Unit 11 Handout – Electricity and Magnetism

Physics 200

Name: Al/z

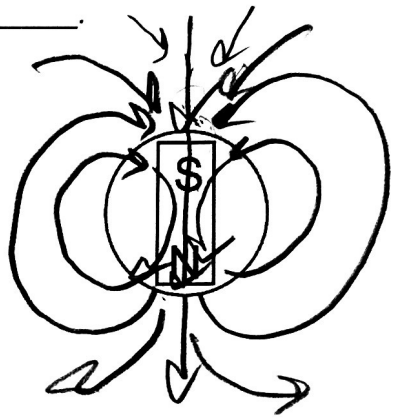
Magnetism: a class of phenomena resulting in attractive and repulsive forces between objects and relating to motions of electric charge.

All magnets have two poles. [redacted]

Magnetic field lines: magnetic field is drawn as arrows flowing out of a magnet's north pole and into a magnet's south pole. For our conceptual exploration of electricity and magnetism, all you really need to know is that...

1) Magnetic field lines are drawn like electric field lines, where the south poles are like negative charges and the north poles are like positive charges.
2) As with electric field lines, magnetic field lines' proximity indicates the magnitude of the field.
3) The direction of the field, indicated by the arrowheads, will be of practical use in telling us which way to point our fingers.

Symbol for Magnetic Field = B



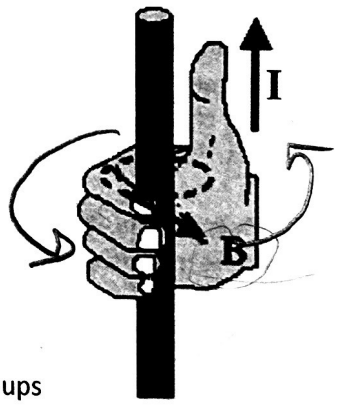
North Pole: the pole of a magnet that tends to point itself toward the Earth's (current) North Pole. This is because, if you think of the Earth as a magnet, the North Pole is really its magnetic south pole. We call it the North Pole because magnets' north poles point toward it.

South Pole: the pole of a magnet that points toward the Earth's south pole.

Moving Charges Create Magnetic Fields:

Current (I) in a wire creates a magnetic field (B), according to a *right* hand rule.

Right hand rule (for current and magnetic field): If you point your right thumb in the direction of current flow, and you curl your fingers on that hand, your fingers point in the direction of the magnetic field lines. *[Image on the right from http://physicsed.buffalostate.edu/SeatExpts/resource/rhr/CNB.JPG]*

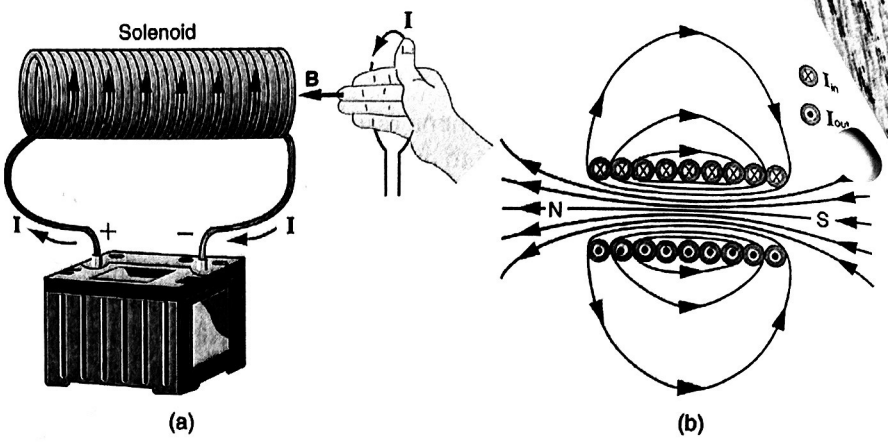


FYI (not on the test) Electrons in atoms create magnetic fields:

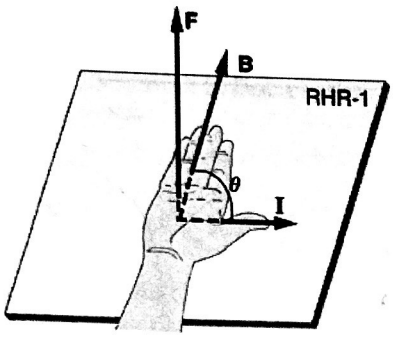
- Most atoms have paired electrons. Electrons in pairs have opposite spin, so they cancel one another's magnetic fields.
- Iron, however, has unpaired spinning electrons that create magnetic fields. In groups of iron atoms, called **domains**, the unpaired electrons align with one another's magnetic fields. However, throughout the iron, the aligned domains are randomly oriented, so the iron has no overall magnetic field. When a strong magnet is brought near a piece of iron, the iron's domains align with the magnet's magnetic field. The iron becomes "magnetized," and it sticks to the other magnet. When the magnet is taken away, the iron's domains usually return to their normal orientations, so the iron does not become a permanent magnet.

Solenoid (electromagnet):

A solenoid is a coil of wire through which current is flowing. The right hand rule can be used to understand the direction of the magnetic field, B. In the cross-section diagram on the far right, an X represents current flowing into the page. A dot represents current flowing out of the page.

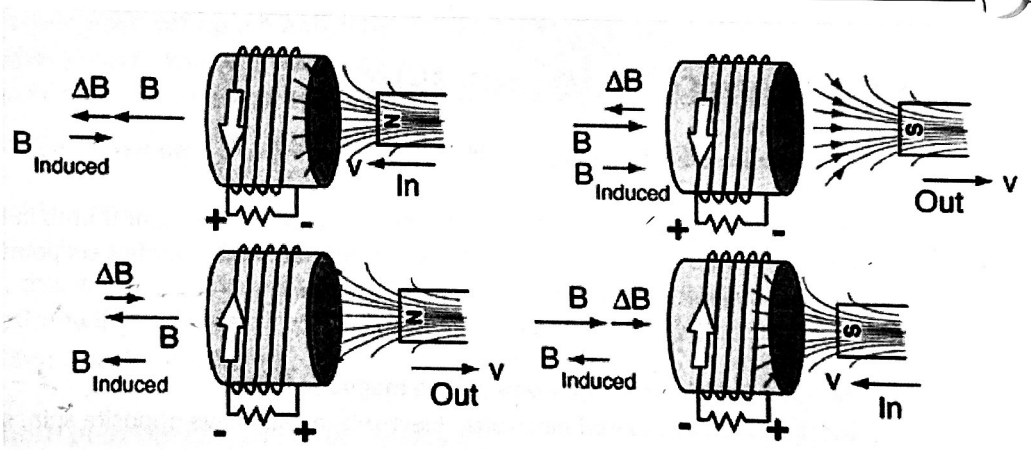


(another) Right Hand Rule: concerning the direction and magnitude of the Magnetic force exerted on charge moving in a magnetic field (e.g. through a wire, near a magnet)



Lenz' Law: A change in magnetic flux through a conductive coil induces a current in the coil, such that the induced current's magnetic field opposes the first change in magnetic flux.

Magnetic Flux is a measure of the magnitude and direction of magnetic field passing through a given area.



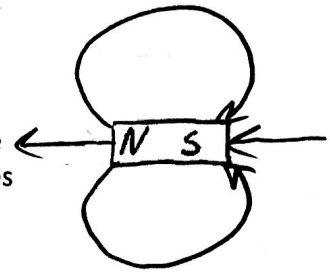
Physics 200 (Stapleton)
Electricity and Magnetism
2018-2019 Quiz Review

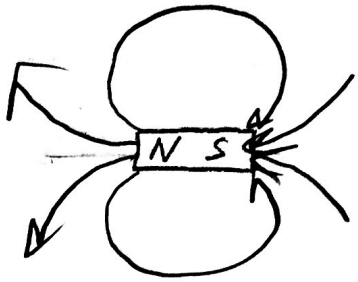
Name: Key

*Note: except for the steel guitar strings (which are magnetizable), all other wires and coils are made of copper (which is not magnetic).

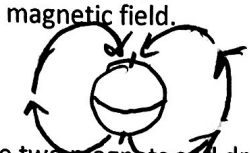
1. What is the symbol for magnetic field? B

2. The rightmost magnet is twice as strong as the leftmost magnet. Draw the magnetic field lines surrounding the two magnets.

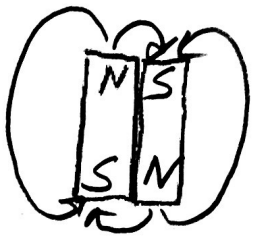




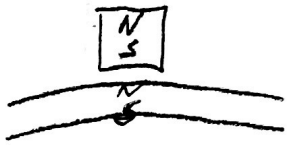
3. Sketch a diagram of the Earth's magnetic field.



4. Label the remaining poles of the two magnets and draw their magnetic fields.



5. Show the poles of the magnetized section of the steel string adjacent to the magnet.



6. When the right hand rule is applied with curled fingers, what part of the right hand indicates...
   a. Direction of the magnetic field Fingers
   b. Direction of Current Thumb

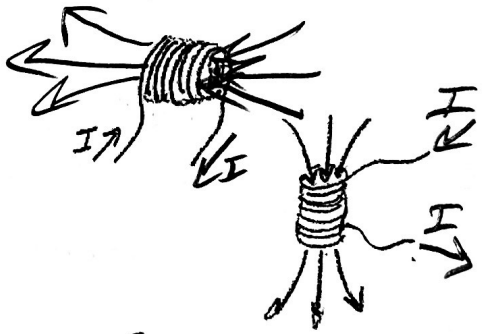
7. When the right hand rule is applied with straight fingers, what indicates the direction of the force applied to a moving charge? Palm

8. What symbol represents a direction pointing into the paper? What symbol represents "out of the paper?"
   • = Out of page X = Into page

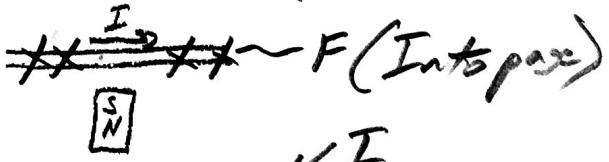
9. Use the symbols from number 8 to show the direction of the magnetic field around the wire.

11. Show the direction of the solenoid's magnetic field.

12. Show the direction of the solenoid's current.

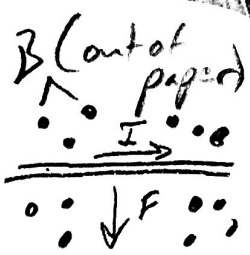


13. Show the direction of the force acting on the wire.

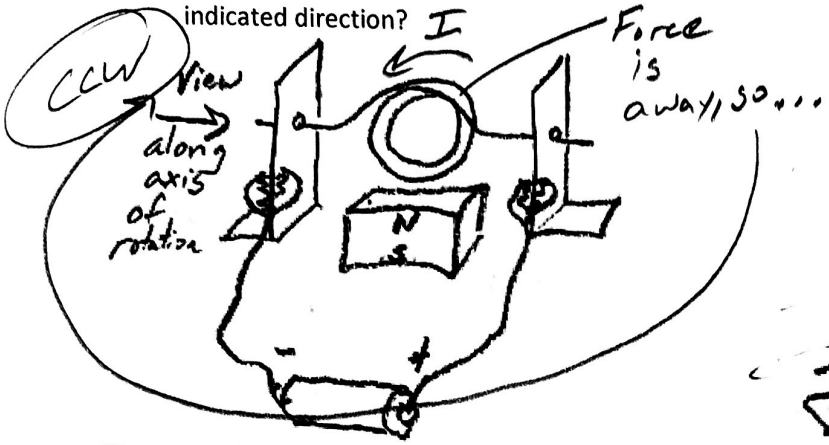


14. Show the direction of the current traveling through the wire.

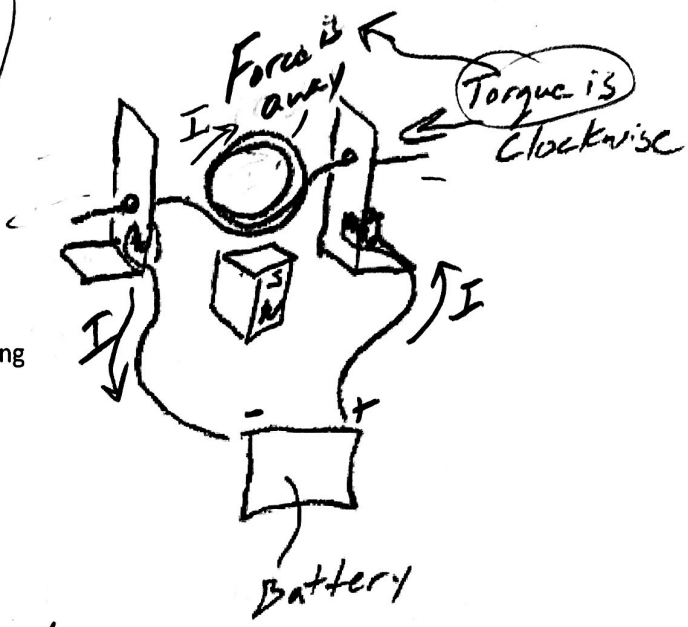
15. Show the direction of the magnetic field in the diagram on the right.



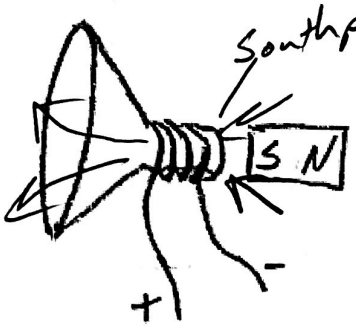
16. In which direction will the motor rotate when viewed along the axle in the indicated direction?



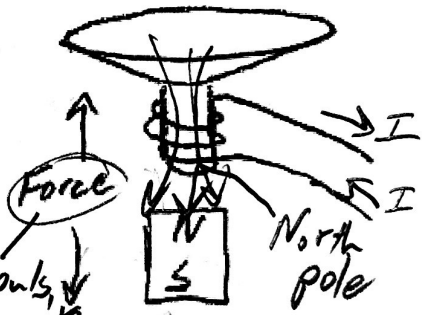
17. In which direction current flowing through the motor coil? Torque is clockwise when viewed along the axle in the indicated direction.



18. In which direction will the voice coil and speaker move?



19. Show the direction of current flowing through the voice coil.



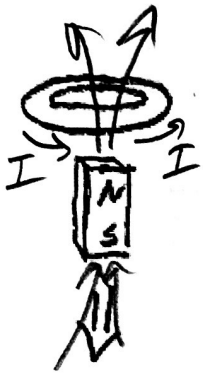
20. Describe magnetic flux in basic terms.

The intensity (magnitude) of a magnetic field where it passes through a surface (or plane)

21. According to Lenz's law, what is the relationship between magnetic flux and the current induced in a coil?

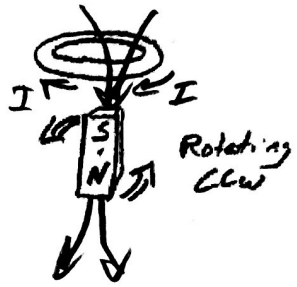
When magnetic flux through a conducting coil changes, an electric current is induced (forms) in the coil, such that the current produces its own magnetic field that opposes the change in magnetic flux.

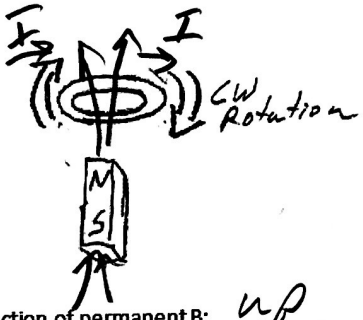
22. Each of these drawings shows a "coil" (metal ring) and a permanent magnet. The drawing is a perspective drawing; the thicker section of the ring is closer to the viewer. Either the magnet or the coil is moving, and its direction of movement is indicated. For each drawing... field
    a. describe the general direction of the permanent magnet's at the coil (choose up, down, left, or right)
    b. describe the change in magnetic flux through the coil (increasing or decreasing)
    c. describe the direction of the magnetic field that is produced by the induced current in the coil
    d. Show (using an arrow) the direction of the induced current along the near side of the coil.



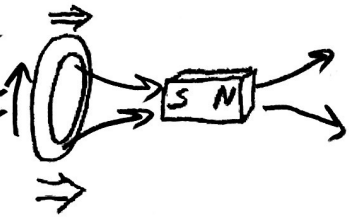
Direction of permanent B: Up
Change in Φ (flux): Decrease
Direction of induced B: Up

Direction of permanent B: Down
Change in Φ (flux): Decrease
Direction of induced B: Down



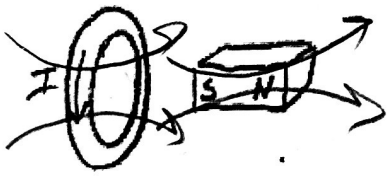


Direction of permanent B: right
Change in Φ (flux): Increase I
Direction of induced B: Left



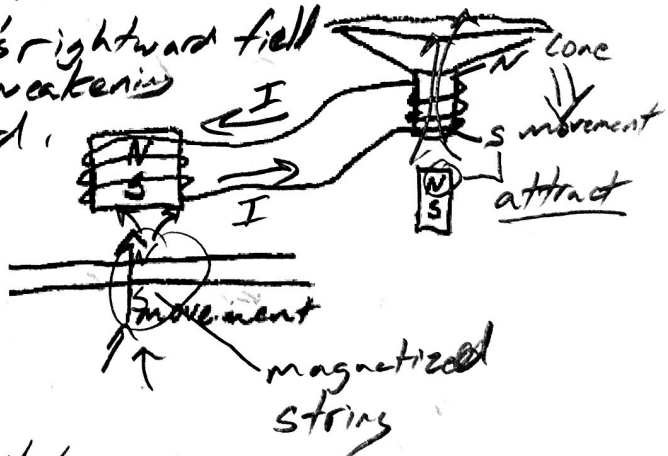
Direction of permanent B: up
Change in Φ (flux): Decrease
Direction of induced B: up

23. In what direction must the magnet be shifted (left or right) in order to produce a current in the indicated direction?



- A rightward field is induced
- The permanent magnet's field is rightward.
- The magnet's rightward field must be weakening
- It's moving rightward.

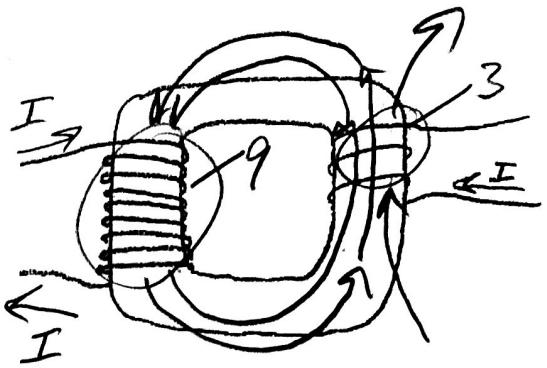
24. Show the direction of current leaving the magnetic pickup when the steel string moves as indicated. Then show the direction of the speaker cone's movement (Note that the movement will be minimal without the signal being amplified).



- Upward field increase.
- Inducing a current that creates a downward field.

25. The source current entering a transformer is shown on the right. If we assume that current is increasing...
a. Is this transformer increasing voltage or decreasing voltage?
b. By what factor is voltage changing?
c. Show the direction of the current that is induced in the other coil of the transformer.

more coils



9/3 = 3x

26. In which direction will the "motor" rotate around the indicated axis (from the indicated perspective) when the "generator" magnet is moved as shown?

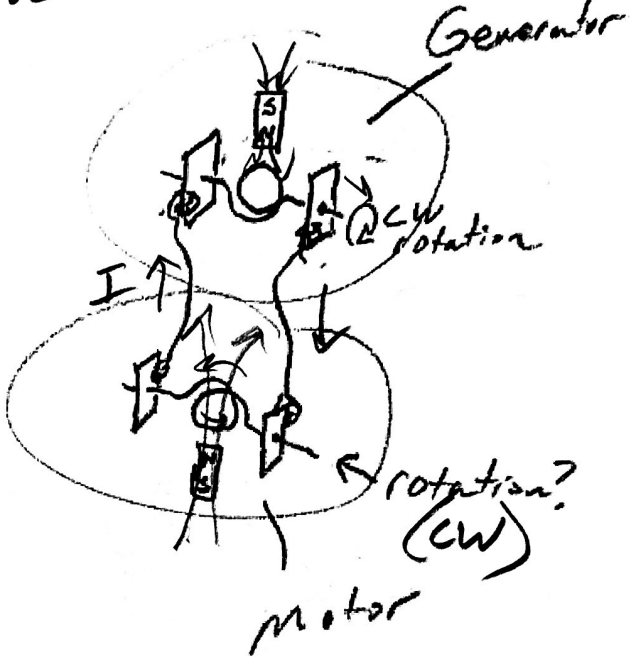
coil

Clockwise

27. True or false: When a magnet moves near a conducting coil, a force is always produced that opposes the magnet's movement.

True

28. ~~Sketch a solenoid buzzer, with correct wiring, connected to a battery, in the *on* position.~~



29. Describe an easy way to generate significant electricity without building a generator.

Force a motor to move. This will produce current.

30. Briefly describe how an electric motor works.

Current flows through a conducting coil, producing a magnetic field that exerts a force on a permanent magnet.

31. Briefly describe how a generator works.

A conducting coil or a magnet is moved in the presence of the other, producing a current in the coil.

Physics 200 (Stapleton)
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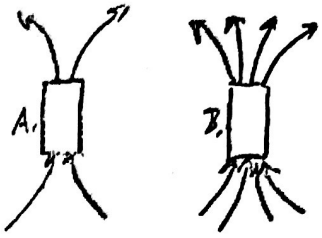
*Note: except for the steel guitar strings (which are magnetizable), all other wires and coils are made of copper (which is not magnetic).

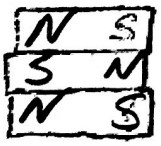
1. What is the symbol for magnetic field?
   a. M b. B c. I d. F e. E

2. Compared to magnet A, magnet B is _____
   a. The same strength b. 2x stronger c. ½ as strong d. 4x stronger e. ¼ as strong

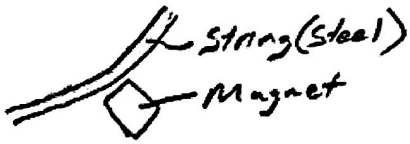


3. A compass needle is a small magnet. Which of the compass' poles points in the general direction of the Earth's North Geographic Pole?
   a. The needle's north pole b. The needle's south pole

4. The diagram on the right shows three magnets sticking together. What magnetic pole is in the position of the question mark?
   a. South b. North c. Not enough information



5. Which pole of the magnet is closest to the steel guitar string?
   a. North b. South c. Not enough information



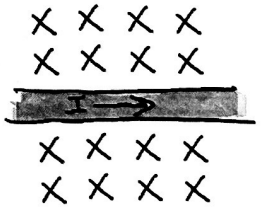
6. When the right hand rule is applied with curled fingers, what indicates the direction of current?
   a. Palm b. Thumb c. Fingers

7. When the right hand rule is applied with curled fingers, what indicates the direction of the magnetic field?
   a. Palm b. Thumb c. Fingers

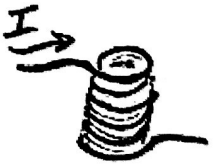
8. When the right hand rule is applied with straight fingers, what indicates the direction of the force applied to a moving charge?
   a. Palm b. Thumb c. Fingers

9. What direction does the letter "X" represent?
   a. Up b. down c. into the paper d. out of the paper e. NE, SE, NW, and SW

10. Given the magnetic field, B, if current is flowing rightward through the wire, what is the direction of the force exerted on the wire?
    a. toward the top of this paper b. toward the bottom of this paper

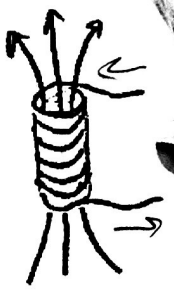


11. What is the direction of the magnetic field inside the solenoid?
    A. upward
    B. Downward



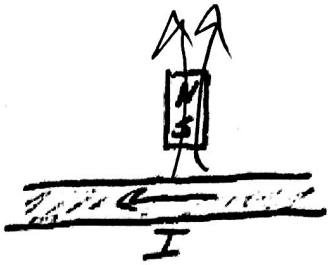
12. Relative to an observer looking downward through the solenoid, which way is current traveling?

a. Clockwise b. Counter-Clockwise



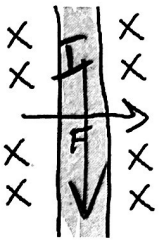
13. What is the direction of the force acting on the wire?

a. Upward (Toward the top margin of this paper)
b. Downward (toward the bottom margin of this paper)
c. Into the paper
d. Out of the paper
e. Leftward



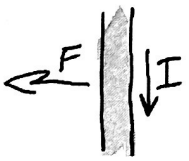
14. What is the direction of the current traveling through the wire?

a. Upward (Toward the top margin of this paper)
b. Downward (toward the bottom margin of this paper)
c. Into the paper
d. Out of the paper



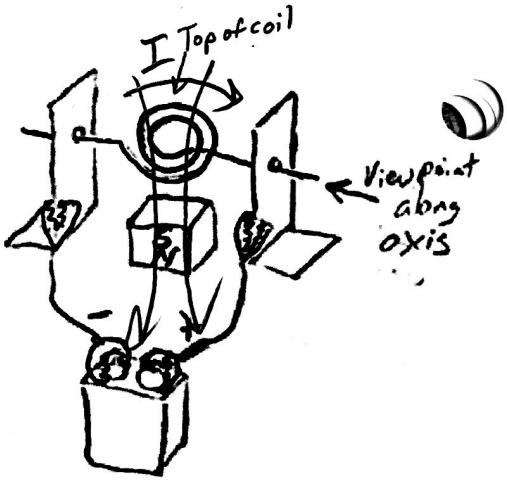
15. What is the direction of the magnetic field.?

A. Leftward B. Rightward C. Into the Paper d. Out of the paper



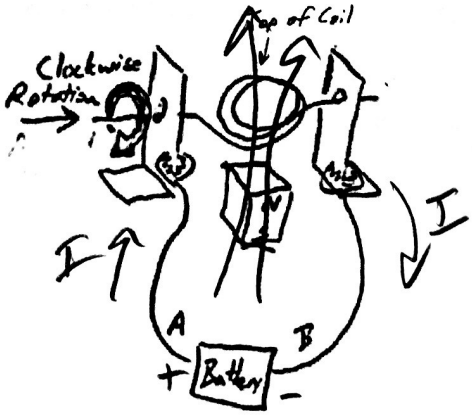
16. In which direction will the motor on the right rotate when viewed along the axle in the indicated direction?

A. Clockwise B. Counter-Clockwise

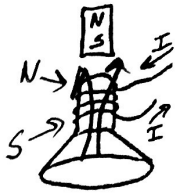


17. As the generator coil below is rotated clockwise (when viewed as shown), which wire connects to the battery's negative terminal?

A. Wire A B. Wire B

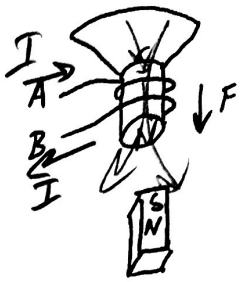


18. In which direction will the voice coil and speaker be pushed by the permanent magnet?



A. Upward B. Downward C. Leftward
D. Rightward E. Clockwise

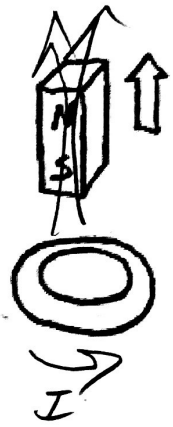
19. Through which end of the wire is current flowing leftward if the speaker coil is being pulled downward ~~toward~~ the magnet?



A. Wire A B. Wire B

20. Magnetic Flux through a coil is:
a. The direction of a magnetic field near the coil
b. The change in a magnetic field near the coil
c. The number of turns in a solenoid that is moving near a magnet
d. ~~The number of magnetic field lines passing~~ through the coil
e. The strength of a permanent magnet that is used in a generator or motor

21-24. This drawing shows a "coil" (metal ring) and a permanent magnet. The drawing is a perspective drawing; the thicker section of the ring is closer to the viewer. The arrow shows movement of the permanent magnet.

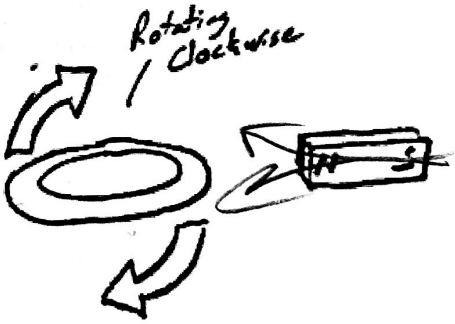


21. What is the direction of the permanent magnet's field?
A. up B. Down C. Left D. right
22. What is happening to the absolute magnitude of the magnetic flux through the coil?
a. Increasing b. Decreasing c. No change
23. What is the direction of the magnetic field that is created in the coil?
A. up B. Down C. Left D. right
24. What is the direction of the induced current along the near side of the coil?
A. up B. Down C. Left D. right

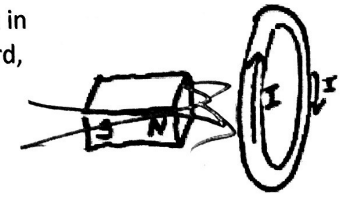
25-28. This drawing shows a "coil" (metal ring) and a permanent magnet. The drawing is a perspective drawing; the thicker section of the ring is closer to the viewer. The arrow shows movement.

25. What is the direction of the permanent magnet's field?
A. up B. Down C. Left D. right
26. What is happening to the absolute magnitude of the magnetic flux through the coil?
a. Increasing b. Decreasing c. No change
27. What is the direction of the magnetic field that is created in the coil?
A. up B. Down C. Left D. right
28. What is the direction of the induced current along the near side of the coil?
A. up B. Down C. Left D. right

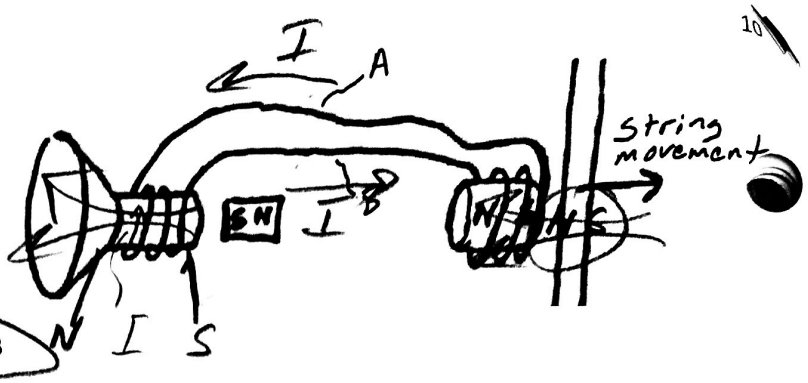
Not Good test Questions



29. In what direction must the magnet be shifted in order to produce a current in the indicated direction? A. Rightward, upward, or downward b. Leftward, upward, or downward
c. Rightward only d. Leftward only e. upward or downward



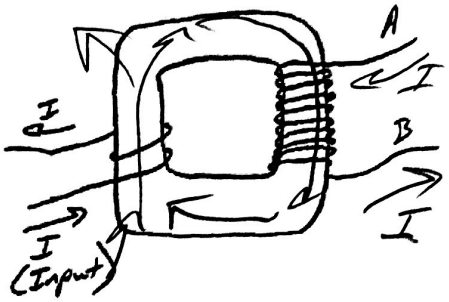
30. On the diagram to the right, show the north and south poles of the magnetized section of the steel guitar string.



30.5 In the diagram on the right, through which wire will the current travel leftward, from the speaker voice coil to the pickup?
A. Wire Segment A B. Wire Segment B

31. In the same diagram, which way will the voice coil and speaker cone be pushed by the nearby permanent magnet?
A. leftward B. rightward

32-34. The source current entering a transformer is shown on the right. If we assume that current is **decreasing**...

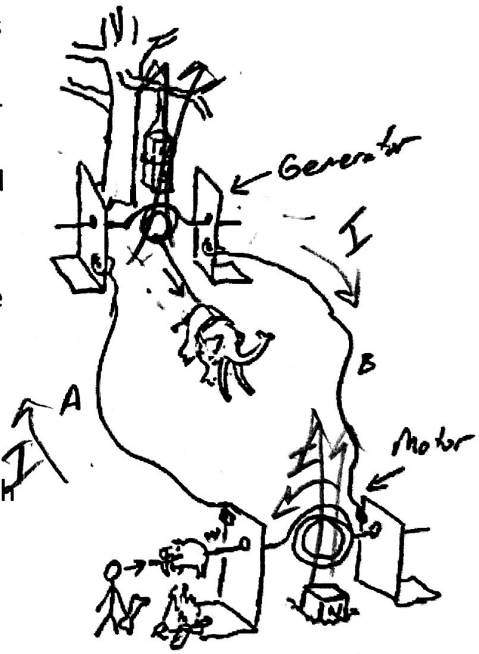


32. Is this transformer increasing voltage or decreasing voltage? A. Increasing b. Decreasing

33. In terms of voltage, how much stronger is the high voltage coil, compared to the lower voltage coil?
A. 2x B. 3X C. 4X D. 5X E. 6X

34. Through which of the wires in the output coil is current traveling leftward?
A. Wire A B. Wire B

35-36. In their first attempt at creating a rotisserie for roasting pigs and whatnot, the cave people have set up a mammoth-powered generator to drive a motor that will rotate a saber-toothed pig as it cooks over a fire. Notice that they have hung the generator magnet from a tree limb and half-buried the motor magnet in the ground. As you can see, the mammoth is harnessed to the bottom of the generator coil, so the beast will only be able to cause ¼ of a rotation before it must stop (remember, this is the first attempt). Nonetheless, that ¼ rotation will produce current that will travel to the motor and begin to rotate the pig.



35. When the mammoth pulls the coil, as shown, through which wire will current flow from the generator to the motor?
A. Wire A B. Wire B

36. From the perspective of the cave person, in which direction will the saber-toothed pig rotate as the mammoth pulls the rope.
A. Clockwise B. Counter-Clockwise

37. If you pass electricity through a coil of wire, in the presence of a permanent magnet, you have made a simple _____ (generator or motor). If you move a magnet in the presence of a coil of wire (or you can move the coil and keep the magnet still), you have made a simple _____ (generator or motor).