PHYS 205 Final practice questions.

1. Consider the DC circuit in Figure (a), where $R_1 = 10.0\ \Omega$, $R_2 = 20.0\ \Omega$, $R_3 = 30.0\Omega$, $R_4 = 40.0\ \Omega$, $R_5 = 50.0\ \Omega$, $\varepsilon_1 = 12.0$ V, and $\varepsilon_2 = 24.0$ V.
   (a) Identify all the currents in the circuit.
   (b) Find the value of all the currents in the circuit.
   (c) Compute the power delivered to resistor R_4 in the steady state.

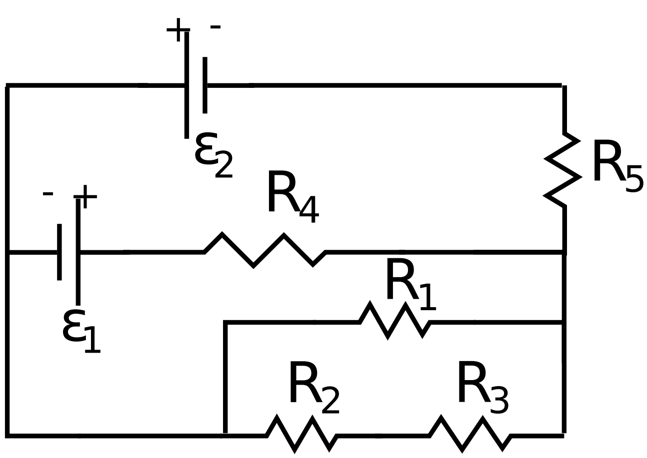
2. Consider a circuit composed of a battery ($\varepsilon = 20$ V), a resistor ($R = 10\ \Omega$), a capacitor ($C = 1\ \mu$F), and a switch all connected in series. The switch is kept open for a long time, and at $t = 0$ it is closed.
   (a) Find the charge in the capacitor as a function of time.
   (b) Do a schematic plot of the charge in the capacitor vs. time.
   (c) How long will it take the capacitor to reach 63.2% ($\approx 100(1-1/e)$) of its maximum possible charge?

3. Consider a circuit composed of a battery ($\varepsilon = 20$ V), a resistor ($R = 10\ \Omega$), an inductor ($L = 1$ mH), and a switch all connected in series. The switch is kept open for a long time, and at $t = 0$ it is closed.
   (a) Find the current in the circuit as a function of time.
   (b) Do a schematic plot of the current in the circuit vs. time.
   (c) How long will it take the current to reach 63.2% ($\approx 100(1-1/e)$) of its maximum possible value?

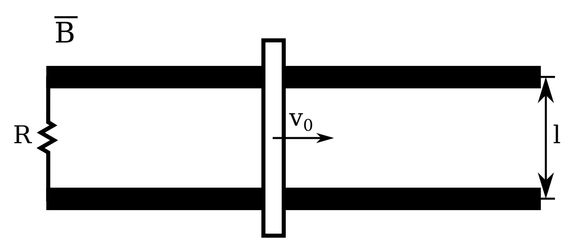
4. A metal bar with mass m can slide over two frictionless, parallel, metal rails which are separated by a distance l. There is no resistance in the circuit except for a resistor R joining the two rails at one end. A uniform magnetic field of magnitude B, perpendicular to the plane holding the rails and pointing downwards (see the diagram in Figure (b)), is present. The bar is given an initial velocity $v = v_0$ to the right at $t = 0$.
   (a) Find the velocity of the bar as a function of time.
   (b) Find the current circulating through the bar as a function of time.

5. Consider a series RLC circuit, with $R = 10.0\ \Omega$, $L = 1.00$ mH, and $C = 1.00\ \mu$F. The circuit is connected to an AC power source that provides a voltage $\Delta v = \Delta V_{\max} \sin(\omega t)$, $\Delta V_{\mathrm{rms}} = 240$ V. The frequency (f, not ω) of the current is 6.00×10^3 Hz.
   (a) Calculate the impedance of the circuit.
   (b) Calculate the magnitude and phase of the current in the circuit. Is the current in the circuit leading or lagging the voltage source?
   (c) Calculate the RMS current in the circuit.
   (d) Calculate the angular resonance frequency of the circuit (ω_{res}).
   (e) Calculate the average power transferred to the resistor when $\omega = \omega_{\mathrm{res}}$, $\omega = 2\omega_{\mathrm{res}}$, and $\omega = \omega_{\mathrm{res}}/3$.
   (f) Calculate the Quality factor of the circuit.

6. Consider a very long ideal solenoid, with n turns per unit length, which is carrying an electric current I.
    (a) What is the direction of the magnetic field inside the solenoid? What is its spatial dependence?
    (b) State clearly which Amperian loop you need to use to find the magnitude of the magnetic field inside the solenoid.
    (c) Apply Ampére's law to the loop in part (b), and find an expression for the magnitude of the magnetic field inside the solenoid.
7. Write down Faraday's law, and explain it in your words.
8. What is the role of the magnetic field in a cyclotron?
    a Increasing the kinetic energy of the charged particles.
    b Making the charged particles have a curved trajectory.
    c Generating radiation.
    d Modifying the period of the applied potential difference.
9. Write down the electric potential, as a function of the position, inside a hollow metallic (i.e. conducting) cavity.
10. An electron, with electric charge $q = -e$ is moving with velocity $\vec{v} = v_0\ \hat{\imath}$ and enters a region of space where $\vec{E} = E\ \hat{\imath}$, and $\vec{B} = B\ \hat{\jmath}$. Write down the force acting on the electron in the two following cases:
    (a) $v_0 = 0$
    (b) $v_0 \neq 0$



(a) Circuit for problem 1.



(b) Diagram for problem 4.