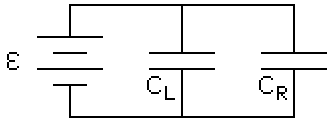
Name _____ **Student ID** _____ **Score**_____

last *first*

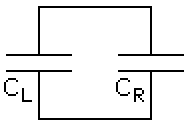
Part I. [21 points] An E = 18 V battery is used to charge two identical capacitors $C_L = C_R = 5.0$ μF, as shown in this diagram.



1. [4 points] Which choice best represents the magnitude of charge Q_R on either plate of the right hand capacitor C_R?

   A. 2.8×10^{-7} C
   B. 2.6×10^{-6} C
   C. 2.3×10^{-5} C
   D. 4.5×10^{-5} C
   E. 9.0×10^{-5} C

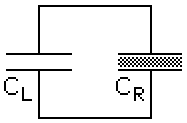
The battery is now removed as indicated in this diagram:



2. [5 points] Calculate the total energy stored in the capacitor network

   A. 3.2×10^{-7} J
   B. 1.8×10^{-4} J
   C. 2.0×10^{-4} J
   D. 8.1×10^{-4} J
   E. 1.6×10^{-3} J

Next a dielectric with $k = 2.0$ is inserted between the plates of C_R, fully filling the available space as shown. (The dielectric carries zero net charge.)



3. [5 points] Recalculate the resulting charge Q_R on either plate of the right capacitor, C_R.

   A. 2.8×10^{-5} C
   B. 6.0×10^{-5} C
   C. 1.2×10^{-4} C
   D. 1.8×10^{-4} C
   E. 3.6×10^{6} C

4. [3 points] Calculate the voltage across C_R:

   A. 6.0 V
   B. 9.0 V
   C. 12 V
   D. 15 V
   E. 18 V

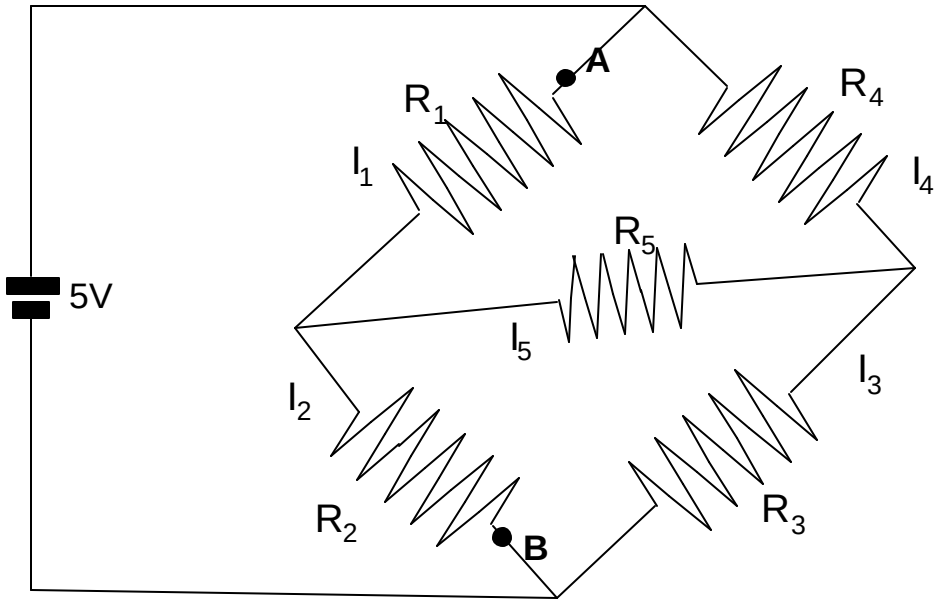
5. [4 points] A 30 V battery is reconnected to the circuit as above (though the dielectric is left in C_R). Calculate the energy now stored in the capacitor network.

   A. 4.5×10^{-4} J
   B. 5.9×10^{-4} J
   C. 1.1×10^{-3} J
   D. 4.5×10^{-3} J
   E. 6.8×10^{-3} J

Name _____ **Student ID** _____ **Score**_____

last *first*

Part II. [34 points] Consider the circuit at the left. The ideal battery is rated at 5V. R_1 is 25 Ω, R_2 is 50 Ω, R_3 is 150 Ω, and R_5 is 75 Ω. R_4 is set so that the current I_5 is zero.



6. [3 points] What is the magnitude of potential difference across R_5?

   A. 0.0 V
   B. 1.3 V
   C. 2.5 V
   D. 5.0 V
   E. 7.3 V

7. [5 points] What is the value of R_4?

   A. 25 Ω
   B. 50 Ω
   C. 75 Ω
   D. 150 Ω
   E. 175 Ω

8. [4 points] If the resistor R_5 is doubled, how will R_4 have to change in order to keep I_5 zero?

   A. Increase R_4
   B. Decrease R_4
   C. No Change to R_4
   D. It will not be possible to make I_5 zero.
   E. Not enough information

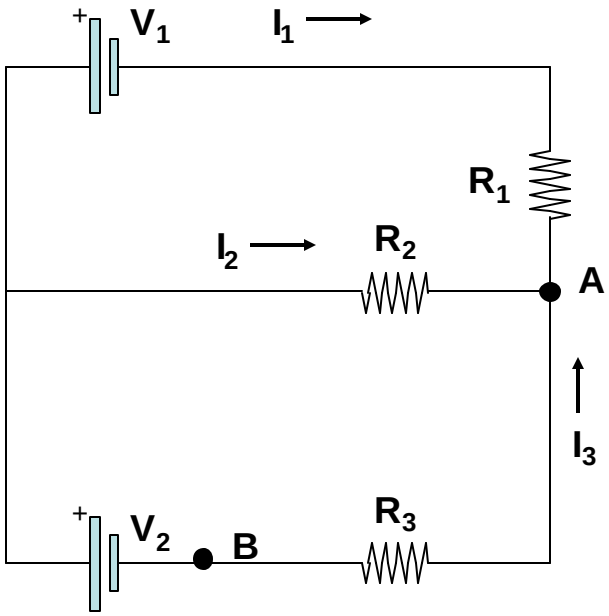
9. [4 points] What is the magnitude of the potential between points A and B?

   A. 0.0 V
   B. 1.2 V
   C. 4.0 V
   D. 5.0 V
   E. 6.2 V

Name _____ **Student ID** _____ **Score**_____

last *first*

Consider the circuit at the right for the rest of this problem. V_1 is 5 V and V_2 is 9 V. R_1, R_2, and R_3 are 20 Ω, 130 Ω, and 40 Ω, respectively. The voltage between points A and B is measured to be 1.3 V



10. [5 points] What is the current I_1?

A. 13 mA
B. 63 mA
C. 73 mA
D. 85 mA
E. 140 mA

11. [5 points] What is the current I_2?

A. 10 mA
B. 28 mA
C. 38 mA
D. 59 mA
E. 69 mA

12. [3 points] What is the current I_3?

A. 21 mA
B. 33 mA
C. 37 mA
D. 43 mA
E. 48 mA

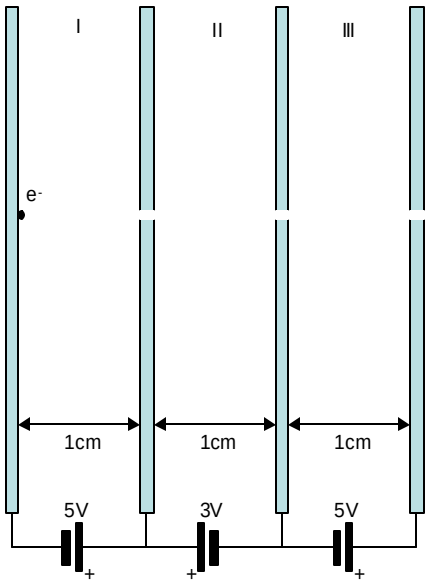
13. [5 points] Which of the following loop equations is correct, given the directions of the assumed current flow on the diagram?

A. $V_1 - R_1I_1 + I_2R_2 = 0$
B. $I_1 + I_3 = I_2$
C. $-V_1 + I_1R_1 - I_3R_3 - V_2 = 0$
D. $-V_2 - I_3R_3 + I_2R_2 = 0$
E. $V_2 + I_3R_3 + I_2R_2 = 0$

Name _____**Student ID** _____ **Score**_____

last *first*

Part III. [25 points] An electron accelerator element consists of 4 metal plates separated by 1cm with small holes, as shown in the figure (as a cross section). The two outer plates are connected by 5 V batteries, and a reversed biased 3V battery in the middle, as shown. Each plate is very thin compared to the distance between them. $m_e = 9.11 \times 10^{-31}$ kg, charge on en electron is 1.6×10^{-19} C.



14. [10 points]An electron is released from the left-most plate. How fast is it moving when it leaves the small hole in the right most plate?

15. [10 points] Calculate the direction and magnitude of the electric field between the plates, in regions I, II, and III (see labels at the top of the figure).

16. [5 points] How would removing the middle two plates change your answers above? Assume all three batteries remain connected as before. Explain.