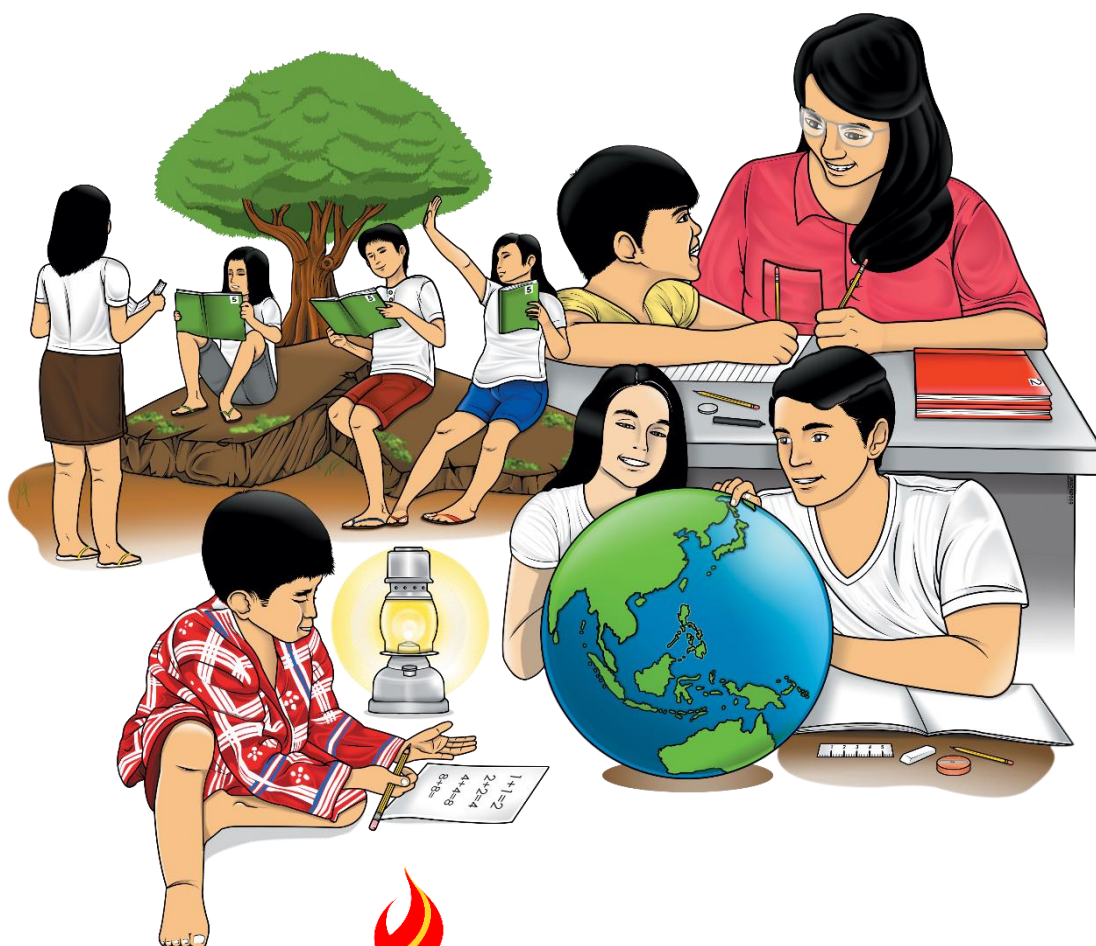


# Science

## Quarter 2- Module 4

### Properties of Metals



**Science- Grade 9**  
**Alternative Delivery Mode**  
**Quarter 2 - Module 4: Properties of Metals**  
**First Edition, 2020**

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**Development Team of the Module**

Author/s: Mark Robel A. Enerio, Marjorie D. Balanay  
Reviewers: Gemma C. Raterta and Jocelyn S. Bangoy  
Illustrator and Layout Artist: Chris T. Sagarino and May Arapoc

**Management Team**

Members:  
Henry B. Abueva OIC-CID Chief  
Ann Q. Solijon, EPS-Science  
Sherlita L. Daguisanan, LRMS Manager  
Meriam S. Otarra, PDO II  
Charlotte D. Quidlat, Librarian II

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Telefax: (063)221-6069  
E-mail Address: [iligan.city@deped.gov.ph](mailto:iligan.city@deped.gov.ph)

# **Science**

## **Quarter 2- Module 4**

### **Properties of Metals**

## **Introductory Message**

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

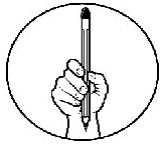
Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.



## ***What I Know (Pretest)***

Multiple Choice: Read the statements carefully. Choose the BEST answer. Write the letter of your answer on a separate sheet of paper.

1. Which of the following properties is best described as the ability of metals to be rolled or hammered into flat sheets or shapes without breaking?

- A. luster    B. malleability    C. ductility    D. electrical conductivity

2. Which of these group of elements have the characteristic of luster/shiny?

- A. Metalloids  
B. Non-metals  
C. Metals  
D. Both metals and metalloids

3. It is the ability of the material to carry electric current.

- A. Thermal conductivity  
B. Ductility  
C. Malleability  
D. Electrical conductivity

4. What are the two properties that make metals a good choice to use as a wire in electronics?

- A. Conductivity and malleability  
B. Ductility and malleability  
C. Malleability and high density  
D. Malleability and luster

5. What best explains why metals are good electrical conductors?

- A. Their atoms are loosely packed and able to move freely  
B. Metal atoms form a long line that allows little movement  
C. Metal ions form a lattice surrounded by a “sea” of free electrons  
D. Their atoms are held together by strong electrostatic attraction between anions and cations

6. Which of the following statement is TRUE about metals?

- A. Metals are heavy and produce sound when hit with an object.  
B. Mercury metal is solid at room temperature.  
C. Metals have low densities.  
D. Metals cannot be converted into thin sheets.

7. Why are metals alloyed?

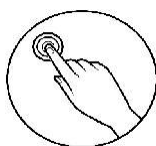
- A. To make them more expensive and durable  
B. To enhance their properties  
C. To limit their ability to be used as insulators  
D. To make them pure and become more useful

8. Why is Aluminum used for making cooking utensils?
- A. It is good conductor of heat.
  - B. It is sonorous.
  - C. It is malleable
  - D. It is ductile.
9. Which of the following metals is used in making airplanes?
- A. Iron
  - B. Copper
  - C. Zinc
  - D. Aluminum
10. Which of the following groups of three metals is arranged in order of increasing chemical reactivity?
- A. Potassium, iron, lead
  - B. Gold, tin, sodium
  - C. Zinc, calcium, silver
  - D. Lithium, silver, gold

## Lesson

# 1

# Properties of Metals



## *What I Need to Know*

At the end of the lesson, you will be able to explain the properties of metals in terms of structure.

- Explain how metallic bonding takes place
- Describe the arrangement of atoms in metals
- Relate the properties of metals to the kind of bond they are made of
- Describe alloys and give examples of how their superior properties make them more suitable in certain situations
- Give examples of uses of metals that take advantage of their unique properties



## *What's New*

An element is a substance made up of the same kind of atom that cannot be broken down into simpler parts. Generally, elements are classified as metals and non-metals.

Some of these elements are considered stable while others aren't. That is why to attain stability, they need to form bonds with other elements. Bonding can take place between a non-metal and another non-metal or a metal and a non-metal.

Previously, you have learned about how covalent and ionic bonding are formed. The electrons in the outermost shell of an atom interact to form bonds. In **ionic bonding**, a metal transfers or donates its electron(s) (cations) to a non-metal (anion) forming an ionic compound. While in **covalent bonding**, non-metals share electrons to become stable forming a covalent compound whose representative particle is a molecule. The kind of bond they form accounts for most of their properties.

Now, if a non-metal can bond with a non-metal, would it be possible for metallic elements to bond? What do you think will make bonding among metals possible?

The world itself has many elements. Around 80% of these elements are metals. Take a look at the periodic table of elements and see where metals can be found and how are they grouped.

1 IA	2 IIA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIII
3	4	5	6	7	8	9	10	11	12									
13	14	15	16	17	18													
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132

Figure 1. Metals in the Periodic Table

Elements are divided into three groups –metals, non-metals, and metalloids. Looking at the periodic table you will see a heavy zigzag line. The elements on the left side are **metals** except hydrogen while those on the right are **non-metals**. Some elements do not belong to either group. They are called **metalloids**. They are found next to the stair step having either both the properties of metals and non-metals.

## Let's Check

Get your periodic table. Name the given element and identify whether it's a metal, non-metal or a metalloid based on its location in the periodic table.

- Group II, Period IV
- Group I, Period II
- Group XII, Period IV
- Group V, Period VII
- Group XI, Period V
- Group XV, Period V
- Group XVI, Period III

Now you know where metals could be found. It wasn't a mere coincidence that these elements are grouped this way. There are reasons why they arranged in this manner.

Dmitri Mendeleev revealed a pattern when he arranged the elements based on their properties. He noticed that the pattern was periodic. Each column represents a group based on the number of electrons in the outer energy level or valence configuration. In particular, metals can be distinguished from non-metals and metalloids based on their chemical and physical properties. Their location in the periodic table tells you more about the kind of elements and how they can possibly be used.

	Group																	
	I	II											III	IV	V	VI	VII	VIII
Period	1	2																
	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
8	119 Uun																	
	* Lanthanides		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
	** Actinides		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Alkali metals	Alkaline earth metals	Lanthanides	Actinides	Transition metals
Poor metals	Metalloids	Nonmetals	Halogens	Noble gases

[https://commons.wikimedia.org/wiki/Periodic\\_table\\_of\\_elements](https://commons.wikimedia.org/wiki/Periodic_table_of_elements)

Furthermore, metals belonging to the same group share common characteristics.

The **alkali metals**(Group IA) except hydrogen are very reactive that they have to be stored under a substance like kerosene in which they become inert. They are fairly soft metals and can be cut with a knife. They have low densities, in fact sodium (Na), potassium (K), and Lithium (Li) have lower densities compared to water. Most of their compounds are soluble in water.

The **alkaline earth metals**(Group 2A) except Beryllium tarnish readily in air. They react with oxygen and water in the air but not as fast as the alkali metals. They are commonly used to make alloys.

Groups of **transition metals** are found in periods 4 through 7 between groups 2A and 13 in the periodic table. Most of the metals belonging to this group are shiny, easy to shape, hard and strong, except for mercury. This is what you usually think when you think of metals.

Some transition metals could also be classified as **noble metals**. They are found as pure metals, very nonreactive, and don't corrode easily. These make them ideal for jewelry and coins. Noble metals include copper, palladium, silver, platinum, and gold.

Others are considered **poor metals** because they are fairly soft, and most are not used very much on their own. They become so useful when added to other substances. Poor metals include aluminum, gallium, tin, thallium, antimony, and bismuth.

The elements found at the bottom of the periodic table that are seemingly detached from it, and are divided into two rows of elements are called **inner transition metals**. The inner transition metals are not that common compared to the other group of metals. **Actinides** are synthetic while, **lanthanides** mostly occur in nature.

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*The groupings of elements based on similarities in their properties is important in determining their uses.*

---

Metals are infinitely recyclable and could be employed in all kinds of objects and products. The human body requires certain metals for specific purposes like formation of the blood, bones, teeth and other tissues. It helps in maintaining and keeping bodily processes in order. Computers would not even exist without metals. Metals and their compounds have important applications in industries and biological systems such as the human body.

In this modern time, metals are considered a necessity. Almost everything we see around us has metals. With this, complete the table below by giving some examples of metals that could be found at home. How did you know that the object is a metal/made of metals? What is your basis in classifying them?

<b>Metallic Object</b>	<b>Observable Characteristics</b>	<b>Uses</b>
e.g. Kettle	Shiny	used for heating water
1.		
2.		
3.		
4.		
5.		

Describe the objects based on their observable characteristics. Identify the features common to all and their differences.

You noticed that metals have certain unique characteristics. They come in different shapes. They are being used in various ways. What is the reason behind this variation? What made it possible for metals to be used in many ways?

There are remarkable benefits from knowing the properties of elements. Learning about the properties enables you to find practical application of this knowledge in big industries and in modern technology.



## What Is It

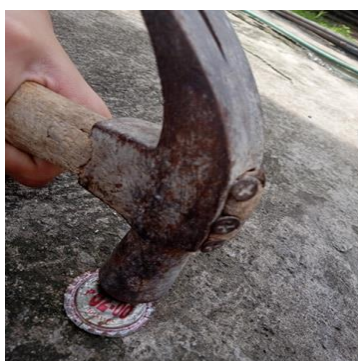
Metals have unique characteristics within a specific group and some at varying degrees. Exploring these characteristics made it possible for humans to maximize their uses.

In Grade 7, you have learned about the varying properties of matter specifically for metals and non-metals. The properties of matter can either be extensive or intensive and either physical or chemical.

**Extensive properties** like mass and volume depend on the amount of substance that is being measured. **Intensive properties** like density, color, melting and boiling point do not depend on the amount of matter. These two are **physical properties** which means that they can be measured and observed without changing the substance's chemical composition or identity.

Meanwhile, **chemical properties** become evident during a chemical reaction when a substance's chemical identity is changed. To recall some of the properties, look at the pictures and describe the properties of metals exhibited in each figure.

### Let's Recall

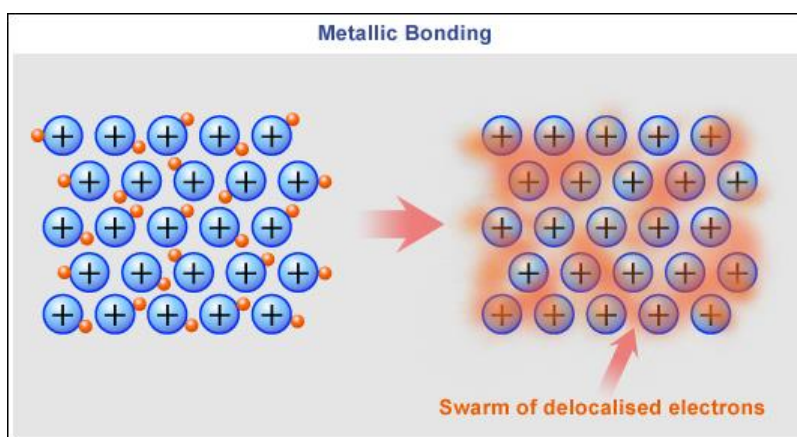


Metals have common properties that make them very useful. The unique combination of these properties makes metals suitable for various purposes. Subsequently, metals have similar physical and chemical properties because they have a common atomic arrangement.

### Arrangement of Atoms in Metals

In metals the outermost electrons are free to move between atoms forming the so-called “**sea of electrons**” or sea of delocalized electrons. The metal ions are arranged in a lattice structure surrounded by these electrons. The structure is held by strong forces of attraction between positively charged metal ions and negatively charged valence electrons known as **metallic bonding**.

It can be described as the sharing of free electrons among a lattice of positively charged metal ions. The structure of metallic bonds is not the same with that of covalent and ionic bonds. While ionic bonds join metals to non-metals, and covalent bonds join non-metals to non-metals, metallic bonds are responsible for the bonding between metal atoms. This type of bond exists in all metallic elements and metallic mixtures called **metal alloys**.



[https://commons.wikimedia.org/wiki/File:Elektroi\\_itsasoa.jpg](https://commons.wikimedia.org/wiki/File:Elektroi_itsasoa.jpg)

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*Metals are made up of lattices of metal ions surrounded by delocalized electrons.*

---

### Physical Properties of Metals

Have you ever asked why metallic objects come in different shapes? Why they are shiny? Why most of your cooking equipment are made of metals? Why electrical wires are made of metals? You might have asked these questions but you do not know exactly the reason behind these.

Remember, atoms in metals lose electrons forming cations. The delocalized electrons surround the ions. Atoms are arranged like closely packed spheres due to the electrostatic interactions between the ions and the electron cloud which bond the metallic solid together. Metallic bonding accounts for many physical properties of metals. Below are the most common properties of metals.

Physical Properties	Descriptions
Malleability	Ability to be rolled or hammered into flat sheets or shapes without breaking
Ductility	Ability to be drawn into wires
Electrical Conductivity	Ability to carry electric current
Thermal Conductivity	Ability to transfer heat
Luster	Shininess due to the reflection of light
High Melting Point	Temperature at which metal changes from solid to liquid

Understanding metallic bonding will help you explain and figure out why metals have these unique properties.

Most metals are **malleable and ductile**, as shown in the figures below, but the amount of force needed to reshape or flatten a metal varies. For example, thin sheets of lead can be readily bent into shape using your hands, while iron requires heating and hammering. Metals can easily be formed into different shapes without breaking because the layers within the lattice structure are able to slide over each other due to the free floating electrons and non-directional nature of metallic bond.



You haven't seen a wire made of plastic or wood. This is because these materials are not capable of conducting electricity. Materials in which electric current cannot pass through are called **insulators**. Hence, the flow of electric charge is not possible. Metals are **electrically conductive** due to the highly mobile electrons which can transmit or transfer electrical charges.



Most of the cooking wares at home are metals, like the metal pot in the picture. Metals **conduct heat** more readily than any materials. The delocalized valence electrons acquire heat faster and transfer heat to its neighboring electrons and cations.



Aside from these, metals are **lustrous** which means that they have shiny appearance due to light reflected off by delocalized electrons. The electrons can move freely causing any light incident to get reflected back.

Lastly, almost all metals except mercury are solids with **high melting points**. This is related to the strength of metallic bond due to the attraction between electrons and cations. High amount of energy is needed to overcome the bond strength which is generally high in metals. This is also directly related to some of the properties such as hardness and tensile strength of metals.

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*The properties of metals can be understood by looking at their atomic structure.*

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## Chemical Properties of Metals

You are living near the beach. You noticed that some parts of your house are tarnishing with a reddish-brown colored substance. What do you think happened to these parts? What causes them to rust?



<https://www.pexels.com/photo/arrow-bali-beach-direction-1654688/>

Aside from the physical properties, metals also have chemical properties. They react with other substances leading to some changes in their composition.

Remember, metals form positive ions arranged in a lattice structure by losing their electrons. This means that metals are electropositive elements. Metals undergo chemical reactions due to its electropositive character.

Almost all metals except the noble metals like gold and silver react with **oxygen** to form basic or metal oxides. Metals vary in terms of **reactivity**. They combine with oxygen at different temperature and intensities. For example, sodium (Na) metal is always kept immersed in kerosene because it reacts so vigorously with oxygen present in air that it catches fire.

Some metals will undergo chemical change on their own or with other elements and release energy. They cannot be found in pure form and are hard to separate from the minerals they are found in. Sodium and potassium are the most reactive metals. They react violently with air and water. Potassium ignites when it comes in contact with **water**. Not all metals react with water at equal intensity. There are metals that are very reactive in cold water while some in hot water or steam. For example, magnesium reacts mildly with water but vigorously with steam while zinc and iron react mildly with steam. Copper, gold and silver do not react with water at all. Metals react with water to produce metal oxide (or metal hydroxide) and hydrogen gas.

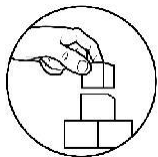
In addition, metals react with dilute acid to form salts and hydrogen gas. Sodium and magnesium react with dilute hydrochloric acid to form their salts.

Moreover, metals that are highly reactive are more prone to chemical destruction or **corrosion**. This is primarily due to the reaction between oxygen and metals. For example, iron and steel have serious corrosion problems if not treated and prevented.

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*Due to the electropositive nature of metals, they tend to lose electrons in order to become stable as they undergo chemical reaction.*

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## What's More

**Part I.** Identify whether the property is intensive or extensive.

1. \_\_\_\_\_ Mass
2. \_\_\_\_\_ Boiling point
3. \_\_\_\_\_ Color
4. \_\_\_\_\_ Volume
5. \_\_\_\_\_ Density

**Part II.** Identify whether the property is either physical or chemical.

1. \_\_\_\_\_ Malleability
2. \_\_\_\_\_ Corrosiveness
3. \_\_\_\_\_ Thermal Conductivity
4. \_\_\_\_\_ Reactivity
5. \_\_\_\_\_ Ductility
6. \_\_\_\_\_ Oxidation
7. \_\_\_\_\_ Electrical Conductivity
8. \_\_\_\_\_ Luster
9. \_\_\_\_\_ Melting Point
10. \_\_\_\_\_ Formation of hydroxides



## What's New

Metals offer a variety of uses in everyday life. They have useful physical and chemical properties which makes them beneficial in a variety of ways. Their properties can be altered by mixing two or more of them together resulting to substance known as **alloys**. Alloys are mixture of metal with other metals. It gives the product a more desirable property like increased tensile strength, hardness and lower melting points. Mixing them together offers more advantages since their physical and chemical properties are enhanced.

You probably see metals wherever you may go. But, did you know that 90% of these metals are alloys? You just learned that alloys are metal solutions which means that various metals and other elements are melted together to improve their properties.

## Try This!

Now, many of these alloys are found at home. Try to identify the alloy the objects below are made of.



wallpaperflare.com



peakpx.com



flickr.com



flickr.com

## Research Time

Determine the elements combined to make these alloys:

1. Bronze
2. Sterling Silver
3. Stainless Steel

### Guide Questions:

1. What elements are combined to make bronze?
2. What is added to iron to make stainless steel?
3. What is the percentage of silver and other elements used in making sterling silver?
4. Why are elements have to be mixed up to form alloys?



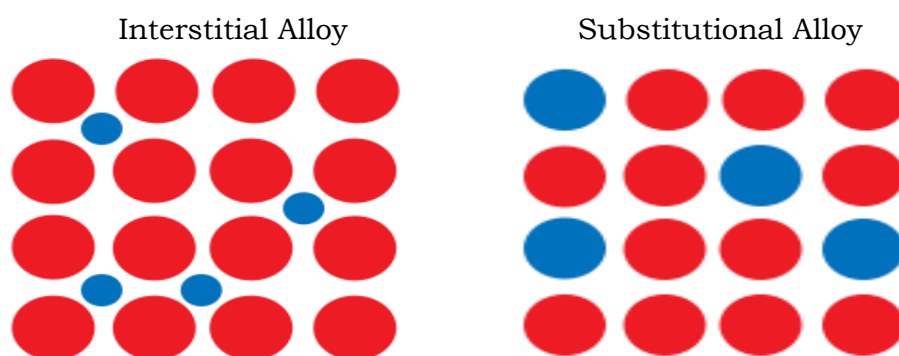
## What Is It

You have learned that some metals are highly reactive and can easily be destroyed by surrounding gases and moisture. Alloys are produced by combining metals to enhance their physical and chemical properties.

The atomic arrangement in metals makes it easier to make alloys. Keep in mind that electrons are not localized or in fixed position which means that the electrons can move easily from one atom to another. So, the atoms can just slide past each other. When metals react together, the atoms normally just mix into a lattice structure forming metallic bond having no fixed proportion and with random distribution.

## Types of Alloys

**Interstitial alloys** are alloys where atoms of the added element occupy spaces (interstices) between atoms in the lattice, rather than displace atoms of the main metal. The atoms of the interstitial element are much smaller than the atoms of the main metal. **Substitutional alloys** are alloys where atoms of the added element substitute atoms of the main metal in the lattice. The atoms of the substitutional element are of comparable size to atoms of the main metal.



[https://en.wikipedia.org/wiki/File:Alloy\\_Substitutional.svg](https://en.wikipedia.org/wiki/File:Alloy_Substitutional.svg)

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*Additional atoms occupy spaces within the lattice structure in interstitial alloys, while atoms within the metallic lattice are replaced by other atoms in substitutional alloys.*

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## Common Metal Alloys in Everyday Life

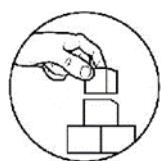
You are probably not aware that you are using alloys every day in your life. Actually, most of the tools and equipment you use are made of alloys like when you eat your meal, cook in the kitchen or drive your car. Below are the most common alloys with their constituent elements.

Alloy	Composition	Uses
<b>Bronze</b> - made to improve the properties of copper.	85-88% copper, 12-12.5% tin with the addition of some other metals like aluminum, manganese, zinc or nickel in small proportions	Used in making of sculptures, musical instruments, medals, and in industrial applications.
<b>Steel</b> - an alloy of iron which has the property of being tough, hard, and corrosion-resistant E.g. stainless steel	iron with about 2% carbon, 1% manganese and small amount of silicon, phosphorus and sulfur	used widely in the construction of roads, railways, airports, bridges, and making of different construction materials, household products, etc.
<b>Brass</b> - an alloy made to improve the electrical and mechanical properties	copper and zinc with some other elements like arsenic, lead, phosphorus, aluminum, manganese, and silicon	used in the manufacturing of decoration items, locks, zippers, gears, doorknobs, musical instruments, plumbing purpose and electrical applications

<b>Sterling Silver</b> - improves the strength, hardness and to reduce tarnishing of silver	92.5% of silver and 7.5% of other metal, usually copper	used in making cutlery, jewelry, musical instruments, and different medical tools
<b>White Gold</b> - an alloy of gold to increase its strength and durability	gold with at least one white metal, usually silver, nickel or palladium	used in making rings and pins
<b>Aluminum Alloys</b> - have improved properties, such as greater strength, hardness and corrosion resistance. They are lightweight, durable and strong	mixing aluminum with small amount of other elements, such as copper, magnesium, manganese, silicon, tin and zinc	Used widely in the construction, transportation and aerospace industries
<b>Titanium Alloys</b> - have superior strength to weight ratios, durable, and corrosion resistance	mixing titanium with small amount of other elements, like tin, aluminum, molybdenum, silicon and vanadium	Used in the military, airline and aerospace industries, as well as consumer electronics, sporting goods, in medical and dental implants

Metals really have a wide variety of functions and uses. It has an extremely wide scope of usefulness and can be utilized in many disciplines.

Indeed, metal is an important resource that is very beneficial to everyone. The many properties of metals help us do a lot of things and make our life more comfortable. That is why it is important that we take responsibility on the safe extraction of metal resources for a sustainable future.



## ***What's More***

Let's practice what you have learned. Answer the test below.

**Part A.** Using your own words, describe what an alloy is. Write your answer on the lines provided.

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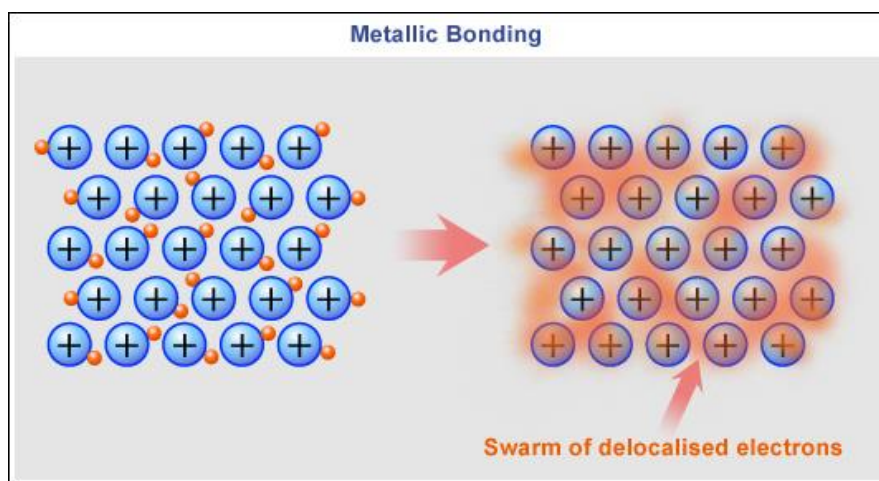
**Part B.** Identify the alloy based on the given description.

- \_\_\_\_\_ 1. Formed by combining a small amount of tin with copper
- \_\_\_\_\_ 2. Formed by mixing small amounts of carbon (<2%) with iron
- \_\_\_\_\_ 3. Contains copper and a significant proportion of zinc
- \_\_\_\_\_ 4. Alloy that contains Iron and smaller amount of carbon and other elements.
- \_\_\_\_\_ 5. Aluminum with small amount of other elements
- \_\_\_\_\_ 6. The most abundantly produced metal in the world
- \_\_\_\_\_ 7. Have superior strength to weight ratios, durability and used in aerospace industries
- \_\_\_\_\_ 8. More malleable than either copper or zinc and is used in musical instruments
- \_\_\_\_\_ 9. Stronger and more durable than either copper or tin
- \_\_\_\_\_ 10. Made of 92.5% of silver and 7.5% of other metal, usually copper



## ***What I Have Learned***

**Part I.** Look at the picture below. Answer the following questions.



Questions:

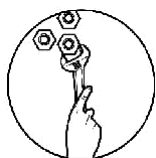
- 1. How does metallic bonding take place?
- 2. How are the atoms in metals arranged?

**Part II.** Explain how the arrangement of atoms in metals accounts for their properties. Complete the table below.

<b>Metallic Property</b>	<b>Explanation</b>
e.g. Luster	Metals are lustrous because when light strikes the surface of the metal, the loosely-bound electrons near the surface move and reflect the light giving the metal a shiny appearance
1.	
2.	
3.	
4.	
5.	

**Part III.** Based on the properties you have listed above, make a list of the uses of metals/metal alloys.

<b>Metal/Metal Alloys</b>	<b>Uses</b>
e.g. copper	Electrical wiring, metal sculpture, and component of jewelry
1.	
2.	
3.	
4.	
5.	



## ***What I Can Do***

### **Activity 1:**

#### **Rusting of Iron**

##### **Objective:**

To investigate the conditions under which iron nail rusts

##### **Procedure:**

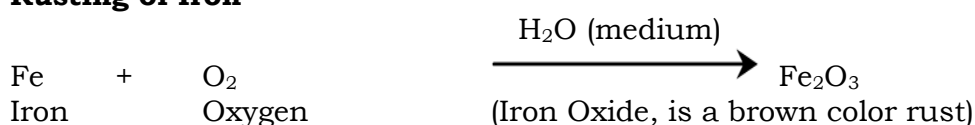
1. Take 3 test tubes. Label them A, B, and C.
2. Place 1 iron nail in each test tubes.
3. In test tube A, pour some water and make sure to seal it with a cork.
4. In test tube B, pour boiled water which does not contain dissolved air. Put some oil in test tube B to form another layer which will prevent air from entering.
5. In test tube C, put some anhydrous chloride and cork it. Anhydrous calcium chloride is added to absorb all the moisture present in the air of the test tube.
6. Keep it undisturbed for several days. Observe what will happen.

### Guide Questions:

1. What happens to the nail in test tube A? test tube B? and test tube C?
2. Which of the nails in the test tube exhibit rusting?
3. Which of the nails did not rust?
4. What are the conditions needed for the iron nail to rust?

When iron or steel forms a reddish-brown layer, it indicates that chemical reaction has taken place. This layer, simply known as **rust**, continually flakes away exposing more of the metals until the metal is eventually destroyed or eaten through. Below is the chemical reaction of rusting of iron with its reactants and product in the equation.

#### Rusting of Iron



### Let's Apply

Look around your house for examples of metallic objects that undergo corrosion. How will you prevent further corrosion of these objects? What will you do to protect them from getting corroded?



<https://www.needpix.com/photo/1813936/corrosion-fencing-brown-metal>  
<https://pxhere.com/en/photo/1024748>

## Activity 2:

### Iron or Steel?

#### Objective:

To investigate and describe how the superior properties of alloys make them suitable for certain situations

#### Procedure:

Review the table below. Answer the questions that follow

Metal	Description	Properties	Uses
Iron (Fe)	-Element -with atomic number 26 -the fourth most abundant element in the Earth's crust	-Density: 7.8 g/cm <sup>3</sup> -Melting point: 1538 °C -Very reactive -Rapidly corrodes -Hard -Brittle	-Make alloys -Vital to plant and animal life; (it carries oxygen)
Steel	-Alloy (mixture) Composed of mostly iron, magnesium, silicon and carbon	-Density: 7.9 g/cm <sup>3</sup> -Melting point: 1510 °C -Non-corrosive in most environments -High strength Non-brittle	- to make bridges and buildings (skyscrapers)

#### Guide Questions:

1. How do the properties of iron change once it is alloyed?
2. Why do engineers prefer the use of steel over pure iron in building bridges?

#### Summary

- An element is a substance made up of the same kind of atom
- Elements are classified into three groups –metals, non-metals, and metalloids.
- Around 80% of the elements are metals.
- The elements on the left side of the Periodic Table are metals except hydrogen while those on the right are non-metals. Some elements do not belong to either group. They are called metalloids.
- The location of elements in the periodic table tells you more about the kind of elements and how they can possibly be used.
- The groupings of elements based on similarities in their properties is important in determining their uses.
- The properties of matter can either be extensive or intensive and either physical or chemical.
- Metals have similar physical and chemical properties because they have a common atomic arrangement.
- In metals, the outermost electrons are free to move between atoms forming the so-called “sea of electrons” or sea of delocalized electrons. The metal ions are arranged in a lattice structure surrounded by these electrons.

- The structure is held by strong forces of attraction between positively charged metal ions and negatively charged valence electrons known as metallic bonding.
- Metals can easily be formed into different shapes without breaking (malleability and ductility) because the layers within the lattice structure are able to slide over each other due to the free-floating electrons and non-directional nature of metallic bond.
- Metals are electrically conductive due to the highly mobile electrons which can transmit or transfer electrical charges.
- Metals conduct heat more readily than any materials. The delocalized valence electrons acquire heat faster and transfer heat to its neighboring electrons and cations.
- Metals are lustrous which means that they have shiny appearance due to light reflected off by delocalized electrons.
- Almost all metals are solids with high melting points. This is related to the strength of metallic bond due to the attraction between electrons and cations.
- Metals undergo chemical reactions due to its electropositive character.
- Metals vary in terms of reactivity. Almost all metals except the noble metals like gold and silver react with oxygen to form basic or metal oxides.
- Metals react with water to produce metal oxide (or metal hydroxide) and hydrogen gas.
- Metals that are highly reactive are more prone to chemical destruction or corrosion.
- Mixing metals together to form alloys offer advantages since their physical and chemical properties are enhanced. Bronze, brass, and steel are some examples of alloys.
- Interstitial alloys are alloys where atoms of the added element occupy spaces (interstices) between atoms in the lattice. Substitutional alloys are alloys where atoms of the added element substitute atoms of the main metal in the lattice.



## ***Assessment: (Post-Test)***

Multiple Choice: Read the statements carefully. Choose the letter of the BEST answer. Write the letter of your answers on your answer sheet.

1. Which of the following statements best describes metallic bonding?
  - A. Metal transfers or donates its electron to a non-metal forming an ionic compound
  - B. Non-metals share electrons to become stable forming a compound whose representative particle is a molecule
  - C. Strong forces of attraction between positively charged metal ions and negatively charged valence electrons
  - D. Bond between two atoms where the electrons forming the bond are unequally distributed

2. What do you call the outermost electrons that are free to move between atoms in metals?
  - A. Cloud of electrons
  - B. Electro positivity
  - C. Sea of electrons
  - D. Electron configuration
3. These are properties that can be measured and observed without changing the substance's chemical composition or identity.
  - A. Intensive properties
  - B. Chemical properties
  - C. Extensive properties
  - D. Physical properties
4. Most metals are malleable. What do you mean by this?
  - A. They are strong and hard.
  - B. They are solids at room temperature.
  - C. They can be shaped without breaking or cracking.
  - D. They will turn into another element over time.
5. It is the ability of the material to carry electric current.
  - A. Thermal conductivity
  - B. Ductility
  - C. Malleability
  - D. Electrical conductivity
6. Which of the following statement is TRUE about metals?
  - A. Metals do not produce sound when hit with an object.
  - B. Mercury metal is liquid at room temperature.
  - C. Metals have low densities
  - D. Metals cannot be converted into thin sheets.
7. Why is aluminum used for making cooking utensils?
  - A. It is good conductor of heat.
  - B. It is sonorous.
  - C. It is malleable
  - D. It is ductile.
8. What best explains why metals are good electrical conductors?
  - A. Their atoms are loosely packed and able to move freely
  - B. Metal atoms form a long line that allows little movement
  - C. Metal ions form a lattice surrounded by a "sea" of free electrons
  - D. Their atoms are held together by strong electrostatic attraction between anions and cations
9. Which of the following groups of three metals is arranged in order of increasing chemical reactivity?
  - A. Potassium, iron, lead
  - B. Gold, tin, sodium
  - C. Zinc, calcium, silver
  - D. Lithium, silver, gold
10. Which of the following metals is used in making airplanes?
  - A. Iron
  - B. Copper
  - C. Zinc
  - D. Aluminum



## Answer Key

<p>Assessment: Post-Test</p> <ol style="list-style-type: none"> <li>1. C</li> <li>2. C</li> <li>3. D</li> <li>4. C</li> <li>5. D</li> <li>6. B</li> <li>7. A</li> <li>8. C</li> <li>9. B</li> <li>10. D</li> </ol>	<p>What's More (IIA)</p> <ol style="list-style-type: none"> <li>1. An alloy is mixture of metals with other substances</li> </ol> <p>What's More (IIB)</p> <ol style="list-style-type: none"> <li>1. Bronze</li> <li>2. Steel</li> <li>3. Brass</li> <li>4. Stainless steel</li> <li>5. Aluminum alloy</li> <li>6. Steel</li> <li>7. Titanium alloy</li> <li>8. Brass</li> <li>9. Bronze</li> <li>10. Sterling silver</li> </ol>
<p>What's More (IA)</p> <ol style="list-style-type: none"> <li>2. Extensive</li> <li>3. Intensive</li> <li>4. Intensive</li> <li>5. Extensive</li> <li>6. Intensive</li> </ol> <p>What's More (IB)</p> <ol style="list-style-type: none"> <li>1. Physical</li> <li>2. Chemical</li> <li>3. Physical</li> <li>4. Chemical</li> <li>5. Physical</li> <li>6. Chemical</li> <li>7. Physical</li> <li>8. Physical</li> <li>9. Physical</li> <li>10. Chemical</li> </ol>	<p>What I know-Pretest</p> <ul style="list-style-type: none"> <li>• B</li> <li>• C</li> <li>• D</li> <li>• B</li> <li>• A</li> <li>• B</li> <li>• A</li> <li>• C</li> <li>• B</li> <li>• D</li> <li>• A</li> <li>• B</li> <li>• D</li> <li>• B</li> </ul>

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**For inquiries or feedback, please write or call:**

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex  
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: [blr.lrqad@deped.gov.ph](mailto:blr.lrqad@deped.gov.ph) \* [blr.lrpd@deped.gov.ph](mailto:blr.lrpd@deped.gov.ph)