King Abdulaziz University	Faculty of Science	Department of Physics
PHYSICS 202: CA	Summer term 2010	Quiz#4

Solution

1. A proton, moving with a speed of 4×10^{6} m/s through a magnetic field of 1.15 T, experiences a magnetic force of 6.4×10^{-13} N. Determine the angle between the proton's velocity and the magnetic field.

The magnetic force is defined as

$$\vec{F} = q\,\vec{v}\times\vec{B}$$

Hence the magnitude of the magnetic field is given as

$$F = qvB\,sin\theta$$

Therefore the angle is

$$sin\theta = \frac{F}{q\,vB} = \frac{6.4\times10^{-13}}{1.6\times10^{-19}\times4\times10^{6}\times1.15} = 0.869$$

$$\theta = 60.4^{0}$$

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1. A 2 eV proton rotates in a circle, of radius 4.2 cm, under the influence of a uniform magnetic field. Calculate the magnitude of the magnetic field.

The radius of the curvature is

$$R = \frac{mv}{qB} \quad\rightarrow\quad B = \frac{mv}{qR}$$

From the kinetic energy we get

$$K = \frac{1}{2}mv^2 \quad\rightarrow\quad v = \sqrt{\frac{2K}{m}} = \sqrt{\frac{2\times2\times1.6\times10^{-19}}{1.67\times10^{-27}}} = 1.96\times10^{4}\ \mathrm{m/s}$$

Therefore the magnitude of the magnetic field is

$$B = \frac{mv}{qR} = \frac{1.67\times10^{-27}\times1.96\times10^{4}}{1.6\times10^{-19}\times4.2\times10^{-2}} = 4.9\ \mathrm{mT}$$

Constants: electron's mass $m_e=9.11\times10^{-31}$ kg, proton's mass $m_p=1.67\times10^{-27}$ kg, electronic charge $e=1.6\times10^{-19}$ C