Name_____

Physics 111 Quiz #4, October 6, 2025

Please show all work, thoughts and/or reasoning to receive partial credit. The quiz is worth 10 points total, and all parts may not be of equal weight.

I affirm that I have carried out my academic endeavors with full academic honesty.

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1. A uniform magnetic field with magnitude $B = 1.2mT$ is directed vertically upward throughout the volume of a laboratory chamber. That is, the magnetic field points from the floor to the ceiling. A proton with kinetic energy $5.3MeV$ enters the chamber moving horizontally parallel to the floor from south to north. What is the speed of the proton?

$$K = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2K}{m}} = \sqrt{\frac{2 \times 5.3 \times 10^6 eV \times \frac{1.6 \times 10^{-19} J}{1eV}}{1.67 \times 10^{-27} kg}} = 3.2 \times 10^7 \frac{m}{s}$$

2. What is the magnitude of the magnetic deflecting force on the proton due to the proton's interaction with the magnetic field?

$$F = qvB \sin\theta = qvB \sin 90 = qvB = 1.6 \times 10^{-19} C \times 3.2 \times 10^7 \frac{m}{s} \times 1.2 \times 10^{-3} T$$

$$F = 6.1 \times 10^{-15} N$$

3. What is the direction of the magnetic deflecting force on the proton? Simply stating a direction with no explanation will earn minimal credit. Please explain how you arrived at your choice of direction.

   By the right-hand rule, if your thumb points north (along the velocity into the page) and your fingers point vertically up (along the magnetic field up the page), the force on a positive charge (given by the palm of the hand) points to the right across the page, or east. Since the force needs to be perpendicular to the plane that contains the velocity and magnetic field, you needed to specify either east or west to get full.

4. What is the diameter of the proton's circular orbit?

   $$F = qvB = \frac{mv^2}{R} \rightarrow R = \frac{mv}{qB} = \frac{1.67\times10^{-27}kg\times3.2\times10^{7}\frac{m}{s}}{1.6\times10^{-19}\times1.2\times10^{-3}T} = 278.3m$$

   Or,

   $$F = \frac{mv^2}{R} \rightarrow R = \frac{mv^2}{F} = \frac{1.67\times10^{-27}kg\times\left(3.2\times10^{7}\frac{m}{s}\right)^2}{6.1\times10^{-15}N} = 280m$$

   Thus, $D = 2R = 2\times280m = 560m$

5. What is the current produced by the proton in one orbit about the magnetic field?

   The orbital period:

   $$v = \frac{2\pi R}{T} \rightarrow T = \frac{2\pi R}{v} = \frac{2\pi\times278.3m}{3.2\times10^{7}\frac{m}{s}} = 5.5\times10^{-5}s$$

   The current:

   $$I = \frac{\Delta Q}{\Delta t} = \frac{1.6\times10^{-19}C}{5.5\times10^{-5}s} = 2.9\times10^{-15}A$$