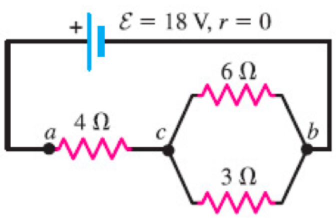
1. A cylindrical wire has a resistance R and resistivity ρ. If its length and diameter are both cut in half, its resistance will now be:

   a) $4R\ \Omega$
   b) $2R\ \Omega$
   c) $R\ \Omega$
   d) $R/2\ \Omega$
   e) $R/4\ \Omega$

2. A person with a body resistance R_1 between her hands accidentally grasps the terminals of a power supply with EMF $= \mathcal{E}$ and internal resistance R_2. What is the power P dissipated in her body?

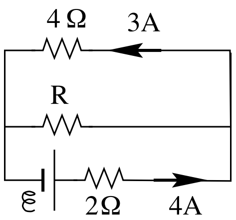
   a) $P = R_1\mathcal{E}/(R_1 + R_2)$
   b) $P = \mathcal{E}^2/R_1$
   c) $P = \mathcal{E}^2/(R_1 + R_2)$
   d) $P = R_1\mathcal{E}^2/(R_1 + R_2)^2$
   e) $P = (R_1 + R_2)\mathcal{E}^2/R_1R_2$

3. Consider the circuit in the figure. When inserted at point a, the reading of a ammeter with resistance 3 Ω is



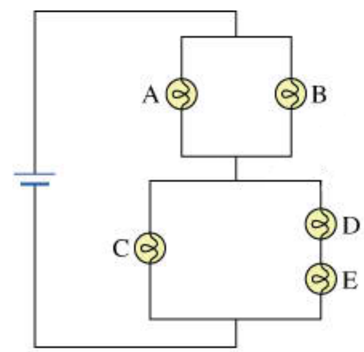
   a) 1.4 A
   b) 4.5 A
   c) zero
   d) 3 A
   e) 2 A

4. In this circuit, what is the EMF of the battery? Assume zero internal resistance for the battery.



   a) $EMF = 4$ V
   b) $EMF = 12$ V
   c) $EMF = 8$ V
   d) $EMF = 20$ V
   e) Impossible to determine without knowing the value of R.

5. Consider a circuit containing five identical light bulbs and an ideal battery. Assume that the resistance of each light bulb remains constant. Which statement is TRUE for the brightness of the bulbs (A through E)?



   a) Bulb A is brighter than bulb B is brighter than bulb C is brighter than bulb D is brighter than bulb E.
   b) Bulb A and bulb B are equally bright and brighter than bulb C.
   c) Bulb D and bulb E are equally bright and brighter than bulb C.
   d) Bulb C is the brightest.
   e) All of the bulbs are equally bright.

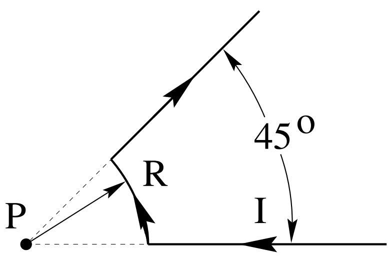
6. A capacitor charged to a potential of 12.0 V is put in series with a 7.5 MΩ resistor (note 1 MΩ = 10^6 Ω). After a time of 4.0 s the potential across the capacitor is 6.0 V. The time constant of the circuit therefore is

a) 2.8 s
b) 4.0 s
c) 8.0 s
d) 1.6×10^{-6} s
e) 5.8 s

7. A charged particle of mass m and charge q is accelerated from rest through a potential difference V. Then the particle enters a uniform magnetic field B perpendicular to its velocity and moves in a circular arc. The radius of the circular arc is:

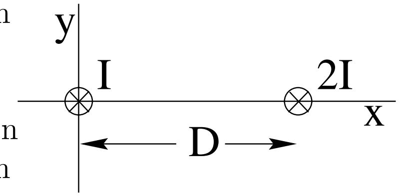
a) $\frac{V}{qB}$ b) $(\sqrt{\frac{2mV}{q}})(\frac{1}{B})$ c) $\frac{1}{2}$ mV^2/B d) $\frac{qB}{m}$
e) $\frac{mV}{qB}$

8. In the figure shown, a conductor consisting of a circular arc of 45° with radius R and two wires attached to this arc going radially outward (and effectively infinite in length) has a current I passing through it. What is the magnetic field at point P, the center of the arc?



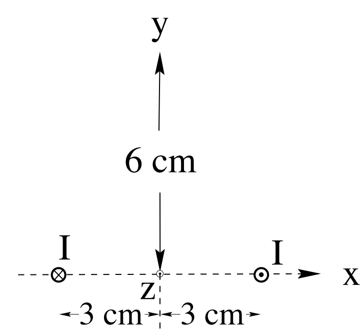
a) (μ_0 I)/(2R)
b) (μ_0 I)/(8R)
c) 0
d) (μ_0 I)/(16R)
e) (μ_0 I)/(4πR)

9. At $x = 0$ a long straight wire carries current I <u>into</u> the plane of the paper. At $x = D$, another long straight wire carries current $2I$ <u>into</u> the plane of the paper. What is the direction of the force on the wire at the origin?



a. None of the other answers
b. towards the positive y-direction
c. out of the plane of the paper
d. towards the negative x-direction
e. towards the positive x-direction

10. Two long straight wires lie parallel to the z-axis as shown. The wire at $x = -3$ cm carries current I into the page and the other at $x = +3$ cm carries current I out of the page. In what direction is the net magnetic field at the point $(x, y, z) = (0, +6$ cm$, 0)$?

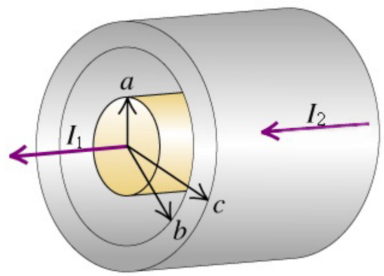


a) $\hat{k}$
b) $-\hat{\imath}$
c) $\hat{\imath}$
d) $-\hat{\jmath}$
e) $\hat{\jmath}$

11. A solenoid is 3.0 cm long and has a radius of 0.50 cm. It is wrapped with 500 turns of wire carrying a current of 2.0 A. The magnetic field at the center of the solenoid is:

a) 9.9×10^{-8} T
b) 1.3×10^{-3} T
c) 4.2×10^{-2} T
d) 16 T
e) none of these

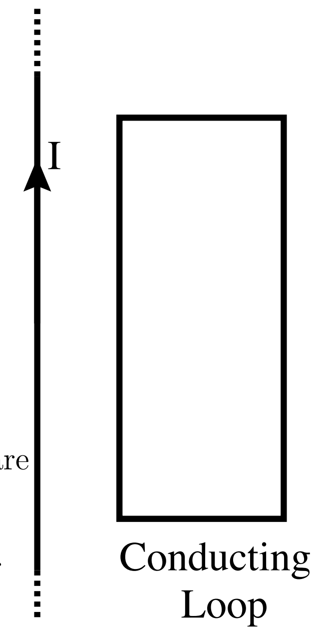
12. A solid conductor of radius a is supported by insulating disks on the axis of a conducting tube with inner radius b and outer radius c. The central conductor and tube carry currents in the same direction I_1 and I_2 respectively. The currents are distributed uniformly over the cross sections of each conductor. What is the magnitude of the magnetic field at points a distance $r > c$, outside of the tube?



a) $\mu_0(I_1 + I_2)/2\pi r$
b) $\mu_0(I_1 + I_2)/2\pi r^2$
c) $\mu_0(I_1 + I_2)/\pi r^2$
d) zero
e) $\mu_0(I_1 - I_2)/2\pi r$

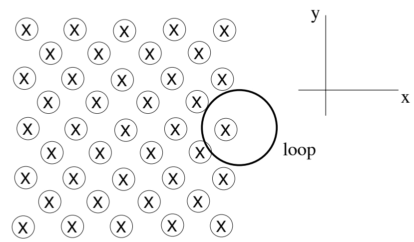
13. Initially, a long straight wire is carrying a current I, as shown in the figure. Next to the wire is a square conducting loop (in the plane of the paper), which, initially, has no electric current in it. Beginning at a certain time, the current in the straight wire is reduced, i.e. $dI/dt < 0$. Under this latter condition, which of the following statements is correct?

a) a clockwise current will be induced in the square loop, and it will feel a net force repelling it away from the straight wire.
b) a counter-clockwise current will be induced in the square loop, and it will feel a net force repelling it away from the straight wire.
c) a clockwise current will be induced in the square loop, and it will feel a net force attracting it towards the straight wire.
d) a counter-clockwise current will be induced in the square loop, and it will feel a net force attracting it towards the straight wire.
e) a current will be induced in the square loop, but it will feel no net force. There *will* be a torque, tending to twist the loop out of the plane of the paper.



14. A circular loop of wire is positioned half in and half out of a square region of uniform B field directed into the page, as shown. To induce a clockwise current in this loop:

a) move it in the $+x$ direction
b) move it in the $+y$ direction
c) move it in the $-y$ direction
d) move it in the $-x$ direction
e) increase the strength of B



15. A wire forms a loop of radius R around the middle of a long solenoid with which it shares a common axis. For a given time varying current in the solenoid, an emf $\mathcal{E}_R$ is induced in the loop. If the radius of the loop is doubled, the same time varying current is in the solenoid will induce an emf $\mathcal{E}_{2R}$ where:

a) $\mathcal{E}_{2R} = 2\mathcal{E}_R$ b) $\mathcal{E}_{2R} = \mathcal{E}_R$ c) $\mathcal{E}_{2R} = 4\mathcal{E}_R$
d) $\mathcal{E}_{2R} = \frac{1}{2}\,\mathcal{E}_R$ e) $\mathcal{E}_{2R} = \frac{1}{4}\mathcal{E}_R$

16. Which of the following statements is **false**?

a) The magnetic force does zero work on a charged particle moving in a magnetic field.
b) A current-carrying planar loop of wire in a constant, uniform magnetic field has zero net magnetic force on it.
c) The net magnetic flux through any closed surface is zero.
d) The magnetic force on a charged particle moving along a magnetic field line is zero.
e) The magnetic torque on a current-carrying coil of wire is larger when the magnetic field is perpendicular to the plane of the coil than when the magnetic field is in the plane of the coil.

REFERENCE PAGE: Useful Information

c = speed of light = 3.00×10^8 m/s
$q_e = -e$ = charge on an electron = -1.602×10^{-19} Coulombs
$q_p = +e$ = charge on a proton = $+1.602 \times 10^{-19}$ Coulombs
m_e = electron mass = 9.11×10^{-31} kg
m_p = proton mass = 1.67×10^{-27} kg
$k = 9 \times 10^9$ N m^2/C^2
$\epsilon_0 = 8.85 \times 10^{-12}$ C^2/(Nm^2)
$g = 9.80$ m/s^2
1 $eV = 1.602 \times 10^{-19}$ J
1 mC = 10^{-3} C 1 μC = 10^{-6} C
1 nC = 10^{-9} C 1 pC = 10^{-12} C