Electronic Devices

Tutorial -1

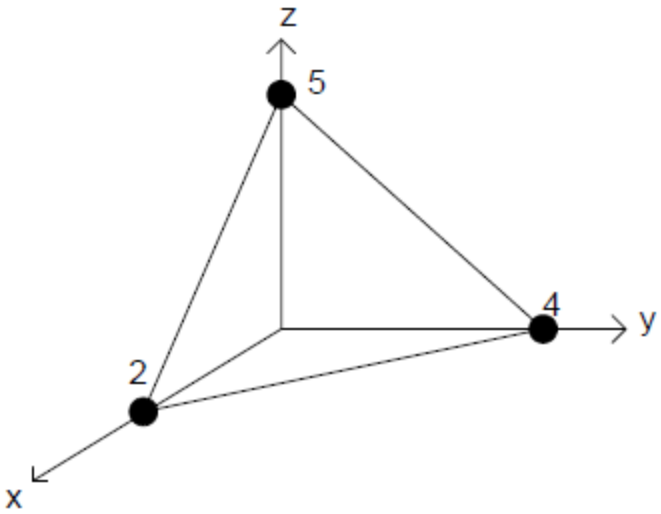
13-08-2018

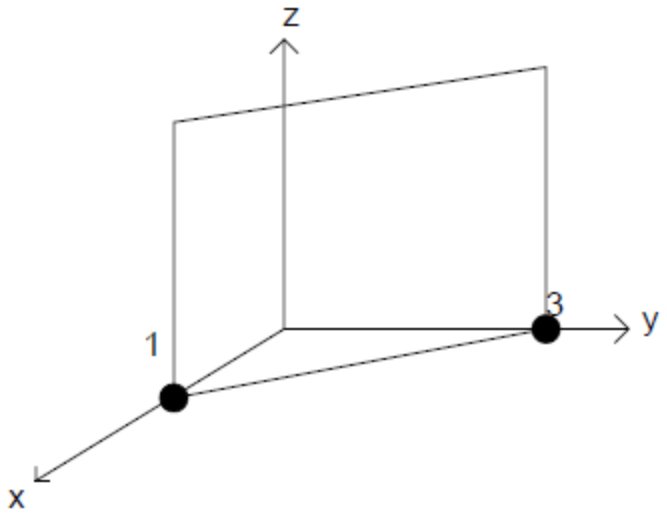
Problem-1

Q1: In a particular crystalline the plane touches the x-axis at a, y-axis at 2a and z-axis at 3a. Find the miller indices.

Problem-2

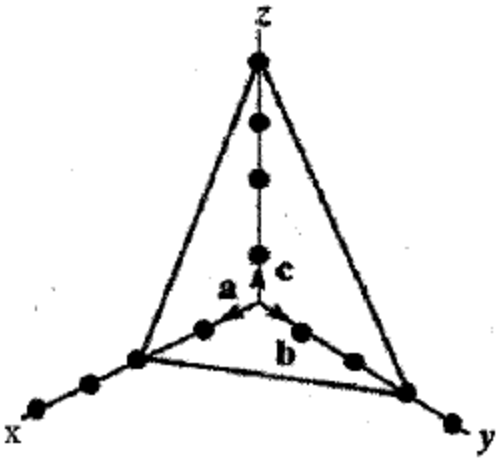
- Miller Index is a popularly used metric for defining the planes in a single crystal lattice structures. Find the miller indices of different planes shown below

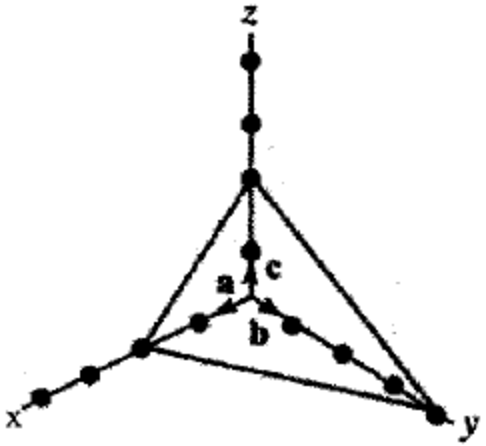




Problem-3

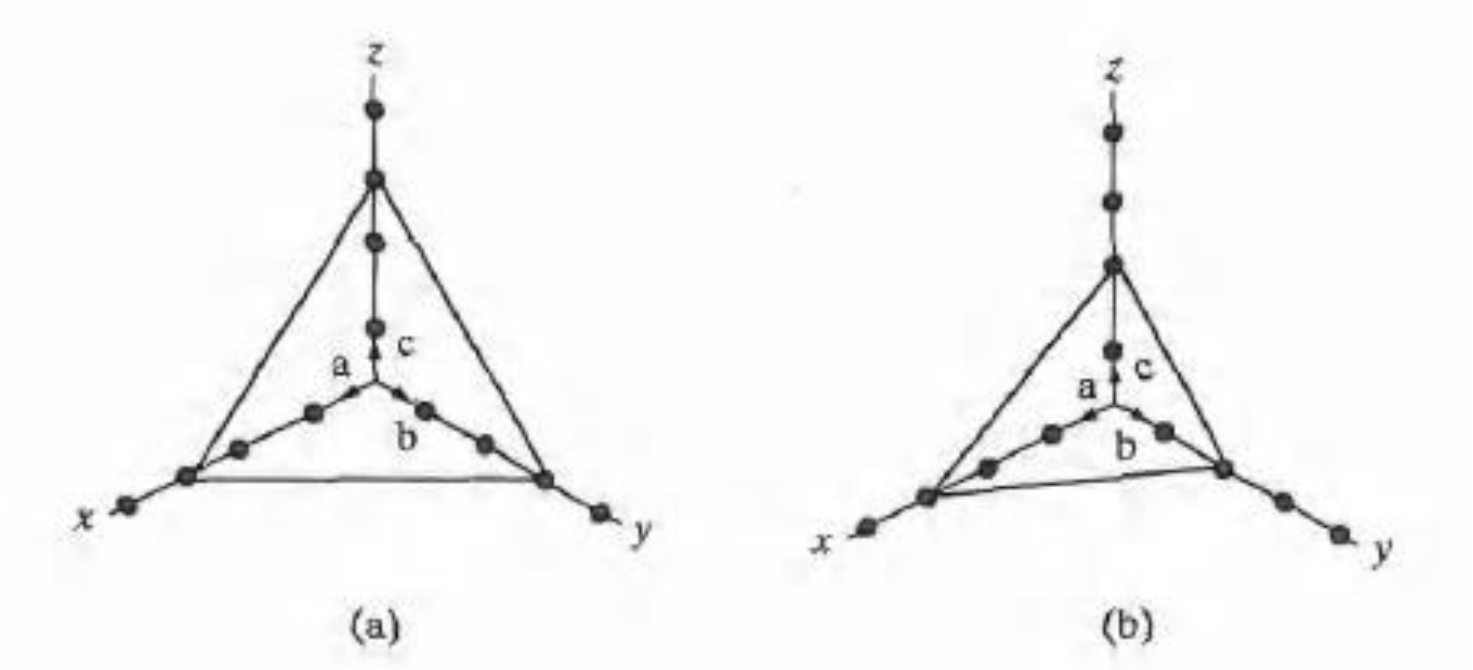
Label the planes illustrated in Fig (a) and (b) given below





Problem-4

Label the planes illustrated in Fig (a) and (b) given below



Problem-5

A sample of chromium (Cr) is analyzed by x-ray diffraction using copper K_α radiation for which $\lambda_{K_\alpha} = 1.5418$ Å. Determine the Miller indices of the plane from which the angle of reflection, θ, is 31.4°. The lattice constant of Cr, *a*, is 2.96 Å. Report your answer in the form (*hkl*).

$$\lambda = 2d\sin\theta$$

$$d = \frac{a}{\sqrt{h^2 + l^2 + k^2}}$$

$$h^2 + l^2 + k^2 = \frac{4a^2\sin^2\theta}{\lambda^2} = 4$$

$$h^2 + l^2 + k^2 = 4$$

The miller indice is (002)

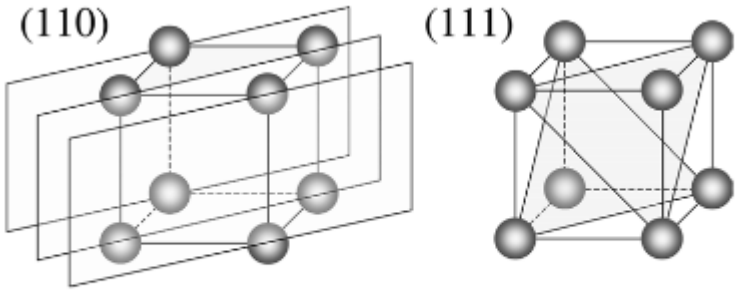


Figure 1.5 Lattice planes with Miller indices (110) and (111) in a simple cubic lattice.

Problem-6

How many atoms are found inside a unit cell of an SC, a BCC, and an FCC crystal?

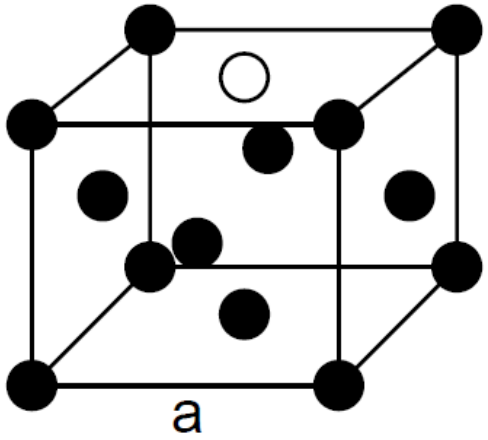
How far apart in terms of lattice constant *a are the nearest neighbor atoms in each* case, measured from center to center?

Problem-7

- Calculate the atomic density of a Simply Cubic, Body Centred Cubic and Face Centered Cubic lattice with a lattice constant of 5 A^0

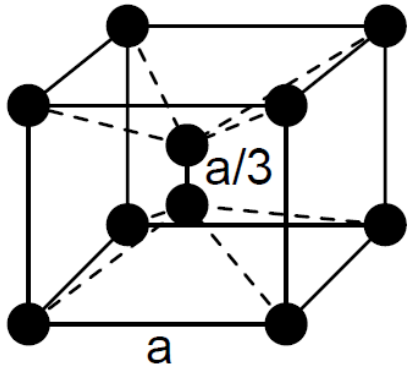
Problem-7

A defect in a crystal is absence of regularity in the lattice. A vacancy is a kind of defect where the atom is missing from its nominal position and this in result affects both the lattice shape and the electrical properties of the crystal. In such a defective crystal with a FCC lattice structure and a lattice constant of ‘a’ units, 50% of the unit cells have a missing atom in two of the faces. Assume that the shape of the unit cell remains intact in spite of the missing atom. Now compute the volume density of the crystal and compare it with the regular FCC crystal lattice.



Problem-8

An impurity in an crystal is the presence of other atoms in the lattice that may distort the shape of the lattice. There are two kinds of impurities, substitutional impurity and the interstitial impurity. In the unit cell shown below, the crystal is a BCC crystal with a interstitial impurity. it has two atoms in centre (each forming five covalent bonds as opposed to 8 in the normal case). Compute the volume density of such a crystal. Also compute the plane in which the surface density is maximum.



Problem-9

Calculate the Surface atomic density of a 110 and 111 plane in a simply cubic, FCC and BCC lattice. With a lattice constant of ‘a’ units, what is the plane that contains the maximum surface density in FCC and BCC crystal lattice structures.