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# Fundamentals of Electromagnetic Fields and Waves: I

Fall 2006, EE 30348, Electrical Engineering, University of Notre Dame

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## Assignment 1

Remember the policy on assignments - you should turn them in by 5pm of the due date. The due date for this assignment is **Friday, September 1st, 2006**.

General notes: Present your solutions *neatly*. Do not turn in your rough worksheet where you might have walked down blind alleys - turn in the final solutions. Think of every assignment solution as a final report. If I can't read them, I can't grade. Show all steps, so that I can award partial points for correct steps. BOX your final answers. Draw figures wherever necessary.

1) This question is for you to brush up your vector math.

Iskander<sup>1</sup>: Problem 1.2, Problem 1.6, Problem 1.10, & Problem 1.12.

2) This question is for you to brush up your "old" electrostatics.

Iskander: Problem 1.19 & Problem 1.21.

3) This question is for you to brush up your "old" magnetostatics.

Iskander: Problem 1.24 & Problem 1.25.

4) May the Lorentz Force be with you.

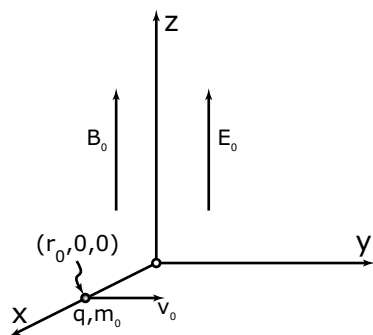


Figure 1: Setup for Problem 4.

A particle of mass  $m_0$  and charge  $q$  is launched at  $t = 0$  from the point  $(r_0, 0, 0)$  with a velocity  $\mathbf{v} = v_0 \mathbf{a}_y$ . There is an electric field  $\mathbf{E} = E_0 \mathbf{a}_z$  and a magnetic field  $\mathbf{B} = B_0 \mathbf{a}_z$ , both along the  $z$ -axis.

a) Assume for this part that  $E_0 = 0$ . Show that the particle moves in a circular orbit in the  $x - y$  plane with an angular frequency  $\omega_0 = qB_0/m_0$  and radius  $r_0 = v_0/\omega_0$ . Google to find out popular names of  $r_0, \omega_0$ .

b) Now consider the situation when the electric field is non-zero. Show that the particle moves in a spiralling motion. Find the velocity vector  $\mathbf{v} = (v_x(t), v_y(t), v_z(t))$  and the spatial coordinates  $\mathbf{r} = (x(t), y(t), z(t))$  at any time  $t$ .

c) Find the approximate number of rotations the particle completes around the  $z$ -axis in moving a distance  $L_0$  along this axis.

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<sup>1</sup>For many problems in Iskander, there are answers at the back of the book - you can check your answers before turning them in.