JSS2 2ND TERM BASIC TECHNOLOGY E-NOTE

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WEEK 2

Topic: QUADRILATERALS

Definition

A quadrilateral is a closed figure with four straight sides. You can make a quadrilateral by taking (or imagining) anything straight and thin you might have handy: pens, toothpicks, chopsticks, etc. A square is one type of a special quadrilateral.

Quadrilateral just means “four sides”

(*quad* means four, *lateral* means side).

A Quadrilateral has four-sides, it is **2-dimensional** (a flat shape), **closed** (the lines join up), and has **straight** sides.

Properties

A quadrilateral has:

- four sides (edges)
- four vertices (corners)
- interior angles that add to **360 degrees**:

Exercise

Try drawing a quadrilateral, and measure the angles. They should add to **360°**

Types of Quadrilaterals

There are special types of quadrilateral:

Some types are also included in the definition of other types! For example a **square**, **rhombus** and **rectangle** are also ***parallelograms***.

Let us look at each type in turn:

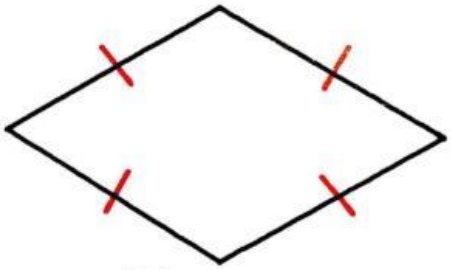
The Rectangle

and *means "right angle"*
show equal sides

A rectangle is a four-sided shape where every angle is a right angle (90°).

Also **opposite sides** are parallel and of equal length.

The Rhombus



Rhombus

A rhombus is a four-sided shape where all sides have equal length.

Also opposite sides are parallel *and* opposite angles are equal.

Another interesting thing is that the diagonals (dashed lines in second figure) meet in the middle at a right angle. In other words they "bisect" (cut in half) each other at right angles.

A rhombus is sometimes called a **rhomb** or a **diamond**.

The Square

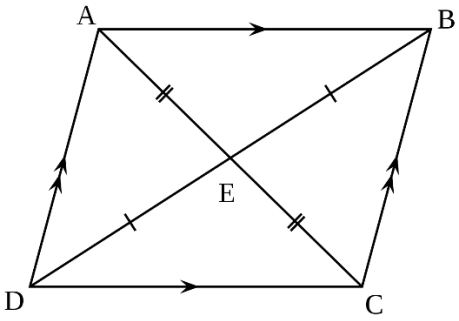
means "right angle"
show equal sides

A square has equal sides and every angle is a right angle (90°)

Also opposite sides are parallel.

A square also fits the definition of a **rectangle** (all angles are 90°), and a **rhombus** (all sides are equal length).

The Parallelogram



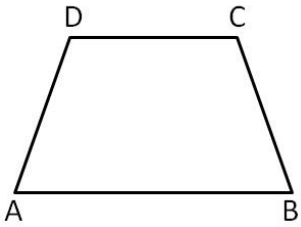
A parallelogram has opposite sides parallel and equal in length. Also opposite angles are equal (angles "a" are the same, and angles "b" are the same).

NOTE: Squares, Rectangles and Rhombuses are all Parallelograms!

A **parallelogram** with:

- all sides equal and
- angles "a" and "b" as right angles is a **square**!

The Trapezoid/Trapezium



Isosceles Trapezoid

Trapezoid

A trapezoid *(called a trapezium in the UK)* has a pair of opposite sides parallel.

And a **trapezium** *(called a trapezoid in the UK)* is a quadrilateral with NO parallel sides:

	Trapezoid	Trapezium
In the US:	a pair of parallel sides	NO parallel sides
In the UK:	NO parallel sides	a pair of parallel sides

(the US and UK definitions are swapped over!)

An **Isosceles** trapezoid, as shown above, has left and right sides of equal length that join to the base at equal angles.

The Kite

Hey, it looks like a kite (usually).

It has **two pairs** of sides:

Each pair is made of two equal-length sides that join up.

Also:

- the angles where the two pairs meet are equal.
- the diagonals, shown as dashed lines above, meet at a right angle.
- one of the diagonals *bisects* (cuts equally in half) the other.

… and that's it for the special quadrilaterals.

Irregular Quadrilaterals

The only regular (all sides equal and all angles equal) quadrilateral is a square. So all other quadrilaterals are **irregular**.

The "Family Tree" Chart

Quadrilateral definitions are **inclusive**.

Example: a square is also a rectangle.

So we **include** a square in the definition of a rectangle.

*(We **don't** say "Having all 90° angles makes it a rectangle except when all sides are equal then it is a square.")*

This may seem odd, as in daily life we think of a square as **not** being a rectangle … but in mathematics it **is**.

Using the chart below we can answer such questions as:

- Is a Square a type of Rectangle? (Yes)
- Is a Rectangle a type of Kite? (No)

Complex Quadrilaterals

Oh Yes! when two sides cross over, we call it a "Complex" or "Self-Intersecting" quadrilateral, like these:

They still have 4 sides, but two sides cross over.

Polygon

A quadrilateral is a polygon. In fact it is a 4-sided polygon, just like a triangle is a 3-sided polygon, a pentagon is a 5-sided polygon, and so on.

Other Names

A quadrilateral can sometimes be called:

- a **Quadrangle** ("*four angles*"), so it sounds like "triangle"
- a **Tetragon** ("*four* and *polygon*"), so it sounds like "pentagon", "hexagon", etc.

ASSESSMENT

1. What is the name of this quadrilateral?
   (a) kite
   (b) square
   (c) rhombus
   (d) trapezium
2. What is the name of this quadrilateral?

   (a) trapezoid or trapezium
   (b) kite
   (c) parallelogram
   (d) rhombus
3. What is the name of this quadrilateral?

   (a) kite
   (b) parallelogram
   (c) rhombus
   (d) trapezoid or trapezium
4. What is the name of this quadrilateral?

   (a) parallelogram
   (b) rectangle
   (c) trapezoid or trapezium
   (d) kite
5. One of these statements is **not true** of kites
   (a) it has two pairs of sides
   (b) it has three pairs of sides
   (c) the angles where the two pairs meet are equal
   (d) one of the diagonals *bisects* (cuts equally in half) the other

WEEK 3

PLANE FIGURE

Content:

- POLYGON: Definition
- Types/Sketches
- Construction

Definition of a Polygon

Polygons are everywhere! A polygon is any 2-dimensional shape formed with straight lines. Triangles, quadrilaterals, pentagons, and hexagons are all examples of polygons. The name tells you how many sides the shape has. For example, a triangle has three sides, and a quadrilateral has four sides. So, any shape that can be drawn by connecting three straight lines is called a triangle, and any shape that can be drawn by connecting four straight lines is called a quadrilateral.

A polygon is a plane figure formed by joining three or more straight sides. A polygon is said to be regular if all its sides are equal and its angles are equal.

Types of Polygon

A **pentagon** is a polygon with five sides.

A **hexagon** is a polygon with six sides.

A **heptagon** has seven sides.

An **octagon** has eight sides.

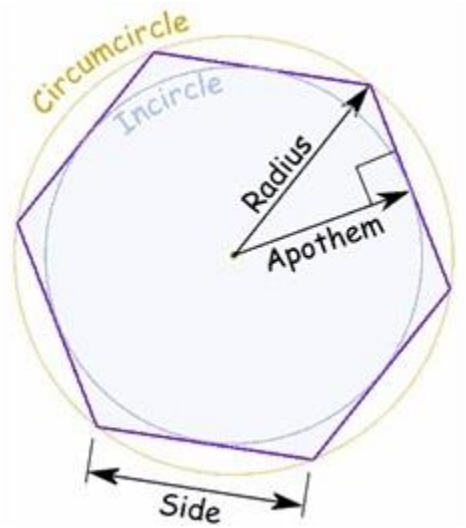
A **decagon** has ten sides.

Construction of a Polygon

(A) To construct a regular a Regular Hexagon given its side

(I) Using 60^0 set square

i. Draw a horizontal line and mark off AB equal to the side of the hexagon.



ii. Through A, draw a line at 60^0 and mark off AC equal to AB.

iii. Through B, draw a line at 60^0 parallel to BD and mark off BD equal to AB.

iv. Through C, draw a line of 60^0 parallel to BD and mark off CE equal to AB.

v. Through D, draw a line of 60^0 parallel to AC and mark off DF equal to AB.

vi. Join EF to complete the hexagon

(II) Using a pair of Compass

This method is best remembered as the constant Radius Rule.

i. Draw a circle whose radius is equal to the side of the hexagon. Draw the horizontal diameter AB.

ii. With centre A and the same radius, cut the circle above AB at E and below AB at F.

iii. With centre B and the same radius, cut the circle above AB at E and below AB at F.

iv. Join AD, DF, FB, BE, EC, and CA to obtain a hexagon.

Note: This procedure is required to draw a regular hexagon given the distance across corners. The diameter of the circle is equal to the distance across corners.

(B) To construct a regular hexagon given the distance across flats

i. Draw a circle whose diameter is equal to the distance across flats. Draw the vertical diameter AB.

ii. Draw diameter CD and EF at 30^0.

iii. Through A and B, draw horizontal tangents.

iv. Through C, D, E, F, in turn, draw tangents at 60^0. The figure that is formed by the intersection of the tangents is the required hexagon.

Hexagon

Note: This is the procedure when it is required to describe a regular hexagon about a given circle.

(C) To construct a regular octagon given its side

i. Through C and D, draw vertical lines and mark off CE and DF equal to AB.

ii. Through E and F, draw lines at 45^0 and mark off EG and FH equal to AB.

iii. Join GH to complete the octagon.

iv. Through C and D, draw vertical lines and mark off CE and DF equal to AB.

v. Through E and F, draw lines at 45^0 and mark off EG and FH equal to AB.

vi. Join GH to complete the octagon.

(D) To construct a regular octagon given the distance across flats

i. Draw a circle whose diameter is equal to the distance across flats. Draw horizontal diameter AB and vertical diameter CD.

ii. Draw diameters EF and GH at 45^0.

iii. Draw vertical tangents through A and B and horizontal tangents through C and D.

iv. Through E, F, G H in turn draw tangents at 45^0. The figure formed by the intersection of the tangents is the required octagon.

Note: This is the procedure when it is required to describe a regular about a given circle.

(E) General methods for constructing a regular polygon on a given base

(a) The 'External – 360^0/N Rule'

i. Obtain the external angle of the required polygon by dividing 360^0 by the number of sides (N) of the polygon i.e. external angle = 360^0/N.

ii. Draw a horizontal line and mark off AB equal to the given base.

iii. Through A, draw a line at 360^0/N and mark off a length equal to AB. Also N at B, draw a line at 360^0/N and mark off a length to AB.

iv. Continue the process until you have obtained the polygon N side where N = 5, 6, 7, 8, 9, 10, ….

Suppose that N = 5, then external angle = 360^0/N = 72^0. The pentagon will be obtained by drawing at 72^0(b).

(b) The 'Two-Triangle Rule'

i. Draw a horizontal line and mark off AB equal to the given base.

ii. Bisect AB and produce its bisector as long as it is convenient.

iii. On AB as base, draw an isosceles triangle with base angle 45^0 and an equilateral triangle so that the apexes of the two triangles lie on the bisector of AB. Denote the apex of the isosceles triangle as d, and that of the equilateral triangle as f.

iv. Bisect fd to obtain point e.

v. Along the bisector of AB, from the point f, step off length de (or ef) to obtain points g, h, I, j, etc. The points d, e, f, g, I, j are the centres of the

circumscribing circles for a square, regular pentagon, hexagon, heptagon, octagon, nonagon and decagon respectively.

vi. suppose you want to draw a polygon of 9 sides (nonagon). With centre I and radius I A (or iB) draw a circle. Take length AB and step it off on the circle to obtain the points, C, D, E, F, G, H, I.

Join the points to obtain the required regular nonagon.

(Observed that d = 4; e = 5; f= 6; g = 7; h = 8; i = 9; j = 10.)

(F) The General Method for Describing a Regular about a given Circle

The method is best remembered as the 'Centre – $360^0/N$ Rule'.

i. Obtain the angle included by any two normals at the centre of the given circle by dividing $360^0/N$ by the number of sides N of the required described polygon, i.e. angle at centre = $360^0/N$.

ii. Draw the given circle with centre O and draw a vertical radius OA.

iii. Use a protractor to set out angles of $360^0/N$ and draw radii of OB, OC, OD etc., until you have got N radii.

iv. Through the points A, B, C, D, etc., draw tangents to obtain the required polygon. Suppose it is required to draw an octagon.

$360^0/N = 360^0/8 = 45^0$.

ASSESSMENT

1. Define Polygon?
2. List FIVE types of Polygon?

WEEK 4

Topic: AREA OF PLANE FIGURES

INTRODUCTION

The idea of area may be explained as the amount of space enclosed within the boundary of a figure. For instance, the area of the floor of a classroom is the amount of space enclosed within the four corners of the room. Also, the area of the top of the teacher's table is the amount of space enclosed within the edges of the table.

To measure this amount of space, we determine the number of square units. As an example, let us find the area of the rectangular floor of length 10cm and width 6cm. To do this, one method may be to take a square cardboard of one centimeter side and starting from one corner of the floor, mark the outline of the cardboard, edge to edge, until the whole space of the floor is covered. Then the number of the one-square centimeter marking is counted and that gives the area of the floor in square centimeters.

(A) To construct a triangle equal area to give a given triangle

(a) When the triangles are on equal bases

i. Draw the given triangle ABC and produce the base AB to D, making DE = AB.

ii. Through C, draw CF parallel to AD.

iii. With centre E and radius equal to a side of the required triangle, cut CF at G.

(B) To construct a triangle given its base and its area

Suppose that the given base and area are 5cm and 9sq. cm respectively:

i. Divide the given area by the given base, i.e. 9/5 =1.8cm.

ii. Draw a rectangle ABCD whose length is 5cm and width is 1.8cm.

iii. Produce the width of the rectangle to twice it magnitude, i.e. mark off CE = BC = 1.8cm.

iv. Join E. Triangle ABE is the required triangle.

(C) To construct a triangle equal in area to any to any given parallelogram

i. Draw the given parallelogram ABCD and draw diagonal BD.

ii. Through C, draw a line parallel to DB to intersect AB produced at E.

iii. Join DE. Triangle AED is the required triangle.

(D) To construct a rectangle equal in area to a given rectangle of different length

i. Draw the given rectangle ABCD.

ii. On AB (produced), mark off AE equal to the different length of the required rectangle.

iii. Join DE.

iv. Through B, draw a line parallel to ED to intersect AD (produced)at F. AF is the width of the required rectangle AEGF.

(E) To construct a square in area to a given rectangle

i. Draw the given rectangle ABCD.

With centre B and radius BC, swing arc CE to intersect AB produced at E.

iii. Bisect AE in F and draw a semi-circle on AE diameter.

iv. Produce BC to meet the semi-circle at G. BG is the side of the required square.

v. Complete square BGHI.

(F) To construct a square equal in area to the sum of the area of two given squares

i. Draw a line and mark off AB equal to the side of one of the given squares.

ii. At A, erect a perpendicular and mark off AC equal to the side of the other given square.

iii. Join CB. CB is the side of the required square.

iv. Complete the required square CBDE.

Note: This is based on Pythagoras' theorem. This theorem states that the square on the hypothenuse of a right-angled triangle is equal to the sum of the squares on the other two sides.

Enlargement and Reduction of Regular Plane Figures

(A) To construct a figure similar to a given figure ABCDEF with its sides in the ratio of 6.4 to those of the given figure.

i. Draw the given figure ABCDE.

ii. Divide the figures into triangle by drawing lines AC, AD and AE.

iii. Draw line AG at a convenient angle and set off on it from A, 6 equal parts.

iv. Join point 4 to B and draw GB1 parallel to GB to cut AB produced at B1.

V. Draw B1, C1, D1, and D1 E1 parallel to BC, CD, and DE respectively to complete the required figure.

(B) To construct a figure similar to a given figure ABCDEF with its sides in the ratio of 4:6 to those of the given figure

i. Draw the given figure ABCDEF.

ii. Divide the figures into triangles by drawing lines AC, AD and AE.

iii. Divide AB into six equal parts.

iv. Draw B1, C1, C1, D1 and D1 E1 parallel to BD, CD and DE respectively to complete the required figure.

(C) To construct the size of a given rectangle by a given proportion

Let the proportion be 6:4.

1. Draw the given rectangle ABCD.

ii. Choose point P at any convenient distance from the rectangle, and from radiate lines to corner A, B, C and D.

iii. Divide PA into 6 equal parts.

iv. Draw A1, D1, D1, C1 and B1 A1 respectively to complete the required rectangle.

ASSESSMENT

1. Define Area?

WEEK 5

Topic: **WOOD WORK MACHINES**

INTRODUCTION

Woodwork machines refer to the common equipment used in the workshop. Most of these machines are heavy and cannot be handled ordinarily. Some of them are fixed on the ground and are used with electric power. A few of these machines will be discussed.

Two sections exist here in this topic:

1. Portable power tools

2. Machines

Portable Power Tools

These are tools that are held in the hand and operated with electric current. The examples to be discussed here are:

1. Sanders

2. Hand drills

3. Fret-saw

Sanders

Sanding means smoothing of work with coated abrasives. The abrasives may be made of glass, garnet (a type of precious stone), silicon carbide, aluminium oxide (a brown African abrasive), etc.

Available portable sanders for wood-work smoothing including belt sanders and drum sanders.

Disc sander Orbiter sander Belt Sander Drum sander

Hand Drills

Holes in materials can be made by many methods, e.g. punching, flame cutting, boring and drilling. This section is concerned only with making cylindrical holes with the aid of drills. Drills and drilling machines are the commonest tools used for making holes. The operation is called drilling and the tool used is called a drill.

There are different types of drills used in a metal workshop:

a. Twist drill;

b. Flat drill;

c. Straight-fluted drill;

d. Counter-sink drill.

Sensitive Drilling Machine (Bench)

This type of drilling machine is also designed for light jobs. It is possible to drill holes from 1mm diameter to about 18mm.

The main difference between this machine and the electrical hand-drilling machine is that the bench type is to the work bench.

Fret-Saw

This saw is used for complex shapes and curves in plywood and veneers. The blade of this saw is finer than the coping saw blade. It has a high frame which allows it to be used over a wide area. Its blade is about 125mm long.

Fret Saw

Machines

The other types of the equipments used in woodworks are those equipment which are not portable as the discussed earlier. These machines are heavy. They are fixed on a spot most of the times. Examples are circular saw, band saw, wood lathe, surface planner, thicknesser, sanders, drills, etc.

Safety Hints in Using the Woodwork Machines

1. Remove loose fitting clothings, rolling sleeves aprons and eye shield.

2. Remove scraps from saws, tables and floor.

3. Regular oiling and greasing of bearing must be encouraged.

4. Use the correct saw for each job.

5. Saws should be properly set and should be sharp.

6. Before switching one, make sure the blade runs free.

7. Stand to one side when switching on.

8. Switching on to make adjustments on machine or checking measurements or changing belt speed.

9. Do not overload the machine or force it to work beyond its capacity.

10. Make sure you know how to use the machine that you want to use.

ASSESSMENT

1. Define woodwork machines?

WEEK 6

Topic: METAL WORK MACHINES

Introduction

A machine tool is a machine that cuts metals and performs some other operations by manipulation of its parts. This chapter introduces you to the five basic machines normally regarded as machine tools.

Content:

- Types of metal work
- The centre lathe and its operation

Types of Metal work

Machines and their Functions

i. Lathe

ii. Shaper and planer

iii. Milling machine

iv. Drill press

Modern machinery production technology has made it possible to manufacture other production machine tools for special purposes by utilizing

the technology of these basic ones. In this chapter, we shall briefly present the functions and uses of these machine tools.

Lathes

There are two types of metal lathes – the plain lathe and the screw cutting lathe. The purpose of a lathe is to remove metal by use of a rigidly controlled hard steel-cutting tool. The revolving is the held firmly in a chuck or between centres while the tool cuts. Lathes are equipped with various devices as presented below:

a. Setting the tail stock

b. Checking for correctness

c. Turning between centers

Taper Turning

Taper turning is the production of a piece of round work in which one end is bigger than the other. It is always a conical shape. There are few methods by which the shape could be produced on the lathe. Tapering with a form tool is the simplest. It involves the use of shaped tool or cutter fed into the work piece to produce the taper required. Such tapers are termed short tapers and can be used for either internal or external turning.

Surfacing

Surfacing is achieved when the cutting tool moves perpendicular to the axis of rotation of the job being machined and therefore produces a flat surface. A good face is got when a suitable surfacing tool is used. While surfacing to the center point of a work, it is important to set the tool tip to the exact centre height. On the other hand, if the tool moves parallel to the axis of rotation of the workpiece, a cylindrical surface is produced. This is called a plane face.

Turning of a series of plain diameters on a work piece can simply be carried out on the centre lathe. This is better achieved with the use of carriage movement, because the straightness of the bed ways ensures the parallelism of the workpiece, and can be power-operated and produced at one setting. The further maintains concentricity between the different diameters. If the workpiece is removed for any reason while still turning, accuracy is lost, and this should be avoided. This process is ideal in producing what is termed stepping turning.

Sawing

The power sawing machine is used to cut the soft material with coarse tooth back-saw blades. The coarse tooth ensures that the metal chips do not clog the teeth. There are many brands of the hack sawing machine but a good one is the type incorporated with relief of pressure on return stroke by oil pump or by adjustable oil dash pot in conjunction with the angular setting of the slide. The work piece should be gripped rigidly, and the frame lowered carefully to start the cut.

Abrasives

In metal working, two types of abrasive are used. These are aluminium oxide and silicon carbide. Silicon carbide is suitable for the grinding of materials of low tensile strength such as iron, brass, bronze, copper, aluminium and cemented carbide.

Its abrasive forms are obtainable in powder form, grinding paste, lapping compound wheels and variously shaped stones and on cloth or paper in grades O, FF, 1, 1½, 2, 2 2/2 – 3 to 4 which is the coarsest.

Drill Press

Small diameter holes can be drilled with the use offhand drills, as the holes to be drilled becomes larger, the handle of the drill can be replaced with breast plates at right angles.

(Most work is gripped in a vice, fastened to work table with boils. The bottom of the vice must be parallel, and square to the jaws.

It is dangerous to drill a piece of work on the drill press without holding the job firmly and securely. In order to avoid accidents, it is necessary to clamp down the work to the body of the drill, thus becoming breast drill as much pressure is needed, say about 25mm or over, hand powered drilling machine can be used, or a drilling pillar and a ratchet brace. For thicker metal boring, the use of power-driven sensitive drilling machine can be used. The work table is a special vice or jig as the case may be. Work held by hand on a drill press often results in injuries, and should be avoided. These are twist drill, combination drill, reamer (sunblind drill), countersink, counter bore cutter, spot face cutter, trepanning tool, tap, etc.

Cutting Fluids

These are sometimes called coolants or cutting lubricants. They are important on machine tools. They are used to:

a. cool works and tools, and to lessen distortion.

b. lubricate, thereby reducing power consumption.

c. preventing welding of chips to tool.

d. wash away tools chips and swarf.

e. improve surface finish

f. protect tools against corrosion.

Coolant may be divided into three main classes:

a. Soluble oils

b. Straights oils

c. Water-based fluids

Soluble oils: These are mineral oils treated to form an emulsion when added to water. They can be used neat, or diluted with water to increase their cooling powder.

They usually leave on the machine a protective cooling or film that is rust resistant.

Straight oils: These are mainly mineral and extreme pressure (EP) cutting oils. They are used undiluted for slow heavy-cutting operations, as they process good lubricating properties.

Water-base fluids: These are solutions of salts and other minerals in water. They have good cooling properties. They are best applied by using a point, an oil tray and reservoir to give a slow continuous stream over the cutting action. An oil pipe can be used where pumping devices are not possible.

ASSESSMENT

1. A machine tool is___
2. List THREE types of metal work?

WEEK 7

Topic: METAL WORK MACHINES (continued)

Metalwork tools are split in two major categories. The first category includes the industrial metalwork tools. They are very advanced and can easily do various jobs with minor help from an engineer. Industrial metalwork tools can easily be referred to as machines. Their prices reach astronomical numbers. If you own such tools, then you probably need a professional to take care of them. They require particular maintenance operations that cannot be done by a regular owner. However, this is a valid statement only if you own a large scale company or you are… An eccentric person.

A regular person interested in metalworking opts for a different category of tools. Most garage owners don't usually use them to host their car inside. Almost every garage has a small area in a corner full of tools. It is a common hobby for men to do various crafting operations. Sometimes they are needed in the house, sometimes they are just fun times. However, such metalwork tools are easier to maintain than industrial machines. Let's see how.

Among the most common tools, hammers and screwdrivers are the easiest to take care of. They must be kept out of moisture and if somehow they end up wet, they need to be taken through scrapping operations. However, such unpleasant situations appear over long periods of time, like for instance constant leaks through your garage roof in your tools set. On the other hand, clippers may require more operations. Every once in a while, oil their mechanisms in order to keep them working smoothly. Also, avoid using them for anything else they are not designed for. Especially if you own pneumatic or blading clippers. Blades need to be used for very clear and soft surfaces. Any small particle of dirt may ruin them.

If your passion goes beyond the Sunday fun metal crafting, then you probably need more than just the basic tools. If you are practicing to become a professional or just having a little business going in your garage, you may opt for mechanical or electric tools. They are more expensive, but they can make a better job. They also need particular maintenance operations for a good functionality.

For a proper care of more advanced metal crafting tools, make sure you read their manuals first. It is imperative to avoid going beyond the limits if you care for your tools. Since most of them come with warranty periods, you are basically obliged to resume to exactly what you should do. If somehow you think you are smarter than the manufacturers and start doing your own

things, you will lose the warranty. This only means two things – you have a wrecked tool and you need to pay money to fix it, congratulations!

Among the basic maintenance operations for mechanical or electrical tools, you might have to clean them with wet and clean sponges, or use oil for their joints. Make sure you keep them at the temperatures indicated in their manuals and avoid direct sunlight or moisture. Dusty places are also a bad idea for depositing your tools.

Assessment

1. List the two metal works categories.
2. How do you care for metals?

WEEK 8

Topic: FRICTION

Definition of Friction

Friction is the resistance to motion of one object moving relative to another. It is not a fundamental force, like gravity or electromagnetism. Instead, scientists believe it is the result of the electromagnetic attraction between charged particles in two touching surfaces.

In liquids, friction is the resistance between moving layers of a fluid, which is also known as viscosity. In general, more viscous fluids are thicker, so honey has more fluid friction than water.

The atoms inside a solid material can experience friction as well. For instance, if a solid block of metal gets compressed, all the atoms inside the material move, creating internal friction.

In nature, there are no completely frictionless environments: even in deep space, tiny particles of matter may interact, causing friction.

Causes of Friction

Friction is a force that resists the relative motion between two objects or materials. The causes of this resistive force are molecular adhesion, surface roughness, and deformations.

Adhesion is the molecular force resulting when two materials are brought into close contact with each other. Trying to slide objects against each other requires breaking these adhesive bonds. For years, scientists thought that friction was caused only by surface roughness, but recent studies have shown that it is actually a result of adhesive forces between the materials.

But surface roughness is a factor when the materials are rough enough to cause serious abrasion. This is called the sandpaper effect.

When one or both of the materials is relatively soft, much of the resistance to movement is caused by deformations of the objects or by a plowing effect.

Molecular adhesion

When two objects are brought into contact, many atoms or molecules from one object are in such close proximity to those in the other object that molecular or electromagnetic forces attract the molecules of the two materials together. This force is called adhesion. Trying to slide one object across the other requires breaking these adhesive bonds. Adhesion is the essence of friction.

You've seen a water drop adhere to a window pane. The force of friction prevents this liquid from sliding down the solid material. But most cases of friction you see concern a solid object sliding or moving against another solid.

Sliding objects against each other requires breaking these millions of contact points where the adhesion force takes effect, only to result in millions of new contact points of adhesion.

Sticky materials
Some solid materials may have a composition that greatly increases their adhesion and makes them even "sticky" to the touch. This stickiness greatly increases the fiction. Rubber and adhesive tape are examples of sticky materials that have this type of friction.

Fluids
Fluids often exhibit molecular adhesion, increasing the friction. This adhesion force is often seen in the capillary effect. This is where water will be pulled up a glass tube by the forces of molecular adhesion. That same force can slow down fluid motion.

One example is how a coin will easily slide down a ramp. But if you wet the coin, it will stay in place. That is because of the molecular friction of the fluid on the hard surfaces.

The motion of two fluids or two sections of a fluid against each other is also slowed down by the molecular attraction factor. This type of fluid friction is usually not considered as friction and is studied under the complex field of fluid dynamics.

Surface roughness

All solid materials have some degree of surface roughness. If you looked at what seems to be a smooth surface under a high-powered microscope, you would see bumps, hills and valleys that could interfere with sliding motion.

Close-up view of surface roughness

At one time it was thought that the surface roughness of materials was the cause for friction. In reality, it only has a small effect on friction for most materials.

If the surfaces of two hard solids are extremely rough, the high points or asperities can interfere with sliding and cause friction because of the abrasion or wear that can take place when you slide one object against the other. This is the "sandpaper effect" where particles of the materials are dislodged from their surfaces. In such a case, the friction is caused by surface roughness, although the adhesion effect still plays a part in the abrasion.

Deformations

Soft materials will deform when under pressure. This also increased the resistance to motion. For example, when you stand on a rug, you sink in slightly, which causes resistance when you try to drag your feet along the

rug's surface. Another example is how rubber tires flatten out at the area on contact with the road.

When materials deform, you must "plow" through to move, thus creating a resistive force.

Pushing object on soft surface

When the deformation becomes large, such that one object sinks into the other, streamlining can affect the friction, similar to what happens in fluid friction.

ADVANTAGES OF FRICTION

Friction plays a vital role in our daily life. Without friction we are handicap.

1. It is becomes difficult to walk on a slippery road due to low friction. When we move on ice, it becomes difficult to walk due to low friction of ice.

2. We cannot fix nail in the wood or wall if there is no friction. It is friction which holds the nail.

3. A horse cannot pull a cart unless friction furnishes him a secure Foothold.

DISADVANTAGES OF FRICTION

Despite the fact that the friction is very important in our daily life, it also has some disadvantages like:

1. The main disadvantage of friction is that it produces heat in various parts of machines. In this way some useful energy is wasted as heat energy.

2. Due to friction we have to exert more power in machines.

3. It opposes the motion.

4. Due to friction, noise is also produced in machines.

5. Due to friction, engines of automobiles consume more fuel which is a money loss.

METHODS OF REDUCING FRICTION

There are a number of methods to reduce friction in which some are discussed here.

USE OF LUBRICANTS: The parts of machines which are moving over one another must be properly lubricated by using oils and lubricants of suitable viscosity.

USE OF GREASE: Proper greasing between the sliding parts of machine reduces the friction.

USE OF BALL BEARING: In machines where possible, sliding friction can be replaced by rolling friction by using ball bearings.

DESIGN MODIFICATION: Friction can be reduced by changing the design of fast moving objects. The front of vehicles and airplanes made oblong to minimize friction.

ASSESSMENT

1. What is friction?

2. What are the causes of friction?

3. Mention 3 advantages of friction.

4. Identify 4 disadvantages of friction.

WEEK 9

Topic: FRICTION (Continued)

Reduction of friction

It is beneficial to reduce the friction between surfaces to make movement easier or reduce the wear and tear on a surface. There are a number of ways to reduce friction:

1. **Make the surfaces smoother:** Rough surfaces produce more friction and smooth surfaces reduce friction. Some swimmers wear suits to reduce underwater resistance. These suits mimic the smooth skin of sharks.

2. Lubrication is another way to make a surface smoother. A lubricant is a slippery substance designed to reduce the friction between surfaces. You might use oil to stop a door from squeaking – the oil reduces the friction in the hinge. Water can be used as a lubricant – think of how a floor becomes slippery after it has been mopped.

3. **Make the object more streamlined:** A streamline shape is one that allows air or water to flow around it easily, offering the least resistance. Compare a boxy old car with a new car that has a rounded shape, allowing it to move with less effort.

4. **Reduce the forces acting on the surfaces:** The stronger the forces acting on the surfaces, the higher the friction, so reducing the forces would reduce the friction. If you apply the handbrake when you try to drive a car, the car will have a lot of difficulty moving because of the force immobilising (stopping the movement of) the wheels. If you release the handbrake, the wheels will move more freely because there is no extra force acting on them.

5. **Reduce the contact between the surfaces:** Have you ever tried to roll a cube? Spheres are the best shape for reducing friction because very little of a spherical object is in contact with the other surface. Several types of wheels, such as skateboard wheels, contain small spheres called ball bearings to reduce the friction between the moving parts. You can witness the effect of ball bearings by comparing the friction between sliding a book on a table and then doing the same, but using marbles between the book and the surface of the table. Notice how the marbles act as ball bearings, reducing the friction.

LUBRICATION

Lubrication is simply the use of a material to improve the smoothness if movement of one surface over another; the material which is used in this way is called a lubricant. Lubricants are usually liquids or semi-liquids, but may be solids or gases or any combination of solids, liquids, and gases.

The smoothness of movement is improved by reducing friction. This is not, however, always the case, and there may be situations in which it is more important to maintain steady friction than to obtain the lowest possible friction.

In addition to reducing or controlling friction, lubricants are usually expected to reduce wear and often to prevent overheating and corrosion.

TYPES OF LUBRICANTS

Lubricants are usually divided into four basic classes.

(a) **Oils**: A general term used to cover all liquid lubricants, whether they are mineral oils, natural oils, synthetics, emulsions, or even process fluids.

(b) **Greases**: Technically these are oils, which contain a thickening agent to make them semi-solid. It is convenient, however, to include the anti-seize pastes and the semi-fluid greases under the same heading.

(c) **Dry lubricants**: These include any lubricants, which are used in solid form, and may be bulky solids, paint-like coatings, or loose powders.

(d) **Gases**: The gas usually used in gas bearings is air, but any gas can be used which will not attack the bearings, or itself decompose.

The advantages and disadvantages of oils stem from their ability to flow easily. Thus, on the credit side, it is very easy to pour them from a container, to feed them into a bearing by dripping, splashing or pumping, and to drain them out of a machine when no longer fir for use. Other advantages are the cooling of a bearing by carrying away heat, and cleaning it by removing debris.

The behavior of greases is very similar to that of oils, but the former are used where the advantages of easy flow are outweighed by the disadvantages. Thus grease do not easily leak out of a machine, or container, do not migrate away, and will form an effective seal against contaminants.

The advantages and disadvantages of solid lubricants are rather like the extremes for greases, where the lubricant will not flow at all. Similarly, the advantages and disadvantages of gas lubricants are like the extremes of oils, where the flow properties are almost too good.

ASSESSMENT

1. Which of the following actions will reduce friction?
   (a) Make the surfaces rougher
   (b) Make the surfaces smoother
   (c) Increasing the contact between the surfaces
   (d) Exerting more force on the surfaces
2. Lubrication is a way to make a surface
   (a) clean
   (b) smooth
   (c) rough
   (d) dirty
3. The stronger the forces acting on the surfaces…
   (a) the higher the friction
   (b) the lower the friction
   (c) the higher the smoothness
   (d) the lower the smoothness
4. One of these is not a class of lubricants
   (a) solid
   (b) liquid
   (c) gaseous
   (d) flat
5. Greases contain a thickening agent that makes them
   (a) solid
   (b) semi-solid
   (c) liquid
   (d) gas