SCH4U1

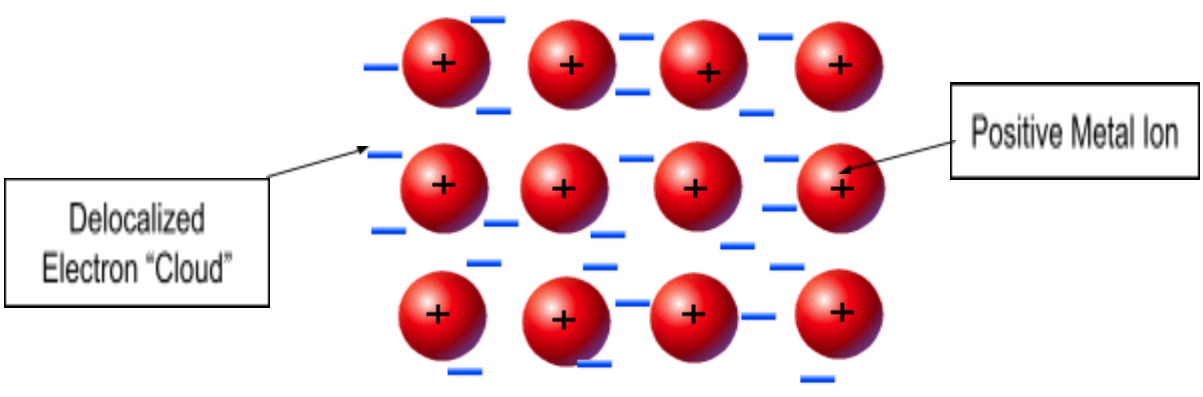
METALLIC SOLIDS

As a group, metals have small numbers of valence electrons. Therefore, metals have outer energy levels which are less than half filled. Also, metals are readily ionized so their valence electrons are not tightly held. In addition, metals are very good conductors of electricity. All of these factors tend to indicate that the valence electrons in metals are delocalized (able to move) throughout the solid. Thus, one can think of a metallic solid as being an array of positive ions in a "sea" of mobile electrons. The positive nuclei are not attracted to one another; they are all attracted to the cloud of electrons. This cloud of electrons serves as the "glue" which holds the nuclei together. Therefore, a metallic bond is the attraction between a cloud of mobile electrons and the positive metallic ions arranged in that cloud.

This model can be used to explain the properties of metals:

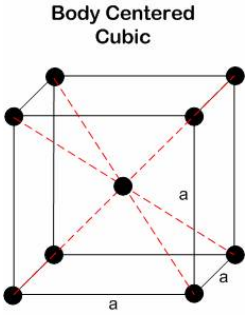
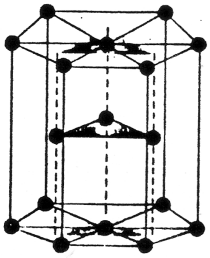
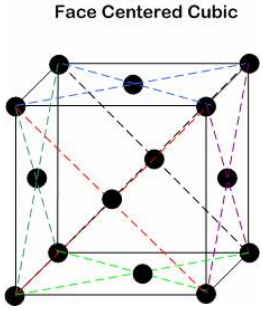
- It is the mobility of the electrons that allows metals to conduct electricity.
- Metals are also good heat conductors because of the mobile electrons. When one end of a metallic solid is warmed, the electrons in that region acquire large amounts of kinetic energy. These electrons move rapidly through the solid and give extra energy to the atoms in the cooler part of the solid.
- Metals can be drawn into wires (ductile) and can be hammered into sheets without cracking (malleable). This is because one plane of ions in a metallic crystal can slip over another and, as it does so, the electron cloud merely distorts to maintain bonding.
- The mobile electrons are also able to absorb and re-emit light of all wavelengths. Therefore, metals are good reflectors of light,.which explains why they have a lustre. Finally, as one goes across a period of the periodic table, one finds that metals become harder and they become more difficult to melt or boil, too. This is because, as one goes across a period, there is an increasing number of valence electrons. Thus, there are more electrons for the positive nuclei to be attracted to and therefore the metallic bonding is stronger.

The Electron Sea Model of a Metallic Crystal



Geometry of Metals

Almost all pure metals crystallize in one of the following three patterns.

1) Body-Centred Cubic Structure	2) Hexagonal Close-Packed Structure	3) Cubic Close-Packed Face-Centred Cubic Structure
8 neighbours/atom	12 neighbours/atom	12 neighbours/atom
		
e.g. Li, Na, K, Fe	e.g. Be, Mg	e.g. Al

Metallic Solids – Questions

1. Lithium is far more malleable than aluminum. Explain why this is true.

2. Which element would have the highest heat of vapourization, K or Sc? Explain.