On a thin rod of length $L$ lying along the $x$ axis with one end at the origin ($x = 0$) as shown below, there is a distributed charge per unit length given by $\lambda = kx$ where $k$ is a constant. (a) Taking the electrostatic potential at infinity to be zero, find $V$ at the point $P$ on the $y$ axis. (b) Determine the vertical component, $E_y$, of the electric field intensity at $P$ from the result of part (a).
Consider a charged disc with a charge of $Q$, and radius of $R$. Calculate its electric field along its axis, $z$ distance from the center of the disc as shown below figure.
Two conducting spheres have radii of 4 cm and 5 cm and are positioned such that their centers are separated by 4.0 m. The electric field magnitude on the surface of each sphere is $10^6$ V/m. The two spheres are then connected to each other using a very thin 4 meter long wire. Find the magnitude of the electric field on the surface of each sphere after being connected to each other and electrostatic equilibrium is reached.
A uniformly charged ball of radius \( a \) and charge \( -Q \) is at the center of a hollow metal shell with inner radius \( b \) and outer radius \( c \). The Electric Field strength on the outside of the shell is \( E \).

Given the following values:

\[
\begin{align*}
E &= 45 \text{ N/C} \\
-Q &= -4 \text{ nC} \\
c &= 1.0 \text{m} \\
b &= 0.5 \text{m} \\
a &= 0.2 \text{m}
\end{align*}
\]

a) Find the charge on the shell

b) Determine the strength of electric field in the three regions:

i) \( r \leq a \)

ii) \( a < r < b \)

iii) \( b \leq r \leq c \)
A spherical capacitor consists of two thin concentric spherical shells of radii $R_1$ and $R_2$. (a) Show that the capacitance is given by,

$$C = 4\pi \varepsilon_0 \frac{R_1 R_2}{(R_2 - R_1)}$$

(b) Show that when the radii of the shells are nearly equal, the capacitance is given approximately by the expression for the capacitance of a parallel-plate capacitor, $C = \varepsilon_0 A/d$, where $A$ is the area of the sphere and $d = R_2 - R_1$. 
The current density inside a long, solid, cylindrical wire of radius $a$ is in the direction of the central axis and varies linearly with radial distance $r$ from the axis according to $J = J_0 \frac{r}{a}$. Find the magnetic field inside the wire. (Hint: Assume that the current density is constant through an incremental ring of thickness $dr$, which is concentric with the cylinder).
In the capacitor circuit below, the switch is initially positioned as shown. The initial charges on C3 and C4 are zero.

**a)** Find the charge on C2

**b)** Find the energy stored in C2

The switch is then flipped to the right, creating a closed circuit with C3 and C4.

**c)** Find the charge on C3

**d)** Find the energy stored on C3 and C4
Using the circuit below, consider the following cases:

a) Immediately when the switch is closed (t=0),
   i) Find and draw the Current through each resistor
   ii) Find the charge on the Capacitor

b) Switch is still closed, but a long time has passed,
   i) Find the charge on the Capacitor

c) Now we open the switch,
   i) Find the charge on the capacitor after 14 μs.
For the circuit in Figure below, find (a) the current in each resistor, (b) the power supplied by each emf, and (c) the power dissipated in each resistor.
A length of wire is formed into a closed circuit with radii $a$ and $b$, as shown in Fig. below, and carries a current $i$. (a) What are the magnitude and direction of at point $P$? (b) Find the magnetic dipole moment of the circuit.
What uniform magnetic field, applied perpendicular to a beam of electrons moving at 1.3x10^6 m/s, is required to make the electrons travel in a circular path of radius 0.35m?

Charge of electron = 1.602 x 10^{-19} C

Mass of electron = 9.11 x 10^{-31} kg
The long straight wire in the figure has current $I = 1$ A flowing in it. A square loop which has 10-cm sides is positioned 10 cm away from the wire as shown below. The loop is then moved in the positive $x$-direction with a speed $v = 10$ cm/s. If the loop has resistance of 0.02 ohms,

a) Find the direction of the induced current.

b) Sketch the directions of the magnetic forces acting on each side of the square loop.

c) Calculate direction and magnitude of the net force acting on the loop the instant the loop is made to move.
The rectangular coil in Figure below has 80 turns, is 25 cm wide and 30 cm long, and is located in a magnetic field $B = 1.4 \, \text{T}$ directed out of the page as shown, with only half of the coil in the region of the magnetic field. The resistance of the coil is $24 \, \Omega$. Find the magnitude and direction of the induced current if the coil is moved with a speed of $2 \, \text{m/s}$ (a) to the right, (b) up, (c) to the left, and (d) down.
The switch in the circuit shown below has been open for a very long time. It is closed at $t = 0s$.

What is the current through the 20 $\Omega$ resistor:

a. immediately after the switch is closed?

b. after the switch has been closed a very long time?

c. immediately after the switch is reopened?
An inductance $L$ and resistance $R$ are connected in series with a battery as in Figure below. A long time after switch $S_1$ is closed, the current is 2.5 A. When the battery is switched out of the circuit by opening switch $S_1$ and closing $S_2$, the current drops to 1.5 A in 45 ms. (a) What is the time constant for this circuit? (b) If $R = 0.4 \, \Omega$, what is $L$?
A single loop of wire with radius 0.05 m carrying a current of 5.0 A is placed in the x-y plane as shown in the figure below. The loop is placed in a 0.24 T magnetic field.

a) Find the direction and magnitude of the magnetic moment of the loop.

b) Find the magnitude and direction of the torque on the loop (Draw in the figure).