1. In the circuit shown, \( C = 5.9 \mu F \) and \( V = 28.0 \, V \). Initially the capacitor is uncharged and the switch \( S \) is in position 1. The switch is then moved to position 2, so that the capacitor begins to charge.

a. What will be the charge on the capacitor a long time after the switch is moved to position 2?

\[ Q = CV = (5.9 \times 10^{-6}) \times 28 \, V \]
\[ Q = 1.65 \times 10^{-4} \, C \]

b. After the switch has been in position 2 for 3.0 ms, the charge on the capacitor is measured to be 110 \( \mu C \). What is the value of the resistance \( R \)?

\[ R = \frac{2.73 \times 10^{-3}}{5.9 \times 10^{-4}} \]
\[ R = 462.2 \, \Omega \]

\[ R = \frac{1}{\tau} = \frac{1}{0.33} = \frac{3 \times 10^{-3}}{10^{-3} \, \Omega} \]
\[ RC = \frac{1}{0.33} = \frac{3 \times 10^{-3}}{10^{-3} \, \Omega} \]
\[ RC = 2.73 \times 10^{-3} \, \Omega \]
1. The capacitor is initially uncharged then at $t = 0$ the battery is connected.
   a. At $t = 0$ what is the current through each resistor?
   b. What is the final charge on the capacitor?

\[ I = \frac{42V}{14A} = 3A \]

\[ V_2 = V_C = I \cdot R_C = 3A \cdot 6Ω = 18V \]

\[ C = \frac{Q}{V} \]

\[ Q = C \cdot V = (4.0 \times 10^{-6}F) \cdot 18V = 7.2 \times 10^{-5}C \]
2. A coaxial cable consists of a solid inner conductor of radius $R_1$, surrounded by a concentric cylindrical tube of inner radius $R_2$ and outer radius $R_3$. The conductors carry equal and opposite currents $I_0$ distributed uniformly across their cross-sections. Determine the magnetic field at a distance $r$ from the axis for $r < R_1$.

\[
\int B \cdot d\mathbf{A} = \mu_0 I_{en}
\]

\[
B \int \mathbf{dA} = \mu_0 I_{en}
\]

\[
B(2\pi r) = \frac{r^2}{R_2^2} I_0
\]

\[
B = \frac{I_0}{2\pi R_2^2} r
\]

\[
I_{en} = 9 \frac{\pi r^2}{2}
\]

\[
y = \frac{I_0}{\pi R_1^2}
\]

\[
I_{en} = \frac{I_0}{\pi R_1^2} \pi r^2
\]

\[
I_{en} = \frac{r^2}{R_1^2} I_0
\]
2. A coaxial cable consists of a solid inner conductor of radius \( R_1 \), surrounded by a concentric cylindrical tube of inner radius \( R_2 \) and outer radius \( R_3 \). The conductors carry equal and opposite currents \( I_0 \) distributed uniformly across their cross-sections. Determine the magnetic field at a distance \( r \) from the axis for region \( R_1 < r < R_2 \).

\[
\int B \cdot dl = \mu_0 I_0
\]

\[ I_{ax} = I_0 \]

\[ B \int dl = \mu_0 I_0 \]

\[ B (2\pi r) = \mu_0 I_0 \]

\[ B = \frac{\mu_0 I_0}{2\pi r} \]
3. A straight piece of conducting wire with mass \( M \) and length \( L \) is placed on a frictionless incline tilted at an angle \( \theta \) from the horizontal. There is a uniform, vertical magnetic field \( B \) at all points. To keep the wire from sliding down the incline, a voltage source is attached to the ends of the wire. When just the right amount of current flows through the wire, the wire remains at rest. Determine the magnitude and direction of the current in the wire that will cause the wire to remain at rest.

\[
\begin{align*}
ILB \cos \theta &= Mg \sin \theta \\
B &= \frac{Mg \tan \theta}{IL} \\
I &= \frac{Mg \tan \theta}{BL}
\end{align*}
\]
4. A long straight wire carries current $I_1$. At a distance $a$ from this wire and perpendicular to it is a short wire segment of wire with length $b$ carrying current $I_2$. Calculate the force on the short section of wire. What is the direction of the force?

\[ B = \frac{\mu_0 I_1}{2\pi r} \]

\[ dF = I_2 \, dr \times B \]

\[ dF = I_2 B \, dr \]

\[ dF = I_2 \frac{\mu_0 I_1}{2\pi r} \, dr \]

\[ F = \frac{\mu_0 I_1 I_2}{2\pi} \int_{a}^{a+b} \frac{dr}{r} \]

\[ F = \frac{\mu_0 I_1 I_2}{2\pi} \ln \frac{a+b}{a} \]
4. Two loops of wire are moving in the vicinity of a very long straight wire carrying a steady current as shown.

a. Is there a current in loop 1? Direction?

b. Is there a current in loop 2? Direction?

a) Loop 1 - No current

b) Current clockwise

\[ B = \frac{N_0 I}{2\pi r} \]

Flux in and getting weaker