JSS 3 BASIC TECHNOLOGY NOTES

MACHINES

Definition:

A machine is an equipment, which man uses to make his work faster, easier, more accurate and at low cost.

The world we live in today has come to the point where man can no longer live without machines. In a better sense, we can safely say that mankind and machines have become married to each that they can hardly be separated. This is the reason why we have to study to know more about it.

Types of machines:

Although at this level of learning, you are expected to learn about two main types of machines namely simple and complex machines, there are actually three known types of machines. These are briefly stated and explained below:

1. **Simple Machine:** This is a machine type that does not require any engine, electrical and or electronic system for it to work. It is purely mechanical, requiring only human hands, legs or other body parts to work. E.g. Scissors, knife, pen, wheelbarrow, pliers, hammer, crowbar, mallet, hoe, cutlass, bicycle, etc.
2. **Compound Machine**: This type of machine requires an engine, mechanical system, and or some electrical systems to work. Some examples of compound machines are: fan, washing machine, motorcycle, electric pressing iron, mixer, toaster, barbing machine, roller coaster, elevator, etc.
3. **Complex machine**: This is a type of machine which has mechanical systems, electrical, electronic and an engine system in it. Examples of this type of machine included: train, aircraft, vehicle, ship, computers, phones, radio set, scanner, X-ray machine, telescope, etc.

Mechanical Advantage (M.A):

This is a technical term that is used to know the amount of value a machine can give to man. Numbers are used to know how beneficial a machine is to man. This benefit or value is actually based on the amount of energy, power or effort that man has to put into a machine for it to work for man. The smaller the number, the greater the effort; and the bigger the number, the smaller the effort man applies. Mechanical Advantage is calculated by using the mathematical formula below:

$$\text{Mechanical Advantage (M.A)} = \frac{\textbf{Load}}{\textbf{Effort}} \quad \text{-(1)}$$

Example problem: Two machines are expected to lift a load of 350N. If the force machine A applied to lift it is 75N and machine B used a force of 105N to do the same, (a) calculate the mechanical advantages for each of the machines? (b) Which of the machines is more efficient?

Solution:

(a) (i) For machine A, the Lord is 350N, and the effort is 75N, applying equation (1) above, mechanical advantage, M.A will be:

$$M.A = \frac{\textbf{Load}}{\textbf{Effort}},$$

$$= \frac{\textbf{350N}}{\textbf{75N}}$$

$$M.A = \underline{4.7}$$

(ii) For machine B, the Lord is 350N, and the effort is 75N, applying equation (1) above, mechanical advantage, M.A will be:

$$M.A = \frac{\textbf{Load}}{\textbf{Effort}},$$

$$= \frac{\textbf{350N}}{\textbf{105N}}$$

$$M.A = \underline{3.3}$$

(b) Machine A is more efficient than machine B.

Velocity Ratio (V.R)

Just like mechanical advantage, velocity ratio is also used to find out how efficient a machine is at work; but in this case, we compare the distance that the effort has to cover to produce the distance the load would travel.

To understand this idea very well, we have to make it clear that the distance in question is not only the one measured on a straight line. It also involves the distance a rotating round object like a shaft can cover as it rotates. You can test this by rolling a pipe on a flat surface or ground. Mark the point where you placed it and then move it to roll once. You will see that it will cover a distance on the ground. This then makes it clear that a round object rotating faster can cover more distance than the one rotating slower. This is what velocity ratio uses to measure the efficiencies of machines, because machine parts rotate. Mathematically, velocity ratio is written like this:

$$\text{Velocity Ratio, VR} = \frac{\textbf{Distance moved effort}}{\textbf{Distance moved by load}} = \frac{\textbf{dE}}{\textbf{dL}} \quad \text{- - - - -(2)}$$

Example Problem: If the distance a leg on a bicycle pedal covers while pedaling is 300m and the bicycle covers a distance of 896m within this period, what is the velocity ratio of the bicycle?

Solution:

The distance moved by the effort (pedal) is 300m; and the load (bicycle) cover a distance of 896m. From equation (2) above,

$$\text{Velocity Ratio, VR} = \frac{\textbf{Distance moved effort}}{\textbf{Distance moved by load}} = \frac{\textbf{dE}}{\textbf{dL}}$$

$$= \frac{\textbf{300}}{\textbf{896}}$$

$$= \underline{0.33}$$

It can therefore be stated from the values of VR that the smaller the velocity ratio, the more efficient the machine and vice versa. But in the case of mechanical advantage, the bigger the MA, the more efficient is the machine, and the smaller the MA, the less efficient it is.

TOPIC: MOTION TYPES

Definition:

Motion is an active state when an object or a particle is continuously changing its position. When an object moves from the position it is to another position, that object has experienced motion. But, the exact moment when it is moving to the new location is what we call motion.

Types of motion

There are basically four types of motion. We shall mention them, explain them and give some examples of some machine parts that experience these types of motion.

1. **Linear (also known as translational) motion:** Is the type of motion which requires an object to move in a straight line. Examples of object that experience linear motion are: link assembly, lever, slide and slots.
2. **Rotary (circular) motion:** Is the type of motion that sees and object moving round in a circle. Example of things that experience this type of motion is the tire in a car, engine crank shaft, flywheel, ceiling fan, etc.
3. **Oscillatory (to and fro) motion:** Is the movement of an object in a back and forth direction; going and returning to its initial position through the same path. Examples of some things that experience this type of motion are arm of pendulum clock, rack and pinion, see-saw, the knee of someone riding a bicycle, etc.
4. **Random (zig-zag) motion:** Is the movement of an object in any direction. The movement of the object cannot be predicted. Examples of things that experience random motion include gases, atomic molecules, electrons, etc.

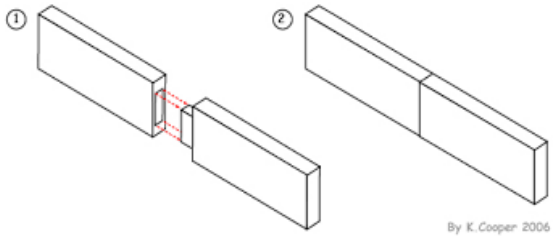
TOPIC: Wood Work Projects

Woodwork project is the activity that involves the use of wooden materials to make or produce items that are useful to man. It is difficult for these useful items to be cut out from one single wood without using joints. This is the reason why we have to study and know more about the different types of joints that are used to achieve these goals.

Classification of Wood Joints

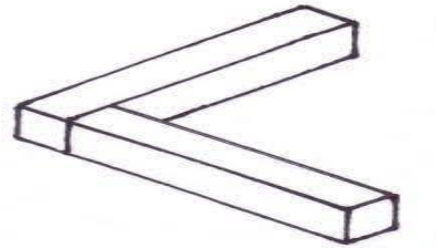
Wood joints can be classified into three main categories:

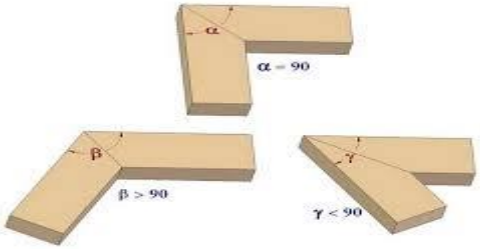
1. **Lengthening**: This is the category of joints that are used to increase the length of wood.



2. **Widening**: This is when joints are used to increase the wideness of a wooden member.

3. **Framing/Corner**: This is when joints are used to change the direction of structural members.





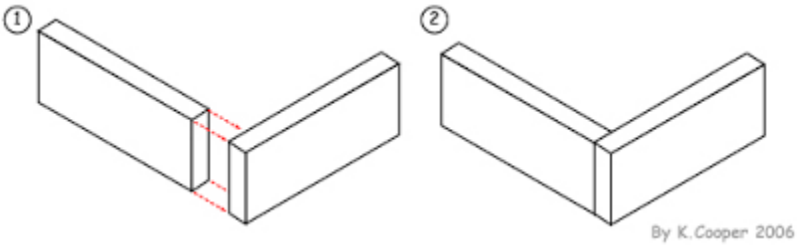
Types of Wood Joints

The various types of wood joints can be discussed under two headings:
1. Those used to increase the length and width of wooden members
2. Those used to change the direction of wooden members.

Let's look at them closely.

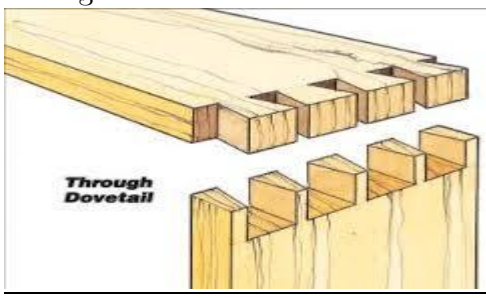
Wood Lengthening and Widening Joints

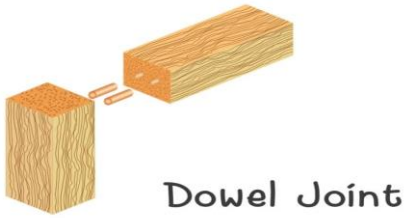
1. **Butt joint**: Is the type of joint where the flat faces of the wood to be joined are placed together and held by a glue of a fastener. It is shown below.



2. **Tongue and groove Joint**: Is the type of joint where a groove in cut through the center of one of the wooden member and a tongue is cut on the center of the other. The two are joined by meshing them together as shown below.

3. Dowell Joint: In this type of joint, square or circular holes are drilled into the two wooden members. Pins made in the forms of cylinders of cuboids are used to hold to them together. This is shown below.

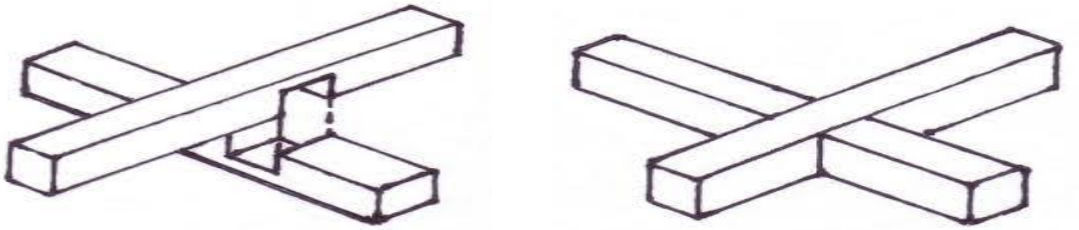




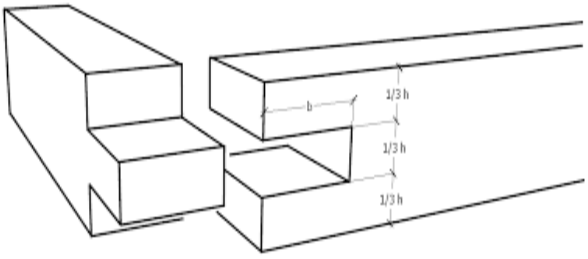
4. Slot Screwed Joint: This type of joint is similar to Dowell joint. The only difference is that screws are used to join the wooden members instead of pins.

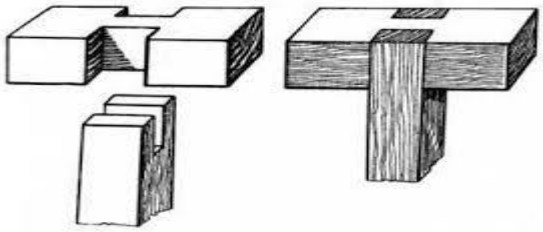
Joints Used to Change the Direction of Wooden Members

5. Halving Joint: This is the type of joint that is formed by cutting the wooden members half way into their thicknesses. These provide the surfaces for the joining. Halving joint comes in different form as shown below.

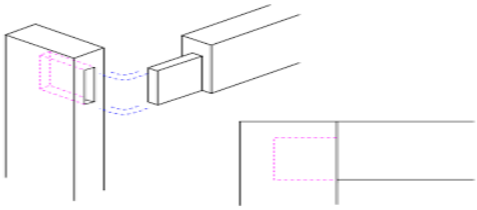


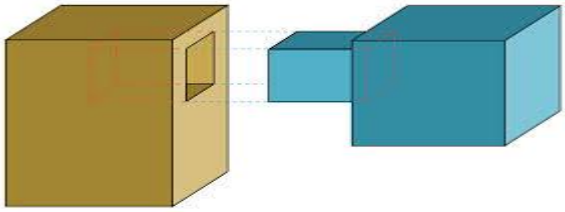
6. Bridle Joint: Is a joint that is similar to tongue and groove. The difference between them is that while tongue and groove has its groove and tongue cut in the center of the wooden member, in bridle joint, they are cut at the ends of the wooden member. This is shown below.



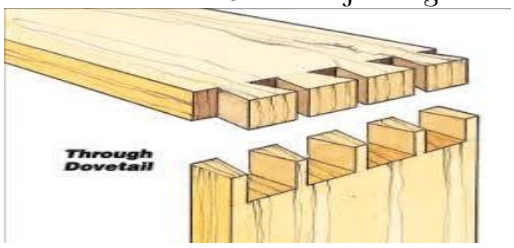


7. Mortice and Tenon Joint: Is the type of joint whereby a pin is cut out at the end of one of the members, and a hole to receive the pin is cut into any chosen location on the second wooden member. Both are then joined as shown below.





8. Dovetail Joint: This is a joint that contains pins and grooves that have the shape of dovetail cut at the ends of the joining members. This is shown below.



Uses of Wood Joints

Wood joints are used to do the following:

1. To make chairs, tables, beds, wardrobes, and shelves.
2. To make vehicle, aircrafts, ship, trains, etc body parts.
3. To make sculptures and other art works.
4. To give special wooden items unique shapes and twists.
5. To roof houses, makes staircases, and build bridges.
6. To make door frames, picture frames, window frames and the shutters.
7. To make wooden floor, alters and pulpits, and balustrades for staircases and verandahs, etc.

TOPIC: Metal Work Projects:

Metal work project is the activity which man does that helps him to produce different kinds of items that are useful to him. In this topic, we will consider some of the activities or processes that man engages in while working with metals to produce something useful to him.

Metal Work Processes

Metal work processes or activities are so many. We consider some of them as follows:

1. Marking: This is the use of a tool called Engineer's Pen or Scriber to draw lines on a metal sheet
2. Bending: Is the act of giving a metal sheet some shapes by bending it.
3. Surface: Is the process of reducing the diameter of thickness of a metal bar.
4. Folding: Is the process of folding metal sheet into tubes, prisms, and pyramids.
5. Welding: Is the process of joining metal members by heating them at a very high temperature.
6. Drilling: Is the process of making a new hole in a metal member.
7. Boring: Is the process of increasing the diameter or size of an existing hole in a metal member.
8. Facing: Is the process of cutting a flat surface across the length of a metal bar.
9. Planning: Is the process of cutting a flat surface on a chosen face of a metal member and along its length.
10. Brazing: This is the process of joining two or more metals by using another softer metal members.
11. Filing: This is the process of using a file to remove unwanted areas or parts on the surface of a metal.
12. Threading: Is the cutting of thread profiles in or on metal members.
13. Case-hardening: Is the process of making the surface of a metal member to become harder than its inner parts.
14. Alloying: This is process of combining two or more metals to produce one special type of metal.
15. Casting: Is the process of producing metal items from liquid metals.
16. Shaping: Is the process of cutting solid metal members into desired shapes

TOPIC: Metal (Steel) Production

The processes that are involved in metal production are very tedious. We shall look at some of the steps that steel metal go through to become what we use today.

The Ore: This is the special type of rock from where metals of different types are extracted. There is an Ore for gold, tin, silver, iron, etc. The Ore for iron is different from that of tin, etc. It is dug up from the ground, passed through many harsh conditions, to arrive at the final metal product. We shall now take a brief look at some of the processes that iron undergo to become steel.

Smelting: The metal Ore that is used to produce iron and subsequently steel is called Ferrite, Magnetite or Ironmite. This Ore is raw, and it is mixed with impurities called **gangue.** The impurity is composed of such chemicals as phosphorus, manganese, silicon, and others. This Ore is poured into a furnace and then heated to a very high temperature. While the Ore is heated it dissolves; limestone and coke are added in portions, which help to move the impurities to the surface of the molten metal, thus separating the gangue from the pure metal

iron. That is why this method of producing metal is called **Smelting** (**Separation** during **melting: S-melting**). This pure iron, when allowed to cool is brittle; meaning it can break easily. That is why it is called **Pig Iron** at this stage. Later, the liquid **Pig Iron** is mixed with carbon and other elements to produce different types of steel metal, having different amount of strengths.

Furnaces: There are different types of furnaces that are used to produce metal. Each type of furnace has a role is plays specifically. For instance, Blast Furnace is used for smelting iron. Copula Furnace is used for refining metals. Bessemer Converter is used to convert metal from one form to another. High Frequency Induction Furnace is used to produce tool steel from Pig Iron. These are some examples of furnaces that are used during the production of different types of metals.

Types of Steel and their Carbon Contents: There are five types of steel that are made from Pig Iron. It is Copula Furnace that is used to refine iron to these steel types. They are briefly stated and explained below.

1. **Mild (Low Carbon) Steel:** Contains about 0.05% to 0.15% of carbon in it. It is very soft and can be bent and twisted easily. It rusts easily; and is for making nails, wires, sheet metals, car body parts, roofing sheet, etc.
2. **Medium Carbon Steel**: Contains about 0.2% to 0.5% carbon in it. It is stronger than mild steel, and is not too easy to bend. It is used to make such metals as nails, rods, metal bars, cooking utensils, etc.
3. **High Carbon (Tool) Steel**: Contains above 0.8% carbon. It is very hard. Normally, all kinds of hand tools are produced from it. These include Pliers, chisel, file, hammer, spanner, etc.
4. **Cast Iron**: Contains 2% to 5% carbon in it. It is extremely tough, making it easy to break when given a hard blow. Some of the vehicle parts, engine blocks and weapons are made from cast iron.
5. **Wrought Iron**: This is the hardest of all steel. In fact, it is so hard that it is resistant to rust. It contains more than 5% carbon in it. It is used to make such things like railway lines, chains, gates, valves, etc.

Metal Alloy: An alloy is a special metal that is formed by mixing two or more metals together while they are in liquid forms. Stated below are some examples of metal alloy.

1. **Brass**: It is formed by combining 65% copper and 35% zinc.
2. **Bronze**: Contains 80% copper and 20% tin.
3. **Duralumin**: Contains 4.5% copper, 0.5% manganese, 0.5% magnesium, and 94.5% aluminum.
4. **Gilding Metal**: Contains 90% copper and 10% Zinc.
5. **Alloy Steel**: Is an alloy of steel or iron. It is made by combining iron and other type metals at different percentages.

TOPIC: Wood Production

This involves all the activities that leads to the provision of wooden material which man uses to make items that useful to him. Wood production activities include timber growth, felling, transportation, conversion, preservation and seasoning. We shall now look at each of these activities in turn.

1. **Timber Growth**: Timber grows as a tree, which is later cut down. When the timber or log of wood is wet, it is called **evergreen wood**; but when it is dead, it is called **dried wood.** These trees are planted **artificially** in forest reserves by man or **naturally** by God in thick bushes. The tree standing is not timber. It becomes timber when it has been cut down or felled.
2. **Felling of Timber**: There are processes involved before trees are cut down. These processes include: (i) the person to cut down a tree must obtain a permit from relevant government agencies in charge of tree preservations. (ii) With the permit, he approaches the forest reserve officials who then help him to select the right tree that is mature. (iii) The feeling of the tree is done during dry seasons for effective transportation. And, (iv) a safe direction is selected where the tree should fall once it is been cut down.
3. **Log transportation**: The tree that has been felled is then chopped into timber or logs of wet wood. These logs are then transported to the saw mill through the road – on trucks or by floating them on a river.
4. **Timber Conversion**: The logs of wood or timber are then cut into planks by applying one out of the two known methods used. These methods are **Plain Sawing** and **Quarter Sawing.**
5. **Wood preservation**: because the ease with which insects and fungi attack wood, it is often safe to treat the wood while they are wet. The chemicals used for this purpose are solignum, creosote, chlorinated phenol, Acid Copper Chromate, Chromated Copper Arsenate, Copper Azole, etc.
6. **Timber Seasoning**: This is process of removing the water content in the wood already converted to planks. There are two ways by which planks are dried. They are (a) The artificial method, which involves the use of kiln. And, (b), the natural method, which involves the use of dry, open air. The first method is faster, taking a few weeks, like six weeks or less. The second method takes months to dry the wood.

TOPIC: Hydraulic and Pneumatic Devices

Meaning. This topic has to do with the discussion involving power devices. One category of these devices gets their power from moving oil and the other category get theirs from moving air. Both the oil and the air are under intense pressure, because they have been squeezed into that horrible condition by another device called compressor. We shall now look at these two categories of power transmission devices.

1. **Hydraulic devices**: These are devices that transmit the power they receive from compressed oil such as engine oil, hydraulic oil, and other types of specified oil. Examples of such type of devices include the following: hydraulic car jack, hydraulic steering wheel,

hydraulic brake systems, hydraulic press, cladding machine, bricklaying machine, hydraulic power pack, crane, shock absorber, etc. One important thing to note about hydraulic devices is that the pressure applied at one point on the liquid is the same throughout the body of that liquid.

2. **Pneumatic Devices:** These are devices that transmit power by the used of compressed air mass. In the case of pneumatic devices, the pressure applied at one point on the air mass is not the same throughout the air mass. This is because air molecules have spaces between them. Examples of pneumatic devices are turbine, fan, pneumatic hammer, sir blast cleaner, blower, vacuum cleaner, atomizers, paint sprayer, forging presses, rock drills or crushers, pavement breakers, riveters, etc.

TOPIC: Airflow

Definition: Airflow is the movement of air mass from one location to another. Air is an invisible matter which we can hear or feel when it is passing around us. Research has shown that air contains 21% Oxygen, 76% Nitrogen and 1% other gases.

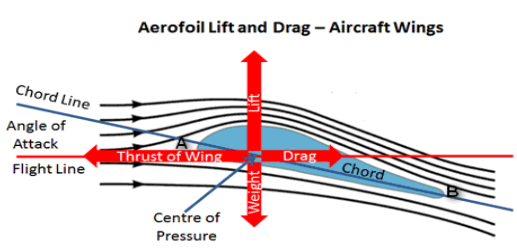
The movement of air is cause by a change in temperature and pressure. The movement of air is very important to man and other living things. This is because, without air moving, it will be very difficult for us to move around freely. It is the air mass that is responsible for what we know as gravity. This is because it is the moving air that makes every object to remain on the face of the earth. That means, the weight of everything we know is caused by moving air mass. In fact, it is the moving air that gives us balance as we move and do whatever we like to do.

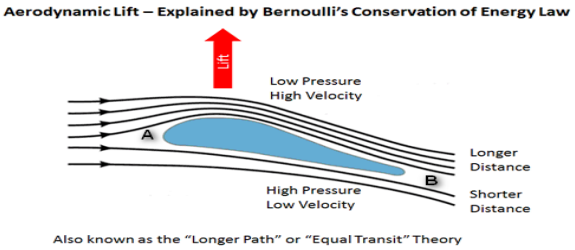
Uses of Airflow

Man has studied the behaviour of air mass when it moves, and so, he used his finding to produce things that are today useful to him. Example of such things are balloon, aircraft, hovercraft, turbine engine, scramjet (jet engine), fans, air conditioner, compressors, vacuum cleaners, blowers, airship, windmill, etc.

How Aircraft Flies

The principle behind the flying of aircraft is explained below. Study the diagram below and then read the detail that follows.





From this diagram it is easy to see how aircrafts fly. When the aircraft begins to run on the Runway, air mass moves very fast from A towards B. The wings of the aircraft cut through the air mass. The speed of the air above the wings is many times more than that under the wings. This condition builds up a very high pressure under the wings that automatically overcomes the weight of the entire aircraft. As the Pylon is tilted upward, pressure builds above it, forcing the front end of the wing to rise. And as the turbine engine pushes more hot air to the back, the aircraft experiences the thrust and subsequently lift force, which then takes it into the air. The wings keep the aircraft on the air, while the engine keeps it moving. When aircraft is landing, the process described above is reversed. The Pylon tilted down. In this manner, pressure is built under the back end of wings and, thus forcing the front part of the wings to start facing down. And by sustaining this under a good control, the aircraft lands successfully.

TOPIC: Metal Joining

Definition: This is a process that leads to two or more metal members being joined together as one metallic object. Metal joining is very crucial because it is central to every work that involves the production of metallic items. There are so many ways by which metals can be joined. Some of these methods are considered briefly below.

1. **Brazing**: This is the method of using a softer metal to join two or more harder metals together. The softer metal, which has higher melting point than the solder that is used during soldering operations, is placed between the two harder metals. Intense heat and pressure are applied at the outer surfaces of the harder metal, leading to the softer metal placed between them to dissolve and bond the two metals together. Brazing is regarded as the modified form of soldering.
2. **Soldering**: This is the process of using soft solder, which is made for Zinc and Lead, to bond two metals together. A soldering bit, which provides the heat, is brought in contact with the soft solder. The very hot soldering bit dissolves the solder, which is covered with flux. As the flux rise like white smoke, it expels the dirt around the surfaces to be joined together, thus making it clean. The two metals are the placed together in the liquid solder, which once it cools, hold the metals together.
3. **Bending or Folding**: This has to do with the folding of two metal sheets or bars at one of their ends each. The folded ends are hooked into each other; and with the help of hammer, the two metals are hammered into one piece.
4. **Riveting**: This is the method that requires the use of a rivet (a small metal bar) to join metals together. A hole is drilled into the two metals. The rivet is passed through the holes.

Then, a hammer is used to strike at the rivet till its ends flatten and hold the metals firmly together.

5. **Forming/Forging:** This is process whereby two metals are heated to red-hot temperature in an oven or a furnace. Then, with the use of hammer, while they are still hot and reddish, they are joined into one piece by hammering them together.

6. **Nut and Bolts**: This is the method that requires the use of a nut to tighten a bolt that was passed through the holes drilled into the two metals to be joined. With the help of a spanner, the nut is tightened firmly to hold the metals in place.

7. **Welding**: this is the method that requires the use of heat to dissolve a portion of the two metals to be joined, so that the liquid metals flow into each other and by that join into one as they cool again to a solid form. There are basically for types of welding; and these are:

- **Arc Welding:** this involves the use of a transformer and an electric rod called electrode to provide the heat needed to dissolve the metals that are to be joined.
- **Laser Welding:** this involves the use of laser beam to dissolve the metals that are to be joined together.
- **Oxyacetylene Gas Welding:** involves the use of hot gas provided by acetylene gas to dissolve the metals that are to be joined together.
- **Impact or Notch Welding:** This involves the use of two pointed bits that make contact with each other to join metals together. The bits of the device, which make contact with each other at time intervals, become extremely hot when they make the contact. Because the metals they want to join pass between them, once the contact it made, the extreme heat from the bits dissolve the metal, which instantly bond together and cool moments after the bits have separated from each other.

TOPIC: Building Parts

The buildings we live in have so many parts. It is important we know what these parts are for reference purposes when the need arises. To do this, we shall look at these parts from three categories, namely: the foundation, the wall, and the roof.

1. **The foundation**: This is the foot of the building, which carries the entire weight of the house. It is usually deep, measuring 3 feet or more below the top soil. The following parts are found in and on the foundation: **Hardcore** (which is made up stones buried in the ground); **Concrete Slab** (which is the next part that is laid on the stones or the hardcore, and it's made up of a mixture of gravels, sand, cement and water); **DPC – Damp Proof Course** (which is the polythene leather that is laid on the concrete slab to stop moisture from damaging the top floor); **Sand screed** (is the fine layer sand and cement, which is laid over the DPC); and **The Floor** (which is the topmost layer of the foundation, which is made of either pure cement, wood tiles, ceramic tiles, stone work, etc.) **Verandah** (is the open surface of the floor extension, which lay outside the room, providing a path for people to walk on. It is flanked on one side by the wall, and on the other by nothing, short wall or a balustrade.) **Corridor** (is a pathway inside a house where people walk through to access other rooms. It is flanked on both sides by high walls.)

2. **The Walls**: These are the vertical partitions that are raised on the foundation, usually above the floor level, to divide the floor into rooms. These have the following parts in them: **Pillars** (these are concrete work which are strengthened with rods as reinforcements. They form the strong support for any building, acting like the bones of the house); **Door** (that is the opening, which allows people access into and out of a room. It is made up of the following parts: **Door Frame, Door Seal/Lid/Shutter,** and **Lintel**); **Window** (is the opening on the wall that allows air to come into and leave a room. It is made up of **Sill, Frame, Shutter/Lid/Seal,** and **the Lintel**); **Wall Plate** (is a wooden member that is laid at the top of the wall, which serves as the seat for the roof to sit on. Usually, it is held in place by metal strips or wires). **Skirting Board** (is the small layer of ceramic sheet laid at the foot of the wall to cover up the blemishes existing between the wall and the floor.) **Balustrade** (is the protector that is placed by the sides of staircases, verandahs, or short walls.)

3. **The Roof**: This is the topmost cover for houses. It protects the entire house from rain, sun, wind, and other hazards. The following parts are found in the roof: **Beams** (these are concrete works that are laid horizontally at the top of the building walls. They provide support for the roof and he struts). **Struts** (these are the horizontal wooden members that are laid on the wall plate, from where the roof is crafted and raised. **Rafter** (is the long wooden members that are laid in such a way that they decide the sloppy nature of a roof); **Batten** (are the wooden bars that are laid on the surface of the rafter. It is on them that the roofing sheets are laid.) **Purlin** (this is the wooden bars that are laid under the rafter, to support the rafter.) **King Post** (this is the vertical wooden member that stands in the middle of the roof, extending from the horizontal beam to the ridge at the top.) **Ridge** (is the horizontal wooden member, which is laid at the topmost point of the roof, and it runs from one end of the roof to the other.) **Truss** (these are the wooden members that are used to build a network of woodwork that form the entire roof skeleton.) **Fascia Board** (Is the wooden or aluminum member that is used to cover the lower ends of the roofing sheets.) **Soffit** (is the piece of ceiling that is used to cover the space between the wall and the fascia board.) **Ceiling** (is the inner surface of the roof that faces inside the rooms.)