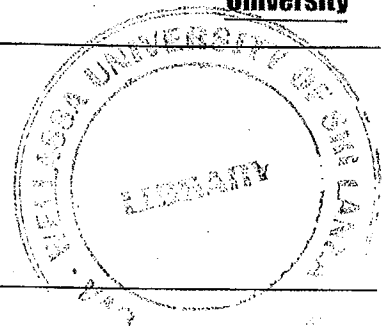


Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 level 1st Semester Examination – May/July 2017
SCT 344-2 Physics of Materials



Instructions to candidates

Duration: 02 hours

Number of questions: 04

Answer all questions.

Mark allocation: 100 marks.

1.
 - a. Briefly explain what you mean by a primitive cell and a unit cell. (04 marks)
 - b. Which one is true from the following two statements? Justify your answer.
 - I. Every primitive cell is a unit cell.
 - II. Every unit cell is a primitive cell. (06 marks)
 - c. Briefly explain what you mean by a "Bravais Lattice". How many Bravais lattices are there in three dimension (3D)? (05 marks)
 - d. Into how many groups the Bravais lattices you mentioned in part c can be divided, based on the type of unit cell? Name those groups. (10 marks)
2.
 - a. Briefly explain what you mean by reciprocal lattice. Express the relationship between direct lattice vectors and reciprocal lattice vectors in three dimension using an equation. (08 marks)
 - b. What is the definition of "First Brillouin Zone"? (06 marks)
 - c. Explain in point form how you construct the first Brillouin zone in two dimension (2D). (06 marks)
 - d. Construct the first Brillouin zone for the 2D reciprocal lattice shown in the figure 01 in next page. (05 marks)

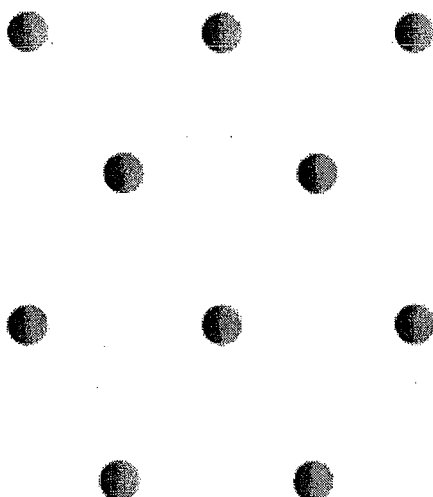


Figure 01

- 3.
- Briefly explain what you mean by Fermi energy. (05 marks)
 - Write an expression for the Fermi energy in three dimension (3D). (03 marks)
 - Draw a graph between the Fermi Dirac Distribution, $f(E)$ vs E for $T = 0$ K state and $T > 0$ K state. (04 marks)
 - Calculate the Fermi energy for magnesium, assuming two free electrons per atom. The density of magnesium is 1.74 g/cm^3 and the molar mass of magnesium is 24.305 mol/g . Note that the Avogadro's number is 6.022×10^{23} . (08 marks)
- 4.
- What is Bragg's law regarding X-ray diffraction. (03 marks)
 - For which set of crystallographic planes will a first order diffraction peak occur at a diffraction angle of 44.53° for FCC nickel (Ni) when monochromatic radiation having a wavelength of 0.1542 nm is used? Note that the atomic radius of Ni is 0.1246 nm . (08 marks)

- c. What are the Miller indices for the plane shown in the following cubic unit cell in figure 02 ?

(04 marks)

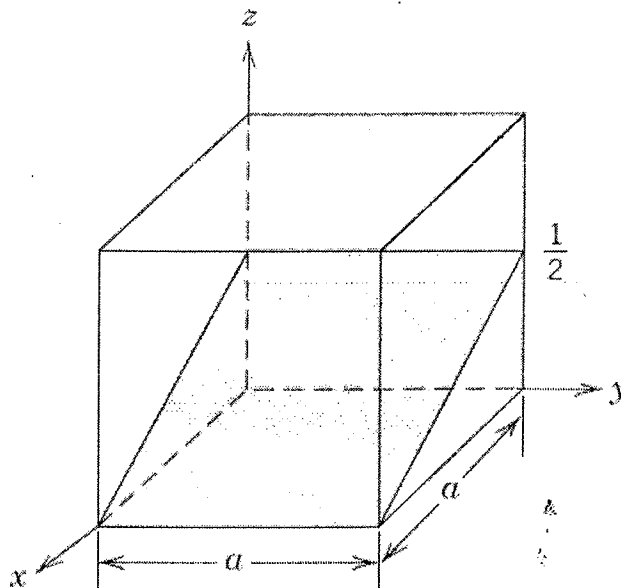


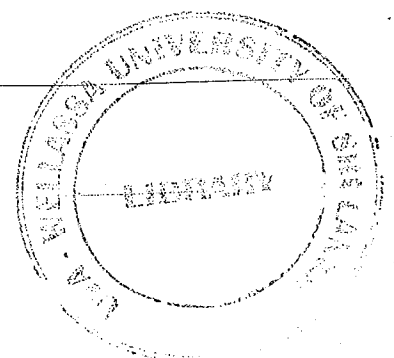
Figure 02

- d. Calculate the unit cell edge length and radius of a palladium (Pd) atom, given that Pd has a FCC crystal structure, a theoretical density of 12.0 g/cm^3 and an atomic weight of 106.4 g/mol . Note that the Avogadro's number is 6.022×10^{23} .

(08 marks)

- e. With the aid of figure 03 and figure 04 shown in next page, derive an expression for the planar density of (0001) plane of hexagonal close packed (HCP) crystal structure in terms of atomic radius R.

(07 marks)



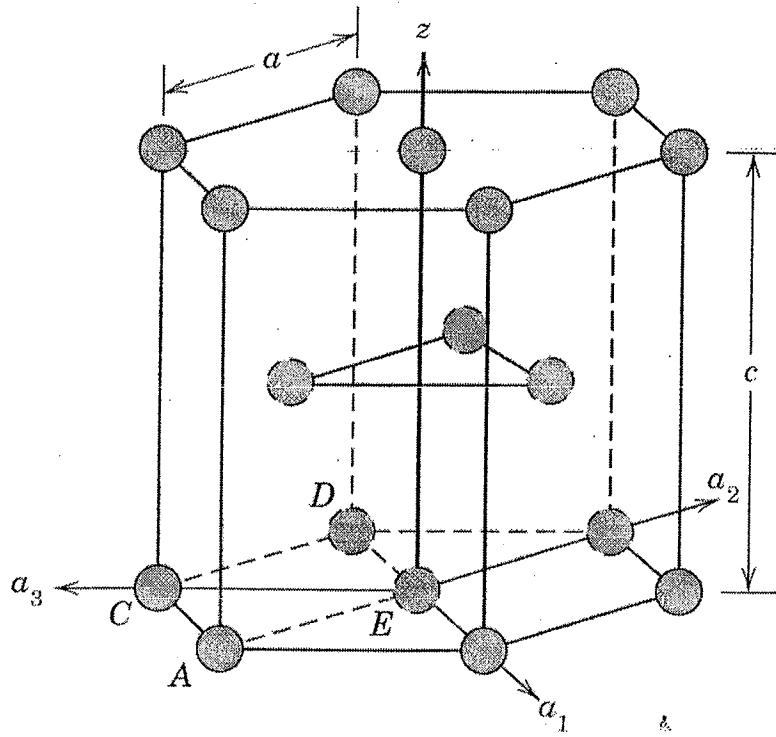


Figure 03

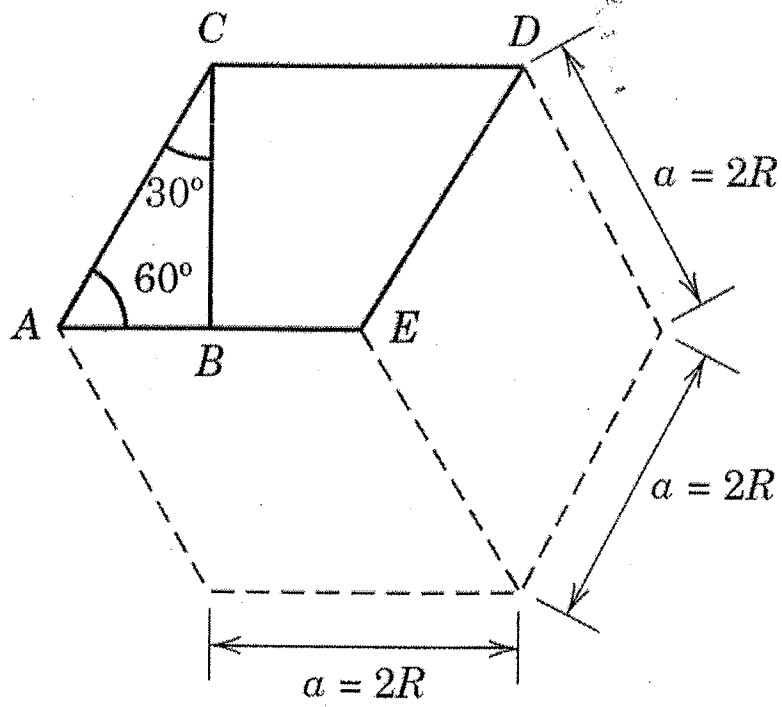


Figure 04