

Chapter 2 THE NATURE OF MATERIALS

Multiple-Choice Quiz

Answers to multiple-choice questions are available to students at the end of each labeled section.

Atomic Structure and the Elements

- 2.1 The basic structural unit of matter is which one of the following: (a) atom, (b) electron, (c) element, (d) molecule, or (e) nucleus?

Answer. (a).

- 2.2 Approximately how many different elements have been identified: (a) 10, (b) 50, (c) 100, (d) 200, or (e) 500?

Answer. (c).

- 2.3 In the Periodic Table, the elements can be divided into which three of the following categories: (a) ceramics, (b) gases, (c) liquids, (d) metals, (e) nonmetals, (f) polymers, (g) semimetals, and (h) solids?

Answer. (d), (e), and (g).

Bonding between Atoms and Molecules

- 2.4 Which three of the following bond types are classified as primary bonds: (a) covalent bonding, (b) electronic bonding, (c) hydrogen bonding, (d) ionic bonding, (e) metallic bonding, and (f) van der Waals forces?

Answer. (a), (d), and (e).

- 2.5 London forces are classified as which one of the following: (a) British expeditionary troops, (b) primary bonding, or (c) secondary bonding?

Answer. (c).

Crystalline Structures

- 2.6 A crystalline structure is one in which the atoms are located at regular and recurring positions in three dimensions, and the pattern may be replicated millions of times within a given crystal: (a) True or (b) false?

Answer. (a).

- 2.7 In a crystalline structure, the unit cell is the basic geometric grouping of atoms that is repeated throughout the crystal: (a) True or (b) false?

Answer. (a).

- 2.8 How many atoms are there in the body-centered cubic (BCC) unit cell: (a) 8, (b) 9, (c) 10, (d) 12, (e) 14, or (f) 17?

Answer. (b).

- 2.9 How many atoms are there in the face-centered cubic (FCC) unit cell: (a) 8, (b) 9, (c) 10, (d) 12, (e) 14, or (f) 17?

Answer. (e).

- 2.10 The term for a metal that changes its crystal structure at different temperatures is which one of the following: (a) allotropic, (b) ambivalent, (c) anisotropic, (d) autogenous, or (e) isotropic?

Answer. (a).

- 2.11 Which three of the following are point defects in a crystal lattice structure: (a) edge dislocation, (b) grain boundaries, (c) interstitialcy, (d) Schottky defect, (e) screw dislocation, or (f) vacancy?

Answer. (c), (d), and (f).

- 2.12 Grain boundaries are an example of which one of the following types of crystal structure defects: (a) dislocation, (b) Frenkel defect, (c) line defects, (d) point defects, or (e) surface defects?

Answer. (e).

- 2.13 Which one of the following crystal structures has the fewest slip directions and therefore the metals with this structure are generally more difficult to deform at room temperature: (a) BCC, (b) FCC, or (c) HCP?

Answer. (c).

- 2.14 Among the mechanisms of deformation in metallic crystals, slip can be described as which two of the following: (a) elastic deformation, (b) more likely at high deformation rates, (c) more likely in metals with HCP structure, (d) plastic deformation, (e) relative movement of atoms on opposite sides of a plane in the lattice, and (f) type of dislocation?

Answer. (d) and (e).

- 2.15 A block of metal may contain millions of individual crystals, called grains, whose lattice structures are all oriented in the same direction: (a) True or (b) false?

Answer. (b). The lattice structures of the grains are randomly oriented, not all in the same direction.

- 2.16 Faster cooling promotes larger grain size, whereas slower cooling promotes smaller grain size: (a) True or (b) false?

Answer. (b). The effects of cooling rate are reversed in the statement.

- 2.17 Smaller grain size in a metal has which of the following effects on the strength of the metal: (a) decreases strength, (b) increases strength, or (c) no effect on strength?

Answer. (b).

Noncrystalline (Amorphous) Structures

- 2.18 Which two of the following materials are characterized by noncrystalline structures: (a) diamond, (b) glass, (c) most ceramics other than glass, (d) rubber, and (e) solid metals?

Answer. (b) and (d).

2.19 As a metal transforms from solid to liquid at its melting point, a certain quantity of heat energy must be added, which is called which one of the following: (a) heat exchange, (b) heat exhaustion, (c) heat of fusion, (d) heat of transformation, (e) melting heat, or (f) thermal diffusivity?

Answer. (c).

2.20 As an amorphous material such as glass cools from the molten (liquid) state, it becomes increasingly viscous, finally converting into a solid where there is a change in the thermal expansion slope at a temperature called which one of the following: (a) freezing point, (b) fusion temperature, (c) glass transition temperature, (d) melting temperature, or (e) solidification temperature?

Answer. (c).

Engineering Materials

2.21 Ceramics are characterized by which two of the following atomic bonding types: (a) adhesive, (b) covalent, (c) hydrogen, (d) ionic, (e) metallic, and (f) van der Waals?

Answer. (b) and (d).

2.22 In general, metals are characterized by which three of the following properties: (a) brittleness, (b) chemical inertness, (c) electrically insulating, (d) high electrical conductivity, (e) high hardness, (f) high thermal conductivity, (g) low density, and (h) low thermal conductivity?

Answer. (d), (e), and (f).

2.23 In general, polymers are characterized by which three of the following properties: (a) brittleness, (b) chemical inertness, (c) electrically insulating, (d) high electrical conductivity, (e) high hardness, (f) high thermal conductivity, (g) low density, and (h) low thermal conductivity?

Answer. (c), (g), and (h).

Additional Multiple-Choice Questions for Instructor Use

Atomic Structure and the Elements

2.1 The element with the lowest density and smallest atomic weight is which one of the following: (a) aluminum, (b) argon, (c) helium, (d) hydrogen, or (e) magnesium?

Answer. (d).

2.2 In the planetary model of atomic structure, the electrons in the outermost shell are called which one of the following: (a) atomic electrons, (b) orbital electrons, (c) quantum electrons, or (d) valence electrons?

Answer. (d).

Bonding between Atoms and Molecules

2.3 Which two of the following bond types are called intramolecular bonds: (a) covalent bonding, (b) electronic bonding, (c) hydrogen bonding, (d) ionic bonding, (e) metallic bonding, and (f) van der Waals forces?

Answer. (a) and (d).

Crystalline Structures

2.4 How many atoms are there in the hexagonal close-packed (HCP) unit cell: (a) 8, (b) 9, (c) 10, (d) 12, (e) 14, or (f) 17?

Answer. (f).

2.5 Which one of the following metals has a body-centered cubic crystal structure at room temperature: (a) aluminum, (b) copper, (c) iron, (d) nickel, and (e) zinc?

Answer. (c).

2.6 Twinning can be described as which three of the following: (a) elastic deformation, (b) more likely at high deformation rates, (c) more likely in metals with HCP structure, (d) plastic deformation, (e) slip mechanism, and (f) type of dislocation?

2.7 **Answer.** (b), (c), and (d).

2.8 Grain boundaries in metals interfere with dislocation movement, which contributes to which one of the following properties that are characteristic of metals: (a) crystal structure, (b) ductility, (c) electrical conductivity, (d) strain hardening, or (e) thermal conductivity?

Answer. (d).

Noncrystalline (Amorphous) Structures

2.9 As an amorphous material such as glass cools from the molten (liquid) state, it transforms into the solid state gradually, first going through a transition phase which is called which one of the following: (a) mushy zone, (b) passing phase, (c) supercooled liquid, (d) superheated solid, or (e) transformation phase?

Answer. (c).

Engineering Materials

2.10 Polymers are characterized by which two of the following bonding types: (a) adhesive, (b) covalent, (c) hydrogen, (d) ionic, (e) metallic, and (f) van der Waals?

Answer. (b) and (f).

2.11 In general, ceramics are characterized by which four of the following properties: (a) brittleness, (b) chemical inertness, (c) electrically insulating, (d) high electrical conductivity, (e) high hardness, (f) high thermal conductivity, and (g) low density?

Answer. (a), (b), (c), and (e).