



Industrial Technology Virtual Learning

9-12/Advanced Metals/Classification of Metal

April, 13 2020



Classification of Metals: April, 13 2020

Objective/Learning Target:

Students will read the PPT and learn about the Classifications of Metal. At the end of the PPT students will test their knowledge by answering five questions.

Types of Metal and Their Classification

A large number of metals are available in nature. They can be classified in a variety of ways depending on what property or characteristic you want.

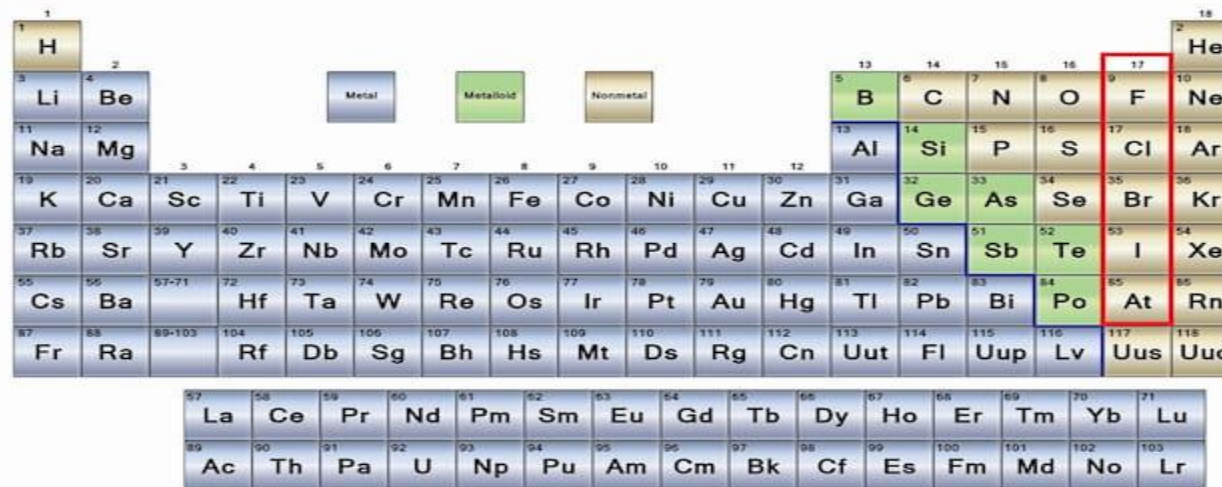
Classification by Iron Content

The most common way of classifying metals is by iron content.

- When a metal contains iron, it is known as a **Ferrous Metals**.
- Metals that DO NOT contain any iron content are **Non-Ferrous Metals**.

Classification by Atomic Structure

Metals may also be classified based on their atomic structure according to the periodic table. Metal may be known as alkaline, alkaline earth, or a transition metal. Metals belonging to the same group behave similarly and have similar chemical properties.



The periodic table is color-coded to show the classification of elements based on their atomic structure. The table is divided into three main regions: Metal (blue), Metalloid (green), and Nonmetal (yellow). The Metal region includes elements from groups 1 to 10, plus the lanthanide and actinide series. The Metalloid region includes elements from groups 13 to 16. The Nonmetal region includes elements from groups 17 and 18. A red box highlights the elements Fluorine (F) and Chlorine (Cl) in group 17, which are nonmetals.

1																	18															
H																	He															
3	4											5	6	7	8	9	10															
Li	Be											B	C	N	O	F	Ne															
11	12											13	14	15	16	17	18															
Na	Mg											Al	Si	P	S	Cl	Ar															
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36															
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr															
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54															
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe															
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86															
Cs	Ba												Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn					
87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118															
Fr	Ra												Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Ff	Uup	Lv	Uus	Uuo					
																		57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
																		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
																		89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
																		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Magnetic and Non-Magnetic Metals

- Another way to differentiate metals is by looking how they interact with magnets. It is possible to divide metals as magnetic and non-magnetic based on that basis.
- Ferrous Metals metals attract strongly to magnets. Non-Ferrous Metals show weak interactions to magnets.

Iron

- **Iron** is a chemical element with symbol **Fe** and atomic number 26. It is a metal that belongs to the first transition series and group 8 of the periodic table. It is by mass the most common element on Earth, forming much of Earth's outer and inner core. It is the fourth most common element in the Earth's crust.
- Pure iron is an unstable element though. At the first opportunity, it reacts with the oxygen in the air to form **iron oxide (Rust)**.
- Extracting iron from its ores uses a blast furnace. Pig iron is achieved from the first stage of the blast furnace which can be further refined to obtain pure iron. This iron often ends up in steels and other alloys.
- Almost 90 per cent of manufactured metals are ferrous metals.

Steel

- **Steel** is an alloy of iron and carbon, and sometimes other elements like chromium. Because of its high tensile strength and low cost, it is a major component used in buildings, infrastructure, tools, ships, trains, automobiles, machines, appliances, and weapons.
- Iron is the base metal of steel.
- Adding carbon to iron alleviates weaknesses to a certain extent. This mixture of iron and carbon up to specified limits is known as carbon steel. Adding carbon to iron makes the iron much stronger along with imparting other great characteristics.
- Other elements may be added in trace amounts to incorporate their properties.

Types of Steel

Depending on the iron content, steel is classified into three categories.

- **Low carbon steel.** Up to 0.25% of carbon in iron give us low carbon steel, also known as **mild steel**. It is used for tubing in moderate pressure applications. Reinforcing bars and in I-beams in construction are usually from low carbon steel. Any applications that require a high amount of steel without much forming or bending are also suitable for it. An example is a ship's hull.
- **Medium carbon steel.** Contains 0.25...0.6% of carbon. Medium carbon steel's applications include ones that need high tensile strength and ductility. They find applications in gearing and shafts, railway wheels and rails, steel beams in buildings and bridges etc. Another use is pressure vessels, except if it contains cold gases or liquids because of its tendency to cold cracking.
- **High carbon steel.** Steel that contains more than 0.6% of carbon is high carbon steel. This steel is harder and more brittle than the previous two. It finds applications in making chisels and cutting tools. Great qualities include hardness and good resistance to material wear. It may also be used in presses and for manufacturing drill bits.

Alloy Steels

- A metal made by combining two or more metallic elements, especially to give greater strength or resistance to corrosion.
- This type of metal contains multiple elements to enhance various properties. Metals such as manganese, titanium, copper, nickel, silicon, and aluminum may be added in different proportions.
- This improves steel's hardenability, weld ability, corrosion resistance, ductility and formability. Applications for alloy steels are electric motors, bearings, heating elements, springs, gears, and pipelines.
- **Stainless steel**: Stainless steel contains high amounts of chromium. Making it 200 times higher resistance to corrosion than mild steel. Making it ideal candidate to manufacture kitchen utensils, piping, surgical and dental equipment.
- **Tool steel**: Tool steels are used for making cutting and drilling tools.

Different Types of Metals

In addition to ferrous metals, we have a large selection of non-ferrous ones. Each has certain qualities that make them useful in different industries.

- **Aluminum**

Aluminum derives primarily from its ore bauxite. It is light, strong, and functional. It is the most widespread metal on Earth and its use has permeated applications everywhere. This is because of its properties such as durability, light weight, corrosion resistance, electrical conductivity and ability to form alloys with most metals. It also doesn't magnetize and is easy to machine.

- **Copper**

When talking about different types of metals, copper and its alloys cannot be overlooked. It has a long history because it is easy to form. Even today, it is an important metal in the industry. It does not occur in nature in its pure form. Thus, smelting and extracting from ore is necessary.

Metals are good conductors and copper stands out more than the others. Due to its excellent electrical conductivity, it finds application in electrical circuits as a conductor. Its conductivity is second only to silver. It has also excellent heat conductivity. This is why many cooking utensils are from copper.

Different Types of Metals Continued

- **Bronze**

Bronze is also an alloy of copper. But instead of zinc, bronze contains tin. Adding other elements such as phosphorus, manganese, silicon, and aluminum may improve its properties and suitability for a particular application. Bronze is brittle, hard, and resists fatigue well. It also has good electrical and thermal conductivity and corrosion resistance. Bronze finds application in the manufacturing of mirrors and reflectors. It is used for electrical connectors. Due to its corrosion resistance, it finds usage in submerged parts and ship fittings.

- **Titanium**

Titanium is an important engineering metal due to being strong and lightweight. It also has high thermal stability even at temperatures as high as 480 degrees Celsius. Due to these properties, it finds application in the aerospace industry. Military equipment is one use-case for this metal. Since titanium is also corrosion resistant, medical applications also use it. Titanium is also used in the chemical and sporting goods industry.

- **Brass**

Brass is an alloy of copper and zinc. The amount of each of the metals may vary depending on the electrical and mechanical properties sought of the metal. It also contains trace amounts of other metallic elements such as aluminum, lead, and manganese. Brass is a great candidate for low friction applications such as locks, bearings, plumbing, musical instruments, tools and fittings. It is indispensable in intrinsically safe applications to prevent sparks and allow usage in flammable environments

Different Types of Metals Continued

- Zinc

Zinc is a widespread metal and finds a lot of use in the medical and industrial sector. Its primary use is to galvanize steel. This protects the steel from corrosion. Zinc is also used to manufacture die castings for the electrical, hardware, and automobile industry. Since zinc has low electrochemical potential, its uses include marine applications to prevent corrosion of other metals through cathode protection. Sacrificial zinc anodes may protect valves, pipelines, and tanks.

- Lead

Lead is a highly machinable, corrosion resistant metal. Piping and paint represent some use-cases. Lead was used as an anti-knocking agent in gasoline. Later, it was discovered that the byproduct of this lead was responsible for serious health complications. Lead is still common in ammunition, car batteries, radiation protection, lifting weights, cable sheathing etc.

References

- https://www.edu.xunta.gal/centros/cafi/aulavirtual2/pluginfile.php/38297/mod_imsdp/content/1/metals_general_properties_extraction_and_classification_of_metals.html
- <https://www.thoughtco.com/steel-grades-2340174>

Metal Classification Quiz

Question #1

Which of the following metal contains IRON?

A. Ferrous

B. Non-Ferrous

Answer

Ferrous

Question #2

Metals can be classified by which of the following means?

- A. Magnetic, It Sparkles, Lead Content.
- B. Iron Content, Atomic Structure, Magnetic.
- C. Weight, Iron Content, Bionic Structure.

Answer

Iron Content, Atomic Structure, Magnetic

Question #3

- True or False/Iron is the base material for STEEL?

Answer

True

Question #4

What is an ALLOY?

- A. A very pretty color.
- B. A metal that contains no IRON.
- C. A metal made by combining two or more metallic elements.

Answer

A metal made by combining two or more metallic elements.

Question #5

What metal is made from a combination of Cooper and Tin?

- A. Bronze.
- B. Aluminum.
- C. Zinc.

Answer

Bronze