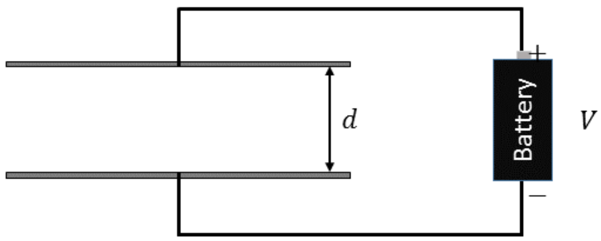
The next two questions pertain to the situation described below.

Consider a parallel plate capacitor with separation d:

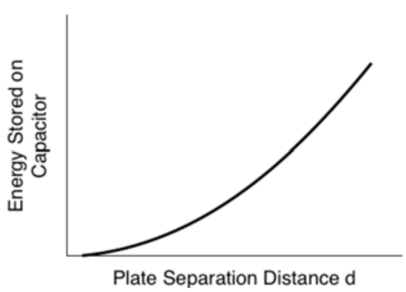


It is connected to a battery with constant emf V.

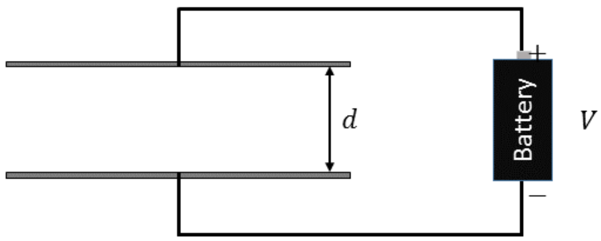
1) Which diagram best describes the energy stored in the capacitor as a function of the separation distance d *while the capacitor is connected to the battery*?

a. 

b. 

c. 

2) The battery provides an emf $V = 9$ V. Once the capacitor is fully charged the battery is disconnected. What energy is stored in the capacitor?

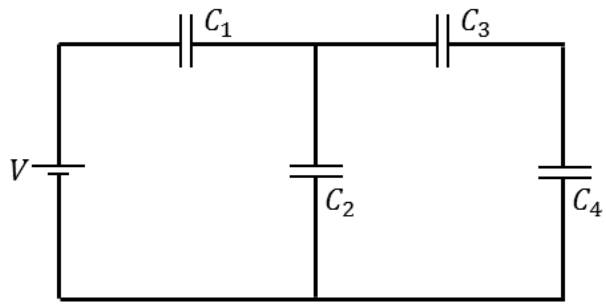


The separation distance is $d = 3$ mm and the plate area is $A = 5500\ \text{mm}^2$. The capacitor gap is filled with vacuum ($\kappa = 1$).

a. $E = 0.07$ nJ
b. $E = 2.64$ nJ
c. $E = 0.66$ nJ
d. $E = 0$ nJ
e. $E = 1.32$ nJ

The next two questions pertain to the situation described below.

Consider the following capacitor network:



All capacitors in this network are the same and have capacitance $C = 6\ \mu$F. The network is connected to a battery that provides a potential difference $V = 9$ V.

3) The equilavent capacitance of the branch containing capacitors C_3 and C_4 is

a. $2C$
b. $C/2$
c. C

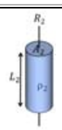
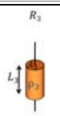
4) What is the charge on capacitor C_2 after the network has been connected to the battery for a long time?

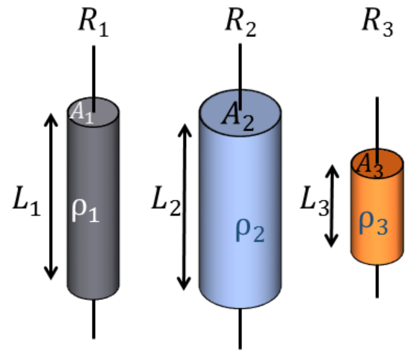
a. $Q_2 = 21.6\ \mu$C
b. $Q_2 = 135\ \mu$C
c. $Q_2 = 18\ \mu$C
d. $Q_2 = 13.5\ \mu$C
e. $Q_2 = 72\ \mu$C

The next two questions pertain to the situation described below.

Consider the three resistors shown. They each have *known dimensions,* listed in the table, but *unknown resistivities*.

You attach each resistor to a battery of known voltage, V, and measure the power dissipated by the resistors. The measurements are recorded in the table:

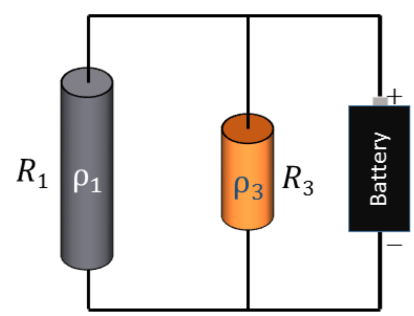
Resistor	**Length (mm)**	**Area (mm^2)**	**Power Dissipated (W)**
 R_1	$L_1 = 40$	$A_1 = 2$	$P_1 = 200$
 R_2	$L_2 = 40$	$A_2 = 8$	$P_2 = 400$
 R_3	$L_3 = 20$	$A_3 = 2$	$P_3 = 200$



5) What conclusion can you draw about the *resistivities* of resistors R_2 and R_3?

a. $\rho_2 = \rho_3$
b. $\rho_2 < \rho_3$
c. $\rho_2 > \rho_3$

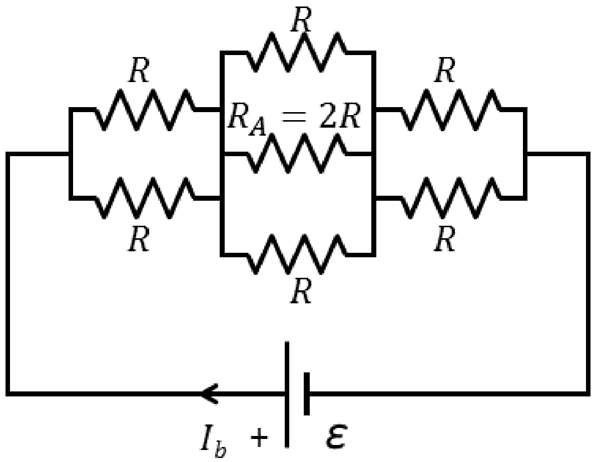
6) Resistors R_1 and R_3 are placed in parallel and attached to the battery (with voltage V). The total power dissipated by these resistors in parallel will be



a. $P_1/2$
b. $2P_1$
c. P_1

The next two questions pertain to the situation described below.

Consider the following network of resistors. The network is connected to a battery, with emf ε, through which a current I_b passes.



All resistors *except* R_A have resistance R. Resistor $R_A = 2R$.

7) Calculate the equivalent resistance, R_{eq}, of the network.

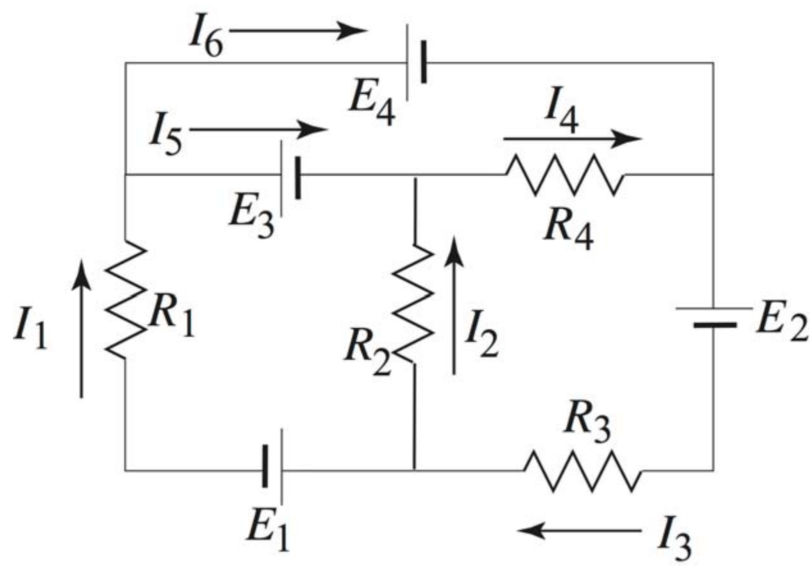
a. $R_{eq} = R/3$
b. $R_{eq} = R/2$
c. $R_{eq} = 7R/5$
d. $R_{eq} = 2R/5$
e. $R_{eq} = R$

8) Calculate the current I_A through resistor R_A in terms of the battery current I_b.

a. $I_A = I_b/5$
b. $I_A = I_b/3$
c. $I_A = 2I_b$
d. $I_A = I_b/2$
e. $I_A = I_b$

The next three questions pertain to the situation described below.

Consider this circuit.



9) Choose the correct relation among the branch currents from the following five equalities.

a. $I_4 - I_2 + I_1 = 0$
b. $I_1 - I_5 + I_6 = 0$
c. $I_2 - I_1 - I_3 = 0$
d. $I_5 - I_2 - I_4 = 0$
e. $I_3 - I_6 - I_4 = 0$

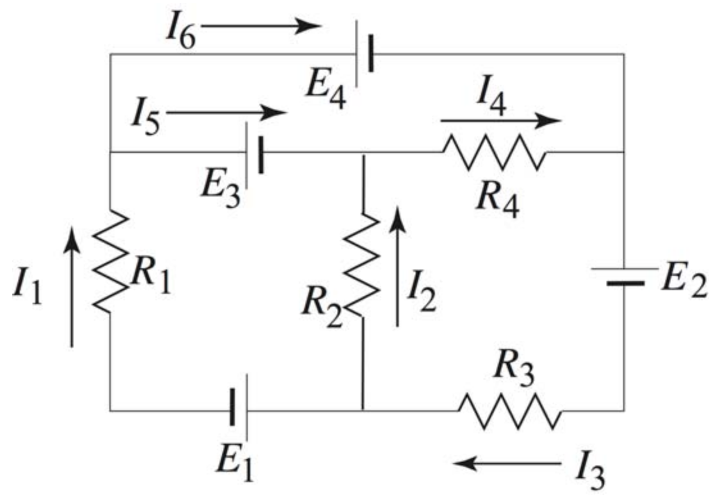
10) This newtork has several closed loops.

From among the following 5 equalities, which **does not** describe a loop in this network?

a. $R_1 I_1 + E_1 - R_2 I_2 + E_3 = 0$
b. $-R_1 I_1 - E_3 - R_4 I_4 - E_2 - R_3 I_3 - E_1 = 0$
c. $E_4 - E_3 - I_4 R_4 = 0$
d. $E_4 - E_3 + R_2 I_2 + R_3 I_3 + E_2 = 0$
e. $-R_2 I_2 - R_4 I_4 - E_2 + R_3 I_3 = 0$

11) Suppose:

$R_1 = R_2 = R_3 = R_4 = 20\ \Omega$.
$E_1 = E_2 = E_3 = 25$ V.
$E_4 = 55$ V.

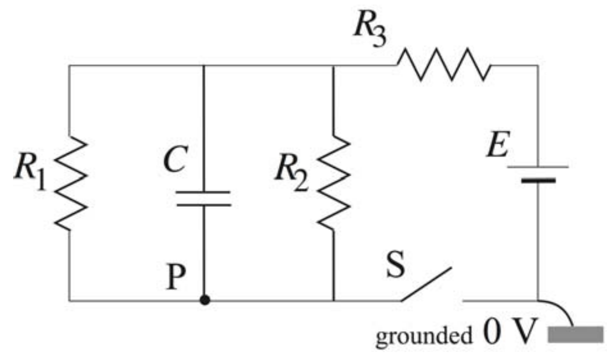


What is the current I_6?

a. $I_6 = 1.5$ A
b. $I_6 = -1.5$ A
c. $I_6 = 4$ A

The next four questions pertain to the situation described below.

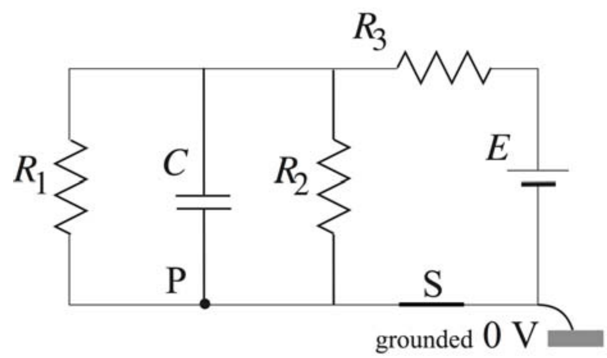
In the following circuit $R_1 = R_2 = R_3 = 20\ \Omega$, $C = 0.35$ F, and $E = 90$ V. Initially the switch S is open for a long time.



12) What is the voltage at point P? The switch, S, is open.

a. $V_P = 0$ V
b. $V_P = 90$ V
c. $V_P = 30$ V
d. $V_P = 45$ V
e. $V_P = 15$ V

13) What is the current I_2 through R_2 and the current I_3 through R_3 immediately after the switch, S, is closed? Choose the right combination.

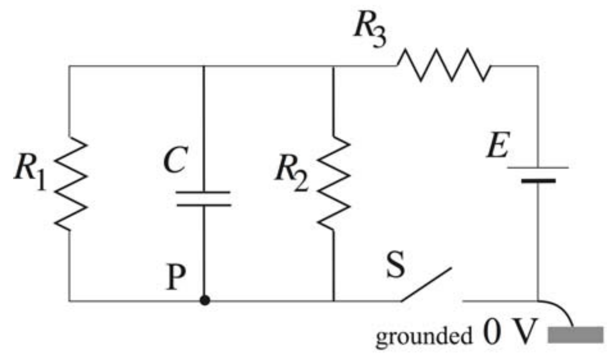


a. $I_2 = 0$ A, $I_3 = 4.5$ A.
b. $I_2 = 1.5$ A, $I_3 = 4.5$ A.
c. $I_2 = 0$ A, $I_3 = 2.25$ A.
d. $I_2 = 1.5$ A, $I_3 = 2.25$ A.
e. $I_2 = 4.5$ A,$I_3 = 4.5$ A.

14) What is the charge stored in capacitor C long after switch, S, is closed for a long time?

a. $Q = 31.5$ C
b. $Q = 0$ C
c. $Q = 15.75$ C
d. $Q = 10.5$ C
e. $Q = 21$ C

15) After a long time since switch, S, is closed, the switch is opened again. How long does it take for the stored charge to be halved?

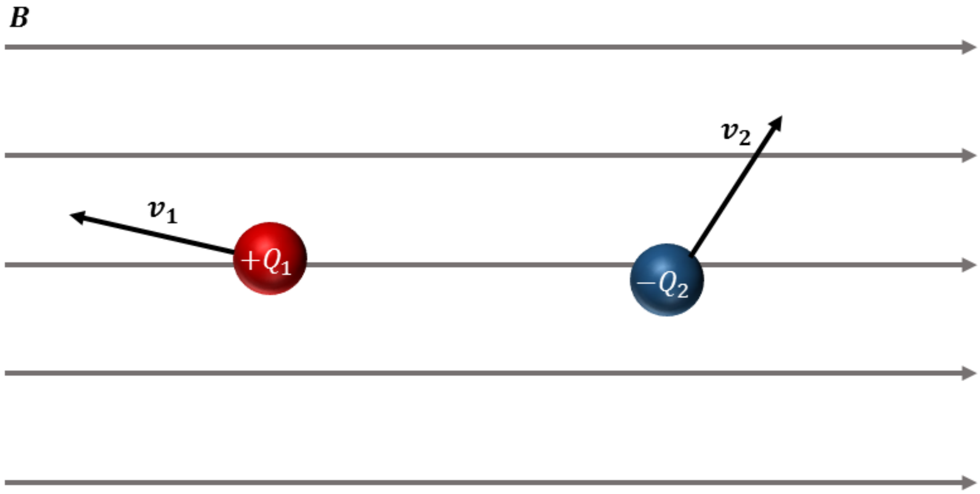


a. $t = 3.82$ s
b. $t = 2.43$ s
c. $t = 2.14$ s
d. $t = 5.42$ s
e. $t = 4.37$ s

The next two questions pertain to the situation described below.

Two charges of equal magnitude and opposite sign are positioned in a uniform magnetic field (gray lines).

The charges travel in the plane of the page, at velocities $\boldsymbol{v_1}$ and $\boldsymbol{v_2}$ with $|\boldsymbol{v_1}| = |\boldsymbol{v_2}|$ at the angles shown



16) What charge experiences the largest force due to the magnetic field?

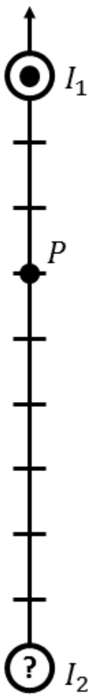
a. Charge 1 ($+Q_1$)
b. Charge 2 ($-Q_2$)
c. They experience the same force.

17) What is the direction of the force on charge 2?

a. To the right
b. Out of the page
c. Into the page

The next two questions pertain to the situation described below.

Two wires are shown in the diagram. Wire 1 carries current I_1 out of the page. Wire 2 carries current I_2 of unknown magnitude and direction.



The magnetic field at point P is zero.

18) What direction is the current traveling in wire two?

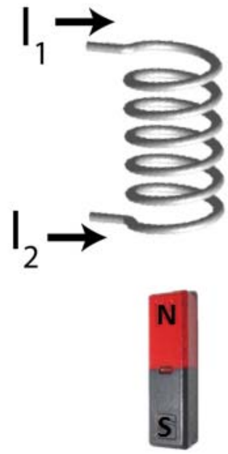
a. into page
b. out of page
c. no current

19) What is the magnitude of I_2?

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

20) The diagram shows a permanent magnet with its north pole oriented up. Above the magnet is a solenoid.

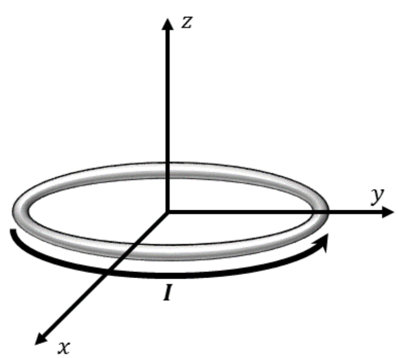
In what direction should current flow through the solenoid so that the solenoid **repels the magnet**?

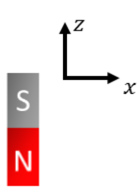


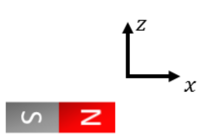
a. I_2
b. No current is necessary.
c. I_1

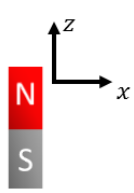
21) A loop of wire carries a current I and sits in the xy-plane as shown in the figure.

Which figure best describes the **direction** of the magnetic dipole moment produced by this current loop?



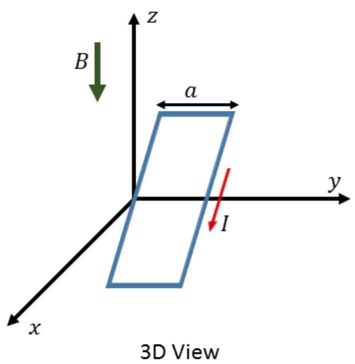
a. 

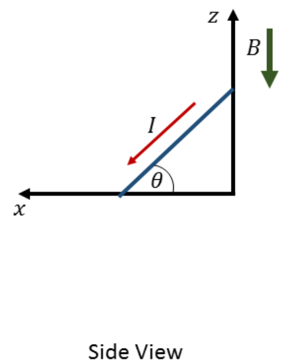
b. 

c. 

The next three questions pertain to the situation described below.

A rectangular loop (blue) carries a current $I = 1$ A. The current flows in the direction shown by the red arrow. The area of the loop is 0.1 m^2. The loop is at an angle $\theta = 40°$ with the xy-plane (side view). A uniform magnetic field $B = 1$ T is in the $-z$ direction. One segment of the loop is labeled a.





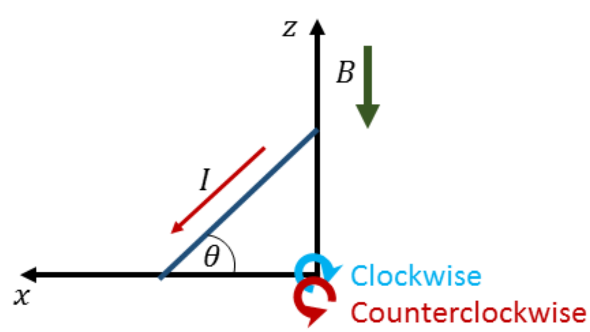
22) What is the direction of the force on segment a of the loop due to the magnetic field?

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

23) What is the magnitude of the torque on the loop?

a. $|\tau| = 0.129$ N · m
b. $|\tau| = 0.1$ N · m
c. $|\tau| = 0.064$ N · m

24) In the **Side View** representation of the loop what direction does the loop rotate?



a. clockwise
b. counterclockwise
c. does not rotate