King Fahd University of Petroleum & Minerals

Physics Department

Phys212- Quiz#5

Chapter5

Name: Key ID#:

1. The "seeing ability", or resolution, of radiation is determined by its wavelength. If the size of the atom is of the order of 1 Å, how fast must an electron travel to have a wavelength small enough to "see" an atom?

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

$$\lambda = 1\,\text{Å} = 1\times10^{-10}\,\text{m} = \frac{6.626\times10^{-34}}{9.1\times10^{-31}\times v}$$

$$v = 7.28\times10^{6}\ \text{m/s}$$ Non-relativistic

2. When a pebble is tossed into a pound, a circular wave pulse propagates outward from the disturbance. It can be shown that the phase velocity is given by $v_p = \sqrt{\frac{2\pi S}{\lambda\rho}}$ where S is surface tension and ρ is the density of the liquid and λ is the wavelength of these waves. Determine the group velocity of these water waves.

$$v_g = v_p\Big|_{k_0} + k\,\frac{dv_p}{dk}\Big|_{k_0} \qquad v_p = \sqrt{\frac{kS}{\rho}} =$$

$$\frac{dv_p}{dk} = \frac{1}{2}\left(\frac{S}{\rho}\right)\left(\frac{kS}{\rho}\right)^{-1/2} \Rightarrow k\,\frac{dv_p}{dk} = \frac{1}{2}\left(\frac{kS}{\rho}\right)\left(\frac{kS}{\rho}\right)^{-1/2}$$

$$= \frac{1}{2}\sqrt{\frac{kS}{\rho}} = \frac{1}{2}v_p$$

$$v_g = v_p + \frac{1}{2}v_p = \frac{3}{2}v_p$$

$$\boxed{v_g = \frac{3}{2}v_p}$$