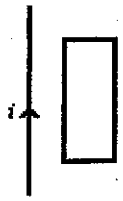
1. An inductor is connected in series with a 1000 Ω resistor and a battery. What must be the inductance in millihenries of the inductor if the current in the circuit is required to reach 90% of its "final" value after 20 microseconds?
   A) 2.3
   B) 3.5
   C) 5.6
   D) 8.7
   E) None of these

2. A time-varying voltage source varies according to the equation, $V = 3t^2$, where t is in seconds, and V is in volts. What is the source's average voltage (in volts) over the time interval from t = 1.00 s to t = 1.50 s?
   A) 4.119
   B) 5.006
   C) 7.125
   D) 9.233
   E) None of these

3. A coil of 200 turns, 3-cm^2 area, and 24 Ω is place perpendicular to a magnetic field. The field is reduced from 0.80 T to zero in 20 ms (milli-seconds). What average current (in amperes) flows in the coil?
   A) 0.64
   B) 0.55
   C) 0.40
   D) 0.10
   E) None of these

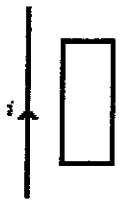
4. A long straight wire is in the plane of a rectangular conducting loop. The straight wire carries a constant current *i*, as shown. While the wire is being moved toward the rectangle the current in the rectangle is:



   A) zero
   B) clockwise
   C) counterclockwise
   D) clockwise in the left side and counterclockwise in the right side
   E) counterclockwise in the left side and clockwise in the right side

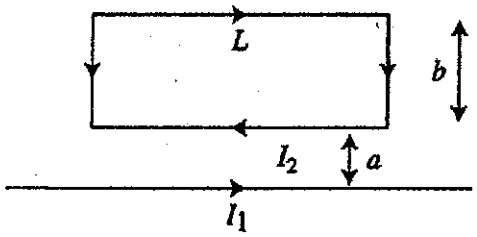
5. Two long parallel straight wires carry equal currents in opposite directions. At a point midway between the wires, the magnetic field they produce is:
   A) zero
   B) non-zero and along a line connecting the wires
   C) non-zero and parallel to the wires
   D) non-zero and perpendicular to the plane of the two wires
   E) none of the above

6. A long straight wire is in the plane of a rectangular conducting loop. The straight wire initially carries a constant current *i* in the direction shown. While the current *i* is being shut off, the current in the rectangle is:



   A) zero
   B) clockwise
   C) counterclockwise
   D) clockwise in the left side and counterclockwise in the right side
   E) counterclockwise in the left side and clockwise in the right side

7. A long straight wire carrying current I_1 is placed in the plane of a rectangular loop carrying current I_2. What is the net force on the loop?

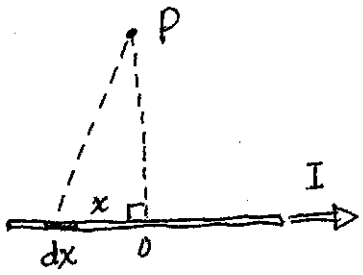


   A) $(\mu_0/2\pi)\, I_1 I_2 L/(b-a)$
   B) $(\mu_0/4\pi)\, I_1 I_2 L/(b-a)^2$
   C) $(\mu_0/2\pi)\, I_1 I_2 L\, b/(a+b)^2$
   D) $(\mu_0/4\pi)\, I_1 I_2 L\, b/(a^2+ab)$
   E) None of these

8. A inductor has an inductance of 4 milli-henries. The current in the inductor varies with time according to the equation,
$I = 6\,(1 - e^{-2t})$, where t is in seconds, and I is in amperes. What is the emf (in milli-volts) induced in the inductor at time
$t = 0.5$ seconds?
A) 6.78
B) 11.45
C) 17.66
D) 21.45
E) None of these

9. A coil of N turns and area A is placed in a magnetic field B and rotated at constant angular velocity ω about a diameter perpendicular to the magnetic field. Which of the following expressions for the magnitude of the maximum induced emf ε in the coil is correct?
A) NAB
B) ω^2NAB
C) ωNBA
D) $(\omega/2\pi)$ NAB
E) None of these

10. A long, cylindrical straight wire carries a current density J that varies linearly with respect to the distance r from the axis according to the equation, $J = 2r$, where J is in A/m^2, and r is in meters. Use Ampere's Law to find the magnetic field inside the wire at a distance R from the axis.
A) $B = (1/3)\,\mu_0 R$
B) $B = 2\mu_0 R^2$
C) $B = 3\mu_0 R^3/4$
D) $B = 2\mu_0 R^2/3$
E) None of these

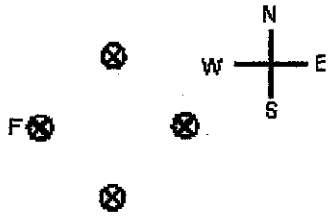


11. The point P in the figure is a distance R from a straight, current carrying wire. What is the expression for the element of magnetic field, dB, contributed at point P by the current element dx?
A) $\mu_0 I dx/(x^2+R)$
B) $\mu_0 I dx/(x^2+R^2)^{1/2}$
C) $\mu_0 I dx/(x^2+R)^{3/2}$
D) $\mu_0 I dx R/(x^2+R^2)^{3/2}$
E) None of these

12. Recall that the magnetic field at the center of circular loops of wire of radius R, and carrying current I is $B = \mu_0 I/2R$. A circular disk of radius R carries a uniform surface charge density σ. It rotates about its axis at a frequency f. Treat the disk as an infinite number of concentric circular current loops of varying radius, r and thickness dr, and obtain the magnetic field B at the center of the disk. (An integration will be necessary.)
A) $\mu_0 \pi \sigma R f$
B) $\mu_0 \pi \sigma f/R$
C) $2\mu_0 \pi \sigma R f$
D) $\mu_0 \sigma R f/2\pi$
E) None of these

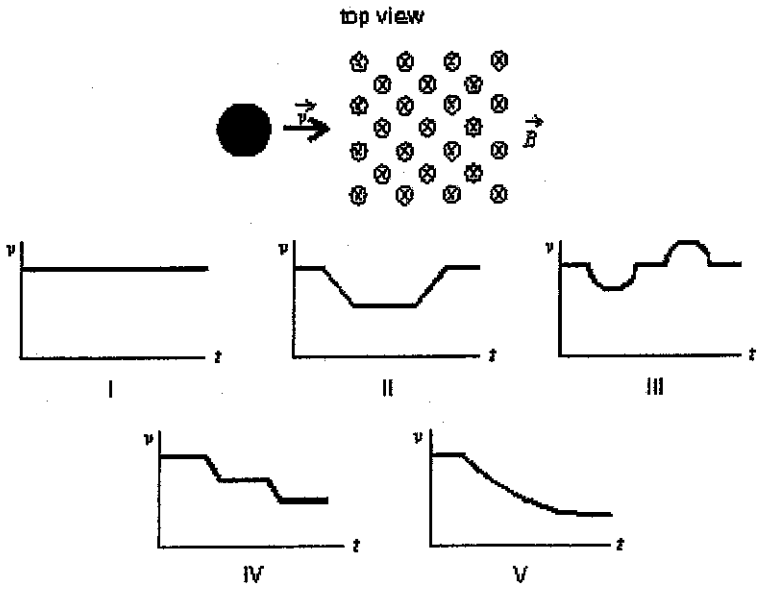
13. An amplitude-modulated (AM) radio receiver uses an LC resonant circuit whose frequency matches the frequency of incoming radio waves. If the inductor's inductance is 16 μH (micro-henries), what must be the capacitance (in nanofarads) of the capacitor in order to "tune" the receiver to a 1200 kHz broadcast signal?
A) 3.45
B) 1.10
C) 2.23
D) 6.78
E)

14. Four long straight wires carry equal currents into the page as shown. The magnetic force exerted on wire F is:



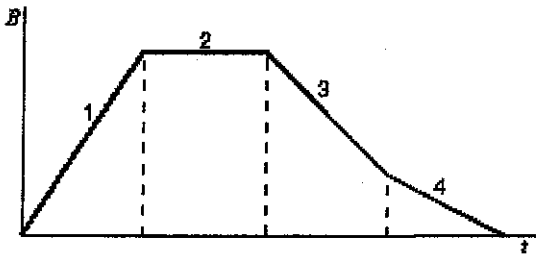
A) north
B) east
C) south
D) west
E) zero

15. A copper penny slides on a horizontal frictionless table. There is a square region of constant uniform magnetic field perpendicular to the table, as shown. Which graph correctly shows the speed v of the penny as a function of time t?



A) I
B) II
C) III
D) IV
E) V

16. The graph shows the magnitude B of a uniform magnetic field that is perpendicular to the plane of a conducting loop. Rank the five regions indicated on the graph according to the magnitude of the emf induced in the loop, from least to greatest.



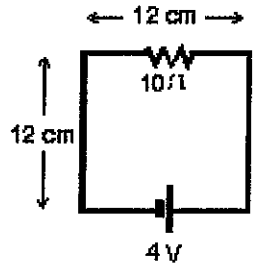
A) 1, 2, 3, 4
B) 2, 4, 3, 2
C) 4, 3, 1, 2
D) 1, 3, 4, 2
E) 4, 3, 2, 1

SKIP
Correct answer is 2, 4, 3, 1
Everyone given credit for this problem

17. The maximum emf of an AC power supply is 40 volts. The maximum current from the power supply is 10 amperes. What is the average power output of the power supply, in watts?

A) 200
B) 400
C) 800
D) 283
E)

18. A 10 ohm resistor is connected to a 4 volt battery, as shown in the figure. The circuit is in a uniform magnetic field that is into the page. The current in the circuit is 0.20 A. At what approximate rate (in T/s) is the magnitude of the magnetic field changing?



A) zero
B) 140
C) 160
D) 420
E) 360

19. The diagram shows an inductor that is part of a circuit. The direction of the emf induced in the inductor is indicated. Which of the following is possible?

A) The current is constant and rightward
B) The current is constant and leftward
C) The current is increasing and rightward
D) The current is increasing and leftward
E) None of the above

20. A 10-turn ideal solenoid has an inductance of 3.5 mH. When the solenoid carries a current of 2.0 A the magnetic flux (in T/m^2) through each turn is:

A) 0
B) 3.5×10^{-4}
C) 7.0×10^{-4}
D) 7.0×10^{-3}
E) 7.0×10^{-2}