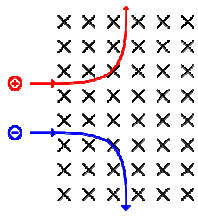
Charged Particles in Magnetic Fields



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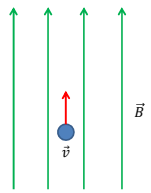
Paths of Charged Particles in Uniform Magnetic Field Case #1



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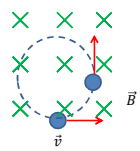
Paths of Charged Particles in Uniform Magnetic Field Case #2



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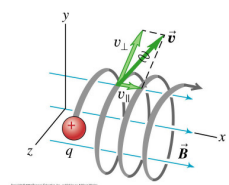
Paths of Charged Particles in Uniform Magnetic Field Case #3



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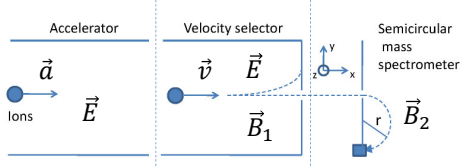
Mass Spectrometry



Particle enters electric field:
$\vec{F} = \vec{F}_e = q\vec{E} = m\vec{a}$

Only particles with a given velocity selected
$q\vec{E} = q\vec{v} \times \vec{B}_1$
$\Rightarrow |\vec{v}| = \frac{|\vec{E}|}{|\vec{B}_1|}$

Radius of curvature measured
$\frac{m|\vec{v}|^2}{r} = q|\vec{v}||\vec{B}_2|$
$\Rightarrow r = \frac{m|\vec{v}|}{q|\vec{B}_2|}$

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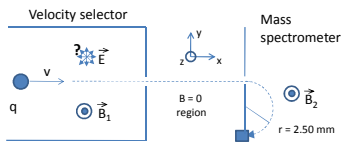
Demo Problem

A charged particle moving in the positive x-direction enters a velocity selector in which B points in the positive z-direction with magnitude $0.070\ \mathrm{T}$. There is also a uniform electric field inside the velocity selector with magnitude $E = 600.0\ \mathrm{V/m}$. The particle is undeflected and so passes through the velocity selector. It then enters a mass spectrometer in which the magnetic field is twice as strong. As a result of the magnetic force in the mass spectrometer, the particle begins to curve downward (in the $-y$ direction). It follows a clockwise semicircular arc of radius $r = 2.55\ \mathrm{mm}$ in the xy-plane, eventually entering one of the detectors in the mass spectrometer.

What direction must the electric field in the velocity selector be pointing?



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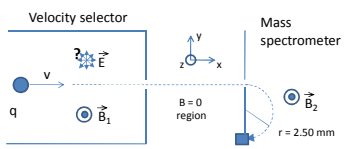
What is the speed of the particle in the velocity selector?



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Demo Problem

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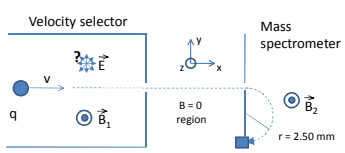
Find the ratio of charge to mass (q/m) for this particle.



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