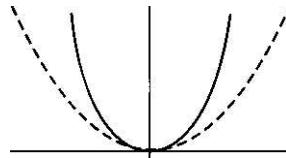


# Physics 3

Test 2  
2011, May 10.

Useful constants:  $h = 6.63 \cdot 10^{-34}$  Js,  $e = 1.6 \cdot 10^{-19}$  C,  $m_e = 9.1 \cdot 10^{-31}$  kg

1. What are the mechanical and electrical properties of kovalent solids?
2. Consider a 3 dimensional cubic lattice with a lattice constant  $a$  Sketch the following planes: (100), (110), (310) and (230)!
3. Prove that the reciprocal lattice of the reciprocal lattice of a simple cubic lattice is the original lattice!
4. Draw the convencional and primitive unit cells of a 2 dimensional fcc lattice!
5. Draw the Wigner-Seitz cell of a 2 dimensional hexagonal lattice!
6. Calculate the surface density of atoms on a (100) plane of an fcc crystal! Assume the lattice constant is 60 nm.
7. What can we determine from an X-ray diffraction pattern?
8. Sketch the dispersion relation of a diatomic linear chain, and name the branches! What is the difference between the vibration modes in these branches?
9. Give the definition of the Fermi level in metals! What is the probability that an energy level  $3k_B T$  above  $E_F$  is occupied by an electron?
10. Give the formula to calculate the average value of a physical quantity  $O$  in a solid!
11. Two possible conduction bands are shown on the next figure. State which of the conduction bands will result in a heavier electron effective mass and why!



12. What are the assumptions of the Drude Model?
13. Give the formula of a Bloch electron wave function! What will be the resistivity of a ideal crystal in which this formula is valid?
14. What is the difference between the resistivity as a function of temperature of a metal and a semiconductor and why?
15. The wavelength of visible light is in the range 400 – 600 nm. Diamond has a band gap of about 4 eV. Explain why diamond is transparent in the visible spectrum!
16. Give the definition, and compare the width of the depletion layer (region), the space charge region and the transition zone for a p-n junction!