**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**

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).

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

**Answer**. (c).

1. 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**

1. 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).

1. 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**

1. 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).

1. 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).

1. 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).

1. 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).

1. 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).

1. 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).

1. 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).

1. 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).

1. 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).

1. 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.

1. 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.

1. 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**

1. 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).

1. 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).

1. 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**

1. 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).

1. 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).

1. 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**

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).

1. 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**

1. 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**

1. 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).

1. 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).

1. 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. **Answer**. (b), (c), and (d).
3. 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**

1. 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**

1. 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).

1. 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).