Physics 4B: Problem Set 7 - The magnetic force

1. Show that no work is done by a magnetic field.

2. Derive the period of a charge's circular motion in a uniform magnetic field.

3. A particle of mass *m* and charge q enters a region where there is a uniform magnetic field B along the x axis. The initial velocity of the particle is $\mathbf{v} = v_{ox}\mathbf{i} + v_{oy}\mathbf{j}$, so the particle moves in a helix.

a. Find the radius of the helix.

b. Find the period of the orbit.

c. Find the distance along the x axis the particle travels in one period.

4. velocity selector ("crossed fields"): A charge q with speed v enters a region where a uniform electric field is vertically down. The charge has a velocity to the right. Find the direction and magnitude of a magnetic field in this same region such that the charge experiences no acceleration. Show what happens if the charge is negative instead of positive.

5. A circular loop of radius *a* and mass *m* carries a current through it of I. The loop is in a uniform magnetic field that is horizontal. The loop is a rest on a horizontal surface such that its area is flat on that surface. Find the value of the current in the loop such that is *just* starts to lift off the table on one side.

6. A conducting bar of mass *m* is placed along a conducting inclined plane of angle θ such that the bar completes a circuit with the edges of the plane and then there is a current through the bar I. There is gravity in this problem. Say that there is a uniform magnetic field that is vertically

up. Find the value of the current I such that the bar has zero acceleration. Also, find the normal force of the plane on the bar.

7. A conducting bar of mass *m* and length L is positioned across two parallel horizontal wires such that it completes a circuit allowing a current to run through the bar. There is no friction in this problem. There is a uniform magnetic field that is vertical and perpendicular to the rod's length such that the rod accelerates horizontally. Say that the current is maintained to be constant through the rod (why this is necessary will be explained in the future). Starting from rest, find the speed of the bar as a function of time.

8. A spherical shell of radius R and charge Q is spinning with an angular velocity ω in a uniform magnetic field that is perpendicular to the direction of the angular velocity. Find the torque of the field on the sphere and describe what happens to the sphere's motion from this torque.