Physics 111 Homework Solutions Week #5 - Wednesday

Friday, January 31, 2014

Chapter 17

Questions

- None

Multiple-Choice

- None

Problems

17.6. The radius of the electron's orbit is determined by the magnetic force. We have

$$F_B = F_C \rightarrow qv_\perp B = m\frac{v_\perp^2}{R}$$

$$\rightarrow R = \frac{mv_\perp}{qB} = \frac{9.11\times10^{-31}kg\times0.05\times3\times10^8\,\tfrac{m}{s}\sin 45}{1.6\times10^{-19}C\times0.5T} = 1.21\times10^{-4}m$$

The pitch is given as product of the parallel component of the velocity (a constant) and the period of the circular motion about the magnetic field line. The period is given by $T = \frac{2\pi R}{v_\perp} = \frac{2\pi\times1.21\times10^{-4}m}{0.05\times3\times10^8\,\tfrac{m}{s}\sin 45} = 7.15\times10^{-11}s$ and thus the pitch is

$$p = v\cos\theta\times T = 0.05\times3\times10^8\,\tfrac{m}{s}\cos 45\times7.15\times10^{-11}s = 7.6\times10^{-4}m.$$

17.8 For ^{64}Zn, the mass is 64 times $1.67x10^{-27}\ kg = 1.0688x10^{-25}\ kg$, while for ^{66}Zn, the mass is 66 times $1.67x10^{-27}\ kg = 1.1022x10^{-25}\ kg$. The magnetic force causes the particles to move in a circle of radius r at constant speed given by

$$r = \frac{mv}{qB} = \frac{m}{qB}\sqrt{\frac{2q\Delta V}{m}} = \frac{1}{B}\sqrt{\frac{2m\Delta V}{q}}.$$

For ^{64} Zn, the radius is

$$r = \frac{1}{B}\sqrt{\frac{2m\Delta V}{q}} = \frac{1}{10T}\sqrt{\frac{2\times1.0688\times10^{-25}kg\times10000V}{2\times1.6\times10^{-19}C}} = 8.2mm.$$

For ^{66}Zn, the radius is $r = \frac{1}{B}\sqrt{\frac{2m\Delta V}{q}} = \frac{1}{10T}\sqrt{\frac{2\times1.1022\times10^{-25}kg\times10000V}{2\times1.6\times10^{-19}C}} = 8.3mm.$

17.10 From a free body diagram we find for the forces in the vertical direction $F_B - ky - ky = 0 \rightarrow F_B = 2kx$. The magnetic force is given as ILB and this produces for the stretch $x = \frac{ILB}{2k} = \frac{2.5A\times0.5m\times2T}{2\times10\,\tfrac{N}{m}} = 0.125m = 12.5cm$

17.11. The torque is given by $\tau = IAB\sin\theta$. The cross sectional area of the loop is $A = \pi r^2 = \pi(0.025m)^2 = 1.96\times10^{-3}m^2$. The minimum torque (which equals *0 Nm*)is then the magnetic moment is parallel to the magnetic field and the maximum torque is when the magnetic moment is perpendicular to the magnetic field. The maximum torque is $\tau = IAB\sin\theta = 2A\times1.96\times10^{-3}m^2\times0.5T\times\sin 90 = 1.96\times10^{-3}Nm$

17.21 A cyclotron

a. To calculate the radii of a particle of mass *m* and charge *q*, we equate the magnetic force to the centripetal force experienced by the mass. This gives for the radius of a particle of mass m, $F_B = F_C \rightarrow qvB = \frac{mv^2}{r} \rightarrow r = \frac{mv}{qB}$.

b. We want the particle to travel a semi-circle of distance πr and calculate the amount of time that this takes. To do this we need to know that velocity of the particle. Again we equate the centripetal force experienced by the particle to the magnetic force and this time solve for the velocity. Doing this we find $F_B = F_C \rightarrow qvB = \frac{mv^2}{r} \rightarrow v = \frac{qrB}{m}$. The velocity, a constant, is the ratio of the distance traveled by the time it takes to travel this distance. Thus the time is $v = \frac{\pi r}{t} \rightarrow t = \frac{\pi r}{v} = \frac{\pi rm}{qrB} = \frac{\pi m}{qB}$.

Monday, February 3, 2014

Chapter 17

Questions

- None

Multiple-Choice

- None

Problems

- None