Homework No. 07 (Fall 2025)

PHYS 203B-001: COLLEGE PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale

Due date: Thursday, 2025 Oct 16, 12:30 PM, on D2L

Instructions

- You are encouraged to use any of the resources to complete this homework. However, the extent to which you depend on resources while doing this homework is a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Links to solutions are provided.
- Variations of homework problems and additional problems are available in Lecture Notes. These serve as practice problems.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments). You can replace your PDF file as many times as you like, only the last file is graded. The deadline has an (undisclosed) buffer period, so do not hesitate to try submissions after the deadline.

Problems

1. (**10 points.**) An electron, is traveling at a velocity of $5.1 \times 10^6\,\mathrm{m/s}$ due East, in a magnetic field that has a magnitude of of 0.10 Tesla along a direction 30° West of North. (Caution: Be careful while interpreting the angle.)

   (a) What is the magnitude of the magnetic force acting on the electron?

   (b) What is the direction of the magnetic force acting on the electron? (Use the notation, $+x$ for East, $-x$ for West, $+y$ for North, $-y$ for South, $+z$ for vertically up, and $-z$ for vertically down.)

   (c) Describe the path taken by the electron using a diagram.

   Solution

2. (**10 points.**) A proton and an electron enters a region containing a magnetic field going into the page, $\vec{\mathbf{B}} = -2.0\,\hat{\mathbf{k}}\,\mathrm{T}$. Let the velocity of both the particles while they enter the region be to the right, $\vec{\mathbf{v}} = 3.0 \times 10^5\,\hat{\mathbf{i}}\,\mathrm{m/s}$.

(a) Determine the magnitude of the magnetic force on the proton and the electron.

(b) Determine the direction of the magnetic force on the proton and the electron, using the right-hand rule.

(c) Determine the corresponding accelerations experienced by the proton and the electron.

(d) Determine the cyclotron frequency of the proton and the electron.

(e) Determine the radius of the circle described by the paths of the proton and the electron.

Solution

3. (**10 points.**) A magnetic field has a magnitude of 1.50 mT and points in the $-\hat{\mathbf{z}}$ direction, and an electric field has a magnitude of 6.00 kN/C pointing in the $\hat{\mathbf{x}}$ direction. A positive 1.0 μC charge moves at a speed of 2.00×10^6 m/s in the direction of $\hat{\mathbf{x}}$ at an instant. Determine the magnitude of the net force that acts on the charge at the instant.

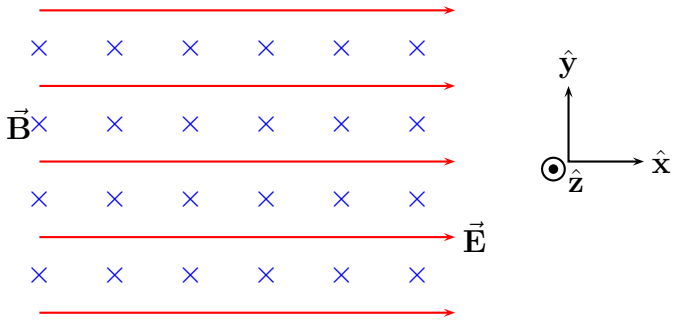

Figure 1: Problem 3.

Solution

4. (**10 points.**) The electric field and the magnetic field both deflect charged particles due to the respective forces. In a velocity selector these forces are exactly balanced for particles moving with a particular velocity which go through undeviated. See Figure 2. Determine the magnitude and direction of the velocity selected by a velocity selector consisting of an electric field of $\mathbf{E} = -3.0 \times 10^3\,\hat{\mathbf{j}}$ N/C and a magnetic field of $\mathbf{B} = -1.5\,\hat{\mathbf{k}}$ T.

Solution

5. (**10 points.**) You are driving in your car in the direction of positive x-axis with speed 31 m/s ($\sim$ 70 miles/hour). The magnetic field due to Earth in this region is in the xz-plane with its vertically downward component (along negative z-axis) having a magnitude of 50 μT. The car being made of metal has charges that are free to move. These charges feel a magnetic force in the presence of the magnetic field and drift towards the sides of

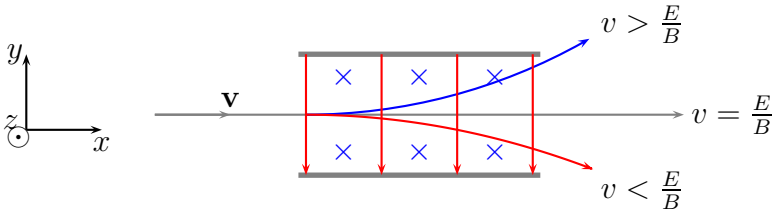

Figure 2: Problem 4

the car. Assuming the width of the car to be 1.0 m, determine the Hall voltage built up across the car.

Solution

6. (**10 points.**) A loop in the shape of a right triangle of sides $a = 3.0\,\text{cm}$ and $b = 2.0\,\text{cm}$, carrying a current $I = 2.0\,\text{A}$, is placed in a magnetic field 0.30 T going into the page. See Figure 3. Determine the magnitude and direction of the force on side 3 of the triangle.

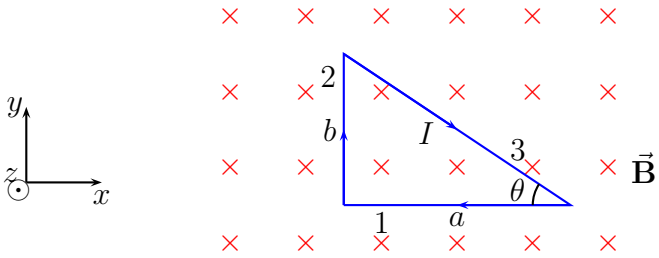

Figure 3: Problem 6.

Solution

7. (**10 points.**) A current of 16 mA is maintained in a single circular loop of $1.20\,\text{m}^2$ area. A magnetic field of 0.60 T is directed parallel to the plane of the loop.

   (a) Calculate the magnetic dipole moment of the loop.

   (b) What is the magnitude of the torque exerted by the magnetic field on the loop?

Solution