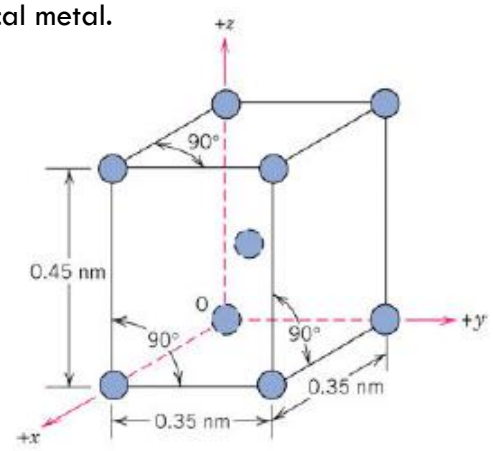
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN MEKANIKAL

BMCB 2423 – MATERIALS SCIENCE

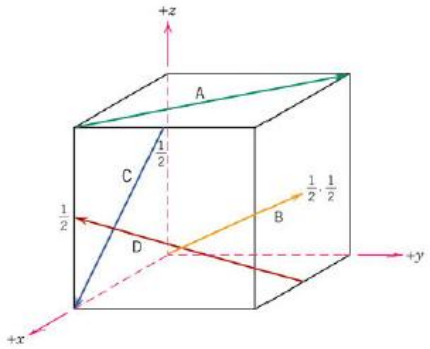
TUTORIAL 2

1. What is the difference between atomic structure and crystal structure?
2. Show for the body-centered cubic crystal structure that the unit cell edge length a and the atomic radius R are related through $a = 4R/\sqrt{3}$.
3. For the HCP crystal structure, show that the ideal c/a ratio is 1.633.
4. Calculate the radius of a tantalum atom, given that Ta has a BCC crystal structure, a density of 16.6 g/cm^3, and an atomic weight of 180.9 g/mol.
5. The unit cell for uranium has orthorhombic symmetry, with a, b, and c lattice parameters of 0.286, 0.587, and 0.495 nm, respectively. If its density, atomic weight, and atomic radius are 19.05 g/cm^3, 238.03 g/mol, and 0.1385 nm, respectively, compute the atomic packing factor.
6. For a ceramic compound, what are the two characteristics of the component ions that determine the crystal structure?
7. On the basis of ionic charge and ionic radii, predict crystal structures for the following materials: (a) MnS, and (b) CsBr. Justify your selections.
8. Calculate the theoretical density of NiO, given that it has the rock salt crystal structure.
9. Below is a unit cell for a hypothetical metal.

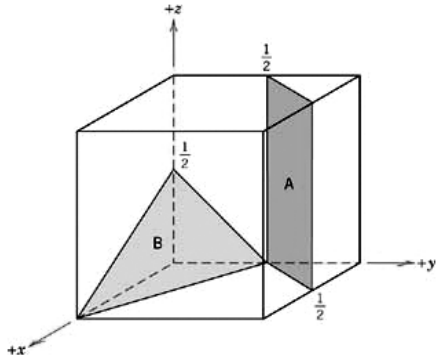


   (a) To which crystal system does this unit cell belong?
   (b) What would this crystal structure be called?
   (c) Calculate the density of the material, given that its atomic weight is 141 g/mol.
10. List the point coordinates for all atoms that are associated with the FCC unit cell.
11. List the point coordinates of both the zinc and sulfur atoms for a unit cell of the zinc blende crystal structure.

12. Determine the indices for the directions shown in the following cubic unit cell:



13. Convert the [110] direction into the four-index Miller–Bravais scheme for hexagonal unit cells.
14. Draw a monoclinic unit cell, and within that cell a (200) plane.
15. Determine the Miller indices for the planes shown in the following unit cell:



16. Cite the indices of the direction that results from the intersection of each of the following pair of planes within a cubic crystal: **(a)** (110) and (111) planes, **(b)** (110) and (110) planes, and **(c)** (111) and (001) planes.
17. (**a**) Derive linear density expressions for BCC [110] and [111] directions in terms of the atomic radius *R*. (**b**) Compute and compare linear density values for these same two directions for iron.
18. (**a**) Derive planar density expressions for FCC (100) and (111) planes in terms of the atomic radius *R*. (**b**) Compute and compare planar density values for these same two planes for aluminum.
19. The zinc blende crystal structure is one that may be generated from close-packed planes of anions.
    (a) Will the stacking sequence for this structure be FCC or HCP? Why?
    (b) Will cations fill tetrahedral or octahedral positions? Why?
    (c) What fraction of the positions will be occupied?
20. Explain why the properties of polycrystalline materials are most often isotropic.
21. Using the data for aluminum in Table 3.1, compute the interplanar spacing for the (110) set of planes.