Name: _____ Instructor:_____

Louisiana State University Physics 2102, Exam 2,

October 14, 2010.

• Please be sure to write your name and class instructor above.

• The test consists of 3 questions (multiple choice), and 4 problems (numerical). All numerical quantities must have appropriate units. *Points will be deducted if units are absent.*

• For the problems: Show your reasoning and your work – *no credit will be given for an answer without explanation or work*. Note that in many of the problems, you can do parts (b) or (c) even if you get stuck on (a) or (b).

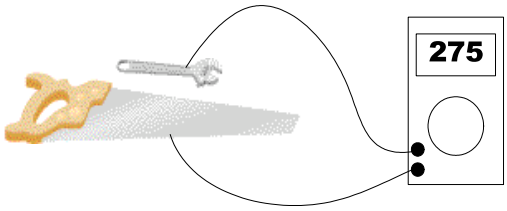
• You may use scientific or graphing calculators. Cell phones cannot be used as calculators.

• Feel free to detach, use, and keep the formula sheet pages. No other reference material is allowed during the exam.

• **Good Luck!**

Problem 1 [15 points]

The saw in the figure has a net charge on it of +700 pC.
The metric crescent wrench has a net charge of –700 pC.
A voltmeter is connected from the wrench to the saw in order to measure the potential difference (275 V) between the two tools.



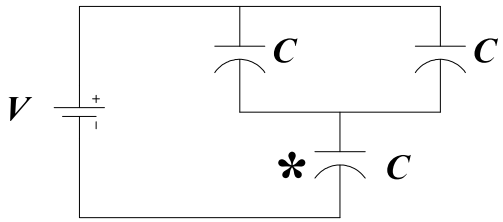
(a) [5 pts] Calculate the capacitance of this arrangement of the two tools.

(b) [7 pts] Suppose you used insulating gloves (so that no charge can escape) and moved the wrench to a new position so that the voltmeter now reads twice as great a voltage (550 volts). Calculate the work required by an external force (in this case you) to move the wrench in this way. Make sure to indicate whether the work is positive or negative.

(c) [3 pts] Did you move the wrench closer to, or farther away from the saw? Explain your reasoning in one or two sentences.

Question 1 [10 points]

The circuit shows three identical capacitors of capacitance C, connected to an ideal battery of potential difference V, in the configuration illustrated.



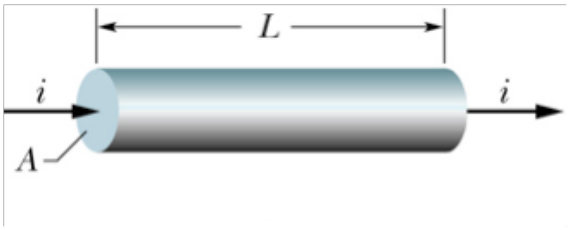
(a) [5 pts] The equivalent capacitance for this arrangement of three capacitors is

a) C
b) $2C$
c) $C/2$
d) $2C/3$
e) $3C/2$
f) none of the above

(b) [5 pts] The amount of charge stored on the capacitor marked "*" is

a) CV
b) C/V
c) V/C
d) $2CV/3$
e) $3CV/2$
f) none of the above

Problem 2 [15 points] The figure shows a copper wire of cross sectional area $A = 2.0 \times 10^{-6}$ m^2 and length $L = 4.0$ m has a current of 2.0 A uniformly distributed across that area. The resistivity of copper is 1.69×10^{-8} Ωm.



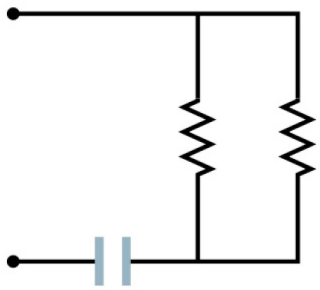
(a) [4 pts] Calculate the magnitude of the electric field inside the wire:

(b) [3 pts] Which end of the wire has the highest electric potential? Explain your answer briefly

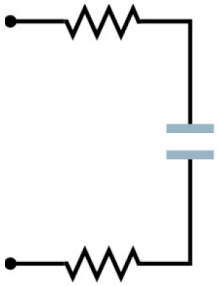
(c) [8 pts] Calculate how much electrical energy is dissipated in the wire in 30 minutes:

Question 2 [10 points]

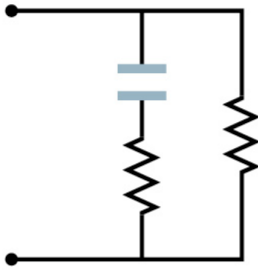
The figures show three sections of an RC-circuit that are to be connected in turn to the same battery. The resistors are all identical, as are the capacitors.



(1)



(2)



(3)

(a) [5 pts] Rank the circuits according to the final (equilibrium) charge on the capacitor:

$Q_2 > Q_3 > Q_1$ $Q_1 > Q_3 > Q_2$ $Q_2 > Q_1 = Q_3$

$Q_1 > Q_2 > Q_3$ $Q_1 = Q_2 = Q_3$

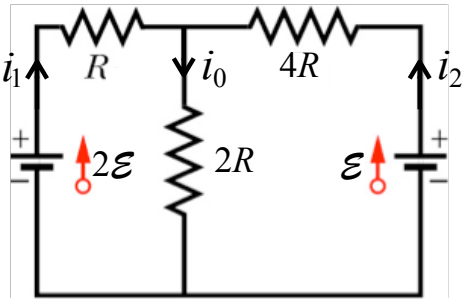
(b) [5 pts] Rank the circuits according to the time required for the capacitor to reach 50% of its final charge:

$t_2 > t_3 > t_1$ $t_1 > t_3 > t_2$ $t_2 > t_1 = t_3$

$t_1 > t_2 > t_3$ $t_1 = t_2 = t_3$

Problem 3 [20 points]

In the circuit shown in the figure $\mathcal{E} = 1.0$ V and resistance $R = 1.0\ \Omega$.
Use the indicated directions of the currents i_1, i_2, and i_0 in your equations below.



(a) [3 pts] Write down the junction equation for the junction located just above the i_0 arrow:

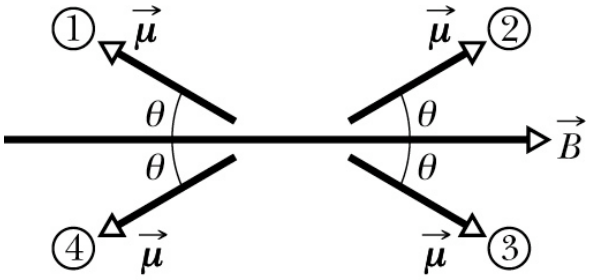
(b) [8 pts] Write down two different loop equations for this circuit. Indicate on the figure which loop is which:

(c) [4 pts] Write down an expression for current i_2 in terms of i_1, $\mathcal{E}$, and R

(d) [5 pts] Calculate the power of the 2V battery (emf) on the left:

Question 3 [10 points]

The figures show four orientations of a magnetic dipole with moment $\boldsymbol{\mu}$ in a magnetic field **B**.



(a) Rank the orientations with respect to the magnitude of the torque on the dipole:

$\tau_4 > \tau_1 > \tau_2 > \tau_3$ $\tau_1 = \tau_4 > \tau_2 = \tau_3$

$\tau_2 = \tau_3 > \tau_1 = \tau_4$ $\tau_1 = \tau_2 = \tau_3 = \tau_4$

(b) Rank the orientations with respect to the potential energy of the dipole:

$U_4 > U_1 > U_2 > U_3$ $U_1 = U_4 > U_2 = U_3$

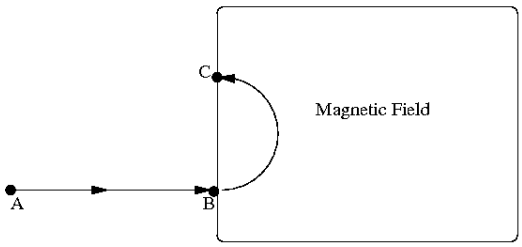
$U_2 = U_3 > U_1 = U_4$ $U_1 = U_2 = U_3 = U_4$

(c) If the dipole is rotated from orientation 1 to orientation 2 is the work done by the magnetic field:

positive negative zero

Problem 4 [20 points]

The figure shows a beam of electrons which is first accelerated from rest (from point A to point B) through a potential difference of 500 V. Then the electrons enter a rectangular region with a uniform magnetic field. The magnetic force causes the electrons to follow a curved path with a radius of 10 cm. You can find the electron and proton masses in the formula sheet.



(a) [4 pts] What is the direction of the magnetic field in the rectangular region:

into the page out of the page upward downward

(b) [6 pts] Calculate the magnitude of the magnetic field in the rectangular region:

(c) [5 pts] Calculate the time it takes for the electrons to follow the curved path inside the magnetic field region, from point B to point C:

(d) [5 pts] If instead a beam of protons entered the same magnetic field with the same initial velocity, what would be the radius of the proton's circular path?