University of Kasdi Merbah - Ouargla-

Faculty of Mathematics and Material Sciences

Department of Physics

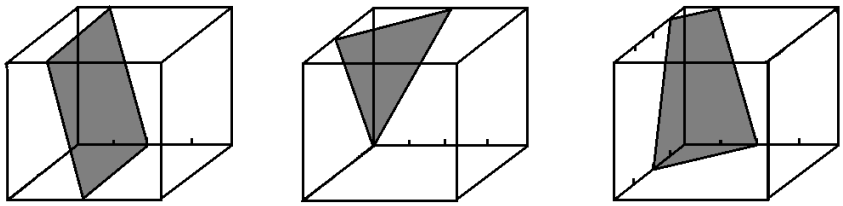
Second Year Physics

2024-2025

Series of exercises and problems - Physics of Crystallography - No. 03

Exercise (1):

Write the Miller indices for the crystallographic plans shown in the figure below:



-a- **-b-** **-c-**

Exercise (2):

a) Find the angles between the following crystallographic directions:

$$[101]\ ,\ [1\bar{2}3] \textit{ and } [3\bar{1}0]$$

b) Deduce the angles between the following crystal planes.

$$(10\bar{1})\ ,\ (\bar{1}2\bar{3}) \textit{ and } (3\bar{1}0)$$

Exercise (3):

1. Calculate and compare the packing densities of CFC and HCP.
2. Assuming the packed spheres model, show the difference between them, specifying the crystallographic orientation in both cases.
3. Identify the denser crystallographic orientations for the two previous structures.

Exercise (4):

The gold and copper alloy crystallizes in the cubic system, where the copper atoms' positions are: $\left(\frac{1}{2},\frac{1}{2},0\right)$,$\left(\frac{1}{2},0,\frac{1}{2}\right)$,$\left(0,\frac{1}{2},\frac{1}{2}\right)$, and the position of gold atom is $(0,0,0)$.

1) Determine the Bravais lattice corresponding to this alloy.

2) Find the number of the first nearest neighbor and its type and calculate the corresponding distance.

3) Deduce the chemical formula of this alloy.

4) If the radius of the gold atom is within the range of 1.36 Å, and the radius of the copper atom is 1.32 Å, calculate the weight density of this alloy, where

> *The molecular Weight of gold is* **196.97 g/mol,** *and the molecular Weight of copper equal to* **63.55 g/mol.**

Exercise (5):

Tow elements A and B form a crystal in the cubic system, similar to the sodium chloride crystal (table salt). Considering the atoms as packed spheres with radii R_A and R_B respectively, prove that the atoms on the vertices of a cube with side length a/2 cannot touch if the ratio: : $1 + \sqrt{2} < \frac{R_A}{R_B}$

Exercise (6):

Due to temperature variation, a substance crystallizes in the cubic system, where the atoms are rearranged into different phases, starting from the simple cube, let it be α , to the body-centered cube β, and finally, to the face-centered cube γ.

- Among these phases, what is the most transparent phase for light?

- If the cell parameter in the simple lattice is a=4.5 Å, find the most transparent lattice directions for light rays greater or equal to 3Å in each phase.

- Calculate the density of the most transparent plans in each case.

Exercise (7):

Assuming that the reflection of rays is on a parallel family of crystal planes of d_{hkl}, demonstrate geometrically Bragg's law.