

# Wednesday Reading Assessment: Unit 3, Magnetic Forces and Fields

Prof. Jordan C. Hanson

March 25, 2020

## 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.
- $\vec{z}(t) = (v_{\perp}/\omega_B)\sin(\omega_B t)\hat{j}$  ... The z-position.
- $\omega = 2\pi f = 2\pi/T$  ... 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  $t = 0$ ?

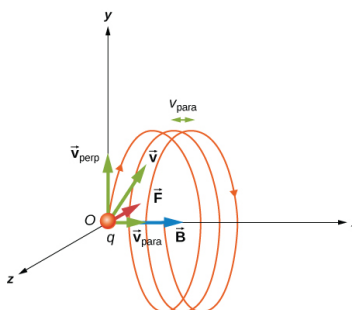


Figure 1: A graph of charge passing through a certain circuit versus time.

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?