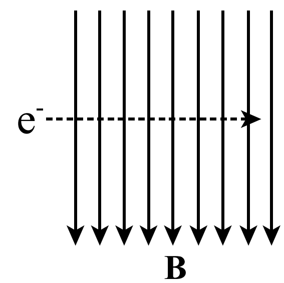
PHYSICS HOMEWORK #121 MAGNETISM
MAGNETIC FORCE ON MOVING CHARGES

$$F_m = q \cdot \bar{v} \times \bar{B} = I \cdot \bar{l} \times \bar{B}$$

1. A proton [mass of 1.67×10^{-27} kg and a charge of 1.6×10^{-19} C] is moving with a velocity of v = 820 m/s through a magnetic field which has a field intensity of B = 1.20 Tesla. Assuming that this proton is moving at right angles to the field.
   a. What will be the magnitude of the resultant magnetic force?
   b. What will be the force on the proton if the direction of motion of the proton is parallel to the direction of the magnetic field lines?

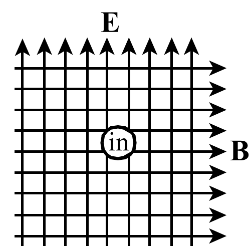
2. A magnetic field, which has an intensity of T = 0.950 Tesla, is directed vertically downward. An electron ($m_e = 9.11 \times 10^{-31}$ kg, $q_e = 1.6 \times 10^{-19}$ C) is moving horizontally through the field from left to right at v = 12,000 m/s:
   a. What will be the direction of the magnetic force acting on this electron?
   b. Describe the path of motion of this electron as it moves through the magnetic field.
   c. What will be the magnitude of the magnetic force acting on this electron?
   d. What will be the radius of the circle in which this electron will move?



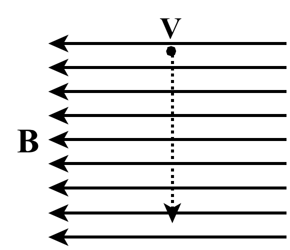
3. A proton is moving with a velocity of v = 21,000 m/s through a uniform magnetic field such that the proton moves in a circular path which has a radius of r = 4.50 cm. What is the strength of the magnetic field B?

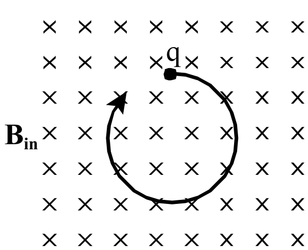
4. An alpha particle ($\alpha_{mass} = 6.64 \times 10^{-27}$ kg, $q_\alpha = 3.2 \times 10^{-19}$ C) is moving with a velocity of v = 20,000 m/s through a uniform magnetic field, which has a field strength of B = 2.20 Tesla, at right angles to the field. What will be the magnitude of the resulting magnetic force?

5. A charged particle moves through an area of space where both an electric field, which has an intensity of E = 12,000 N/C, and a magnetic field, which has an intensity of B = 2.40 Tesla, are present. The two fields are mutually perpendicular as shown to the right and the velocity of the charged particle is moving perpendicularly into the paper as shown such that the charged particle passes through the fields undeflected. What is the velocity of the charged particle?



6. A magnetic field is directed as shown in the diagram to the right. The magnetic field has a strength of B = 0.78 Tesla. A positively charged particle of 1.20 μC enters the field from the top of the paper as shown with a velocity of V = 550 m/s.
   a. What will be the direction of the resultant magnetic force?
   b. What will be the magnitude of the magnetic force acting on this positive particle?
   c. What will be the direction of the force if the particle is negative?
   d. What will be the direction of the force if the negative particle is moving from left to right?



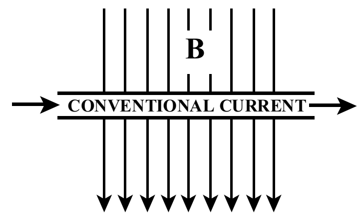


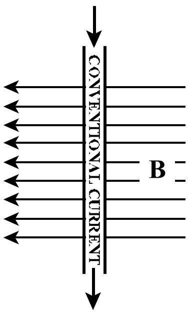
7. A doubly ionized [$q = -3.2 \times 10^{-19}$ C] Gold atom [$m_{gold} = 3.29 \times 10^{-25}$ kg] is moving in a circular path in a uniform magnetic field as shown below. The radius of the path is r = 12.8 cm and the gold atom is moving with a velocity of $v = 6.50 \times 10^5$ m/sec. What is the strength of the required magnetic field B?

ANSWERS TO OPPOSITE SIDE: 8a. 0.209 N b. into paper 9a. 1.27 N b. into paper c. parallel to B 10a. 0.132 N 10b. out of paper 11a. 853 Gauss b. into paper c. out of the paper 12a. 16.5 N/m b. toward the bottom of the page 13a. 0.47 Amperes b. counter-clockwise

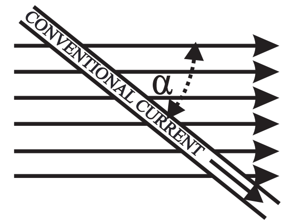
PHYSICS HOMEWORK #122 MAGNETISM
MAGNETIC FORCE ON CURRENT CARRYING WIRES

8. A piece of wire L = 15.0 cm long has a current of I = 3.10 Amperes flowing through it and is sitting in a uniform magnetic field which has an intensity of B = 0.450 Tesla. The wire is oriented perpendicularly to the magnetic field as shown to the right.
   a. What will be the magnitude of the resulting magnetic force?
   b. What will be the direction of the resulting magnetic force?



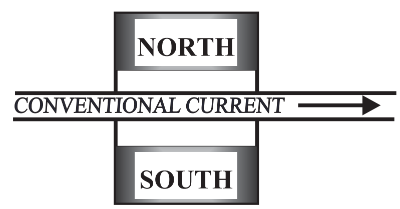


9. A conventional current of I = 5.30 Amperes is flowing through a wire oriented perpendicularly to a magnetic field as shown to the left. The strength of the magnetic field is B = 0.600 Tesla and the length of the wire sitting in the magnetic field is L = 40.0 cm.
   a. What will be the magnitude of the resulting magnetic force?
   b. What will be the direction of the resulting magnetic force?
   c. How could this wire be oriented so that it will feel NO magnetic force?

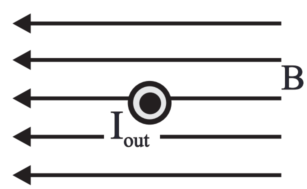


10. A wire L = 30.0 cm long is sitting in a uniform magnetic field and is oriented as shown in the diagram at the right. The strength of the magnetic field is B = 0.220 Tesla, a current of I = 3.25 Amperes is flowing through the wire and the wire is oriented at an angle of $\alpha = 38.0^o$ relative to the magnetic field.
   a. What will be the magnitude of the resulting magnetic force?
   b. What will be the direction of the resulting magnetic force?

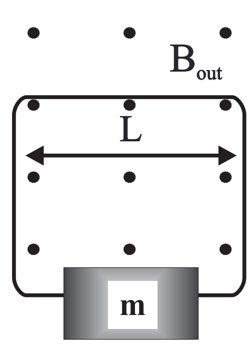
11. A wire loop [As in the lab!] is sitting in a uniform magnetic field between the poles of a permanent magnet as shown to the left. The magnet is L = 3.00 cm wide. When a conventional current of I = 6.25 Amperes flows through this wire it feels a magnetic force of F_m = 0.0160 N.
   a. What is the strength of the magnetic field generated by the permanent magnet?
   b. What will be the direction of the magnetic force acting on the wire?
   c. What will be the direction of the magnetic force if the direction of the current is reversed?



12. A conventional current of I = 7.50 Amperes is flowing out of the paper as shown to the right where the magnetic field has a strength of B = 2.20 Tesla and is directed toward the left as shown.
   a. What is the magnitude of the resulting magnetic force for each meter of length of this wire?
   b. What is the direction of the resulting magnetic force?



13. A loop of wire is attached to a mass of m = 50.0 grams. One end of the loop is sitting in a magnetic field directed out of the paper as shown and which has a magnitude of 3.00 Tesla. The length of the wire sitting in the magnetic field is L = 35.0 cm.
   a. What is the magnitude of the conventional current in the wire if the loop is to support the weight of the hanging mass?
   b. What will be the direction of the required conventional current to support the hanging mass?



ANSWERS TO OPPOSITE SIDE: 1a. 1.57×10^{-16} N b. zero 2a. out of paper b. circle 2c. 1.82×10^{-15} N d. 7.19×10^{-8} m 3. 4.87×10^{-3} Tesla 4. 1.41×10^{-14} N 5. 5000 m/s

PHYSICS HOMEWORK #123 MAGNETISM
MAGNETIC FORCE BETWEEN CURRENT CARRYING WIRES

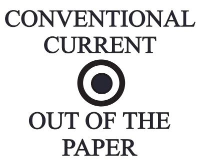
$$B = \frac{\mu_o \cdot I}{2 \cdot \pi \cdot r}$$

1. What will be the magnetic field strength r = 4.00 cm from a straight wire carrying a current of I = 2.50 Amperes?

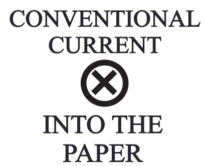
2. What will be the current flowing through a straight wire if the magnetic field strength is B = 5.50 Gauss a distance of r = 2.20 cm from the wire?

3. Describe **EXACTLY** the magnetic field for each of the following.

a.



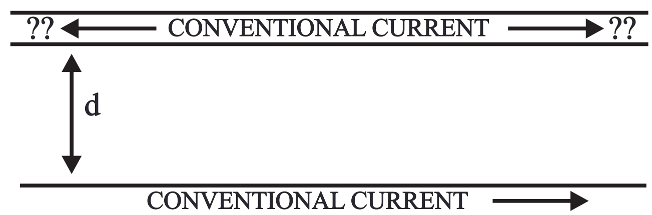
b.



c.

4. Two parallel, current carrying wires are spaced d = 2.00 cm apart. The currents in the two wires are I_1 = 3.50 Amperes and I_2 = 5.50 Amperes respectively.
   a. What will be the magnitude of the magnetic force per unit length between these two wires?
   b. What will be the direction of this force if the two currents are in the same direction?
   c. What will be the direction of this force if the currents are in opposite directions?

5. Consider two parallel wires oriented such that one wire is immediately above the other as shown at the right. The current in the lower wire is I_2 = 38.0 Amperes to the right and the distance between the wires is d = 2.20 cm. A second current flows in the upper wire so that the upper wire "floats" above the lower wire due to the magnetic repulsion between the two wires. The upper wire is made of copper [density of copper = 8.90 gm/cm^3] and has a diameter of D = 1.10 millimeters.



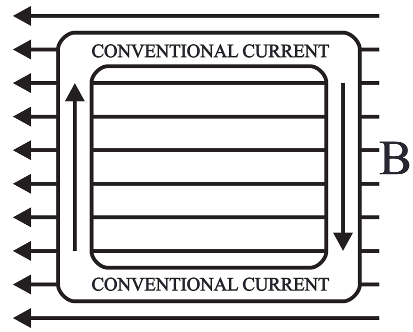
   a. What will be the direction of the magnetic field at the location of the upper wire as caused by the lower wire?
   b. In what direction should the current flow in the upper wire so that the force between these two wires is repulsive?
   c. What will be the magnitude of the required current in the upper wire?

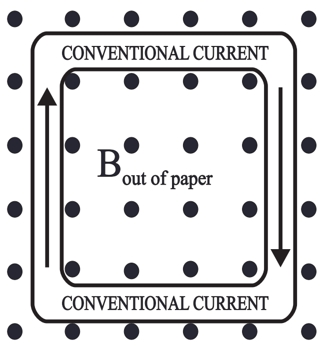
ANSWERS TO OPPOSITE SIDE: 6a. upper wire - no force, right wire - 0.351 N into paper, 6a. lower wire - no force, left wire - 0.351 N out of the paper 6b. 0.063 Nm 6c. 1.26 Nm 7a. upper wire - 0.144 N downward, right wire - 0.144 N left, lower wire - 0.144 N upward 7a. left wire 0.144 N right 7b. tends to compress the loop 7c. tends to expand the loop 8a. 4.33 Nm 8b. 3.75 Nm 8c. zero 8d. 4.33 sinΘ 8e. 1.33 Nm/T

PHYSICS HOMEWORK #124 MAGNETISM
MAGNETIC TORQUE ON A LOOP/COIL & MAGNETIC MOMENT

$$T = N \cdot I \cdot A \cdot \hat{n} \cdot \vec{B} = \vec{m} \times \vec{B} \qquad \vec{m} = N \cdot I \cdot A \cdot \hat{n}$$

6. A conducting loop is sitting in a uniform magnetic field directed to the left as shown in the diagram to the right. The current in the loop is I = 1.30 Amperes clockwise and the magnetic field has an intensity of B = 2.25 Tesla. The loop is 12.0 cm high and 18.0 cm wide as shown.
   a. Determine the direction and magnitude of the resulting magnetic force on each section of the loop.
   b. What will be the direction and magnitude of the resulting magnetic torque exerted on the loop?
   c. What will be the magnitude of the resulting torque if the loop consists of 20 turns of wire instead of a single loop?





7. A conducting loop, which is 15 cm by 15 cm, is sitting in a uniform magnetic field directed out of the paper as shown in the diagram to the left. The current is flowing clockwise as shown and has a magnitude of I = 1.75 Amperes. The magnetic field strength is B = 0.550 Tesla.
   a. Determine the direction and magnitude of the magnetic force exerted on each segment of the loop.
   b. What will be the resulting magnetic effect on the loop? Explain!
   c. What will be the effect on this loop if the direction of the current is reversed? Explain!

8. A coil of wire, which is shaped into a square where each side is L = 5.50 cm., consists of N = 110 turns and through which a current of I = 4.00 Amperes flows, is placed in a uniform magnetic field which has a magnitude of B = 3.25 Tesla.
   a. What will be the maximum torque felt by this loop?
   b. What will be the torque applied to this loop when the normal to the plane of the loop is tilted at an angle of $\Theta = 60.0^o$ relative to the direction of the magnetic field?
   c. What will be the torque on the loop when the normal to the plane of the loop is parallel to the direction of the magnetic field lines?
   d. Write an equation which would describe the torque acting on this loop as a function of the angle Θ between the normal to the loop and the direction of the magnetic field?
   e. What is the magnetic moment of this coil of wire?

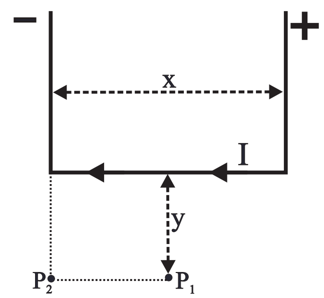
ANSWERS TO OPPOSITE SIDE: 1. 1.25×10^{-5} Tesla 2. 60.5 Amperes 3a. counterclockwise 3b. clockwise 3c. out of paper above, down in front, into paper below 4a. 1.93×10^{-4} N/m b. attractive c. repulsive 5a. out of paper b. to the left c. 240 Amperes

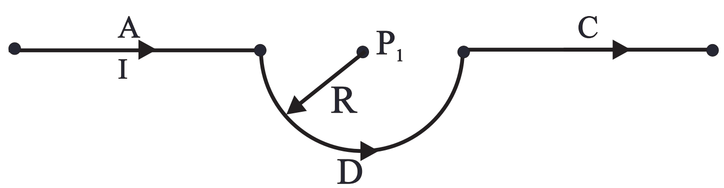
PHYSICS HOMEWORK #125 MAGNETISM
MAGNETIC FIELD AND THE BIOT-SAVART LAW

Use the Biot-Savart Law to solve the following problems! →

$$dB = k_m \cdot \frac{I \cdot d\vec{l} \times \hat{r}}{r^2} \qquad k_m = \frac{\mu_o}{4\pi} = 10^{-7} \cdot \frac{N}{A^2} \qquad \mu_o = 4\pi \text{ x } 10^{-7} \text{ N/A}^2$$

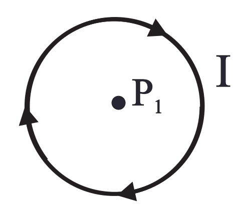
1. Consider conductor bent into the shape shown to the right. The conductor has a current of I = 5.00 Amperes flowing through it from right to left as shown. The horizontal segment of the conductor is x = 12.0 cm long. There is a point P_1 located a distance y = 8.00 cm from the segment as shown and there is a second point P_2 located y from the segment and perpendicular to the corner of the segment. [Ignore any contribution to the magnetic field caused by the vertical wire segments!] Using the Biot-Savart Law determine:
   a. the direction and magnitude of the magnetic field B at point P_1.
   b. the direction and magnitude of the magnetic field B at point P_2.

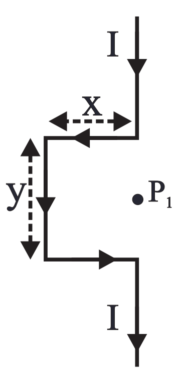




2. A current of I = 8.00 Amperes is flowing from left to right through the wire shown above. The central segment D of the wire is in the shape of a semi-circular loop, as shown, with a radius of R = 12.0 cm. while segments A and C are straight.
   a. What is the direction and magnitude of the magnetic field B_A at point P_1 as caused by wire segment A?
   b. What is the direction and magnitude of the magnetic field B_D at point P_1 as caused by wire segment D?
   c. What is the direction and magnitude of the magnetic field B_C at point P_1 as caused by wire segment C?
   d. What will be the direction and magnitude of the magnetic field B at point P_1?

3. A current of I = 3.50 Amperes is flowing in a circular, closed conducting path which has a radius of R = 6.00 cm. as shown to the right.
   a. What will be the direction of the magnetic field at point P_1?
   b. What will be the strength of the magnetic field at the center P_1 of this closed conducting loop?
   c. What will be the strength of the magnetic field B at point P_1 if this loop of wire is actually a coil of wire with N = 20 turns, each turn of which has a current of I = 3.50 Amperes?





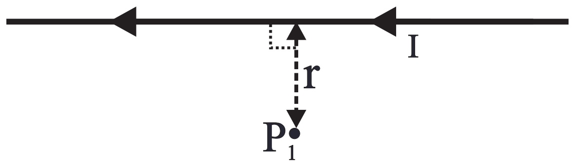
4. A segment of wire is bent into the shape shown to the left. A current of I = 10.0 Amperes is flowing through the wire from top to bottom as shown. The segment x = 4.00 cm and y = 8.00 cm.
   a. What will be the direction of the magnetic field B at point P_1?
   b. What will be the magnitude of the magnetic field B at point P_1?

Answers to opposite side: 5a. out of the paper b. $3.46 \text{ x } 10^{-5}$ Tesla 6a. 9550 A/m^2
6b. down & left c. $3.00 \text{ x } 10^{-5}$ Tesla d. toward the right e. $6.00 \text{ x } 10^{-5}$ Tesla
6f. 2.82 Amperes g. $5.64 \text{ x } 10^{-5}$ Tesla 7a. 3570 turns/m b. none, perpendicular
7c. very little, weak d. none, perpendicular e. B•l f. n•I•l g. $1.57 \text{ x } 10^{-2}$ Tesla
8. $-6.00 \text{ x } 10^{-5}$ Tesla out of the paper

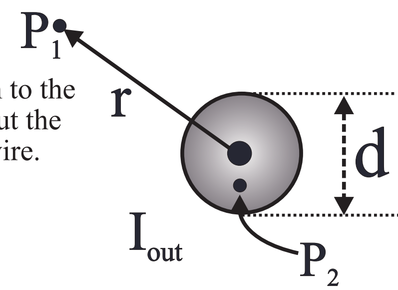
PHYSICS HOMEWORK #126 MAGNETISM
MAGNETIC FIELD AND AMPERE'S LAW

Use Ampere's Law to solve each of the following problems! ⟶ $\oint \vec{B} \cdot d\vec{l} = \mu_o I_{enclosed}$

5. A current of I = 3.80 Amperes is flowing through a long straight conductor as shown below. Point $\mathbf{P_1}$ is located a distance r = 2.20 cm from the wire.

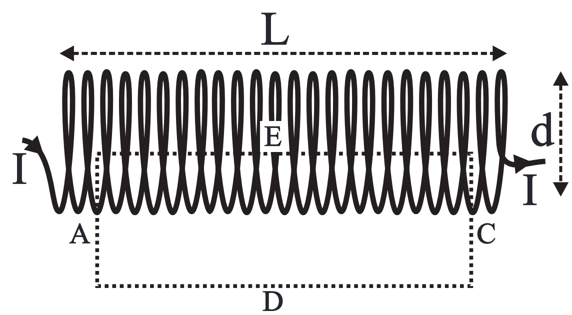


a. What will be the **direction** of the magnetic field **B** at point $\mathbf{P_1}$?
b. What will be the **magnitude** of the magnetic field **B** at point $\mathbf{P_1}$?



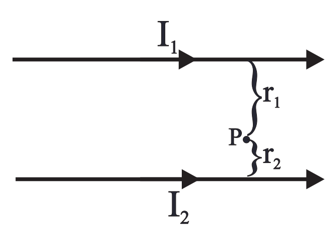
6. Current of I = 12.0 Amperes is flowing through a wire directed out of the paper as shown to the right. The wire has a diameter of d = 4.00 cm. and current density J is uniform throughout the interior of the wire. Point P_1 is located a distance of r = 8.00 cm from the center of the wire.
a. What is the **current density J** within this wire?
b. What will be the **direction** of the magnetic field strength $\mathbf{B_1}$ at point $\mathbf{P_1}$?
c. What will be the **magnitude** of the magnetic field strength $\mathbf{B_1}$ at point $\mathbf{P_1}$?
d. What will be the **direction** of the magnetic field $\mathbf{B_2}$ at point $\mathbf{P_2}$ within the wire?
e. What will be the **magnitude** of the magnetic field strength $\mathbf{B_2}$ at a second point $\mathbf{P_2}$ located only r = 1.00 cm from the center of the wire?
Suppose that the current density within this wire varies with distance from the center of the wire according to the relationship J = (8400 + 86,200r) Amperes/m^2.
f. What will be the total current $\mathbf{I_{enclosed}}$ within the appropriate Ampere's closed path for point $\mathbf{P_2}$?
g. What will be the magnetic field strength $\mathbf{B_2}$ located at point $\mathbf{P_2}$ within this wire?

7. Consider a **solenoid** which contains N = 500 turns, has a diameter of d = 2.50 cm and is L = 14.0 cm. long. An Ampere's closed path is set up according to the diagram to the right. A current of I = 3.50 Amperes is flowing through the solenoid.



a. What is the number of turns per unit length **n** for this solenoid?
b. Based on Ampere's Law, what contribution does segment **A** of the designated Ampere's closed path contribute to the integral? Explain!
c. What contribution does segment **D** make to the integral? Explain!
d. What contribution does segment **C** make to the integral? Explain!
e. What contribution does segment **E** make to the integral? Explain!
f. What is the **total current** enclosed by the Ampere's closed path?
g. What is the magnetic field strength **B** within the solenoid?

8. Two parallel wires are carrying currents of I_1 = 6.00 Amperes and I_2 = 9.0 Amperes respectively as shown in the diagram to the right. There is a point **P** between the two wires which is r_1 = 4.00 cm from the wire carrying the current I_1 and r_2 = 2.00 cm from the wire carrying the current I_2. What will be the **direction** and **magnitude** of the magnetic field $\mathbf{B_P}$ at point **P**?



Answers to opposite side: 1a. 7.50 x 10^{-5} Tesla - out b. 5.20 x 10^{-6} Tesla - out 2a. zero b. 2.09 x 10^{-5} Tesla - out 2c. zero d. 2.09 x 10^{-5} Tesla - out 3a. in b. 3.67 x 10^{-5} Tesla c. 7.33 x 10^{-4} Tesla 4a. out b. 3.54 x 10^{-5} Tesla

PHYSICS HOMEWORK #127 MAGNETISM
MAGNETIC FLUX AND FARADAY'S LAW

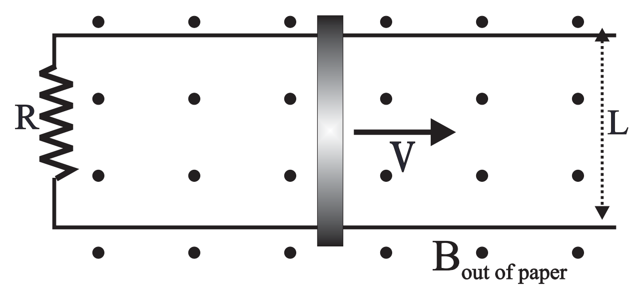
$$EMF = -N \cdot \frac{\Delta\phi}{\Delta t}$$

1. Consider a single loop of wire which is 25 cm by 25 cm. Passing through this loop is a magnetic field which has a magnitude of B = 0.220 Tesla.
   a. Assuming that the magnetic field is parallel to the normal to the loop, what will be the total magnetic flux passing through the loop?
   b. Assuming that the magnetic field meets the normal to the loop at an angle of $\Theta = 35.0^o$, what will be the total magnetic flux passing through the loop?
   c. Assuming that the magnetic field is perpendicular to the normal to the loop, what will be the total magnetic flux ϕ passing through the loop?

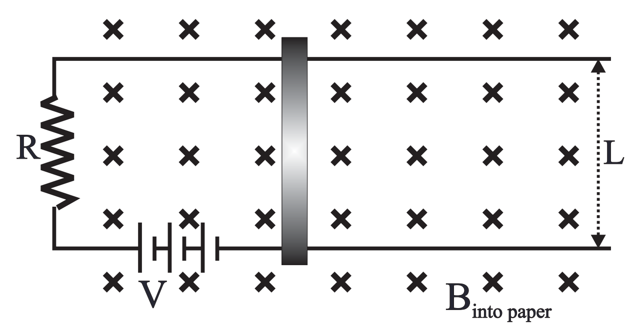
2. Consider a single loop of wire which encloses an area of A = 50.0 square centimeters. A magnetic field, which is parallel to the normal of this loop, initially has an intensity of B = 0.220 Tesla. Over a time period of $\Delta t = 0.200$ seconds the magnetic field strength B drops to zero.
   a. What will be the resulting EMF in the loop?
   b. What will be the EMF in this circuit if the loop consists of 1000 turns rather than a single turn as above?

3. Consider a coil of wire which has N = 1200 turns, encloses an area of A = 18.0 cm^2 and contains a magnetic field of B = 3.50 Tesla oriented parallel to the normal to the loop. What will be the induced EMF in this coil if the magnetic field B drops to zero in t = 0.0167 seconds?

4. Two parallel rails are connected together at one end by a resistance of R = 20.0 Ω as shown in the diagram to the right. Across these two rails, which are L = 45.0 cm apart, there lies a conducting metal bar. The magnetic field is uniform, has a strength of B = 2.20 Tesla and is directed out of the paper as shown. A force is applied to the metal bar so as to push the bar to the right with a velocity v = of 8.40 m/s.
   a. What will be the resulting EMF in this circuit?
   b. What will be the direction of the resulting conventional current flowing through this circuit?
   c. What will be the magnitude of the resulting current?
   d. At what rate is electrical energy being generated?
   e. How much force is being applied to this bar?
   f. At what rate is mechanical energy being consumed?



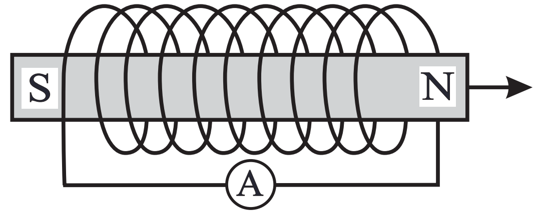
5. Consider the inverse of problem #22 above. Suppose that instead of pushing the metal bar through the magnetic field a battery, which has an EMF of V = 6.00 Volts, is inserted into the circuit as shown. The magnetic field has an intensity of B = 2.20 Tesla and is directed into the paper as shown and the resistance has a value of 20.0 Ω. A current of I = 0.20 Amperes is measured to be flowing through the circuit.
   a. What will be the resulting velocity of the bar?
   b. How much force is being applied to the bar by the the magnetic field as it moves through the field?



Answers to opposite side: 6a. left to right b. left to right c. zero d. left to right e. left to right
7. counterclockwise 8. counterclockwise 9. counterclockwise 10. clockwise 11a. right to left
11b. zero c. counterclockwise d. clockwise

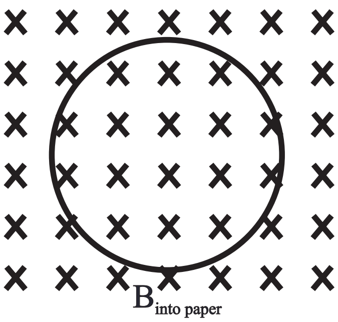
PHYSICS HOMEWORK #128 — MAGNETISM

MAGNETIC INDUCTANCE AND LENZ'S LAW



6. Consider a coil of wire formed into a solenoid [a solenoid is a coil whose length is much greater than its diameter] as shown to the right. Initially, a bar magnet is sitting at rest within the solenoid with the polarity as shown. The bar magnet is then quickly removed to the right.
   a. What will be the direction of the magnetic field within the solenoid BEFORE the permanent magnet is removed from the solenoid?
   b. What will be the direction of the magnetic field within the solenoid IMMEDIATELY after removing the permanent magnet?
   c. What will be the direction of the magnetic field within the solenoid a long time after the permanent magnet has been removed from the solenoid?
   d. What will be the direction of the resulting current through the ammeter? Explain!
   e. Suppose, instead, that the magnet is removed quickly to the left. What will be the direction of the resulting current through the ammeter? Explain!

7. A single loop of wire is lying in the plane of the paper as shown to the right. A bar magnet is approaching the loop from in front of the paper with the North end of the magnet entering the loop first. What will be the direction of the induced current flowing in the loop? Explain!

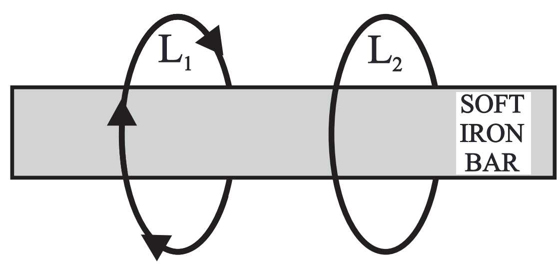


Each of the following 3 problems refers to the diagram to the left which represents a single coil of wire sitting in a uniform magnetic field B directed into the paper.

8. Suppose that this coil is quickly flipped over. What will be the direction of the induced current in the loop immediately after it has been flipped? Explain!

9. Suppose that the magnetic field B is slowly getting stronger with time. What will be the direction of the induced current? Explain!

10. Suppose that the magnetic field B is slowly getting weaker with time. What will be the direction of the induced current? Explain!

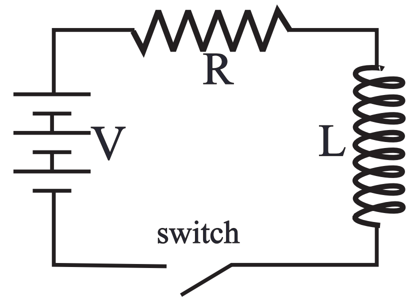


11. A soft iron bar is sitting surrounded by two separate loops of wire. The loop on the left, L_1, initially has a current flowing clockwise as viewed from the right and as shown.
   a. What will be the direction of the magnetic field in the soft iron bar? Explain!
   b. What will be the direction of the initial current flowing through the right hand loop L_2? Explain!
   c. The current flowing through loop L_1 is slowing increasing with time. What will be the direction of the resulting current flow in loop L_2? Explain!
   d. The current flowing through loop L_1 is slowing decreasing with time. What will be the direction of the resulting current flow in loop L_2? Explain!

Answers to opposite side: 1a. 0.01375 Webers b. 0.0113 Webers c. 0.0 Webers
2a. 0.0055 Volts b. 5.50 Volts 3. 453 Volts 4a. 8.32 Volts b. clockwise c. 0.416 Amperes
4d. 3.46 Watts e. 0.412 Newtons f. 3.46 Watts 5a. 2.02 m/s b. 0.198 Newtons

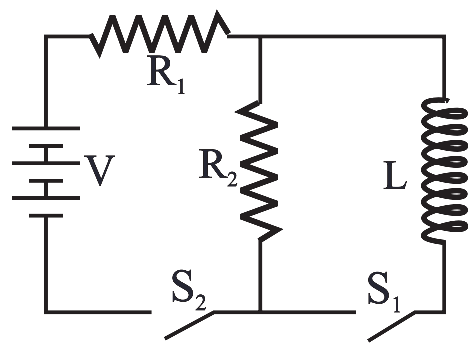
PHYSICS HOMEWORK #129 MAGNETISM
MAGNETIC INDUCTANCE & SIMPLE CIRCUITS

1. An induction coil, which has an inductance of L = 250.0 milliHenrys, is connected in series with a resistance of R = 20.0 Ω and with a battery which has a DC voltage of V = 36.0 Volts. Initially, the switch has been closed for a long time but at t = 0 sec. the switch is opened.



   a. What will be the current $\mathbf{I_o}$ is this circuit **immediately before** the switch is opened? Explain!
   b. What will be the current through the circuit **immediately after** the switch has been opened? Explain!
   b. What is the inductive time constant $\mathbf{t_c}$ for this circuit?
   c. What will be the current $\mathbf{I_t}$ flowing through this circuit t = 15.0 millisec after the switch has been opened?
   d. What will be the current I_f flowing in this circuit a long time after the switch has been opened?

2. An induction coil, which has an inductance of L = 22.0 milliHenrys, is connected with two resistors, R_1 = 100 Ω and R_2 = 1500 Ω, and a battery V = 32.0 Volts as shown in the diagram to the right. At t = 0 seconds both switches are closed simultaneously.

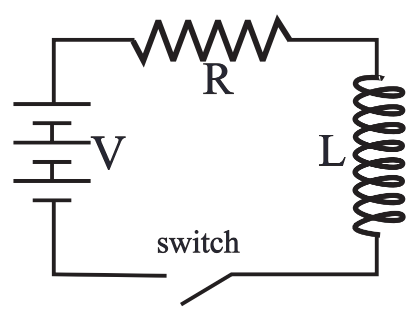


   a. What will be the **current** flowing in the inductor L **immediately** after the switches have been closed?
   b. What will be the **current** flowing through resistor R_2 **immediately** after the switches have been closed?
   c. What will be the **current** flowing through resistor R_2 **a long time** after the switches have been closed?
   d. What will be the **current** flowing through resistor R_1 **a long time** after the switches have been closed?
   e. What will be the **current** flowing through the inductor L **a long time** after the switches have been closed?

   After a long time switch S_2 is re-opened. [S_1 remains closed.]

   f. What will be the **current** flowing through the inductor **L immediately** after switch $\mathbf{S_2}$ has been re-opened?
   g. What will be the **current** flowing through the resistor $\mathbf{R_1}$ **immediately** after switch $\mathbf{S_2}$ has been re-opened?
   h. What will be the **potential difference** across resistor $\mathbf{R_2}$ **immediately** after switch $\mathbf{S_2}$ has been re-opened?
   i. What will be the **potential difference** across the inductor **L immediately** after switch $\mathbf{S_2}$ has been re-opened?
   j. What will be the **current flowing** through the inductor **L** a **long time** after switch $\mathbf{S_2}$ has been re-opened?

3. An induction coil, which has an inductance of L = 12.0 milliHenrys, is connected in series with a resistance of R = 50 Ω and with a battery which has a DC voltage of V = 24.0 Volts. At t= 0 seconds the switch is closed.



   a. What will be the current is this circuit **immediately** after the switch is closed? Explain!
   b. What will be the inductive time constant $\mathbf{t_c}$ for this circuit?
   c. What will be the current $\mathbf{I_t}$ flowing through this circuit t = 50 μsec after the switch has been closed?
   d. What will be the current I_f flowing in this circuit a long time after the switch has been closed?

Answers to opposite side: 4a. 0.437 Henrys b. 9.61 Volts c. 5.24 Henrys d. 115 Volts
5a. 0.91 Amperes b. 0.0174 s c. $I = 0.91\ e^{-t/.0174}$ Amperes d. 0.859 Amperes e. 0.0386 Amperes f. 0.080 sec
6a. 66.3 μH b. 0.445 Ω c. 0.667 Ω d. 0.802 Ω e. 29.9 Amperes f. $I = 29.9 \sin [1.01 \times 10^4 t]$
6g. $3.01 \times 10^5 \cos [1.01 \times 10^4 t]$ h. $-19.9 \cos [1.01 \times 10^4 t]$ i. 4.07 Volts 7a. 415 Ω b. 419 Ω
7c. 0.076 Amperes d. 82.5° e. 0.317 Watts

PHYSICS HOMEWORK #130 MAGNETISM
MAGNETIC INDUCTANCE & IMPEDANCE

4. A given solenoid consists of 7250 turns of wire, has a diameter of 4.4 cm and is 23 cm long.
   a. What is the self inductance of this solenoid?
   b. Suppose that the current flowing through this solenoid is initially 12.5 Amperes and is decreasing at a rate of 22.0 Amperes/second. What will be the EMF generated across this coil as a result of this changing current?
   c. Suppose that this coil is surrounded by a second coil which has the exact same length as the first coil, consists of 87,000 turns and has a radius that is only slightly larger than the first coil. What will be the mutual inductance of these two coils?
   d. What will be the induced EMF in the secondary coil?

5. Consider a coil which has a self inductance of 0.23 Henrys and a resistance of 13.2 Ω. A DC voltage of 12.0 Volts is applied to this coil until a steady state current is flowing through the coil.
   a. What will be the magnitude of this steady state current?
   b. What will be the time constant for this coil?
   c. Suppose that the supply of EMF is suddenly cut off. Write an equation describing the current flowing through this coil as a function of time.
   d. What will be the current flowing through this coil 1.0 milliseconds after the source of EMF is removed?
   e. What will be the current flowing through this coil 55.0 milliseconds after the source of EMF is removed?
   f. How long will it take for the current flowing through the coil to drop to 1.0% of its initial steady state value?

6. Consider a solenoid which consists of 210 turns of wire, has a diameter of 0.8 cm., and is 4.2 cm long. The solenoid is made of gauge 24 [diameter = 0.051cm] copper [r = 1.72×10^{-6} Ω cm] wire. An AC voltage of 24 Volts RMS at 1600 Hz. is applied to this solenoid.
   a. What is the self inductance of this solenoid?
   b. What is the resistance of this solenoid?
   c. What will be the inductive reactance of this solenoid?
   d. What will be the impedance of this solenoid at this frequency?
   e. Based on the applied voltage , what will be the peak current flowing through this solenoid?
   f. Write an equation describing the current flowing through this solenoid as a function of time.
   g. Write the equation describing the rate of change of current in this solenoid as a function of time?
   h. What will be the resulting EMF generated by this coil as a function of time?
   i. What will be the phase angle between the voltage across the solenoid and the current flowing through the solenoid?

7. An AC voltage of 45.0 Volts at a frequency of 880 Hz. is applied to a coil which has a resistance of 55.0 Ω and an inductance of L = 0.075 Henrys.
   a. What is the inductive reactance of this coil?
   b. What is the impedance of this coil at this frequency?
   c. What will be the RMS current flowing through this coil?
   d. What is the phase angle between the current and the voltage across this coil?
   e. At what rate is power being dissipated in this coil?

Answers to opposite side: 1a. 1.80 Amperes b. 1.80 Amperes c. 0.0125 seconds d. 0.542 Amperes 1e. zero 2a. zero b. 0.020 Amperes c. zero d. 0.320 Amperes e. 0.320 Amperes 2f. 0.320 Amperes g. 0.320 Amperes h. 480 Volts i. 480 Volts j. zero 3a. zero 3b. 2.40×10^{-4} seconds c. 0.0903 Amperes d. 0.480 Amperes