UNIT 4.- METALS

metals

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1. DEFINITION OF METALS

DEFINITION:

> Metal is a **technical material** that comes from **minerals contained in rocks** which can be obtained in nature. They are typically **hard, ductile, non-adhesive, cold, smooth and often shiny.**

Brass — Aluminium — Cast Iron
Bronze — Steel — Copper
Metal Sludge

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https://www.nde-ed.org/EducationResources/CommunityCollege/Materials/Introduction/metals.htm

2. PROPERTIES OF METALS

PHYSICAL PROPERTIES:

- **Mechanical Strength** (Resistencia Mecánica). Metals can resist forces (compression – tensile – flexural – bending - shear) without being deformed easily.
- **Ductility and Malleability** (Ductilidad y maleabilidad). They can be made into **wires** or thin **sheets**.
- **Toughness** (Tenacidad). They **can't be broken** easily.
- **Elasticity & Plasticity** (Elasticidad y Plasticidad). They **depend on the type of metal.** They are elastic if they can bend and return to their original shape when the external forces stop affecting them.
- **Conductivity (Electrical, Thermal & Acoustic)** (Conductividad eléctrica, térmica y acústica). They are **good conductors** of electricity, heat and sound.
- **Magnetism** (Magnetismo). **Not all metals** can be attracted by magnets.
- **Fusibility** (Fusibilidad). Metals can be **melted** (to melt= fundir) and **welded** (to weld= soldar) easily to other metallic objects.
- **Expansion & Contraction.** Under high temperature circumstances they expand and when it falls, they contract.

CHEMICAL PROPERTIES:

- **Oxidation** (Oxidación). Metals react with oxygen in air and water.

ECOLOGICAL PROPERTIES:

- **Renewable** (Renovable). Metals aren't renewable but they can be reusable.
- **Toxic** (Tóxicos). Some metals such as lead or mercury (plomo o mercurio) present a danger to human beings and the environment.
- **Recyclable and Reusable** (Reciclable y reutilizable).

	TENSILE STREGTH	BRITTLENESS	DUCTILITY	MALLEABILITY	CORROSION RESISTANCE
MORE ↑	Iron	Cast Iron	Gold	Gold	Gold
	Copper	Hardened Steel	Silver	Silver	Platinum
	Platinum	Bronzes	Platinum	Aluminium	Silver
	Silver	Aluminium	Iron	Copper	Mercury
	Zinc	Brass	Nickel	Tin	Copper
	Gold	Structural Steels	Copper	Lead	Lead
	Aluminium	Zinc	Aluminium	Zinc	Tin
	Tin	Tin	Zinc	Iron	Nickel
LESS	Lead	Copper	Tin		Iron
		Iron	Lead		Zinc
					Magnesium
					Aluminium

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http://pixabay.com/en/pyrite-pyrites-mineral-sulfide-345637/

3. EXTRACTION OF METALS

WHERE AND HOW METALS ARE OBTAINED:

> Metals are taken from minerals in rocks so that, **depending on the place**, we can classify their location into:
> - **Surface mining** (Canteras - Minas a cielo abierto). Used when the mineral layer is near the surface.
> - **Underground mining**. (Minas subterráneas). Used when the mineral is deep below the surface.

In both types of mines explosives, excavators, drills and other machines are used to extract the mineral from the rock.
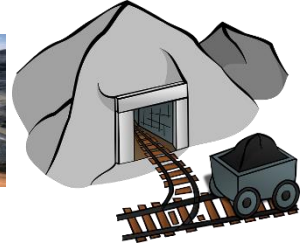
4. PARTS OF MINERALS

After mining, minerals are transported to the ironworks where they must be separated, using physical and chemical processes, into:

> - **Ore** (Mena). It's the usable part of the mineral to produce metals.
> - **Gangue** (Ganga). It's the unusable part of the mineral.
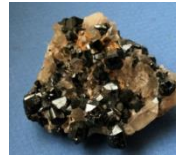
5. TYPES OF METALS

Depending on their origin metals can be classified as:

> - **Ferrous** (Férricos o ferrosos). Its main component is iron. They are Iron, Steel and Cast iron. (Hierro, acero, Fundición)
> - **Non-Ferrous** (No ferrosos). They don't contain iron or just a little. Examples: Copper, bronze, tin, zinc.

6. METALLURGY & SIDERURGY

> **Metallurgy** is an industry involved with the extraction and processing of **metal ores**. (Extracting metals from their ores, purifying and alloying metals, and creating useful objects from metals).

> **Siderurgy** (Iron & Steel industry) is the branch of metallurgy that performs the extraction and processing procedures of **only ferrous metals**.

UNIT 4.–METALS

Technologies in secondary school for Spanish speakers
Tekneso

7. METALS CLASSIFICATION

FERROUS METALS

- **Contain iron.**
- **Common** *(Muy utilizados)*
- **Inexpensive to extract** *(Relativamente económicos de extraer).*
- **Need processing to produce pure iron** *(Requieren y precisan de diferentes procesos para obtener hierro puro).*
- **Used to make alloys** *(Se usan para hacer aleaciones)*

An **Alloy** is a **mixture of 2 or more chemical elements** where the primary element is a metal.

Iron alloys are created by adding carbon and there are 3 types:

	Concentration of carbon
PURE IRON	0,008% – 0,03%
STEEL	0,03% – 1,76%
CAST IRON	1,76% – 6,67%

PURE IRON	STEEL	CAST IRON
(Hierro)	*(Acero)*	*(Fundición-Forja)*

PURE IRON
- Greyish White metal
- Good magnetic properties
- It corrodes easily
- Only melts at very high t^{re}
- It's difficult to machine
- It's brittle
- Litle utility
- Uses: electrical & electronic components

STEEL
- It's harder & stronger than pure iron (better mechanical properties)

CAST IRON
- Extremely hard & resistant
- Uses: Machinery parts, pistons, street lamps, drain covers, fences, rails…and so on.

ALLOY STEELS

Other chemical elements can be added to steel **to improve or achieve certain properties**:

- **Silicon** *(Silicona).* Makes the alloy magnetic and flexible
- **Manganese** *(Manganeso)* Makes the alloy harder & heat resistant. Stainless steel.
- **Nickel** *(Niquel)* Improves strength and prevent corrosion.
- **Tungsten** *(Tungsteno)* Makes the alloy harder & heat resistant, prevents corrosion.
- **Chrome** *(Cromo)* Makes the alloy harder and tougher, more rustproof.
- **Lead***(Plomo)* Makes the alloy easier to cut with machine tools.

THE STEEL MAKING PROCESS
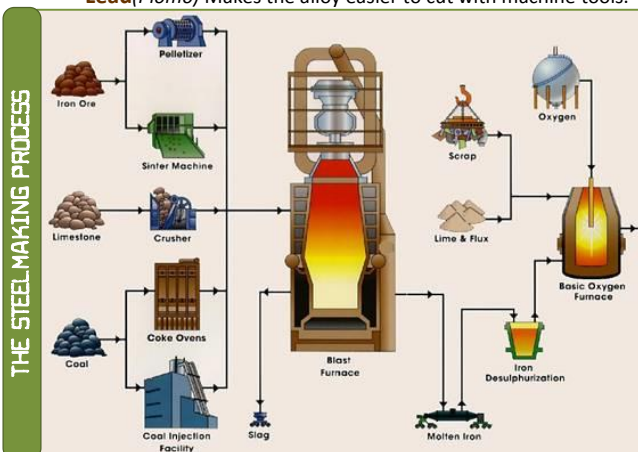
1.-The iron mineral is washed to remove impurities
2.- It is crushed and sieved (gangue is separated from the ore)
3.- Then iron mineral (ore) is mixed with coal and limestone *(caliza)*
4.- This is melted (1500° temperature) in a blast furnace
5.- Pig iron *(arrabio)* is obtained (molten iron mixed with carbon and impurities)
6.- Pig Iron *(arrabio)* is processed to reduce the percentage of carbon and impurities which is called slag *(escoria)*

NON-FERROUS METALS

- **Don´t contain iron.**
- **They're often expensive** because they're rare and more difficult to extract.
- **They're classified by density** Ultra light, light and heavy.

ULTRALIGHT	Aluminium
LIGHT	Magnesium, Titanium
HEAVY	Lead, Tin, Zinc, Copper, Bronze, Brass

(Plomo, Estaño, Cinc, Cobre, Bronce, Latón)

LIGHT &ULTRALIGHT

Aluminium	Magnesium	Titanium

Aluminium
- Processed from bauxite
- Silvery light
- Highly resistant to corrosion
- Very Soft
- Low density
- High malleability and ductility
- Good electrical & heat conductor.
- Uses: High voltage power lines, Planes, cars, bicycles, Light metalworks, roofing, decorations, Kitchen tools and drink cans.

Magnesium
- Extracted from several minerals: Magnesite, dolomite, carnallite, epsomite,and olivine. *(Magnesita, Dolomita, Carnalita, Epsomita y olivino).*
- Silvery light andShiny
- Very light
- Soft
- Malleable but not very ductile
- Reacts very strong with oxigen
- Uses: Pyrotechnics (fireworks), Aerospace, Cars and bicycles.

Titanium
- Extracted from minerals: Rutile & ilmenite. *(Rutilo e ilmenita).*
- Silvery light and Shiny
- Light
- Very hard and strong
- Uses: The aerospace industry, Building structures & medical prostheses.

HEAVY

Lead	Tin	Zinc

Lead
- Source: Galena
- Silvery grey
- Soft& Malleable
- It's very toxic (fumes)
- Uses: Batteries, Protection against nuclear radiation, Additive in glass to give hardness and weight.

Tin
- Source: Cassiterie.
- Shiny white
- Very Soft
- Does not oxidase at room t^{re}
- Uses: Alloyed with lead it is used for soft soldering..

Zinc
- Source: Sphalarite & Hemimorphite
- Blueish grey
- Shiny
- Weak at low t^{re}
- Not very hard
- Uses: Roofing Plumbing Car industry On other materials it stops corrosion (galvanizado)

Copper	Bronze	Brass

Copper
- Source: Cuprite, Chalcopyrite and malachite
- Redish orange
- Soft & Malleable & Ductile
- Uses: Electrical wires Telephone lines Pipes Radiators Decoration Jewellery

Bronze
- Source: Alloy of copper and tin.
- Yellowish orange
- Resistant to corrosion
- Uses: Boat propellers Filters Church bells Sculptures

Brass
- Source: Alloy of copper and zinc
- Yellowish
- Very resistant to corrosion
- Uses: Handicrafts Jewellery Plumbing Turbines
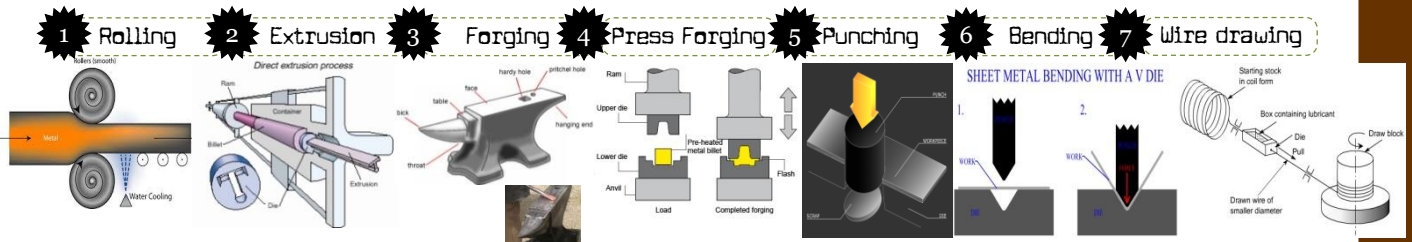
8. SHAPING TECHNIQUES

DEFINITION:

> Shaping techniques are the different processes and techniques used to shape metals. These will depend on the type of metal and the object we want to make.

TYPES of TECHNIQUES:

- **Shaping** *(Conformación)*. Used to modify the shape of the unprocessed metal and improve its mechanical properties.
- **Powder Metallurgy** *(Pulvimetalurgia ó Metalurgia de polvos*
- **Casting** *(Moldeado)*

Shaping

| 1 Rolling | 2 Extrusion | 3 Forging | 4 Press Forging | 5 Punching | 6 Bending | 7 Wire drawing |

1. **Rolling** *(Laminación)*. The unprocessed metal is passed through a series of rollers that compress it, reduce its thickness and increase its length. This method generally uses heat. It's used to make metal sheets and bars, and so on.
2. **Extrusion** *(Extrusion)*. The heated metal is pushed through a die *(molde)* of the required shape, by a piston, using compression. It's used to make long objects (bars, tubes…)
3. **Forging** *(Forja manual)*. The unprocessed metal is usually heated first and placed on an anvil *(yunque)*.Then the hammer repeatedly rises and falls on the unprocessed metal. Many objects can be produced by this method.
4. **Press forging** *(Estampación)*. The heated unprocessed metal is placed between 2 dies (one fixed and the other mobile). The dies contain the shape of the object we want to make. They are pressed together to make the required shape. This method is used to produce car body panels, radiators, etc.
5. **Punching** *(Embutición)*. This is a cold forging method in which a sheet of metal is hit with a punch to make the required shape in a mould *(molde)*. This method is used to form hollow objects.
6. **Bending** *(doblado)*.
7. **Wire drawing** *(Trefilado)*. A wire is pulled through a hole that has the required dimensions. A rotating drum (draw block) is used to pull it through the hole to increase its length while reducing the diameter. This method is used to make metal strings and wires.

Powder Metallurgy

The Powder Metallurgy Process (5 stages):

1°. The metal **is ground** into powder.
2°. It is **pressed** into steel dies.
3°. It is **heated** to a t^{re} close to 70% of the metal's melting point.
4°. **Pressure** is applied to produce the required dimensions.
5°. The object is left to **cool**.
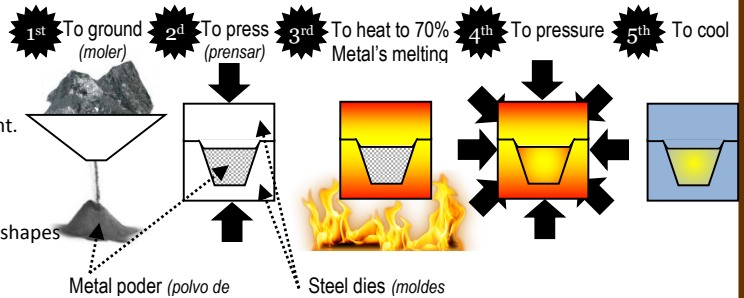
This method is used to manufacture objects with very precise shapes (bearings *(cojinete)*, engine contact points, cutting tools,etc…)

| 1st To ground *(moler)* | 2d To press *(prensar)* | 3rd To heat to 70% Metal's melting | 4th To pressure | 5th To cool |

Metal poder *(polvo de*   Steel dies *(moldes*

Casting

The Casting Process (4 stages):

1°. The metal **is heated** to melting point.
2°. The liquid metal **is poured** *(vertido)* into the mould.
3°. The mould & metal are **left to cool** until the metal has solidified.
4°. The solidified piece **is extracted** from the mould.
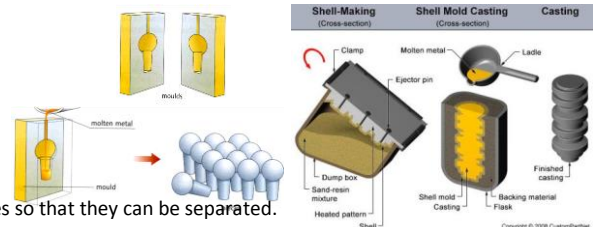
The moulds can be made from sand, steel or cast iron and they are of 2 pieces so that they can be separated.
The casting method depends on the type of object we want to make and they are:

- **Sand Casting** *(Moldeo en arena)*. Engine blocks, fire hydrants…
- **Die Casting** *(Moldeo en metal)*. Small parts and alloys with low melting points
- **Wax Casting** *(Moldeo en cera)*. Ornaments, jewellery, sculptures and dental prosthetics.

Centrifugal casting is another casting technique which uses a mould that rotates when the liquid metal is poured inside. The centrifugal force makes the liquid stick to the walls of the mould. This technique is used to make pipes and objects that are composed of various layers of material.

9. EQUIPMENT, TOOLS AND MACHINES

Look at the sketch attached.

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