S11 PHY114 Problem Set 6

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Due Monday 14 Mar 2011

1. A particle of mass m and charge q moves in a circular path in a magnetic field B. How does its kinetic energy depend on the radius of its orbit? Find angular momentum of a particle about the center of the circle.

2. A sort of "projectile launcher" is shown in Figure 1. A large current moves in a closed loop composed of fixed rails, a power supply, and a very light, almost frictionless bar touching the rails. A magnetic field B is perpendicular to the plane of the circuit. Should the field point up or down? If the rails are a distance d apart, and the bar has a mass of m , what constant current flow I is needed to accelerate the bar from rest to a speed v in a distance L ?

3. An atomic nucleus moves in a straight line through perpendicular electric and magnetic fields E and B respectively. If the electric field is turned off, and the magnetic field is kept the same, the particle moves in a circular path of radius r . What is the ratio of mass to charge of this nucleus?

4. A proton, a deuteron and an alpha particle enter a magnetic field B, after being accelerated from rest by the same potential difference V. The proton is found to be moving in a circle of radius R . What are the radii of the orbits of the deuteron and of the alpha particle?

5. A particle with positive charge q and mass m travels in a uniform magnetic field $\mathbf{B} = B_0\mathbf{k}$. At time $t = 0$, the particle's speed is v_0 and its velocity vector lies in the plane directed at an angle of 30° with respect to the y-axis as shown in the figure. At a later time t_1, the particle will cross the axis at $x = \alpha$. In terms of q, m, v_0 and B_0 , determine α and t_1.

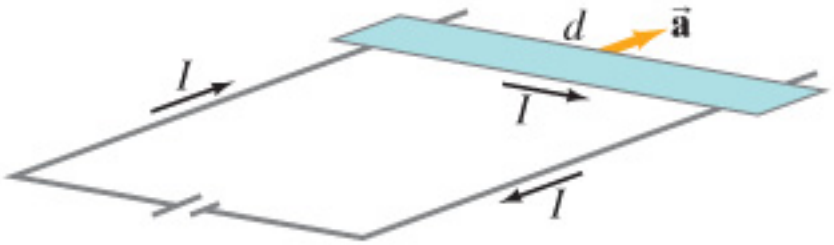

Figure 1:

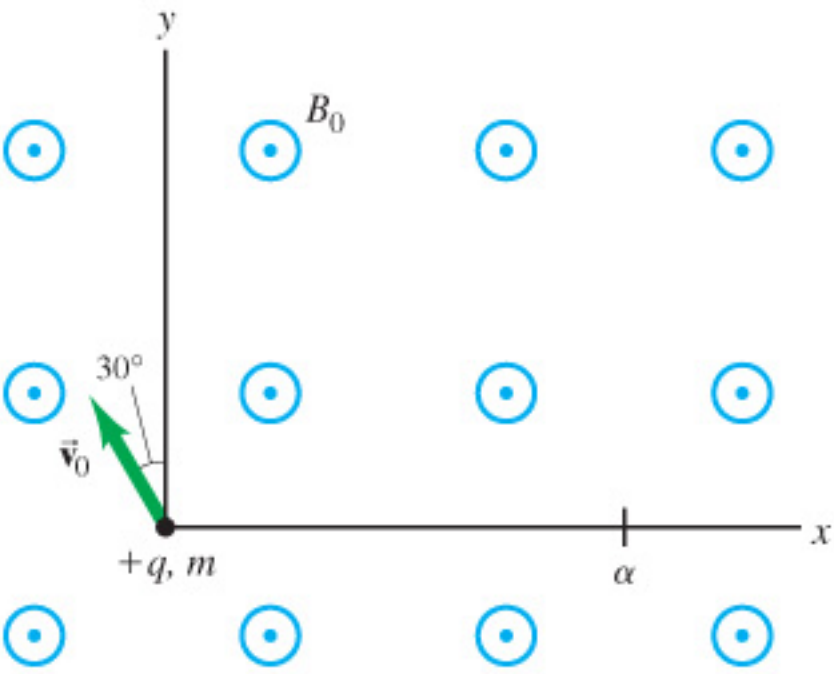

Figure 2: