The Structure and Properties of Solids

Chapter 4.8

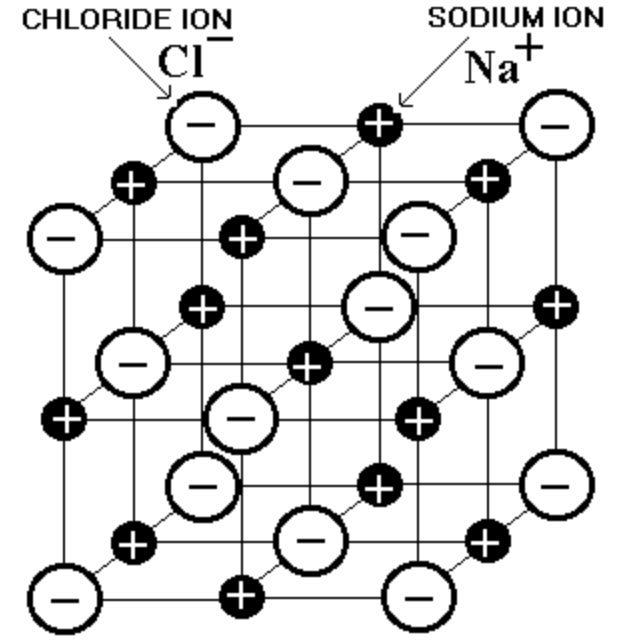
Types of Solids

- There are 4 types of solids:

1. Ionic Crystals
2. Metallic Crystals
3. Molecular Crystals
4. Covalent Network Crystals

Ionic Crystals

- **Ionic Crystals** are solids in which positive and negative ions arrange in a crystal lattice structure, with alternating packing of the positive and negative ions

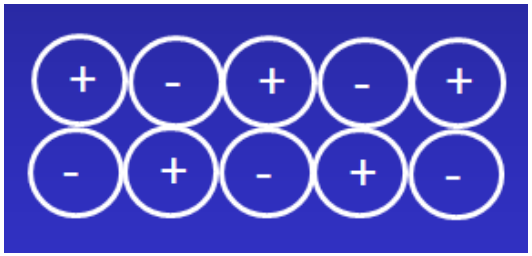


SODIUM CHLORIDE LATTICE STRUCTURE

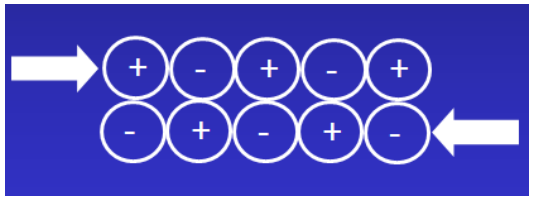
Properties of Ionic Crystals

Ionic Crystals are **BRITTLE**

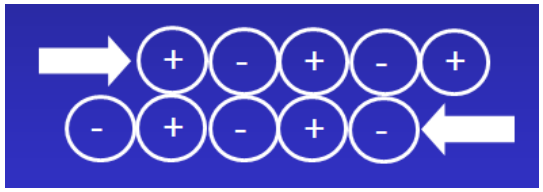
The crystal lattice structure of an ionic crystal is held together by the attraction of oppositely charged ions



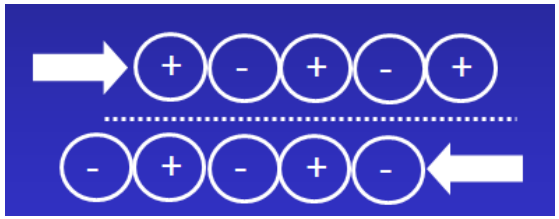
If the crystal is struck with a hammer



The ions become distorted

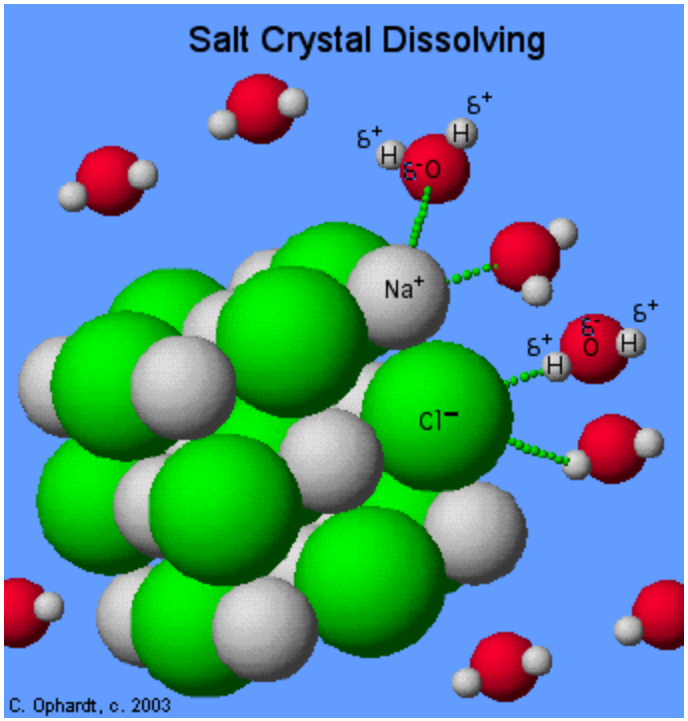


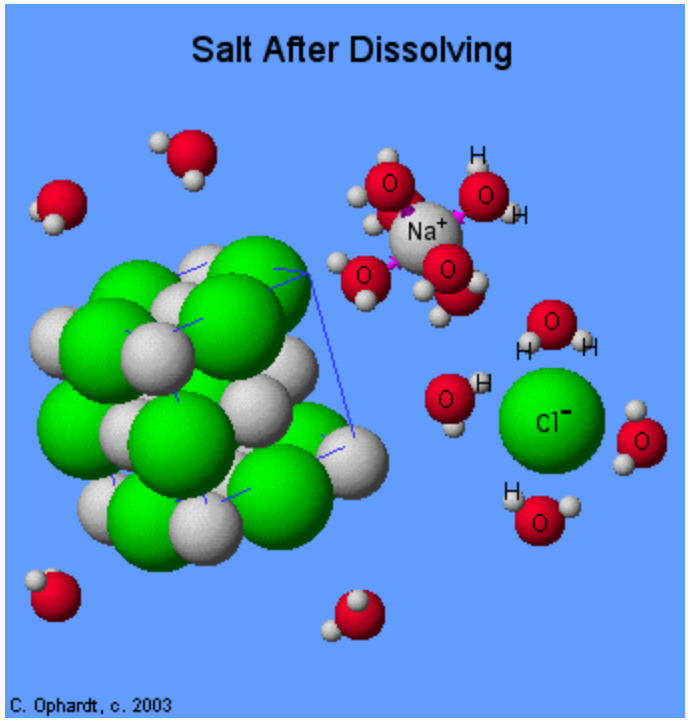
And they repel one another causing the crystal to break or shatter



Properties of Ionic Crystals

Ionic Crystals are **SOLUBLE** in water

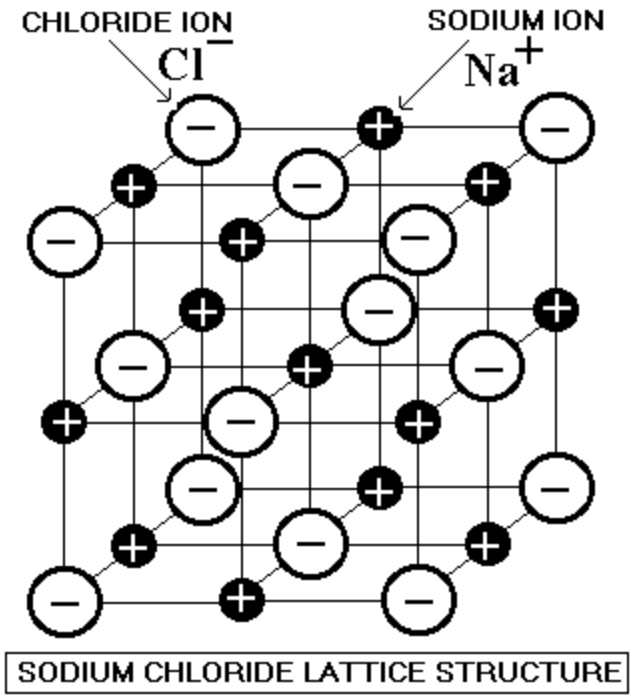




They also **CONDUCT ELECTRICITY** but only in solution or in the liquid state

Other Properties of Ionic Crystals

- Hard
- High melting points



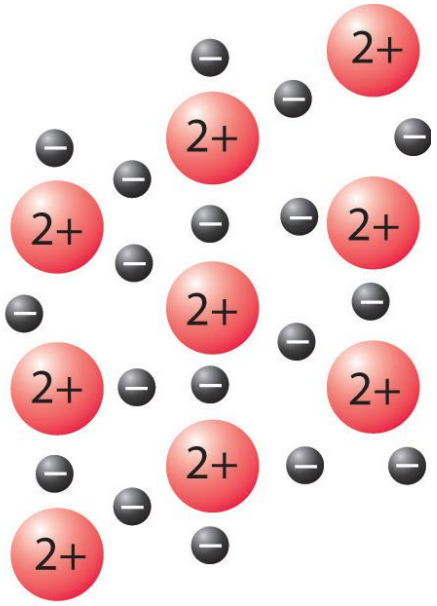
SODIUM CHLORIDE LATTICE STRUCTURE

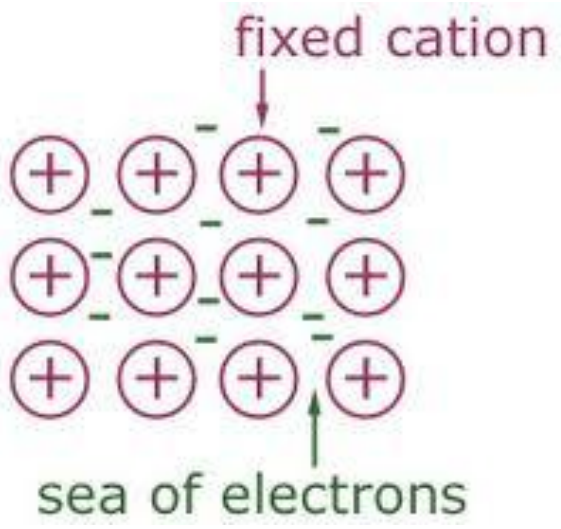
Metallic Crystals

- **Metallic Crystals** are solids with closely packed atoms held together by electrostatic interactions and free moving electrons
- **Electron Sea Theory** is a theory that states that the electrons in a metallic crystal move freely around the positively charged nuclei
- **Metallic Bonding** is the bonding that holds the nuclei and electrons of metals together

Metals have a **low ionization energy** and easily give up electrons

The metallic ions pack together as closely as possible and are held in place because of strong electrostatic forces between the ions and the **delocalized electrons**





Properties of Metallic Crystals

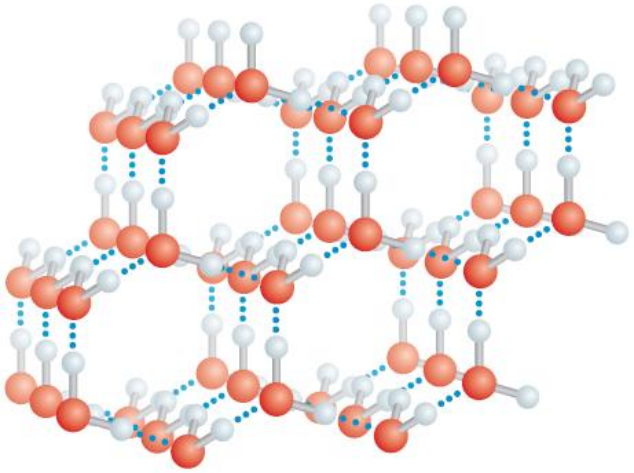
- Melting points vary widely

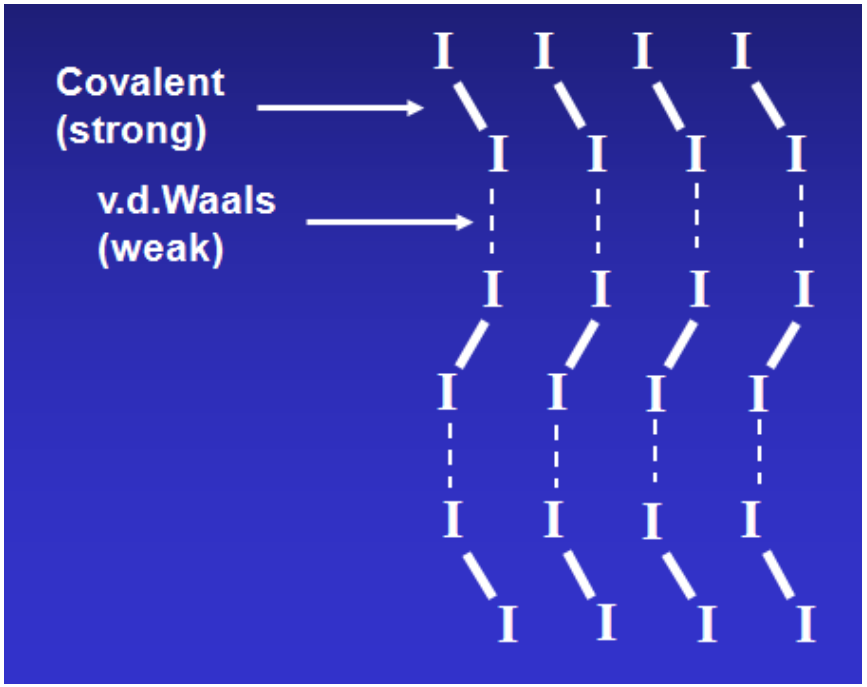
Table 1 Properties of Metallic Solids

Property	Explanation
sheen	Mobile valence electrons absorb and emit light energy of many wavelengths of light.
malleability	The “electron sea” allows atoms to slide over each other.
electrical conductivity	Mobile valence electrons produce an electric current when a metal is connected to a battery.
hardness	The “electron sea” surrounding the positive nuclei produces strong electrostatic attractions that hold the nuclei together.

Molecular Crystals

- **Molecular crystals** are solids composed of individual molecules held together by intermolecular forces of attraction





Properties of Molecular Crystals

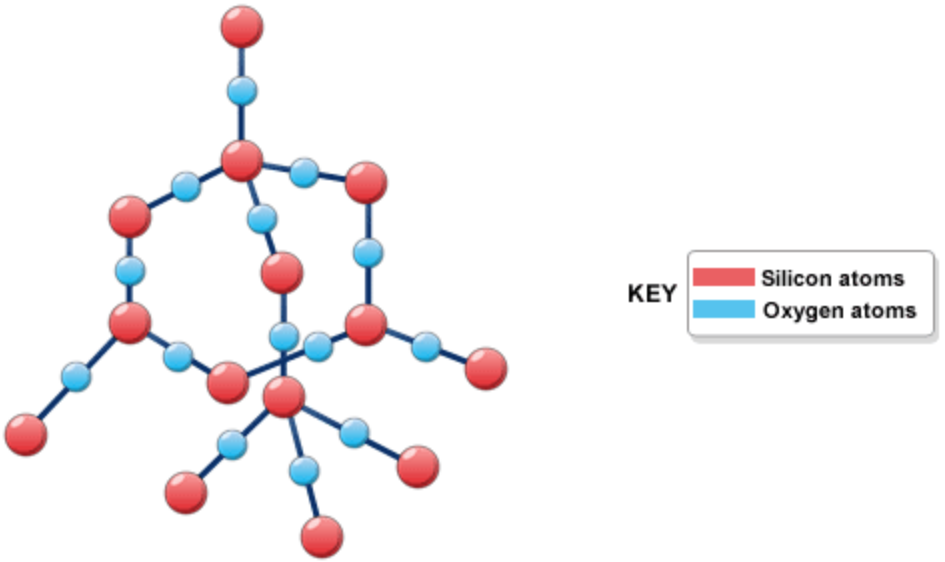
Table 2 Properties of Molecular Crystals

Property	Reason
low melting point	intermolecular interactions
little hardness	intermolecular interactions
electrical non-conductor	composed of neutral molecules

Covalent Network Crystals

- A **Covalent Network Crystal** is a solid in which the atoms form covalent bonds in an interwoven network

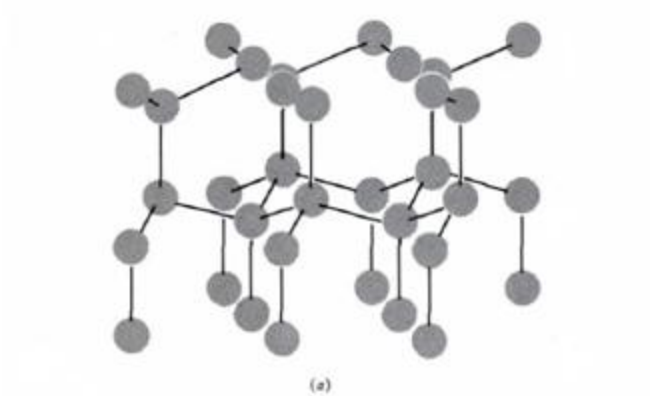
Ex: Quartz Crystal



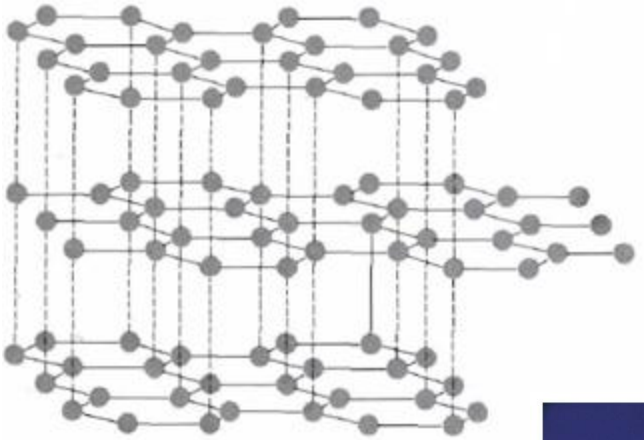
Properties of Covalent Network Crystals

- Very high melting points
- Extreme hardness
- Not good conductors of electricity

Diamond vs. Graphite

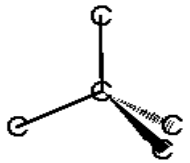


(a)

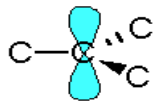


(b)

Diamond	Graphite
Hardest natural substance	Soft and slippery
Density 3.5 g/cm³	Density 2.4 g/cm³
Non-conductor of electricity	Good conductor of electricity
Colourless and transperent	Black and opaque
High refractive index of 2.4	Opaque to light
Does not mark paper	Leaves mark on paper
Burns at 900 degree c to form carbon dioxide	Burns at 700 degree c to form carbon dioxide



tetrahedral carbon in diamond



trigonal planar carbon in graphite with p orbital

HOMEWORK

Required Reading:

p. 248-254

(remember to supplement your notes!)

Questions:

p. 254 #1-9