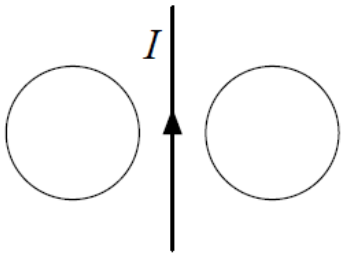
Practice problems, Physics 121 Common Exam 3, Fall 2024

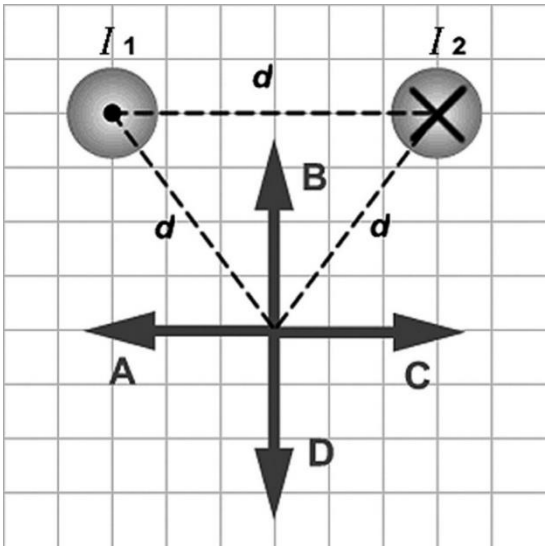
Chapters: 27, 28, 29

1. The current I in a long wire is going up as shown in the figure and increasing in magnitude. What is the direction of the induced current in the left loop and the right loop? List the direction of the induced current in
the left loop first. (CW = clockwise, CCW = counterclockwise)



Answer: CW, CCW

2. The figure shows two long wires carrying equal currents I_1 and I_2 flowing in opposite directions. Which of the arrows labeled A through D correctly represents the direction of the magnetic field due to the wires at a point located at an equal distance d from each wire?



A) A
B) B
C) C
D) D
E) The magnetic field is zero at that point.

3. Force on moving charges: A particle with charge -5.00 C initially moves at $\vec{v}$ = (1.00 $\hat{i}$ + 7.00 $\hat{j}$) m/s. If it encounters a magnetic field $\vec{B}$ = 10.00 T $\hat{k}$, find the magnetic force vector on the particle.

A) (- 350 $\hat{i}$ + 50.0 $\hat{j}$) N

B) (- 350 $\hat{i}$ - 50.0 $\hat{j}$) N

C) (350 $\hat{i}$ + 50.0 $\hat{j}$) N

D) (350 $\hat{i}$ - 50.0 $\hat{j}$) N

4. A point charge *Q* moves on the *x*-axis in the positive direction with a speed of 280 m/s. A point *P* is on the *y*-axis at $y = +70$ mm. The magnetic field produced at the point *P*, as the charge moves through the origin, is equal to -0.30 μT $\hat{k}$. What is the charge *Q*? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) - 53 μC

B) + 53 μC

C) - 39 μC

D) + 39 μC

E) + 26 μC

5. Two long parallel wires carry currents of 20 A and 5.0 A in opposite directions. The wires are separated by 0.20 m. What is the magnitude of the magnetic field midway between the two wires? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) 1.0×10^{-5} T

B) 2.0×10^{-5} T

C) 3.0×10^{-5} T

D) 4.0×10^{-5} T

E) 5.0×10^{-5} T

6. A circular loop of wire of radius 10 cm carries a current of 6.0 A. What is the magnitude of the magnetic field at the center of the loop? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

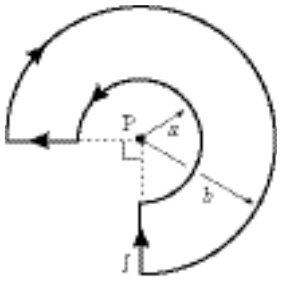
A) 3.8×10^{-5} T
B) 3.8×10^{-7} T
C) 1.2×10^{-5} T
D) 1.2×10^{-7} T
E) 3.8×10^{-8} T

7. A solenoid with 400 turns has a radius of 0.040 m and is 40 cm long. If this solenoid carries a current of 12 A, what is the magnitude of the magnetic field near the center of the solenoid? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) 16 mT
B) 4.9 mT
C) 15 mT
D) 6.0 mT
E) 9.0 mT

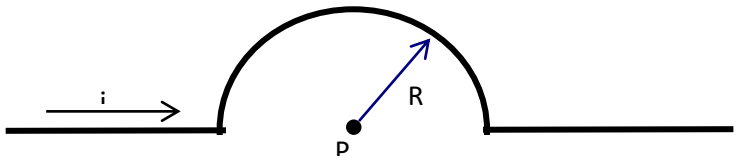
8. What is the magnitude of the magnetic field at point P if *a = 5 mm* and *b = 12 mm* and current *I = 16 A*?

A) 0.28 mT
B) 0.44 mT
C) 0.88 mT
D) 1.08 mT
E) 1.50 mT



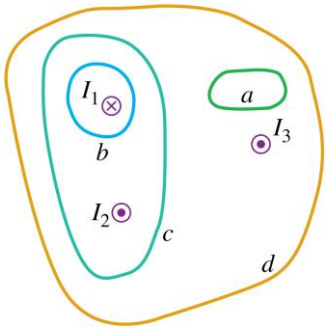
9. Point P is the center of the semicircle in the accompanying sketch, with current I flowing from left to right as shown. The magnitude and direction of the magnetic field at P are:

A) $\mu_0 i/4R$, out of paper
B) $\mu_0 i/4\pi R$, into paper
C) $\mu_0 i/4\pi R$, out of paper
D) $\mu_0 i/4R$, into paper
E) $\mu_0 i/2R$, into paper



10. The figure shows, in cross section, three conductors that carry currents perpendicular to the plane of the figure. If the currents I_1, I_2, and I_3 all have the same magnitude, for which path(s) is/are the line integral of the magnetic field equal to zero?

A) path *a* only
B) paths *a* and *c*
C) paths *b* and *d*
D) paths *a*, *b*, *c*, and *d*
E) depends on whether the integral goes clockwise or counterclockwise around the path



11. A proton is moving with a speed of $3x10^5$ m/s in an uniform magnetic field of B = 0.01 Tesla. The field points directly out of the page, and the velocity of the proton lies within in the plane of the page. Find the frequency of revolution and the direction (CW or CCW) The frequency is the reciprocal of the period. The mass of the proton is approximately $1.7x10^{-27}$ kg. The answer is closest to:

A) 150 kHz, CCW
B) 150 kHz, CW
C) 150 MHz, CCW
D) 150 MHz, CW
E) the particle keeps moving in a straight line

12. Two parallel wires are each 5 meters long. They are separated by a perpendicular distance of 100 cm and carry currents of 40 A. and 50 A. in the same direction. Find the interaction force between the wires:

A) zero
B) 0.2 N, attraction
C) 0.2 N, repulsion
D) 2×10^{-3} N, attraction
E) 2×10^{-3} N, repulsion

13. A flat circular coil of wire has 100 turns each of which is carrying current I = 10 A. in the counterclockwise direction as shown. The radius of each loop in the coil is r = 10 mm. The magnetic field at the center of the loop is closest to:

A) zero
B) 0.063 T , out of the page
C) 0.063 T , into the page
D) 0.63 mT , into the page
E) 0.63 mT, out of the page

14. A long solenoid has 500 turns of wire per meter. It carries a current of 10 A. Find the magnetic field at the center of the solenoid.

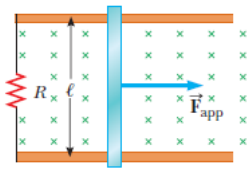
A) 0.63 mT
B) 0.0063 T
C) 0.063 T
D) 0.63 T
E) 6.3 T

15. A negatively charged particle (an electron) with charge -1.6 x 10^{-19} C is moving at a velocity v = 10^{6} m/s in the positive x direction. It is crossing a region where a uniform magnetic field with B = 500 kT (kilo-Teslas) points in the negative y direction. Find the force acting on the particle.

A) 8.0 x 10^{-8} N, -x direction
B) 8.0 x 10^{-8} N, -y direction
C) 8.0 x 10^{-8} N, +y direction
D) 8.0 x 10^{-8} N, -z direction
E) 8.0 x 10^{-8} N, +z direction

16. Consider the arrangement shown in Figure. Assume R= 6 Ohm, l= 1.20 m, and a uniform 2.50-T
magnetic field is directed into the page. At what speed should the bar be moved to produce a current of 0.500 A in the resistor?

A) 1m/s

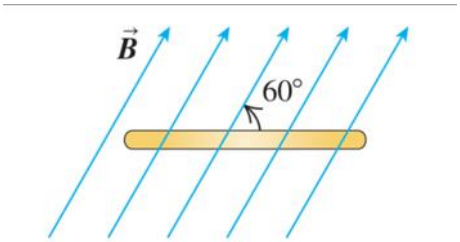


17. (a) What is the speed of a beam of electrons when the simultaneous influence of an electric field of 1.56 x 10^{4} V/m and a magnetic field of 4.62 x 10^{-3} T, with both fields normal to the beam and to each other, produces no deflection of the electrons? (b) In a diagram, show the relative orientation of the vectors **v**, **E**, and **B** . (c) When the electric field is removed, what is the radius of the electron orbit? What is the period of the orbit?
Ans. a)3.38 x10^{6} m/s, c) 4.17 x10^{-3} m; 7.74 x10^{-9}s

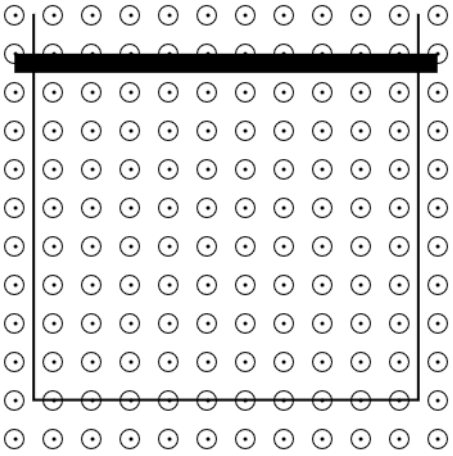
18. A flat, circular, steel loop of radius 75 cm is at rest in a uniform magnetic field, as shown in an edge-on view in Figure. The field is changing with time, according to $B(t) = (1.4T)e^{-(0.057s^{-1})t}$ (a) Find the emf induced in the loop as a function of time. (b) When is the induced emf equal to 1/10 of its initial value?

A) $\mathbf{|\varepsilon_{ind}| = (0.12V)e^{-(0.057s^{-1})t}}$

B) t=40.4 s



The picture below relates to the following 4 questions. A horizontal slider is 10 cm long and can move up or down the conducting rails in the plane of the page. The net resistance of the circuit formed by the slider and the rails is 3.0 kOhm. A magnetic field points out of the page. In each case find the magnitude and direction of the induced current.



19. Slider is not moving but the field increasess at a rate of 6.0 T/s. The veritcal distance between the slider and the horizontal rail is 10 cm.

Ans. 2 x 10^-5 amp, CW

20. Same as above but the field *decreases* at 6 T/s.

Ans. 2 x 10^-5 amp, CCW

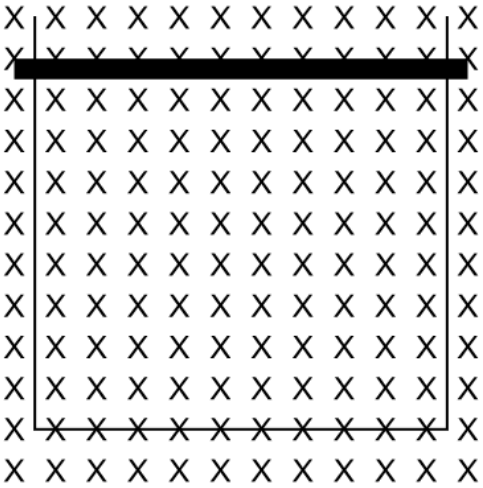
21. Field B=2.4 T is costant but the slider is moving up at 18 m/s.

Ans. 0.00144 amp, CW

22. Same as above but the slider is moving *down* at 18 m/s.

Ans. 0.00144 amp, CCW

The figure below relates to the same set of 4 questions as above but now the field point *into* the page.



23. Stationary slider but field increases at 6.0 T/s. (Vertical distance between the slider and the horizontal rail is 10 cm).

Ans. 2 x 10^-5 amp, CCW

24. Stationary slider but field decreases at 6 T/s.

Ans. 2 x 10^-5 amp, CW

25. Constant field B=2.4 T , but slider moves up at 18 m/s .

Ans. 0.00144 amp, CCW

26. Constant field B=2.4 T but the slider moves down at 18 m/s,

Ans. 0.00144 amp, CW

The figure below relates to the following 5 questions. A straight wire carries current I up in the plane of the page. A conducting rectangular frame is to the right of the straight wire. In each case find the direction of the induced current in the frame.

27. Current I increases with time.

Ans,: CCW

28. Current decreases with time.

Ans, CW

29. Current is constant but the frame moves right in the plane of the page.

Ans. CW

30. Current is constant but the frame moves left in the plane of the page, without crossing the wire.

Ans. CCW

31. The frame moves up in the plane of the page, parallel to the wire.

Ans. zero