EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2012/2013

SECOND SEMESTER (PROPER/REPEAT)

(October 2015)

PH 304 CONDENSED STATE PHYSICS

Time: 01 hour.

Answer ALL Questions

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1. Give a sketch of hexagonal close-packed (*hcp*) structure and show that the *c/a* ratio of the unit cell dimensions of an *hcp* lattice is $\sqrt{8/3}$.

   Identify the *Bravias lattice* and the *basis* that generate the h.c.p crystal structure.

   Zinc has an *hcp* structure with lattice parameter a=2.66 Å. If the atomic mass of zinc is 65.37 a.m.u., find the packing fraction and density of zinc. (1a.m.u.=1.66 x 10^{-27} kg).

   Draw the atomic plane represented by Miller indices (1 1 0) in zinc lattice and find the atomic planar density (number of atoms per unit area) of this plane.

2. Show that for a one-dimensional linear chain of identical atoms having mass m, the dispersion relation for the longitudinal vibrations is given by

$$\omega = 2\sqrt{\frac{\beta}{m}}\sin\left(\frac{ka}{2}\right),$$

where ω and k are respectively the angular frequency and wave vector of the longitudinal phonon wave in the linear atomic chain and β is the binding force per unit length between the adjacent atoms separated by distance a. Hence, show that the dispersion relation reduces to the continuum results $\omega = v_s k$ for long wavelength limit, where v_s is the velocity of sound.

Obtain expressions for phase velocity v_p and group velocity v_g of the phonon wave in the linear atomic chain, and show that both v_p and v_g are the same and equal to v_s in the long wavelength non-dispersive regime. Also show that at maximum frequency of vibration (i.e. at $\omega_{\max}$) $v_p = 2v_s/\pi$ and $v_g = 0$.