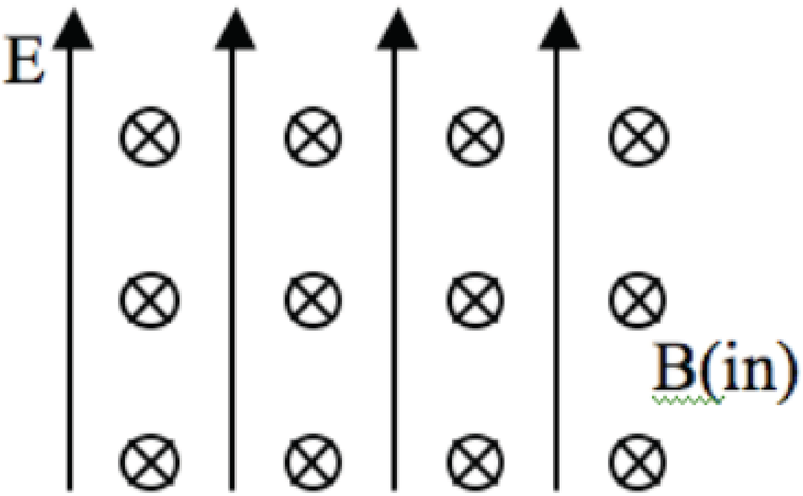
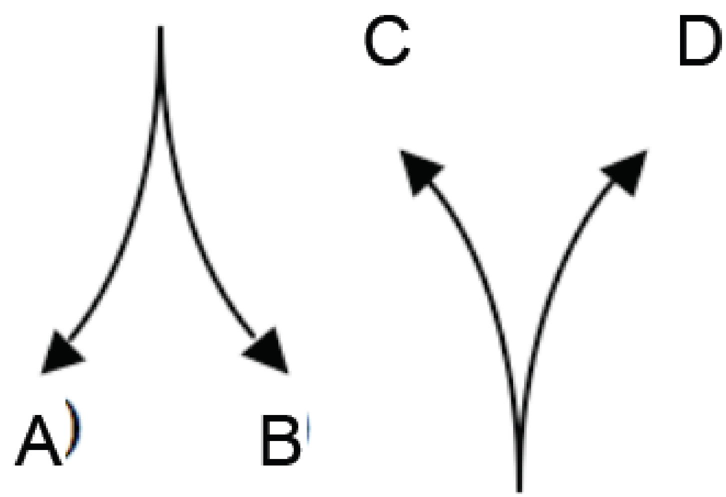
LORENTZ FORCE

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

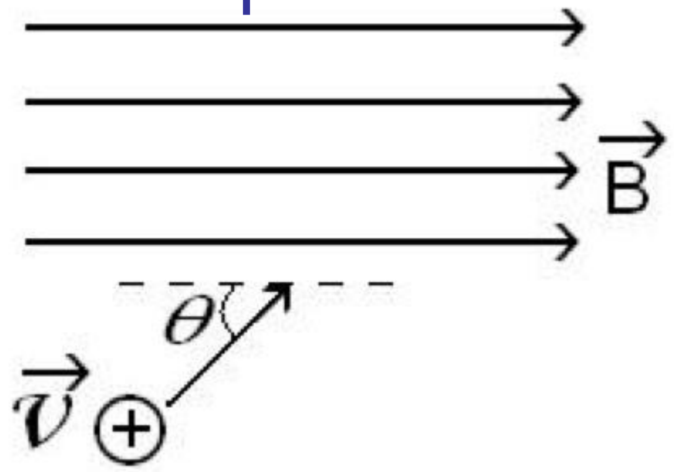




E. It will remain stationary

(To think about: what happens after longer times?)

5.3 A proton (speed v) enters a region of uniform **B**.
v makes an angle θ with **B**.
What is the subsequent path of the proton?



A) Helical

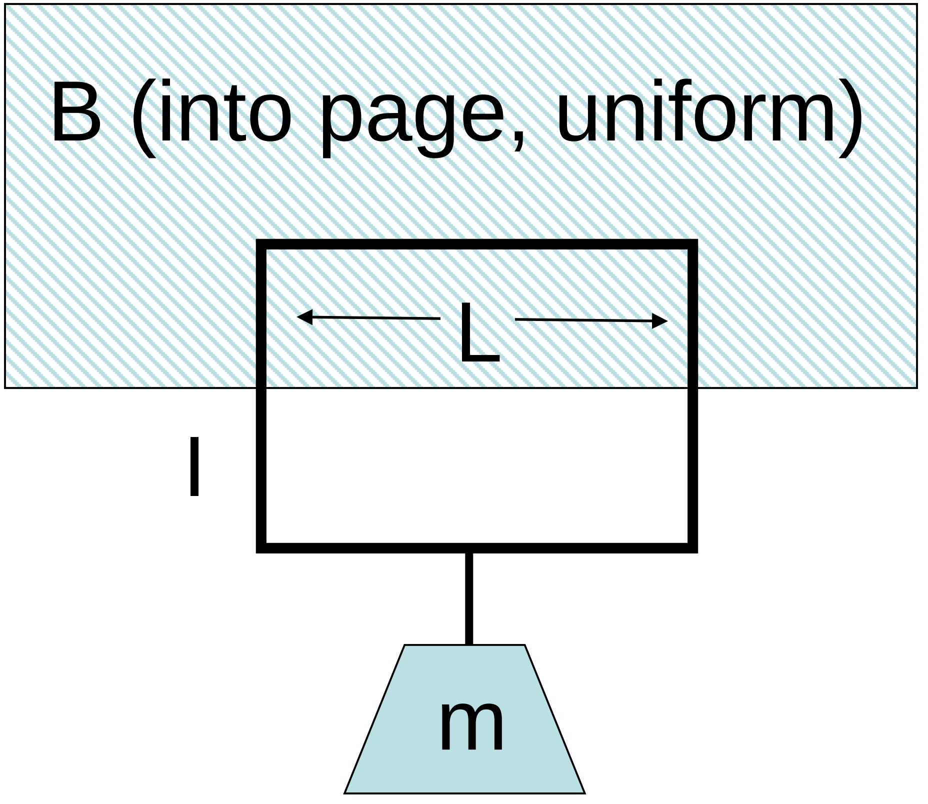
B) Straight line

C) Circular motion, ⊥ page.
(plane of circle is ⊥ **B**)

D) Circular motion ⊥ page.
(plane of circle at angle θ w.r.t. **B**)

E) Impossible. **v** should always be ⊥ **B**

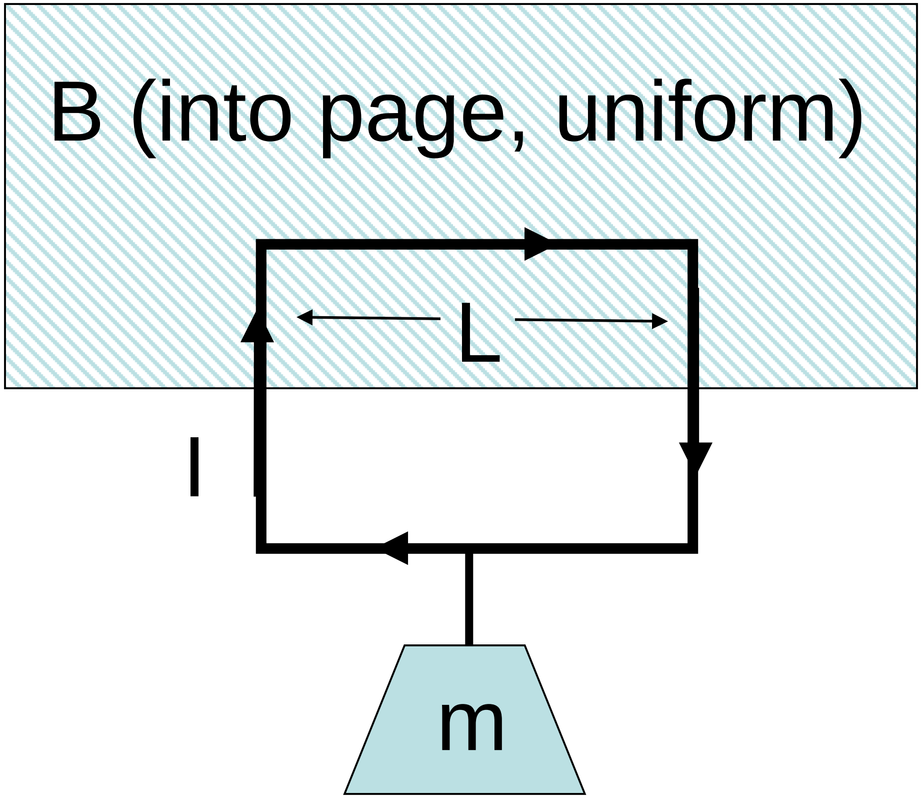
A wire loop in a B field has a current I.
The B-field is localized, it's only in the hatched region, roughly zero elsewhere.
Which way is I flowing to hold the mass in place?



A) CW
B) CCW
C) You cannot "levitate" like this!

A wire loop in a B field has a current I.
The mass is "levitated" by the magnetic force $F_{mag}=ILB$. If you increase the current , does the magnetic force do positive work on the mass?

A) Yes
B) No

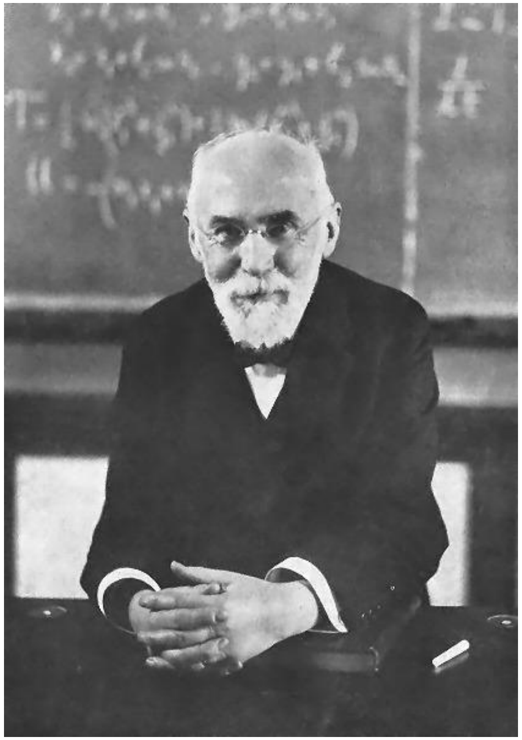


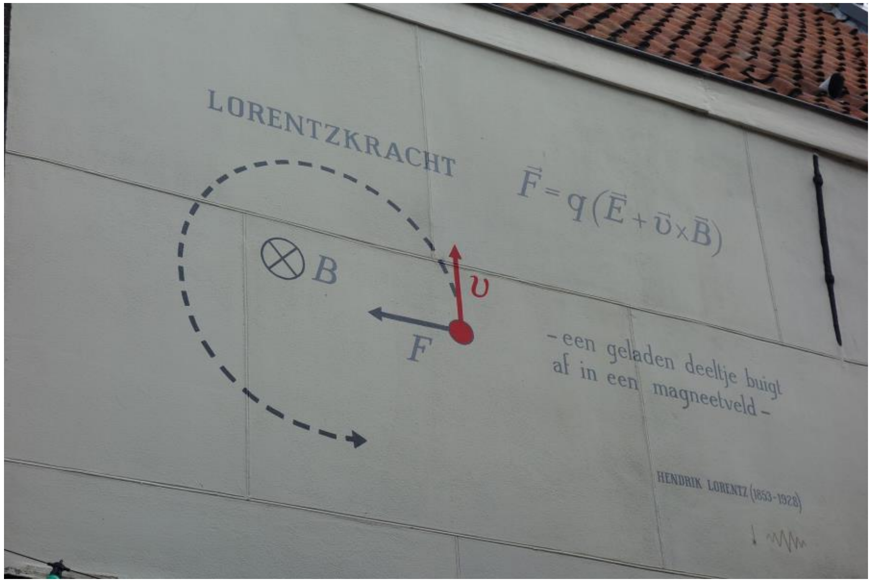
Hendrik Lorentz

1853 – 1928

Dutch physicist who shared the 1902 Nobel Prize in Physics for the discovery and theoretical explanation of the Zeeman effect.

Derived the transformation equations of special relativity and frame invariance of EM equations. Predicted length contraction, time dilation, mass increase with speed (before Einstein!)





Regarded by all theoretical physicists as the world's leading spirit at the time

Einstein: “*For me personally he meant more than all the others I have met on my life's journey.”*

CURRENTS & CHARGE CONTINUITY

5.5

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

5.7

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 !

5.6 Current I flows down a wire (length L) with a square cross section (side *a*) If it is uniformly distributed over the outer surfaces only, what is the magnitude of the surface current density *K*?

A) $K = I/a^2$

B) $K = I/a$

C) $K = I/(4a)$

D) $K = aI$

E) None of the above

5.8 A "ribbon" (width a) of surface current flows (with surface current density K)

Right next to it is a second identical ribbon of current.

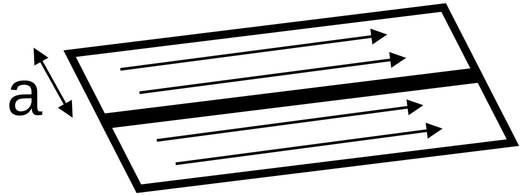
Viewed collectively, what is the new total surface current density?

A) K

B) 2K

C) K/2

D) Something else



ERK5-1

A "ribbon" (width a) with uniform surface current density K passes through a uniform magnetic field $\mathbf{B}_{ext}$. Only the length b along the ribbon is in the field. What is the magnitude of the force on the ribbon?

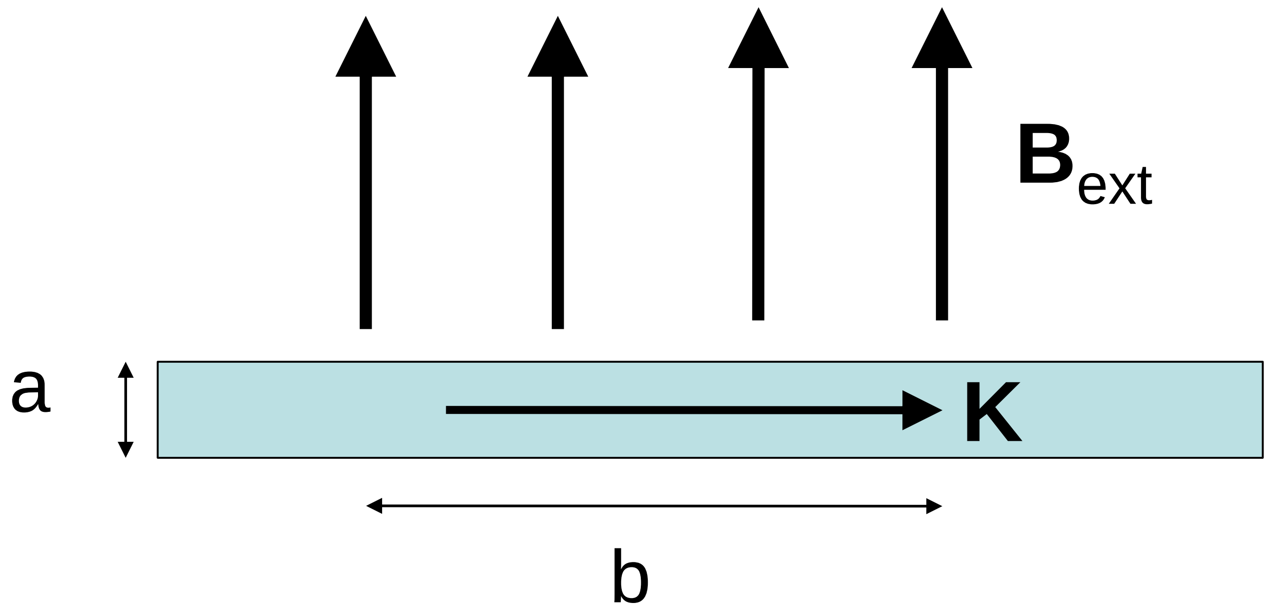
A) KB

B) aKB

C) abKB

D) bKB/a

E) KB/(ab)



5.10 Which of the following is a statement of charge conservation?

A) $\frac{\partial \rho}{\partial t} = -\nabla \vec{\mathbf{J}}$

B) $\frac{\partial \rho}{\partial t} = -\nabla \cdot \vec{\mathbf{J}}$

C) $\frac{\partial \rho}{\partial t} = -\iiint (\nabla \cdot \vec{\mathbf{J}})\, d\tau$

D) $\frac{\partial \rho}{\partial t} = -\oiint \vec{\mathbf{J}} \cdot d\vec{\mathbf{A}}$

E) Not sure