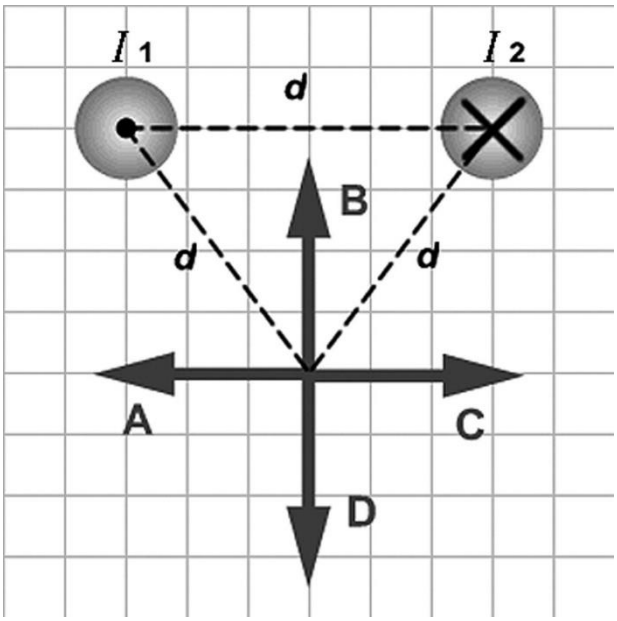
Practice problems, Physics 121 Common Exam 3 (Chapter 27, 28)

Spring 2025

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 $\vec{B} = 10.00\ \text{T}\ \hat{k}$, 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 $280\ \mathrm{m/s}$. A point P is on the y-axis at $y = +70\ \mathrm{mm}$. The magnetic field produced at the point P, as the charge moves through the origin, is equal to $-0.30\ \mu\mathrm{T}\,\hat{k}$. 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)

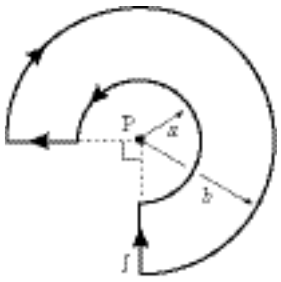
A) 3.8 $\times$ 10^{-5} T
B) 3.8 $\times$ 10^{-7} T
C) 1.2 $\times$ 10^{-5} T
D) 1.2 $\times$ 10^{-7} T
E) 3.8 $\times$ 10^{-8} T

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 $12\ \mathrm{A}$, 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

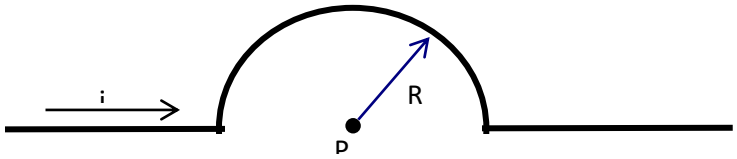
7. What is the magnitude of the magnetic field at point P if *a = 5 mm* and *b = 12 mm* and current *I = 16 A*?

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



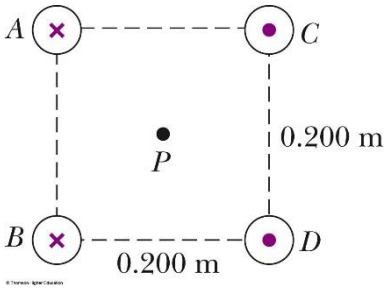
8. Point P is the center of the semicircle in the accompanying sketch, with current I flowing from left to right as shown. The magnitude and direction of the magnetic field at P are:

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



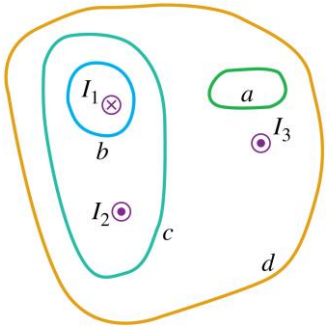
9. The sketch shows four very long parallel wires carrying equal currents of I = 1.0 A that are flowing into or out of the plane of the sketch. The wires are located at the corners of a square, each side of which is 0.200 m long. Current flows into the sketch at A and B, and flows out of the sketch at 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



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



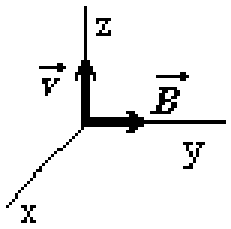
11. A rectangular coil of dimensions 5.40 cm x 8.50 cm consists of 25 turns of wire and carries a current of 15.0 mA. A 0.350-T magnetic field is applied parallel to the plane of the loop. What is the magnitude of the torque acting on the loop?

Ans. 6.02×10^{-4} N·m

12. An alpha particle (a He nucleus, containing two protons and two neutrons and having a mass of 6.64×10^{-27} kg) traveling horizontally at 35.6 km/s enters a uniform, vertical, 1.80 T magnetic field. (a) What is the diameter of the path followed by this alpha particle? (b) What are the magnitude and direction of the acceleration of the alpha particle while it is in the magnetic field?

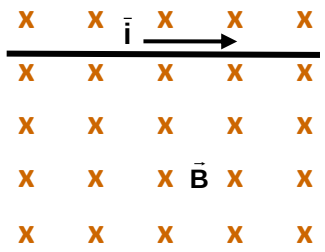
Ans. a) 0.821mm; b) 3.09×10^{12} m/s^2 towards the center of the curvature.

13. A proton is moving with velocity $v = 5 \times 10^5$ m/s in the positive z direction. It is crossing a region in which a uniform magnetic field with B = 0.20 T points in the positive y direction. Find the force acting on the particle.



A) 10^{-14} N, -z direction
B) 1.6×10^{-14} N, +x direction
C) 1.6×10^{-14} N, -x direction
D) 8.0×10^{-13} N, -y direction
E) 8.0×10^{-13} N, +z direction

14. A wire whose length L = 5 cm is placed in a uniform magnetic field of magnitude B = 1 T which points into the page. The wire carries a current of 20 A to the right in the plane of the page. What are the magnitude and direction of the force exerted on the wire by the magnetic field?



A) 1.0 N out of the page

B) 1.0 N, up in the plane of the page

C) 1.0N, down in the plane of the page

D) 2.0 N, up in the plane of the page

E) 2.0 N, down in the plane of the page

15. The uniform magnetic field over a certain region is given by $\underline{\mathbf{B}} = B_x\mathbf{i} + B_y\mathbf{j}$ where B_x = 2 T and B_y = 2 T. An electron moves into the field with a velocity $\underline{\mathbf{v}} = v_x\underline{\mathbf{i}} + v_y\underline{\mathbf{j}} + v_z\underline{\mathbf{k}}$, where v_x = 5 m/s, v_y = 5 m/s and v_z = 5 m/s. The charge on the electron is -1.6×10^{-19} C.

What force **F** does the magnetic field exert on the electron?

A) $\mathbf{F} = 1.6 \times 10^{-18}\,\mathbf{i} + 1.6 \times 10^{-18}\mathbf{k}$

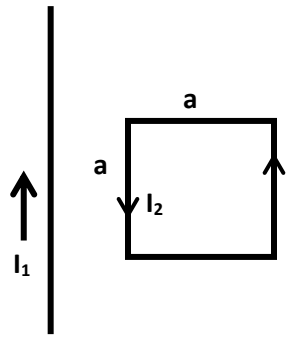
B) $\mathbf{F} = 1.6 \times 10^{-18}\,\mathbf{i} + 1.6 \times 10^{-18}\,\mathbf{j}$

C) $\mathbf{F} = 1.6 \times 10^{-18}\,\mathbf{i} - 1.6 \times 10^{-18}\,\mathbf{j}$

D) $\mathbf{F} = 2.4 \times 10^{-18}\,\mathbf{i} + 2.4 \times 10^{-18}\mathbf{j} + 2.4 \times 10^{-18}\mathbf{k}$

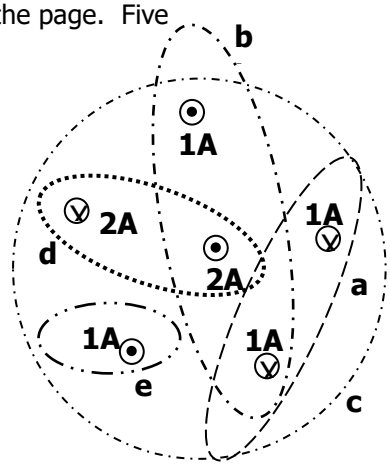
E) $\mathbf{F} = 2.4 \times 10^{-18}\,\mathbf{j} + 2.4 \times 10^{-18}\,\mathbf{k}$

16. In the sketch (not to scale) a long straight wire carries a current I_1 upward in the plane of the page. A square wire loop is also in the plane of the page and to the right of the straight wire. It carries a counterclockwise current of I_2 and its side is parallel to the wire. Which of the following statements correctly describes the net force on the frame of wire:



A) The net torque on the wire frame attempts to rotate it counterclockwise.
B) The net force on the wire frame is zero, but the net torque attempts to rotate it around a horizontal axis.
C) The net force and torque on the wire frame are both zero.
D) The frame is repelled by the wire.
E) The frame is attracted to the wire.

17. The sketch shows a cross-section view of 6 wires carrying current into or out of the page. Five possible Amperian paths labeled a, b, c, d, and e are shown.



For which Amperian paths in the picture is

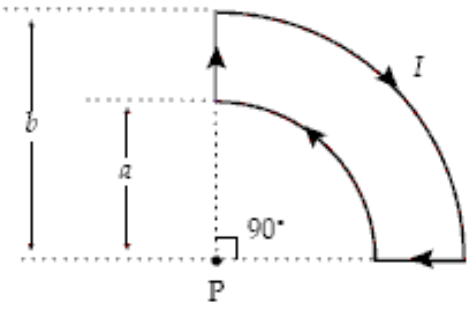
$\oint \vec{B} \circ d\vec{s} = 0$ in Ampere's Law?

A) d
B) a and c
C) b
D) a, b, and c
E) c and d

18. A pair of parallel wires are each carrying currents of 10 A in opposite directions. The wires are separated by a perpendicular distance of 0.5 cm. The force per unit length between the wires is:

A) 0.004 N/m, repulsion
B) 0.004 N/m, attraction
C) 0.001 N/m, repulsion
D) 0.001 N/m, attraction
E) zero

19. If a = 1.0 cm, b = 3.0 cm, and I = 30 A, what is the magnitude of the magnetic field at point P, the center of curvature for the arc segments?



A) 0.62 mT
B) 0.59 mT
C) 0.35 mT
D) 0.31 mT
E) 0.10 mT

20. A wire is bent to form a circular loop whose radius is 5 cm. The wire carries a current of 10.0 A. The resulting current loop is placed in a uniform magnetic field of 12 T, with its magnetic dipole moment vector making an angle of 30^o

With the direction of the field. Find the magnitude of the torque that the magnetic field exerts on the wire.

A) 1.88 N.m

B) 0.94 N.m

C) 0.47 N.m

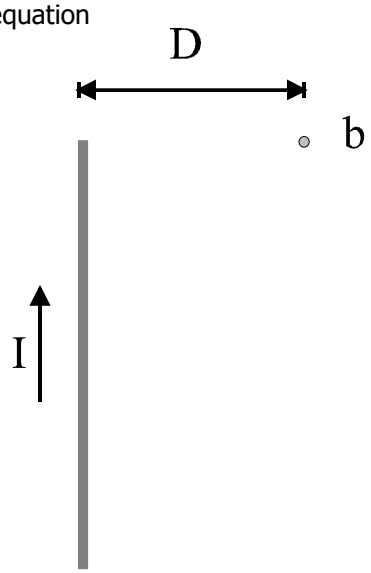
D) 0.16 N.m

E) 0.0 N.m

21. A solid wire conductor has radius R = 5 mm. The wire carries a current of 0.3 A which is uniformly distributed over the cross-section of the wire (current density is constant). What is the magnitude of the magnetic field due to the current in the wire at a radial distance of r = 2 mm from the center axis of the wire? HINT: Use Ampere's law, noting that B is tangential.

A) 4.8 μT
B) 6 μT
C) 12 μT
D) 30 μT
E) 0

22. A segment of wire of length 5 cm has a current of 0.5 A flowing in the wire as shown in the figure below. What is the magnitude of the magnetic field due to this wire segment at point (b) which is D = 3 cm from the end of the wire? HINT: Use the Biot-Savart Law and look on your equation sheet for some helpful integrals:



A) B = 0.8 μT
B) B = 1.6 μT
C) B = 1.7 μT
D) B = 3.3 μT
E) B = 1.4 μT