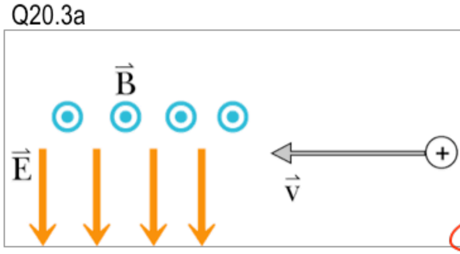
Mar 20

Get clickers and whiteboards

Next week office hours canceled. Email me questions.

Last midterm is April 1 (no fooling).
Practice exam is on website.

Q20.3a

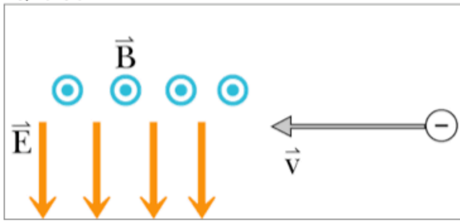


Forces on the moving POSITIVE charge:

	F_{elec}	F_{mag}
~~A~~	~~UP~~	~~UP~~
B	DOWN	DOWN
~~C~~	~~UP~~	~~DOWN~~
D	DOWN	UP

$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$ ← Lorentz force

Q20.3b

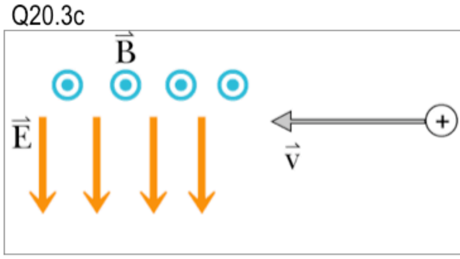


Forces on the moving NEGATIVE charge:

	Felec	**F**mag
A	UP	UP
~~B~~	~~DOWN~~	~~DOWN~~
C	UP	DOWN
~~D~~	~~DOWN~~	~~UP~~

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

Q20.3c



Particle of charge +q travels in a straight line at constant speed. Which is true?

A. $qE = qvB$
B. $E = B$
C. $E = q / (vB)$
D. $qE = qB$

$$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B}$$

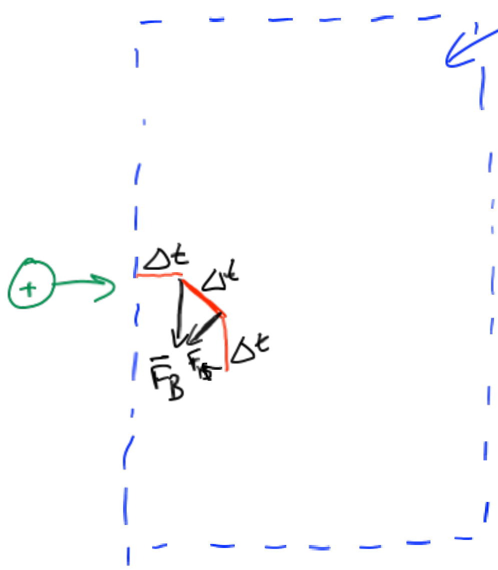
$$|q\vec{E}| = |q\vec{v}\times\vec{B}|$$

Velocity selector

$$E = |\vec{v}\times\vec{B}|$$

$$\hookrightarrow vB = E$$

Ponderable: You spin me right round



Region of space where $\vec{B}$ is out of page $\odot$, const

$\Delta \vec{p} = \vec{F} \Delta t$

$\vec{F}_B \perp$ to the momentum

A charge particle will travel in circle in region of const magnetic field if $\vec{p}_\perp \perp \vec{B}$

5. After being in the magnetic field for a short time Δt, how has the magnitude of the proton's momentum changed?

A. It has increased
B. It has decreased
C. It has not changed

Magnetic forces only change the direction of proton

Magnetic forces do no work   KE, PE are unchanged

$$W = \int \vec{F} \cdot d\vec{r} = 0$$

What is radius of Circle?   (in const $\vec{B}$)

$$\frac{d\vec{p}}{dt} = \vec{F}_{net}$$

Hint: $\left|\frac{d\vec{p}_\perp}{dt}\right| = |\vec{p}|\, v/R$

non rel. $p = mv$

$$\left|\frac{d\vec{p}_\perp}{dt}\right| = \frac{|\vec{p}|\,v}{R} = |q\,\vec{v} \times \vec{B}| = |q|\,v B \sin\theta \Rightarrow \frac{|\vec{p}|}{R} = |q| B \sin\theta$$

if $\vec{v} \perp \vec{B} \Rightarrow \sin\theta = \sin 90 = 1 \Rightarrow mv = R|q|B$

Demo: VPython Helix

Ponderable: Force on a current-carrying wire

+ charge cores not moving $\Rightarrow$ no force

− charges feel force into page

total of $n A \Delta l$ charge carriers in wire (Area A, length Δl)

But $n A q v = I$

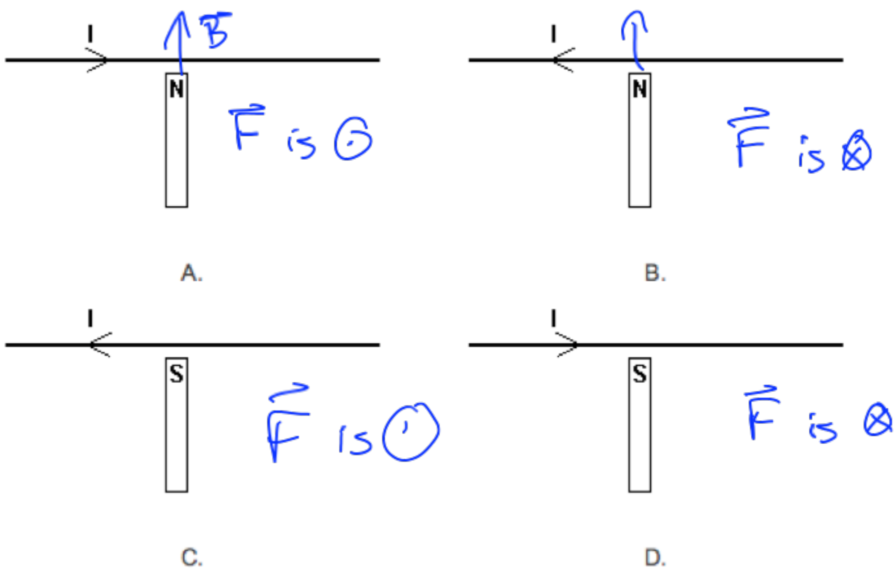
$\vec{F}_{mag} = n A \Delta l \, q \, \vec{v} \times \vec{B}$

$= I \, \vec{\Delta l} \times \vec{B}$

$\vec{\Delta l}$ is in direction as $\vec{E}$ in wire, I

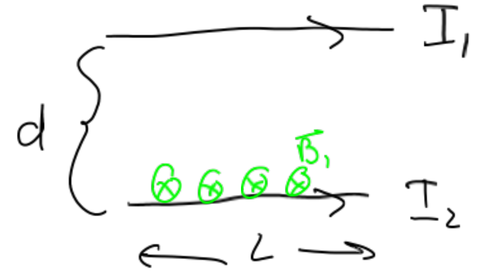
$\vec{F} = I \Delta \vec{\ell} \times \vec{B}$

Tangible: Swing Low…



Sweet Chariot

Ponderable: Let me spring this on you



What is magnitude of $\vec{F}_2$ due to 1?

First need $\vec{B}$ at 2

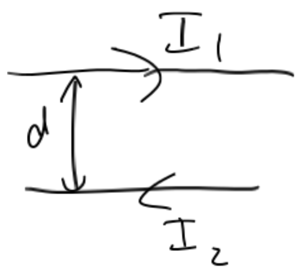
$$|\vec{B}_1| = \frac{\mu_0}{4\pi}\frac{2I_1}{d} \qquad d \ll L$$

Now force on 2

$$|\vec{F}_{21}| = I_2 \Delta\vec{l}\times\vec{B}_1 = I_2 L B_1 \overset{1}{\cancel{\sin\theta}}$$

$$|\vec{F}_{21}| = \frac{\mu_0}{4\pi}\frac{2I_1I_2L}{d}$$

direction? (on 2) up ⇒ wires are pulled together

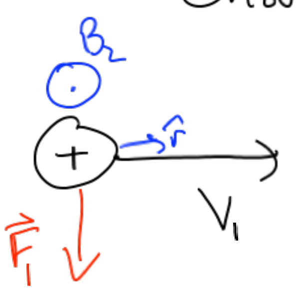


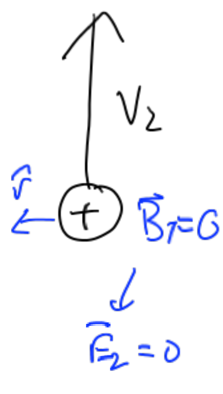
$$\left|\vec{F}_{21}\right| = \frac{\mu_0}{4\pi}\,\frac{2 I_1 I_2 L}{d}$$

direction $\Rightarrow$ wires pushed apart

Ponderable: Push me, will you?

Shove It





$$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2}$$

$$\vec{F}_1 = q_1 \vec{V}_1 \times \vec{B}_2$$

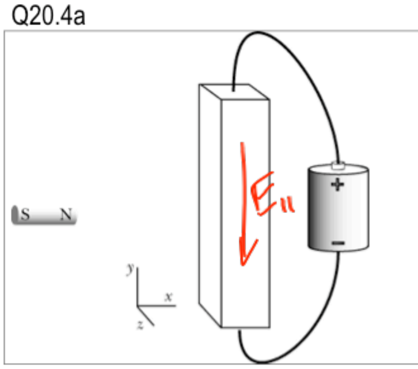
$$\Delta\vec{p} = \vec{F}_{net}\,\Delta t$$

$$\vec{F}_1 \overset{?}{=} -\vec{F}_2 \quad \text{no}$$

Newton's 3rd does not hold for mag forces

Ponderable: Hall Effect

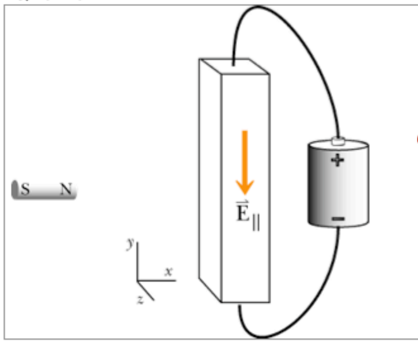
Q20.4a



Direction of $\vec{E}_{||}$ inside bar?

A. +y
B. –y
C. +z
D. –z
E. none (zero magnitude)

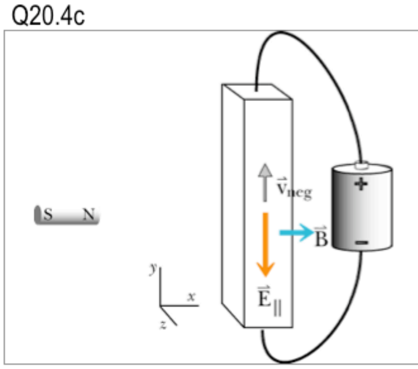
Q20.4b



If mobile charges are negative, direction of motion inside bar?

A. +y
B. –y
C. +z
D. –z
E. none (zero magnitude)

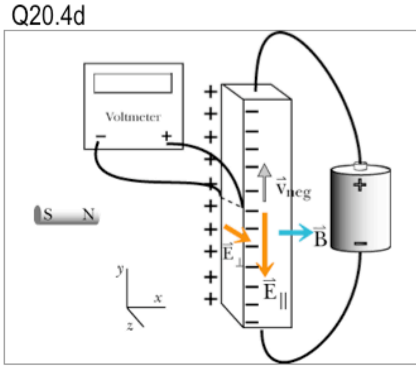
Q20.4c



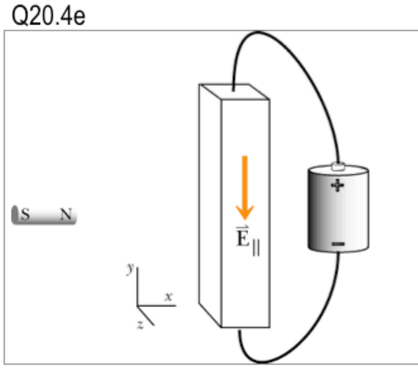
Direction of $\vec{F}_{mag}$ on moving negative charge?

A. +y
B. –y
C. +z
D. –z
E. none (zero magnitude)

Q20.4d

	If mobile charges are negative, sign of voltmeter reading? (Voltmeter reads positive if + lead is connected to higher potential location) A. positive B. negative C. zero

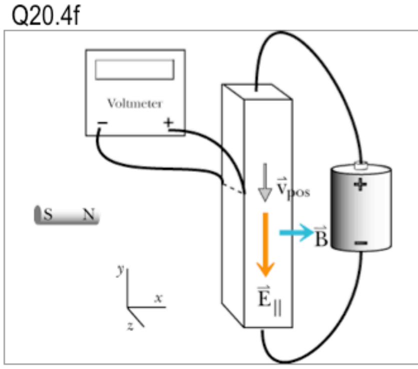
Q20.4e



If mobile charges are positive, direction of motion inside bar?

A. +y
B. –y
C. +z
D. –z
E. none (zero magnitude)

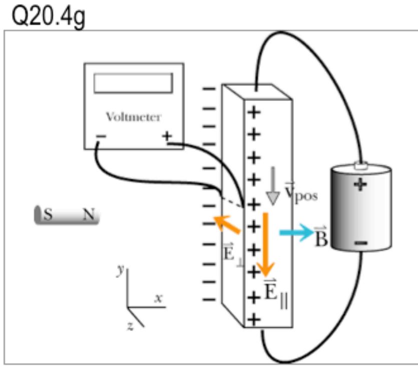
Q20.4f



If mobile charges are positive, direction of magnetic force?

A. +y
B. –y
C. +z
D. –z
E. none (zero magnitude)

Q20.4g

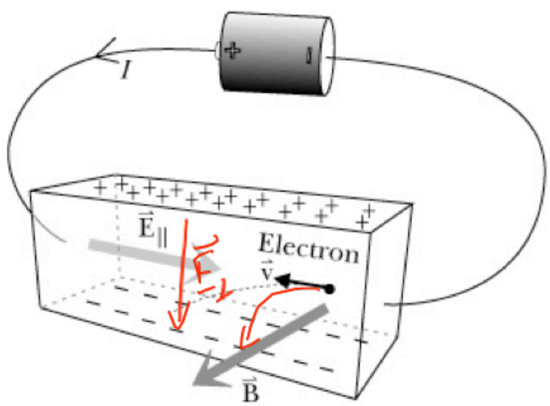


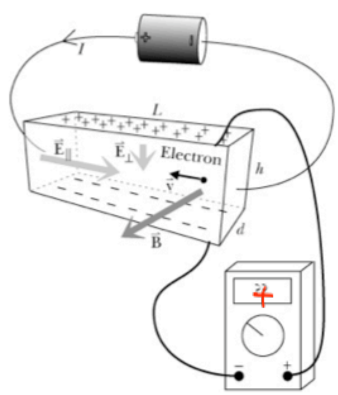
If mobile charges are positive, sign of voltmeter reading?
(Voltmeter reads positive if + lead is connected to higher potential location)

A. positive
B. negative
C. zero

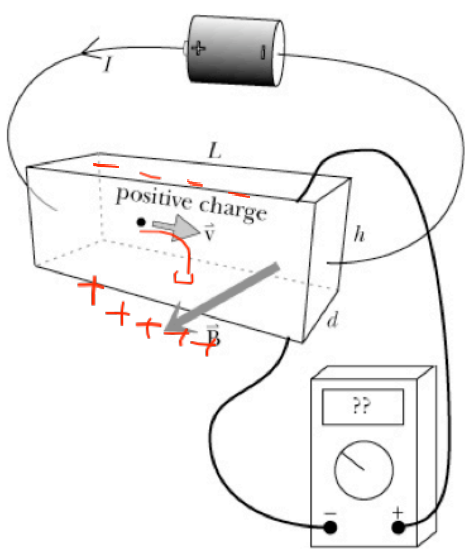
Used to see sign of charges

Hall Effect





reads +



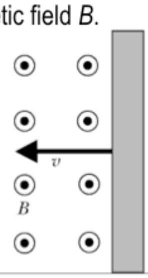
There are materials which have + charge carriers

vred −

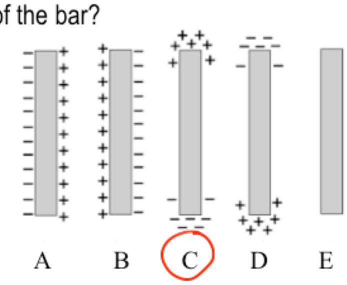
Ponderable: Motional emf

Q20.5a

A neutral copper bar is dragged at speed *v* through a region with magnetic field *B*.

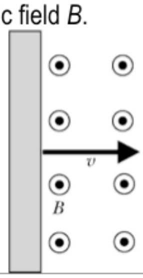


Which diagram best shows the state of the bar?

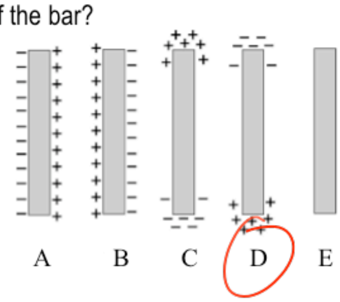


Q20.5b

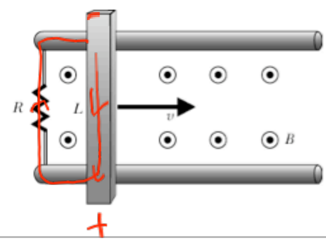
A neutral copper bar is dragged at speed v through a region with magnetic field B.



Which diagram best shows the state of the bar?



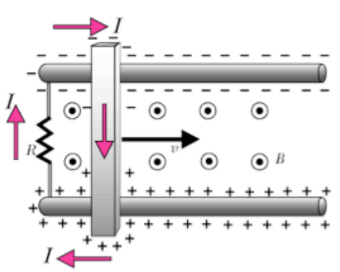
Q20.5c



Which direction will conventional current flow?

A) Clockwise
B) Counter-clockwise
C) No current

Q20.5e



Current flows as shown. Is there a magnetic force on the entire bar?

A) F_{mag} on bar is upward
B) F_{mag} on bar is downward
C) F_{mag} on bar is to the right
D) F_{mag} on bar is to the left
E) F_{mag} on bar = 0

$$\vec{F} = I\, \vec{\Delta l} \times \vec{B}$$