Engineering Physics

(PHY1701)

Dr. B. Ajitha

Assistant Professor
Division of Physics
VIT University
Chennai, India
ajitha.b@vit.ac.in

Problems

1) **The average kinetic energy of neutrons, atoms and molecules is also expressed in terms of temperature through the equipartition law E = 3/2 *k*T. Write down the de-Broglie formula for such particles whose energy corresponds to temperature T. Hence determine the wavelength of thermal neutron; Rest mass of the neutron is 1.67×10^{-27} kg.(T=300 K say)**

$$E = \frac{\boldsymbol{p^2}}{\boldsymbol{2m_0}} = \frac{\boldsymbol{3}}{\boldsymbol{2}}\boldsymbol{kT} \qquad \Rightarrow p = \sqrt{3m_0kT}$$

According to de-Broglie,

$$\lambda = \frac{h}{mv} = \frac{h}{p} = \frac{h}{\sqrt{3m_0kT}} = \frac{6.6\times10^{-34}}{\sqrt{3\times1.67\times10^{-27}\times1.38\times10^{-23}\times300}}$$

Non-relativistic formula for K.E is used, as it is valid for 'T' not very high

$$\lambda = 1.46\times10^{-10}\,m$$

Problems

2) A beam of mono-energetic neutrons corresponding to 27°C is allowed to fall on a crystal. A first order reflection is observed at a glancing angle 30. Calculate the interplanar spacing of the crystal.

According to Bragg's law

$$2d\sin\theta = n\lambda$$

$$2d\sin 30^{o}C = 1\times\lambda \Rightarrow d = \lambda$$

The energy of neutron

$$E = kT = 1.38\times10^{-28}\times300 = 4.14\times10^{-21}\,J$$

Now, $p = \sqrt{2m_nE} = \sqrt{2\times1.67\times10^{-27}\times4.14\times10^{-21}}$

$$\therefore d = \lambda = \frac{h}{p} = \frac{6.62\times10^{-34}}{\sqrt{2\times1.67\times10^{-27}\times4.14\times10^{-21}}}$$

$$= 1.78\times10^{-10}\,m$$

Problems

3) 10 kV electrons are passed through a thin film of a metal for which the atomic spacing is 5.5×10^{-11}m.What is the angle of deviation of the first order diffraction maximum?

Wavelength of the electron

$$\lambda = \frac{h}{\sqrt{2.m.eV}} = \frac{6.6\times10^{-34}}{\sqrt{2\times9.11\times10^{-31}\times10^{4}\times1.602\times10^{-19}}}$$

$$= 1.227\times10^{-11}\,m$$

Applying Bragg's formula for diffraction at the atomic planes,

$$n\lambda = 2d\sin\theta \Rightarrow 1\times1.227\times10^{-11} = 2\times5.5\times10^{-11}\sin\theta$$

$$\sin\theta = 0.1115$$

$$\therefore \theta = 6^{o}24'$$

Angle through which electron is deviated =$2\theta = 12^{o}48'$