States of Matter - Part 3: Solids

-Solids have the strongest attraction due to intermolecular forces (least amount of KE to overcome these forces as compared to liquids and gases)

-Particles tend to be held in a fixed place with only vibrational movement around a fixed point

- Particles are much more ordered than liquids or gases

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Two types of solids

-Crystalline solids

-consist of **crystals**: substance in which the particles are arranged in an orderly, geometric, repeating pattern

-Amorphous solids

- particles are arranged randomly

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Solids have

-definite shape, regardless of the container

-crystalline solids are geometrically regular

-when broken they still contain the geometric pattern of the whole solid

-amorphous solids do not maintain any specific geometric pattern when broken

example: glass

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Solids:

- have a definite volume due to the tightly packed particles
- do not compress because there is little empty space between the particles
- do not flow if they are crystalline because they are rigidly stuck in place

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Melting

- the physical change from solid to liquid by the addition of energy as heat

-occurs when the KE increase enough that the attractive forces holding the molecules together is overcome.

-crystalline solids have a definite melting points

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Supercooled Liquids

-substances that retain certain liquid properties even at temperatures at which they appear to be solid

-amorphous solids (such as glass and plastic) have no definite melting points and have the ability to flow over a range of temperatures

-this is due to the randomness of the arrangement of the molecules, just like in liquids, however the particles are NOT constantly changing positions as they are in a true liquid.

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Solids are

-very dense as compared to gases and only slightly denser than liquids (with some exceptions such as water)

-incompressible

-some solids such as wood and cork may seem compressible, but it is not the solid material that is compressing, it is the air in the pores of the material that compresses

-able to diffuse..... but it takes millions of times longer than liquids or gases

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Crystalline Solids

-the total 3-dimensional arrangement of particles of a crystal is called a **crystal structure**

-the arrangement of the particles can be represented by a coordinate system called a lattice.

-the smallest portion of a crystal lattice is called a **unit cell**

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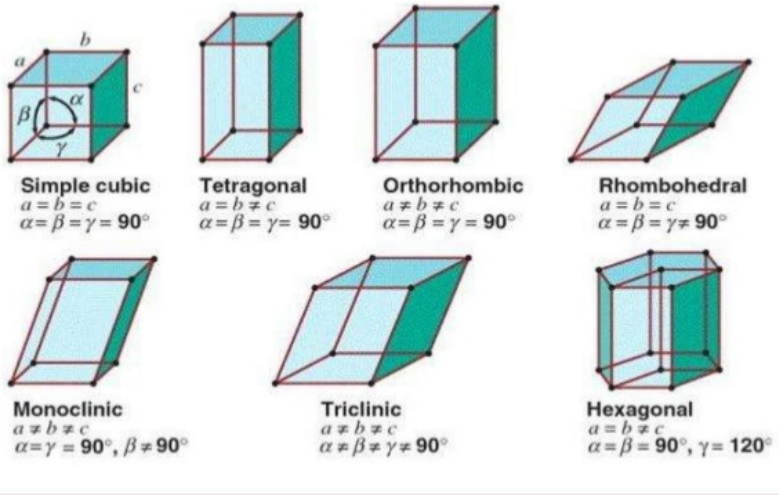
- There are seven unique arrangements ,known as crystal systems, which fill in a three dimensional space.



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Crystals can also be classified by the types of particles and the types of chemical bonds into four categories.

1) ionic crystals

-positive and negative ions arranged in a regular pattern

-can be monatomic or polyatomic

-generally are when metals from groups 1A and 2A combine with nonmetals from groups 6A and 7A or a polyatomic anion

-these strong ionic bonds make the compounds hard and brittle, have high melting points, and are good insulators

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2) Covalent network crystals

-each atom is covalently bonded to its nearest neighboring atoms

-covalent bonding extends throughout a network that includes a very large number of atoms

-examples include C_x, SiO_2 (quartz), and many oxides of transition metals

-these are basically giant molecules

-very hard and brittle

-very high melting points

-nonconductors or semiconductors

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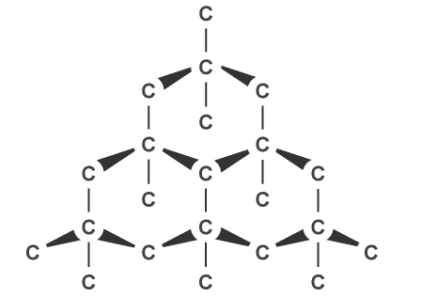
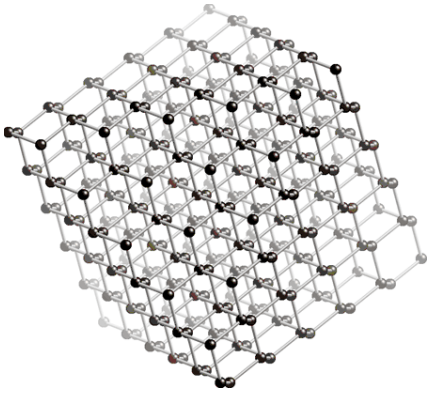
The structure of a diamond





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3) Metallic Crystals

-metal cations surrounded by a sea of delocalized valence electrons.

-the "sea of electrons" is why metals conduct electricity so well

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4) Covalent molecular crystals

-these solids are held together by the intermolecular forces present between covalent compounds

-nonpolar have weak London dispersion forces holding them together

-polar molecules have London dispersion, dipole-dipole, and possibly H-bonding

-lower melting points (easier to overcome these intermolecular forces)

-easily vaporized, soft, and good insulators

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Amorphous Solids

-amorphous from the Greek for "without shape"

-different materials have different melting ranges and this property is why they can easily be shaped

-amorphous semiconductors are often used in electronics

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Questions:

1) Why do crystalline solids shatter into regularly shaped fragments when broken?

2)Explain why ionic crystals melt at much higher temperatures than typical covalent molecular crystals?

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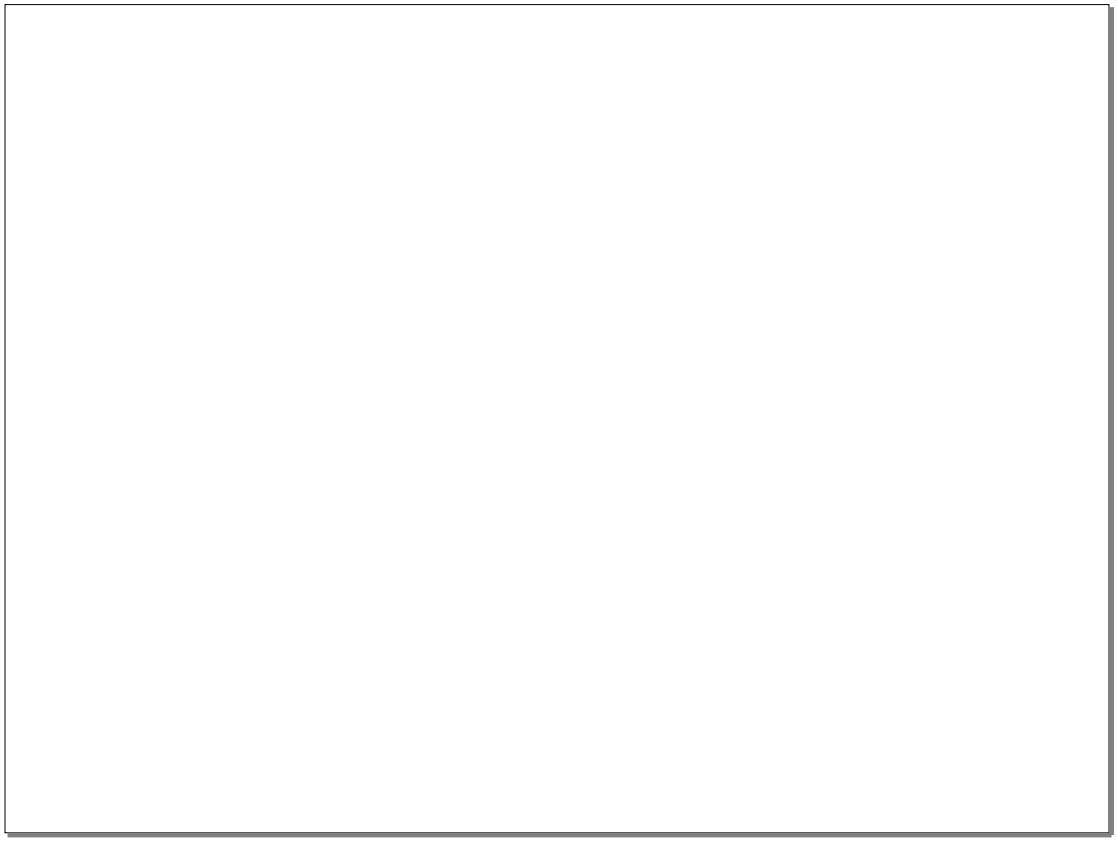

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