

Name _____ Student ID _____

Check your (CRN) section number: **61082 8:00AM - 9:15AM** **61084 9:30AM - 10:45AM**

To get credit you must show work.

<i>Problem</i>	<i>Possible Points</i>	<i>Points Scored</i>
1	8	
2	8	
3	8	
4	10	
5	10	
6	10	
7	6	
8	8	
9	8	
10	10	
11	7	
12	7	
Total	100	

Scaled	
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1. [8 pts] A parallel plate capacitor (with no dielectric) is charged to $V_1=12$ volts and has a charge of 3 nC (3×10^{-9} C) on it.

a) (2) What is the capacitance, C , of this capacitor?

$C =$

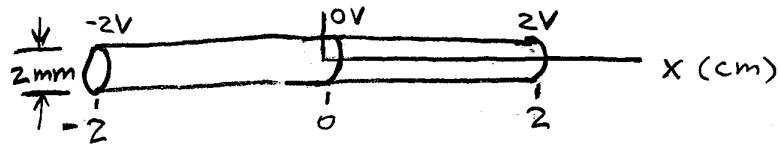
b) (3) With no source attached the plates of the capacitor are changed to twice their original separation. In this process no charge is transferred to or from the capacitor. What is the potential, V_2 , on the capacitor after this is done?

$V_2 =$

c) (3) A mica dielectric, with $K=5$, is inserted between the plates of the capacitor. This dielectric only fills half of the space of the gap of the capacitor and has the same surface area as the parallel plates. What is the potential, V_3 , on the capacitor now?

$V_3 =$

2. [8 pts] The figure below shows part of a conductor with resistivity, $\rho = 10^{-5} \Omega \cdot \text{m}$. Shown is the electric potential at 3 positions in the conductor.



a) (2) What is the direction of the current in the conductor?

direction =

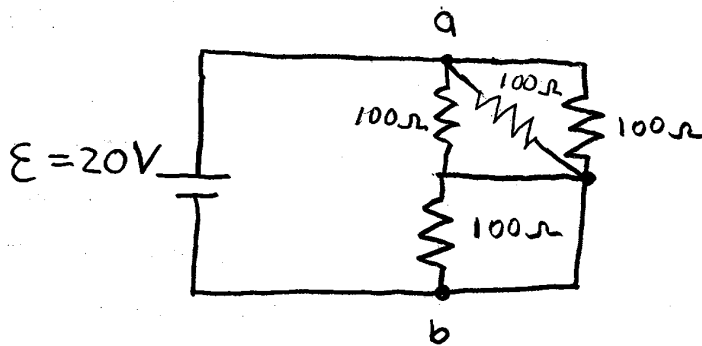
b) (3) What is the current, I , in the conductor?

$I =$

c) (3) What is the magnitude and direction of the electric field, at $x=0$, in the conductor?

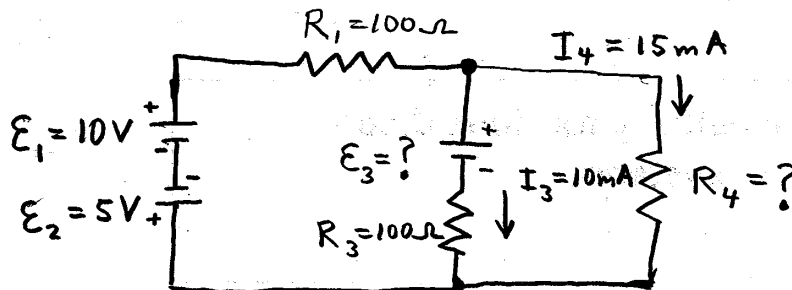
$E =$	direction =
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3. [8 pts] Solve for the equivalent resistance, R_{eq} , that is between the points labeled a and b, and the current, I , that flows from the ideal battery.



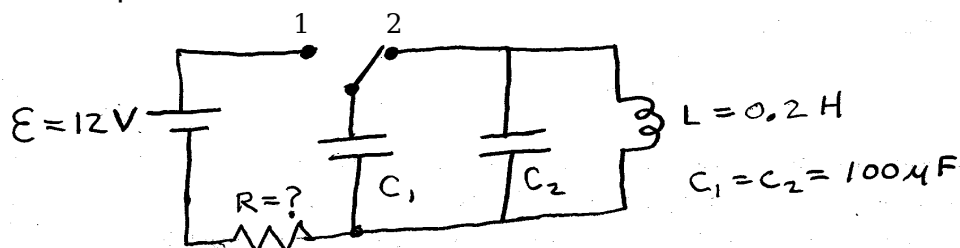
$R_{eq} =$
$I =$

4. [10 pts] All the EMF (voltage) sources are ideal in the circuit shown. Find the current through the resistor R_1 , I_1 , the EMF \mathcal{E}_3 , and the resistance of the resistor labeled R_4 .



$I_1 =$
$\mathcal{E}_3 =$
$R_4 =$

5. [10 pts] The circuit shown has no charges or currents to start with. All circuit components are ideal.



a) (2 pts) The switch is switched to position 1. The capacitor, C_1 , takes 8 seconds to charge to 10 volts. What is R ?

$R =$

b) (2 pts) When the capacitor, C_1 , is charged to 10 volts, the switch is moved to the position labeled 2. What will be the current through the inductor, i_L , just after the switch is moved?

$i_L =$

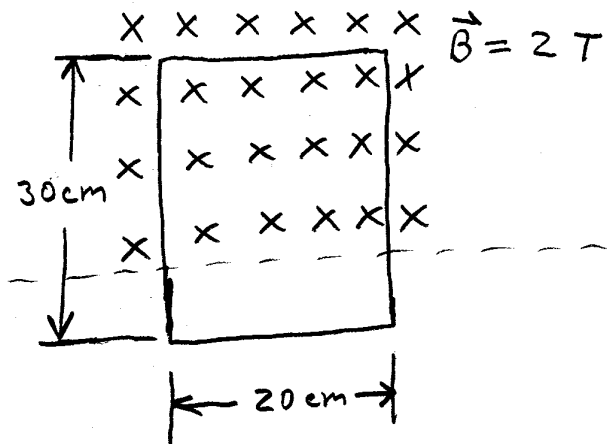
c) (3 pts) What will be the maximum current, $i_{L\text{max}}$, through the inductor?

$i_{L\text{max}} =$

d) (3pts) How long, after the switch is moved to position 2, will it take, t , to first get this current, $i_{L\text{max}}$, in part c?

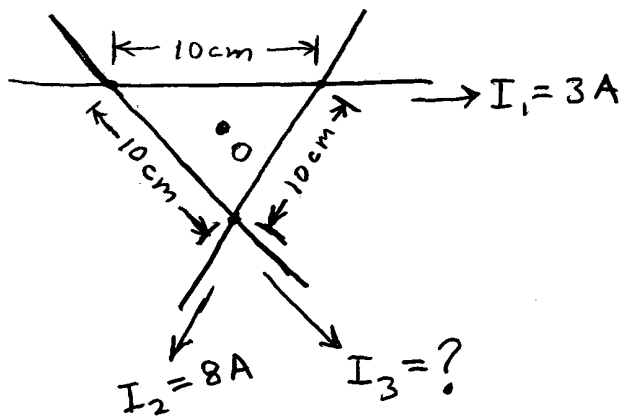
$t =$

6. [10 pts] The rectangular conducting loop, shown, has a resistance of $R=0.01$ ohms and a mass of $m=10$ grams. The loop starts at rest and is released so that the lower-most part of the loop is just outside the uniform magnetic field. When the loop is released two forces act on it, the force of the magnetic field on the current is the top wire (the side wire forces cancel out each other) and the force of gravity ($g = 9.8 \text{ m/s}^2$). Find a) (2) the direction of the induced current in the loop, b) (3) the initial acceleration, $a(0)$, of the loop when it is first released, and c) (5) the acceleration, a , of the loop for all time while it is still partially in the magnetic field as a function of, v , the speed of the loop.



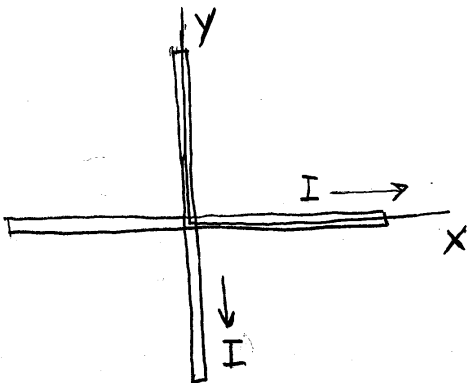
Direction (circle one) = counterclockwise clockwise	
$a(0) =$	$a =$

7. [6 pts] What must be the current, I_3 , so that the magnetic field is zero at the point, O, which is equidistant from the three conductor intersection points?



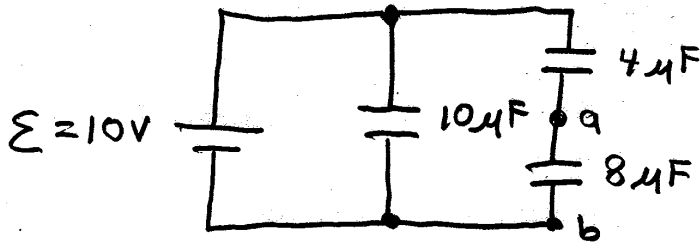
$I_3 =$

8. [8 pts] The two very long conductors shown both carry, I , 5 amps. Find all positions where the magnetic field from these two currents is zero.



At positions:

9. [8 pts] Find V_{ab} for the following circuit.



$V_{ab} =$

10. [10 pts] An electron, with mass $m_e = 9.11 \times 10^{-31}$ kg, moves in a circle, of radius $R=0.5$ m, in the x-y plane in the clockwise direction, with a speed of $v = 6.5 \times 10^6$ m/s. This motion is caused by the forces from a uniform magnetic field. What are the three vector components of this magnetic field, B_x , B_y , and B_z ? The natural charge constant $e = 1.6 \times 10^{-19}$ C.

$B_x =$

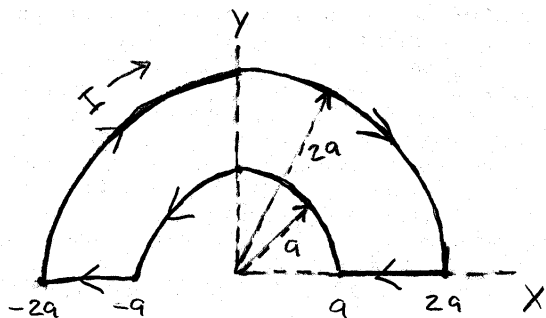
$B_y =$

$B_z =$

11. [7 pts] A steady current, of 2 amps, flows through a long wire in the z-direction at the x-y position $x= 10 \text{ cm}$, $y= 10 \text{ cm}$ (10 cm, 10 cm). Another steady current, of 2 amps, flows through a long wire in the negative z-direction at the x-y position $x= 0 \text{ cm}$, $y= 0 \text{ cm}$ (0,0). What is the magnetic field, B_x , B_y , B_z , from these two currents at position $x= 10 \text{ cm}$, $y= 0 \text{ cm}$ (10 cm, 0)? $\mu_0 = 4 \pi \times 10^{-7} \text{ T m/A}$

$B_x =$
$B_y =$
$B_z =$

12.[7 pts] The loop shown carries a current of I in the direction shown. Find the magnetic field, \mathbf{B} , at the origin. Express your answer in terms of I, and a.



$B_x =$
$B_y =$
$B_z =$