1. (25 points) In the circuit below the voltage of the battery, the capacitance, and the values of the resistances are known. The circuit was put together a long time ago so that the steady state can be assumed. Find all currents and the charges on the capacitor plates.

[Diagram of a circuit with resistors and capacitors labeled R₁, R₃, V₁, and V₂]
2. (25 points) An infinitely long, hollow cylindrical wire carries a current $i$. The wire has outer radius $b$ and the cylindrical hole at its center has radius $a$.

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\[i\] \[i\] \[i\]
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a. Find the force on a charged particle, $q$, if it had a velocity of magnitude $v_0$ and was moving along the axis of the cylinder.

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\[i\] \[i\] \[i\]
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b. Find the force on a charged particle, $q$, if it was moving outside of the cylinder, with a velocity that had a component $v_1$ parallel to the cylinder and a component $v_2$ perpendicular to the axis of the cylinder.
3. (25 points) A very thin circular loop of wire has a flat section as shown. A current \( i \) flows around the loop. Find the magnetic field at the point \( P \), the center of the circular part.
4. (25 points) The two plates of a capacitor are a distance \( W \) apart and have area \( A \). They are connected by a rectangular loop of wire with no resistance. The dimensions of the rectangle are \( H \) by \( D \). The left corner of the rectangle is at the origin, as shown. There is a \( \vec{B} \) field pointed into the page, perpendicular to the loop. It has a magnitude that is a function of \( x \), but is constant in \( y \). It is given by

\[
B(x) = \alpha + \beta x
\]

where \( \alpha \) and \( \beta \) are not functions of \( x \) or \( y \).

a. Find the flux of this magnetic field through the rectangular loop.

b. Find the equation for the charges on the plates as a functions of time if the self inductance of the loop is \( L \) and if \( \alpha = c_1 t \) and \( \beta = c_2 \) where \( c_1 \) and \( c_2 \) are independent of time.

c. Solve the equation for the charges on the plates as a functions of time if \( L \) is ignored.