Name ______________________ Class ________ Date ___________

TEKS Chemistry
Lesson 7D

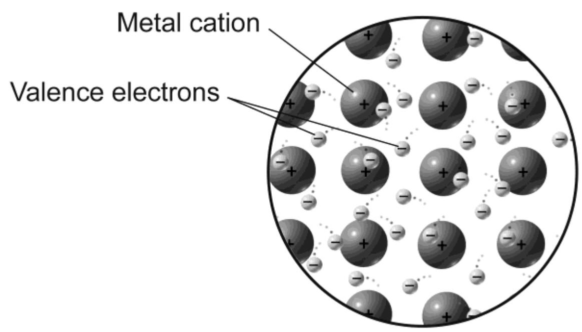
TEKS 7D ***Describe the nature of metallic bonding and apply the theory to explain metallic properties such as thermal and electrical conductivity, malleability, and ductility.***

TEKS Lesson 7D: Metallic Bonding

What is metallic bonding?

You have probably seen decorative fences, railings, or weather vanes made of a metal called wrought iron. Wrought iron is a very pure form of iron that contains trace amounts of carbon. It is a tough, malleable, ductile, and corrosion-resistant material that melts at a very high temperature. **Malleability** allows a material to be hammered or rolled into flat sheets or other shapes. **Ductility** allows a material to be pulled out, or drawn, into wires. Malleability and ductility are common properties of metals. These and other properties derive from the way that metal ions form bonds with one another.

Metallic Bonds Metals consist of closely packed cations and loosely held valence electrons rather than neutral atoms. The valence electrons of atoms in a pure metal can be modeled as a sea of electrons. That is, the valence electrons are mobile and drift freely from one part of the metal to another. **Metallic bonds** are the forces of attraction between the free-floating valence electrons and the positively charged metal ions. These bonds hold metals together in a lattice-like, or crystal, structure. Although the electrons are moving among the atoms, the total number of electrons does not change. So overall, the metal is neutral.



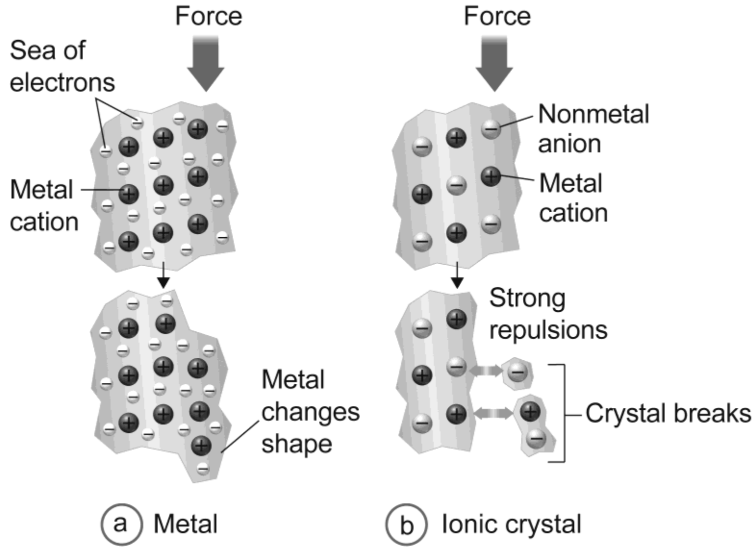
How does metallic bonding explain metallic properties?

The sea-of-electrons model explains many physical properties of metals. For example, the surfaces of polished metals have a shiny and reflective appearance, called metallic luster. This luster results when light strikes the valence electrons. These electrons absorb the light and then re-emit it.

Electrical and Thermal Conductivity You may know that a flow of charged particles is an electrical current. A metal has a built-in supply of charged particles that can flow from one location to another—its sea of electrons. Metals are good conductors of electrical current because electrons can flow freely in the metal. As electrons enter one end of a bar of metal, an equal number of electrons leaves the other end.

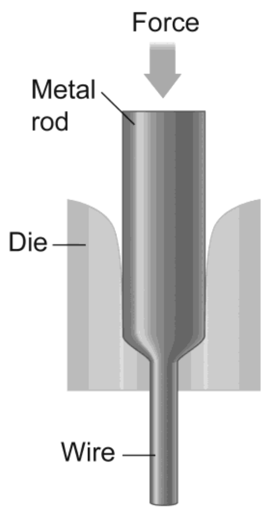
The mobile electrons in metals also result in good thermal conductivity—the ability of an object to transfer heat. Thermal energy is the total energy of all the particles in an object. Thermal energy flows from warmer matter to cooler matter, and the transfer of thermal energy is known as heat. Metals conduct heat easily because the valence electrons within a metal are free to move. Electrons in the warmer part of the metal can transfer energy to electrons in the cooler part of the metal.

Malleability and Ductility Like electrical and thermal conductivity, both malleability and ductility of metals can be explained in terms of the mobility of valence electrons. A sea of drifting valence electrons insulates the metal cations from one another. When a metal is subjected to pressure, the metal cations easily slide past one another. They move like ball bearings immersed in oil, without breaking away from one another. In contrast, if an ionic crystal is struck with a hammer, the blow tends to push the positive ions close together. These positive ions repel one another, and the crystal shatters.



As a result of the ability of metal cations to slide past one another, a metal can be hammered or pressed into thin sheets or other shapes, such as the thin walls of a metal can or aluminum foil. Similarly, pressure can be used to force a metal into the shape of a thin wire. Think of the silver wire used to make jewelry, for example.

A die is a piece of metal with a hole through it. A rod made from another metal can be forced though the narrow opening in the die to produce rods or thin wire.



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Lesson Check

1. **Define** What is meant by the terms *ductility* and *malleability?*

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2. **Describe** Describe the nature of metallic bonding in jewelry made from metals.

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3. **Explain** Why is the “sea of electrons” a useful model to describe metallic bonding?

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4. **Apply Theories** Apply the theory of metallic bonding to explain electrical conductivity in metals.

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5. Apply Theories Apply the theory of metallic bonding to explain why a metal horseshoe bends but does not break when a blacksmith pounds it into shape with a hammer.

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6. Apply Concepts What two properties of metals make copper an excellent material for use in electrical circuits? Explain.

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