PHYS 205-03
Electricity and Magnetism
Practice Exam

Instructions

- This is a closed book exam. You are not allowed to use any resources (formula sheet or any electronic devices, including smart wearables).
- Use proper notation and describe your work clearly. Provide proper units for your final answers.

Short answers

Provide short answers and proper descriptions. Providing mathematical equations/treatment is not necessary.

1. Gauss's law in magnetism states that the flux passing through a closed surface is zero. Why? **(2 marks)**

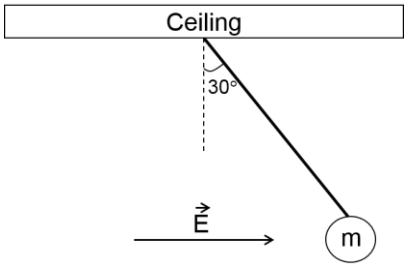
2. If we charge two capacitors C_1 and C_2, disconnect them from the battery and then connect them with opposite polarities, what happens to the energy stored in the system? Does it increase or decrease? Why? **(3 marks)**

3. What is the effect of the inductor on the current, in a RL circuit with DC current, after a long time that the switch is closed? **(2 marks)**

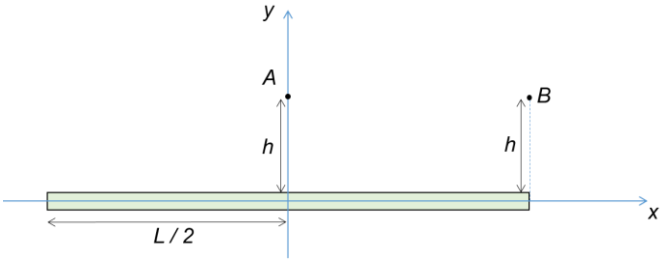
4. A permanent magnet is dropped and passes through a circular loop, North pole first. What is the direction of the induced current in the loop, as the magnet (a) approaches the loop and (b) goes away from the loop after passing through it? **(3 marks)**

Problems

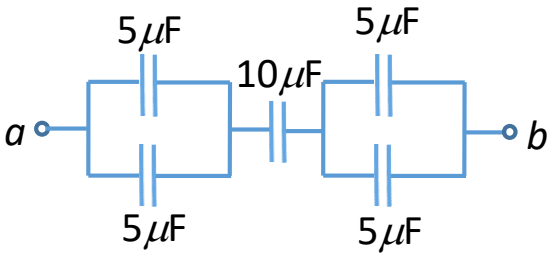
1. A charge of 2μC (2×10^{-6} C) with mass of 100 g is suspended, making an angle of 30° with the vertical line, as shown in the figure below. Determine:
   a) The sign of the charge (positively charged or negatively charged?) **(2 points)**
   b) the magnitude of the electric field **(3 points)**
   Take the gravitational constant $g = 10\frac{m}{s^2}$
   Hint: The forces applied on the object are Tension (T) along the rope, Weight (mg), and Electric force (F_e).



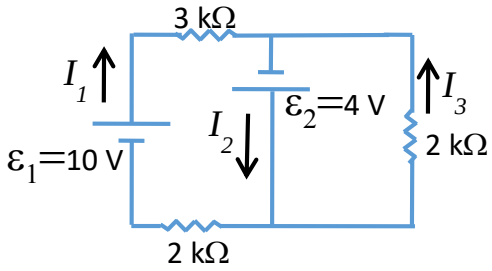
2. Figure below, shows a uniformly charged rod with total charge +Q, length L, and linear charge density λ. Determine:
   a) The electric potential at points A and B. Show your work properly. **(3 points)**
   b) The work required to move a charge +q from point A to point B. **(2 points)**



3. Consider the circuit branch below.
   a) What is the equivalent capacitance between points a and b? **(3 points)**
   b) If we connect a 10 V battery between points a and b, and wait a very long (infinite) time, how much energy is stored in one of the 5 μF capacitor? **(3 points)**



4. Calculate the values of the currents I_1 , I_2 , I_3. **(4 points)**



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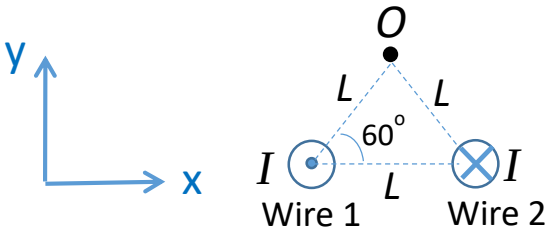
5. Two infinite wires are parallel to each other as shown below. The current in wire 1 points in the + Z direction (out of page) and current in wire 2 is in the –Z direction (into the page). Both currents have a magnitude I. Find the magnetic field vector (magnitude and direction) at point O. **Hint:** solve for one wire first. **(4 points)**



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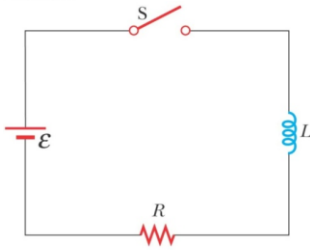
6. For the RL circuit below, the switch is open for time t < 0, then the switch is closed at time t=0. If L= 1 mH, and R= 0.01Ω and Ɛ= 10 V, What is the current in the inductor at t= 0.05s ? **(3 points)**



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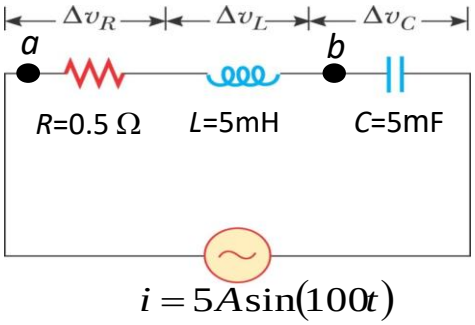
7. For the RLC circuit below $i(t) = 5A\ \sin(100t)$, (a) what is Δv_s the voltage across the source (time dependent function)? (b) What is Δv_{ab} the voltage across both the resistor and inductor? **(4 points)**



$$i = 5A\sin(100t)$$

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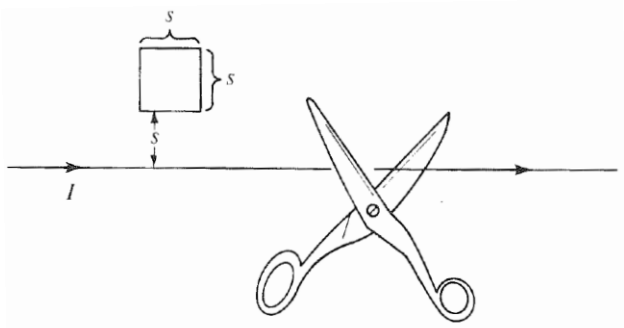
8. An infinite wire carries a current I, and a square loop of wire sits a distance *s* away from the wire as shown below. Initially there is no current in the loop. Suddenly, you cut the infinite wire with a scissor. Explain why (with formulas and a few words) a current is induced in the square loop, and which way it flows. **(4 points)**



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9. High-power lasers in factories are used to cut through cloth and metal. One such laser has a beam diameter of 1 mm and generates an electric field having an amplitude of 0.700 MV/m at the target. Find
   a) the amplitude of the magnetic field produced **(2 points)**
   b) the intensity of the laser **(2 points)**
   c) the power delivered by the laser **(2 points)**
