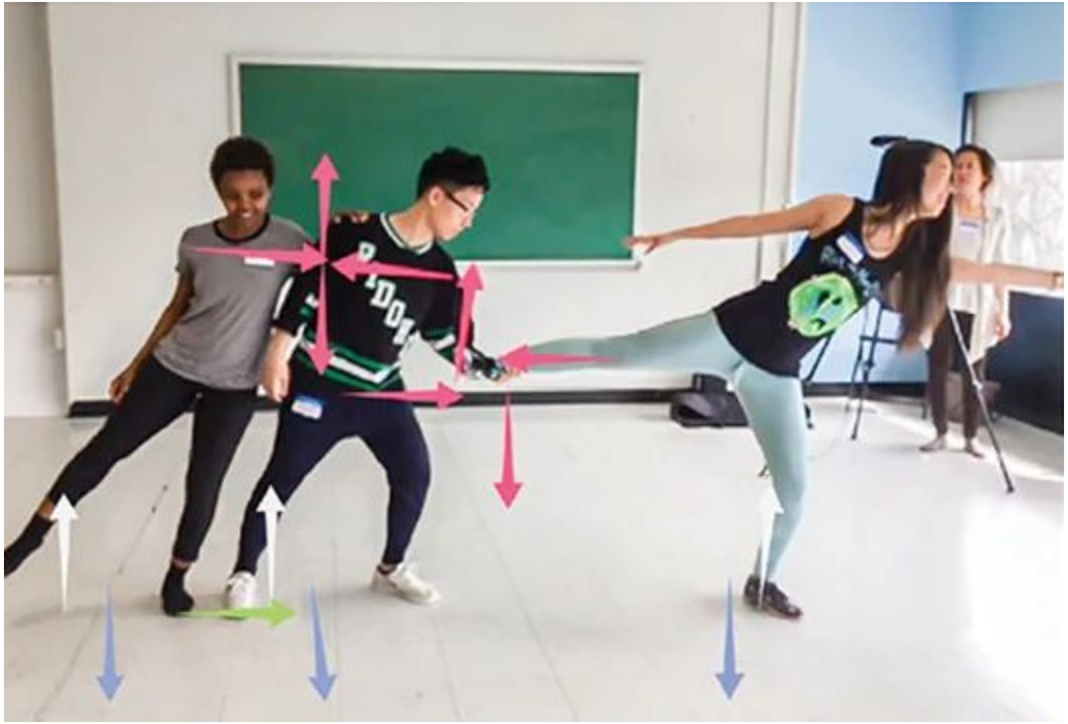
Magnetic Fields and Lenz's Law Activity

Dr. Alexandra Miller
Sonoma State University
Fall 2025

Embodied Learning




TEAM
LEADER
WORK
SUPPORT
GOALS
BRAINSTORMING
GUIDANCE
PARTNERSHIP
GROWTH
SUCCESS
RESULT

Round 1 Roles

Electrons

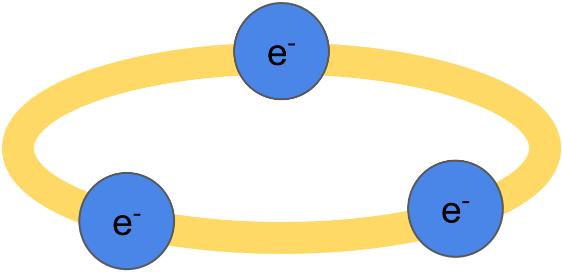
Current

Induced Magnetic Field

External Magnetic Field

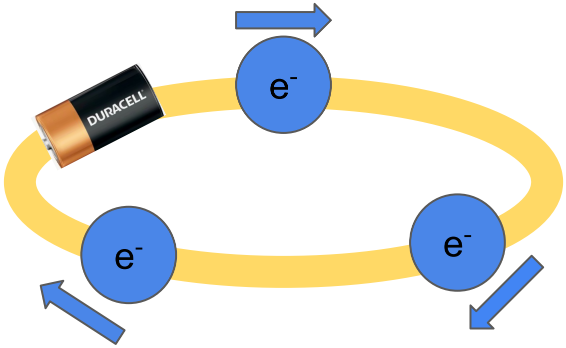
Consider a conducting loop.

<u>Electrons</u>: You will represent electrons in the conductor. Stand in a circle, holding your electrons.

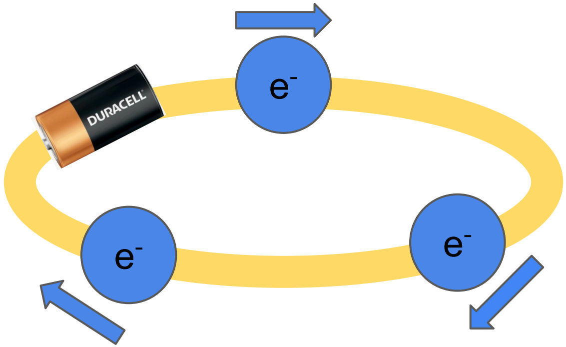


We want the current to flow in our conductor. We will attach a battery to drive this.

Electrons: slowly walk in a circle to represent the flow of electrons.

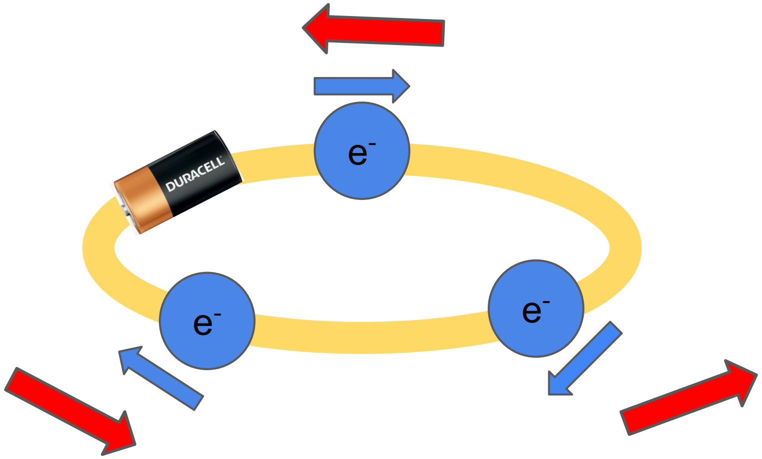


Current: You will display the direction the current flows. Make a slightly larger circle and hold your arrows representing the direction of current flow.

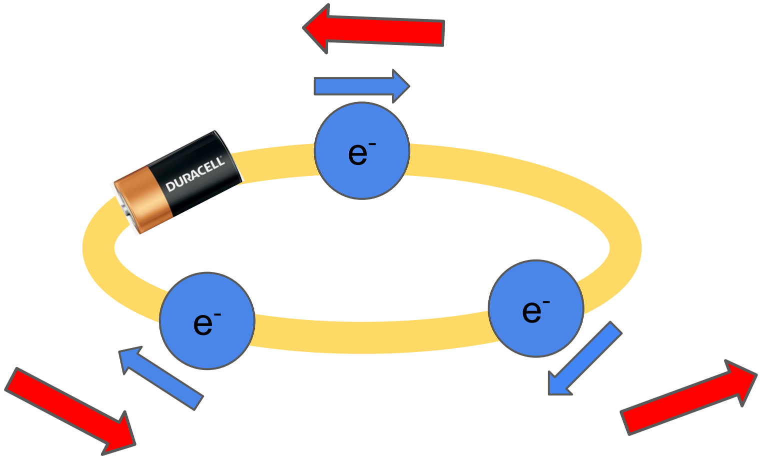


Current: You will display the direction the current flows. Make a slightly larger circle and hold your arrows representing the direction of current flow.

Current flows in the opposite direction as the motion of electrons.

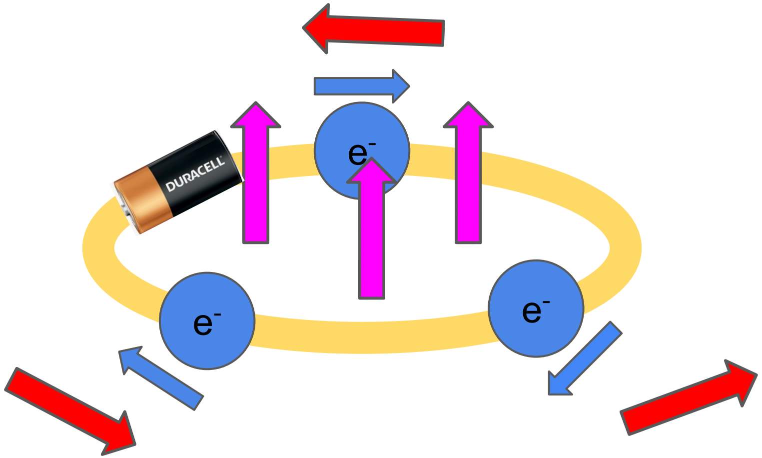


Induced Magnetic Field: Stand in the center of the circle. You are representing the magnetic field that is sourced by the current. What direction do you think the magnetic field should point?



Induced Magnetic Field: Stand in the center of the circle. You are representing the magnetic field that is sourced by the current. What direction do you think the magnetic field should point?

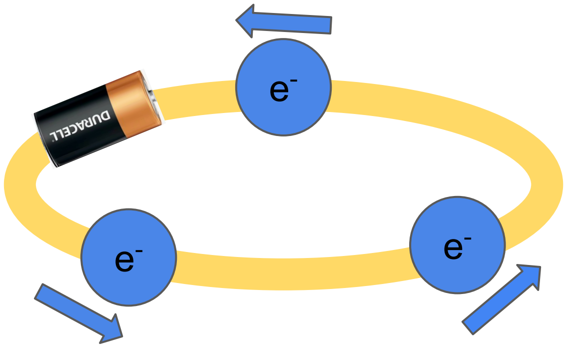
Using the right hand rule, the magnetic field should point up!



Electrons: Reverse your direction.

What direction is the current?

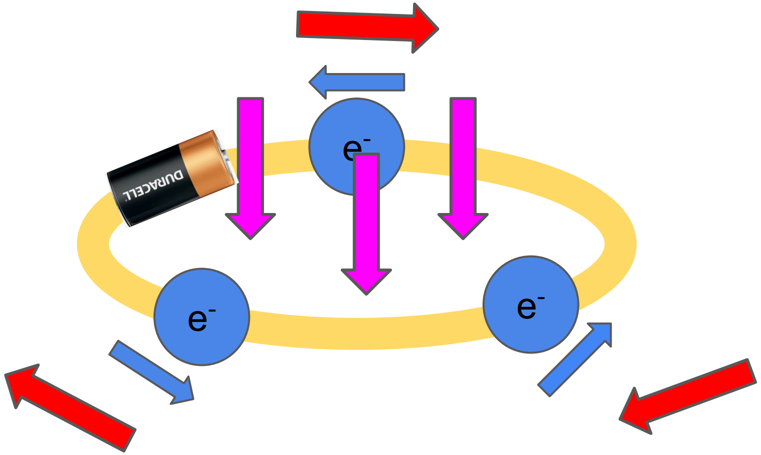
What direction is the magnetic field?



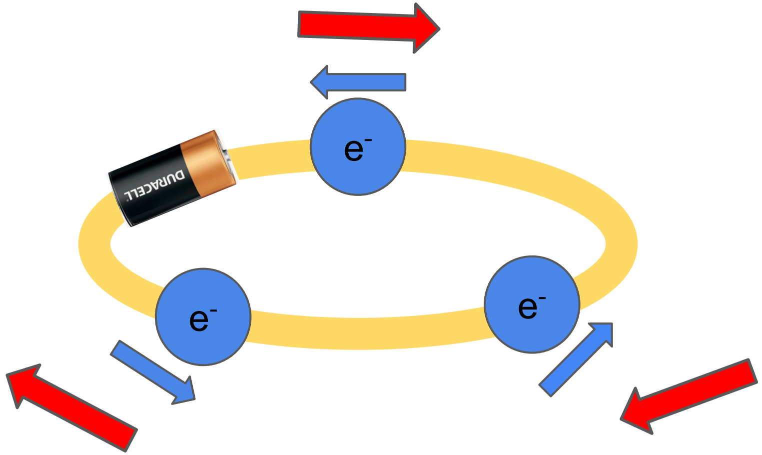
Electrons: Reverse your direction.

What direction is the current? Also reversed

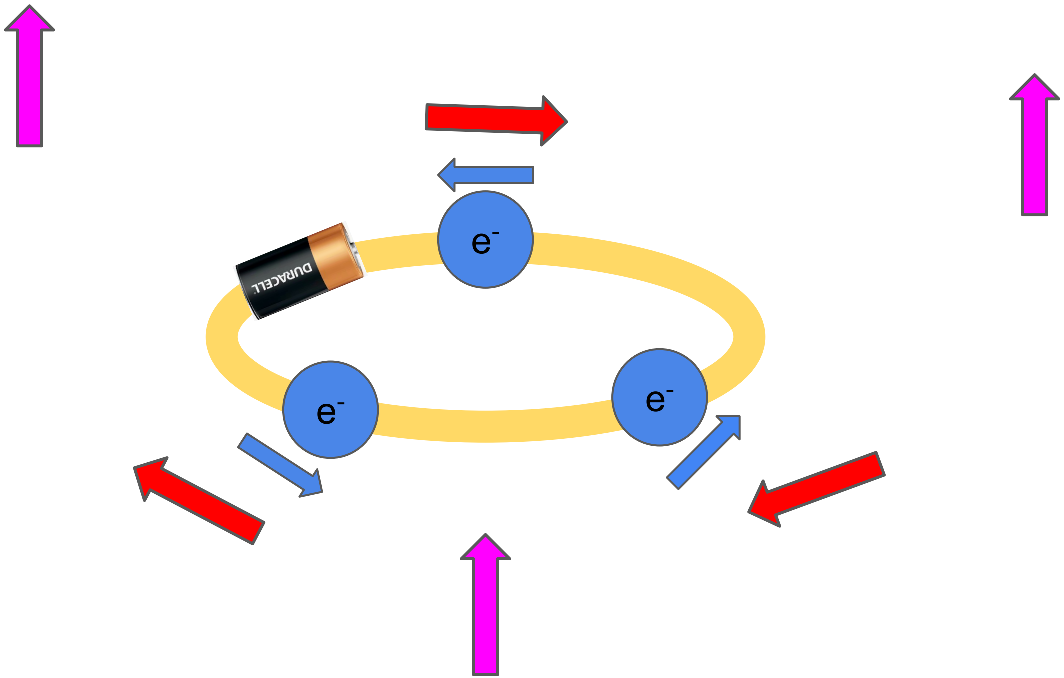
What direction is the magnetic field? Down



Induced Magnetic Field: Stand outside the circle. What direction is the magnetic field outside the loop?



Induced Magnetic Field: Stand outside the circle. What direction is the magnetic field outside the loop? Up!

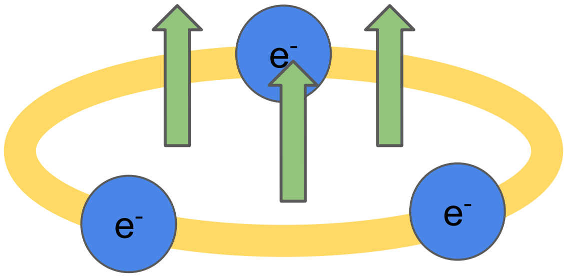


Lenz’s Law

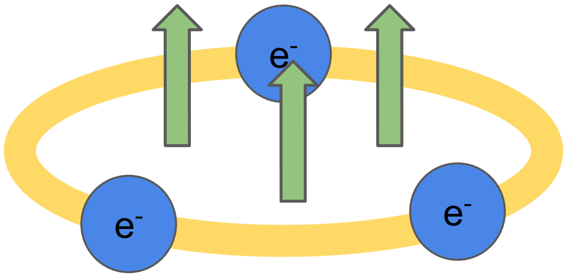
Lenz’s law states that the direction of the electric current induced in a conductor by a changing magnetic flux is such that the magnetic field created by the induced current opposes changes in the initial magnetic flux.

Electrons: You will represent electrons in the conductor. Stand in a circle, holding your electrons.

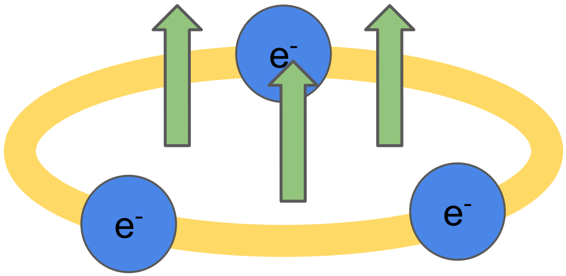
External Magnetic Field: You will represent an external magnetic field. Stand in the middle of the circle with your arrows pointing up, representing an applied magnetic field.



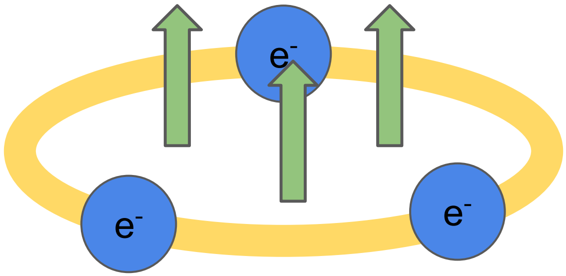
What happens to the electrons?



What happens to the electrons? NOTHING! You only induce an electric field and therefore a current if there is a change in the magnetic field.



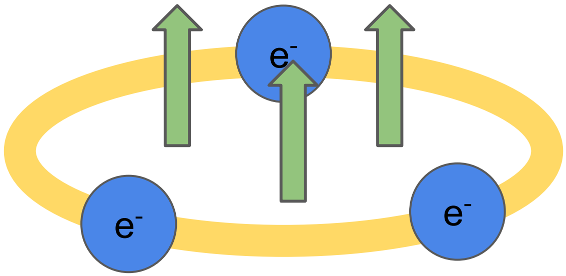
External Magnetic Field: Squat down and then rise up to represent an increasing magnetic field.



External Magnetic Field: Squat down and then rise up to represent an increasing magnetic field.

What happens to the electrons? What happens to the current?

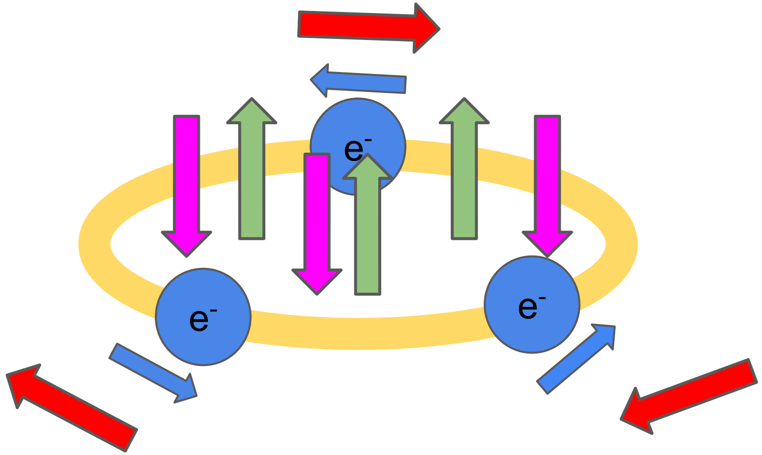
Induced Magnetic Field: Join group in the center of the circle, what happens to the induced magnetic field? (this is the magnetic field caused by the induced current).



Lenz’s law tells us that the induced field should point down, countering the increase in external magnetic field.

This means the induced current flows clockwise.

This means the electrons flow counterclockwise.

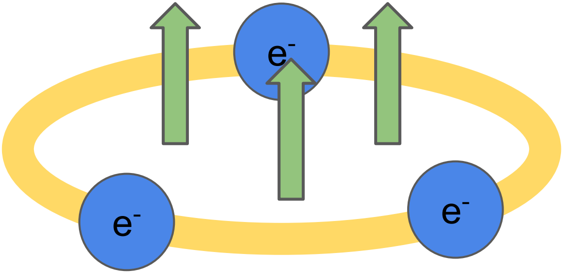


Change Roles

Electrons and External Magnetic Field: Trade Roles

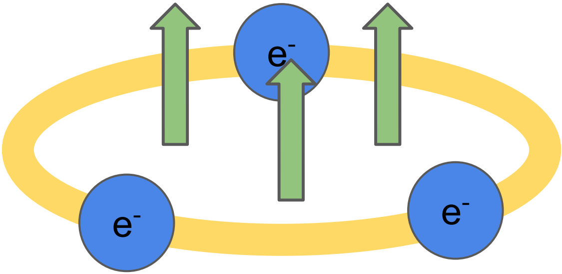
Current and Induced Magnetic Field: Trade Roles

External Magnetic Field: Stand and slowly squat down, representing a magnetic field that is pointed upward, but is decreasing in strength in time.



External Magnetic Field: Stand and slowly squat down, representing a magnetic field that is pointed upward, but is decreasing in strength in time.

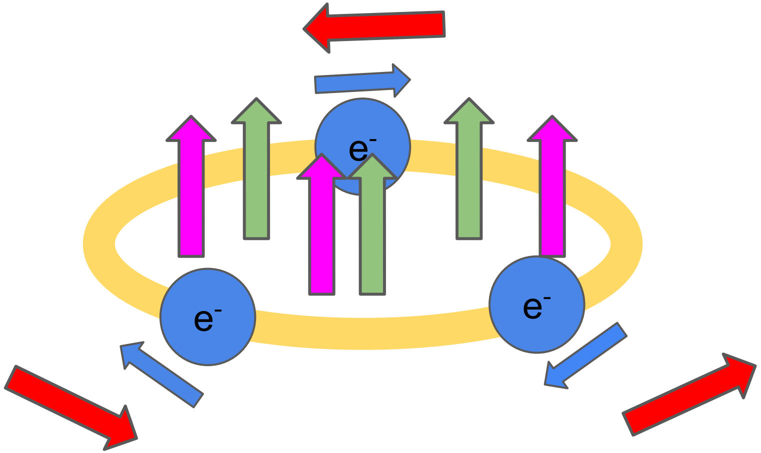
What happens?



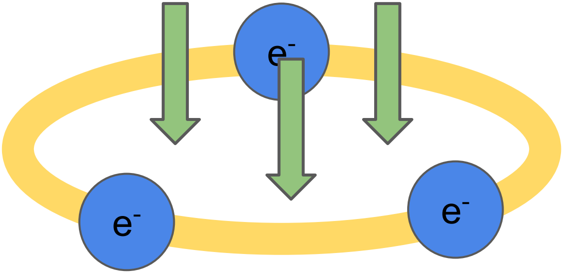
Lenz's law tells us that the induced field should point up, countering the decrease in external magnetic field.

This means the induced current flows counterclockwise.

This means the electrons flow clockwise.

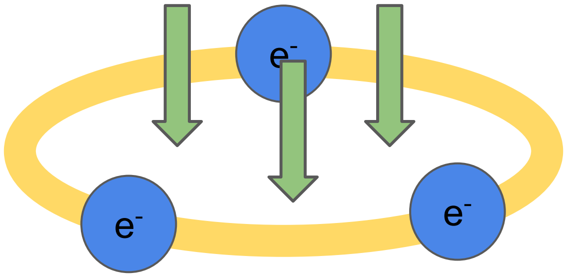


<u>External Magnetic Field</u>: Point your arrows down. Start squatting and slowly stand, representing an increasing downward magnetic field.



External Magnetic Field: Point your arrows down. Start squatting and slowly stand, representing an increasing downward magnetic field.

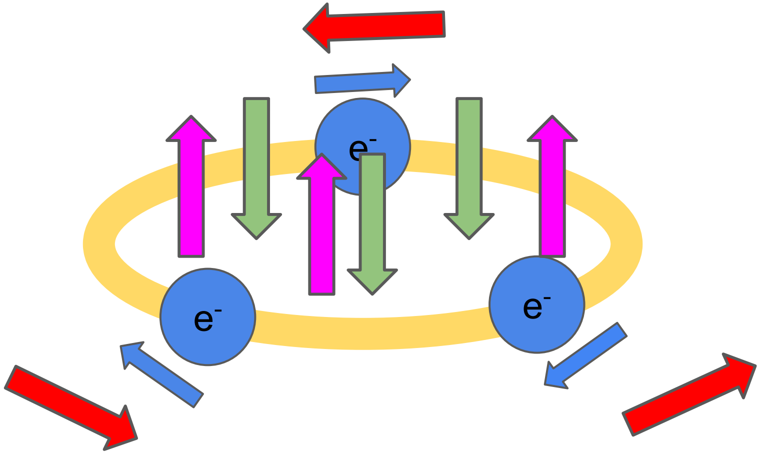
What happens to the electrons, induced current, and induced magnetic field?



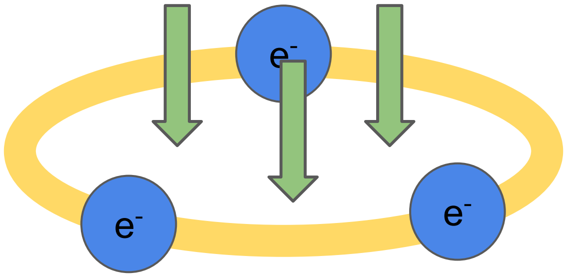
Lenz's law tells us that the induced field should point up, countering the increase in downward external magnetic field.

This means the induced current flows counterclockwise.

This means the electrons flow clockwise.

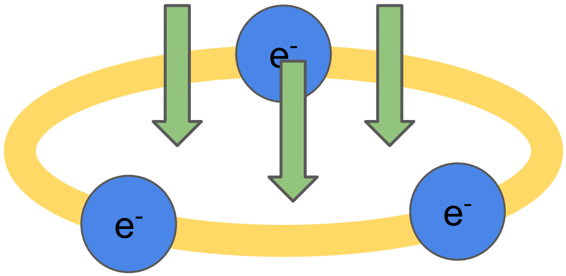


<u>External Magnetic Field</u>: Point your arrows down. Start standing and slowly squat, representing a decreasing downward magnetic field.



External Magnetic Field: Point your arrows down. Start standing and slowly squat, representing a decreasing downward magnetic field.

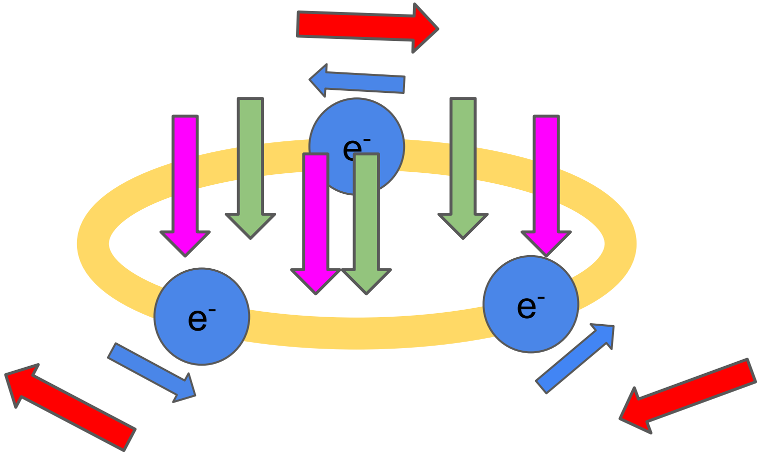
What happens to the electrons, induced current, and induced magnetic field?



Lenz’s law tells us that the induced field should point down, countering the decrease in downward external magnetic field.

This means the induced current flows clockwise.

This means the electrons flow counterclockwise.

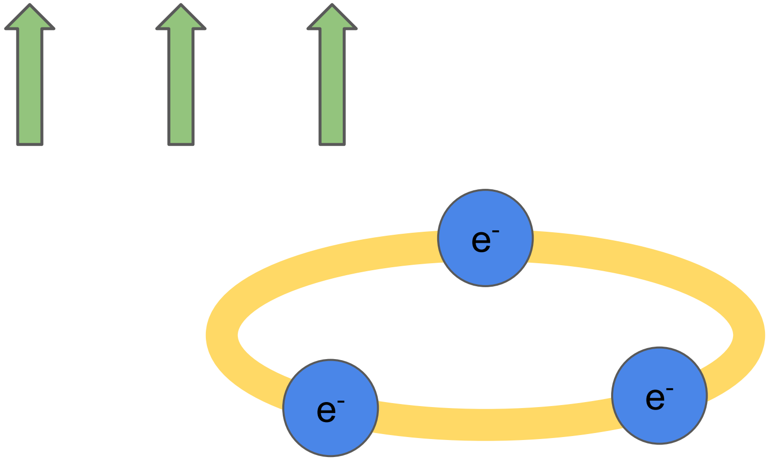


Change Roles

Current and External Magnetic Field: Trade Roles

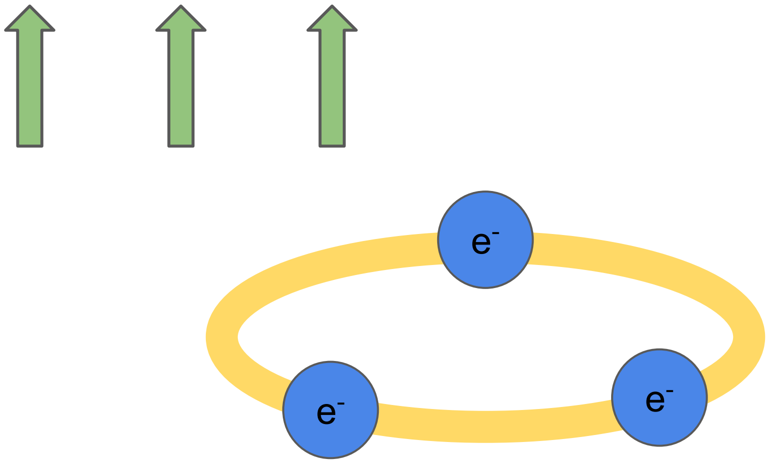
Electrons and Induced Magnetic Field: Trade Roles

External Magnetic Field: Stand at the front of the room and point your arrows up. Slowly stand in order to represent an increasing upward directed field.

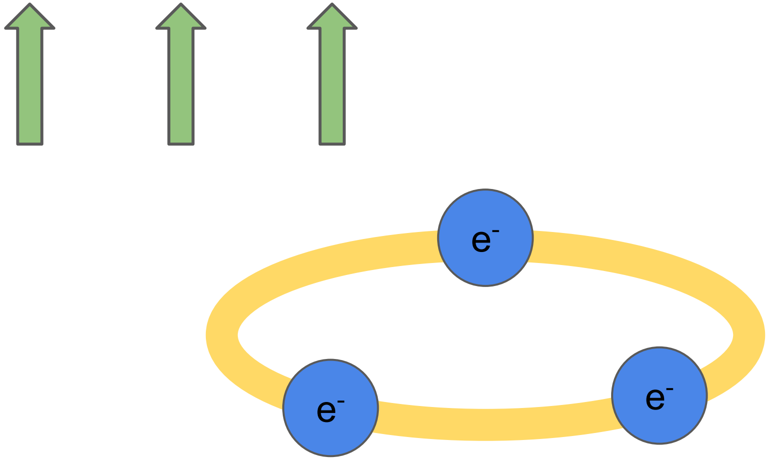


External Magnetic Field: Stand at the front of the room and point your arrows up. Slowly stand in order to represent an increasing upward directed field.

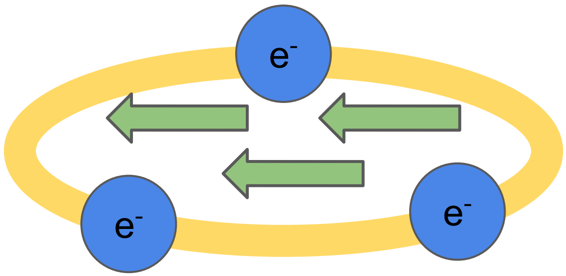
What happens to the electrons, induced current, and induced magnetic field?



Nothing! If the magnetic field only exists outside the ring, then there is no magnetic flux through the ring. Therefore, there is no induced current in the ring.

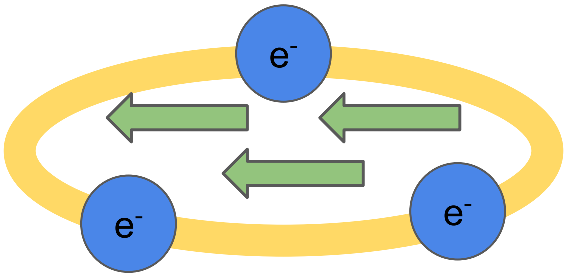


External Magnetic Field: Move to the center of the ring and point your arrows horizontally, toward the front of the classroom, starting with them close to your body and slowly move them toward the whiteboard. This represents a field increasing toward the whiteboard.

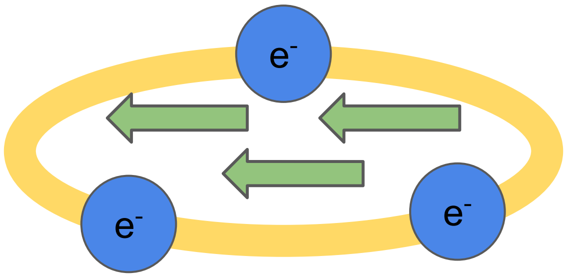


External Magnetic Field: Point your arrows horizontally, toward the front of the classroom, starting with them close to your body and slowly move them toward the whiteboard. This represents a field increasing toward the whiteboard.

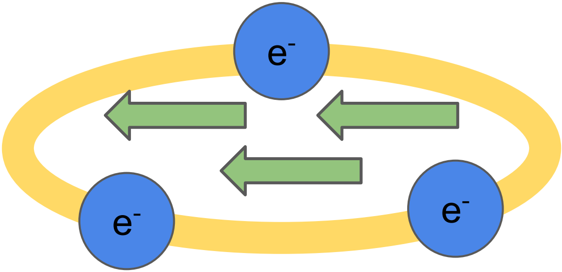
What happens to the electrons, induced current, and induced magnetic field?



NOTHING! If the field is horizontal, in the same plane as the loop, then the magnetic flux through the loop is zero!

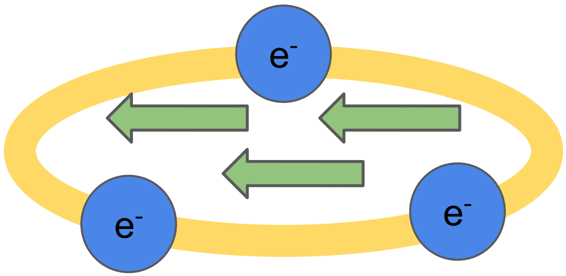


External Magnetic Field: Point your arrows horizontally, reaching your arm out. Then slowly lift your arm up so that it starts to point up. This is to represent a field with constant magnitude, but a changing direction.



External Magnetic Field: Point your arrows horizontally, reaching your arm out. Then slowly lift your arm up so that it starts to point up. This is to represent a field with constant magnitude, but a changing direction.

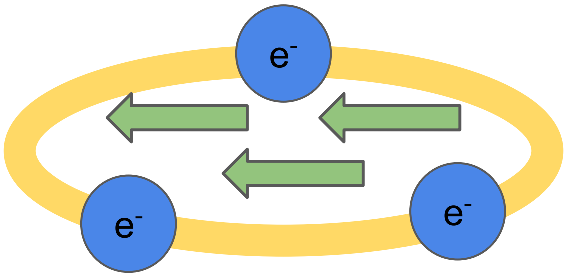
What happens to the electrons, induced current, and induced magnetic field?



<u>External Magnetic Field</u>: Point your arrows horizontally, reaching your arm out. Then slowly lift your arm up so that it starts to point up. This is to represent a field with constant magnitude, but a changing direction.

What happens to the electrons, induced current, and induced magnetic field?

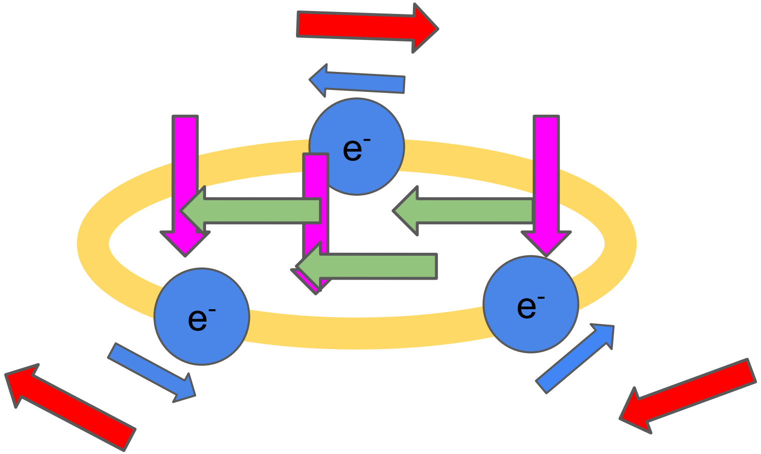
Hint: This causes an increasing magnetic flux in the upward direction.



Lenz’s law tells us that the induced field should point down, countering the increase in upward directed magnetic flux.

This means the induced current flows clockwise.

This means the electrons flow counterclockwise.

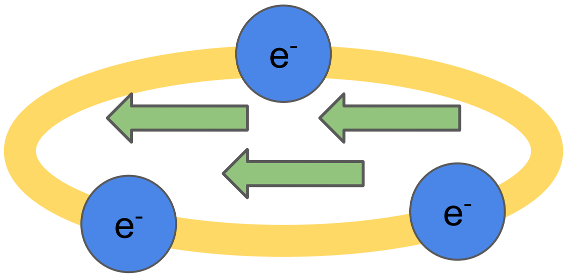


Change Roles

Current and Induced Magnetic Field: Trade Roles

Electrons and External Magnetic Field: Trade Roles

External Magnetic Field: Point your arrows horizontally, reaching your arm out. Then slowly lower your arm up so that it starts to point down. This is to represent a field with constant magnitude, but a changing direction.



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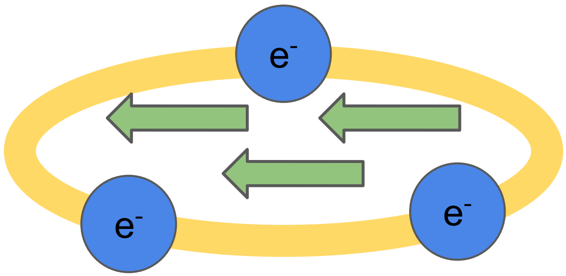
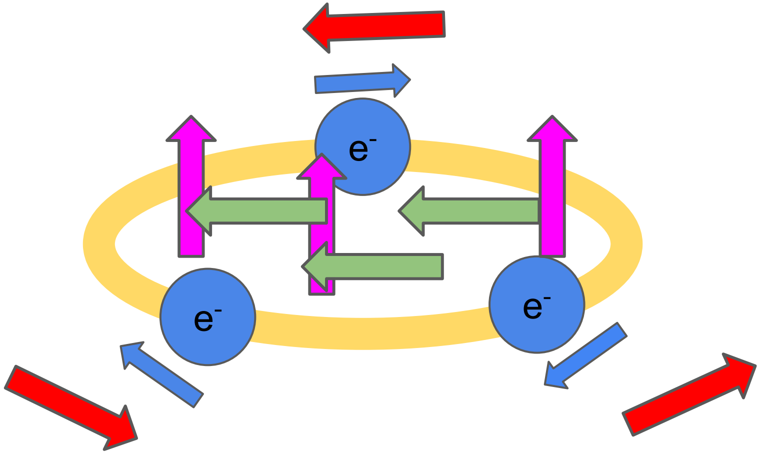
What happens to the electrons, induced current, and induced magnetic field?



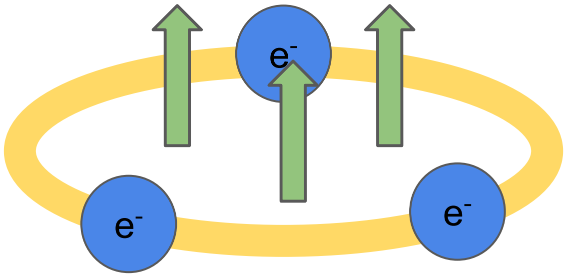
Lenz's law tells us that the induced field should point up, countering the increase in downward external magnetic flux.

This means the induced current flows counterclockwise.

This means the electrons flow clockwise.

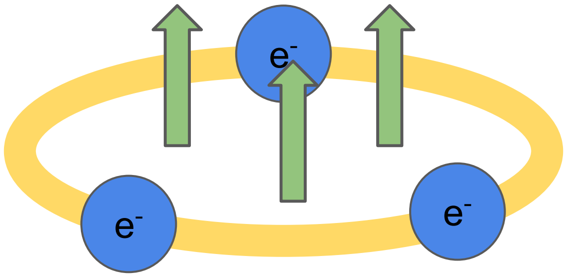


External Magnetic Field: Point your arrows straight up, reaching your arm out. Then slowly lower your arm up all the way until it points downward. This is to represent a field with constant magnitude, but a changing direction.



External Magnetic Field: Point your arrows straight up, reaching your arm out. Then slowly lower your arm up all the way until it points downward. This is to represent a field with constant magnitude, but a changing direction.

What happens to the electrons, induced current, and induced magnetic field?



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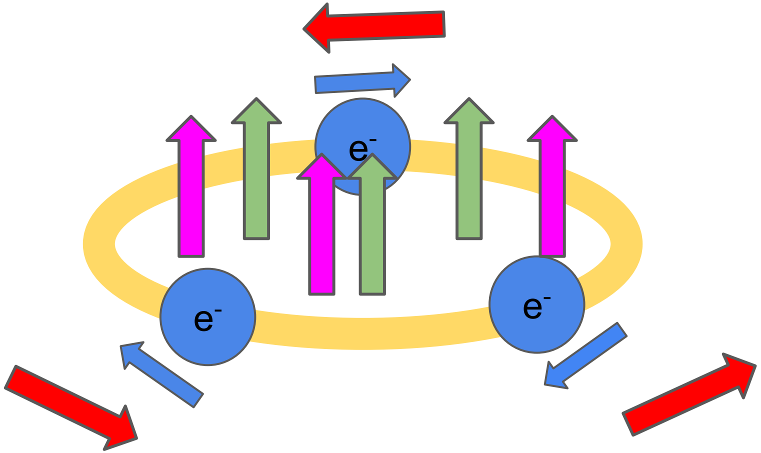
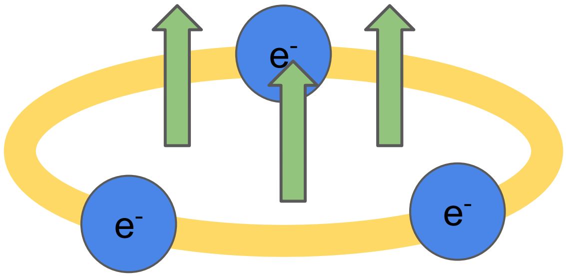


<u>External Magnetic Field</u>: Point your arrows straight up, reaching your arm out. Then slowly lower your arm up all the way until it points downward. Then slowly lift your arm back so that it is pointing straight up. Repeat this motion continuously



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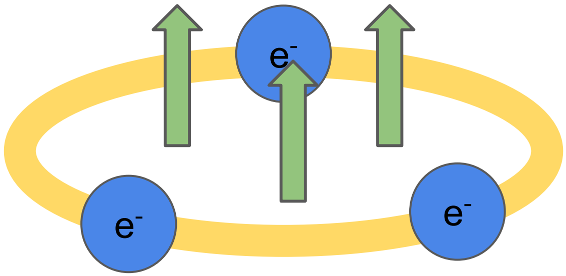
What happens to the electrons, induced current, and induced magnetic field?



We’ve discovered AC!!! Alternating Current!!!