

# FOURTH MIDTERM

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Name: Zhao Hui

Discussion Instructor (circle): Andrade      El-Gendy      Mimoto      Owen

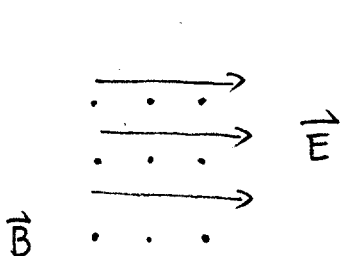
Discussion Section # \_\_\_\_\_

Student ID #: \_\_\_\_\_

**SHOW ALL WORK!!!!**  
**REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!**  
 Use the conversion constants and data given on the front page.

A velocity selector is created with the fields  $E = 1200 \text{ V/m}$  and  $B = 0.300 \text{ T}$ .

- 8 (a) For protons incident on this selector, what velocity is passed?  
 9 (b) What is the cyclotron frequency for protons in the  $0.300 \text{ T}$  magnetic field?  
 8 (c) What is the radius of the cyclotron orbit for protons passed by the velocity selector in (a) in the magnetic field of  $0.300 \text{ T}$ ?



$$\vec{F}_B = \vec{F}_e \quad e\vec{v} \times \vec{B} = e\vec{E}$$

$$vB = E \quad v = \frac{E}{B} = \frac{1200}{0.3} = 4000 \text{ m/s}$$

$$\frac{mv^2}{r} = e v B \quad 2\pi r = vT$$

$$r = \frac{vT}{2\pi}$$

$$\frac{mv}{\frac{vT}{2\pi}} = eB \Rightarrow T = \frac{2\pi m}{eB}$$

$$\frac{mv}{eB} = r$$

$$f = \frac{1}{T} = \frac{eB}{2\pi m} = \frac{1.6 \times 10^{-19} \times 0.3}{6.28 \times 1.67 \times 10^{-27}} = 4.58 \times 10^6 \text{ Hz}$$

$$T = \frac{1}{f} = 2.185 \times 10^{-7} \text{ s}$$

$$r = 1.39 \times 10^{-4} \text{ m}$$