Wednesday Reading Assessment: Unit 3, Magnetic Forces and Fields

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1 Memory Bank

- $\vec{F} = q\vec{v} \times \vec{B}$ ... The Lorentz force
- $\vec{x}(t) = v_{||} t\hat{i}$ ... The x-position.
- $\vec{y}(t) = (v_\perp/\omega_B)\cos(\omega_B t)\hat{j}$ ... The y-position.
- $\vec{z}(t) = (v_\perp/\omega_B)\sin(\omega_B t)\hat{k}$ ... The z-position.
- $\omega_B = (qB)/m$ ... The *cyclotron* frequency.
- $\omega = 2\pi f = 2\pi/T$ ... Relationship between angular frequency, frequency, and period.

2 Motion of a Charged Particle in a Uniform Magnetic Field

1. Consider Fig. 1, in which a charged particle is spiralling around a B-field. In the online video tutorial we showed that the 3D motion follows the equations in the memory bank. (a) Where is the particle at time $t = 0$?

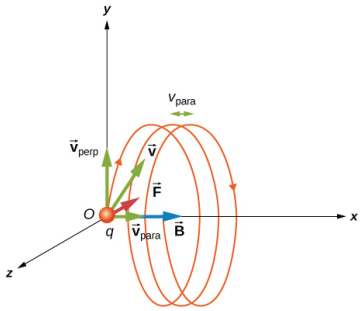

Figure 1: A graph of charge passing through a certain circuit versus time.

2. If the particle starts at $(0, v_\perp/\omega_B, 0)$, and returns there, which of the following is true of $v_{||}$?
   - A: $v_{||} < 0$
   - B: $v_{||} > 0$
   - C: $v_{||} = 0$
   - D: $v_{||}$ is undefined.
3. Suppose the cyclotron frequency is $\omega_B = 40$ MHz, and $v_\perp = 10^6$ m/s. What is the period of the motion around the circle?

4. What would have happened to the motion if $q < 0$? That is, if we switch the sign of the charge, what happens to the spiral?