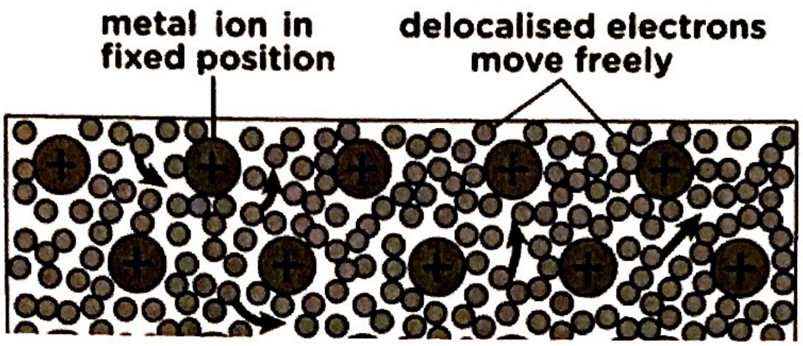
Metallic Bonding and Alloys

Metallic bonds: results from the attraction between metals atoms and the surrounding Sea of electrons.

- The valence electrons of metal atoms are not tightly held, which means its valence electrons are delocalized (not stuck in one place) and mobile (free to move around).
- The sea of electrons occupies the interstitial spaces (the spaces between the metal cores).
- Because each metal atom allows its electrons to roam freely, these atoms become positively charged cations. The attraction between the negative electrons and positive metal cores is a metallic bond.



Metallic bond properties:

1. Highly conductive of heat and electricity (because of mobile electrons).
2. Lustrous (Shiny) because it reflects incoming light photons (because of the mobile electrons.)
3. The structure and uniform bonding in all directions of the metal allow the atoms to slide past each other without breaking, leading to:
   a. Malleability: ability of a substance to be hammered or beaten into thin sheets.
   b. Ductility: ability of a substance to be drawn or pulled through a small opening to produce a wire. (without cracking)

Let's Practice! Explain the following in terms of structure and/or bonding.

1. Solid K conducts a strong electric current, whereas solid KNO_3 does not.

metallic bonding ⇒ Sea of delocalized, mobile e⁻ that can conduct an electric current

ionic bonding ⇒ charges fixed in a crystal lattice, not free to conduct an electric current

2. Which of the following solids will conduct an electrical current? Explain. (Mg) or NaCl or CO_2

Mg: metal ⇒ Sea of e⁻

NaCl: ionic: fixed charges

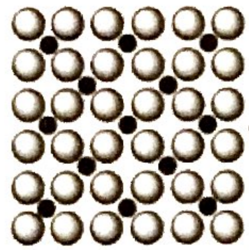
CO_2: Covalent: no charges!

Alloys: similar in structure to pure metal solids, but contain more than one type of element.

There are two types of alloys that are AP tested!

Substitutional Alloys	**Interstitial Alloys**
Form between atoms of similar size, where one atom substitutes for the other in the lattice. • Similar properties to component atoms • Still malleable and ductile	Form between atoms of different size, where the smaller atoms fill the interstitial spaces (lattice holes) between the larger atoms. • Properties change!! • More brittle (harder) • Less malleable and ductile

same size ⇒ similar properties



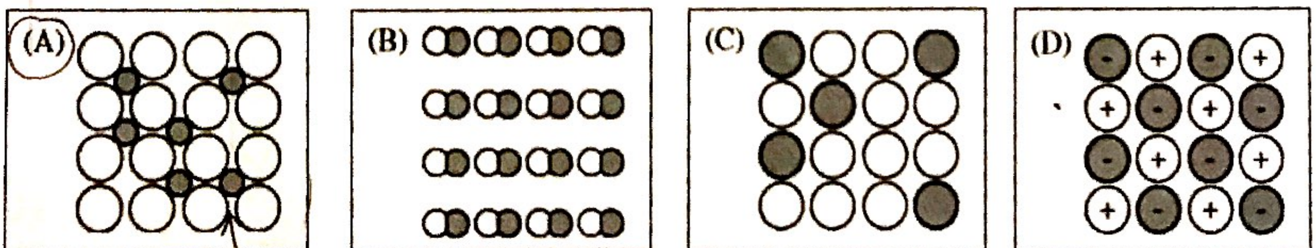
smaller atoms create places where large atoms can't slip by, decreasing deformability

1. Alloys typically retain a sea of mobile electrons and so remain conductive.
2. In some cases, alloy formation alters the chemistry of the surface. An example is the formation of a chemically inert oxide layer in stainless steel.

Let's Practice!

1. To increase its strength and hardness, gold alloys are created by combining it with other metals such as nickel and palladium (Pd). When comparing a Au/Ni alloy with a Au/Pd alloy, both made with the same mole fraction of gold, the Au/Ni alloy is measurably harder than the Au/Pd alloy. Which of the following statements best explains why?
   a. Ni has only one common oxidation state, but Pd has two.
   b. Pd has a lower melting point than Au, but Ni has a higher melting point.
   (c.) Ni atoms are smaller than Pd atoms, and so they interfere more with the displacement of atoms in the alloy.
   d. Ni atoms are less polarizable than either Au or Pd atoms, and so Ni has weaker interparticle forces.

2. Which diagram shown below would be the best representation of steel: an alloy of iron and carbon?



tiny C!