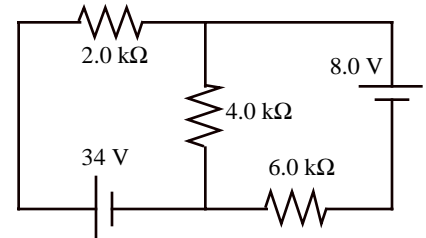


Name _____

PLEASE READ THIS FIRST: Work the problems on separate sheets of paper and staple *this* sheet to the front. Read each problem *carefully*. The credit you receive on each problem will depend *at least* as much on how you get your answer as on what answer you get. There is *no* need to be as “wordy” as I ask you to be on homework, but you must show your work or give at least a brief explanation for *every* answer. I give *no* credit for unsupported answers. I give partial credit for partially correct solutions, but *only* when I can figure out what you are doing, so be as clear as possible. Make *certain* that all numerical answers are given with a reasonable number of significant digits (when in doubt, three is usually a good compromise) and that you have included *appropriate* and *simplified* units. Check your answers for physical *reasonableness* whenever possible; I do deduct points for ridiculous answers that go unmentioned upon.

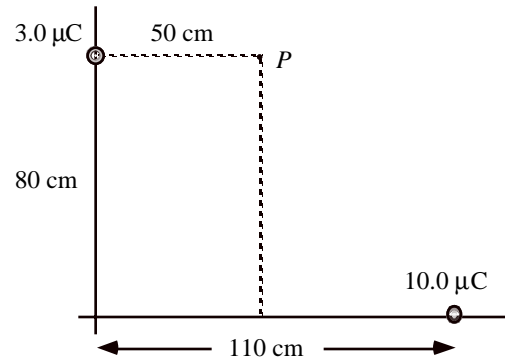
1. a) [14 pts] Find the *current* in the 2.0 kΩ resistor.
- b) [6 pts] Perform a “power accounting” for this circuit—that is, show that the net rate at which the batteries are *supplying* electrical power is the same as the net rate at which the resistors are *dissipating* electrical power.



2. Two point charges are placed as shown at right. [Note: The point *P* is *merely* a labeled position in space.]

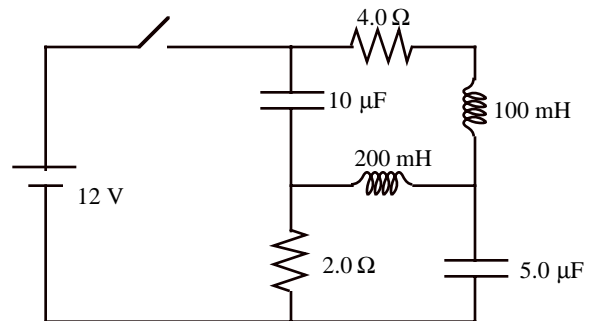
- a) [3 pts] Find the *electrical potential energy* of this charge configuration.
- b) [5 pts] Find the *electrical potential* at point *P*.
- c) [12 pts] Find the *magnitude and direction of the electric field vector* at point *P*.

EXTRA CREDIT [5 pts] Find the *electric force* on a point charge which when placed at point *P* causes the total electrical potential energy of the configuration to vanish.

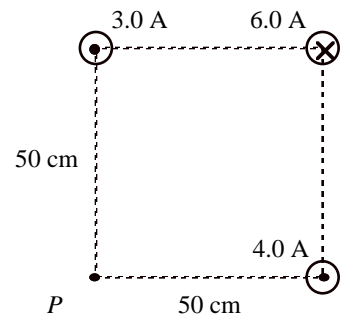


3. Find the *current* being supplied by the battery
 - a) [5 pts] *just* after the switch is closed and
 - b) [5 pts] after a *long time*.
 - c) [5 pts] Find the *energy* that is eventually stored by the 5.0 μF capacitor.

EXTRA CREDIT [5 pts] After being closed for a long time, the switch is reopened. Just after opening the switch, what is the current in the 2.0 Ω resistor?

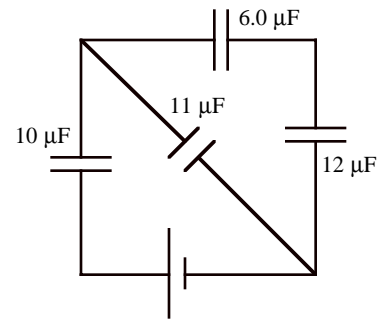


4. [15 pts] *Three* long straight wires carry the indicated currents in the indicated directions either into or out of the page. Find the *magnitude and direction of the magnetic field* at point *P*.

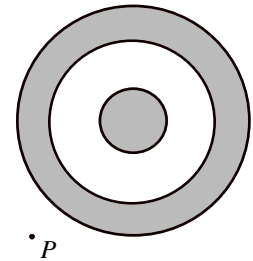


(over for more problems)

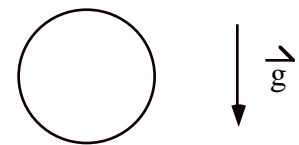
5. [10 pts] Find the equivalent *capacitance* between the terminals of the battery.
 EXTRA CREDIT [5 pts] If the $12\ \mu\text{F}$ capacitor carries $60\ \mu\text{C}$ of charge, what is the *battery emf*?



6. A solid conducting sphere of radius a carries a total charge of $+3Q$. It is surrounded by a concentric conducting spherical shell having inner radius b and outer radius c that carries a total charge of $-Q$.
- [5 pts] Find the amount of charge on each of the three spherical *surfaces*. [Don't forget to explain!]
 - [5 pts] Find the *magnitude of the electric field* at point P which lies a distance a away from the outer surface of the conducting shell.



7. [10 pts] A circular copper loop is *dropped* from an upper region where the magnetic field is zero into a lower region where there is a strong uniform horizontal magnetic field as shown in the drawing. Explain clearly and completely *why* the loop experiences an *upward* magnetic force *while* entering the magnetic field region, but *not* before or after entering the region.



[Note: Your explanation should proceed *logically* starting with what you know and proceeding to things you need to show. Do *not* begin your explanation by saying, "The loop experiences an upward force because ..." I would suggest something more like, "While the loop is entering the magnetic field region ..."]

[Additional note: The phrase "by the right hand rule" is completely meaningless unless you specify *which* right hand rule you are talking about **and** indicate what quantities you are working with as well as their *directions*. I'll be far more likely to give you full credit if you correctly answer the question without using this phrase!]

