Review Questions

1. Why do solids occur in the form of a crystal?

2. How do we classify the different crystals?

3. How many Bravais lattices are there in two dimensions? How many in three dimensions?

4. List the three cubic bravais lattices.

5. How do you explain that the allowed energies for electrons in solids are restricted to energy bands? Why are these bands separated energy band gaps? Why are the energies not discreet as in an atom. Why are they not continuous, as is the case for a free electron?

6. How does the conductivity of a solid depend on whether the energy bands are completely filled, partially filled or empty? How does the existence of overlapping bandgaps affect the conductivity?

7. Why does a completely filled band not contribute the conductivity of a solid?

8. Explain physically why the bandgap of a semiconductor decreases with temperature.

9. What are holes? Carefully justify your definition.

10. What is a state?

11. How many states are there in 1 micron sized cube for which an electron has a kinetic energy less than 1 eV? Treat the electron as a free electron confined to a box with infinite potential walls.

12. What is the physical meaning of the Fermi energy?

13. What is the value of the Fermi function at an energy, which is 3kT larger/lower than the Fermi energy?

14. What is the basic assumption used in statistical thermodynamics when calculating the probability distribution functions?

15. What are the two boundary conditions used to find the possible ways to fill energy levels with electrons.

16. How does a boson differ from a Fermion? Name two bosons.

17. List the assumptions made to obtain equations (2.6.12).

18. What is an intrinsic semiconductors? What is the hole density in an intrinsic semiconductor?

19. Why is the product of the electron and hole density in a non-degenerate semiconductor constant rather than for instance the sum? This relationship is also referred to as the mass-action law. Why?

20. Define a non-degenerate semiconductor. Why do we need this concept?

21. What is the difference between a doped semiconductor and an extrinsic semiconductor?

22. What assumptions are made when deriving equations (2.6.29) and (2.6.30)?

23. Describe the temperature dependence of the carrier density in a semiconductor. Identify the three regions and explain what happens by indicating the filled and empty states on an energy band diagram. Do this for n-type, p-type and compensated material.

24. Name the two transport mechanisms in semiconductors.

25. Describe the microscopic behavior of electrons and holes in a semiconductor.

26. Define the mobility.

27. Explain why the mobility in a semiconductor depends on the doping density.

28. Define the resistivity and conductivity of a semiconductor.

29. Explain why the velocity in a semiconductor is limited.

30. What is the driving force, which causes diffusion?

31. Explain the relation between the mean free path, the scattering time and the thermal velocity.

32. List three recombination-generation mechanisms.

33. Explain why the net recombination rate as described by the simple model depends on the excess carrier density.

34. Describe the continuity equation in words.

35. What assumptions are made to obtain the diffusion equations (2.9.9) and (2.9.10) from the continuity equations (2.9.3) and (2.9.4)?

36. What is the diffusion length and how does it relate to the diffusion constant and the minority carrier lifetime?

37. What is the drift-diffusion model?