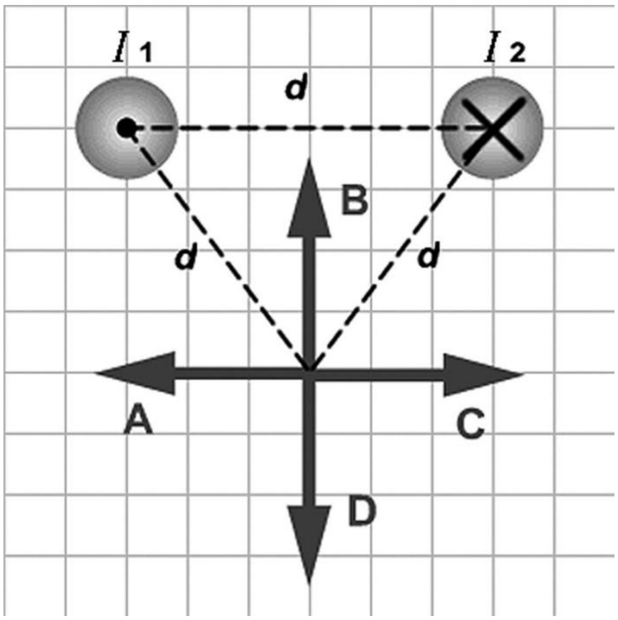
Practice problems, Physics 121 Common Exam 3 (Chapter 27, 28, 29)

Spring 2023

1. 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.

2. 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 $\vec{B} = 10.00\ \mathrm{T}\ \hat{k}$, 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

3. 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

4. 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

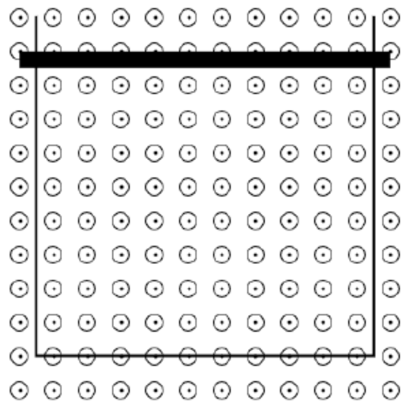
5. A circular loop of wire of radius 10 cm carries a current of 6.0 A. What is the magnitude of the magnetic field at the center of the loop? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

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

6. 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

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.



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

Ans. 2 x 10^-5 amp, CW

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

Ans. 2 x 10^-5 amp, CCW

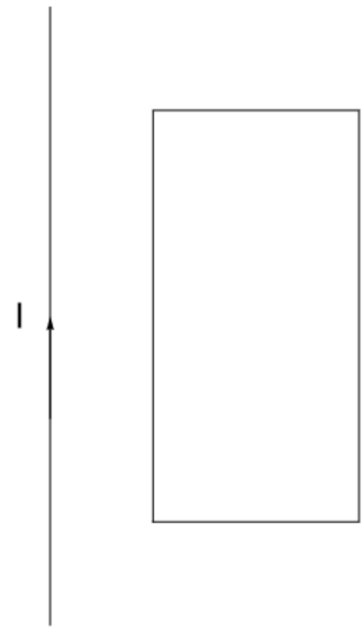
9. Field B=2.4 T is constant but the slider is moving up at 18 m/s.

Ans. 0.00144 amp, CW

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

Ans. 0.00144 amp, CCW

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.



11. Current I increase with time.

Ans,: CCW

12. Current decreases with time.

Ans, CW

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

Ans. CW

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

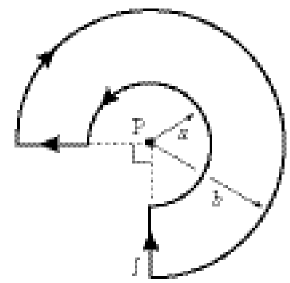
Ans. CCW

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

Ans. Zero

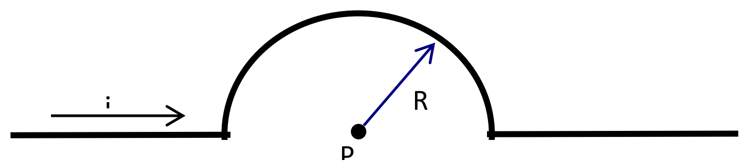
16. What is the magnitude of the magnetic field at point P if *a = 5 mm* and *b = 12 mm* and current *I = 16 A*?

A) 0.28 mT
B) 0.44 mT
C) 0.85 mT
D) 1.08 mT
E) 1.50 mT

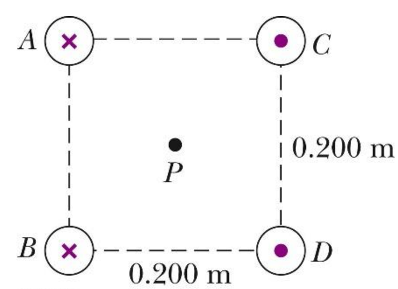


17. Point P is the center of the semicircle in the accompanying sketch, with current I flowing from left to right as shown. The magnitude and direction of the magnetic field at P are:

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

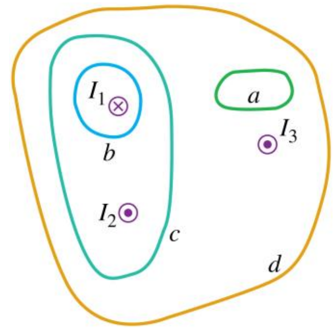


18. The sketch shows four very long parallel wires carrying equal currents of I = 1.0 A that are flowing into or out of the plane of the sketch. The wires are located at the corners of a square, each side of which is 0.200 m long. Current flows into the sketch at A and B, and flows out of the sketch at C and D. Find the magnitude and direction of the net magnetic field at point P – the center of the square.



A) 0 T
B) 4.0×10^{-6} T. down
C) 1.0×10^{-6} T. up
D) 1.0×10^{-5} T. down
E) 4.0×10^{-5} T. up

19. 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

20. A coil 4.00 cm in radius, containing 500 turns, is placed in a uniform magnetic field that varies with time according to $B = (0.0120 T/s)t + (3.00x\ 10^{-5}\ T/s^4)t^4$. The coil is connected to a 600 Ω resistor, and its plane is perpendicular to the magnetic field. You can ignore the resistance of the coil. Find the magnitude of the induced emf in the coil as a function of time.

Ans. $\boldsymbol{\varepsilon(t) = 0.0302V + (3.02x\ 10^{-4}\ V/s^3)\ t^3}$