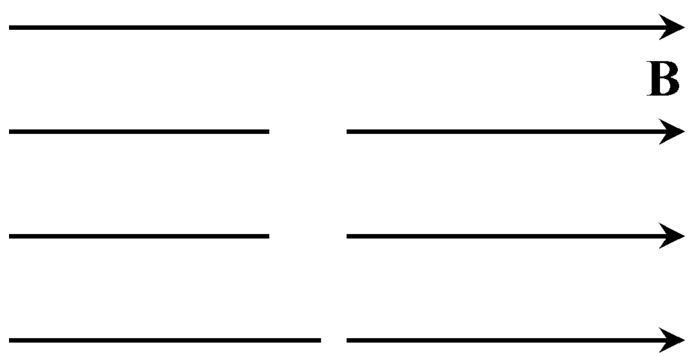
RUTGERS
UNIVERSITY | NEWARK

Week 10 (3/23 – 3/27)	**Due**	**Topics & Reading**
Large Room Meeting I		Chapter 20.1 – 20.3
Small Room Meeting	Homework #7: Questions: 19.6, 19.7, 19.26 Problems: 19.31, 19.33, 19.34, 19.38	
Large Room Meeting II		Chapter 20.3 – 20.6

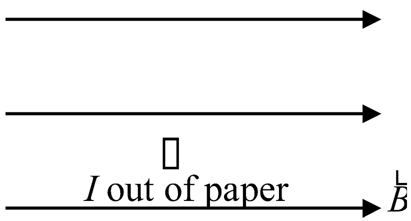
20.3.5 – Represent and Reason

A current-carrying wire shaped into a rectangular loop is placed in an external $\vec{B}$-field as shown below. The loop is positions so that it is perpendicular to the screen. Work with the members of your breakout group to determine the direction of the force the $\vec{B}$-field exerts on each side of the wire loop.

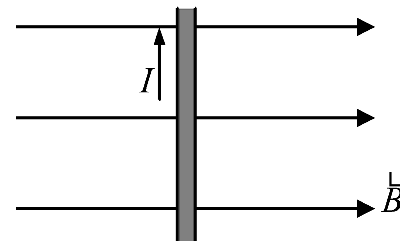


20.3.5 – Represent and Reason

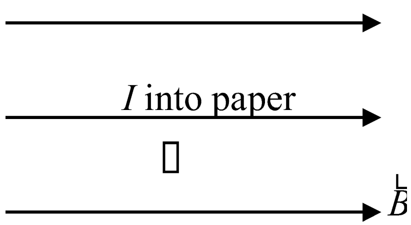
Side 1



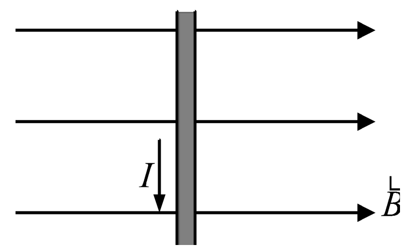
Side 2



Side 3



Side 4



Clicker Question #1

Does the external $\vec{B}$-field exert a non-zero magnetic force on the entire loop?

a) Yes, it points into the page

b) Yes, it points out of the page

c) Yes, it points up

d) Yes, it points down

e) No, the force exerted on the entire loop is zero

Clicker Question #2

Does the external $\vec{B}$-field exert a non-zero magnetic torque on the entire loop?

a) Yes, it exerts a torque that would cause side 4 to rotate to the left and side 2 to rotate to the right.

b) Yes, it exerts a torque that would cause side 4 to rotate to the right and side 2 to rotate to the left.

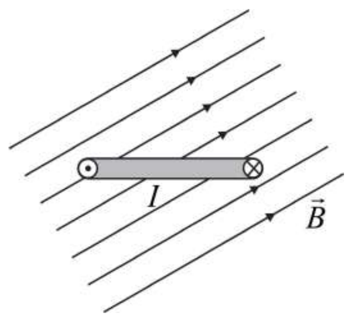
c) No, the torque exerted on the entire loop is zero.

20.3.7 – Represent and Reason

Work with your group to decide whether the magnetic field exerts a nonzero torque on the current loop in each case pictured below. If so, and if the loop is initially at rest, which way would the magnetic torque cause the loop to start turning? For each case, draw in the forces on two opposite sides of the loop and show the direction of the net torque on your whiteboard.

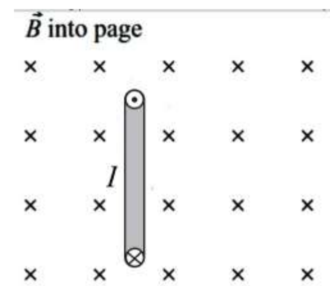
20.3.7 – Represent and Reason

a)



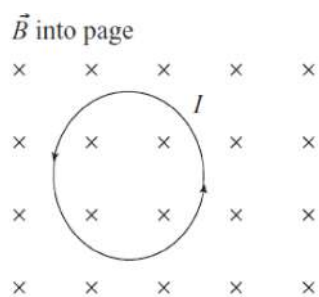
*This is a loop coming perpendicularly out of the page

b)

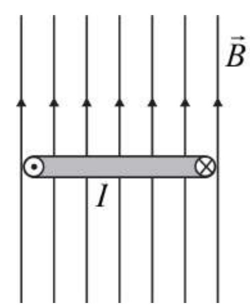


*This is a loop coming perpendicularly out of the page

c)



d)

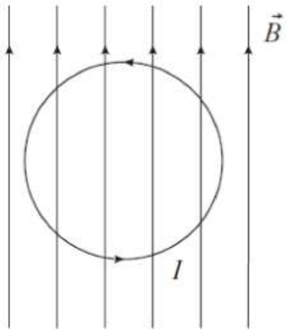


*This is a loop coming perpendicularly out of the page

RUTGERS

20.3.7 – Represent and Reason

e)



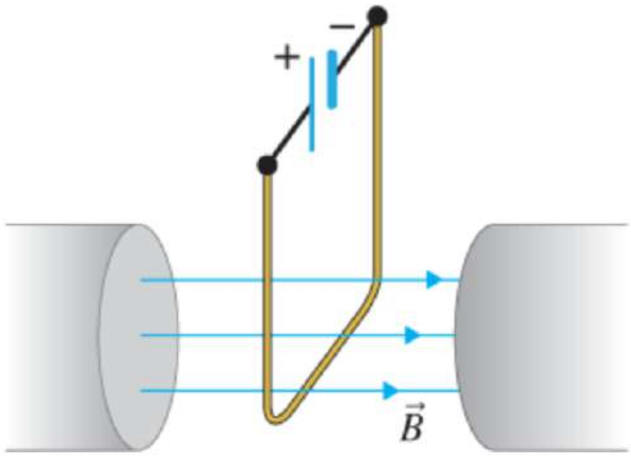
Clicker Question #3

A U-shaped wire with a current in it hangs with the bottom of the U between the poles of an electromagnet. When the magnitude of the $\vec{B}$-field in the magnet is increased, does the U swing to the right or to the left, or does it remain at rest? Be ready to explain your answer.

a) It swings to the right

b) It swings to the left

c) It remains at rest



20.3.9 – Represent and Reason

Two wires are parallel to each other. Wire 1 has electric current going into the page and wire 2 has electric current coming out of the page. We want to know how these two wires interact with one another.

1 2

20.3.9 – Represent and Reason

Draw the lines of the $\vec{B}_1$-field produced by wire 1. Be sure to include one line passing through wire 2.

Use this $\vec{B}_1$-field line to draw the $\vec{B}_1$-field vector at the location of wire 2.

Use the right-hand rule to indicate the direction of the force wire 1 exerts on wire 2.

20.3.9 – Represent and Reason

Draw the lines of the $\vec{B}_2$-field produced by wire 2. Be sure to include one line passing through wire 1.

Use this $\vec{B}_2$-field line to draw the $\vec{B}_2$-field vector at the location of wire 1.

Use the right-hand rule to indicate the direction of the force wire 2 exerts on wire 1.

1 2

20.3.9 – Represent and Reason

Two wires are parallel to each other. Wire 1 has electric current going into the page and wire 2 has electric current coming out of the page. How do these wires interact with one another?

Clicker Question #4

Two wires are parallel to each other. Both wires will have electric current coming out of the page when we connect them to a battery. What will happen to these wires when we connect the battery?

a) They will attract one another

b) They will repel one another

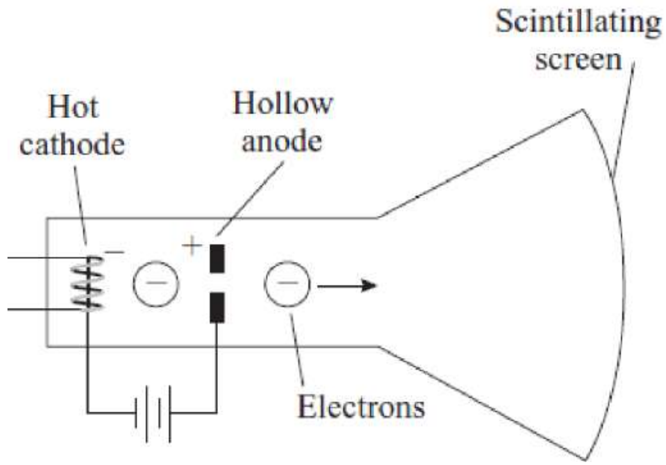
c) The will both move to the left

d) They will both move to the right

e) Nothing will happen

20.4.1 – Observational Experiment

A cathode-ray tube (CRT) is part of a traditional television set or of an oscilloscope. Electrons "evaporate" from a hot filament called the cathode. They accelerate across a potential difference and then move at high speed toward a scintillating screen. The electrons form a bright spot on the screen at the point at which they hit it. Watch what happens when we bring a magnet near the CRT.



20.4.1 – Observational Experiment

Describe what you observed in the video.

Come up with an explanation for your observations.

20.4.1 – Observational Experiment

- With your classmates, invent a rule which describes the direction the of the force an external $\vec{B}$-field exerts on a moving electron relative to the direction of its velocity $\vec{v}$.

20.4.1 – Observational Experiment

Your friend says that the beam of electrons is deflected by the magnet because the electrons are charged particles and the magnet is made of iron. How can you convince your friend that she is mistaken?

Time for Telling

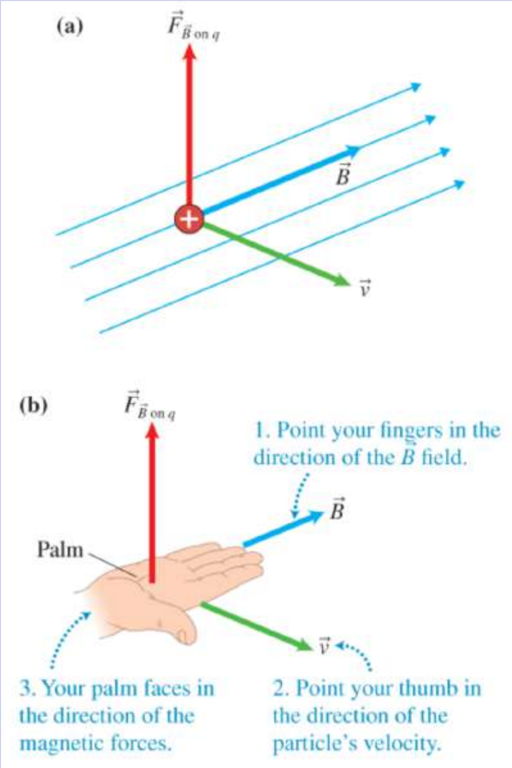
To determine the force an external $\vec{B}$-field exerts on a moving charged object, we use our ***right-hand rule***:

Version #1:

- Place your hand so you fingers point in the direction of $\vec{B}$ and your thumb points in the direction of $\vec{v}$.
- Your palm will point in the direction of $\vec{F}$.

Version #2:

- Point your fingers in the direction of $\vec{v}$ so that when you rotate them 90^o they point in the direction of $\vec{B}$.
- Your thumb will point in the direction of $\vec{F}$.

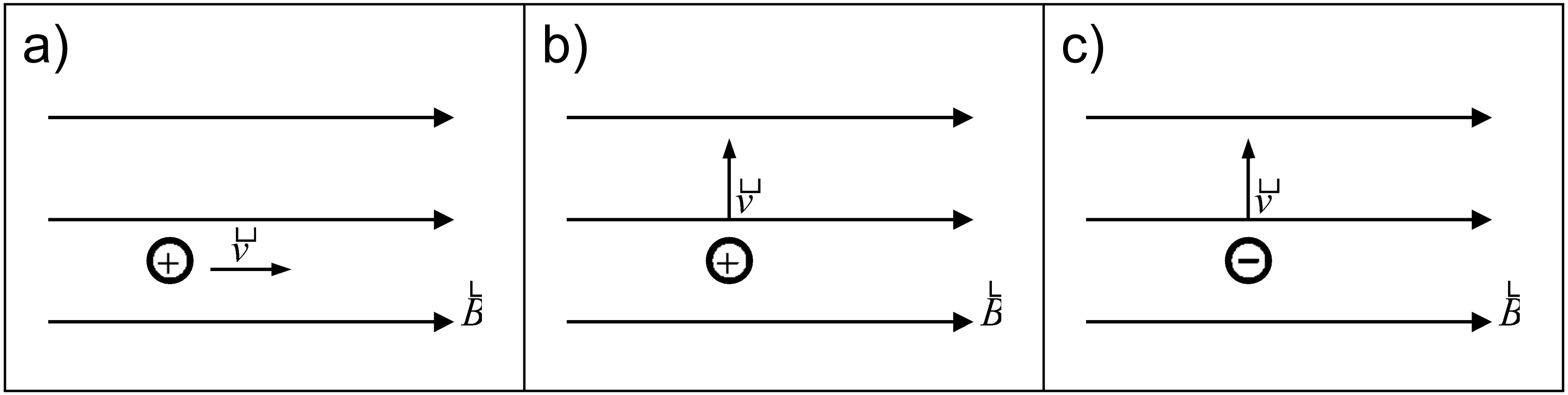


Read and Interrogate

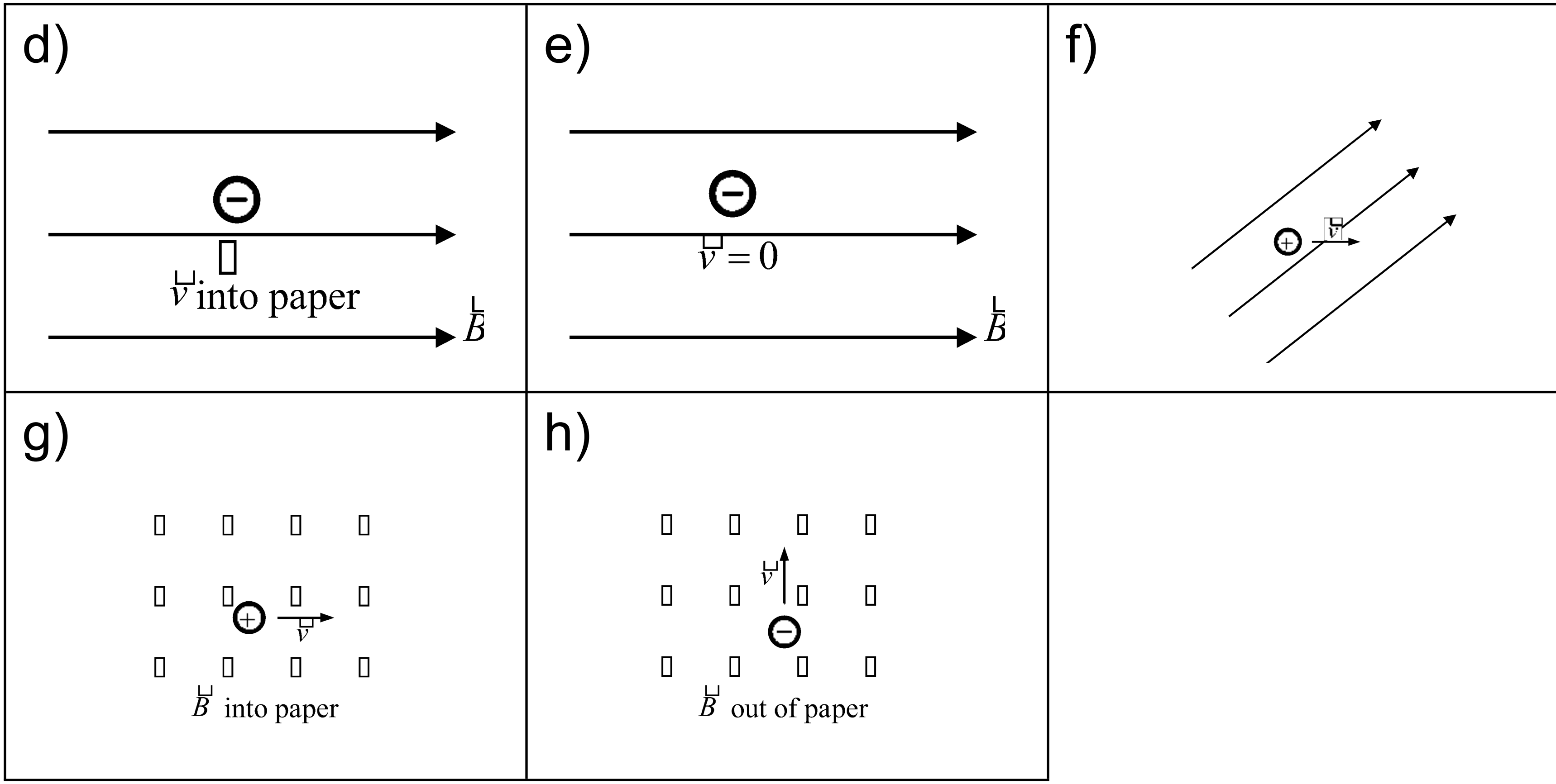
- See the “How to Read the Textbook” document.
- Read and interrogate pgs. 628-630 in the textbook (make sure you follow the steps in derivation on page 629 in the textbook).

20.4.2 – Represent and Reason

For each situation below, decide whether a nonzero magnetic force is exerted on the moving electric charge (test object). If the force is not zero, draw direction of the magnetic force on the figures that follow.



20.4.2 – Represent and Reason



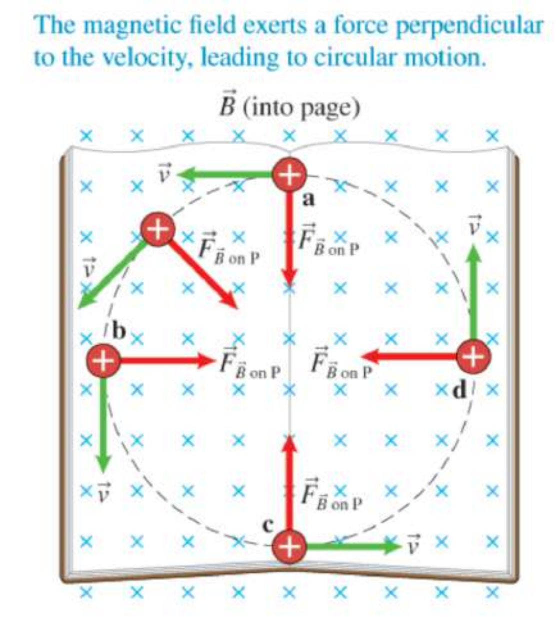
Time for Telling

The magnitude of the force exerted by an external $\vec{B}$-field on…

Because the force exerted on a moving charge is a cross-product including its velocity, the force will always be perpendicular to the velocity of the object.

Time for Telling

Because the force exerted on a moving charge is a cross-product including its velocity, the force will always be perpendicular to the velocity of the object. This means moving charged objects in external magnetic fields will always* move in circles.



Read and Interrogate

- See the “How to Read the Textbook” document.
- Read and interrogate pgs. 630-631 in the textbook.

Magnetic Field Created a Straight Wire

- We've seen the shape of the $\vec{B}$-field created by a straight current-carrying wire, but what about its magnitude?

There are two things we can vary: the current through the wire and our distance from the wire. The following data were obtained by varying each. Identify patterns from these data.

I (A)	1.0	2.0	3.0	1.0	1.0	1.0
r (m)	0.2	0.2	0.2	0.4	0.8	0.1
	1.00	2.00	3.00	0.50	0.25	2.00

Clicker Question #5

Which of the following best represents the relationship between the magnitude of the $\vec{B}$-field created by a straight current-carrying wire and the current running through the wire?

a) $B \propto \frac{1}{I^2}$

b) $B \propto \frac{1}{I}$

c) $B \propto I$

d) $B \propto I^2$

Clicker Question #6

Which of the following best represents the relationship between the magnitude of the $\vec{B}$-field created by a straight current-carrying wire at a specific point and the distance r between that point and the wire?

a) $B \propto \frac{1}{r^2}$

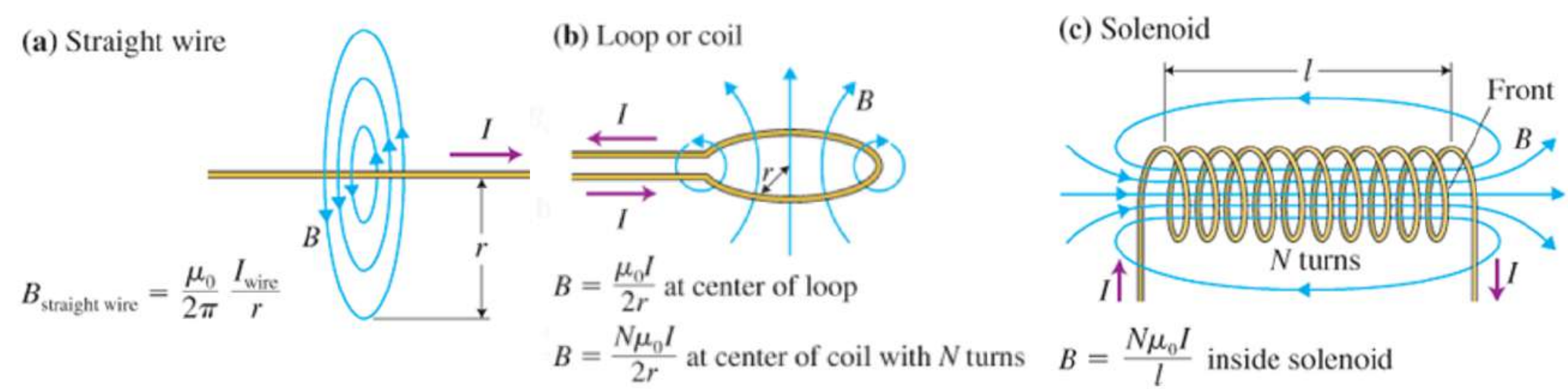
b) $B \propto \frac{1}{r}$

c) $B \propto r$

d) $B \propto r^2$

Time for Telling

- Magnitude of $\vec{B}$-field created by current-carrying wires in various orientations



Where $\mu_0 = 4\pi \times 10^{-7} T \cdot \mathrm{m/A}$ is a constant

20.6.2 – Apply what You've Learned

Your group wonders if you could support your clothesline by running an electric current through it while it resides in the $0.5 \times 10^{-4}\mathrm{T}$ magnetic field due to Earth. We'll assume that you are in Costa Rica near the equator, where the field is parallel to Earth's surface. The line is to be 10 m long. You estimate that, with the clothes attached, its mass is 2.0 kg. What direction should you orient the line and what electric current is needed to support the line? Finally, does this seem like a promising way to support a clothesline? Explain.

Read and Interrogate

- See the “How to Read the Textbook” document.
- Read and interrogate section 20.6 in the textbook. Make sure you can solve all example problems in it on your own.

Reflect on your Learning

Complete the **Week 10 LRM II Learning Survey** on Canvas by midnight tonight!