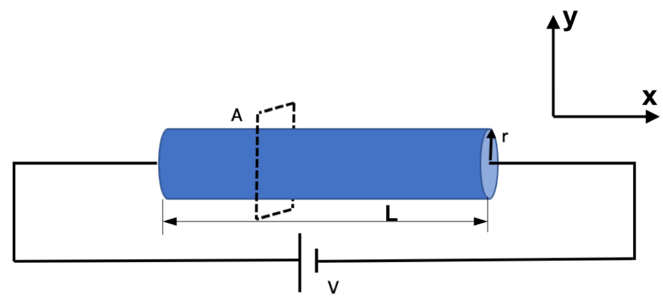
The next two questions pertain to the situation described below.

A cylinderical resistor with length $L = 9$ cm, radius $r = 0.5$ cm and resistivity $\rho = 2 \times 10^{-4}$ Ω·m, is connected to a battery of voltage V= 6 V, as shown in the Figure to the right:



1) What is the electric field inside the resistor?

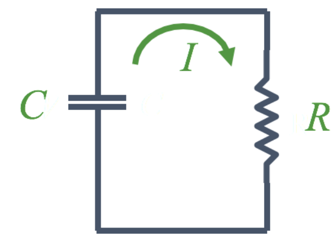
a. 12 $\hat{x}$ V/cm
b. -12 $\hat{x}$ V/cm
c. 0.667 $\hat{x}$ V/cm
d. 3×10^4 $\hat{x}$ V/cm
e. -0.667 $\hat{x}$ V/cm

2) (On average) How much charge passes through the surface A in 1 second?

a. 3×10^4 C
b. 26.2 C
c. -3×10^4 C

The next three questions pertain to the situation described below.

A capacitor with capacitance $C = 10^{-5}$ F is initially charged by connecting it to a battery of voltage 9 V and waiting for a long time. The capacitor is then disconnected from the battery after which it is connected to a resistor with resistance 5 Ω as shown:



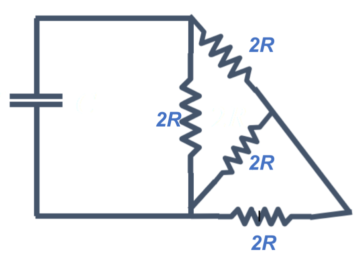
3) Immediately after the resistor is connected what is the current through the resistor?

a. 9×10^{-5} Amps
b. 1.8 Amps
c. 5×10^{-5} Amps

4) How long after the resistor is connected does it take for the charge on the capacitor to reach the value 1/5 of the initial charge?

a. 4.7×10^{-4} sec
b. 8×10^{-5} sec
c. 5×10^{-5} sec

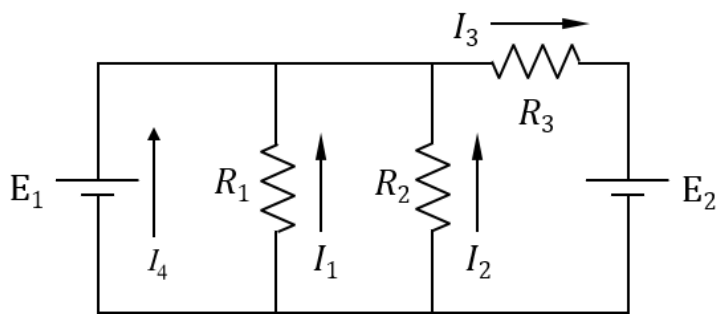
5) We now connect an identical charged up capacitor to a network of resistors shown in the figure below. Compare the new time the capacitor takes to discharge to 1/5 of the initial charge, with the time from the previous problem:



a. It now takes longer
b. It now takes less time
c. It takes the same time

The next three questions pertain to the situation described below.

Three resistors (R_1 = 10 Ω, R_2 = 15 Ω, R_3 = 25 Ω) are connected to two batteries (E_1 is unknown, E_2 = 11 V) as shown in the figure.



6) Which of the following equations is NOT correct:

a. $I_1 R_1 + E_1 = 0$
b. $-I_3R_3+E_1-E_2 = 0$
c. $-I_3R_3+I_1R_1-E_2 = 0$
d. $-I_2R_2-E_1 = 0$
e. $-I_3R_3-I_2R_2-E_2 = 0$

7) The current I_3 through resistor R_3 is measured to be 0.48 amps, in the direction shown by the arrow. What is the voltage across battery E_1?

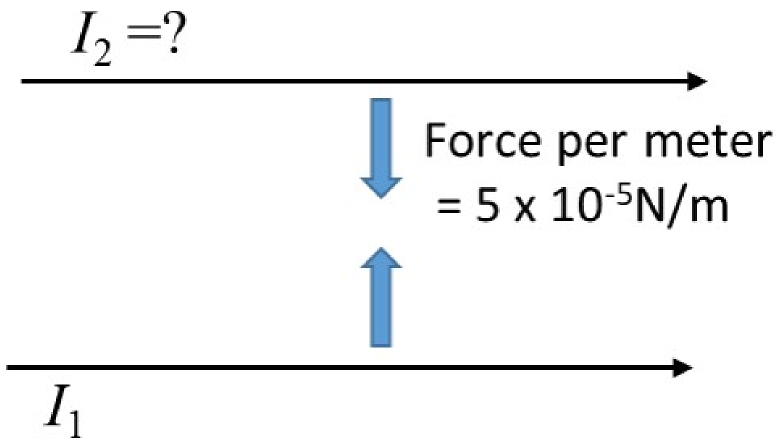
a. E_1 = 11 V
b. E_1 = 23 V
c. E_1 = 1 V

8) What is I_4 the current through battery E_1?

a. I_4 = 2 A
b. I_4 = 2.8 A
c. I_4 = 2.5 A
d. I_4 = 0.92 A
e. I_4 = 4.3 A

The next two questions pertain to the situation described below.

Two long parallel wires are separated by a distance of 2.5 cm. The force per meter that each wire exerts on the other is 5×10^{-5} N/m, and the wires attract each other. The current in one of the wires, I_1, is 0.5 A.



9) What is the current I_2 in the other wire?

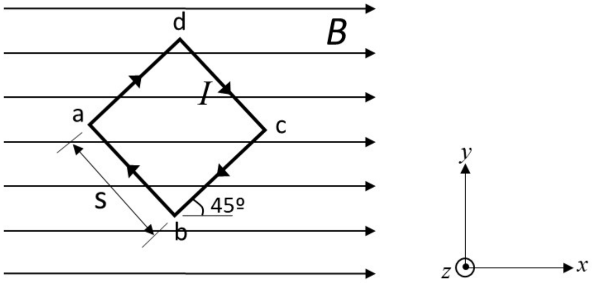
a. 12.5 A
b. 2.5 A
c. 0.5 A
d. 6.25 A
e. 4.81 A

10) Are the currents in the two wires flowing in the same direction or in opposite directions?

a. the same direction
b. not enough information is given in the problem to answer this question
c. opposite directions

The next three questions pertain to the situation described below.

A square loop of side s = 0.5 m lies in the *x*-*y* plane and carries a current of $I = 1.2$ A flowing in the clockwise direction (as viewed from $z > 0$). A constant, uniform magnetic field of magnitude $B = 0.6$ T points in the $+x$ direction, as shown in the figure.



$B = 0.6$ T

$I = 1.2$ A

$s = 0.5$ m

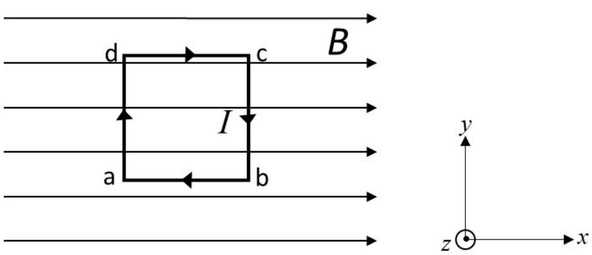
11) The torque exerted by the magnetic force on this loop is pointing in the direction:

a. $+y$
b. $-x$
c. $+z$
d. $-y$
e. $+x$

12) The amount of work required to rotate this loop to an orientation which has the maximum potential energy is:

a. 0 J
b. 0.18 J
c. 0.36 J

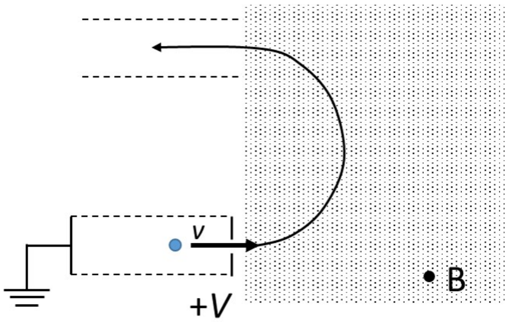
13) How much work is required to rotate the loop by 45 degrees around the *z*-axis such that the segment *ab* is now oriented along the *x*-axis (see figure below)?



a. 0.18 J
b. 0.09 J
c. 0 J

The next two questions pertain to the situation described below.

An electron of mass *m* and charge *q* is put in a track and accelerated to the right (in the plane of the paper) from rest through a potential difference *V*. The electron then enters a region containing a uniform magnetic field (direction of *B* is out of the page). The electron makes a 180° turn in the field to enter a track that is parallel to its initial trajectory.



$V = 300$ V

$B = 0.2$ T out of page

$q = -1.6 \times 10^{-19}$ C

$m = 9.1 \times 10^{-31}$ kg

14) When the electron is in the magnetic field region, its speed *v*:

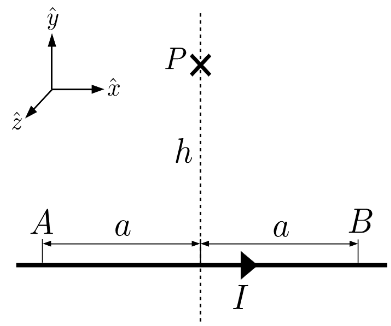
a. remains constant.
b. increases.
c. decreases.

15) How much time does the electron spend in the magnetic field region?

[Hint: Δt = *distance*/*speed*]

a. 2.2×10^{-45} s
b. 9.5×10^{-6} s
c. 4.7×10^{-23} s
d. 2.8×10^{-11} s
e. 8.9×10^{-11} s

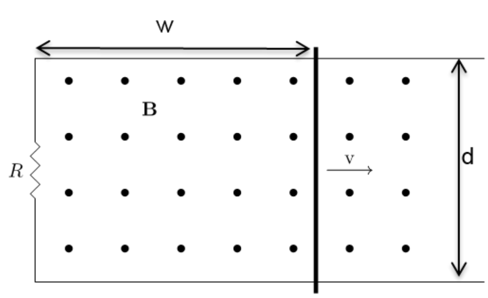
16) An infinitely long, thin wire carries a current I along the x axis. What is the contribution to the magnetic field at a point $P = (0, h)$ due to **only** the segment of the wire between point $A = (-a, 0)$ and point $B = (a, 0)$?



a. $\vec{B}(P) = \int_{-a}^{a} \frac{\mu_0 I}{4\pi} \frac{h}{(x^2+h^2)^{3/2}} dx\hat{z}$
b. $\vec{B}(P) = \int_{-a}^{a} \frac{\mu_0 I}{4\pi} \frac{-x}{h(x^2+h^2)} dx\hat{z}$
c. $\vec{B}(P) = \int_{-a}^{a} \frac{\mu_0 I}{4\pi} \frac{1}{x^2+h^2} dx\hat{z}$
d. $\vec{B}(P) = \int_{-a}^{a} \frac{\mu_0 I}{4\pi} \frac{h}{x(x^2+h^2)} dx\hat{z}$
e. $\vec{B}(P) = \int_{-a}^{a} \frac{\mu_0 I}{4\pi} \frac{-x}{(x^2+h^2)^{3/2}} dx\hat{z}$

The next two questions pertain to the situation described below.

A conducting bar of mass m = 0.3 kg slides with negligible friction along a pair of horizontal conducting tracks separated by a distance d = 0.15 m, as shown in the figure below. The left side of the loop contains a resistor with resistance R = 20 Ω. There is a constant magnetic field, B = 2 T, directed out of the page.



17) What is the current through the resistor when the metallic bar is a distance w = 0.225 m from the end sliding with a constant speed v = 4 m/s?

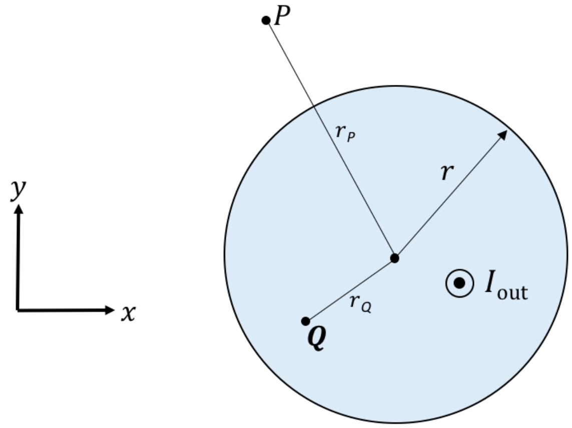
a. I = 0.00338 A
b. I = 0.09 A
c. I = 0.06 A

18) What direction does the current flow, when the bar is sliding to the right at a constant speed?

a. Counter clockwise, down through the resistor.
b. Cannot determine the direction of the current.
c. Clockwise, up through the resistor.

The next two questions pertain to the situation described below.

A wire of radius $r = 11.1$ cm is centered at the origin carries a uniform current $I_{out} = 0.295$ A out of the page. Points P and Q are placed at distances of $r_P = 18$ cm and $r_Q = 5$ cm from the origin respectively, as shown in the figure below.



19) What is the magnitude of the magnetic field at Point P?

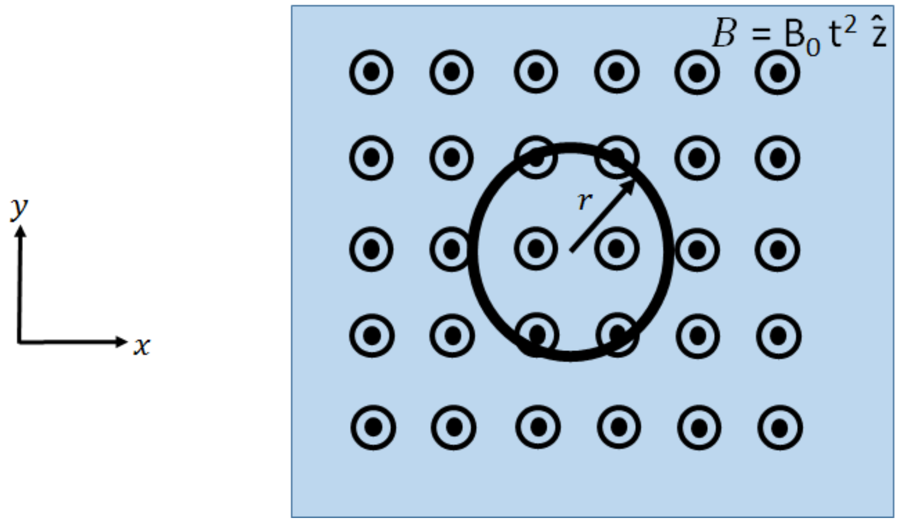
a. $|\vec{B}| = 2.6 \times 10^{-7}$ T
b. $|\vec{B}| = 5.3 \times 10^{-7}$ T
c. $|\vec{B}| = 3.3 \times 10^{-7}$ T

20) What is the magnitude of the magnetic field at Point Q?

a. $|\vec{B}| = 2.9 \times 10^{-9}$ T
b. $|\vec{B}| = 2.4 \times 10^{-7}$ T
c. $|\vec{B}| = 4.75 \times 10^{-7}$ T
d. $|\vec{B}| = 8.6 \times 10^{-8}$ T
e. $|\vec{B}| = 1.2 \times 10^{-6}$ T

The next three questions pertain to the situation described below.

A circular wire with radius r and resistance R is placed within a time-dependent but uniform magnetic field at $t = 0$ sec, as seen in the figure below. The magnetic field is given by $B(t) = B_0 t^2$ and points out of the page. Here, $r = 5.5$ cm, $R = 7\ \Omega$, and $B_0 = 5\ \mathrm{mT/s^2}$.



21) What is the magnetic flux through the wire at t = 5.1 sec?

a. $\Phi = 0.0012\ T \cdot m^2$
b. $\Phi = 4.8 \times 10^{-5}\ T \cdot m^2$
c. $\Phi = 0.0095\ T \cdot m^2$

22) What is the magnitude of the induced current at $t = 3.7$ sec?

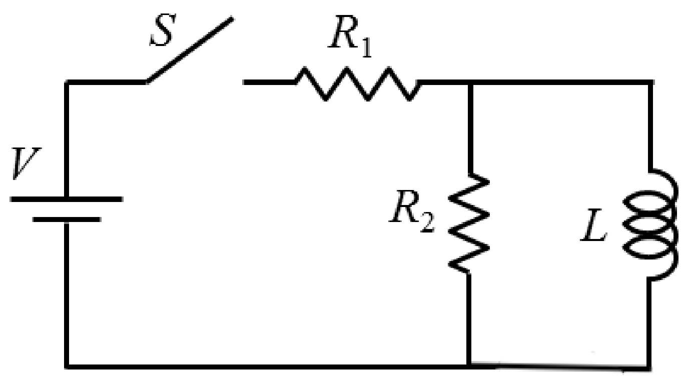
a. $I = 1.8 \times 10^{-4}\ A$
b. $I = 5 \times 10^{-5}\ A$
c. $I = 6.5 \times 10^{-4}\ A$
d. $I = 0\ A$
e. $I = 3.5 \times 10^{-4}\ A$

23) As time increases, the heat dissapated in the loop :

a. Stays the same
b. Decreases
c. Increases

The next two questions pertain to the situation described below.

A circuit is constructed with two resistors and one inductor as shown in the Figure below. The values for the resistors are: $R_1 = 3.5\ \Omega$ and $R_2 = 6\ \Omega$. The battery voltage is $V = 13$ V. The switch S is initially open.



24) After the switch has been opened a long time, it is closed. What is the magnitude of the voltage across L immediately after the switch is closed?

a. 8.2 V
b. 0 V
c. 4.8 V
d. 7.6 V
e. 13 V

25) After the switch has been closed a long time it is opened again. What is the magnitude of the current through R_2 immediately after the switch is opened?

a. 5.6 A
b. 2.2 A
c. 0 A
d. 3.7 A
e. 1.4 A