A. Select the best answer

1. An atom consists of
   a. one nucleus and only one electron
   b. one nucleus and one or more electrons
   c. protons, electrons, and neutrons
   d. answers (b) and (c)

2. Valence electrons are
   a. in the closest orbit to the nucleus
   b. in the most distant orbit from the nucleus
   c. in various orbits around the nucleus
   d. not associated with a particular atom

3. The most widely used semi conductive material in electronic devices is
   a. germanium
   b. carbon
   c. copper
   d. silicon

4. The difference between an insulator and a semiconductor is
   a. a wider energy gap between the valence band and the conduction band
   b. the number of free electrons
   c. the atomic structure
   d. answers (a), (b), and (c)

5. The energy band in which free electrons exist is the
   a. first band
   b. second band
   c. conduction band
   d. valence band

6. In a semiconductor crystal, the atoms are held together by
   a. the interaction of valence electrons
   b. forces of attraction
   c. covalent bonds
   d. answers (a), (b), and (c)

7. The current in a semiconductor is produced by
   a. electrons only
   b. holes only
   c. negative ions
   d. both electrons and holes

8. In an intrinsic semiconductor,
   a. there are no free electrons
   b. the free electrons are thermally produced
   c. there are only holes
   d. there are as many electrons as there are holes
   e. answers (b) and (d)

9. The process of adding an impurity to an intrinsic semiconductor is called
   a. doping
   b. recombination
   c. atomic modification
   d. ionization

10. A trivalent impurity is added to silicon to create
    a. germanium
    b. a p-type semiconductor
    c. an n-type semiconductor
    d. a depletion region

11. The purpose of a pentavalent impurity is to
    a. reduce the conductivity of silicon
    b. increase the number of holes
    c. increase the number of free electrons
    d. create minority carriers

12. The majority carriers in an n-type semiconductor are
    a. holes
    b. valence electrons
    c. conduction electrons
    d. protons

13. Holes in an n-type semiconductor are
    a. minority carriers that are thermally produced
    b. minority carriers that are produced by doping
    c. majority carriers that are thermally produced
    d. majority carriers that are produced by doping

14. A **pn** junction is formed by
    a. the recombination of electrons and holes
    b. ionization
    c. the boundary of a p-type and an n-type material
    d. the collision of a proton and a neutron

15. The depletion region is created by
    a. ionization
    b. diffusion
    c. recombination
    d. answers (a), (b), and (c)

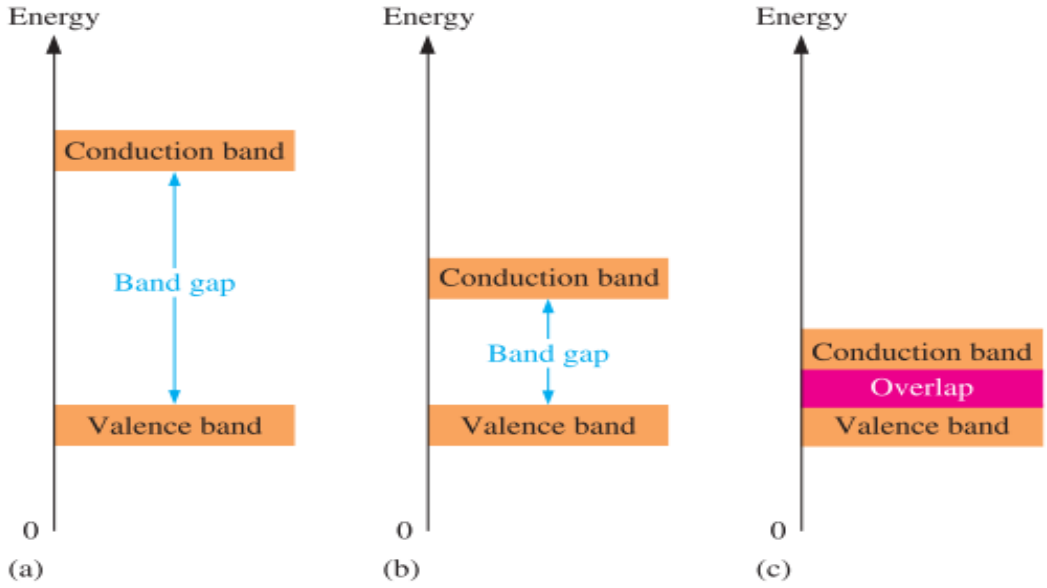
16. The depletion region consists of
    a. nothing but minority carriers
    b. positive and negative ions
    c. no majority carriers
    d. answers (b) and (c)

B. TRUE/FALSE Questions

i. An atom is the smallest particle in an element
ii. Electrons are part of the nucleus of an atom
iii. Crystals are formed by the bonding of atoms
iv. Silicon doped with p and n impurities has one **pn** junction
v. The p and n regions are formed by a process called ionization

C. Further Questions

1. Develop an electron configuration table for the germanium (Ge) atom in the periodic table.
2. For each of the energy diagrams in the following Figure, determine the class of material based on relative comparisons.



3. A certain atom has four valence electrons. What type of atom is it?
4. In a silicon crystal, how many covalent bonds does a single atom form?
5. What happens when heat is added to silicon?
6. Name the two energy bands at which current is produced in silicon.
7. What is antimony? What is boron?
8. How is the electric field across the **pn** junction created?
9. Because of its barrier potential, can a diode be used as a voltage source? Explain.