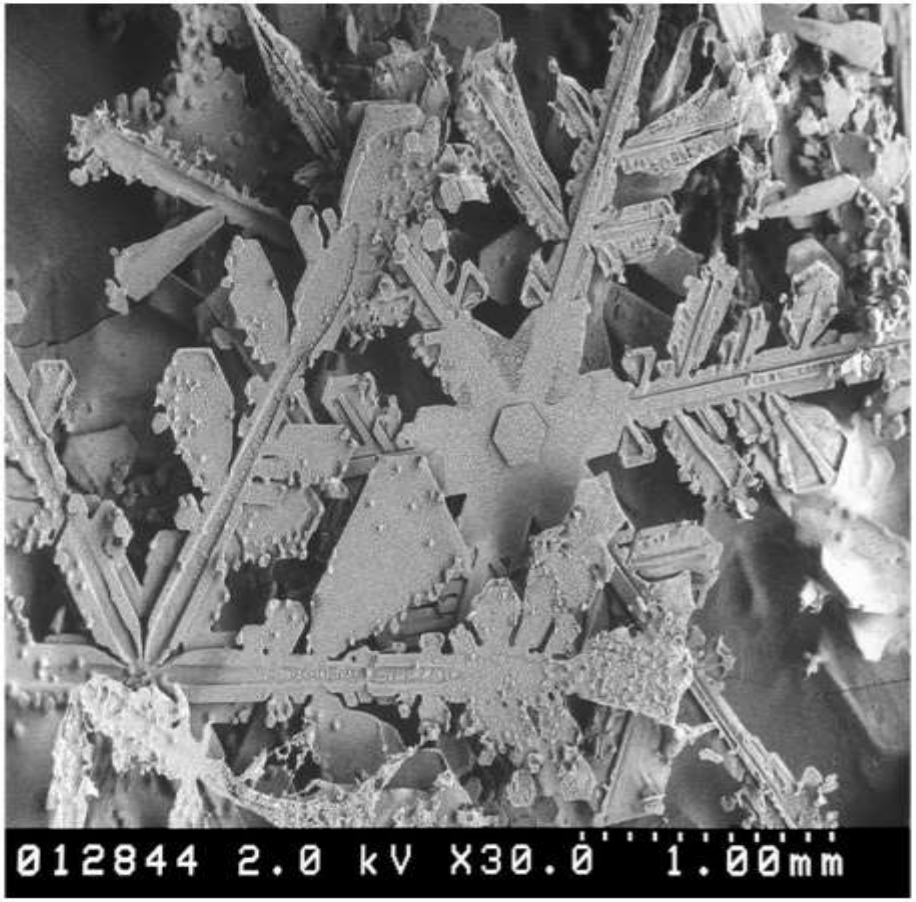
STRUCTURE & PROPERTIES OF SOLIDS

SOLIDS

Structure & properties of a solid are related to the forces between the particles

Types:

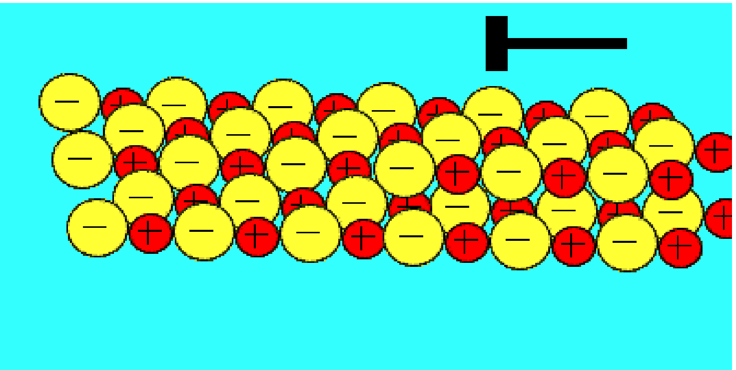
- -Ionic *crystals*
- -Metallic *crystals*
- -Molecular *crystals*
- -Covalent network *crystals*
- -Amorphous solid

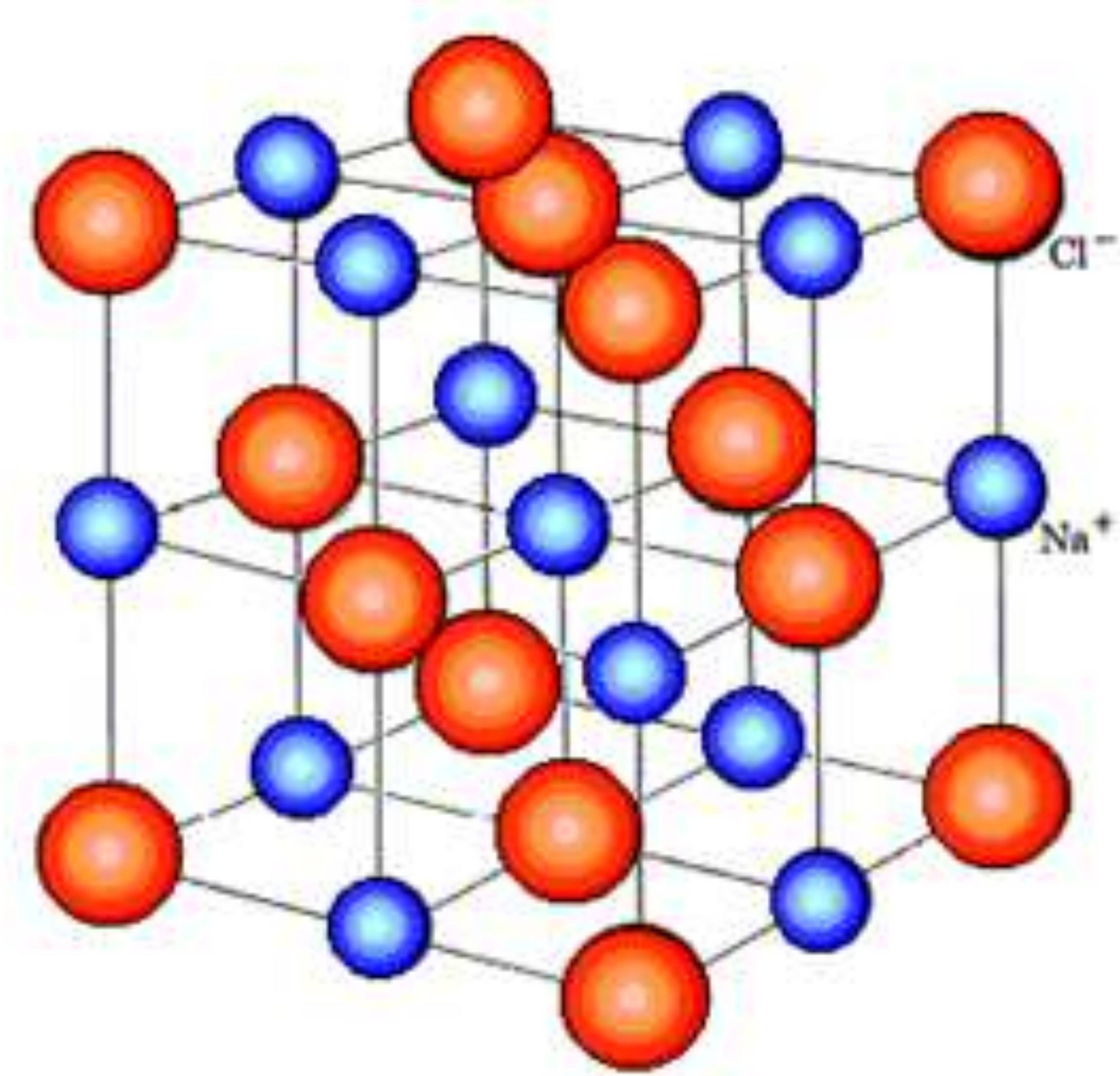


IONIC CRYSTALS

Ionic crystals:

- Ions are arranged in a lattice structure
- Held together by strong directional ionic bonds
- High melting points, conduct electricity as liquids, are hard and brittle



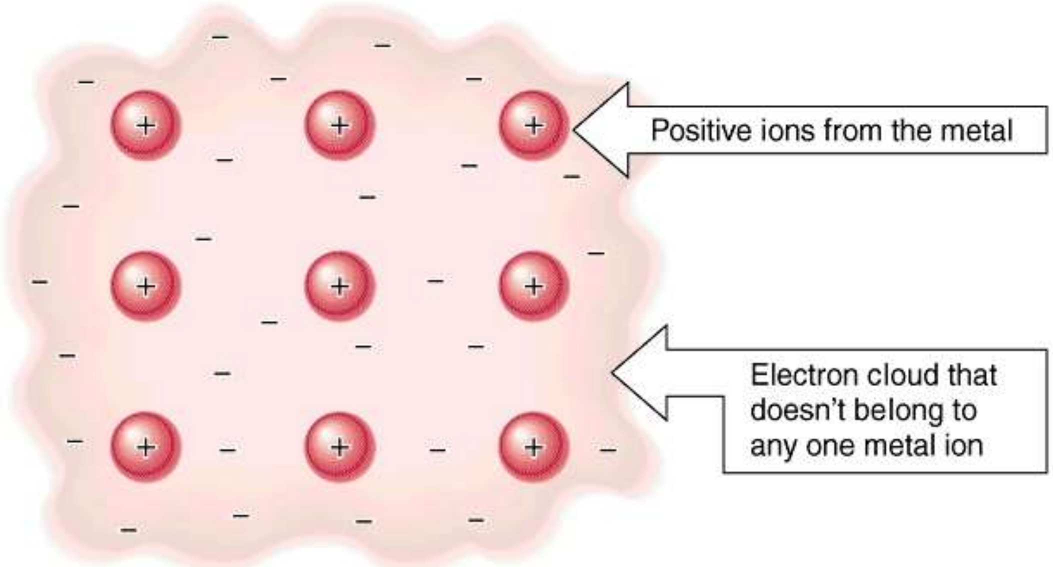


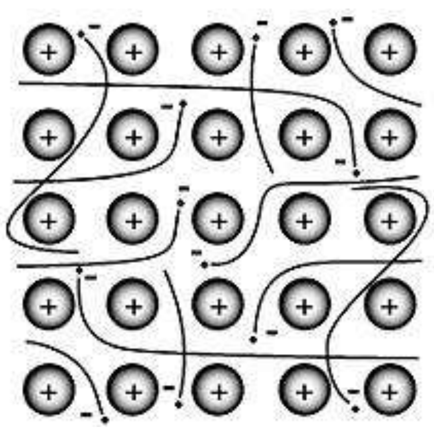
METALLIC CRYSTALS

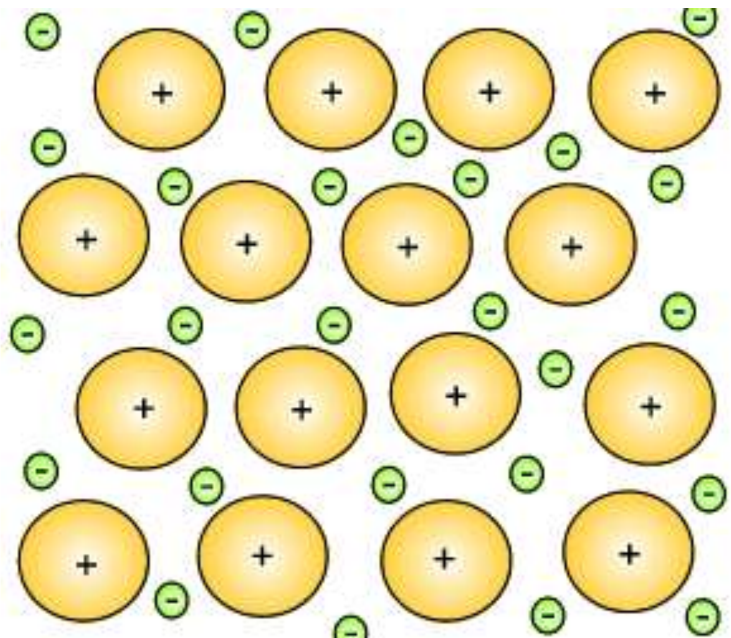
Metallic crystals:

-Positive metal ions are arranged with valence electrons delocalized around them

-Electrons are mobile & able to move throughout the metal structure



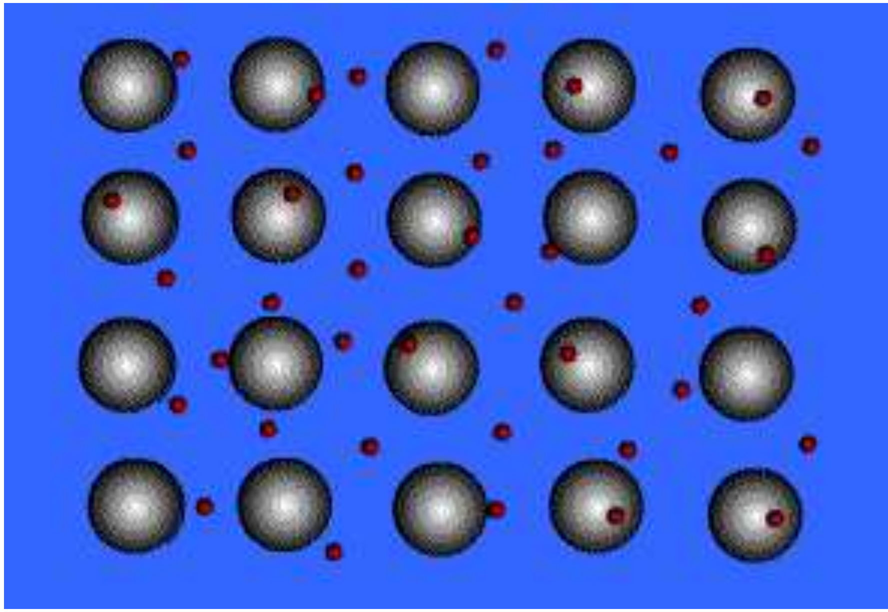




METALLIC CRYSTALS

Metallic crystals:

-Electron Sea Model -resembles positive ions floating in a "sea of electrons" *(pg 249)*



-Explains why metals

- Malleable
- Ductile
- Good heat conductors
- Good electrical conductors
- Lustrous (shiny)
- Hardness

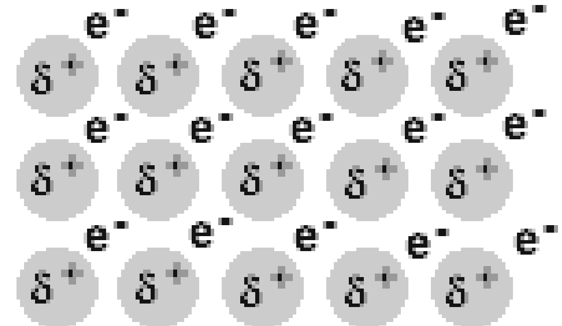
METALLIC CRYSTALS

Metallic crystals:

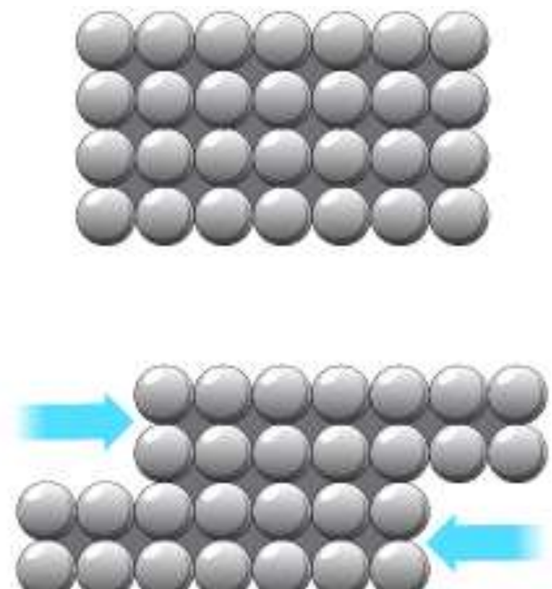
- Malleable & ductile
  - Atoms can slide over each other

Malleability

[redacted]



Ductile

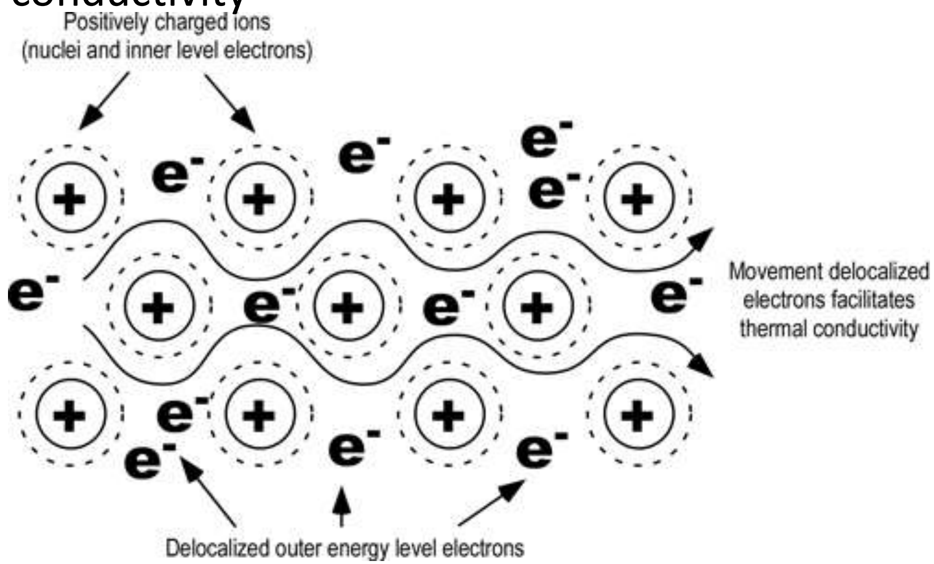


METALLIC CRYSTALS

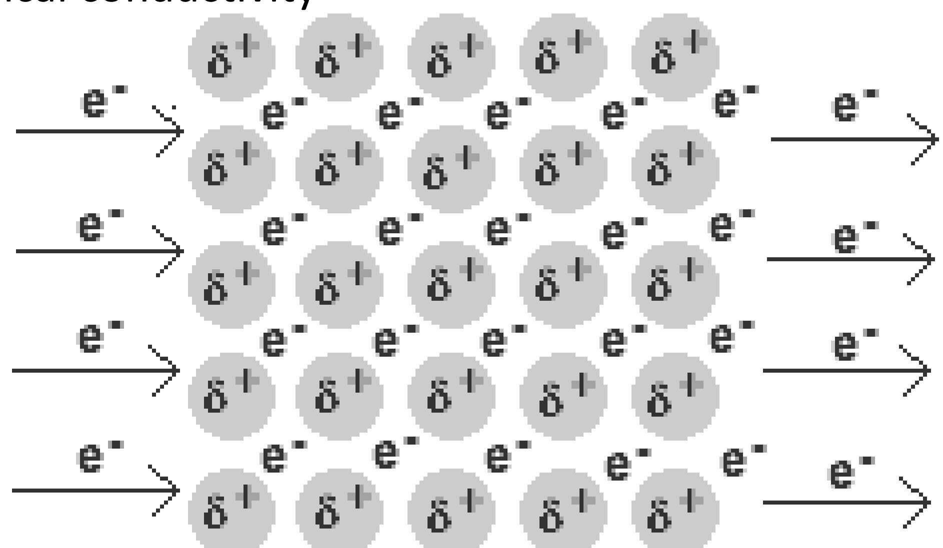
Metallic crystals:

- Good conductors of heat & electricity
  - Electrons are mobile & can transmit energy quickly

Heat conductivity



Electrical conductivity



METALLIC CRYSTALS

Metallic crystals:

- Lustrous (shiny)
    - When light strikes valence electrons absorb and emit light energy of many wavelengths

METALLIC CRYSTALS

Metallic crystals:

- Hardness
  – Strong electrostatic attractions hold nuclei together

MOLECULAR CRYSTALS

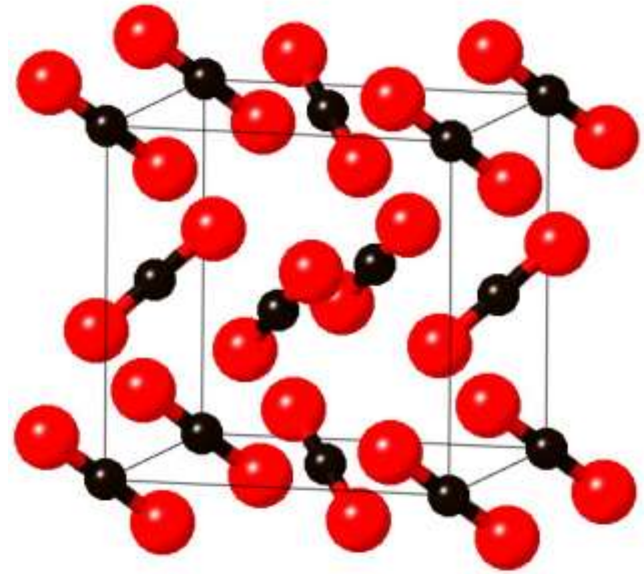
Molecular crystals:

- 3-D arrangement of molecules held together by relatively weak intermolecular forces (London, dipole-dipole, hydrogen bonding)

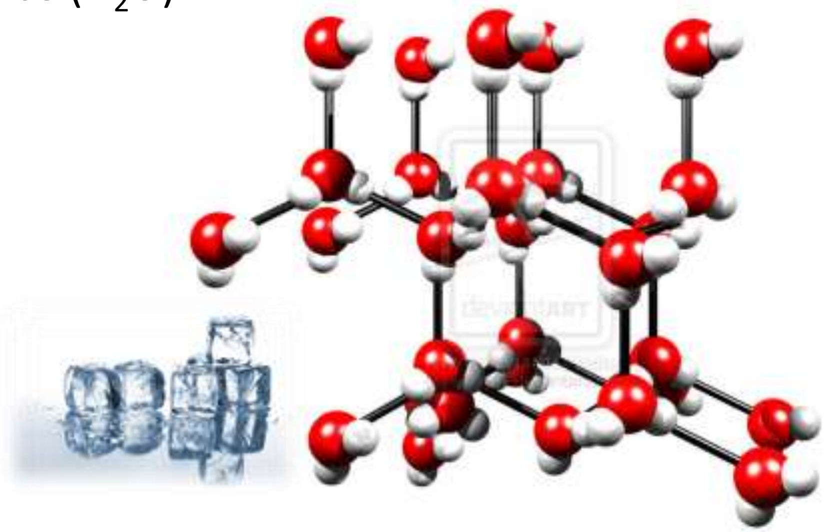
- Molecules are packed together as close as their size & shape allows

- Low melting points, soft & do not conduct electricity

Dry ice (CO_2)



Ice (H_2O)



COVALENT NETWORK CRYSTALS

Covalent network crystals:

-Network solids are macromolecules

- Giant structures of covalently bonded atoms in one, two, or three dimensional arrays

COVALENT NETWORK CRYSTALS

Covalent network crystals:

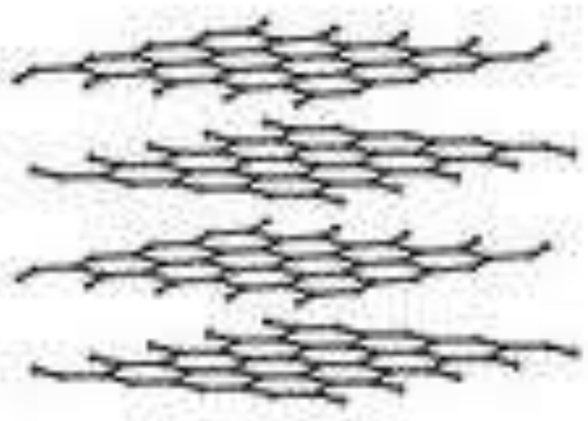
Allotropes: elements that exist in different physical forms but have the same chemical properties

i.e. diamond and graphite are both allotropes of carbon

COVALENT NETWORK CRYSTALS

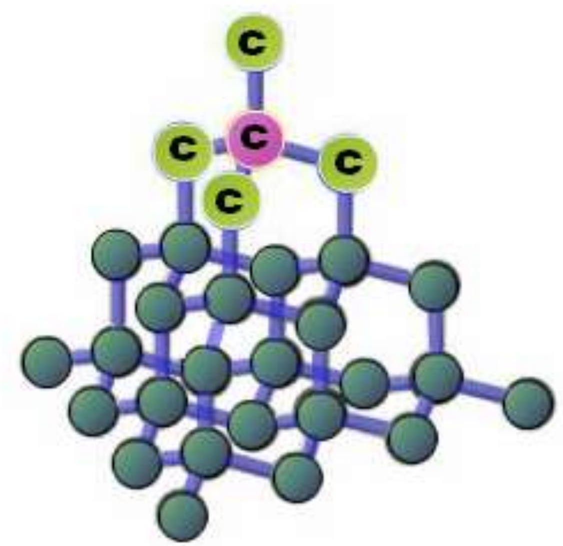
Covalent network crystals:

i.e. diamond and graphite are both allotropes of carbon



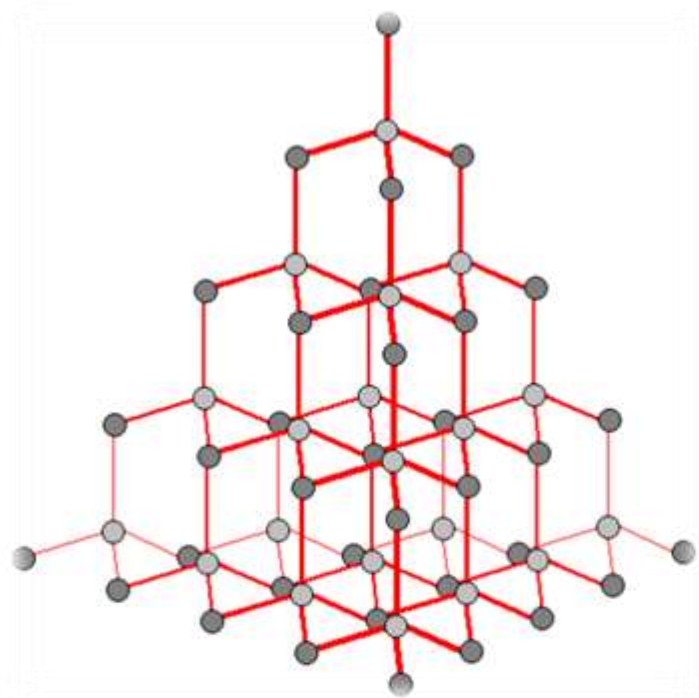
COVALENT NETWORK CRYSTALS

Covalent network crystals:



3-D solids

-Network solids consist of covalently bonded atoms which form regular 3-D arrays of crystals



-Carbon has sp^3 hybridization in diamond, which allows 3D shape

- Examples:
  Diamond
  Quartz
  Silicon carbide

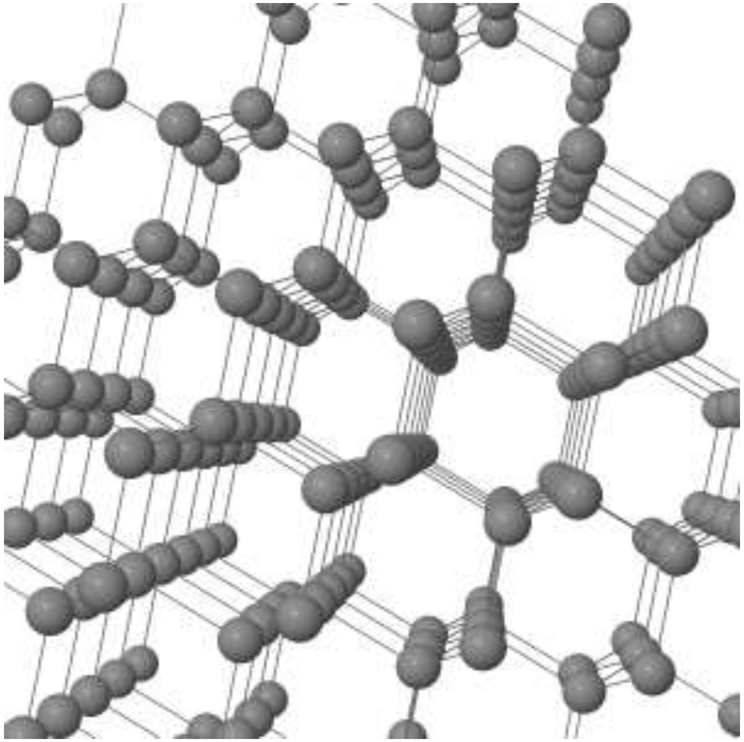
COVALENT NETWORK CRYSTALS

Covalent network crystals:

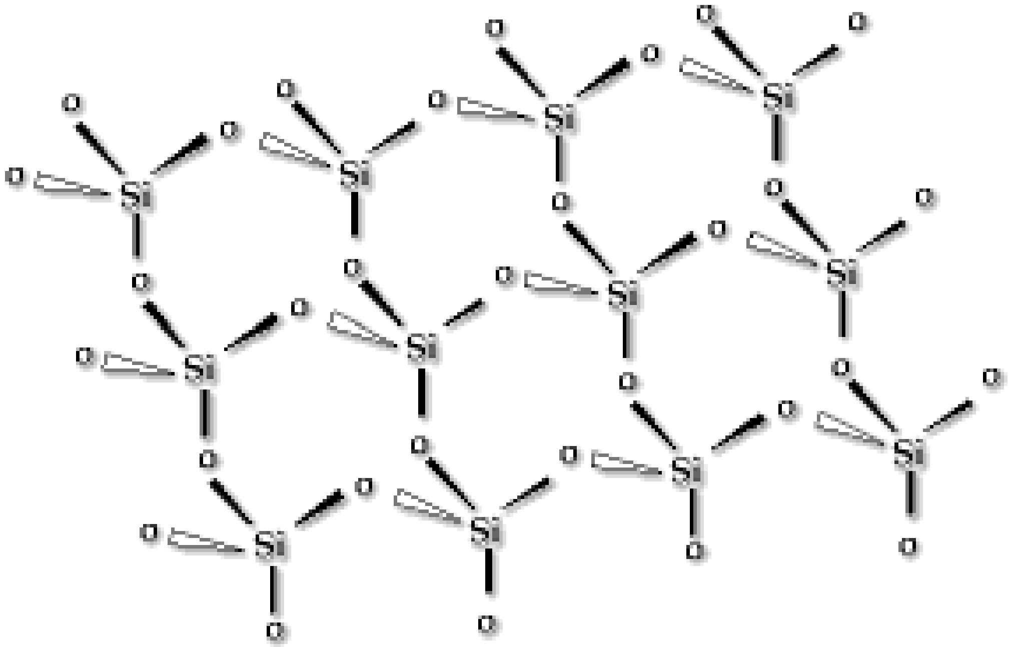
3-D solids

Diamond vs. quartz

Diamond



Quartz



COVALENT NETWORK CRYSTALS

Covalent network crystals:

i.e. sapphire crystal (Al_2O_3) is used for watch glasses due to their hardness, making them scratch resistant

Properties of 3-D solids:

-High melting & boiling points

-Solids @ room temperature

-Extremely hard

-Not soluble in polar or non-polar solvents

-Do not conduct electricity

COVALENT NETWORK CRYSTALS

Covalent network crystals:

2-D solids:

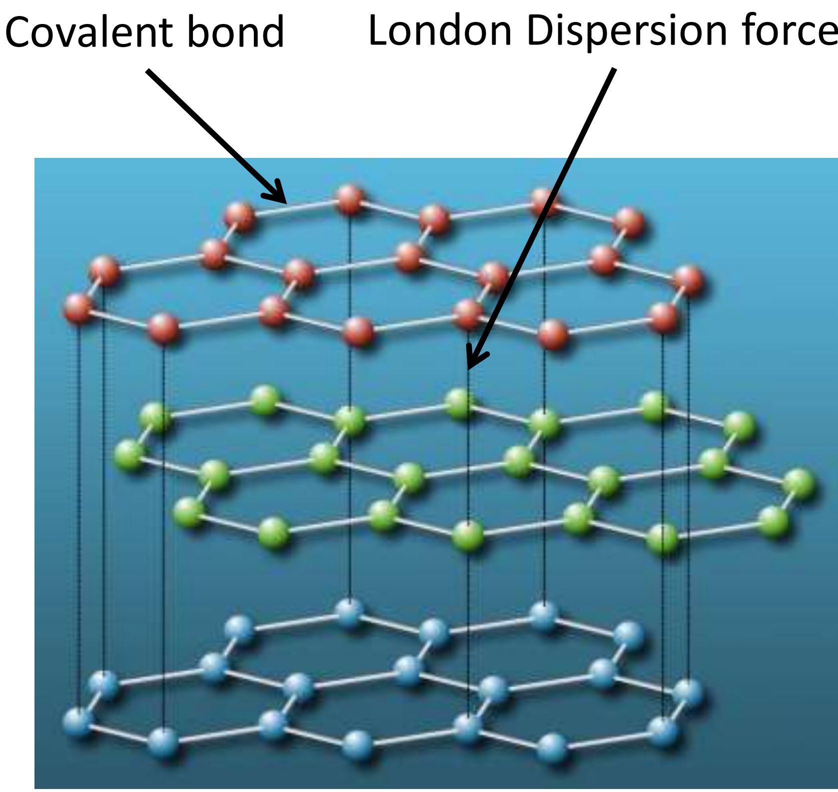
-Networks that form 2-D arrays or sheets

-Within the sheets, the atoms are held together with covalent bonds

-Weak van der Waals (London) forces hold the layers together

-High melting & boiling points

-Soft, because layers will slide over one another (lubricant)



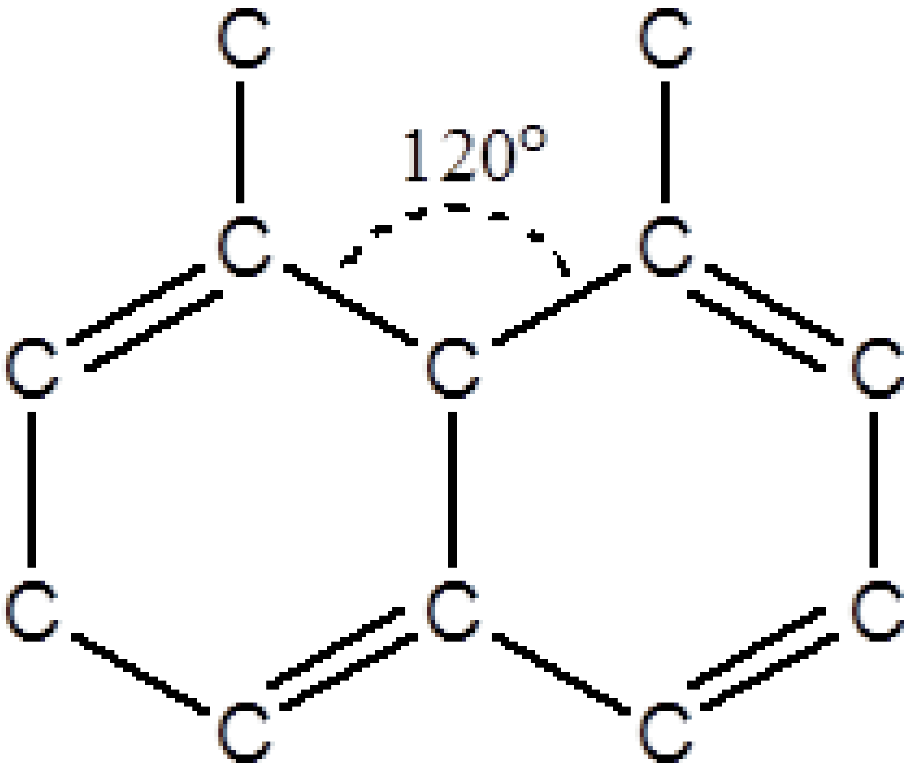
Example: Graphite

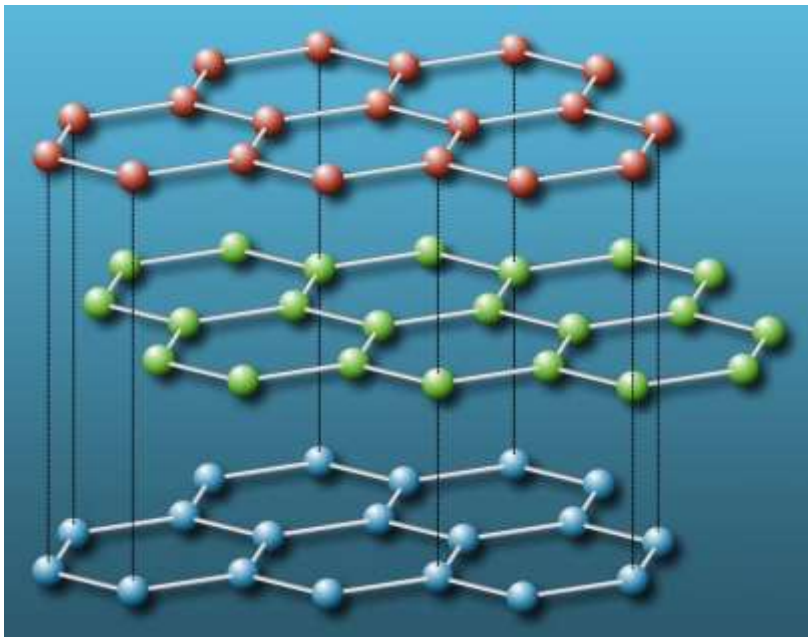
COVALENT NETWORK CRYSTALS

Covalent network crystals:

2-D solids: Graphite (sp^2 + empty p orbital)

sp^2 allows for flat trigonal planar arrangement





COVALENT NETWORK CRYSTALS

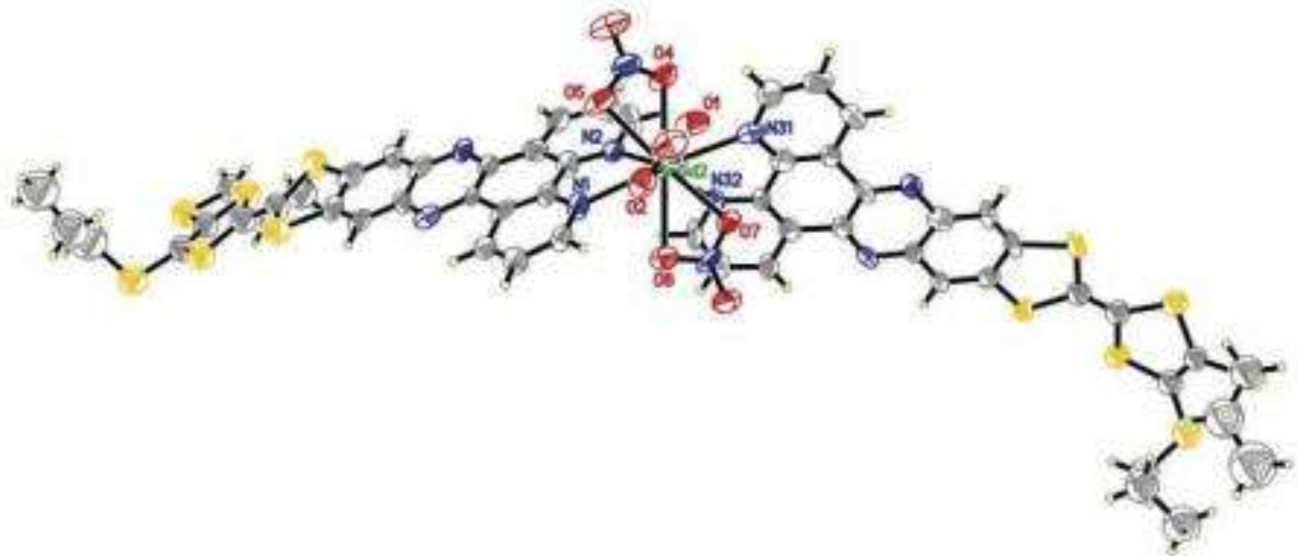
Covalent network crystals:

1-D solids:

-Form networks in a one dimensional array or fibre

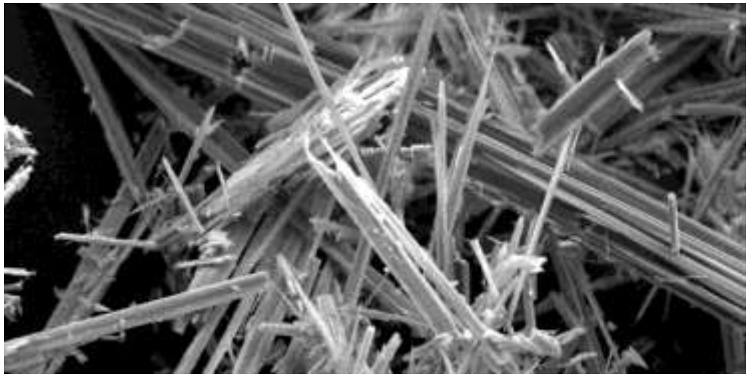
-Long chains held together by covalent bonds

-Forces between adjacent chains are very weak so the solids will form threads



COVALENT NETWORK CRYSTALS

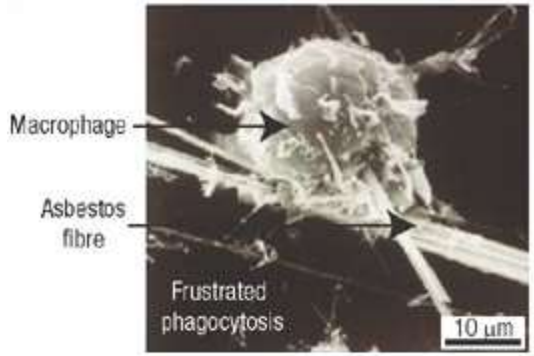
Covalent network crystals:



1-D solids:

-Very high melting & boiling points

Strong covalent bonds

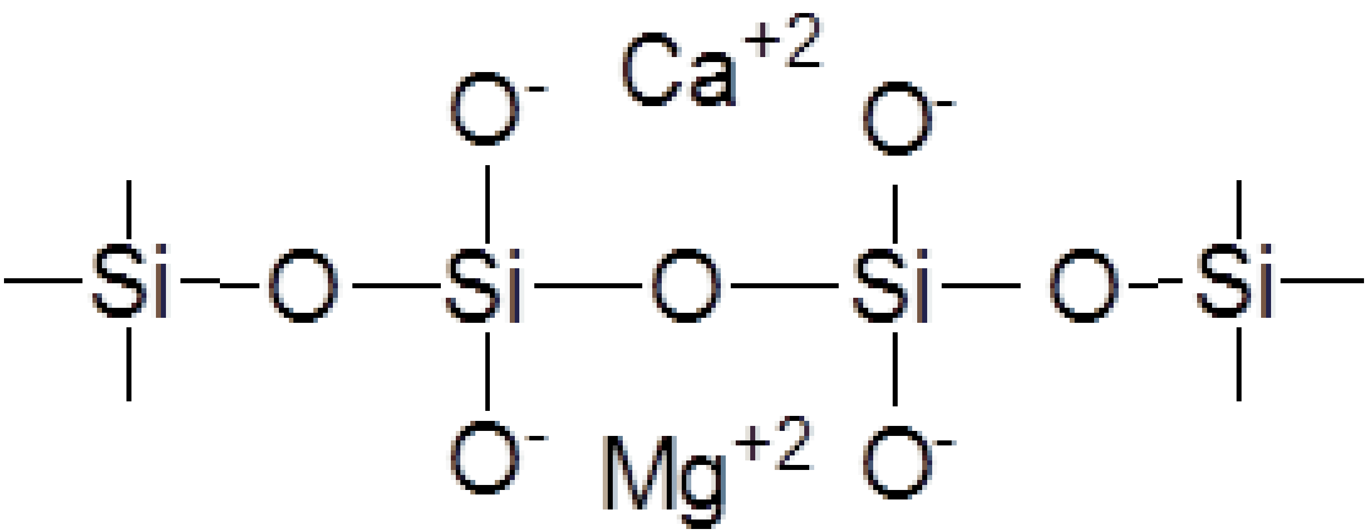


-Solids at room temperature

-Not soluble in water

-Example:

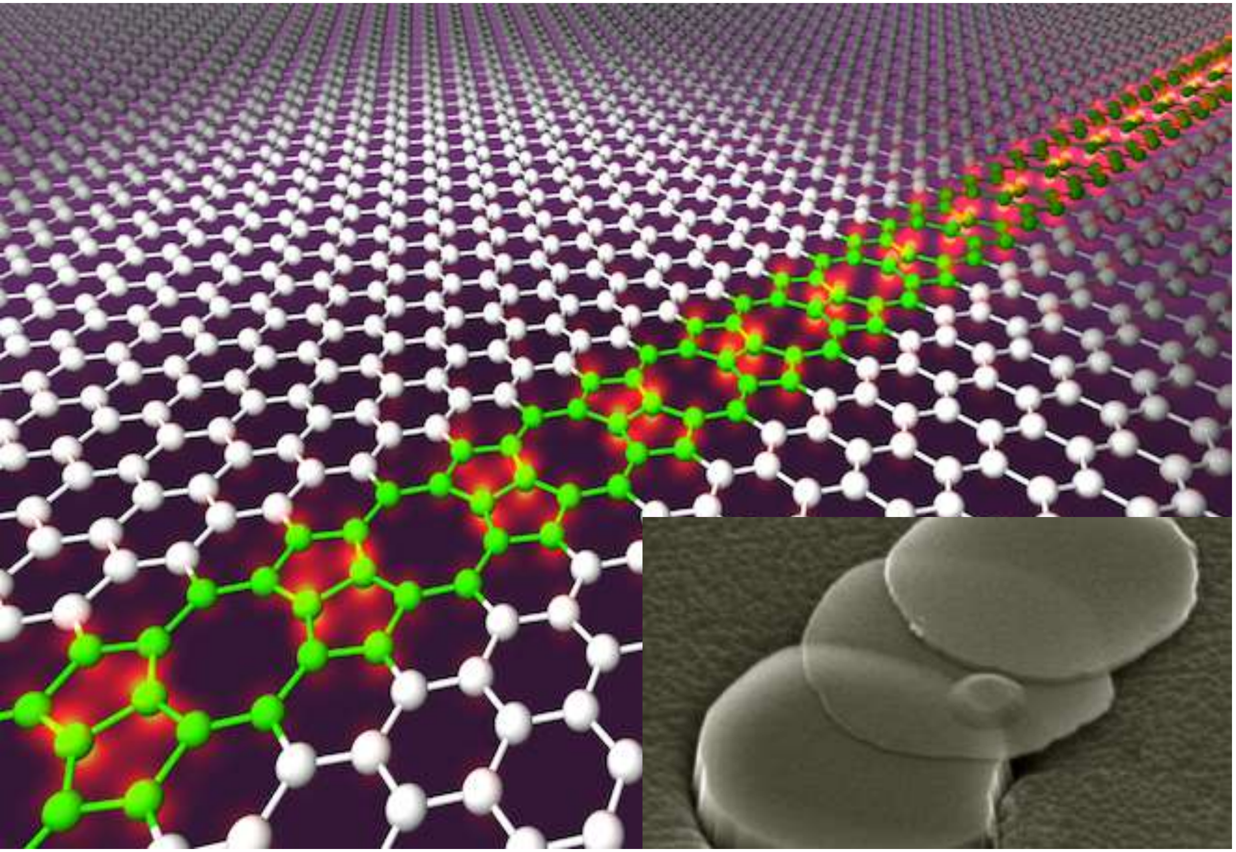
Asbestos



COVALENT NETWORK CRYSTALS

Covalent network crystals:

1-D solids: Graphene



Graphene is a one-atom-thick film of carbon with high strength, flexibility and electrical conductivity.

Graphene is one of the strongest, lightest and most conductive materials known to humankind. It's also 97.3 percent transparent.

STRUCTURE & PROPERTIES OF SOLIDS

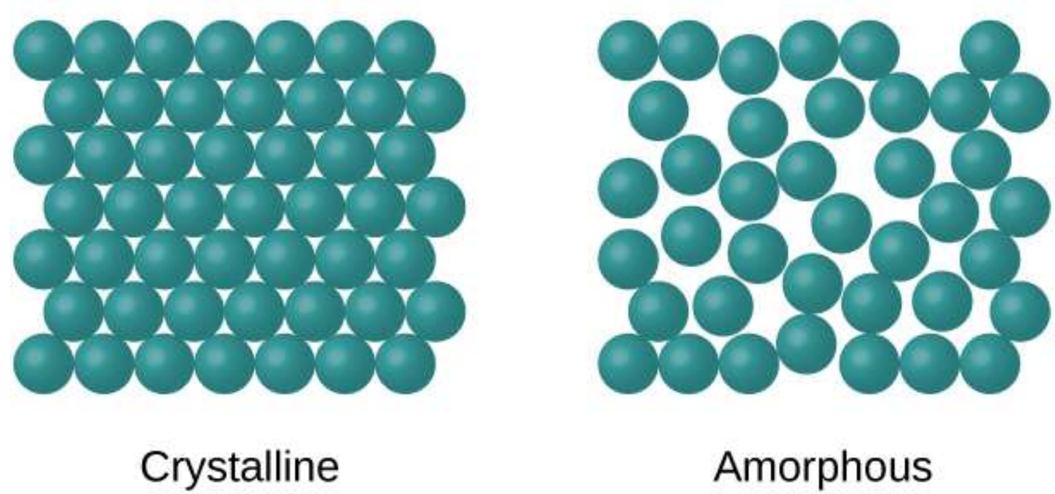
Summary:

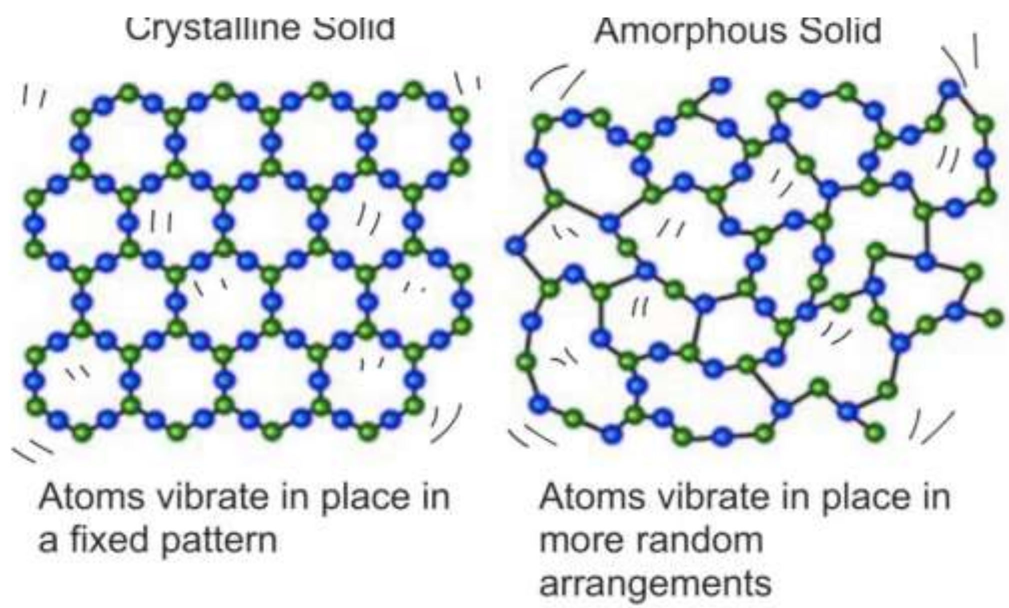
Ionic	Metals	Molecular	Covalent Network
• Electrically conductive if molten • Brittle • Usually crystalline • High melting point (solids at SATP)	• Electrically and heat conductive • Malleable and ductile • Lustrous and hard • Medium to high melting points (solid at SATP)	• Non-conductive • Amorphous • Non crystalline usually • Low melting point (liquid or gas)	• Sometimes conductive (C) • Rigid to flexible • Patterned spatial bonds • Medium to high melting points

AMORPHOUS SOLIDS

Crystalline solids are uniformly arranged.

Amorphous solids are **randomly** arranged.





AMORPHOUS SOLIDS

Examples: Glass, asphalt, plastic, rubber, wax, gel






Amorphous solids do not have distinct melting points. Instead of melting, they become softer when heated.

Homework

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