Name: ________________________

Class: ________________________

Due Date: ________________________

D.4 Induction

Additional HL Understandings

- Magnetic flux Φ as given by $\Phi = BA\cos\theta$.
- A time-changing magnetic flux induces an emf ε as given by Faraday's law of induction $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$.
- A uniform magnetic field induces an emf in a straight conductor moving perpendicularly to it as given by $\varepsilon = Bvl$.
- The direction of induced emf is determined by Lenz's law and is a consequence of energy conservation.
- A uniform magnetic field induces a sinusoidal varying emf in a coil rotating within it.
- The effect on induced emf caused by changing the frequency of rotation.

Additional HL Equations

$\Phi = BA\cos\theta$

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$

$\varepsilon = BvL$

The solutions can be found on the YouTube channel Go Physics Go:

https://www.youtube.com/@gophysicsgo/playlists

Part 1: Use your favorite sources to answer the following questions

1. Define *induction* and *induce*.

2. What are the units of *electromotive force* ε?

3. True or false: *Electromotive force* ε is a force.

4. Define *flux*. Draw a picture.

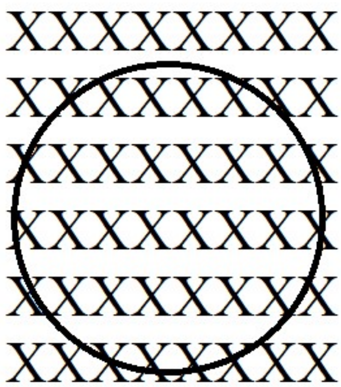
5. *Magnetic flux* is defined as $\Phi = BA\cos\theta$. Define and give the units of each variable. Draw an image showing *magnetic flux* and label theta θ in the image. Also draw an image of magnetic flux when $\theta = 0°$ and when $\theta = 90°$.

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

7. The negative sign in *Faraday's Law* is known as *Lenz's Law*. What does it mean?

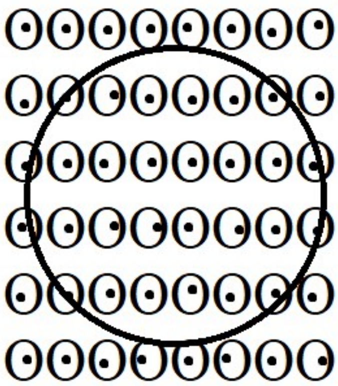
8. Use *Lenz's law* and the right hand rule to determine the direction of the induced current on the metal conducting wire.

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



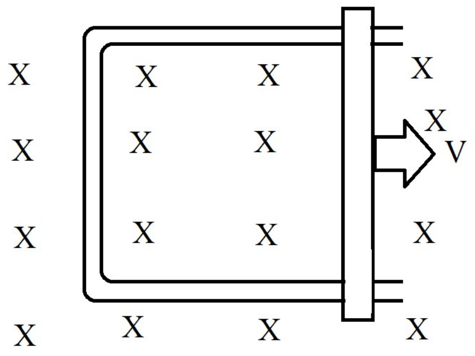
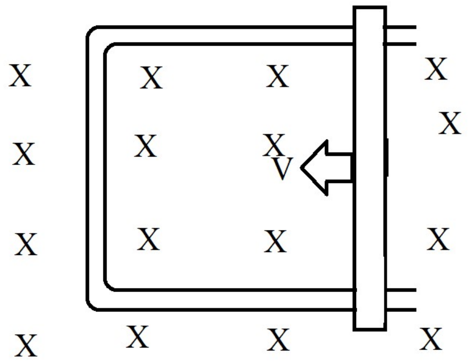
i. decreasing.
ii. constant.
iii. increasing.

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

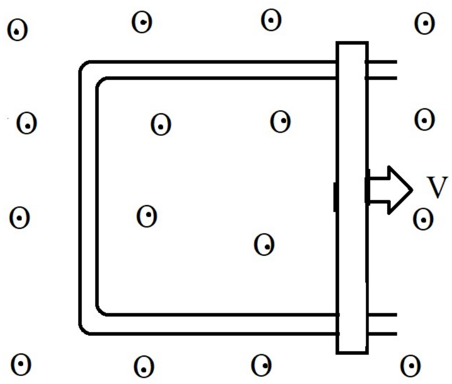
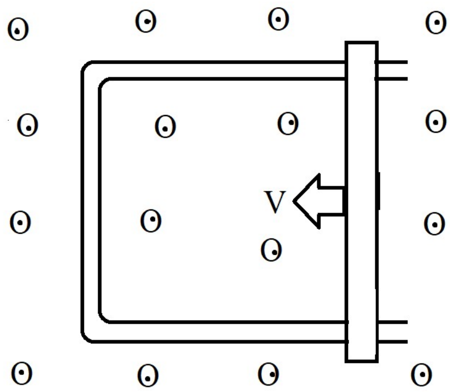


i. decreasing.
ii. constant.
iii. increasing.

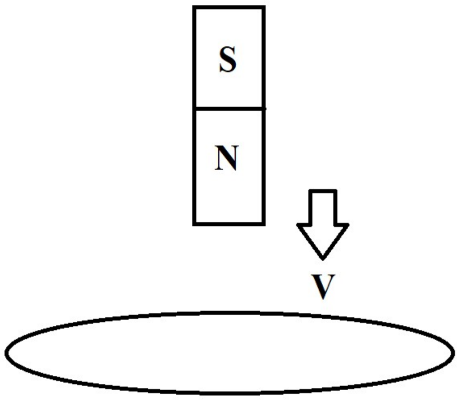
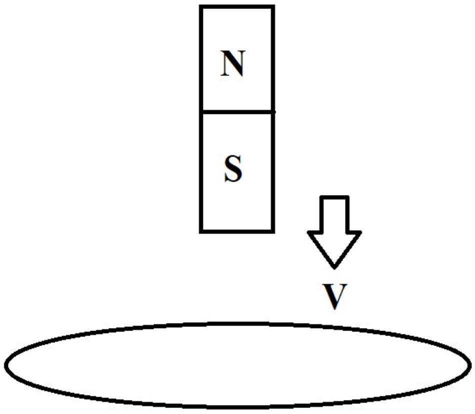
c. There is a constant magnetic field into the page. Which direction is the induced current?

i. The area of the loop is increasing.	ii. The area of the loop is decreasing.
	

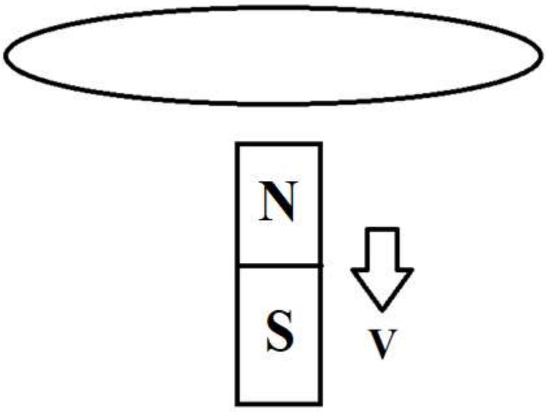
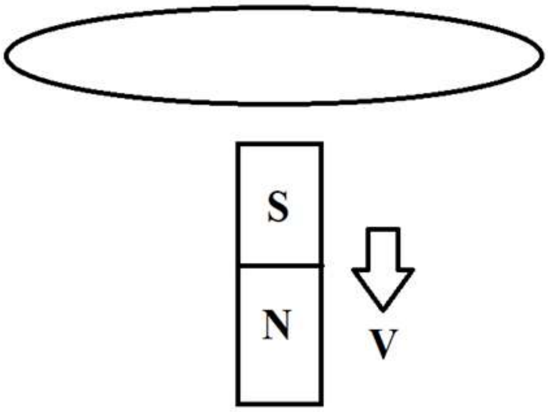
d. There is a constant magnetic field out of the page.

i. The area of the loop is increasing.	ii. The area of the loop is decreasing.
	

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

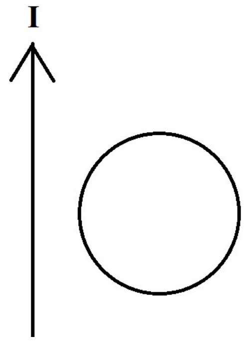
i. The north pole is facing downwards.	ii. The south pole is facing downwards.
	

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

i. The north pole is facing upwards.	ii. The south pole is facing upwards.
	

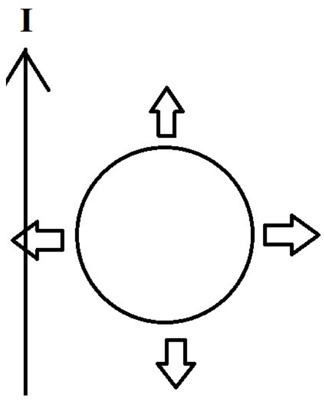
g. There is a current carrying straight wire. There is a circular wire next to it. The current in the straight wire is

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



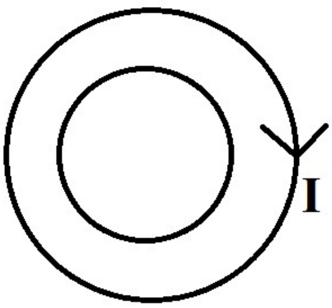
h. There is a current carrying straight wire. There is a circular wire next to it. The circular wire

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.



9. What happens to a magnet if it falls down a hollow metal cylinder? Why?

10. Describe the equation $\varepsilon = BvL$.

11. Draw an *emf vs. time* graph of a conducting loop rotating in the presence of an external magnetic field with a frequency of f and $2f$.

12. Define *self-induction*.