Name: _____ Period: ____

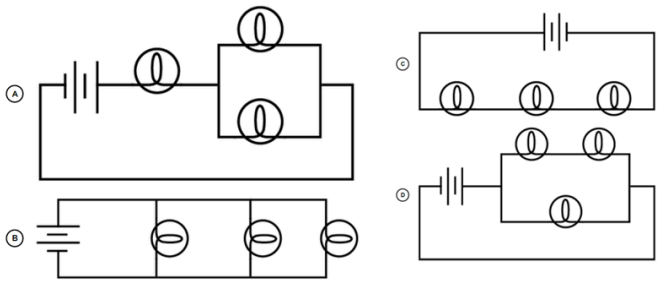
AP Physics 2: Lab Summary
Circuit Labs

For each of the labs completed, summarize the procedure, data, and analysis below. Then, completed the AP Example problems that pertain to that lab.

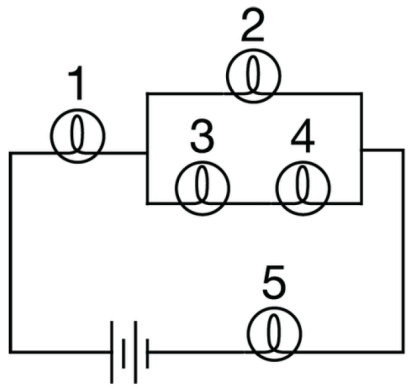
Lab Title: Crack that Circuit Challenge ***Resistors in Series v. Parallel**	What data was collected?
Draw and summarize at least 2 levels (above level 4) of the crack that circuit challenge.	

Example AP Problems:

7. The figures below show the same battery and the same three identical lightbulbs connected in different circuits. In which circuit will the bulbs all have the same brightness? Select two answers.



11.



The circuit above contains five identical lightbulbs and a battery. Which of the following are correct about the current in the circuit? Select two answers.

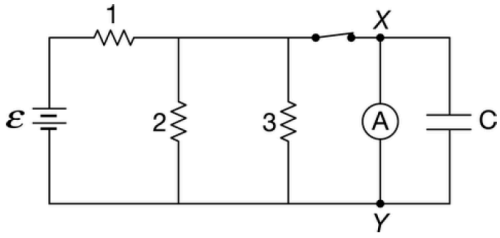
(A) As the current travels clockwise around the circuit through lightbulb 1, then 2, then 5, it decreases.

(B) The sum of the currents in lightbulbs 1, 3, 4, and 5 equals the current through the battery.

(C) The current in lightbulb 1 is greater than the current in lightbulbs 2, 3, and 4.

(D) The currents in lightbulbs 1 and 5 are the same.

2.



After the switch is closed and the circuit has reached a steady state, an ideal ammeter is connected between points *X* and *Y*, as shown above. The circuit is again allowed to reach steady state. Which of the following correctly indicates the reading on the ammeter and explains why it has that reading?

(A) **0 A**, because the capacitor will be fully charged and no current will exist in that branch.

(B) The same as the current in resistor 3, because the ammeter is connected in parallel with it.

(C) The same as the current in resistor 1, because ammeters have very low resistance and it will create a short between the top and bottom wires.

(D) The sum of the currents in resistors 2 and 3, because that current also goes through the capacitor.

The switch is closed and the circuit reaches a steady state. Which of the following correctly ranks the potential difference *V* across each of the components?

(A) $V_{R1} > V_{R2} > V_{R3} > V_C$

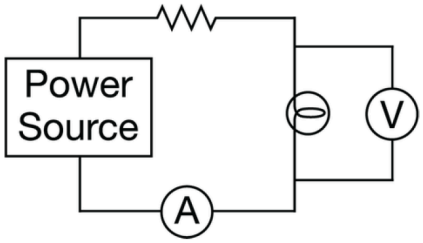
(B) $V_{R1} > V_{R2} > (V_{R3} = V_C)$

(C) $V_{R1} > (V_{R2} = V_{R3} = V_C)$

(D) $V_{R1} > (V_{R2} = V_{R3}) > V_C$

Lab Title: Is it Ohmic?	What data was collected?
Summary of lab procedure:	How was the analysis completed?

Example AP Problems:



A student is given a box of identical lightbulbs and is asked to design a procedure to determine if the lightbulbs are ohmic or nonohmic. The student plans to connect the circuit shown above and use the meters to measure a potential difference and current.

5. Which of the following is the best procedure to use to determine if the lightbulbs are ohmic or nonohmic?

(A) Use one potential difference setting on the power source and take one set of measurements for each lightbulb.

(B) Use two potential difference settings on the power source and take a set of measurements for one lightbulb.

(C) Use one lightbulb and take measurements for a number of different potential difference settings on the power source.

(D) Use each lightbulb and take measurements for the same two different potential difference settings on the power source.

9.

Current Through Bulb (A)	Intensity of Light from the Bulb (W/m^2)
5	74
10	298
15	675
20	1200
40	4800

A student wishes to determine if a particular lightbulb is an ohmic resistor. The student assumes that the intensity of light from the bulb is directly proportional to the power it dissipates. The student measures the light intensity at one location near the bulb and the current through the bulb as the voltage across the bulb is varied. The data are shown above. Based on the data, is the bulb ohmic, and why?

(A) No, because the power is a linear function of the current.

(B) No, because the power is a quadratic function of the current.

(C) Yes, because the power is a linear function of the current.

(D) Yes, because the power is a quadratic function of the current.

23. A student has a variable battery and two resistors, **X** and **Y**. Resistor **X** is ohmic, and the student wants to determine if **Y** is ohmic. The student plans to connect all three components in a circuit and vary the **emf** provided by the battery. The potential difference across and current in resistor **Y** will be measured. How should the resistors be connected for the measurements to be useful?

(A) In series only

(B) In parallel only

(C) Either in series or in parallel

(D) Neither in series nor in parallel

12. A teacher finds an old lightbulb in a supply room. The teacher asks a student to design a procedure to determine if the lightbulb is ohmic or nonohmic. The student plans to connect the light bulb to batteries of different **emf** and measure the potential difference across and the current through the lightbulb. Which of the following is the best way to analyze the data to determine if the lightbulb is ohmic or nonohmic?

(A) Calculating the resistance for each pair of potential difference and current measurements, and then averaging all of the resistance values

(B) Graphing the potential difference across the lightbulb as a function of current through the lightbulb to see if there is a linear relationship

(C) Graphing the power of the lightbulb as a function of the potential difference across the lightbulb to see if there is a linear relationship

(D) Averaging all of the values of the potential difference and average all the values of the current and then calculating an overall value for resistance based on the averages

Lab Title: Resistivity of Play-doh	What data was collected?
Summary of lab procedure:	How was the analysis completed?

Example AP Problems:

1. A wire of length L and radius r has a resistance R. What is the resistance of a second wire made from the same material that has a length $L/2$ and a radius $r/2$?

(A) $4R$

(B) $2R$

(C) R

(D) $R/2$

(E) $R/4$

8. A student plans to determine the resistivity of a specific type of metal. To do this, the student will use wires constructed of the metal with known dimensions that are connected to a variable power source. The potential difference across and the current through each wire are measured and the resistance of each is calculated. The resistance is used to determine the resistivity. Which of the following should be kept constant to ensure that the resistivity values are consistent, and why?

(A) The potential difference across the wires, because then only the currents will be different.

(B) The currents in the wires, because then only the resistances will be different.

(C) The lengths of the wires, because the resistivity changes with length.

(D) The temperature of the wires, because resistivity changes with temperature.

10. A student is asked to determine the cross-sectional area of a thin wire of resistivity ρ. The student determines the resistance R of various lengths L of the wire, graphs R as a function of L to obtain a straight line, and calculates the slope of the line as m. Which of the following is equal to the area of the wire?

(A) m

(B) $m\rho$

(C) m/ρ

(D) ρ/m

15. The following quantities are measured for a cylindrical wire connected in a circuit: potential difference across the wire, current in the wire, length of the wire, and cross-sectional area of the wire. Which of the following correctly indicates whether or not each quantity is needed to determine the resistivity of the wire?

(A)

Potential Difference	Current	Length	Area
Yes	Yes	No	No

(B)

Potential Difference	Current	Length	Area
Yes	Yes	Yes	Yes

(C)

Potential Difference	Current	Length	Area
No	No	Yes	Yes

(D)

Potential Difference	Current	Length	Area
No	No	Yes	No

Lab Title: Internal Resistance	What data was collected?
Summary of lab procedure:	How was the analysis completed?

Example AP Problems:

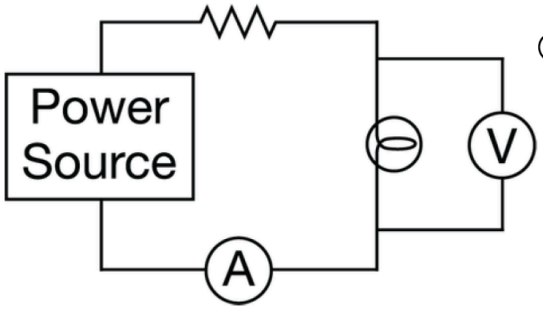
4. A simple circuit has a $12.0\ \mathbf{V}$ battery and three resistors of $6.0\ \Omega$ connected in parallel. If the current through the battery is $4.0\ \mathbf{A}$, what is the internal resistance of the battery?

(A) $0.4\ \Omega$

(B) $1.0\ \Omega$

(C) $2.0\ \Omega$

(D) $3.0\ \Omega$



A student is given a box of identical lightbulbs and is asked to design a procedure to determine if the lightbulbs are ohmic or nonohmic. The student plans to connect the circuit shown above and use the meters to measure a potential difference and current.

6. Do the results of the experiment depend on whether the power source has some internal resistance, and why or why not?

(A) No, because the measurements apply to the lightbulb only.

(B) No, because the resistor in the circuit ensures that the correct current is delivered to the lightbulb.

(C) Yes, because the current in the circuit depends on the total resistance of the circuit.

(D) Yes, because the **emf** provided by the power source will be different if it has internal resistance.

21. A voltmeter must be connected in parallel with a circuit component to correctly measure the potential difference across the component. Which of the following explains why the voltmeter should have a very large resistance?

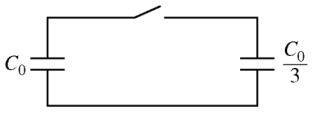
(A) A large resistance is needed to make sure the voltmeter has the same current through it as the circuit component, so the potential difference across the voltmeter is the same as that across the component.

(B) A large resistance is needed to make sure a large current passes through the voltmeter, so the rest of the circuit is not affected.

(C) A large resistance is needed to make sure negligible current passes through the voltmeter, so the rest of the circuit is not affected.

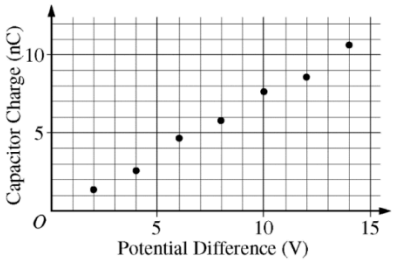
(D) A large resistance is needed to make sure the current through the voltmeter has the same nonnegligible value whenever it is used, regardless of the current in the rest of the circuit.

Lab Title: Capacitance	What data was collected?
Summary of lab procedure:	How was the analysis completed?

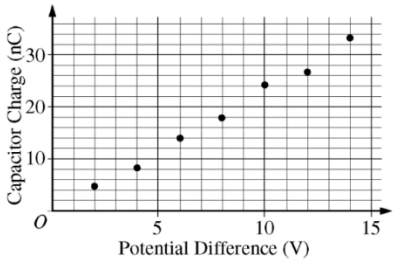


36. A capacitor with capacitance C_0 has a charge Q_0. It is then connected in a circuit with a switch and an initially uncharged capacitor with capacitance $C_0/3$, as shown in the figure above. What are the final charges on the capacitors a long time after the switch is closed?

	Charge on C_0	Charge on $C_0/3$
(A)	$\frac{Q_0}{2}$	$\frac{Q_0}{2}$
(B)	$\frac{Q_0}{3}$	$\frac{2Q_0}{3}$
(C)	$\frac{3Q_0}{4}$	$\frac{Q_0}{4}$
(D)	$\frac{2Q_0}{3}$	$\frac{Q_0}{3}$



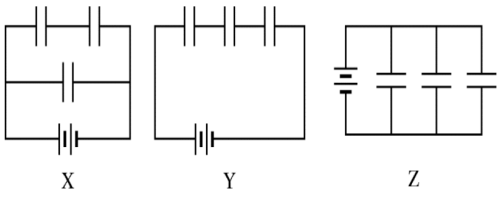
Graph 1: Capacitor with Air



Graph 2: Capacitor with Dielectric

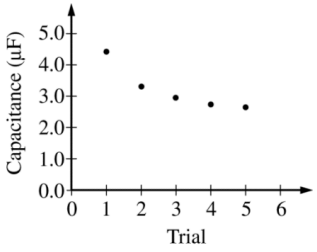
10. A capacitor initially has only air between its plates. The charge on the capacitor as a function of applied potential difference is measured, and the results are shown in graph 1 above. The capacitor is discharged, a dielectric material is inserted between the plates, and the charge as a function of applied potential difference is measured again. The results are shown in graph 2. Which of the following is equal to the dielectric constant of the material inserted into the capacitor?

(A) The slope of graph 1 divided by the slope of graph 2
(B) The slope of graph 2 divided by the slope of graph 1
(C) The vertical intercept of graph 1 divided by the vertical intercept of graph 2
(D) The vertical intercept of graph 2 divided by the vertical intercept of graph 1



12. The figures above show three circuits, each containing the same battery and identical capacitors. Which circuit has the largest stored charge when it reaches steady state?

(A) X
(B) Y
(C) Z
(D) All three store the same charge.

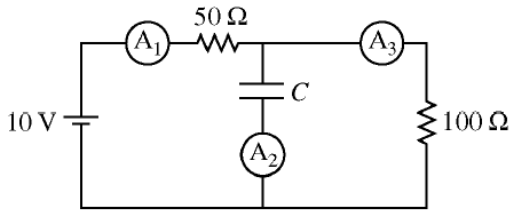


131. A student conducts an experiment to investigate the relationship between the geometry of a capacitor and its capacitance. The student can adjust both the area and separation of the capacitor plates. The capacitance is measured using the capacitance setting on a digital multimeter. The student conducts five trials, numbering them in order from 1 to 5, and creates the graph of capacitance as a function of trial number shown above. Which of the following describes how the capacitor geometry could have been changed between successive trials to generate this data? Select two answers.

(A) Both the plate area and separation were increased.
(B) The plate area was increased, and the plate separation was held constant.
(C) The plate area was held constant, and the plate separation was increased.
(D) The plate area was increased, and the plate separation was decreased.

Lab Title: RC Circuits	What data was collected?
Summary of lab procedure:	How was the analysis completed?

Questions 16-18 refer to the following material.



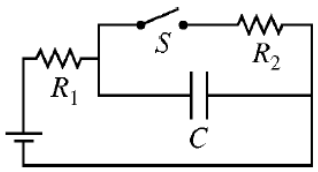
The figure above shows a 10 V battery connected in a circuit with two resistors, a parallel-plate capacitor of capacitance C, and three ammeters. The circuit has been connected for a long time.

16. Let I_i be the current in ammeter A_i. Which of the following correctly ranks the currents in the three ammeters?

(A) $(I_1 = I_3) > I_2$
(B) $I_1 > (I_3 = I_2)$
(C) $I_1 > I_3 > I_2$
(D) $I_3 > (I_1 = I_2)$

17. Which of the following is correct about the voltage V_C across the capacitor?

(A) $V_C = 0$
(B) $0 < V_C < 10$ V
(C) $V_C = 10$ V
(D) $V_C > 10$ V



45. In the circuit represented above, two resistors (R_1 and R_2), a capacitor C, and an open switch S are connected to a battery. The circuit reaches equilibrium. The switch is then closed, and the circuit is allowed to come to a new equilibrium. Which of the following is a true statement about the energy stored in the capacitor after the switch is closed compared with the energy stored in the capacitor before the switch is closed?

(A) The energy is greater.
(B) The energy is less.
(C) The energy is the same.
(D) The energy cannot be determined without knowing the resistances of the resistors.

18. Assume the capacitance C of the capacitor is known. The gap between the capacitor's plates is now filled with an unknown insulating material, and the circuit is again left connected for a long time. Measuring which of the following provides enough information to determine the unknown material's dielectric constant κ?

(A) The potential difference across the capacitor and the current in each branch of the circuit
(B) The potential difference across the capacitor and the charge on one of its plates
(C) The potential difference across the capacitor and the charge on the dielectric material
(D) The separation between the capacitor plates and the area of the plates