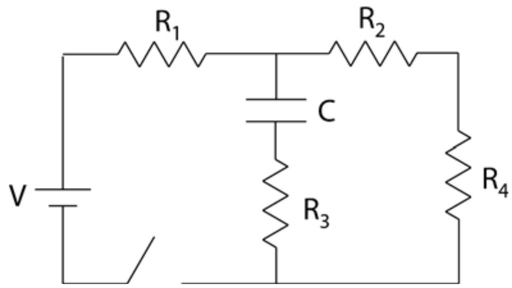
The next four questions pertain to the situation described below.

Consider the electrical circuit shown below. It consists of a switch, an ideal battery, a capacitor and four resistors, whose values are specified below.



V = 19 Volts
$C = 5.6 \times 10^{-6}$ F
$R_1 = 60\ \Omega$
$R_2 = 60\ \Omega$
$R_3 = 80\ \Omega$
$R_4 = 40\ \Omega$

1) The switch has been open for a long time when at time t = 0, the switch is closed. What is $I_1(t=0)$ the magnitude of the current that flows through R_1 immediately after the switch is closed?

a. $I_1(t=0) = 0.475$ A
b. $I_1(t=0) = 0.119$ A
c. $I_1(t=0) = 0.182$ A
d. $I_1(t=0) = 0.317$ A
e. $I_1(t=0) = 0.136$ A

2) What is $I_4(t=\infty)$, the magnitude of the current that flows through R_4 after the switch has been closed a long time?

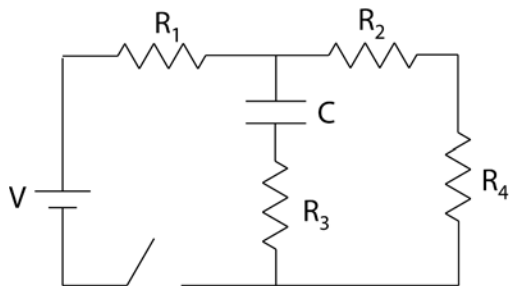
a. $I_4(t=\infty) = 0.119$ A
b. $I_4(t=\infty) = 0$ A
c. $I_4(t=\infty) = 0.182$ A

3) What is $Q(t=\infty)$, the charge on the capacitor after the switch has been closed a long time?

a. $Q(t=\infty) = 1.06 \times 10^{-4}$ C
b. $Q(t=\infty) = 6.65 \times 10^{-5}$ C
c. $Q(t=\infty) = 4.56 \times 10^{-5}$ C

4) **Setup repeated from previous page**

Consider the electrical circuit shown below. It consists of a switch, an ideal battery, a capacitor and four resistors, whose values are specified below.



V = 19 Volts

C = 5.6×10^{-6} F

$R_1 = 60\ \Omega$

$R_2 = 60\ \Omega$

$R_3 = 80\ \Omega$

$R_4 = 40\ \Omega$

After the switch has been closed a long time, it is opened. What is the time constant associated with the capacitor discharging with the switch open?

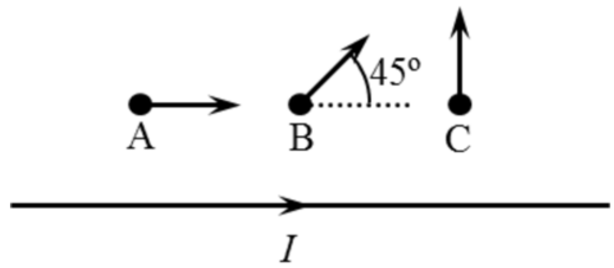
a. $\tau = 0.00101$ s

b. $\tau = 5.6 \times 10^{-4}$ s

c. $\tau = 4.48 \times 10^{-4}$ s

The next two questions pertain to the situation described below.

Three identical positive charges are moving in the vicinity of an infinitely long, straight wire which carries a current I to the right, as shown in the figure. Each charge moves with the same speed v, but with the differing (initial) directions shown in the figure. At the instant shown, all three charges are the same distance from the wire.



5) Compare the magnitude of the magnetic force on charge A with the magnitude of the magnetic force on charge B at the instant shown.

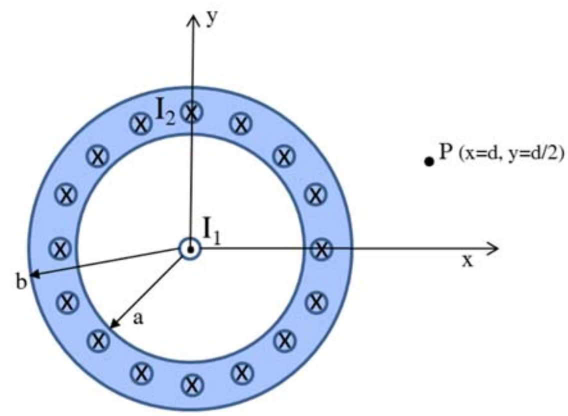
a. $F_A > F_B$
b. $F_A < F_B$
c. $F_A = F_B$

6) Compare the magnitude of the magnetic force on charge B with the magnitude of the magnetic force on charge C at the instant shown.

a. $F_B = F_C$
b. $F_B > F_C$
c. $F_B < F_C$

The next three questions pertain to the situation described below.

An infinitely long solid cylindrical conducting shell of inner radius a = 0.3 m and outer radius b = 0.6 m has its axis aligned with the z-axis as shown. It carries a uniformly distributed current I_2 = 4.5 A in the negative z-direction. An infinitely long conducting wire is located along the z-axis and carries a current I_1 = 3.5 A in the positive z-direction (out of the page).



7) What is the magnitude of the magnetic field at the point labelled P located 0.84 m to the right of the y axis and 0.42 m above the x axis?

a. $B(P) = 2.13 \times 10^{-7}$ T
b. $B(P) = 2.38 \times 10^{-7}$ T
c. $B(P) = 1.7 \times 10^{-6}$ T

8) What is the y component of the magnetic field at point P?

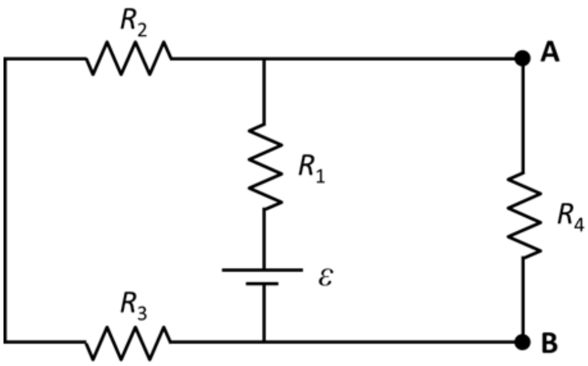
a. $B_y(P) = -9.52 \times 10^{-8}$ T
b. $B_y(P) = 7.62 \times 10^{-7}$ T
c. $B_y(P) = -1.9 \times 10^{-7}$ T

9) What is the magnitude of the magnetic field at a distance y = 0.45 m directly above the origin?

a. $B(0,0.45) = 4.44 \times 10^{-7}$ T
b. $B(0,0.45) = 7.22 \times 10^{-7}$ T
c. $B(0,0.45) = 4.31 \times 10^{-7}$ T
d. $B(0,0.45) = 1.56 \times 10^{-6}$ T
e. $B(0,0.45) = 5.56 \times 10^{-7}$ T

The next three questions pertain to the situation described below.

Consider the electrical circuit shown below. It consists of an ideal battery and four resistors, whose values are specified below.



ϵ = 15 V
R_1 = 4 Ω
R_2 = 3 Ω
R_3 = 3 Ω
R_4 = 9 Ω

10) Resistors R_1 and R_4 are connected

a. in series
b. neither in series nor in parallel
c. in parallel

11) What is the current I_1 flowing through resistor R_1?

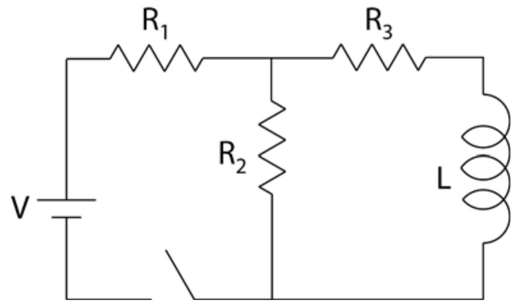
a. I_1 = 1.15 A
b. I_1 = 1.5 A
c. I_1 = 1.97 A

12) What is the electric potential difference between points **A** and **B**?

a. $V_B - V_A$ = -7.89 V
b. $V_B - V_A$ = -7.11 V
c. $V_B - V_A$ = -15 V

The next three questions pertain to the situation described below.

A circuit is constructed with three resistors, one inductor, one ideal battery and a switch as shown in the figure.



V = 12 Volts
R_1 = 20 Ω
R_2 = 50 Ω
R_3 = 100 Ω
L = 0.23 H

13) The switch has been open for a long time when at time t = 0, the switch is closed. What is $I_2(t=0)$ the magnitude of the current that flows through R_2 just after the switch is closed?

a. $I_2(t=0) = 0.171$ A
b. $I_2(t=0) = 0.15$ A
c. $I_2(t=0) = 0.1$ A
d. $I_2(t=0) = 0$ A
e. $I_2(t=0) = 0.225$ A

14) What is $I_2(t=\infty)$ the magnitude of the current that flows through R_2 after the switch has been closed a long time?

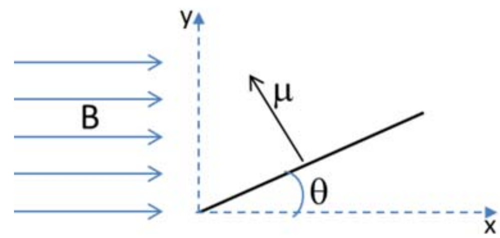
a. $I_2(t=\infty) = 0.171$ A
b. $I_2(t=\infty) = 0.225$ A
c. $I_2(t=\infty) = 0.15$ A
d. $I_2(t=\infty) = 0.1$ A
e. $I_2(t=\infty) = 0$ A

15) After the switch has been closed for a long time, it is opened. What is the ratio of the current through the inductor at a time $t_{open} = 3x10^{-3}$ seconds after the switch was opened, to the I_0 current just after the switch was opened?

a. $I(t_{open})/ I_0 = 0.141$
b. $I(t_{open})/ I_0 = 0.271$
c. $I(t_{open})/ I_0 = 0.499$

The next three questions pertain to the situation described below.

A square wire loop carrying a current of 1.2 A is located in a uniform magnetic field pointing to the right with magnitude 0.75 T. The image shows only the wire closest to you, which is located in the x-y plane at z=0 and makes an angle θ=30° with the x axis. The magnetic dipole moment of the loop has magnitude 1.97 Am^2 and is oriented as shown in the figure.



16) What direction does the current flow in the wire segment located along the z axis?

a. Into the page (negative z)
b. Out of the page (positive z)

17) What is the magnitude of the torque on the loop due to the magnetic field when oriented as shown in the image?

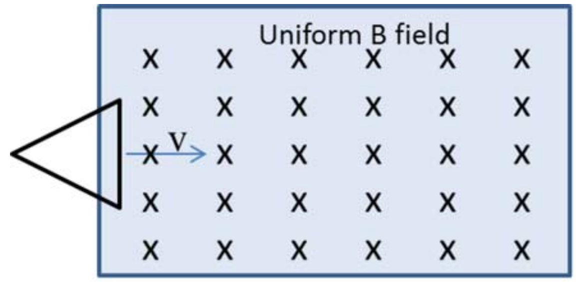
a. τ = 1.28 Nm
b. τ = 0.737 Nm
c. τ = 1.47 Nm

18) What is the direction of the torque on the loop due to the magnetic field when oriented as shown in the image?

a. +z
b. -z
c. +x

The next two questions pertain to the situation described below.

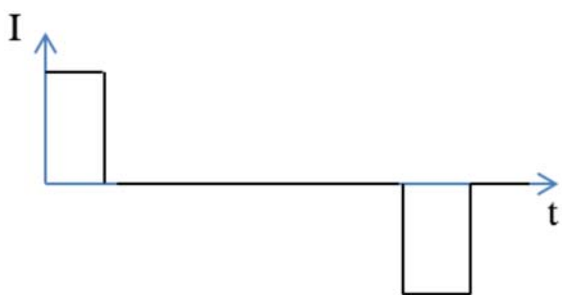
An equilateral triangle of conducting wire with sides of length 0.35 m is pulled from a region of no magnetic field, through a region with uniform magnetic field B = 0.25 T into the page at a constant speed v = 5 m/s.



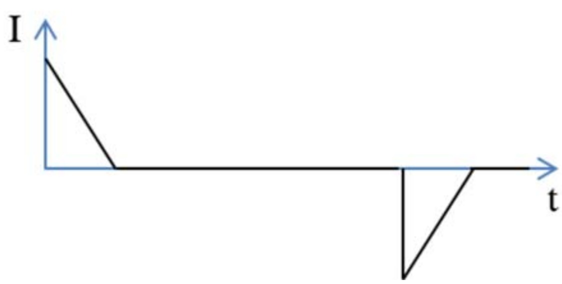
19) What is the direction of the induced current in the triangle at the time shown in the image?

a. Counterclockwise (up along the vertical segment)
b. Clockwise (down along the vertical segment)

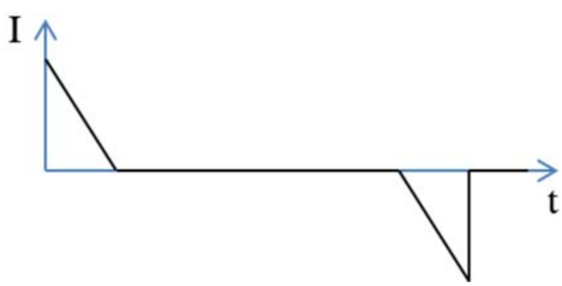
20) Assuming the triangle has a finite resistance, which plot could represent the current around the loop as a function of time, starting when the loop just enters the magnetic field, until it is completely out of the field? (Note answer choice is located BELOW corresponding image)



a.



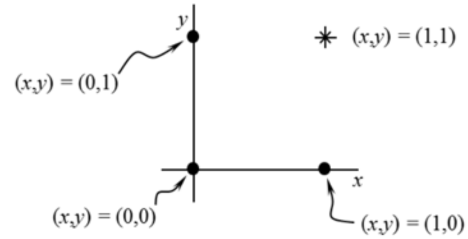
b.



c.

The next two questions pertain to the situation described below.

Three infinitely long, straight wires, are located at three of the corners of a 1 meter square as shown in the diagram. The current in each wire is I= 2.4 A, coming out of the page.



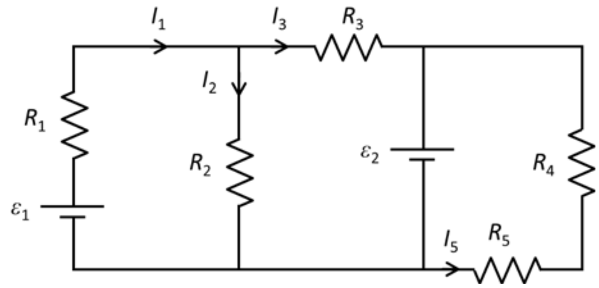
21) The x-component of the magnetic field at the point (x,y) = (1,1) produced by the three currents is

a. $B_x = 2.4 \times 10^{-7}$ T
b. $B_x = -7.2 \times 10^{-7}$ T
c. $B_x = -2.4 \times 10^{-7}$ T

22) The y-component of the magnetic field at the point (x,y) = (1,1) produced by the three currents is

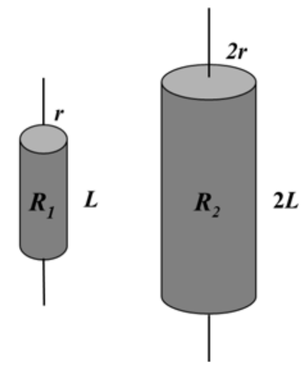
a. $B_y = 7.2 \times 10^{-7}$ T
b. $B_y = -7.2 \times 10^{-7}$ T
c. $B_y = 2.4 \times 10^{-7}$ T

23) Consider the electrical circuit shown below. It consists of two (ideal) batteries and five resistors. The positive directions for the currents are indicated by the directions of the arrows. Which of the following equations is not valid?



a. $I_2 = +I_1 - I_3$
b. $\epsilon_1 - \epsilon_2 - I_5 R_4 - I_5 R_5 - I_2 R_2 = I_1 R_1$
c. $I_1 R_1 + I_2 R_2 - \epsilon_1 = 0$
d. $I_2 R_2 + \epsilon_2 - I_3 R_3 = 0$
e. $I_5 R_4 + \epsilon_2 + I_5 R_5 = 0$

24) Two cylindrical resistors are made of the same material with known resistivity. The second resistor has twice the radius and twice the length of the first resistor as shown in the figure to the right. What is the ratio of their resistance?



a. $R_1 / R_2 = 2$
b. $R_1 / R_2 = 1/2$
c. $R_1 / R_2 = 1$