**Structures of Solids**

Amorphous solid: the particles have no orderly structure (e.g. glass)

Crystalline solid: the particles are in well-defined arrangements

-- Ionic (i.e. NaCl), Molecular (i.e. sucrose), Atomic (i.e. carbon), Metallic (ie. iron, aluminum)

Unit cells: the smallest repeating units of a crystalline solid

Crystal lattice: a 3-D array of points showing the crystal’s structure (seen by x-ray diffraction)

Normal melting point (NMP): a substance’s melting temperature at 1 atm.

**Properties of Solids**

1. Definite volume and shape
2. Usually more dense than liquid phase of same substance
3. Virtually incompressible
4. Vibrate about fixed positions

**Bonding in Solids**

Net attractive forces in solids are at their maximum, resulting from ionic forces, covalent bonds, van der Waals forces/ hydrogen bonds (IMFs), or any combination.

Molecular Covalent-Network Solids, particles held together in large 3D networks or chains by covalent bonds. Brittle, very strong, very high BPs and MPs, normally poor conductors

e.g., diamond, graphite good conductors, SiO2 poor conductor

Graphite has layers of carbon atoms with delocalized electrons (similar to

resonance occurring in benzene). The layers are held together by weak LDFs. Doping – adding impurities to lattice to influence conductivity  
 n-type semiconductor – carries negative charge, replacing Si with P  
 p-type semiconductor – carries positive charge, replacing Si with type 13 element

Ionic Solids consist of ions held together by ionic bonds.  
 -- Brittle, melting points depend largely on magnitude of charges (lattice energy, aka Coulomb's Law), conductive in solution or molten.  
 -- e.g., MP of NaCl = \_\_\_\_\_\_; MP of MgO = \_\_\_\_\_\_

Molecular Solids consist of non-metals only (i.e. polymers and composites).   
 -- Generally weak IMFs (mostly LDFs), soft, low melting points, non-conductors  
 -- Melting points higher are large polymers (SEPT)

Metallic Solids consist entirely of metal atoms through metallic bonding.  
 -- Bonding is due to delocalized valence e– that are free to move throughout solid

-- Generally larger atoms have lower melting points. Malleable, ductile, good conductors  
 -- Strength of metallic bond generally increases as number of valence e– increases

e.g. MP of Na = \_\_\_\_\_\_; MP of Cr = \_\_\_\_\_\_   
 Alloys - mixtures of metals to enhance properties (hard, strong, resist corrosion, shiny)   
 -- Substitutional alloy – solid solution where atoms of another element replace some of the metal atoms. Radii of both atoms normally similar.  
 -- Interstitial alloy – solid solution where atoms of another element occupies “holes” between metal atoms. Radius of atoms occupying hole smaller.

**benzene**

**toluene**

**phenol**

OH

CH3

MP (oC)

BP (oC)

Why?

5

–95

43

182

111

80