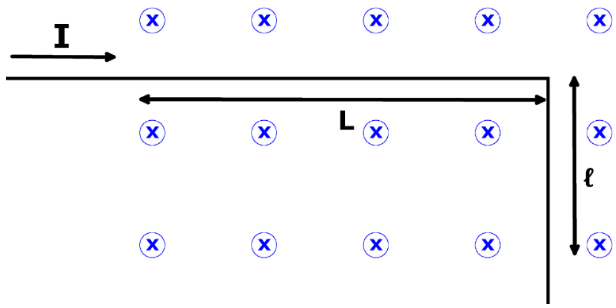
Physics 207 – Exam 3

Sections (519-524; 525-530) – April 13, 2022

1) [8 pts] A current carrying wire enters a region of uniform magnetic field $\vec{B}$ (which points into the page) from the left, makes a 90° turn and exits directly out of the bottom of the region. If the dimensions and current are as indicated in the figure, find the net force acting on the wire.

A) $\vec{F} = \quad I\ell B\hat{\imath} + ILB\hat{\jmath}$ [8]
B) $\vec{F} = -I\ell B\hat{\imath} + ILB\hat{\jmath}$
C) $\vec{F} = \quad I\ell B\hat{\imath} - ILB\hat{\jmath}$
D) $\vec{F} = -I\ell B\hat{\imath} - ILB\hat{\jmath}$ [2]
E) $\vec{F} = \quad ILB\hat{\imath} + I\ell B\hat{\jmath}$ [2]
F) $\vec{F} = -ILB\hat{\imath} + I\ell B\hat{\jmath}$
G) $\vec{F} = \quad ILB\hat{\imath} - I\ell B\hat{\jmath}$
H) $\vec{F} = -ILB\hat{\imath} - I\ell B\hat{\jmath}$



2) [8 pts] A current carrying wire lies horizontally and carries a current I in the $\hat{\imath}$ direction. An electron travels in the $-\hat{\imath}$ direction just above the wire with velocity v. Which direction (if any) will the electron feel a force due to the wire?

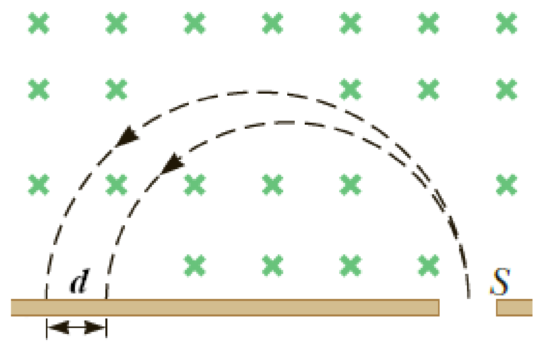
A) $\hat{\imath}$
B) $-\hat{\imath}$
C) $\hat{\jmath}$ [4]
D) $-\hat{\jmath}$ [8]
E) $\hat{k}$
F) $-\hat{k}$
G) no force

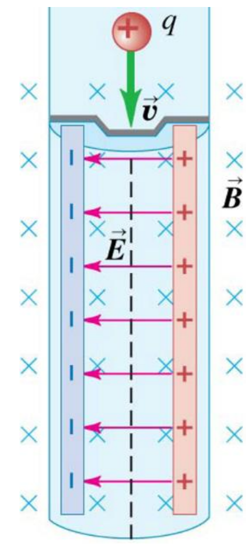
3) [8 pts] A 10 cm radius circle of 25 loops of wire is placed flat in the x-y plane. When a current of 0.2 A flows through the wire in a clockwise direction, there is a torque of $\vec{\tau} = +0.1178\,\hat{\jmath}\,N \cdot m$ on the wire. Determine the strength and direction of the uniform magnetic field producing the torque.

A) $0.0375\,\hat{\imath}\,T$
B) $-0.0375\,\hat{\imath}\,T$
C) $0.0375\,\hat{k}\,T$
D) $-0.0375\,\hat{k}\,T$
E) $0.75\,\hat{\imath}\,T$ [4]
F) $-0.75\,\hat{\imath}\,T$ [8]
G) $0.75\,\hat{k}\,T$ [2]
H) $-0.75\,\hat{k}\,T$

4) [8 pts] A simple mass spectrometer works by sending particles of known charge and velocity into a region of uniform magnetic field and measuring their impact on a flat detector. If two particles with the same charges ($+q$) both enter a mass spectrometer of known magnetic field strength (B into the page) and at the same velocity (v), then what is the mass of the heavier particle, m_2, in terms of the lighter particle, m_1 if they strike the detector as shown a distance d apart?

A) $m_2 = m_1$
B) $m_2 = m_1 + \frac{dqB}{v}$ [4]
C) $m_2 = m_1 + \frac{2dqB}{v}$
D) $m_2 = m_1 + \frac{dqB}{2v}$ [8]
E) $m_2 = m_1 + \frac{4dqB}{v}$
F) $m_2 = m_1 + \frac{dqB}{4v}$



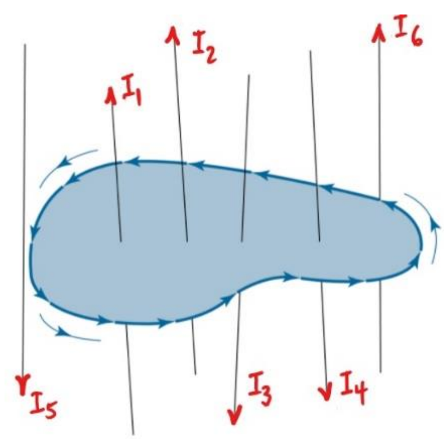


5) [7pts] A positively charged particle enters the region with crossed E and B as shown on the Figure. The speed of the particle is less than E/B. What are the directions of the magnetic force and the total force (magnetic and electric) acting on the particle?

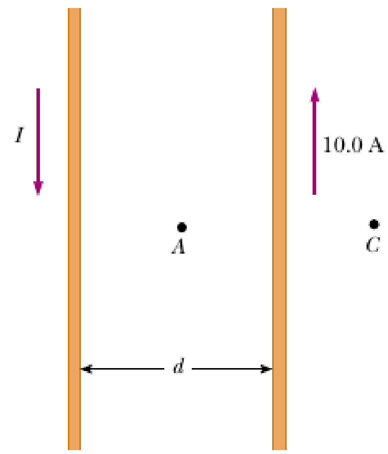
A. To the left and to the left [2]
B. To the left and to the right
C. Into the page and out of the page
D. Out of the page and out of the page
E. To the right and to the left [7]
F. To the right and to the right [2]

6) [7 pts] Find the value of the line integral of the magnetic field around a closed curve in the presence of six electric currents as shown in the figure: with I_1=1 A, I_2=2 A, I_3=3 A, I_4=4 A, I_5=5 A and I_6=6 A

A) 21 μ_0
B) 10 μ_0 [2]
C) -3 μ_0 [2]
D) -4 μ_0 [7]
E) -5 μ_0
F) -7 μ_0



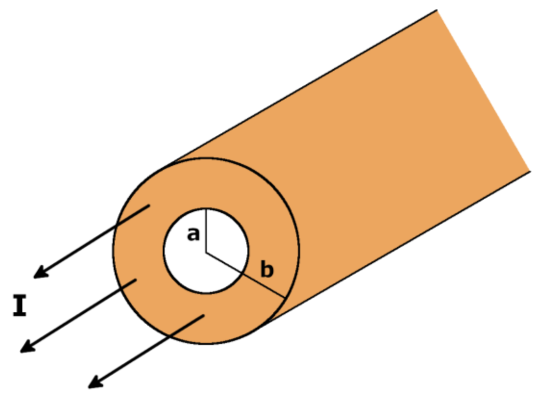
7) [8 pts] Two parallel conductors carry current in opposite directions, as shown in Figure. One conductor carries a current of 10.0 A. Point A is at the midpoint between the wires, and point C is a distance d/2 to the right of the 10.0-A current. If d=16 cm and I is adjusted so that the magnetic field at C is zero, find the value of the current I, and the magnitude and the direction of the magnetic field at A.



A) I=20A, B=10^{-2} T into the page
B) I=20A, B=10^{-6} T out of the page [2]
C) I=20A, B=10^{-2} T out of the page [2]
D) I=30A, B=10^{-3} T into the page
E) I=30A, B=10^{-5} T into the page
F) I=30A, B=10^{-4} T out of the page [8]

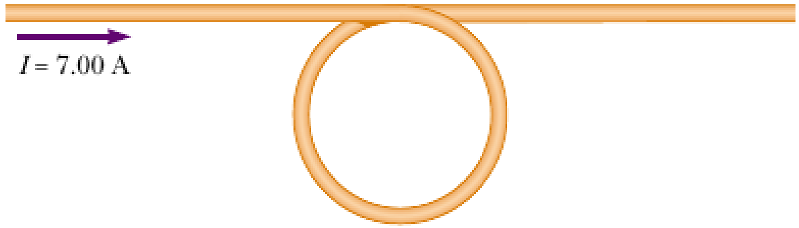
8) [7 pts] A very long hollow cylindrical conductor with inner radius *a* and outer radius *b* carries a uniform current *I* as shown. The magnitude of the magnetic field at a radial distance *r* from the center between *a* and *b* is

A) $\frac{\mu_0 I}{2\pi r}$ [2]
B) $\frac{\mu_0 I}{2\pi r}\frac{r^2}{b^2}$ [2]
C) $\frac{\mu_0 I}{2\pi r}\frac{(r-a)}{(b-a)}$
D) $\frac{\mu_0 I}{2\pi r}\frac{(b-a)}{(r-a)}$
E) $\frac{\mu_0 I}{2\pi r}\frac{(b^2-a^2)}{(r^2-a^2)}$
F) $\frac{\mu_0 I}{2\pi r}\frac{(r^2-a^2)}{(b^2-a^2)}$ [8]



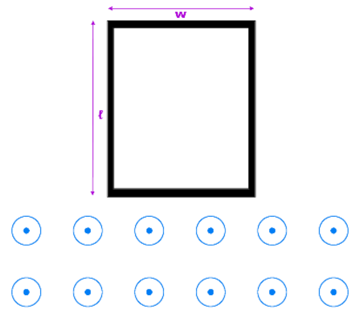
9) [8 pts] A conductor consists of a circular loop of radius R=0.100 m and two straight, long sections, as shown in Figure. The wire lies in the plane of the paper and carries a current of I=7.00 A. Determine the magnitude and direction of the magnetic field at the center of the loop.

A) B=5.8 10^{-5} T into the page [8]
B) B=7.4 10^{-5} T out of the page
C) B=6.8 10^{-5} T into the page [2]
D) B=6.4 10^{-5} T out of the page
E) B=4.7 10^{-5} T into the page [2]
F) B=3.9 10^{-5} T out of the page



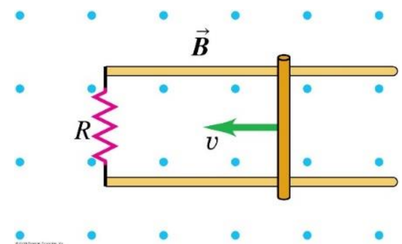
10) [8 pts] A rectangular loop of wire (of width w and length ℓ) is held vertically above a region of uniform magnetic field that points in the $+\hat{k}$ direction as shown. The wire loop is initially at rest with the bottom edge just barely outside the region of the field. If the loop is released at time $t = 0$ and allowed to fall due to gravity, determine the magnetic flux through the loop as a function of time before the upper edge enters the magnetic field. (Neglect self-induction effects.)

A) $\Phi_B(t) = Bwl$
B) $\Phi_B(t) = Bwlt$
C) $\Phi_B(t) = \frac{Bwlt^2}{2}$ [2]
D) $\Phi_B(t) = Bwg$
E) $\Phi_B(t) = Bwgt$
F) $\Phi_B(t) = \frac{Bwgt^2}{2}$ [8]
G) $\Phi_B(t) = 0$



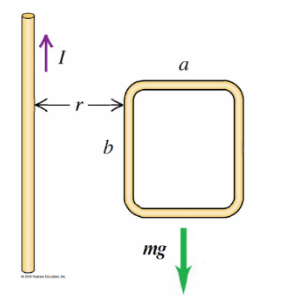
11) [8] A metal rod of length L is being pulled to the left at constant velocity v in a constant magnetic field of strength B pointing out of the page. The current I and its direction flowing in the resistor R is:

A) $I = Bv/R$, up
B) $I = Bv/R$, down
C) $I = BvLR$, up
D) $I = BvLR$, down
E) $I = BvL/R$, up [3]
F) $I = BvL/R$, down [8]



12) [7] A conducting loop of sides a and b is falling under its own weight mg at a constant distance r from a current I flowing upward as shown. The induced current and direction flowing in the loop is

A) $\mu_0 Iab/[2\pi r]$, *clockwise*
B) $\mu_0 Iab/[2\pi r]$, *counter clockwise*
C) $\mu_0 Iab/[2\pi(r + a/2)]$, *clockwise*
D) $\mu_0 Iab/[2\pi(r + a/2)]$, *counter clockwise*
E) $\mu_0 Iab/[2\pi(r + a)]$, *clockwise*
F) 0, no direction [7]



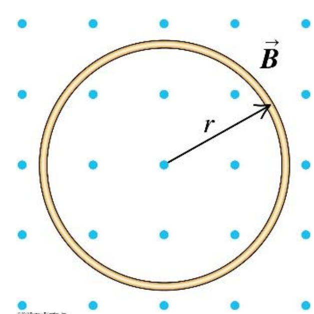
13) [8] A circular loop is perpendicular to a uniform, time-varying magnetic field as shown. ***Rank*** the following uniform magnetic fields in the order of the **magnitude** of the emf they produce in the loop at $t = 0$, from the largest to the smallest

A) ABC
B) ACB
C) BCA
D) BAC
E) CAB [8]
F) CBA [3]

A. $\mathbf{B} = (3.0\mu T)\sin(2t)\ \hat{\mathbf{k}}$

B. $\mathbf{B} = (3.0\mu T)e^{-t}\ \hat{\mathbf{k}}$

C. $\mathbf{B} = (3.0\mu T)(t^2 + 3t + 10)\ \hat{\mathbf{k}}$



Scratch paper