CHAPTER 12 – Solids and Modern Materials

Section 12.1 – Classification of Solids

(a) Metallic solids are held together by _____

_____

(b) Name two properties of metals that can be explained by metallic bonding.

_____ _____

(c) Ionic solids are held together by _____

_____

(d) Can an ionic substance in the solid phase be a good conductor of electricity? _____

(e) If you answered "yes" in part (d), explain why. If you answered "no" in part (d), explain why not.

(f) In order for an ionic substance to behave as a good conductor of electricity it must be either

_____ or _____

(g) Covalent-network solids are held together by _____

_____

(h) Name one property of a covalent-network solid that can be explained by its bonding.

_____

(i) Molecular solids are held together by _____

_____

(j) Name two properties of molecular solids that can be explained by its bonding.

_____ _____

(k) Give two examples of each type of solid.

metallic solid _____ _____ covalent-network solid _____ _____

ionic solid _____ _____ molecular solid _____ _____

Section 12.2 – Structures of Solids

(a) Crystalline solids are solids in which atoms are arranged in _____

_____

(b) Name two examples of crystalline solids.

_____ _____

(c) How are amorphous solids different than crystalline solids?

(d) Name two examples of amorphous solids.

_____ _____

Note: Information regarding specific types of crystal structures, units cells, and crystal lattices are not included in the AP Chemistry curriculum. These concepts will not be tested in this course or on the AP Exam. You can skip the sections on pages 465 – 467 entitled "Unit Cells and Crystal Lattices" and "Filling the Unit Cell."

Section 12.3 – Metallic Solids

(a) Metallic bonding results from the fact that electrons are _____ throughout the entire solid.

(b) A clean metal surface has a characteristic _____, or shiny appearance.

(c) Metals are good conductors of _____ and _____.

(d) Most metals are malleable, which means that they can be _____

_____

(e) Most metals are ductile, which means that they can be _____

You can skip the sections on pages 469 – 472 entitled "The Structures of Metallic Solids" and "Close Packing."

(f) An _____ is a material that contains more than one element and has the characteristic properties of a metal.

(g) Look at Figure 12.15. If two different atoms have similar atomic radii and chemical bonding characteristics, a _____ alloy can be formed in which atoms of the solute occupy positions that are normally occupied by solvent atoms. Examples include 14-karat gold (silver and gold) and brass (copper & zinc).

(h) If the solute atoms are much smaller in size than the solvent atoms, an _____ alloy can be formed. The smaller solute atoms fill in the spaces between the larger solvent atoms. This can often occur when a small nonmetal atom makes covalent bonds to neighboring metal atoms. The presence of the extra bonds makes the lattice harder, stronger, less malleable and less ductile. One example is steel (iron and carbon).

Specific details regarding heterogeneous alloys or intermetallic compounds described on page 475 are not included in the AP Chemistry curriculum.

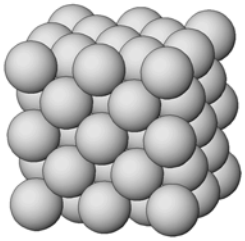
Section 12.4 – Metallic Bonding

(a) Suppose that we follow the "8 – N" rule, in which the number of bonds that an atom normally forms with its neighboring atoms is equal to "8 – N" (in which N represents the number of valence electrons). How many bonds should each of the following atoms form with its neighboring atoms?

Ar _____ Cl _____ S _____ P _____ Si _____ Al _____

(b) Does aluminum form 5 covalent bonds with its neighboring atoms? _____

(c) Explain how aluminum's valence electrons are involved in the structure of aluminum metal, shown below.



(d) Draw a picture similar to Figure 12.21 and discuss the details of the electron-sea model. Explain how the properties of electrical conductivity, malleability, and ductility can be explained by this model.

You can skip the section on pages 478 – 480 entitled "Molecular-Orbital Model."

Section 12.5 – Ionic Solids

(a) Explain why ionic solids have such high melting points and boiling points.

(b) Explain why are ionic solids are brittle. Refer to Figure 12.25.

You can skip the section on pages 482 – 485 entitled "Structures of Ionic Solids."

Section 12.6 – Molecular Solids

(a) Molecular solids consist of atoms or molecules held together by _____,

_____, and/or _____

(b) Explain why molecular solids are soft and have relatively low melting points.

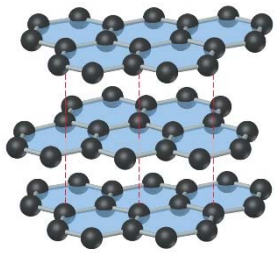
(c) Explain why sucrose has a relatively high melting point (184^{o}C) for a molecular solid.

Section 12.7 – Covalent-Network Solids

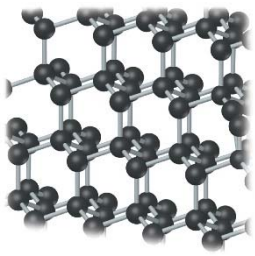
(a) Explain why covalent network solids are much harder and have higher melting points than molecular solids.

(b) Besides diamond and graphite, list a few other examples of covalent-network solids.

(c) Graphite is a soft substance that is used as a lubricant (and in pencil “lead”). However, diamond is a hard substance that can be used for saw blades and cutting tools. Explain why these two substances have such different properties.



(b) Graphite



(a) Diamond

(d) The element _____ is a covalent-network solid and a semiconductor.

(e) The process of adding controlled amounts of impurity atoms to a material is known as

_____.

(f) When a few atoms of phosphorus are added to replace a few silicon atoms in a silicon crystal, the result is the formation of an n-type semiconductor, which has increased conductivity. Explain.

(g) When a few atoms of aluminum are added to replace a few silicon atoms in a silicon crystal, the result is the formation of a p-type semiconductor. Explain.

Section 12.8 – Polymeric Solids

Section 12.9 – Nanomaterials

These final sections present information that is interesting, but not included in the AP Chemistry curriculum and will not be covered on the AP Exam.