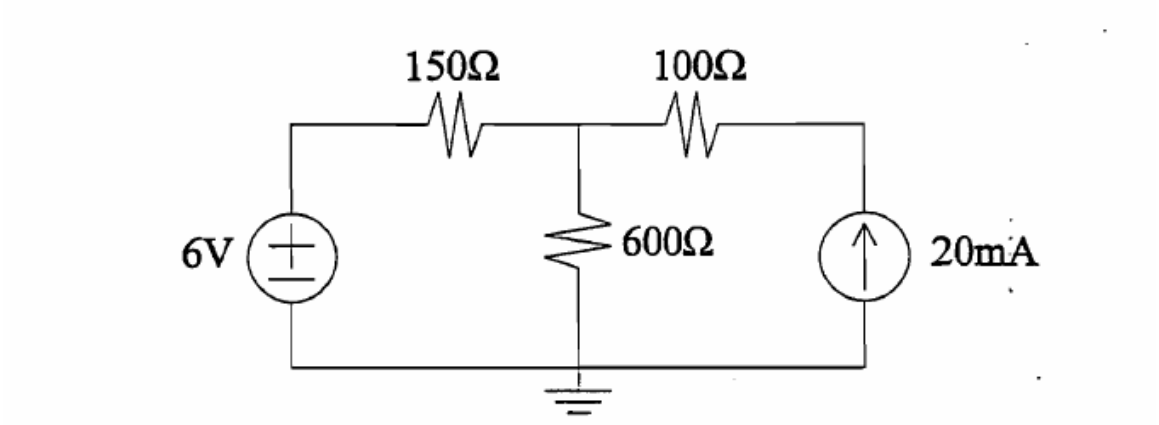
ECSE 200: Fundamentals of Electrical Engineering

Assignment 4 (part 1)

Winter 2006

Question 1

Consider the linear circuit below. Find the power supplied by each source (2 values!).



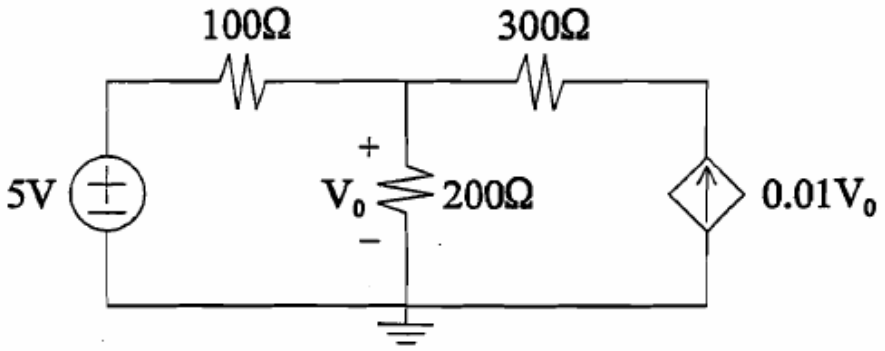
Question 2

Consider a practical battery that exhibits negligible loss under open-circuit conditions. Explain how to accurately determine the values of the open-circuit voltage and internal resistance(s) which model this battery, using only an ideal ammeter and a 10kΩ resistor. Express your answers clearly and concisely in terms of specific current measurements. You are not permitted to use any other equipment or data, except for that given above.

Note: Please feel free to use circuit diagrams to illustrate and clarify your explanation.

Question 3

Consider the circuit provided below and answer each of the following questions:



(a) Prove that the controlled source acts like an ohmic device.

(b) Find the equivalent resistance of the controlled source.

(c) Find the power supplied by the controlled source.

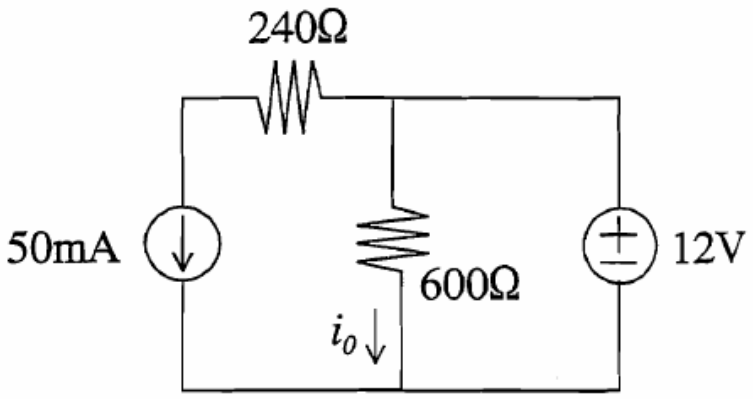
Question 4

Consider the circuit provided below:

a) Calculate the power *supplied* by each of the sources.

b) Calculate the value of the current i_0 that would be measured with a *passive* ammeter which has an internal resistance of 30Ω. Define your ammeter model and show how it should be connected to the circuit to make this measurement.

c) Calculate the power that would be *supplied* by each of the sources while making the current measurement proposed in part (b) above.

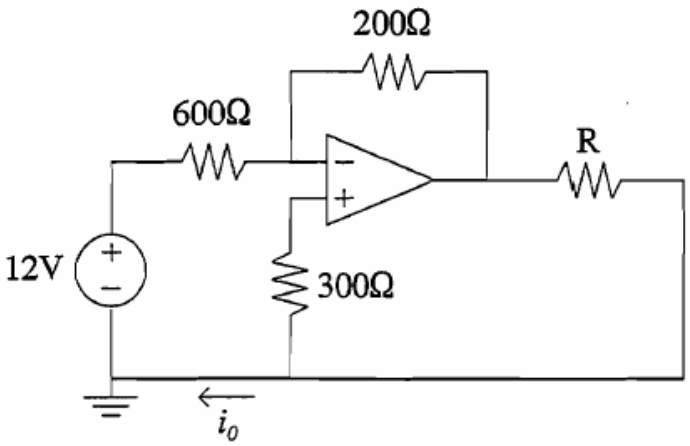


Question 5

Consider the circuit provided below. Use the ideal op-amp model for all calculations.

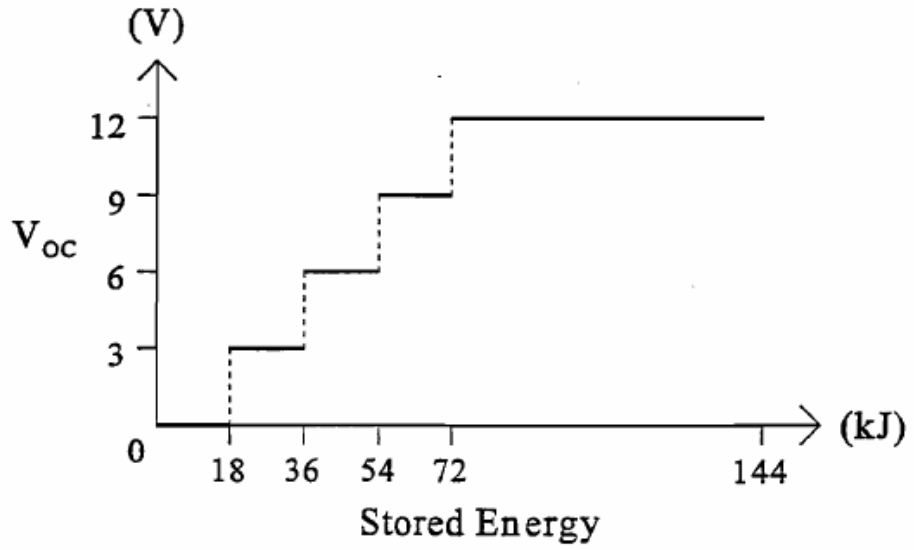
a) Calculate the value of the current i_o if R = 4kΩ.

b) Find the value of resistor R that causes the 12V source to supply exactly half of the total power dissipated as heat within the circuit.



Question 6

Consider a halogen light bulb which is rated to draw 72W from a 12V (d.c.) supply, and an electronically controlled battery which functions according to the ***open-circuit*** voltage (versus stored energy) characteristic plotted below.



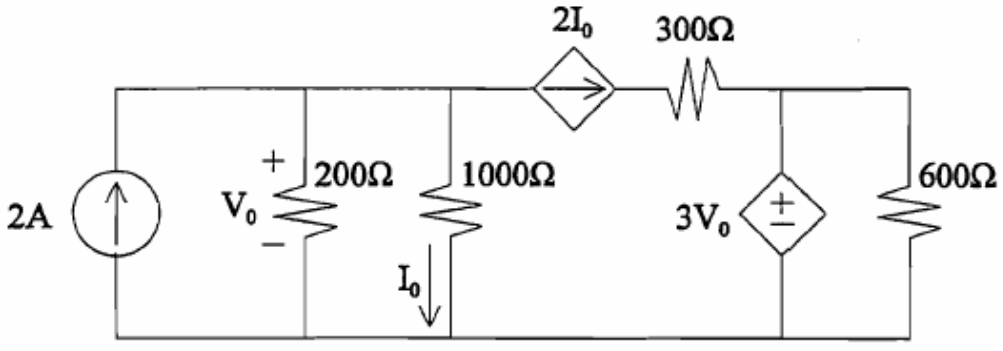
Experiments have shown that the ***open-circuit*** discharge rate of the battery is negligible, and that the bulb is essentially an ohmic device that will produce halogen light as long as the applied voltage is 6V or greater.

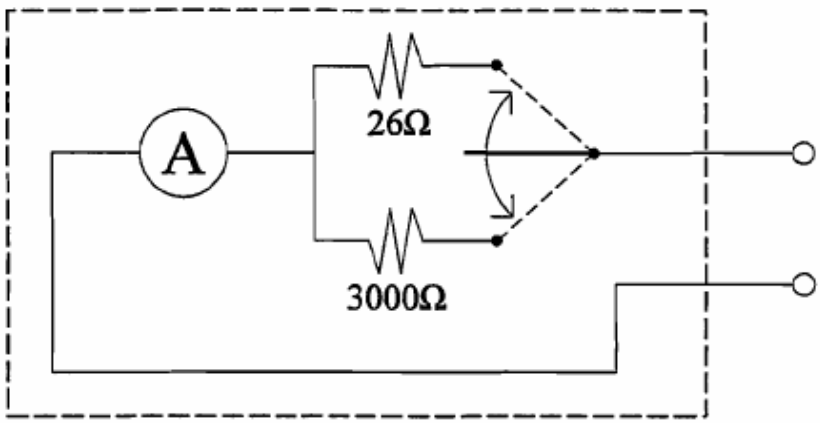
Suppose that the battery is fully charged to 144kJ and then connected directly to the bulb. If the initial current from the battery to the bulb is measured to be 5A, **calculate** how long (i.e. hours/minutes/seconds) the bulb will continue to produce halogen light while connected to the battery. Further, **calculate** how much energy will be left in the battery at the time the bulb stops working, and **calculate** the total amount of energy delivered to the bulb over the full period of halogen operation.

Note: Be sure to describe the circuit model(s) that you choose to use to solve this physical problem, and clearly show how you determine all values (e.g. resistances, etc.) specified in your model(s).

Question 7

Consider the linear circuit and the multimeter illustrated below; answer the following:





(Switchable resistance multimeter)

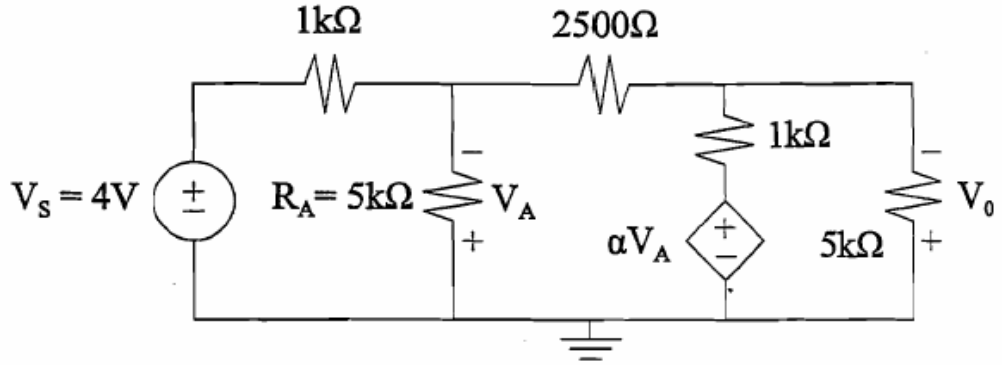
(a) Calculate the actual values of the voltage labeled V_0 and the current labeled I_0.

(b) Calculate the values of V_0 and I_0 that you would measure using this multimeter. Assume your measurements must be taken one at a time, exactly where V_0 and I_0 are defined in the circuit. Use the "best" multimeter resistance setting in each case.

(c) Assume the exact values of the four resistors in the circuit were unknown. Explain how you could find the actual values of V_0 and I_0 using the multimeter provided.

Question 8

Consider the linear circuit shown below and answer each of the following questions:



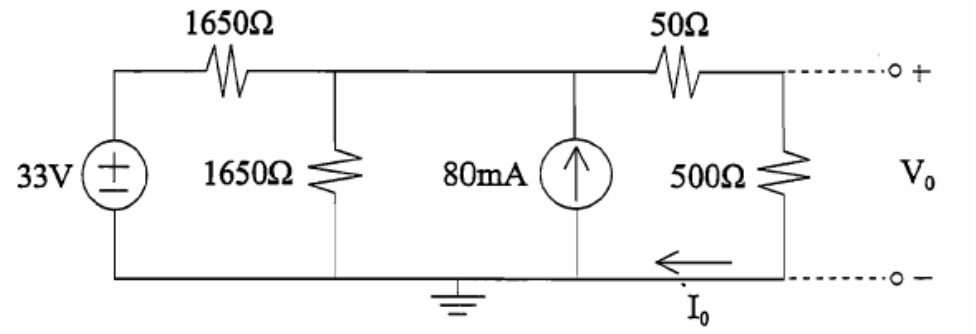
(a) Find the voltage gain of the circuit, defined by V_0 / V_S, in the limit as $\alpha \to \infty$.

(b) Find the power supplied by the controlled source in the limit as $\alpha \to \infty$.

(c) Find the value(s) of α that make the resistance $R_A = 5k\Omega$ absorb $200\mu W$.

Question 9

Consider the linear circuit shown below and answer each of the following questions:



(a) Calculate the exact values of the current labeled I_0 and the voltage labeled V_0.

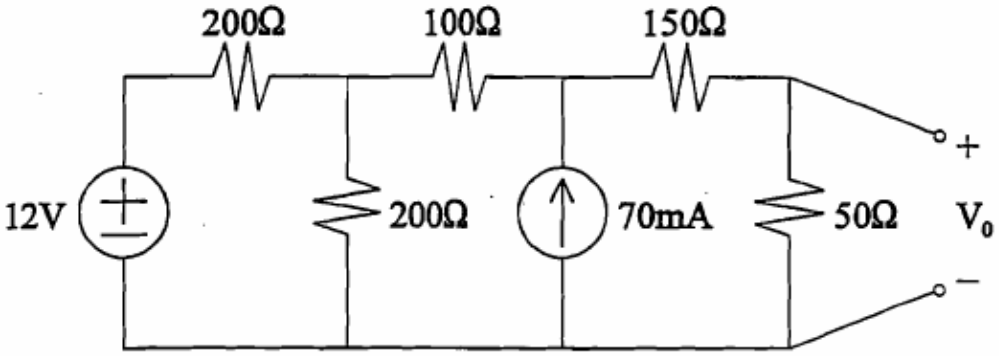
(b) Calculate the value of I_0 that would be measured if an ammeter with an internal resistance of 50Ω was used. What is the percent error of this measurement?

(c) Calculate the value of V_0 that would be measured if an voltmeter with an internal resistance of 4500Ω was used. What is the percent error of this measurement?

(d) Redo the calculations of parts (b) and (c), assuming that the two measurements are done at the same time (both meters connected to the circuit simultaneously). How do the errors change? Briefly explain why this happens (be specific!).

Question 10

Consider the circuit provided below.



a) Calculate the value of the voltage V_0.

b) Calculate the value of V_0 that would be measured using a passive voltmeter with an internal resistance of 5500Ω. Show your voltmeter model and indicate how it must be connected to the circuit to make this measurement.

Question 11

Consider the circuit provided below. Use the ideal op-amp model for all calculations.

a) Calculate the value of the current i_0 if R = 1000Ω.

b) Find the total power supplied to the circuit through the op-amp with R = 1000Ω.

c) Find the value of R that causes the total power dissipated as heat within the circuit to equal exactly 10 times the power absorbed by the 10V source.