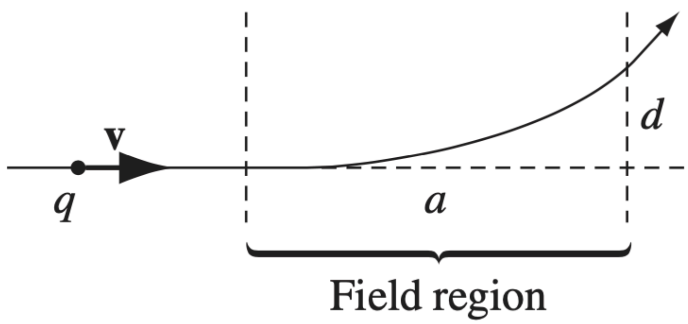
**HW Ch.5 Magnetostatics (Part 1)**

Show **ALL WORK** to get full/partial credit. Begin each problem on a new page, and clearly label each part of the problem.

1) **Problem 5.1 (5 pts)**
A particle of charge $q$ enters a region of uniform magnetic field $\mathbf{B}$ (pointing *into* the page). The field deflects the particle a distance $d$ above the original line of flight, as shown in the Figure below.




(a) **(1 pt)** Is the charge positive or negative ?

(b) **(4 pts)** In terms of $a$, $d$, $B$ and $q$, find the momentum of the particle ?

2) **Problem 5.3 (10 pts)**
In 1897, J.J. Thomson "discovered" the electron by measuring the charge-to-mass ratio of "cathode rays" (actually, streams of electrons, with charge $q$ and mass $m$) as follows:

(a) **(5 pts)** First he passed the beam through uniform crossed electric and magnetic fields **E** and **B** (mutually perpendicular, and both of them perpendicular to the beam), and adjusted the electric field until he got zero deflection. What, then, was the speed of the particles (in terms of $E$ and $B$)?

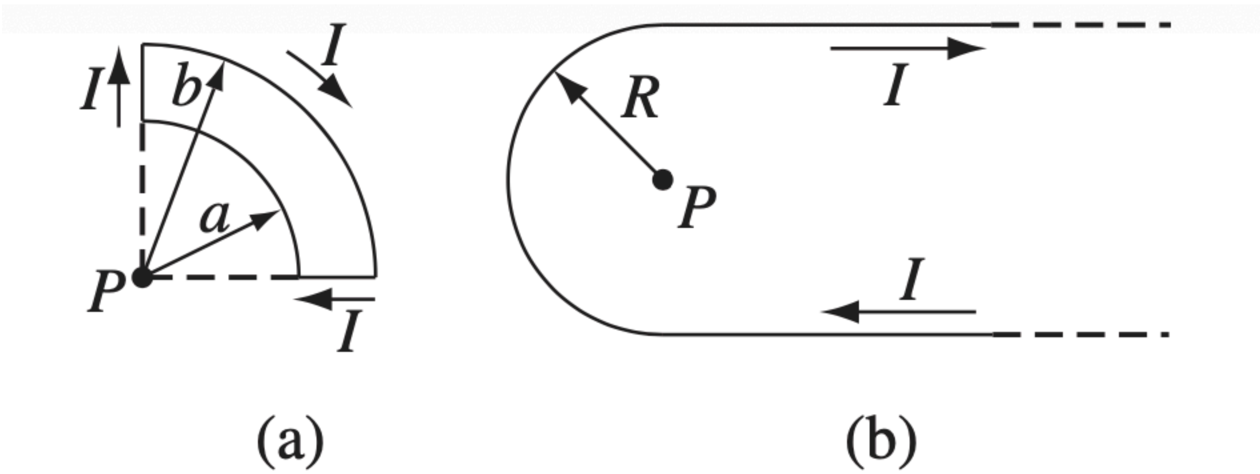
(b) **(5 pts)** Then he turned off the electric field, and measured the radius of curvature, $R$, of the beam, as deflected by the magnetic field alone. In terms of $E$, $B$, and $R$, what is the charge-to-mass ratio ($q/m$) of the particles?

3) **Problem 5.6** **(10 pts)**

(a) **(5 pts)** A phonograph record (old school vinyl records, circular disk shape) carries a uniform density of "static electricity" $\sigma$. If it rotates at angular velocity $\omega$, what is the surface current density $K$ at a distance $r$ from the center? (*hint*: $v = \omega r$)

(b) **(5 pts)** A uniformly charged solid sphere, of radius $R$ and total charge $Q$, is centered at the origin and spinning at a constant angular velocity $\omega$ about the $z$ axis. Find the current density $\mathbf{J}$ at any point $(r, \theta, \phi)$ within the sphere.

4) **Problem 5.9** **(10 pts)**
Find the magnetic field at point $P$ for each of the steady current configurations shown in each of the wire segments in the figures below.



5) **Problem 5.12** **(5 pts)**
Use the result of Ex. 5.6 to calculate the magnetic field at the center of a uniformly charged spherical shell, of radius $R$ and total charge $Q$, spinning at constant angular velocity $\omega$. (*hint*: rotating charged spherical shell forms a surface current density, $K$; recall that for rotational motion, the tangential speed is related to the angular speed by the radius $\perp$ to the axis of rotation, $v = \omega r$)