50. When a diode is forward-biased, the recombination of free electrons and holes may produce

a. Heat
b. Light
c. Radiation
d. All of the above

51. A reverse voltage of 10 V is across a diode. What is the voltage across the depletion layer?

a. 0 V
b. 0.7 V
c. 10 V
d. None of the above

52. The energy gap in a silicon atom is the distance between the valence band and the

a. Nucleus
b. Conduction band
c. Atom's core
d. Positive ions

53. The reverse saturation current doubles when the junction temperature increases

a. 1°C
b. 2°C
c. 4°C
d. 10°C

54. The surface-leakage current doubles when the reverse voltage increases

a. 7%
b. 100%
c. 200%
d. 2 mV

Problems

2-1 What is the net charge of a copper atom if it gains two electrons?

2-2 What is the net charge of a silicon atom if it gains three valence electrons?

2-3 Classify each of the following as conductor or semiconductor:

a. Germanium
b. Silver
c. Silicon
d. Gold

2-4 If a pure silicon crystal has 500,000 holes inside it, how many free electrons does it have?

2-5 A diode is forward biased. If the current is 5 mA through the *n* side, what is the current through each of the following?

a. *p* side
b. External connecting wires
c. Junction

2-6 Classify each of the following as *n*-type or *p*-type semiconductors:

a. Doped by acceptor atoms
b. Crystal with pentavalent impurities
c. Majority carriers are holes
d. Donor atoms were added to crystal
e. Minority carriers are free electrons

2-7 A designer will be using a silicon diode over a temperature range of 0° to 75°C. What are the minimum and maximum values of barrier potential?

2-8 If a silicon diode has a saturation current of 10 nA at 25° to 75°C, what are the minimum and maximum values of saturation current?

2-9 A diode has a surface-leakage current of 10 nA when the reverse voltage is 10 V. What is the surface-leakage current if the reverse voltage is increased to 100 V?

Critical Thinking

2-10 A silicon diode has a reverse current of 5 μA at 25°C and 100 μA at 100°C. What are values of the saturation current and the surface-leakage current at 25°C?

2-11 Devices with *pn* junctions are used to build computers. The speed of computers depends on how fast a diode can be turned off and on. Based on what you have learned about reverse bias, what can we do to speed up a computer?

Job Interview Questions

A team of experts in electronics created these questions. In most cases, the text provides enough information to answer all questions. Occasionally, you may come across a term that is not familiar. If this happens, look up the term in a technical dictionary. Also, a question may appear that is not covered in this text. In this case, you may wish to do some library research.

1. Tell me why copper is a good conductor of electricity.
2. How does a semiconductor differ from a conductor? Include sketches in your explanation.
3. Tell me all you know about holes and how they differ from free electrons. Include some drawings.
4. Give me the basic idea of doping semiconductors. I want to see some sketches that support your explanation.
5. Show me, by drawing and explaining the action, why current exists in a forward-biased diode.
6. Tell me why a very small current exists in a reverse-biased diode.
7. A reverse-biased semiconductor diode will break down under certain conditions. I want you to describe avalanche in enough detail so that I can understand it.
8. I want to know why a light-emitting diode produces light. Tell me about it.
9. Do holes flow in a conductor? Why or why not? What happens to holes when they reach the end of a semiconductor?
10. What is surface leakage current?
11. Why is recombination important in a diode?
12. How does extrinsic silicon differ from intrinsic silicon, and why is the difference important?
13. In your own words, describe the action that takes place when the *pn* junction is initially created. Your discussion should include the formation of the depletion layer.
14. In a *pn* junction diode, which of the charge carriers move? Holes or free electrons?

Self-Test Answers

1.	d	**19.**	a	**37.**	c
2.	a	**20.**	a	**38.**	a
3.	b	**21.**	d	**39.**	b
4.	b	**22.**	a	**40.**	a
5.	d	**23.**	a	**41.**	b
6.	c	**24.**	a	**42.**	b
7.	b	**25.**	d	**43.**	b
8.	b	**26.**	b	**44.**	c
9.	c	**27.**	b	**45.**	a
10.	a	**28.**	a	**46.**	c
11.	c	**29.**	d	**47.**	d
12.	c	**30.**	c	**48.**	a
13.	b	**31.**	a	**49.**	a
14.	b	**32.**	a	**50.**	d
15.	a	**33.**	b	**51.**	c
16.	b	**34.**	a	**52.**	b
17.	d	**35.**	b	**53.**	d
18.	d	**36.**	c	**54.**	b

Practice Problem Answers

2-4 Approximately 5 million holes

2-5 $V_B = 0.65$ V

2-6 $I_S = 224$ nA

2-7 $I_{SL} = 8$ nA