lung problems if inhaled | • Use protective respiratory equipment.<br>• Do not sweep a dusty area, but use water to moisten before sweeping. |
| ***Paint materials and other Chemicals*** | • Can lead to respiratory problems<br>• Can cause cancer of the skin and internal organs<br>• Can affect the eyes | • Use protective respiratory equipment.<br>• Do not stay longer in areas where paint and chemicals are used or stored.<br>• Avoid fire near paint and other chemicals. |

| | | |
|---|---|---|
| | | • Do not use paint and other chemicals in an open environment or where people, animals, vegetation and other living organisms are exposed. |
| ***Metallic materials*** | • Can cause simple or heavy cuts<br>• Can cause fractures if fallen on body | • Always use proper protective equipment such as gloves, safety shoes, head safety helmet.<br>• Always protect metallic materials from environmental rusting and corrosion. |
| ***Wooden Materials*** | • Can lead to injuries such as puncture wounds and sprained ankles, broken toes or worse | • Always lift the appropriate weight.<br>• Use proper protective equipment such as gloves, safety shoes and head safety helmet. |

6.9 In all activities, the learners shall demonstrate disposal of used materials in environmentally responsible ways (e.g. re-use or recycling of materials where possible).

**Waste disposal practices**

The different waste management methods include source reduction and reuse, animal feeding, recycling, composting, fermentation, landfills, incineration and land application.

**Incineration/Combustion**

Incineration or combustion is a type disposal method in which municipal solid wastes are burned at high temperatures so as to convert them into residue and gaseous products.

- Combustible waste is burned at temperatures high enough (900°–1,000°C, or 1,650°–1,830°F) to consume all combustible material.
  - Leaving only ash and non-combustibles to dispose of in a landfill.
- Process of incineration can be used to supplement other fuels and generate electrical power.
- In modern incineration facilities, smokestacks are fitted with special devices to trap pollutants.

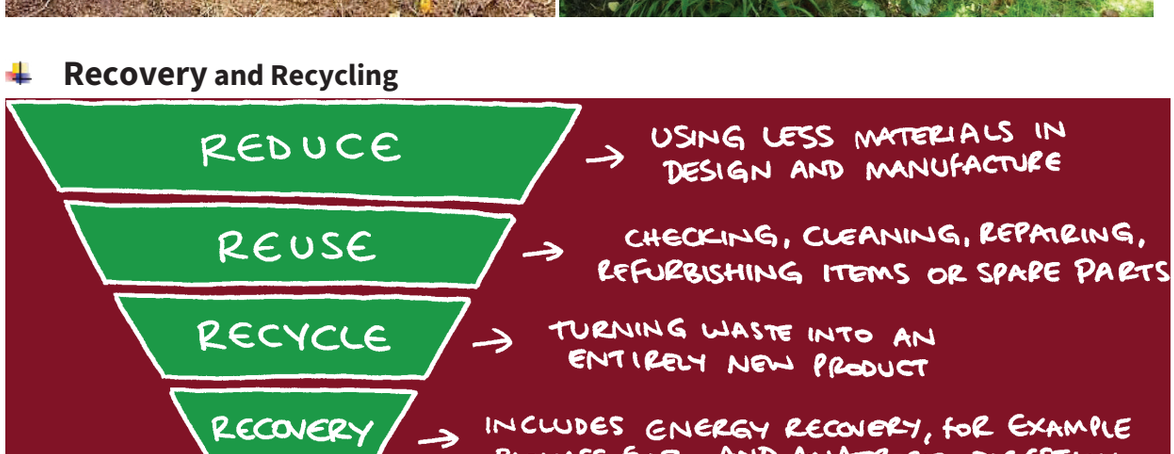
- Incineration is the process of ***control and complete combustion***, for burning solid wastes. It leads to **energy recovery** and **destruction of toxic wastes.**
- In these plants the recyclable material is segregated and the rest of the material is burnt.
- **Example**: waste from hospitals
- In some newer incinerators designed to operate at temperatures high enough to produce a molten material, it may be possible to reduce the volume to about 5% or even less
- One of the most attractive features of the incineration process is that it can be used to **reduce the original volume** of combustible solid waste by 80–90%.

### Composting

- **Composting** is using natural decomposition to transform organic material into compost, a humus-like product with many environmental benefits.
  - With proper management of air and water, composting can transform large quantities of organic material into compost over a short period of time.
  - Small-scale composting can be accomplished in the backyard, mixing green materials (grass clippings, vegetable scraps, etc.) and brown materials (dry leaves, twigs, soiled paper towels).

This process recycles various organic materials otherwise regarded as waste products and produces a soil conditioner (**the compost**). Compost is rich in nutrients.


## Recovery and Recycling




Resource recovery is the process of taking useful discarded items for a specific next use. These discarded items are then processed to extract or recover materials and resources or convert them to energy in the form of useable heat, electricity or fuel.

Recycling is the process of converting waste products into new products to prevent energy usage and consumption of fresh raw materials. Recycling is the third component of reduce, reuse and recycle waste hierarchy. The idea behind recycling is to reduce energy usage, reduce volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions and preserve natural resources for future use.

## Landfill

Landfill is the most popularly used method of waste disposal today. This process of waste disposal focuses attention on burying the waste in the land.

# Chapter 7: Tools


**Key Words**

- tools
- marking out tools
- measuring tools
- marking out
- gauging

**You will need**

1. notebook, pencil, pens
2. different tools
3. engineering materials
4. drawing instruments

After studying this chapter and practising its activities, you should be able to:

1. demonstrate proper use and maintenance of tools used for marking out.
2. demonstrate accuracy while using measuring tools.

Tools are gadgets used in faster and accurate execution of tasks; they maybe hand or power driven.

This chapter introduces you to the different tools used in design. By studying this chapter, you will be equipped with knowledge and skills to accurately use and maintain the common marking-out and measuring tools in design.

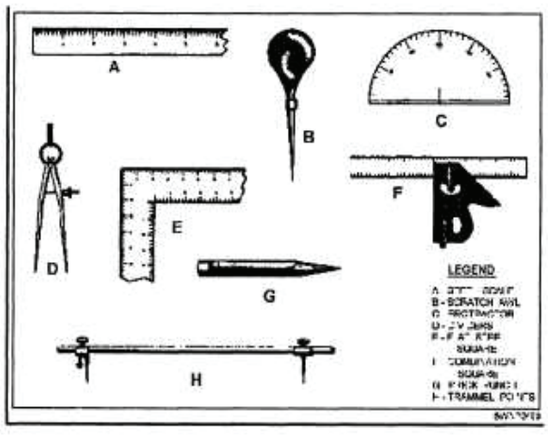
## Activity 7: Observe health, safety, security and environmental rules and regulations

7.1 In groups, brainstorm and identify the marking-out and measuring tools that can be used for the following materials:

i) Wood

ii) Metals

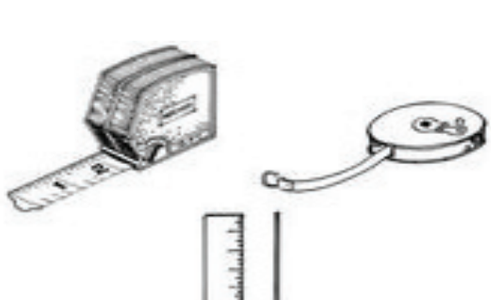
iii) Plastics: tools for metals can as well be used on plastics




## Hand Tools: Measuring Tools

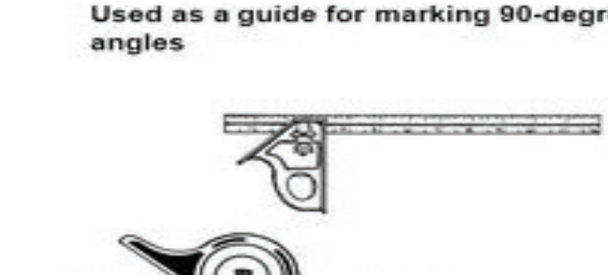
### Tape Measure

Plastic or metal case, appropriate for general scenic measuring



### Tri Square

Used as a guide for marking 90-degree angles



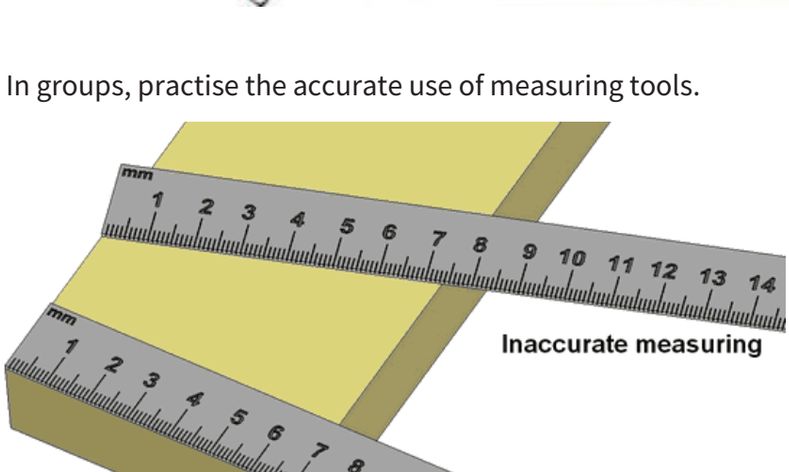
### Combination Square

Used for marking 45- and 90-degree angles

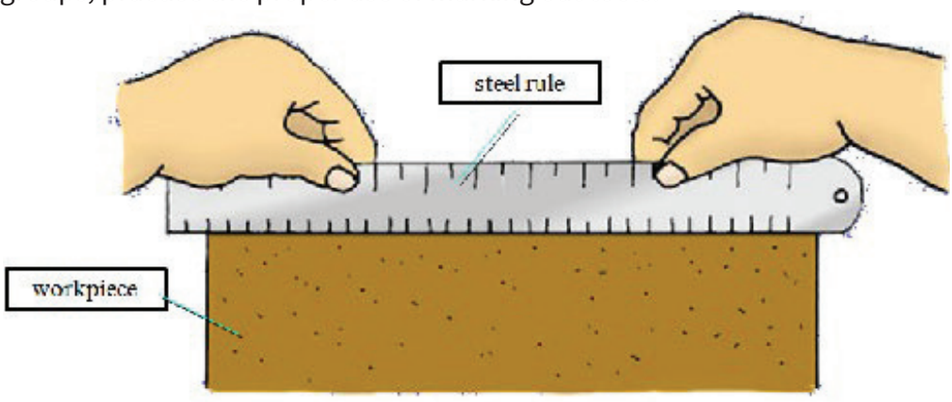
### Bevel Protractor

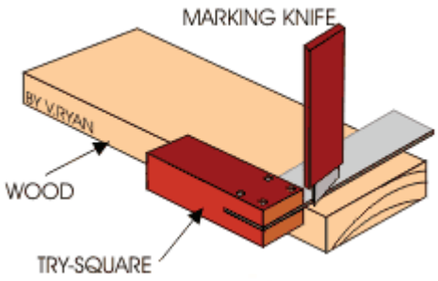
Adjustable and used for marking 0 to 90-degree angles

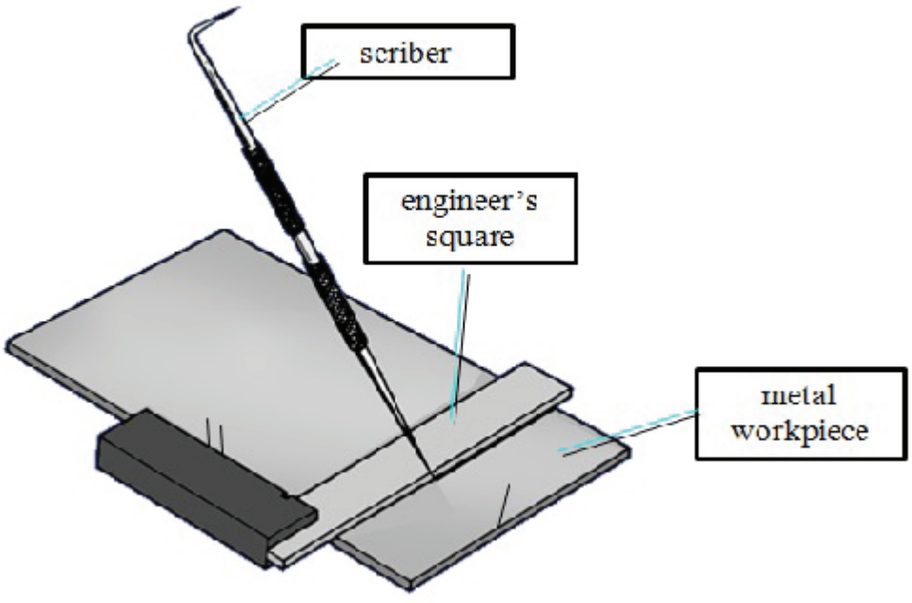
7.2 In groups, practise the accurate use of measuring tools.

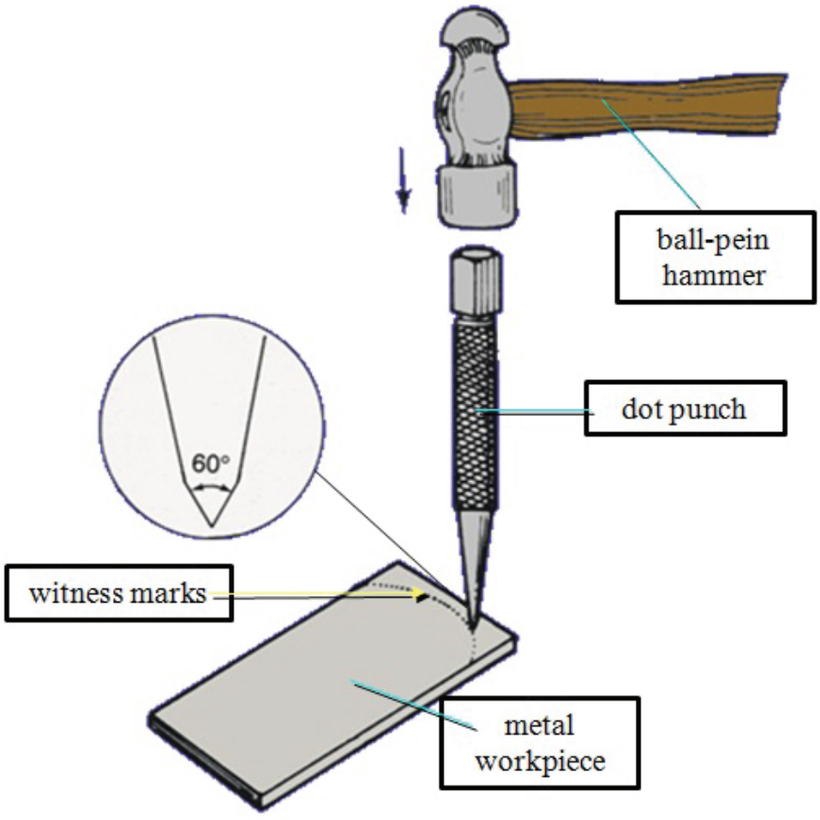


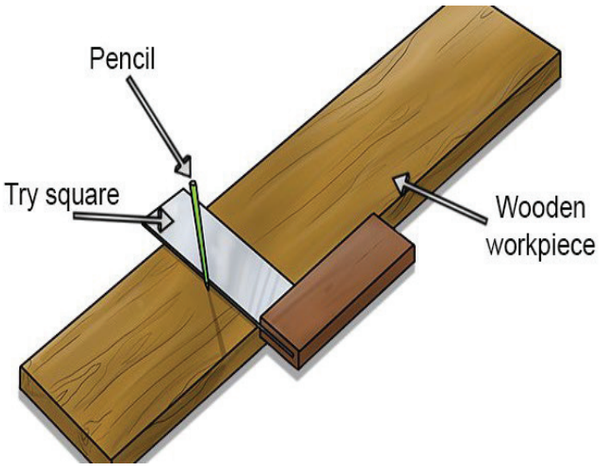
7.3 In groups, practise the proper use of marking out tools.

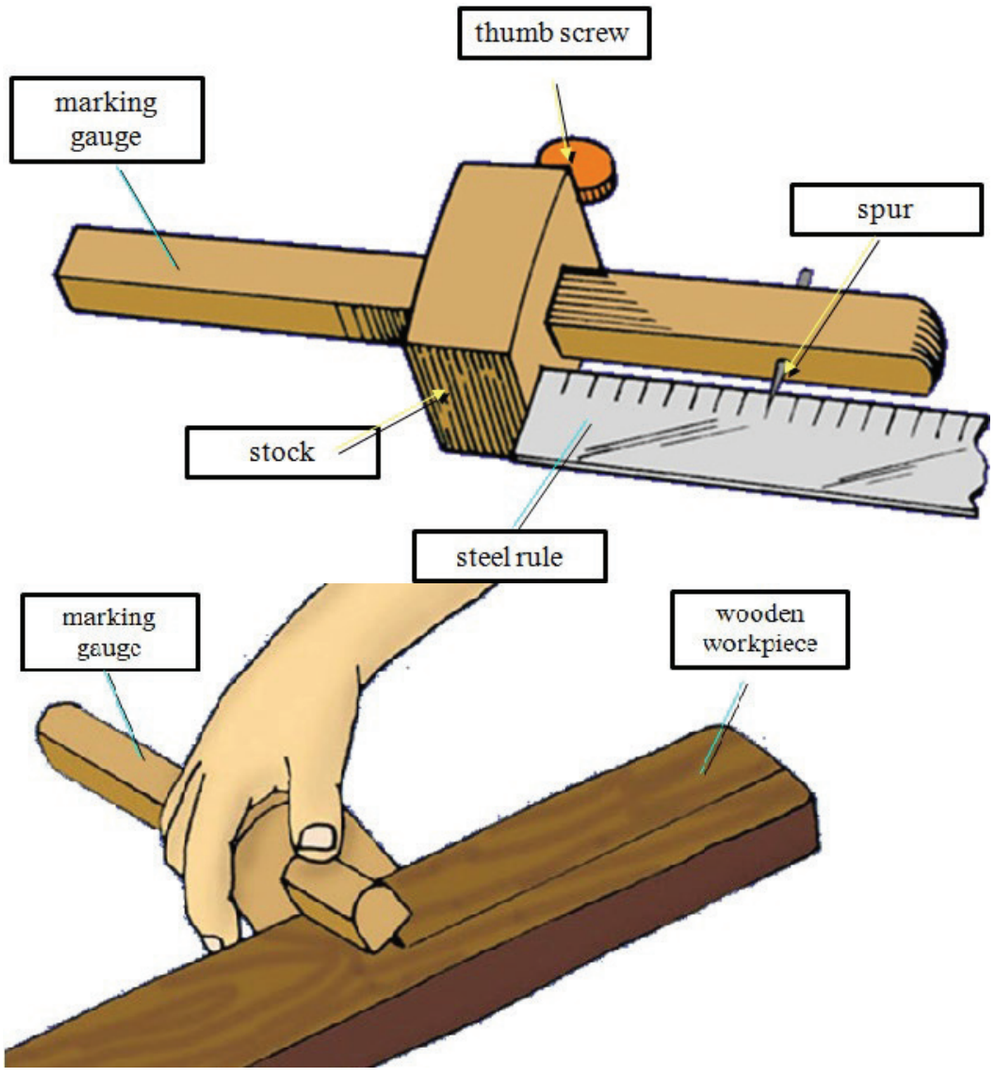



ball-pein hammer
dot punch
60°
witness marks
metal workpiece


Pencil
Try square
Wooden workpiece




7.4 In pairs, practise the proper maintenance of different measuring and marking-out tools.

7.5 Write individual reports on the proper and accurate use and maintenance of the measuring and marking-out tools.

# Chapter 8: Materials


**Key Words**

- materials
- engineering materials
- properties: toughness, brittleness, strength, hardness
- working properties

**You will need**

1. Notebook, pencil, pens
2. Engineering articles

After studying this chapter and practising the activities, you should be able to:

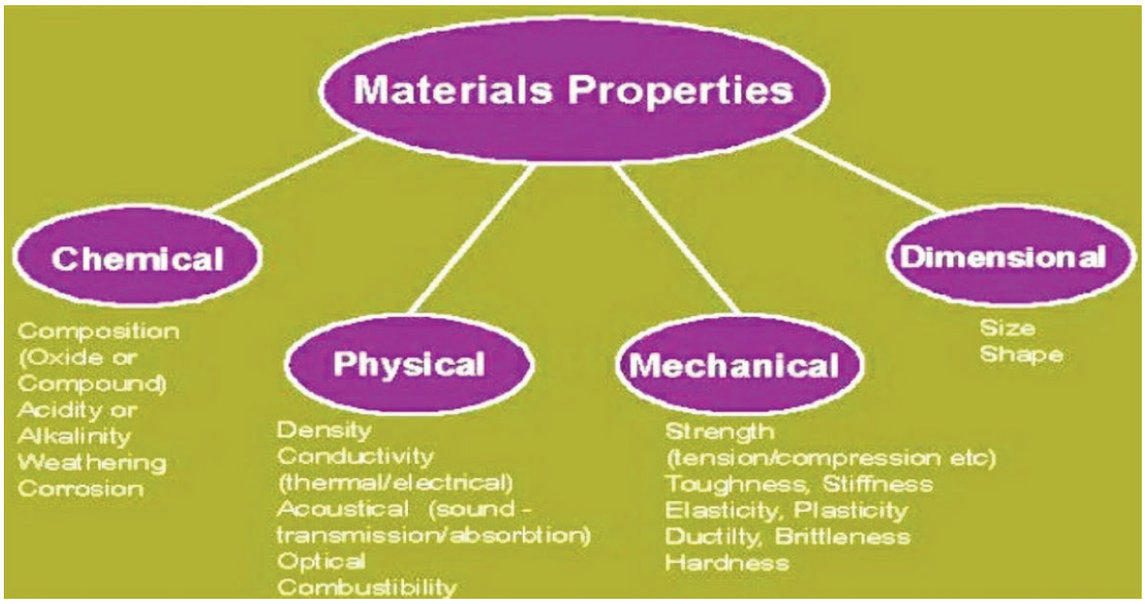
1. analyse the nature and properties of common materials used in design (k, u).
2. use and manipulate the common engineering materials in design work.

## Introduction

This chapter introduces you to the different engineering materials and their application in the design process. The study of this chapter, therefore, will equip you with the necessary knowledge and skills to analyse the nature and properties of common materials and, their applications and manipulation in the design process.

## Activity 8: Manipulating the design materials

8.1 In groups, identify the different design materials and brainstorm their basic properties, such as wood, metals, clay and plastics.

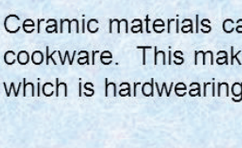



8.2 Individually, draw a chart to illustrate why each of the materials identified above is used in a particular way/situation.

| **Material**<br><br>**Example:** | **Application Areas** | **Reasons for its application in the specific condition** |
|---|---|---|
| Wood | • Making of furniture<br>• Construction industry | • It is light in weight.<br>• It is workable in design.<br>• It is readily available and thus cheap to acquire.<br>• It is long-lasting in structure and resists corrosion and wear.<br>• It contains a good surface appearance. |
| Metals | | |
| Clay | | |
| Plastics | | |


## CERAMIC MATERIALS IN THE HOME

Ceramic materials can be coated onto metals to make cookware. This makes an attractive non-stick surface, which is hardwearing.



A **ceramic knife** is made out of a hard tough ceramic, **zirconium dioxide** ($ZrO_2$ this is also called **zirconia**). The blade is sharpened by grinding on a diamond-dust-coated grinding wheel.

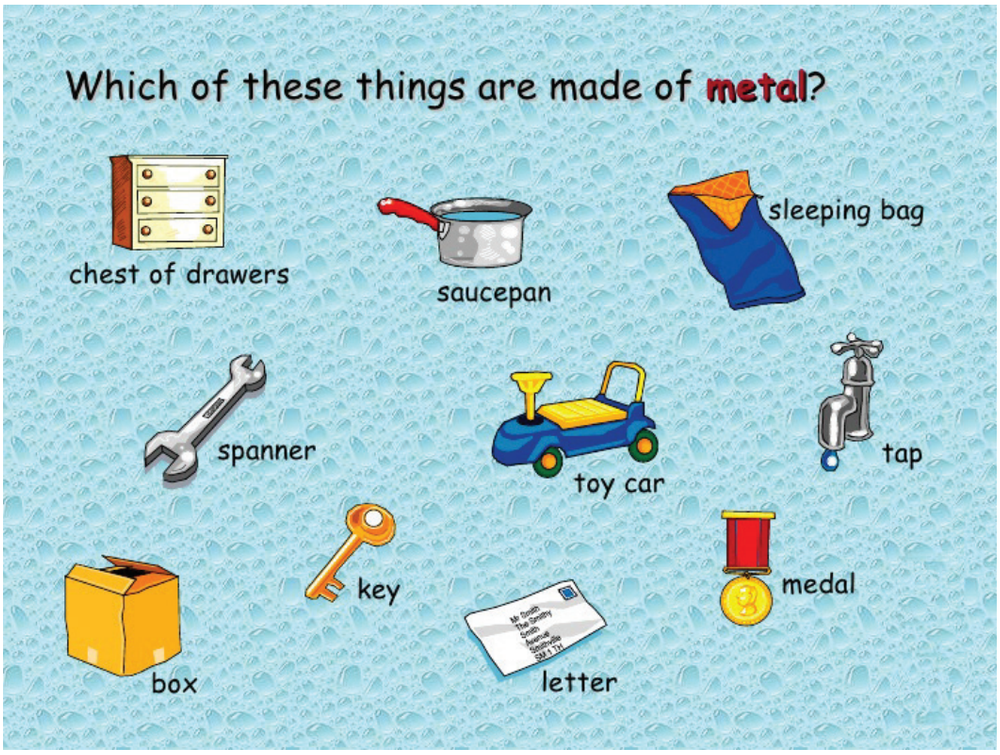
The blade is harder than a steel blade and rarely needs sharpening.


8.3 In pairs, practise the manipulation of the different design materials to explore their properties by making models out of them according to category, for example: wood, clay, metals and plastics.

**A SCHOOL BELL:** Is made out of materials which are good in acoustic conductivity.


Which of these things are made of plastic?
wardrobe
party bag
walkman
watering can
hat
spanner
book
paddling pool
dice
bird table


Which of these things are made of paper?
book
card
radiator
envelope
pyjamas
trouser
magazine
ladder
calendar
kitchen bin




8.4 Write individual reports on the above activity, stating the main steps taken to make the different models and the properties observed in each category of material during its manipulation.

| **Material** | **Model made** | **Steps taken to make the model** | **Properties observed during manipulation** |
|---|---|---|---|
| Wood | | | |
| Metals | | | |
| Clay | Pot | 1. Clay collection and sorting<br>2. Clay preparation<br>3. Moulding process<br>4. Finishing process | 1. Brittleness<br>2. Ductility/ malleability/ flexibility |
| Plastics | | | |

# Plastic Fantastic

For some time now, plastics have been used commercially as alternatives to natural materials such as wood, metals, ceramics and glass. Why are they used extensively?

- ✓ relatively cheap
- ✓ lightweight
- ✓ strong
- ✓ easy to process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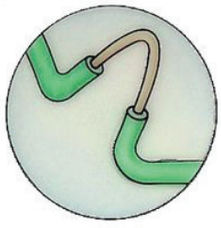
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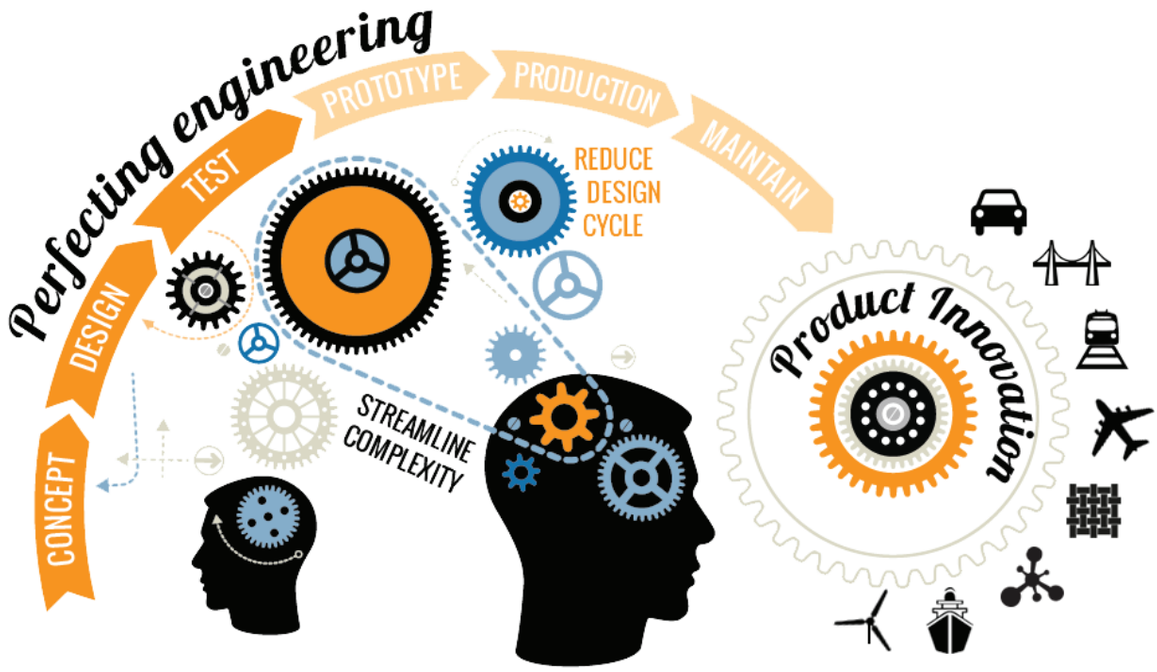
Most polymers are good electrical insulators and also good thermal insulators

These properties are highlighted in science education and by their extensive use in the home.

# Chapter 9: Making Process




**Key Words**
- design
- appropriate
- cut out
- cutting tool
- bend/fold
- join
- assemble

**You will need:**

1. notebook, pencil, pens
2. sample engineering articles
3. models
4. design tools and equipment

After studying this chapter and practising its activities, you should be able to:

1. demonstrate the correct use of tools and simple machines (k, u, s).
2. use and follow the procedure for making a product from a specific design.

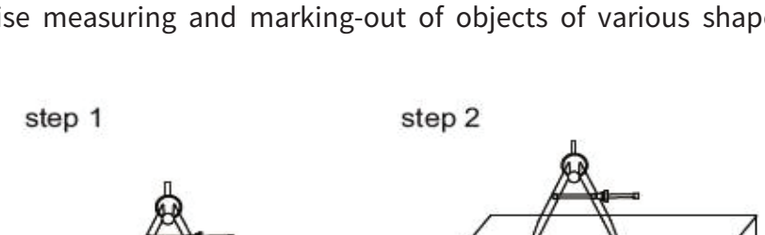
## Introduction

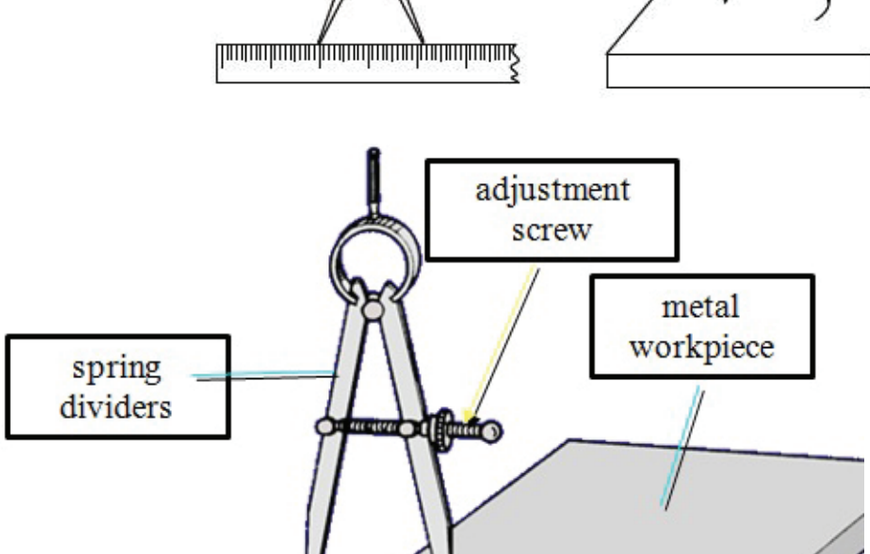
This chapter introduces you to the process of implementing design ideas and transforming them into real-life articles.

This chapter will equip you with the necessary skills to manipulate materials and tools and implement the design process to make different products.

## Activity 9: Manipulating the design materials

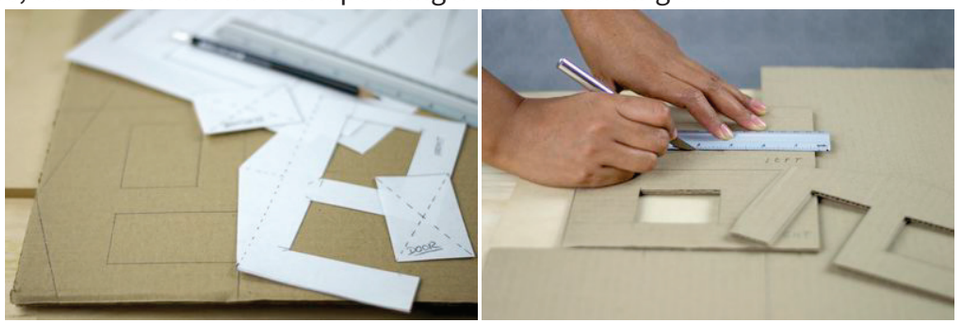
9.1 In pairs, practise measuring and marking-out of objects of various shapes and sizes; for example:




9.2 In pairs, follow a specific design and perform the following tasks:

i) In pairs, cut out the intended shape using a suitable cutting tool.



ii) In groups, bend or fold to make the required shape using suitable tools.

iii) In groups, join and assemble the product using the appropriate method.

iv) Perform other necessary tasks to complete the product making process.

9.3 Write individual reports on the above activity to:

i) describe the making process followed to put the design into and physical product.

ii) explain the safety precautions followed in the making process.

iii) make features of the product.

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