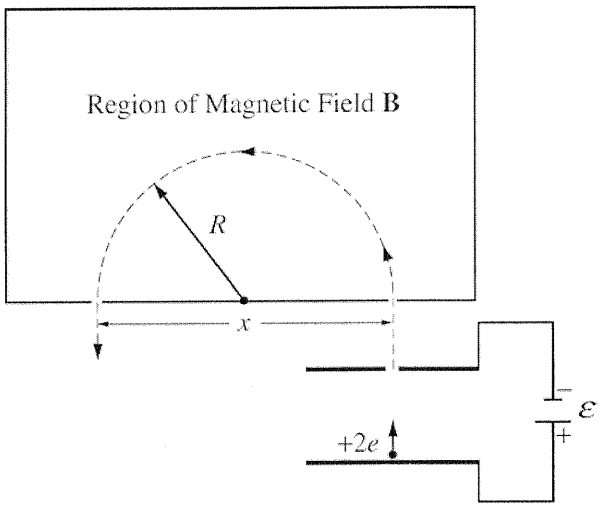


Top View

2. (10 points)

Your research director has assigned you to set up the laboratory's mass spectrometer so that it will separate strontium ions having a net charge of $+2e$ from a beam of mixed ions. The spectrometer above accelerates a beam of ions from rest through a potential difference $\mathcal{E}$, after which the beam enters a region containing a uniform magnetic field **B** of constant magnitude and perpendicular to the plane of the path of the ions. The ions leave the spectrometer at a distance x from the entrance point. You can manually change $\mathcal{E}$.

Numerical values for this experiment:

Strontium atomic number:	38
Strontium ion mass:	1.45×10^{-25} kg
Magnitude of B field:	0.090 T
Desired exit distance x:	1.75 m

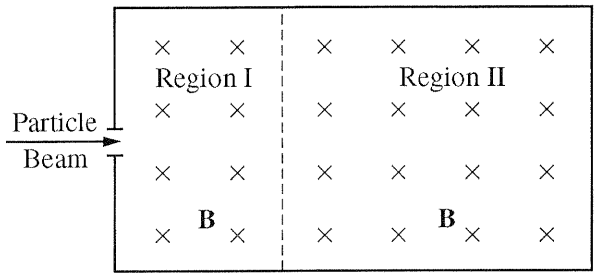
(a) In what direction must **B** point to produce the trajectory of the ions shown?

(b) The ions travel at constant speed around the semicircular path. Explain why the speed remains constant.

(c) Calculate the speed of the ions with charge $+2e$ that exit at distance x.

(d) Calculate the accelerating voltage $\mathcal{E}$ needed for the ions with charge $+2e$ to attain the speed you calculated in part (c).

GO ON TO THE NEXT PAGE.



2. (10 points)

A beam of particles of charge $q = +3.2 \times 10^{-19}$ C and mass $m = 6.68 \times 10^{-26}$ kg enters region I with a range of velocities all in the direction shown in the diagram above. There is a magnetic field in region I directed into the page with magnitude $B = 0.12$ T. Charged metal plates are placed in appropriate locations to create a uniform electric field of magnitude $E = 4800$ N/C in region I. As a result, some of the charged particles pass straight through region I undeflected. Gravitational effects are negligible.

(a)

i. On the diagram above, sketch electric field lines in region I.

ii. Calculate the speed of the particles that pass straight through region I.

The particles that pass straight through enter region II in which there is no electric field and the magnetic field has the same magnitude and direction as in region I. The path of the particles in region II is a circular arc of radius R.

(b) Calculate the radius R.

(c) Within the beam there are particles moving slower than the speed you calculated in (a)ii. In what direction is the net initial force on these particles as they enter region I?

____ To the left ____ Toward the top of the page ____ Out of the plane of the page

____ To the right ____ Toward the bottom of the page ____ Into the plane of the page

Justify your answer.

(d) A particle of the same mass and the same speed as in (a)ii but with charge $q = -3.2 \times 10^{-19}$ C enters region I. On the following diagram, sketch the complete resulting path of the particle.