

Figure 1

2. The circuit shown above is constructed with two 6.0 V batteries and three resistors with the values shown. The currents I_1 , I_2 , and I_3 in each branch of the circuit are indicated.

(a)

- Using Kirchhoff's rules, write, but DO NOT SOLVE, equations that can be used to solve for the current in each resistor.
- Calculate the current in the $200\ \Omega$ resistor.
- Calculate the power dissipated by the $200\ \Omega$ resistor.

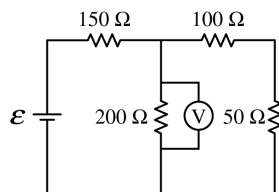


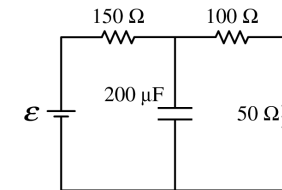
Figure 2

The two 6.0 V batteries are replaced with a battery with voltage $\mathcal{E}$ and a resistor of resistance $50\ \Omega$, as shown above. The voltmeter V shows that the voltage across the $200\ \Omega$ resistor is 4.4 V.

- Calculate the current through the $50\ \Omega$ resistor.
- Calculate the voltage $\mathcal{E}$ of the battery.

(d)

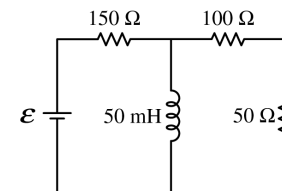
- The $200\ \Omega$ resistor in the circuit in Figure 2 is replaced with a $200\ \mu\text{F}$ capacitor, as shown on the right, and the circuit is allowed to reach steady state. Calculate the current through the $50\ \Omega$ resistor.



- The $200\ \Omega$ resistor in the circuit in Figure 2 is replaced with an ideal $50\ \text{mH}$ inductor, as shown on the right, and the circuit is allowed to reach steady state. Is the current in the $50\ \Omega$ resistor greater than, less than, or equal to the current calculated in part (b) ?

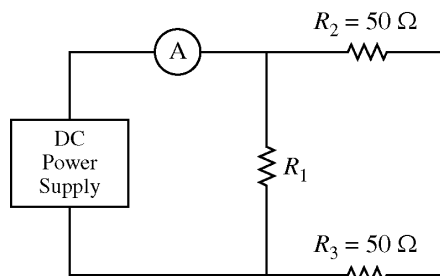
_____ Greater than _____ Less than _____ Equal to

Justify your answer.



PHYSICS C: ELECTRICITY AND MAGNETISM**SECTION II****Time—45 minutes****3 Questions**

Directions: Answer all three questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part.

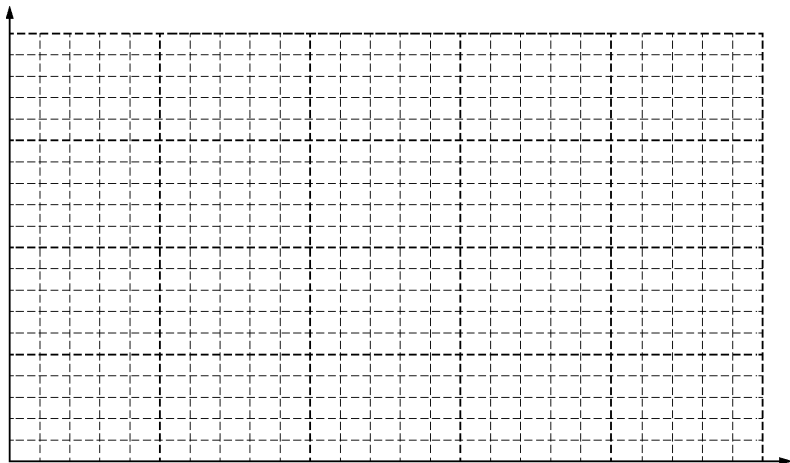


E&M. 1.

Physics students are analyzing the circuit above. A variable DC power supply is connected to an ammeter and three resistors. The resistances of two of the resistors are known to be $R_2 = R_3 = 50\ \Omega$, but the resistance of the third resistor is unknown. The students collect data on the potential difference across the power supply and the current measured by the ammeter, as follows.

Potential Difference (V)	2	4	6	8	10
Current (mA)	40	55	97	138	155

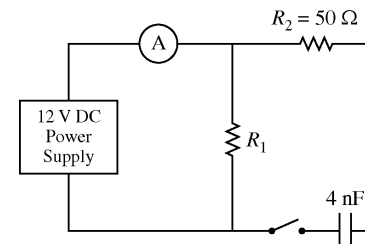
- (a) On the grid below, plot the data points for the current as a function of the potential difference. Clearly scale and label all axes, including units if appropriate. Draw a straight line that best represents the data.



- (b) Using the straight line from part (a), calculate the total resistance of the three-resistor combination.
- (c) Calculate the value of R_1 .

The power supply is now fixed at 12 V.

- (d) Calculate the current through R_2 .
- (e) Resistor 3 is now removed and replaced by an open switch in series with an uncharged 4 nF capacitor, as shown below. The power supply is still fixed at 12 V.



- i. Calculate the current in R_2 immediately after the switch is closed.
- ii. A long time after the switch is closed, will the magnitude of the current in R_2 be greater than, less than, or equal to the current through R_2 found in part (d)?
- ___ Greater than ___ Less than ___ Equal to
- Justify your answer.
- (f) The 4 nF capacitor is replaced with an uncharged 10 nF capacitor. Will the magnitude of the current in R_2 immediately after the switch is closed be greater than, less than, or equal to the current in part (e)i)?
- ___ Greater than ___ Less than ___ Equal to
- Justify your answer.