

In the following multiple-choice questions, indicate the single and best answer.

1. The electrical resistivity of a metal:
  - a) is much lower than that of a semiconductor like silicon;
  - b) is inversely proportional to conductivity;
  - c) increases with increasing temperature;
  - d) almost always increases when alloying elements are added to the metal;
  - e) all of the above.
  
2. The electrical resistivity of a metal increases with increasing temperature, because:
  - a) the conduction band is empty;
  - b) acceptor levels become filled and holes appear in the valence band;
  - c) the vibration amplitude of the metal atoms increase and the probability that a conduction electron will scatter from a metal atom increases;;
  - d) the metal becomes superconducting;
  - e) none of the above.
  
3. Pure silicon can be converted into a p-type semiconductor by doping with small amounts of:
  - a) B;
  - b) Ga;
  - c) Al;
  - d) Cd;
  - e) all of the above.
  
4. n-type silicon:
  - a) has a higher electrical conductivity at room temperature than intrinsic (pure) silicon;
  - b) can be created by doping with a group III element;
  - c) is formed when dopants introduce electrons into the otherwise-empty conduction band;
  - d) can be created by alloying Si with Ge.
  - e) none of the above.
  
5. A hole:
  - a) corresponds to a missing Si atom;
  - b) carries a net charge of  $-1$ ;
  - c) corresponds to a missing electron from the valence band;
  - d) all of the above;
  - e) none of the above.

6. Lithography:

- a) involves photoresist;
- b) is a technology for patterning;
- c) usually requires a mask;
- d) is used several times during the course of semiconductor device fabrication;
- e) all of the above.

7. Ion implantation is used in device fabrication for:

- a) etching;
- b) patterning;
- c) single-crystal growth;
- d) doping;
- e) all of the above.

8. Using well-labeled energy-band diagrams to describe the differences between intrinsic silicon, p-type silicon, and n-type silicon.

9. Estimate the distance a light beam will travel between pulses at a clock frequency of 3 Ghz. Draw this distance on the edge of your solution set.

10. Suppose a 64 Mbyte RAM chip requires a silicon wafer surface of 1 cm x 1 cm. Estimate the dimensions associated with an individual transistor.

11. Design the filament of a 60 Watt light bulb for 110 V. The light bulb operates at 1500 °C.

- a) Briefly describe a commercial light bulb in order to recognize the design constraints.
- b) Select the material, considering the high temperature needed.
- c) Calculate the resistance needed for 60 Watt, then calculate the dimensions of the wire. You will need to make a decision concerning the length or the thickness of the wire. In doing so, be realistic. It will be necessary to visualize these dimensions in order to obtain a reasonable solution.
- d) In commercial light bulbs, the filament has the shape of a double winding. Propose the dimensions of such an arrangement.

12. Ohring problem 11-10

13. Ohring problem 12-13

14. 12 gauge copper wire is typically used in household electrical wiring. The diameter of this wire is 0.0808 inches. Determine the room-temperature resistance associated with a 12 gauge copper wire 1000 feet long.

