

The Nature of Solids

Section 10.3 The Nature of Solids

- Particles in a liquid are relatively free to move
 - Solid particles are not
- Solid particles tend to vibrate about fixed points, rather than sliding from place to place

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- Most solids have particles packed against one another in a highly organized pattern
 - Tend to be dense and incompressible
 - Do not flow, nor take the shape of their container
- Are still able to move, unless they would reach absolute zero

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- When a solid is heated, the particles vibrate more rapidly as the kinetic energy increases
 - The organization of particles within the solid breaks down, and eventually the solid melts
- The melting point (mp) is the temperature a solid turns to liquid

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- At the melting point, the disruptive vibrations are strong enough to overcome the interactions holding them in a fixed position
 - Melting point can be reversed by cooling the liquid so it freezes
 - Solid \rightleftharpoons liquid

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- Generally, most ionic solids have high melting points, due to the relatively strong forces holding them together
 - Sodium chloride (an ionic compound) has a melting point = 801 °C
- Molecular compounds have relatively low melting points

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- Hydrogen chloride (a molecular compound) has a mp = $-112\text{ }^{\circ}\text{C}$
- Not all solids melt- wood and cane sugar tend to decompose when heated
- Most solid substances are crystalline in structure

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- In a crystal, the particles (atoms, ions, or molecules) are arranged in a orderly, repeating, three-dimensional pattern called a crystal lattice
- All crystals have a regular shape, which reflects their arrangement

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- The type of bonding that exists between the atoms determines the melting points of crystals
- A crystal has sides, or faces
- The angles of the faces are a characteristic of that substance, and are always the same for a given sample of that substance

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- Crystals are classified into seven groups, which are shown in Fig. 10.14, page 281
 - The 7 crystal systems differ in terms of the angles between the faces, and in the number of edges of equal length on each face

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- The shape of a crystal depends upon the arrangement of the particles within it
 - The smallest group of particles within a crystal that retains the geometric shape of the crystal is known as a unit cell

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- Three kinds of unit cells that can make up a cubic crystal system:
 - 1. Simple cubic
 - 2. Body-centered cubic
 - 3. Face-centered cubic

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- Some solid substances can exist in more than one form
 - Elemental carbon is an example
 - 1. Diamond, formed by great pressure
 - 2. Graphite, which is in your pencil
 - 3. Buckminsterfullerene (also called "buckyballs") arranged in hollow cages like a soccer ball

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- These are called allotropes of carbon, because all are made of carbon, and all are solid
- Allotropes are two or more different molecular forms of the same element in the same physical state
- Not all solids are crystalline, but instead are amorphous

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- Amorphous solids lack an ordered internal structure
 - Rubber, plastic, and asphalt are all amorphous solids- their atoms are randomly arranged
- Another example is glasses- substances cooled to a rigid state without crystallizing

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- Glasses are sometimes called supercooled liquid
 - The irregular internal structures of glasses are intermediate between those of a crystalline solid and a free-flowing liquid
 - Do not melt at a definite mp, but gradually soften when heated

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- When a crystalline solid is shattered, the fragments tend to have the same surface angles as the original solid
- By contrast, when amorphous solids such as glass is shattered, the fragments have irregular angles and jagged edges
