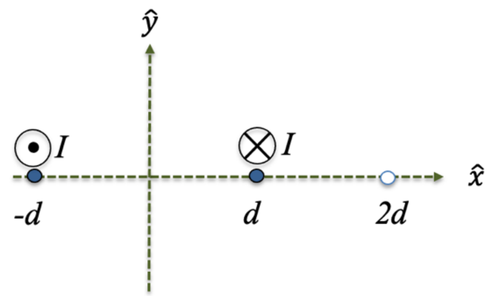
Physics 207 – Exam 3

Sections (207-212, 543-583) – November 11th, 2021

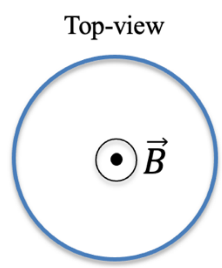
1) *[10pts]* Two long, straight wires are oriented perpendicular to the *xy*-plane. They carry currents of equal magnitude *I* in opposite directions as shown. At point *P* with the coordinates (2*d*,0) the magnetic field due to these currents is equal to

A. $\frac{\mu_0 I}{3\pi d}$ along positive *y*-direction.
B. $\frac{\mu_0 I}{3\pi d}$ along negative *y*-direction.
C. $\frac{2\mu_0 I}{3\pi d}$ along negative *y*-direction.
D. $\frac{3\mu_0 I}{4\pi d}$ along positive *x*-direction.
E. $\frac{2\mu_0 I}{3\pi d}$ along positive *x*-direction
F. $\frac{3\mu_0 I}{4\pi d}$ along negative *x*-direction.



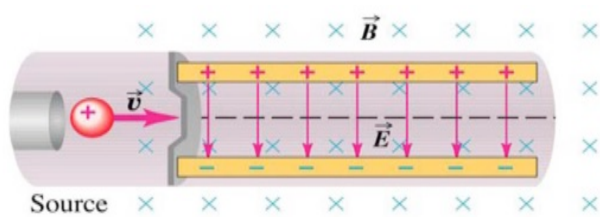
2) *[8pts]* The magnetic field through a loop is orthogonal to the plane of the loop as shown in the figure below. The magnitude of the field changes with time according to the relation B(t) = 6 t^2 T/s^2 + 7 t T/s + 5T. The area of the loop is 1m^2. As viewed from the top, the emf induced in the loop when $t = 2$s is

A. 38 V counterclockwise
B. 38 V clockwise
C. 31 V counterclockwise
D. 31 V clockwise
E. 19 V clockwise
F. 19V counterclockwise

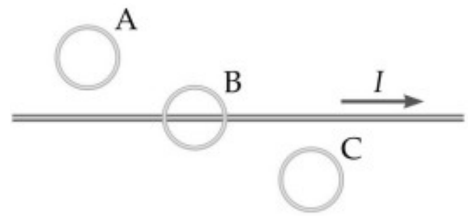


3) *[8pts]* A positively charged particle enters the region with crossed *E* and *B* as shown on the Figure. The speed of the particle is smaller than *E/B*. What are the directions of the magnetic force and the total force (magnetic and electric) acting on a particle?

A. Up and down
B. Up and up
C. Into the page and out of the page
D. Out of the page and out of the page
E. Down and up
F. Down and Down

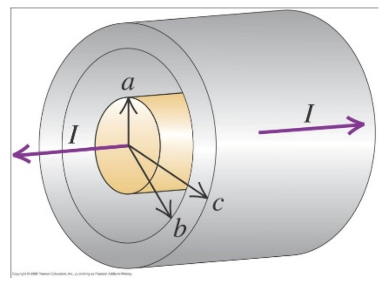


4) *[8pts]* The long straight wire in the figure carries a current I that is decreasing with time at a constant rate. The stationary circular loops A, B, and C all lie in a plane containing the wire. The induced emf in each of the loops A, B, and C is such that



A. no emf is induced in any of the loops.
B. a counterclockwise emf is induced in all the loops.
C. A has a clockwise emf, B has no induced emf, and C has a counterclockwise emf.
D. A has a counter-clockwise emf, B has no induced emf, and C has a clockwise emf.
E. A has a counter-clockwise emf, B and C have clockwise emfs.
F. A has a clockwise emf, B and C have a counter-clockwise emf.

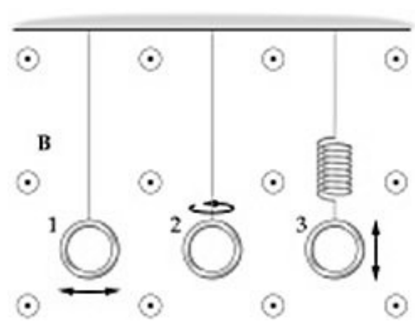
5) *[8pts]* A long solid cylindrical conductor with a radius a carries a current I as shown. It is surrounded by a concentric cylindrical shell with inner radius b and outer radius c carrying current I in the opposite direction. The magnetic field inside the shell $(b < r < c)$ is given by



A. 0
B. $\frac{\mu_0 I}{2\pi r}\left(1 - \frac{r^2-b^2}{(c^2-b^2)}\right)$ and directed counter-clockwise (looking from left)
C. $\frac{\mu_0 I}{2\pi r}\left(1 + \frac{r^2-b^2}{(c^2-b^2)}\right)$ and directed counter-clockwise (looking from left)
D. $\frac{\mu_0 I}{2\pi r}\left(1 - \frac{r^2-b^2}{(c^2-b^2)}\right)$ and directed clockwise (looking from left)
E. $\frac{\mu_0 I}{2\pi r}\left(1 + \frac{r^2-b^2}{(c^2-b^2)}\right)$ and directed clockwise (looking from left)
F. $\frac{\mu_0 I}{2\pi r}\left(1 + \frac{r^2-b^2}{(c^2-a^2)}\right)$ and directed clockwise (looking from left)

6) *[8pts]* The three loops of wire shown in the figure are all subject to the same uniform magnetic field $\boldsymbol{B}$ that is constant in time. Loop 1 swings back and forth as the bob in a pendulum, loop 2 rotates about a vertical axis, and loop 3 oscillates up and down at the end of a spring. Which loop, or loops, will have an induced circulating current in them?

A. loop 1 only
B. loop 2 only
C. loop 3 only
D. loops 1 and 2
E. loops 2 and 3
F. loops 1 and 3

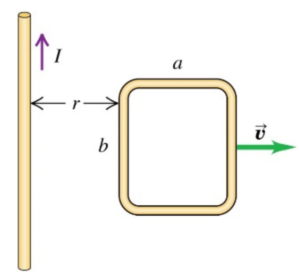


7) *[8pts]* A particle of charge q and mass m is moving with a velocity v along the x-axis in a magnetic field B which is along the z-axis. How much time will it take for the particle to return to its original location?

A. $t = \frac{2\pi qB}{m}$
B. $t = \frac{m}{qB}$
C. $t = \frac{2\pi m}{qB}$
D. $t = \frac{qB}{m}$
E. $t = \frac{qB}{2\pi m}$
F. It will never return to its original location

8) *[10pts]* A loop of wire is being moved to the right at constant velocity v, so that $r = vt$. A constant current I flows in the long straight wire as shown. Find the magnitude and direction of the current induced in the loop with resistance R and sides a and b (see figure).

A. $\mu_0 Iab/[2\pi Rt(vt + a)]$ clockwise
B. $\mu_0 Iab/[2\pi Rt(vt + a)]$ counter clockwise
C. $\mu_0 Iab/[2\pi Rt(vt + b)]$ clockwise
D. no current is induced
E. $\mu_0 Iab/[2\pi Rt(vt + b)]$ counter clockwise
F. $\mu_0 I^2 ab/[2\pi Rt(vt + b)]$ counter clockwise

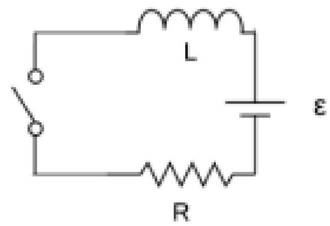


9) *[8pts]* The loop of wire in the previous figure is now stationary and a clockwise current I_1 flows in it. The total magnetic force produced by the long wire on the loop is:

A. $\mu_0 II_1 ab/[2\pi r(r + a)]$ to the left
B. $\mu_0 II_1 ab/[2\pi r(r + a)]$ to the right
C. $\mu_0 II_1 ab \ln(1 + a/r)/2\pi$ up
D. $\mu_0 II_1 ab \ln(1 + a/r)/2\pi$ down
E. $\mu_0 II_1 ab/[2\pi r(r + b)]$ to the left
F. $\mu_0 II_1 ab/[2\pi r(r + b)]$ to the right

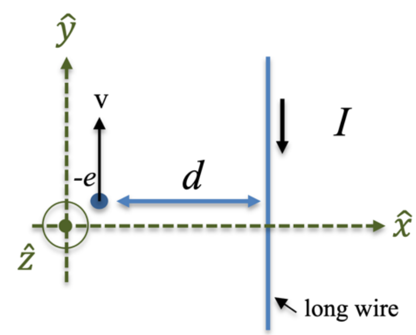
10) *[8pts]* An RL circuit is connected to a source of EMF through a switch ($L = 2.0$ mH, $R = 100\ \Omega$, $\varepsilon = 50$ V). What are the characteristic time constant for this circuit and the energy stored in the inductor after the switch has been closed for a long time?

A. 0.2 s and 635 kJ
B. 20 μs and 0.25 mJ
C. 20 μs and 635 kJ
D. 0.2 s and 0.25 mJ
E. 8 s and 32.2 J
F. 8 ms and 322 J



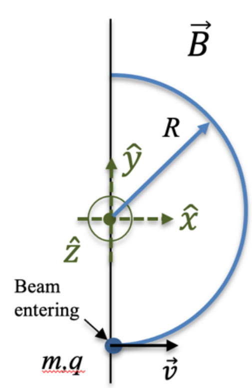
11) *[8pts]* An electron moves with velocity v in a direction opposite to the direction of the current in the neighboring long wire. What is the direction of the magnetic force acting on the electron?

A. x
B. $-x$
C. z
D. $-z$
E. y
F. $-y$



12) *[8pts]* A horizontal beam of negatively charged particles with a charge $q = -10^{-9}$C and mass $m = 2\text{x}10^{-12}$ kg enters a region of a uniform magnetic field with a speed 200 m/s and is bent into a semicircle of radius 1 m. The magnitude and the direction of the magnetic field are:

A. 1 T in y direction
B. 0.4 T in $-z$ direction
C. 0.4 T in z direction
D. 20 T in z direction
E. 1 T in $-y$ direction
F. 20 T in y direction



Scratch Paper