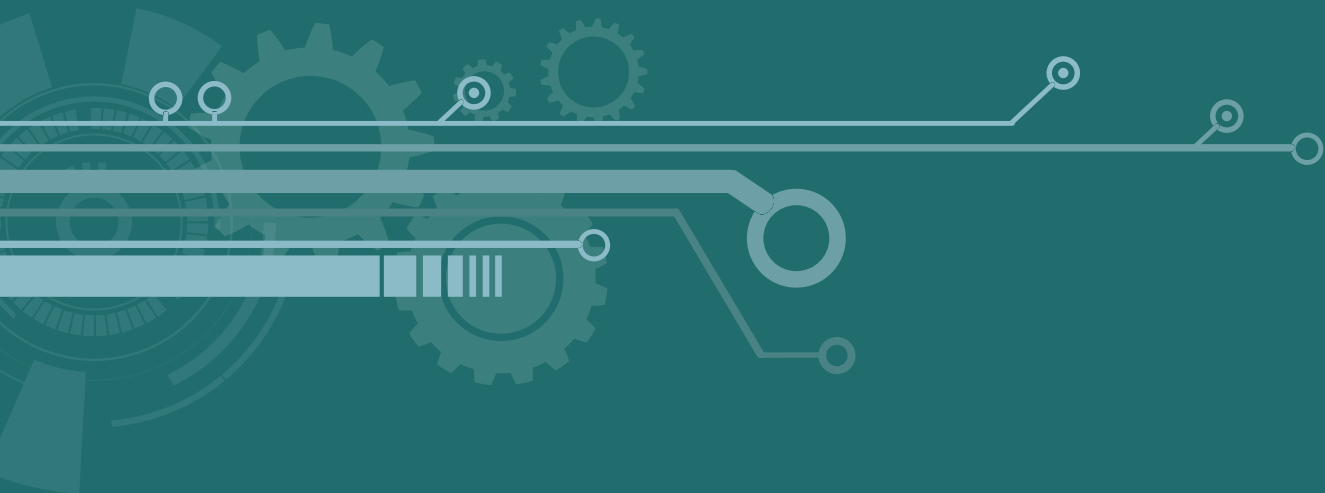


Materials: wood



Introduction

Originally, wood was used by humans as a fuel for fires and as the main material for making tools, utensils, and other instruments.

However, you mustn't think that wood is a prehistoric or obsolete material: tables, chairs, doors, windows, furniture, paper, and many more objects we use every day are commonly made from wood.

Sourcing

Wood is a natural resource with a fibrous structure. Where do we get it from?

1. Trees are felled.
2. The bark is removed and trees are delimbed.
3. They are chopped into smaller pieces. Tree trunks are usually sawed lengthwise. The resulting pieces get their name depending on their shape and dimensions: beams, strips, planks, etc.
4. The pieces are left to dry.



Properties of wood

Physical properties

Acoustic conductivity

Acoustic conductivity is the capacity of a material to conduct sound.

The greater the acoustic conductivity of a material, the more easily the sound waves travel through it. Dry wood has a low conductivity; that's why it is used as an acoustic insulator on walls and floors.

Electrical conductivity

Electrical conductivity is the capacity of a material to conduct an electrical current. The greater the electrical conductivity of a material, the more easily electricity is conducted through it. Dry wood has a low conductivity, this is why it is used as an electrical insulator on walls and floors.

Thermal conductivity

Thermal conductivity is the capacity of a material to conduct heat. The greater the thermal conductivity of a material, the more easily heat is conducted through it. Dry wood has a low thermal conductivity; that's why it is used as a thermal insulator on walls and floors.



Density

Density is the mass of a material per unit of volume. Wood has a wide range of densities.

Hygroscopicity

Hygroscopicity is the ability of a substance to attract water molecules from the surrounding environment. Hygroscopicity affects wood; it affects its density and speeds up putrefaction. Damp wood is likely to rot, and therefore it has to be previously treated.

Mechanical properties

Types of stress

When there are forces of any kind acting on an object, we say that it undergoes **stress**. The response of a piece of a certain material undergoing stress depends on several factors: the intensity of the stress, the size of the piece, the material it is made of, and also the type of stress. We can distinguish the following main types of stress:

- **Traction**

Traction is the type of stress to which a material is subject by two opposing forces that stretch it. Such a stress always causes the piece to elongate in the direction of both forces. If the stress is intense enough, it reduces the cross section of the piece, eventually causing it to break.

- **Compression**

Compression is the type of stress to which a material is subject by two opposing forces that squeeze it and reduce its length.

Such a stress reduces the length of the piece in the direction of both forces. If the stress is intense enough, it increases the cross section of the piece, eventually causing it to break.



- **Bending**

Bending is the type of stress to which a material is subject when certain forces act on it, causing it to fold. Such a stress causes the piece to bend. If the stress is intense enough, the piece will eventually break.

- **Shearing**

Shearing is the type of stress to which a material is subject when two opposing forces act on different spots, which are very close to each other.

This type of stress always causes a piece to deform, and if the stress is intense enough, the piece will break.

- **Torsion**

Torsion is the type of stress to which a material is subject when two forces twist it around an axis.

Such a stress always causes the piece to deform. If the stress is intense enough, the piece will eventually break.

Other mechanical properties

- **Hardness**

Hardness is the measure of the resistance a material displays towards being scratched or dented.

This property changes depending on the different types of wood. Fibrous wood is harder than porous wood.

- **Machinability**

Machinability refers to the ease with which wood can be worked on with a machine. This property is variable, since it not only depends on physical properties and on certain mechanical properties, but also on other more practical matters. Wood is generally easy to work with.

Chemical properties

Chemical properties describe the behavior of materials when they are in contact with other substances.

Combustibility

Combustibility is the capacity of a material to burn.



Biological properties

Biological properties refer to the effects a material has on the environment or living organisms.

Recyclability

Recyclability refers to our ability to transform a material that has already been used so that it can be reused as a different product, with a new useful life. In general, the new product won't be of the same type as the original one.

It is important to stress the fact that the recyclability of a material basically depends on our technical skills: many of the materials that were considered unsuitable for recycling in the past, are now suitable.

Biodegradability

Biodegradability refers to the ability of materials to chemically decompose themselves into simpler substances, as a result of interacting with organisms in the environment.

Classifying wood

Natural wood

Natural wood is obtained directly from tree trunks.

Hard wood

This wood comes from trees that grow slowly. This wood is very resistant. It has a high density, it is difficult to work with, and it is more expensive than other types.

- **Mahogany**

Characteristics

This wood is valued for its hardness, density, and its resistance to decay.

Use

Furniture, sculptures, and fittings.

- **Chestnut**

Characteristics

Flexible and very elastic.

Use

Cabinetwork, building exteriors, and the making of barrels.





Cherry

Characteristics

Hard, heavy, with a fine texture; It can be easily polished.

Use

Furniture, wooden paneling, and musical instruments.

- **Holm oak**

Characteristics

Very heavy and compact.

Use

Cabinetwork and flooring.

- **Ash**

Characteristics

Very elastic, flexible, and tough; Can be cut into thin sheets.

Use

Wooden paneling, cabinetwork, flooring, handles, and sports equipment.



- **Beech**

Characteristics

Hard, heavy. It tends to warp.

Use

Cabinetwork, vegetable crates, flooring, ladders, and wooden paneling.

- **Walnut**

Characteristics

Resistant, compact, and elastic.

Use

Cabinetwork, craftwork, ladders, and sculptures.

- **Oak**

Characteristics

Hard, resistant, and compact, although it splinters easily.

Use

Decoration, ladders, the making of barrels, and floorboards.

- **Teak**

Characteristics

Of a thick, uneven texture. Semi-heavy and semi-hard.

Use

Indoor and outdoor furniture, cabinetwork, and shipbuilding.

- **Wenge**

Characteristics

Strong, very elastic, and fine-textured.

Use

Cabinetwork, flooring, and handles for knives and tools.

Soft

This wood comes from conifers or trees that grow quickly. It has a low density, it is easy work with, and it is much lighter and cheaper than hardwood.

- **Birch**

Characteristics

Elastic and nondurable.

Use

Pipes, boxes, clogs, and furniture linings

- **Fir**

Characteristics

Not very resistant. Tends to break easily.

Use

Wooden paneling, cabinetwork, ship decks, wooden posts, crates, sounding boxes, pianos, paper pulp.

- **White poplar**

Characteristics

Elastic; it does not easily warp or crack.

Use

Musical instruments, masts, toys, and craftwork.

- **Alder**

Characteristics

Fine-textured, nondurable. It dries quickly and easily.

Use

Hydraulic structure, cabinetwork, tool handles.



- Balsa

Characteristics

Light, soft, and a good acoustic and thermal insulator.

Use

Scenery, insulators, scale models, float reinforcements, and toys.

- Cedar

Characteristics

Elastic with a soft texture. Difficult to dry.

Use

Doors, craftwork, moldings, cabinetwork, sculpture, and carving.

- Black poplar

Characteristics

Soft, homogeneous, and not very durable.

Use

Shipping crates, furniture lining, paper pulp, matches, and floorboards.



- Cypress

Characteristics

Light, fine-textured, and usually straight-grained, with a large number of knots.

Use

Indoor and outdoor carpentry, decorative paneling, shipbuilding, musical instruments, and sculpture.

- Pine

Characteristics

Soft, resinous, elastic, and durable.

Use

Carpentry in general, beams, wooden paneling, furniture, and ladders.



Manufactured wood

Manufactured wood is obtained from wood shavings, sawdust, bark, branches, etc. It is usually made into panels.

Particleboard

This type of manufactured wood is made of sawmill shavings pressed and glued together at high temperatures at high pressures, without a finish. Low quality wood can be used, meaning that it is cheaper to manufacture.

Some types of particleboard are covered with thin veneers of natural wood or plastic (melamine based). It can be easily recycled. It's easy to work with and its main disadvantage is the ease with which it deforms when it gets damp: it does not recover its shape when it dries. Its uses include furniture, platforms, and general carpentry.

MDF (medium density fiberboard)

This wood is manufactured with wood fibers bound together by means of heat and high pressure. This type of manufactured board is harder than particleboard.

It has a fine and homogeneous texture, meaning it can be used for applications that are different from those of normal particleboard.

Plywood

Plywood is a wood manufactured by gluing together an uneven number of thin sheets of wood, alternating the direction of the fibers. This means the wood has a uniform resistance and doesn't expand too much. There is a wide variety of plywood. It is used to make furniture, interior paneling, and in ships, etc.

Veneer

This is wood cut into very thin sheets.

It is used for interior paneling, the finishes of furniture, doors, and decorative elements manufactured with particleboard or plywood.

Battens

Battens are thin boards made of sheets of natural wood of the same or a different type. The boards are glued at the edges, which thickens them with a thickness and provides them with a finish. Sometimes, they are made up of a central core, formed by planks of natural wood of the same type and glued at the edges; the outer surfaces are wood veneer glued to the central core. The outer surfaces are usually made of wood of a better quality than the inside core. Battens are relatively light, they are more resistant in the direction of their fibers than transversally, and they are used for floorboards, table tops, doors, wardrobes, and furniture in general.

Laminated wood

Laminated wood is usually made by gluing sheets of wood with their fibers aligned in the same direction, thus obtaining resistant boards that do not deform easily, and which are not affected by moisture. They are versatile in architecture, and in the manufacture of structures and panels.



Cork

Cork is obtained from the bark of certain trees, like the cork oak. It is manufactured by means of applying heat and pressure. It is sold in rolls, sheets, or tiles. Its main characteristics are:

- It is an excellent insulator against heat, sound, and electricity.
- It is fireproof and does not burn.
- It is resistant to moisture.
- It is innocuous as it doesn't emit toxic vapors or particles.
- It favors the transpiration of walls and panels.
- It absorbs vibrations and impacts without deforming.
- It isn't attacked by insects or fungi, so it doesn't easily rot.
- It is one of the most stable and lasting materials in the plant world.

Wood derivatives

Paper

Paper has played a key role in the development of human culture. Nowadays, paper is manufactured non-stop in factories. It is produced in reels and then cut to the desired size.

Paperboard

Like paper, paperboard is a wood derivative that is a bit thicker, harder, and more resistant than paper. It is obtained by pressing paper pulp into thicker sheets, or by gluing different layers of paper together.

The common type of paperboard is **corrugated paperboard**, which is made by gluing a sheet of smooth cardboard onto either side of a sheet of corrugated cardboard. This makes it stronger. The way the sheets are placed means cardboard is very light and resistant. It is used for making boxes, packets, and trays, etc.

Rayon

Rayon is an artificial textile fiber. It is obtained from cellulose which is turned into pulp. It is then purified and treated with chemical products to obtain a soluble product which is extruded into soft, thin filaments that are mixed with other types of natural fibers (silk, cotton, linen, etc.). The resulting thread is in a variety of textile applications, surgical material, and rubber goods. There are different types of rayon fibers; the most well known is **viscose** rayon.

Papermaking process

Paper is made by following the steps described below:

1. Triturating wood

The first stage is to obtain the cellulose which will be used to produce the pulp. There are different methods, depending on the quality of the paper we want to produce.

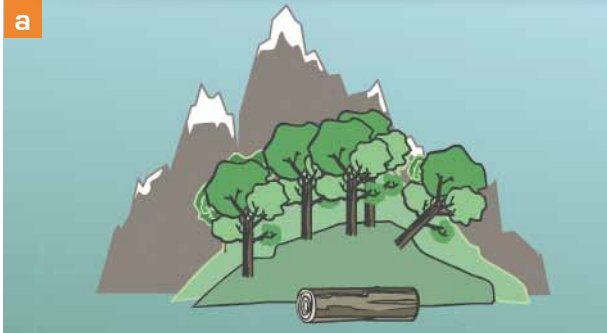
2. Refining wood pulp

In order for the paper to be uniform, the pulp needs to be treated to eliminate the cellulose fibers. The degree of refining depends on the quality of the paper we want to produce: the more it is refined, the higher the quality.

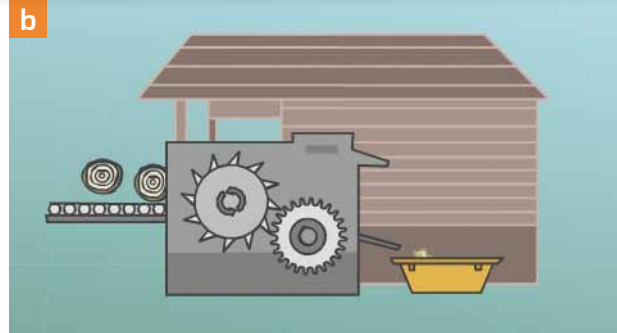
3. Gluing

Glue has to be added to the pulp to ensure the paper is less hygroscopic and to prevent the ink from running when you write. Furthermore, the paper is dyed with pigments to obtain different colors. All these elements are added to the mixer.

Papermaking process



a Collecting wood



b Triturating wood



c Gluing



d Pressing

4. Pressing

This is when the pulp is pressed to obtain a smooth, thin sheet of paper.

5. Drying

All the moisture that has been added to the pulp needs to be removed.

Tools used for wood

All the information in this section can be found on the online version in the chapter dedicated exclusively to tools.

Working with wood

Using tools and safety

When working with wood, the following standards must be respected:

- Always use good quality tools.
- Tools should only be used for the purposes for which they were designed.
- Cutting tools should be well-sharpened. They should be kept in a drawer or case, with the blade inside a protective cover.
- The pieces being worked on should be held securely in the vice on the workbench or the in clamps of the machine tool.

- To tighten or loosen screws, care must be taken to use the tool that best fits the head of the screw or its slot.
- Wrenches should only be used in the event of not having a hex key that properly fits the screw or the nut that needs tightening or loosening.

Additionally, it is necessary to use protective equipment (goggles, gloves, face mask) for tasks that represent a risk to the safety of the worker.

- **Goggles**

These are usually made of resistant plastic. They protect the eyes and the area around them. They must always be used whenever there is a danger of splinters flying around; for example, when drilling, milling, and sawing.

- **Face mask**

This protects the respiratory tract in dusty environments. Its use is recommended when sanding, painting, or sweeping.

- **Gloves**

These are usually made of leather. They protect hands from cuts or splinters. Their use is obligatory when working with machine tools and there is danger of getting cut; for example, when sawing, drilling, sanding or bending.

Joins

Normally, a piece of wood that has been worked on with the corresponding tools will form one of the parts of an larger, useful object. Think of closets, tables, a shelf, etc. All of these objects are formed by several pieces joined together. These joints can be temporary or permanent.

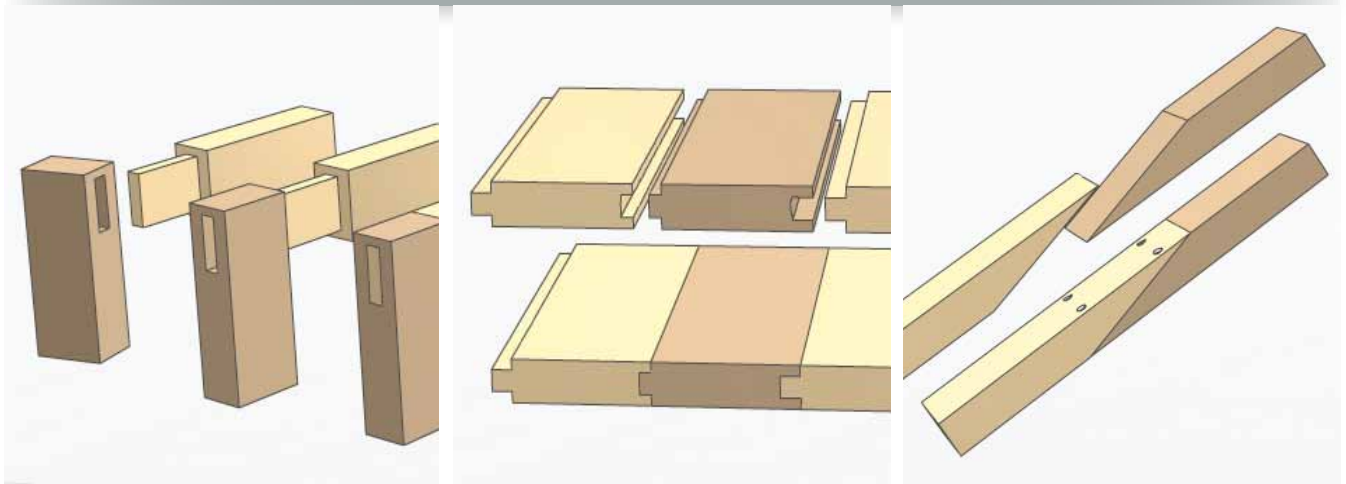


Common types of joints

- **Box joint**

This consists in shaping the pieces before joining them together, to improve their resistance and solidness. Depending on the shape of the pieces to be joined, the joints can be of different shapes; for example, "L-shaped", "T-shaped", or "cross-shaped."

Detachable joints



Box joint

Butt joint

Scarf joint

- **Butt joint**

This consists in joining two or more pieces together to obtain a wider one.

- **Scarf joint**

This consists in joining the ends of two pieces together to make the piece longer. This method is normally used in the construction of horizontal pieces or columns.

Permanent joint

A permanent joint is one which cannot be taken apart without it breaking.

Nails

These are long, thin, cylinder-shaped metallic pieces. They are usually made of steel.

Nails consist of two main parts:

- **Head**

This can be flat, cone-shaped, or round.

- **Shank**

This is the cylinder-shaped part. It has a pointed end which is hammered into the wood.

Classifying nails

Nails are classified according to their length and thickness, by using two numbers.

Glues

Glues are chemical products that, once they have been applied and they have dried, they bond the pieces together.

- **White glue or carpenter's glue**

This is used to bond together wood or wood veneers.

Its watery base makes it suitable for bonding porous surfaces together.

- **Impact glue**

This is usually very toxic.

It is used to bond wood to wood veneer, plastic or metal.

A thin layer of glue is applied to the surfaces of the pieces that are going to be joined. The glue is left to dry for a few minutes, and then the pieces are pressed together.

Common types of joints

A detachable joint is one made up by pieces that do not break when they are taken apart.

To join two pieces together with wood screws, we have to ensure that the piece where the head of the screw will fit has a hole with a diameter that is slightly larger than the screw. This way, when the screw is tightened, it will screw into the other piece without coming out the other end, leaving the two pieces tightly fastened together.

If the pieces are joined together by a nut and bolt, they each have to have a hole with a diameter slightly larger than the screw.

Wood screws

They usually made of steel and brass. Screws consist of two main parts: the head and shank.

- Head

There are many types of head; thicker screws have square, hexagonal, or countersunk heads with hexagonal sockets. This type of screw is tightened and loosened with the aid of the correct tool (a wrench or hex key).

- Shank

This is the round part that is screwed into the wood. It has a helical ridge (known as a thread) along its whole length (for particleboard) or along just a part of it (for solid wood).

Classifying screws

Screws can be classified according to two numbers, which indicate the diameter of their shanks and their length, expressed in millimeters.

Bolts

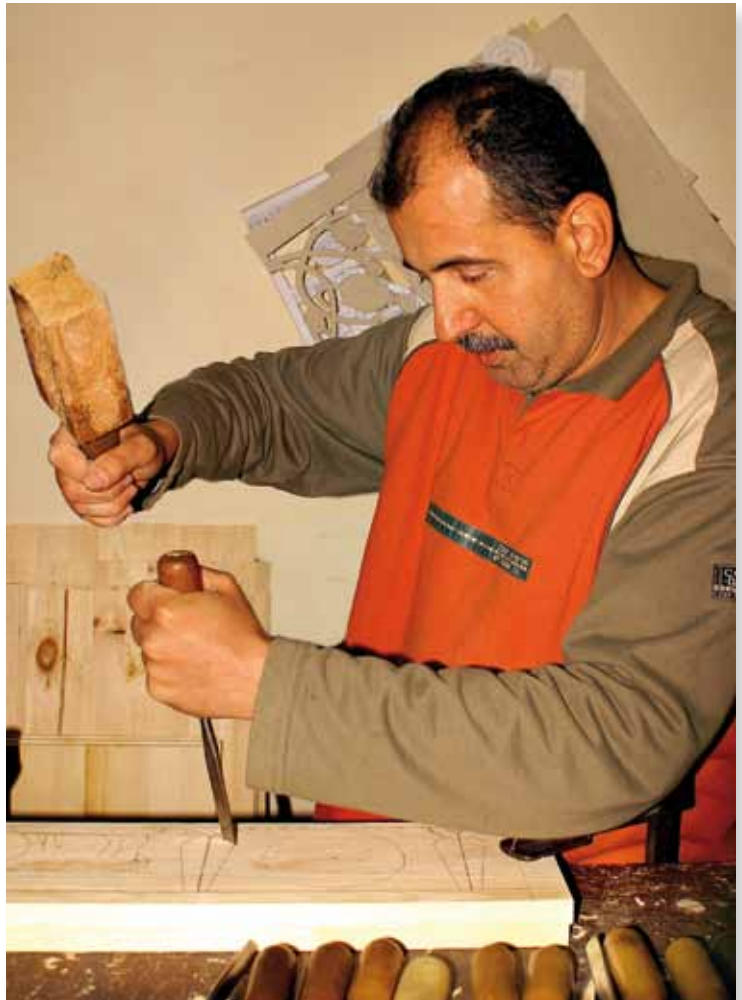
These are usually made of steel. They also consist of a head and a shank.

- Head

The head is usually round (with a groove or hexagonal socket), square, hexagonal, or countersunk (with a hexagonal socket). This type of screw is tightened or loosened with the aid of the appropriate tool.

- Shank

The shank is the cylindrical part which is screwed into the wood. It has a triangular thread along its whole length, or only a part of it.



Classifying screws

Bolts are classified according to the shape of their heads, the diameter of the threaded part, and their length. The type of thread is described by means of an abbreviation: M (metric thread, expressed in millimeters), W (Whitworth thread, expressed in inches).

Nuts and washers

- Nuts

Nuts are usually made of steel and brass. They have a threaded hole in their center, through which the screw or bolt passes. There are several varieties: square, hexagonal, butterfly, blind, and cap.

- Washers

Washers are round with a hole in the center. They are usually made of steel, plastic, rubber, etc. The diameter from the outside edges and their thickness depend on the diameter of the hole in the center, which is always slightly larger than the thickness of the screws that will pass through them. To stop the pieces from deforming and to be able to tighten the screws better, washers are placed between the head of the screw and the wood, or between the wood and the nut.

Finishing techniques

Materials

Finishing a surface consists in applying liquids (dyes, varnishes, and paint) or other similar materials to protect the wood, enhance and change its appearance, and even its feel.

- Dyes

Dyes intensify natural colors and homogenize the shade of different pieces. They hide small imperfections, change the color, enhance, or tone down streaks, or dyes can be used to imitate other types of wood.

- Varnishes

Varnishes can be natural or synthetic, transparent, shiny or matt. Once applied and dry, they form a protective, waterproof layer that can withstand small knocks and bumps.

- Paints

Paint is basically made up of pigments and binders.



- **Coloring or pigments**

These are the elements that provide the color. They are produced with organic, chemical substances in powdered form. These substances come from earth pigments, or certain metal oxides.

- **Agglutinant substances or binders**

Liquid products (water, oils, and resins) which, when dissolved in colorings, allow paint to be obtained. They make drying and adherence easier, and they form a protective layer.

- **Priming**

This is a process that needs to be carried out before painting, in order to ensure the paint will adhere well.

Standards

Dying, varnishing, and painting need to be carried out with great care, following the necessary preparatory steps.



- **Preparing the surface**

After applying the finish to the surface, it is necessary to remove all the dust that might be left on it.

- **Protection**

During the finishing process it is necessary to use protective equipment, such as gloves and a face mask, because many of the products used are toxic if inhaled.

- **Priming**

Care must be taken to use the tools that are appropriate for each type of surface and the characteristics of the wood. If a second coat of paint or varnish is necessary, the first coat must be completely dry.

- **Applying the product**

After the process has finished, all the implements must be properly cleaned with the appropriate products. Then they must be left to dry, the paint pots properly closed, and everything put away in its place.

- **Maintenance and cleaning**

After the process has finished, all the implements must be properly cleaned with the appropriate products. Then they must be left to dry, the paint pots properly closed, and everything put away in its place.

Reduce, reuse, recycle

The 3Rs: trees and environment

Plants are great colonizers. There are plants practically everywhere. Trees aren't an exception. There are trees in almost all climates and all the biomes have their own trees that usually group together to form forests. Because of this, it was always thought that wood was readily available.

However, during recent decades, the extensions of forestland have been decreasing; fires, deforestation to create farmlands, etc. For these reasons, the use of trees as a source of wood and its derivatives should be limited as much as possible. We can achieve this by applying the 3Rs: reduce, reuse, and recycle.

Reduce

We should reduce the generation of unnecessary waste as much as possible by using wood and its derivatives in a correct way. Whenever possible, the following recommendations should be remembered:

- Reduce the use of natural wood. Whenever possible choose manufactured wood.
- Don't purchase products with excess cardboard packaging.
- Don't use paint made with toxic components.
- Don't use machine tools whenever the operation (sawing, polishing, sanding) can be carried out manually. This reduces the consumption of energy.
- Only print things which are absolutely essential.



Reuse

Before starting a task we must ask ourselves what we need, what we have, and what we can use again.

Whenever possible, we must try to:

- Avoid buying unnecessary things.
- Share materials with our classmates.
- Use paper that has only been used on one side.
- Calculate the exact amount of the material you need.
- Generate less waste.



Recycle

You must make an effort to:

- Buy recycled products.
- Take recyclable products to places or banks that are specially provided for collection purposes.
- Use recycled paper.