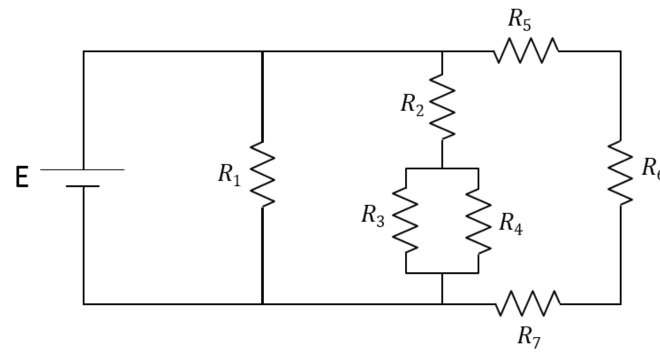
The next four questions pertain to the situation described below.

Seven identical resistors (R = 10 Ω) are connected to a battery (E = 13 V) as shown in the figure.



1) The resistors R_5 and R_7 are in

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

2) What is the current through the battery?

a. I_{battery} = 0.186 A
b. I_{battery} = 2.6 A
c. I_{battery} = 1.3 A

3) What is the power dissipated by resistor R_6?

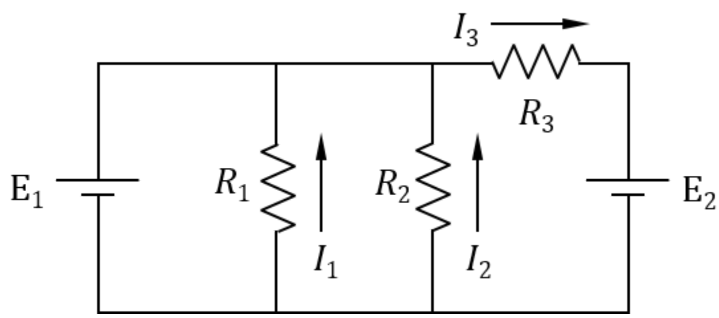
a. P_6= 16.9 J/s
b. P_6= 1.88 J/s
c. P_6= 5.63 J/s

4) What is the voltage across resistor R_4?

a. V_4 = 4.33 V
b. V_4 = 8.67 V
c. V_4 = 6.5 V

The next four 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 = 13 V) as shown in the figure.



5) The resistors R_2 and R_3 are in

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

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?

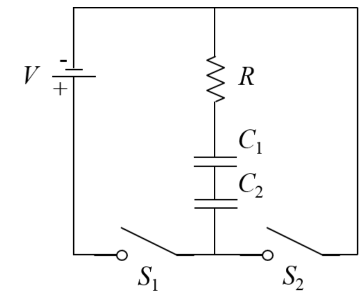
a. E_1 = 13 V
b. E_1 = 25 V
c. E_1 = 1 V

8) Now battery E_1 is replaced by a battery with voltage 13 V. What is I_2 the current through resistor R_2 with this new battery in place?

a. I_2 = -0.867 A
b. I_2 = 0.325 A
c. I_2 = -1.19 A

The next three questions pertain to the situation described below.

A circuit is composed of a battery with voltage V, a resistor R, two capacitors, C_1 and C_2, and two switches, S_1 and S_2, as shown. Initially the capacitors are uncharged and the switches are both open. At time $t = 0$, S_1 is closed.



9) At $t = 0$, what is the voltage, V_{C1}, the voltage across capacitor C_1?

a. $V_{C1} = VC_1 / (C_1+C_2)$
b. $V_{C1} = 0$
c. $V_{C1} = V$

10) What is the charge, Q_{C2}, on capacitor C_2 at time $t = RC_{eff}$ where C_{eff} is the effective capacitance of the combination of C_1 and C_2.

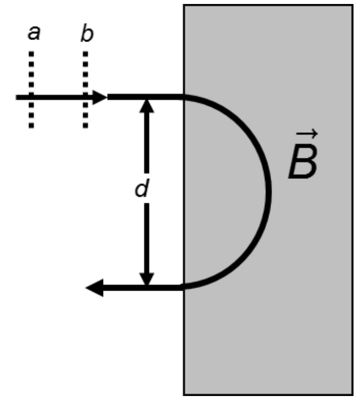
a. $Q_{C2} = (1\text{-}e^{-1})\ VC_2$
b. $Q_{C2} = e^{-1} VC_1C_2 / (C_1+C_2)$
c. $Q_{C2} = (e^{-1} VC_2)$
d. $Q_{C2} = e^{-1} VC_2 / (C_1+C_2)$
e. $Q_{C2} = (1\text{-}e^{-1})\ VC_1C_2 / (C_1+C_2)$

11) After a long time, $t >> RC_{eff}$, S_1 is opened and then, at $t=t_2 S_2$ is closed. What is the magnitude of the current, $|I_R|$, through the resistor immediately <u>after</u> switch S_2 is closed?

a. $|I_R| = V/R$
b. $|I_R| = (1\text{-}e^{-1})V/R$
c. $|I_R| = VC_2/(R(C_1+C_2))$
d. $|I_R| = VC_1/(R(C_1+C_2))$
e. $|I_R| = e^{-1} V/R$

The next three questions pertain to the situation described below.

A charged particle, initially at rest at point *a*, is accelerated through a potential difference, *V*, between points *a* and *b*. The particle enters a uniform magnetic field, ***B***, directed perpendicular to the plane of the page. While in this magnetic field, the particle travels in a semicircle of diameter *d*.



12) What is the direction of the magnetic field?

a. Not enough information to determine.
b. Into the page.
c. Out of the page.

13) If the experiment is repeated with another particle e that has the same charge, but twice the mass, how would *d* change?

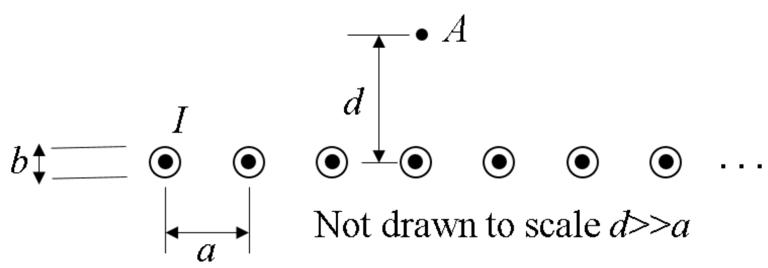
a. *d* would increase by $\sqrt{2}$.
b. *d* would double.
c. *d* would be the same.

14) Let *T* be the amount of time the particle is in the shaded region that contains the magnetic field. If we double *V* (keeping the charge, the mass of the particle, and the magnetic field unchanged), what will happen to *T*?

a. *d* will double.
b. *T* will stay the same.
c. *T* will increase by $\sqrt{2}$.

The next three questions pertain to the situation described below.

An infinite current sheet is composed of an infinite array of small wires with spacing $a = 0.35$ cm, each carrying current $I = 3$ A out of the page, as shown in the figure. For this problem you may assume that $d >> a$ so that you may treat the array of wires as a continuous sheet of current.



15) At the point labelled A, the magnetic field points

a. into the page.
b. out of the page.
c. to the left

16) The magnitude of the field, $|\mathbf{B}|$, at point A, a distance $d = 40$ cm from the current sheet is

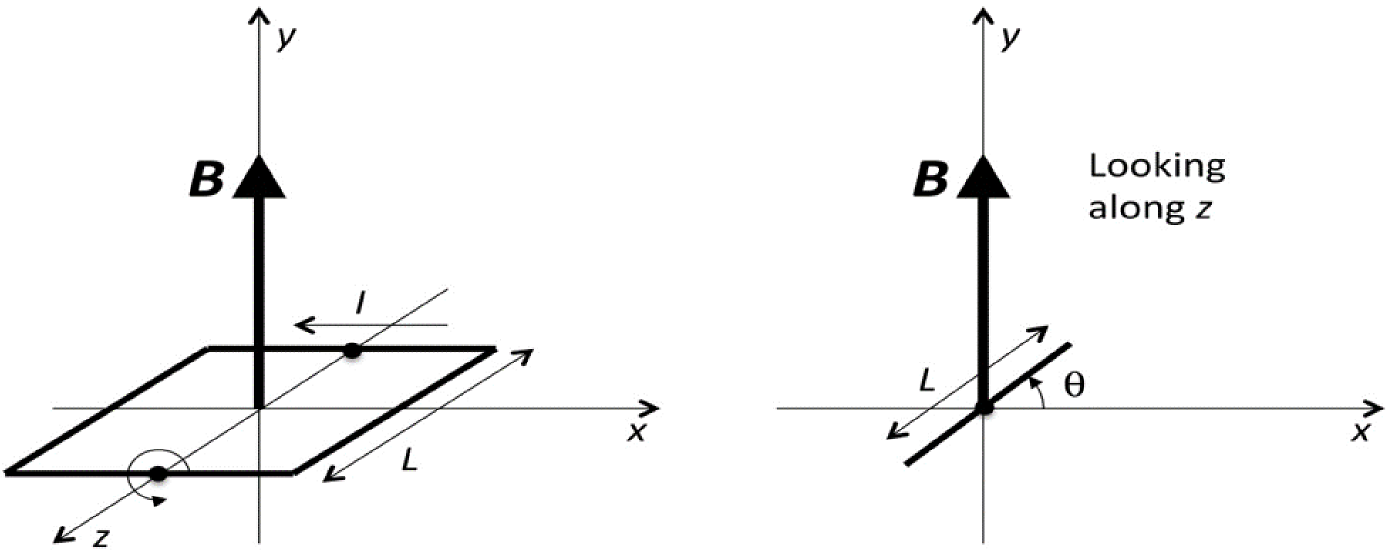
a. $|\mathbf{B}| = 1.71 \times 10^{-4}$ T
b. $|\mathbf{B}| = 9.42 \times 10^{-6}$ T
c. $|\mathbf{B}| = 0.00108$ T
d. $|\mathbf{B}| = 5.39 \times 10^{-4}$ T
e. $|\mathbf{B}| = 1.5 \times 10^{-6}$ T

17) If the array of wires has a thickness $b = 0.088$ cm, what is the average current density, J, of this current sheet?

a. $J = 3.87 \times 10^{6}$ A/m^2
b. $J = 9.74 \times 10^{5}$ A/m^2
c. $J = 85700$ A/m^2

The next three questions pertain to the situation described below.

A square current loop, with sides $L = 0.15$ m, carries a current $I = 0.6$ A, flowing in the direction shown. The loop is in a uniform 0.3 T magnetic field, $\boldsymbol{B}$, that points along the y-axis. The loop can pivot without friction about the z-axis, as shown. The view along z defines the rotation angle, θ. When the loop lies in the x-z plane (as in the left diagram), $\theta=0$.



18) For which orientations is the magnitude of the torque exerted on the loop by the magnetic field a maximum?

a. $\theta = 90°$, $270°$
b. $\theta = 0°$, $180°$
c. $\theta = 45°$, $135°$

19) What is the z component of the torque on the loop when $\theta = 120°$?

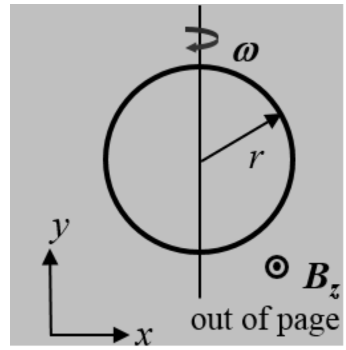
a. $\tau_z = -0.00351$ Nm
b. $\tau_z = -0.00405$ Nm
c. $\tau_z = 0.00405$ Nm
d. $\tau_z = 0.00203$ Nm
e. $\tau_z = -0.00203$ Nm

20) At what orientation is the potential energy of the loop a minimum?

a. $\theta = 90°$
b. $\theta = 0°$
c. $\theta = 180°$

The next four questions pertain to the situation described below.

Copper wire with resistivity $\rho = 1.68 \times 10^{-8}$ Ωm, and cross sectional area A = 7.85×10^{-5} m^2 is formed into a circular loop of radius $r = 0.3$ m. The loop is rotating about the y axis with a constant angular velocity ω in a uniform magnetic field B pointing in the positive z direction as shown in the figure.



21) What is the resistance of the loop?

a. $R = 4.03 \times 10^{-4}$ Ω
b. $R = 8.91 \times 10^{-9}$ Ω
c. $R = 1.93 \times 10^{-5}$ Ω

22) At the instant shown in the figure (loop is flat in the xy plane), the magnitude of the induced emf around the loop is

a. zero.
b. a maximum.

23) As the loop continues to rotate (right side coming out of the page (+z), and left side going into the page (-z) the direction of the induced current is

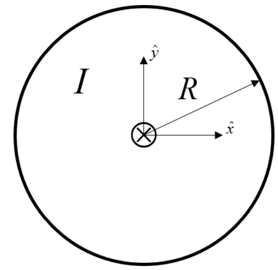
a. counter clockwise
b. clockwise

24) A second loop with twice the radius of the first is created from the same type of copper wire and rotated with the same angular velocity ω. Compare I_1 the maximum current induced in the original loop, with I_2, the maximum current induced in the new loop.

a. $I_2 = 4I_1$
b. $I_2 = I_1$
c. $I_2 = 2I_1$

The next three questions pertain to the situation described below.

A solid cylindrical conductor of radius R has a current I flowing into the page as shown in the figure.



25) What is the magnetic field $\vec{B}$ at the point $a\hat{y}$ with $0 < a < R$ (i.e. inside the conductor, directly above the center)?

a. $\vec{B} = \frac{\mu_0 I}{2\pi a}\hat{y}$
b. $\vec{B} = -\frac{\mu_0 I}{2\pi a}\hat{y}$
c. $\vec{B} = \frac{\mu_0 I}{2\pi a}\hat{x}$
d. $\vec{B} = \frac{\mu_0 I a}{2\pi R^2}\hat{y}$
e. $\vec{B} = \frac{\mu_0 I a}{2\pi R^2}\hat{x}$

26) What is the magnetic field $\vec{B}$ at the point $b\hat{x}$ with $b > R$ (e.g. outside the conductor, directly to the right of the center)?

a. $\vec{B} = -\frac{\mu_0 I}{2\pi b}\hat{y}$
b. $\vec{B} = -\frac{\mu_0 I}{2\pi b}\hat{x}$
c. $\vec{B} = \frac{\mu_0 I}{2\pi b}\hat{y}$

27) A wire carrying current I, <u>out of the page</u> is now placed directly above the conducting cylinder at position $(x,y) = (0,2b)$. The magnitude of the magnetic field at the center of the conductor $|\vec{B}_{0,0}|$ is

a. $|\vec{B}_{0,0}| = \frac{\mu_0 I}{4\pi b} - \frac{\mu_0 I}{2\pi R}$
b. $|\vec{B}_{0,0}| = 0$
c. $|\vec{B}_{0,0}| = \frac{\mu_0 I}{4\pi b}$