

Name: _____

Class: _____

Due Date: _____

51 – Magnetic Induction

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: Define *induction* and *induce*.
2. C: What are the units of *electromotive force* ε ?
3. C: True or false: *Electromotive force* ε is a force.
4. C: Define *flux*. Draw a picture.

5. C: *Magnetic flux* is defined as $\Phi = BA \cos \theta$. Define and give the units of each variable. Draw an image showing *magnetic flux* and label theta θ in the image. Also draw an image of magnetic flux when $\theta = 0^\circ$ and when $\theta = 90^\circ$.
6. E: Consider a single loop of wire which is 25.0 cm by 25.0 cm. Passing through this loop is a magnetic field which has a magnitude of 0.220 T.
- Assuming that the magnetic field is parallel to the normal of the loop, what will be the total magnetic flux passing through the loop?
 - Assuming that the magnetic field meets the normal to the loop at an angle of 35.0° , what will be the total magnetic flux passing through the loop?
 - Assuming that the magnetic field is perpendicular to the normal to the loop, what will be the total magnetic flux passing through the loop?

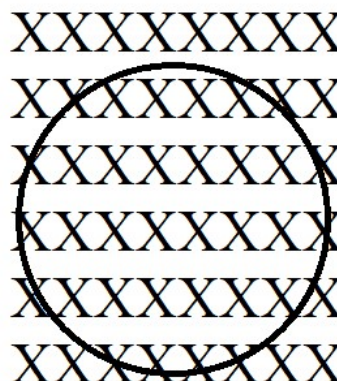
7. C: Use words to define and describe *Faraday's Law* $\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$. Draw a picture if you have to.

8. E: Consider a single loop of wire which encloses an area of 50.0 cm^2 . A magnetic field, which is parallel to the normal of this loop, initially has an intensity of 0.220 T . Over a time period of 0.200 s the magnetic field strength drops to zero.
- What will be the resulting emf in the loop?
 - What will be the emf in this circuit if the loop consists of $1,000$ turns rather than a single turn?
9. E: Consider a coil of wire which has $1,200$ turns, encloses an area of 18.0 cm^2 , and contains a magnetic field of 3.50 T oriented parallel to the normal to the loop. What will be the induced emf in this coil if the magnetic field drops to zero in 0.0167 s ?
- 10.C: The negative sign in *Faraday's Law* is known as *Lenz's Law*. What does it mean?

11.C: Use *Lenz's law* and the right hand rule to determine the direction of the induced current on the metal conducting wire.

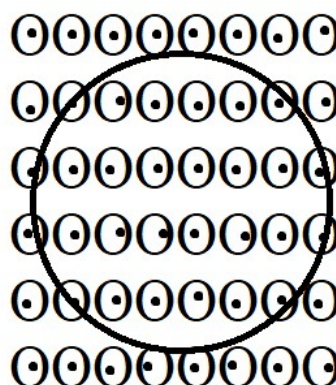
- a. There is a magnetic field which points into the page. The magnitude of the magnetic field is

- i. decreasing.
- ii. constant.
- iii. increasing.

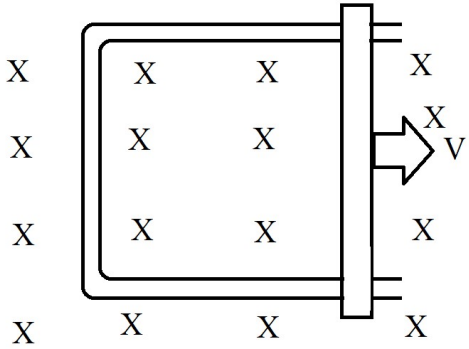
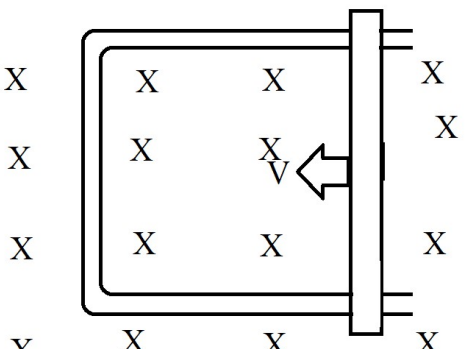


- b. There is a magnetic field which points out the page. The magnitude of the magnetic field is

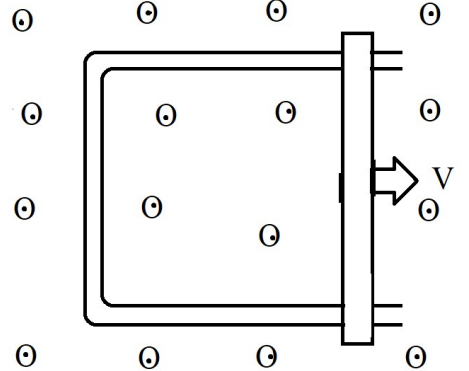
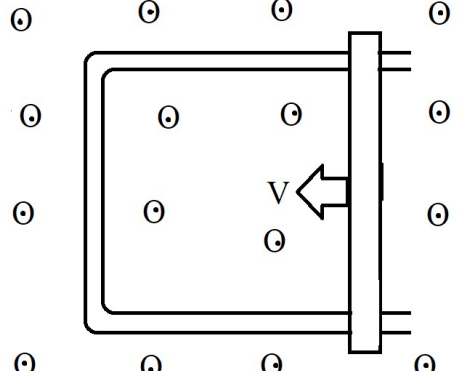
- i. decreasing.
- ii. constant.
- iii. increasing.



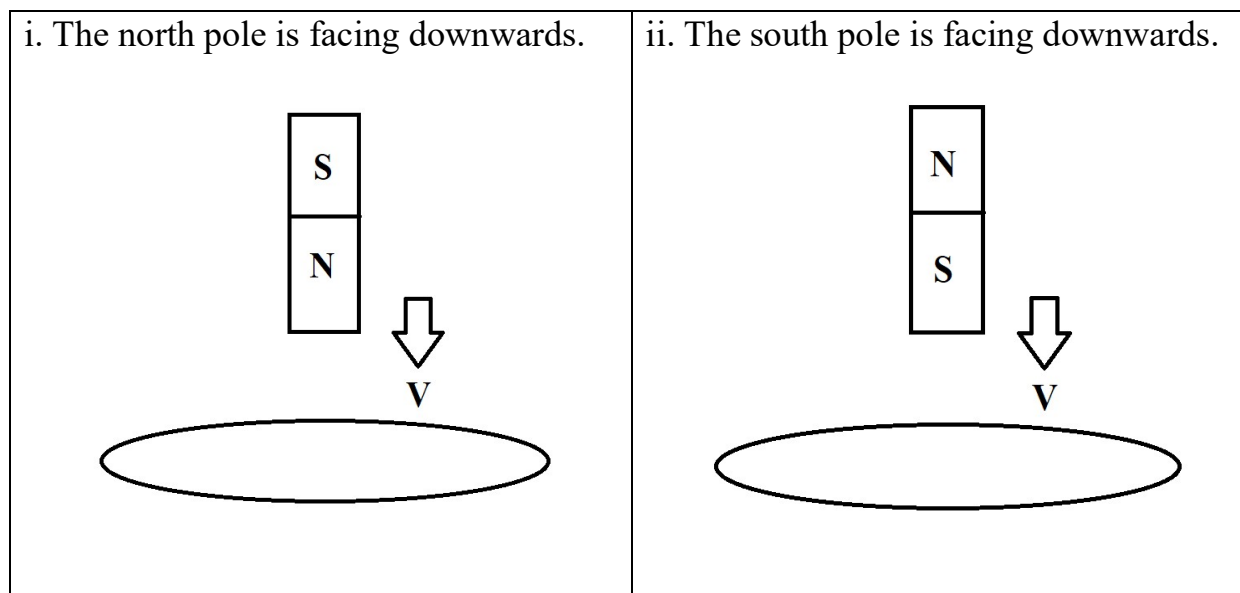
c. There is a constant magnetic field into the page. Which direction is the induced current?

<p>i. The area of the loop is increasing.</p> 	<p>ii. The area of the loop is decreasing.</p> 
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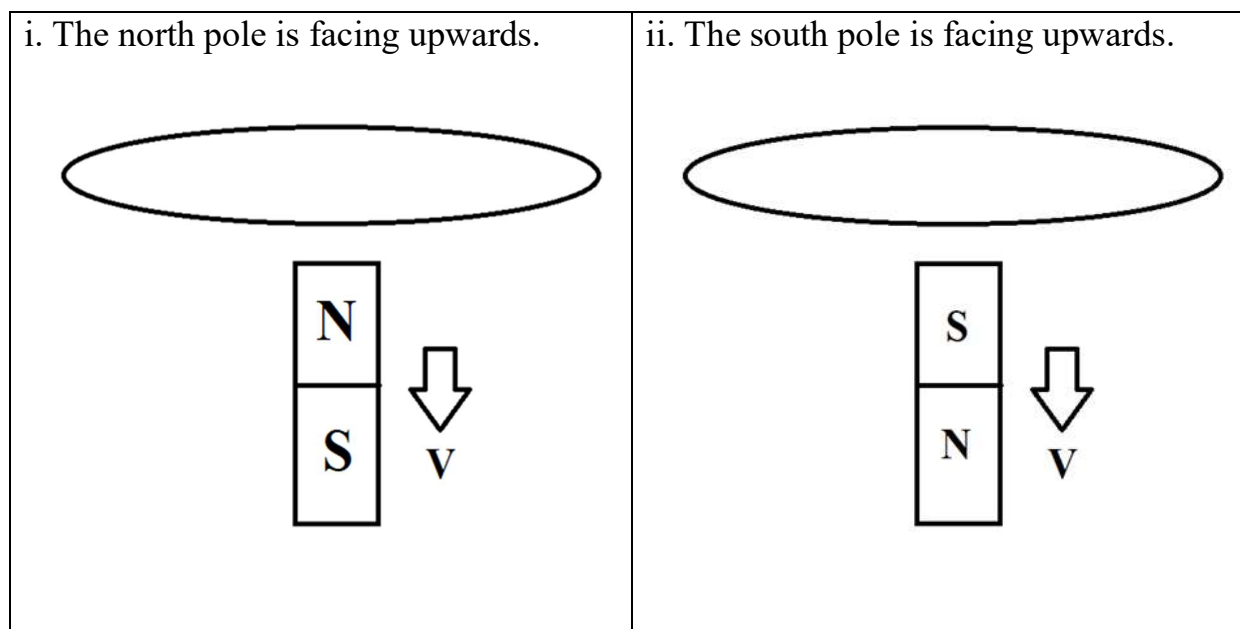
d. There is a constant magnetic field out of the page.

<p>i. The area of the loop is increasing.</p> 	<p>ii. The area of the loop is decreasing.</p> 
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- e. A magnet is falling down and entering a loop. Which direction is the induced current if we are looking downwards?

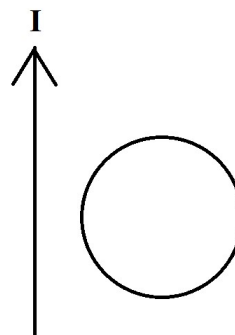


- f. A magnet is falling down and leaving a loop. Which direction is the induced current if we are looking downwards?



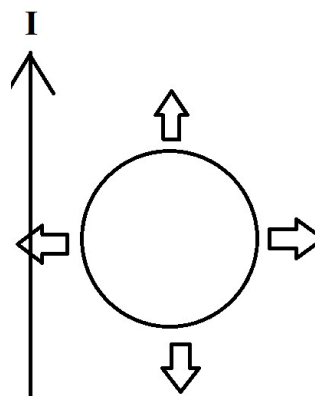
g. There is a current carrying straight wire. There is a circular wire next to it. The current in the straight wire is

- i. decreasing.
- ii. constant.
- iii. increasing.



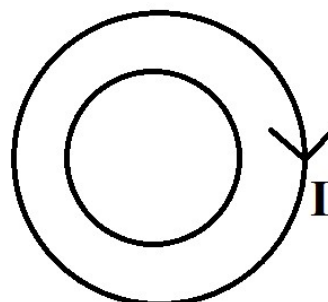
h. There is a current carrying straight wire. There is a circular wire next to it. The circular wire

- i. moves up parallel to the wire.
- ii. moves down parallel to the wire.
- iii. moves to the left perpendicular to the wire.
- iv. moves to the right perpendicular to the wire.



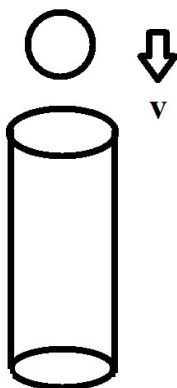
i. A small loop of wire is inside a larger loop of wire. The larger loop of wire has a constant current clockwise. What is the direction of the induced current of the smaller loop if the current of the larger loop is

- i. decreasing.
- ii. constant.
- iii. increasing.



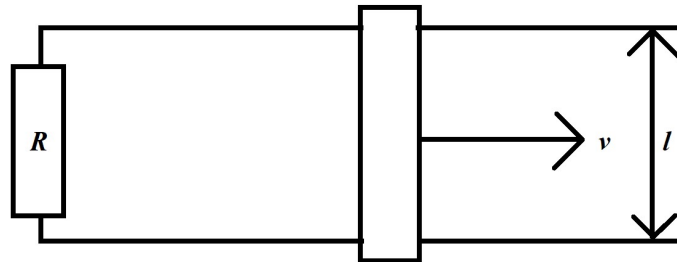
12.C: What is the phase difference between the magnetic flux and emf in Faraday's law?

13.C: What happens to a magnet if it falls down a hollow metal cylinder? Why?



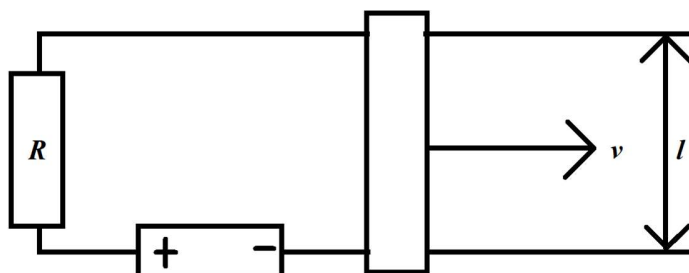
14.C: Describe the equation $\varepsilon = BvL$.

15.E: Two parallel rails are connected together at one end by a resistance of $20.0\ \Omega$. Across these two rails, which are $45.0\ \text{cm}$ apart, there lies a conducting metal bar. The magnetic field is uniform, has a strength of $2.20\ \text{T}$, and is directed into the page. A force is applied to the metal bar so as to push the bar to the right with a velocity of $8.40\ \text{m/s}$.



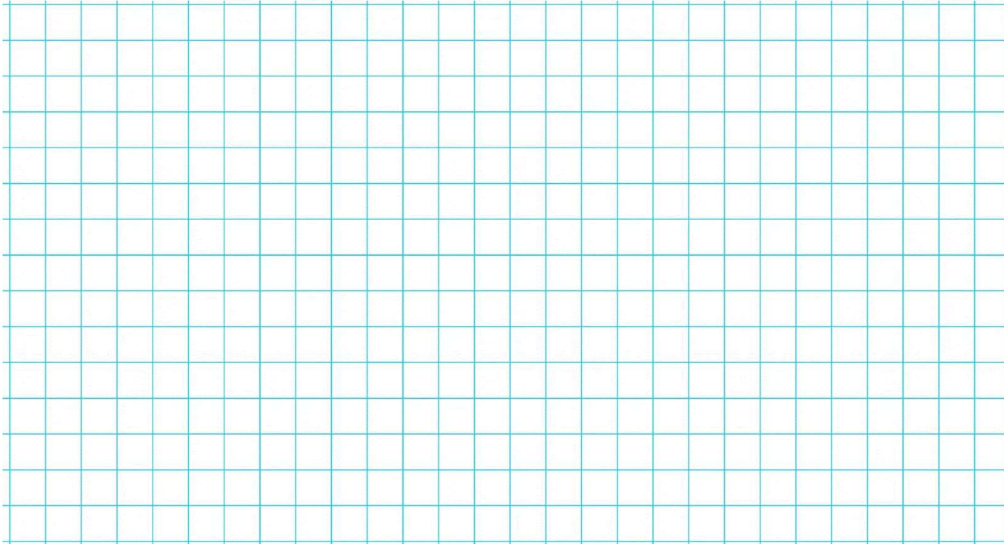
- What will be the resulting emf in this circuit?
- What will be the direction of the resulting conventional current flowing through this circuit?
- What will be the magnitude of the resulting current?
- At what rate is electrical energy being generated?
- How much force is being applied to this bar?
- At what rate is mechanical energy being consumed?

16.E: A battery, which has an emf of 6.00 V, is inserted into a circuit. The magnetic field has an intensity of 2.20 T and is directed into the paper. The resistance has a value of 20.0Ω and the two parallel horizontal rails are separated by a distance of 45.0 cm. A current of 0.200 A is measured to be flowing through the circuit.

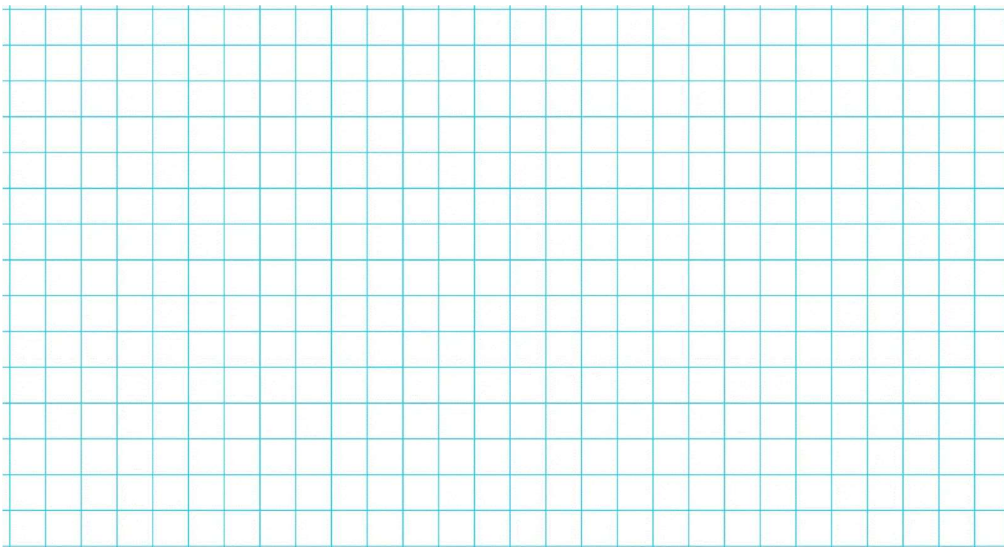


- What will be the resulting velocity of the bar?
- How much force is being applied to the bar by the magnetic field as it moves through the field?

17.C: Draw an *emf vs. time* graph of a conducting loop rotating in the presence of an external magnetic field with an angular frequency of ω and 2ω .



18.C: Draw a *power vs. time* graph of a conducting loop rotating in the presence of an external magnetic field with an angular frequency of ω and 2ω .



19.C: What is the phase difference between the current, emf, and power in Faraday's law?

20.C: Define *self-induction*.