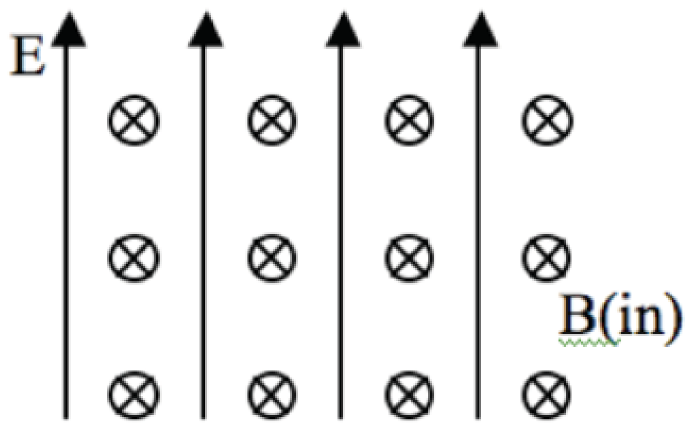
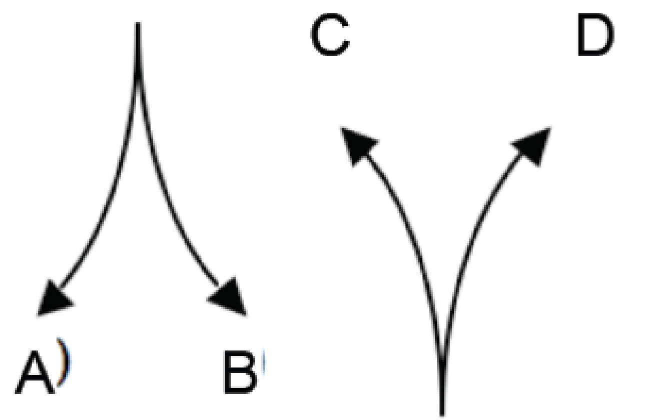
A negative charge ($-q$) is moving in the $+x$ direction when it encounters a region of constant magnetic field pointing in the $-y$ direction. Which is the direction of the initial net force on the charge?

A. $+y$
B. $-y$
C. $+z$
D. $-z$
E. ???

# MAGNETOSTATICS

A proton ($q = +e$) is released from rest in a uniform $\mathbf{E}$ and uniform $\mathbf{B}$. $\mathbf{E}$ points up, $\mathbf{B}$ points into the page. Which of the paths will the proton initially follow?

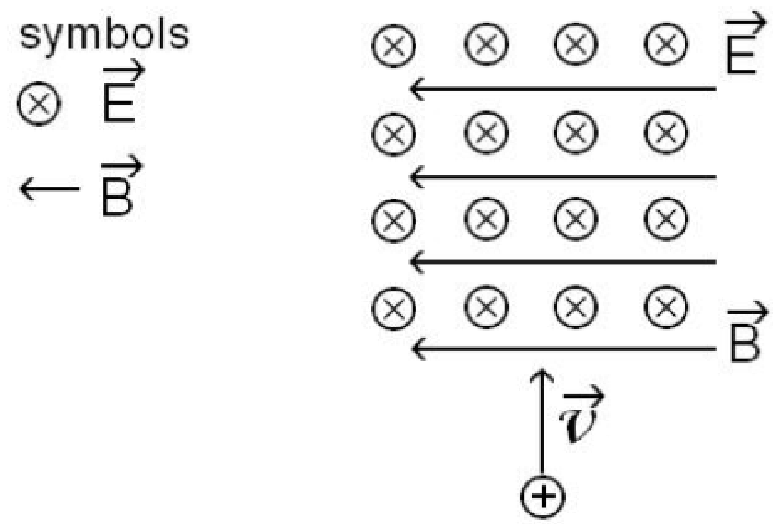


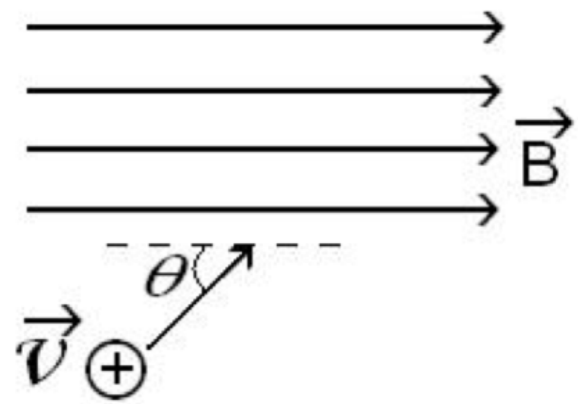

E. It will remain stationary

A + charged particle moving up (speed $v$) enters a region with uniform $\mathbf{B}$ (left) and uniform $\mathbf{E}$ (into page). What's the direction of $\mathbf{F}_{net}$ on the particle, at the instant it enters the region?

A. To the left
B. Into the page
C. Out of the page
D. No net force
E. Not enough information



A proton (speed $v$) enters a region of uniform $\mathbf{B}$. $v$ makes an angle $\theta$ with $\mathbf{B}$. What is the subsequent path of the proton?



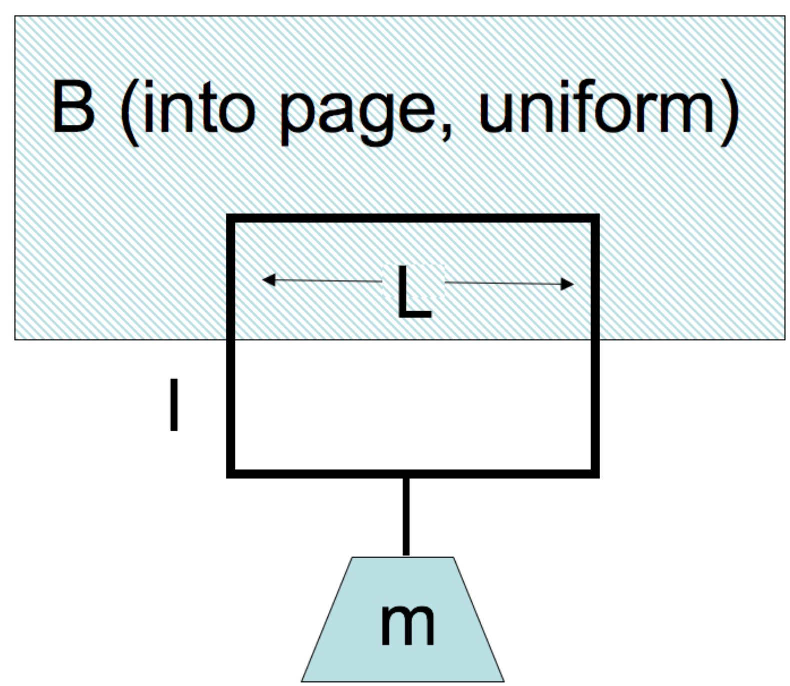

A. Helical
B. Straight line
C. Circular motion, $\perp$ to page. (plane of circle is $\perp$ to $\mathbf{B}$)
D. Circular motion, $\perp$ to page. (plane of circle at angle $\theta$ w.r.t. $\mathbf{B}$)
E. Impossible. $\mathbf{v}$ should always be $\perp$ to $\mathbf{B}$

A wire loop in a $B$ field has a current $I$. The B-field is localized, it's only in the hatched region, roughly zero elsewhere. Which way is $I$ flowing to hold the mass in place?

A. Clockwise

B. Counter-clockwise

C. You cannot "levitate" like this!



In the first stage of the mass spectrometer, with $\mathbf{E} = E_0\hat{z}$ (pointing upward) and $\mathbf{B} = B_0\hat{x}$ (pointing out of the page), which particles travel through in a straight line?

A. All particles regardless of speed
B. Particles with speed $B_0/E_0$
C. Particles with speed $E_0/B_0$
D. Can't tell without knowing $q$ and/or $m$

*You may assume all particles move exclusively in the +y direction.*

If we place a physical filter (i.e., a piece of metal with a thin slot that is a bit larger than the beam width to avoid diffraction) at the end of the first stage, which particles (assume they are all positively charged) hit the upper-part of the filter? Which hit the lower part?

A. Fast moving particles hit the upper part; slow ones hit the lower part
B. Slow moving particles hit the upper part; fast ones hit the lower part
C. It's not possible to tell without $q$ and/or $m$

Can we use the same mass spectrometer set up for negatively and positively charged particles? That is, will our set up distinguish between particles of a given mass and differently-signed charges?

A. Yes

B. No

For our velocity selector where $\mathbf{E} = E_0\hat{z}$ and $\mathbf{B} = B_0\hat{x}$ and we start particles from rest, we end up with the following **coupled** equations of motion,

$$m\dot{v}_y = qv_zB_0$$
$$m\dot{v}_z = qE_0 - qv_yB_0$$

How might we solve them for $y(t)$ and $z(t)$?

A. Just integrate the equations of motion
B. Guess the general solution
C. Take the time derivative of one and plug into the other
D. Give up???

Positive ions flow right through a liquid, negative ions flow left. The spatial density and speed of both ions types are identical. Is there a net current through the liquid?

A. Yes, to the right
B. Yes, to the left
C. No
D. Not enough information given

Current $I$ flows down a wire (length $L$) with a square cross section (side $a$). If it is uniformly distributed over the entire wire area, what is the magnitude of the volume current density $J$?

A. $J = I/a^2$
B. $J = I/a$
C. $J = I/4a$
D. $J = a^2 I$
E. None of the above