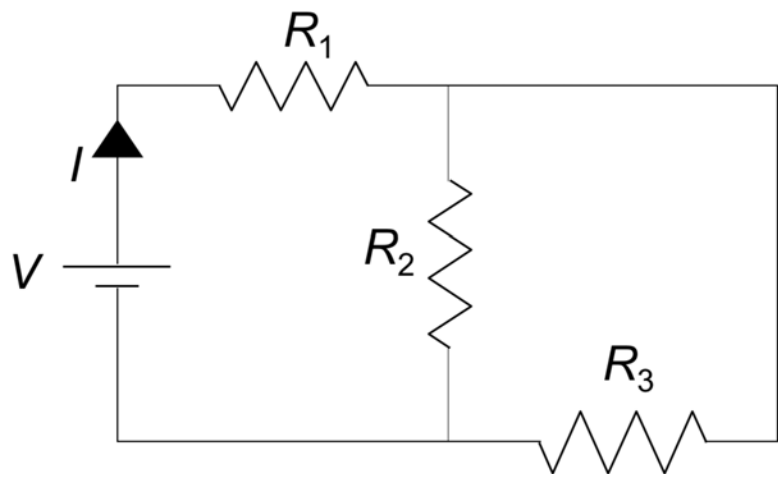
The next three questions pertain to the situation described below.

Three resitors R_1, R_2, and R_3, are connected to a battery with voltage V as shown in the figure. A Current I flows through the resistor R_1.



1) Resistors R_2 and R_3 are in

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

2) What fraction of the current I flows through the resistor R_2

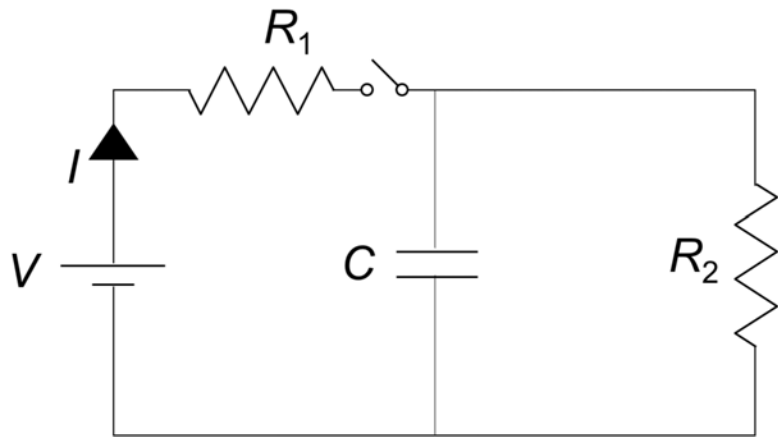
a. $R_3/(R_1 + R_2)$
b. $R_2/(R_1 + R_2)$
c. R_2/R_3
d. $R_2/(R_2 + R_3)$
✓ e. $R_3/(R_2 + R_3)$

3) What is the value of the current I, in terms of the resistances R_1, R_2, and R_3, and the voltage V

a. $I = V/(R_1 + R_2 + R_3)$
b. $I = V(R_2 + R_3)/(R_1 + R_2 + R_3)$
✓ c. $I = V(R_2 + R_3)/(R_1R_2 + R_1R_2 + R_2R_3)$

The next four questions pertain to the situation described below.

Consider the RC Circuit pictured. A Battery with voltage $V = 5$ Volts is connected to two resistors of resistance $R_1 = 25\ \Omega$ and $R_2 = 30\ \Omega$, and a capacitor with capacitance $C = 15\ \mu F$. Assume that the switch has been open for a very long time, so that the initial charge Q on the capacitor is zero.



4) What is the value of the current I immediatgely after the switch is closed?

a. $I = 0.0909$ A
b. $I = 0.167$ A
✓ c. $I = 0.2$ A

5) After the switch has been closed for a long time, what is the charge Q on the capacitor?

a. $Q = 3\ \mu C$
✓ b. $Q = 40.9\ \mu C$
c. $Q = 75\ \mu C$
d. $Q = 34.1\ \mu C$
e. $Q = 1.36\ \mu C$

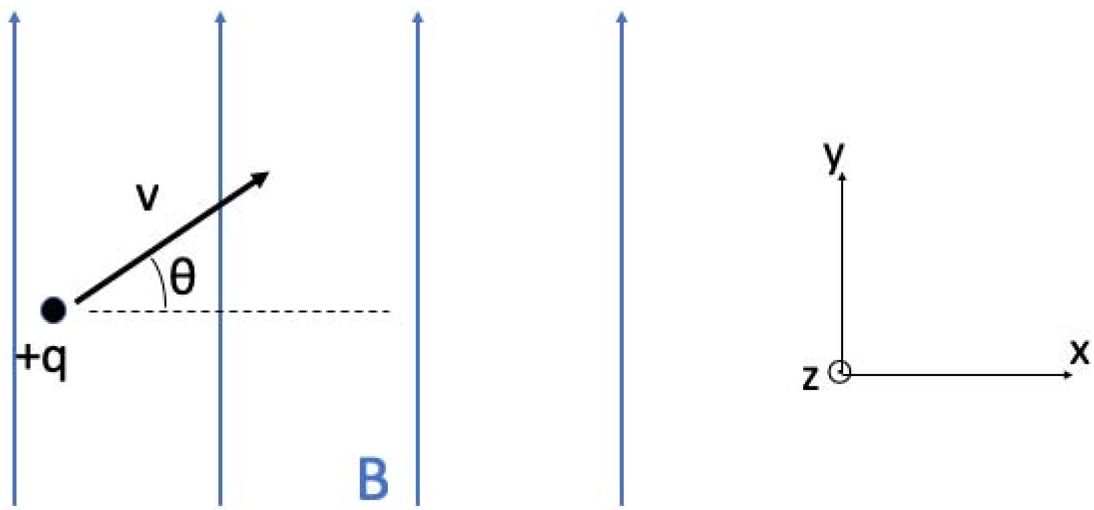
6) The energy expended by the battery in charging the capacitor is

a. Equal to the final value of the energy stored in the capacitor.
b. Less than the final value of the energy stored in the capacitor.
✓ c. Greater than the final value of the energy stored in the capacitor.

7) After the switch has been closed for a very long time, it is then re-opened. If the value of the charge on the capacitor at the instant the switch is reopened is Q_0, what is the charge on the capacitor after a time $t = 90$ μs?

a. $Q = 0.897\ Q_0$
b. $Q = 0.787\ Q_0$
✓ c. $Q = 0.819\ Q_0$

The next two questions pertain to the situation described below.



At a particular moment, a charge q=+0.54 C and mass m=0.06 kg is moving purely in the x-y plane, at an angle from the (horizontal) x-axis of θ=26^{o} at speed v=0.8 m/s through a uniform magnetic field that points in the positive y-direction with strength B_y=0.9 T.

8) What is the acceleration of the charge in the z-direction (where the positive z-axis points out of the page)?

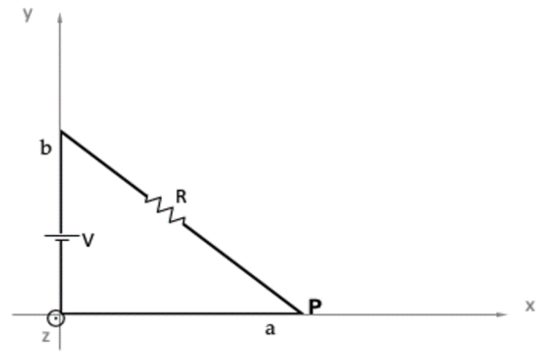
a. -5.8 m/s^2
b. 6.5 m/s^2
✓ c. 5.8 m/s^2
d. -6.5 m/s^2
e. -2.8 m/s^2

9) Which of the following changes would increase the time it takes for the particle spiraling in the magnetic field to complete one revolution?

a. Increase the speed v
✓ b. Decrease the magnetic field B
c. Increase the charge q

The next three questions pertain to the situation described below.

A triangular conducting loop lies in the x-y plane, as shown, with one tip (point P) lying on the +x axis a distance a=5.7 cm from the origin. The triangle is right-angled, with the right angle at the origin and extending a distance b=3.6 cm up the positive y-axis. A battery with voltage V=8 V is attached along the y-axis as shown, with the negative side closest to the origin, and a resistor of resistance R=0.2 Ω is attached along the hypoteneuse of the triangle.



10) What is the magnitude of the magnetic dipole moment of the current loop?

a. 0.13 A m^2
b. 0.052 A m^2
✓ c. 0.041 A m^2

11) In what direction would a magnetic field need to be applied such that the point P would move towards the z-axis, pointing either out of the page or into the page?

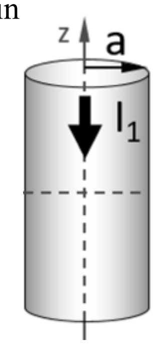
a. z direction
✓ b. x direction
c. y direction

12) A magnetic field is applied in the positive z-direction for the loop held fixed in the x-y plane. What is the sign of the potential energy U?

a. U<0
b. U=0
✓ c. U>0

The next three questions pertain to the situation described below.

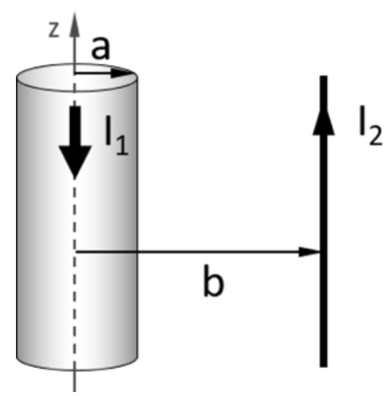
13) Consider an infinitely long, thick wire of radius $a = 7$ cm, that carries a total current $I_1 = 14$ A in the -z-direction, as shown in the figure. What is the magnitude of the magnetic field B at a distance $r = 4$ cm from the center of the wire?



a. $B = 1.6 \times 10^{-6}$ T
b. $B = 4 \times 10^{-5}$ T
c. $B = 7 \times 10^{-5}$ T
d. $B = 9.14 \times 10^{-7}$ T
✓ e. $B = 2.29 \times 10^{-5}$ T

14) Now consider the situation where an infinitely long thin wire carrying current I_2 in the +z-direction is placed parallel to and at a distance $b = 9$ cm from the center of the thick wire, as shown.

The force between the wires is



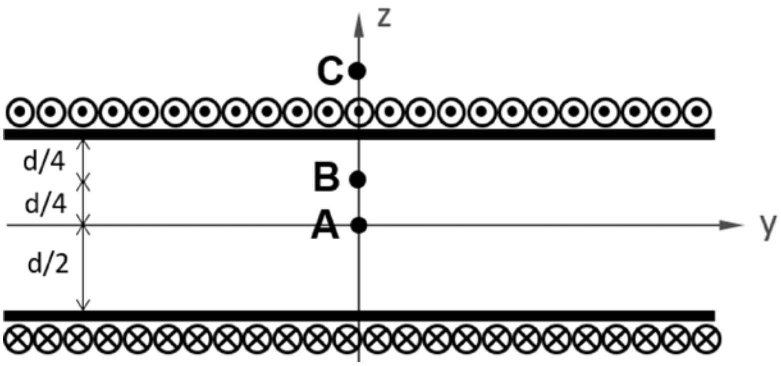
✓ a. repulsive
b. attractive.
c. not determined, without knowing the magnitude of I_2.

15) A student measures that the force per unit length exerted on I_2 by I_1 is 0.0023 N/m. What is the magnitude of I_2?

a. $I_2 = 4.03$ A
b. $I_2 = 16.4$ A
c. $I_2 = 57.5$ A
d. $I_2 = 1030$ A
✓ e. $I_2 = 73.9$ A

The next three questions pertain to the situation described below.

Consider two infinitely long and wide flat metal sheets, placed parallel to the *x*-*y* plane, as shown. The distance between the sheets is $d = 7$ cm. Each sheet carries an evenly distributed linear current density of 10^3 A/m, in the $+x$-direction for the top sheet and in the $-x$-direction for the bottom sheet. Point A is located half-way between the sheets, while point B is located one-quarter of the way between the sheets.



16) What is the direction of the magnetic field at point B?

a. +z-direction
b. -z-direction
✓ c. +y-direction

17) Compare the magnitude of the magnetic field at the points A, B, and C:

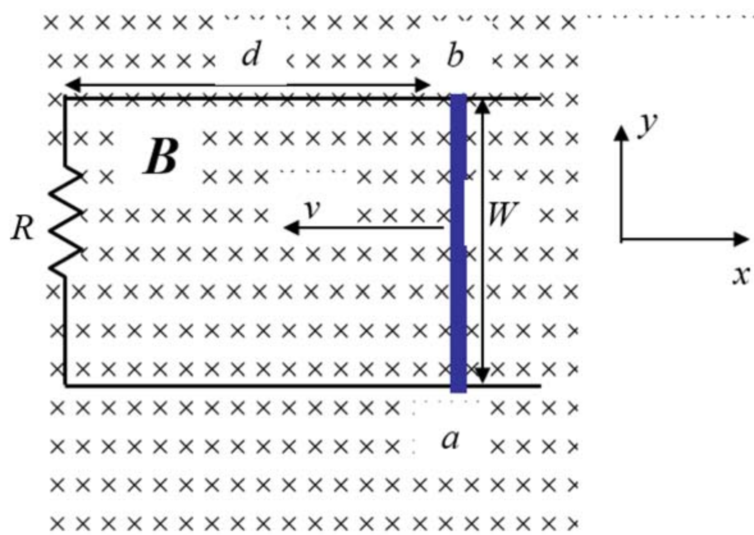
a. $B_A = B_B = B_C$
b. $B_A > B_B > B_C$
✓ c. $B_A = B_B > B_C$

18) What is the magnitude of the magnetic field B_A at point A?

a. $B_A = 6.28 \times 10^{-4}$ T
b. $B_A = 0$ T
✓ c. $B_A = 0.00126$ T

The next three questions pertain to the situation described below.

A conducting bar of mass $m = 0.7$ kg was given an initial push and now slides with negligible friction along a pair of horizontal conducting tracks separated by a distance $W = 0.12$ m, as shown in the figure. The left side of the loop contains a resistor with resistance $R = 3\ \Omega$. There is a constant magnetic field, $B = 1.4$ T, directed into the page. When the bar is a distance $d = 0.15$ m from the resistor the induced current in the loop is $I = 0.8$ A.



19) What is the speed of the bar when it is a distance $d = 0.15$ m from the resistor.

✓ a. $v = 14.3$ m/s
b. $v = 11.4$ m/s
c. $v = 9.14$ m/s

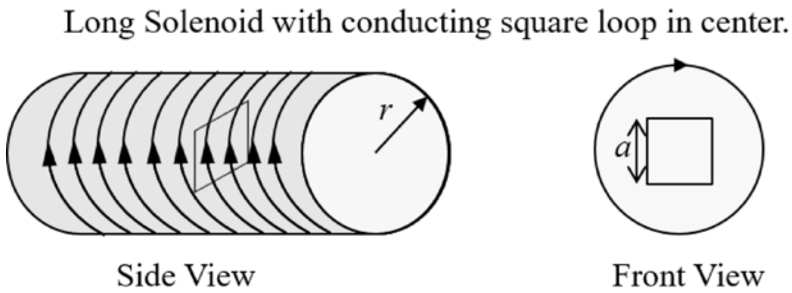
20) What is the magnitude of the acceleration of the bar when it is a distance $d = 0.15$ m from the resistor.

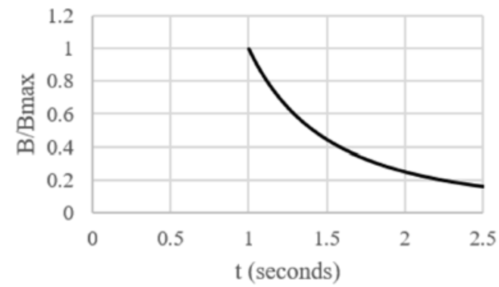
a. $|a| = 0.24$ m/s^2
b. $|a| = 682$ m/s^2
✓ c. $|a| = 0.192$ m/s^2
d. $|a| = 9.61$ m/s^2
e. $|a| = 0$ m/s^2

21) What direction does the current flow through the resistor?

a. Counter clockwise, down through the resistor.
✓ b. Clockwise, up through the resistor.

The next three questions pertain to the situation described below.





A conducting wire with resistance 0.45 Ω is formed into a square with side $a = 0.4$ m and placed in the center of a long solenoid of radius $r = 0.3$ m as shown in the figure. The current through the solenoid is adjusted such that the magnetic field inside is given by $B(t) = 1.2/t^2$ T with $t > 1$ and measured in seconds.

22) If the current through the solenoid at time $t = 1$ s is 3.77 amps, what is the number of turns/meter wrapping the solenoid?

a. $n = 1.59 \times 10^6$ turns/meter
b. $n = 4.77 \times 10^5$ turns/meter
✓ c. $n = 2.53 \times 10^5$ turns/meter

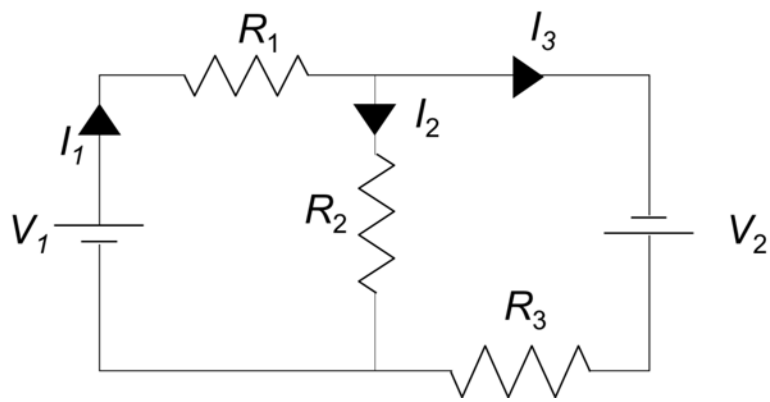
23) What is the magnitude of the current induced in the square loop at time $t = 1.3$ s?

a. $I = 0.218$ A
✓ b. $I = 0.388$ A
c. $I = 0.446$ A
d. $I = 0.252$ A
e. $I = 0.686$ A

24) If the direction of the current in the solenoid is clockwise from the front view (as shown in image), what is the direction of the current induced in the square loop?

a. Counter clockwise
✓ b. Clockwise

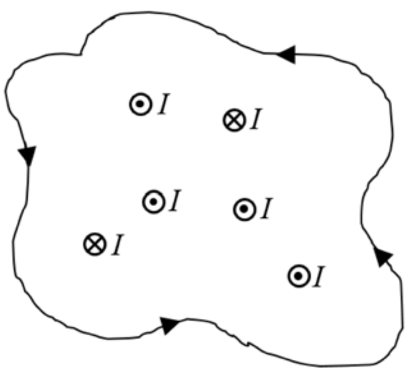
Consider the circuit pictured consisting of three resitors with resistances R_1, R_2, and R_3, two batteries with voltage V_1 and V_2. A current I_1 flows through resistor R_1, a current I_2 flows through resistor R_2, and a current I_3 flows through the resistor R_3 in the direction indicated in the figure



25) Which of the following is a valid Kirchoff voltage law equation for this circuit?

✓ a. $V_1 - I_3R_3 + V_2 - I_1R_1 = 0$
b. $V_1 - I_2R_2 - I_3R_3 = 0$
c. $V_1 + I_3R_3 + V_2 + I_1R_1 = 0$

26) Six parallel wires, each carrying current *I*, have directions into and out of the plane as shown. Consider a closed path enclosing the wires, as shown in the figure. If the value of the line integral of the magnetic field around the closed path is 5.2×10^{-6} T-m, what is the value of *I*?



✓ a. $I = 2.07$ A
b. $I = 0.69$ A
c. $I = 4.14$ A