Name: _____

AP Physics 2

Electric Circuits **Practice** Test

Section I : Multiple Choice Questions (14 Questions – Time: 25 minutes)

Directions: Each of the questions or incomplete statements below is followed by four suggested completions. Select the one that is best in each case and then enter the appropriate letter in the corresponding space on the answer sheet.

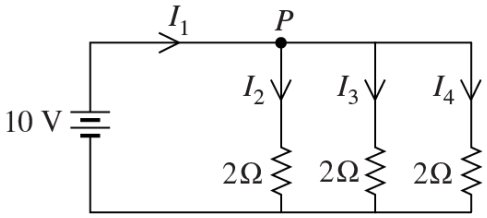
Wire	1	2	3	4	5
Current (A)	0.5	1.0	2.0	2.5	3.0

1. A simple circuit has a 12.0 V battery and three resistors of 6.0 Ω connected in parallel. If the current through the battery is 4.0 A , what is the internal resistance of the battery?

   (A) 0.4 Ω
   (B) 1.0 Ω
   (C) 2.0 Ω
   (D) 3.0 Ω

2. A student was given five wires of the same length and diameter. The student connected the wires to the same battery one by one and measured the current through each wire. The table above shows the data collected. Which of the following can be concluded from the data?

   (A) The wires are ohmic.
   (B) The wires are made of different materials.
   (C) The resistance of the wires depends on their size and shape.
   (D) The battery has internal resistance.



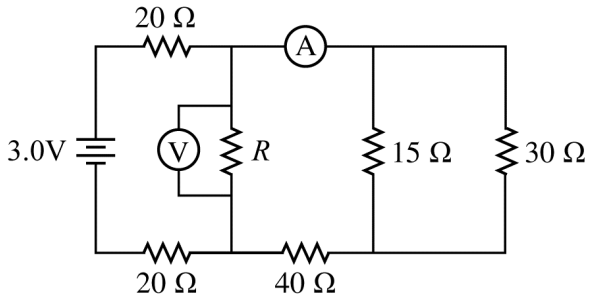
3. In the circuit above, the current through the battery is 15A. Which of the following correctly describes the currents I into and out of point P ?

   (A) $I_1 = I_2 = I_3 = I_4 = 5\ A$
   (B) $I_1 = I_2 = 7.5\text{A}, I_3 = I_4 = 2.5\ A$
   (C) $I_1 = 15\ A, I_2 = I_3 = I_4 = 5\ A$
   (D) $I_1 = 15\ A, I_2 = 7.5\ A, I_3 = I_4 = 3.75\ A$

4. 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) mp
   (C) m/p
   (D) p/m

Questions 5-6 refer to the following material.



In the circuit shown above, the current through the ammeter is 20 mA and the voltmeter indicates 1.0 V.

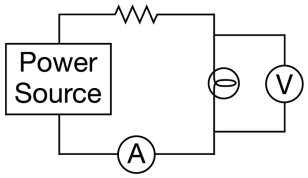
5. What is the current through the 40 Ω resistor?

   (A) 7.5 mA
   (B) 10 mA
   (C) 20 mA
   (D) 40 mA

6. The resistance of resistor R is most nearly

   (A) 50 Ω
   (B) 33 Ω
   (C) 20 Ω
   (D) 14 Ω

Questions 7-8 refer to the following material



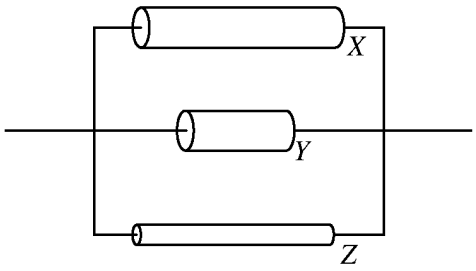
A student is given a box of identical lightbulbs and is asked to design a procedure to determine if the lightbulbs are ohmic or nonohmic. The student plans to connect the circuit shown above and use the meters to measure a potential difference and current.

7. 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

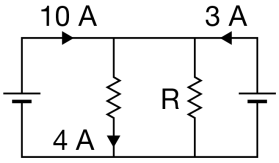
8. Do the results of the experiment depend on whether the power source has some internal resistance, and why or why not?

   (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



9. The figure above represents a section of a circuit containing three resistors, *X*, *Y*, and *Z*, of different sizes but made of the same material. Which of the following correctly ranks the current in the resistors?

   (A) $I_Z > I_X > I_Y$
   (B) $I_Z = I_X > I_Y$
   (C) $I_Y = I_X = I_Z$
   (D) $I_Y > I_X > I_Z$



10. In the circuit shown above, what is the current in resistor R ?

    (A) 3 A
    (B) 6 A
    (C) 7 A
    (D) 9 A

11. 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?

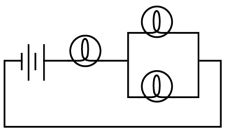
    (A) The potential difference across the wires, because then only the currents will be different.
    (B) The currents in the wires, because then only the resistances will be different.
    (C) The lengths of the wires, because the resistivity changes with length.
    (D) The temperature of the wires, because resistivity changes with temperature.

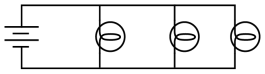
12. Two parallel conducting plates, separated by a distance d, are connected to a battery of emf ε. Which of the following is correct if the plate separation is doubled while the battery remains connected?

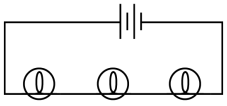
(A) The electric charge on the plates is doubled.
(B) The electric charge on the plates is halved.
(C) The potential difference between the plates is doubled.
(D) The potential difference between the plates is halved.
(E) The capacitance is unchanged.

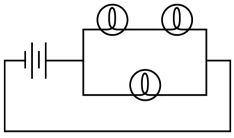
Directions: For questions 30- below, <u>two</u> of the suggested answers will be correct. Select the two answers that are best in each case, and then fill in both of the corresponding circles on the answer sheet. You must select both correct choices to earn credit.

13. 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.

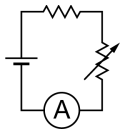
(A)


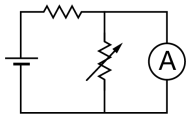
(B)


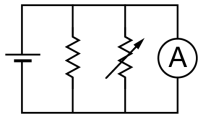
(C)


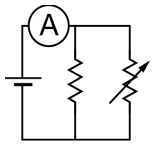
(D)


14. A student has a variable resistor with no markings and wants to determine its resistance for various settings. The student connects it in a circuit with a battery of known emf , a fixed resistor of known resistance, and a meter. Which of the following circuits will allow the student to complete the calibration? Select two answers

(A)


(B)


(C)


(D)


Section II : Free Response Questions (3 Questions – Time: 60 minutes)

1. (12 points, suggested time 25 minutes)

A group of students is given several long, thick, cylindrical conducting rods of the same unknown material with various lengths and diameters and asked to experimentally determine the resistivity of the material using a graph. The available equipment includes a voltmeter, an ammeter, connecting wires, a variable-output DC power supply, and a metric ruler.

(a)

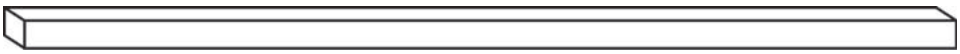
i. Describe a procedure the students could use to collect the data needed to create the graph, including the measurements to be taken and a labeled diagram of the circuit to be used. Include enough detail that another student could follow the procedure and obtain similar data.

Draw a labeled diagram here.

Write your procedure here.

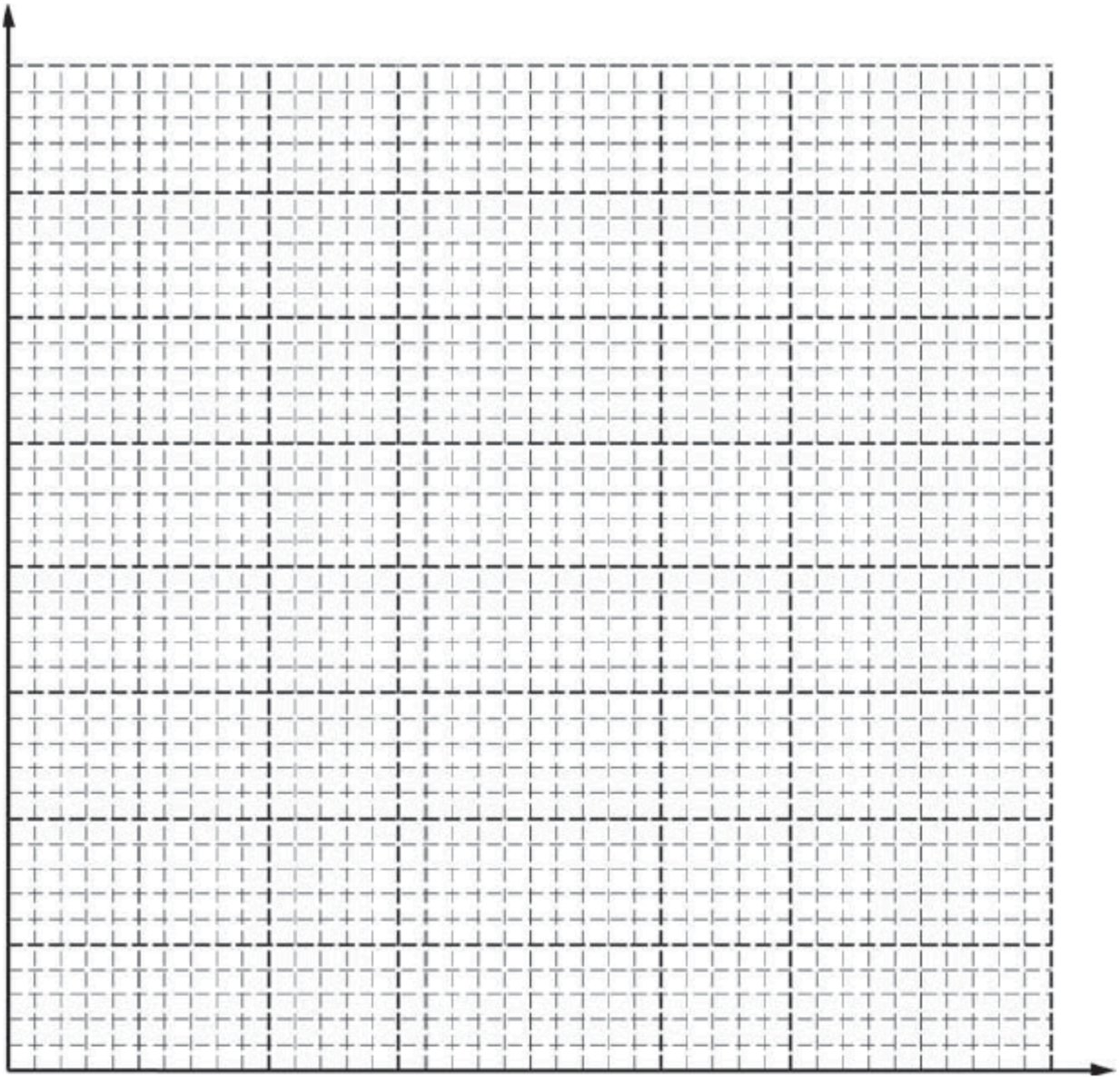
ii. Describe how the data could be graphed in a way that is useful for determining the resistivity of the material. Describe how the graph could be analyzed to calculate the resistivity.

The students are now given a rectangular rod of the material, as shown below, whose dimensions are not known. The students are asked to experimentally determine the resistance of the rod. They obtain the data in the table below for the potential difference ΔV across the rod and the current I in it.



ΔV (V)	6.0	5.0	3.5	2.5	2.0	1.5
I (A)	0.078	0.070	0044	0.036	0.027	0.018

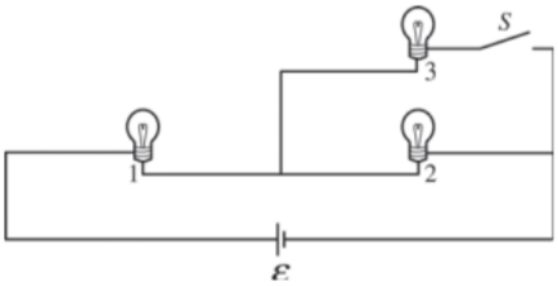
(b) On the axes below, plot the data so that the resistance of the rectangular rod can be determined from a best-fit line. Label and scale the axes. Use the best-fit line to determine the resistance of the rod, clearly showing your calculations.



(c) After completing their calculations, the students begin to consider the factors that might have produced uncertainties in their results.

i The students realize that they did not take into account the internal resistance of the power supply. Briefly describe how this would affect their value of the resistance of the rectangular rod. Explain your reasoning.

ii The students realize that they did not take into account a possible change in the temperature of the cylindrical rods. Should the students be concerned about this? Explain why or why not.



2. (12 points, suggested time 25 minutes)

A battery of emf ϵ and negligible internal resistance, three identical incandescent lightbulbs, and a switch *S* that is initially open are connected in the circuit shown above. The bulbs each have resistance *R*. Students make predictions about what happens to the brightness of the bulbs after the switch is closed.

(a) A student makes the following prediction about bulb 1: "Bulb 1 will decrease in brightness when the switch is closed."

(i) Do you agree or disagree with the student's prediction about bulb 1 ? Qualitatively explain your reasoning.

(ii) Before the switch is closed, the power expended by bulb 1 is P_1 . Derive an expression for the power P_{new} expended by bulb 1 after the switch is closed in terms of P_1 .

(iii) How does the result of your derivation in part (a)ii relate to your explanation in part (a)i?

(b) A student makes the following prediction about bulb 2: “Bulb 2 will decrease in brightness after the switch is closed.”

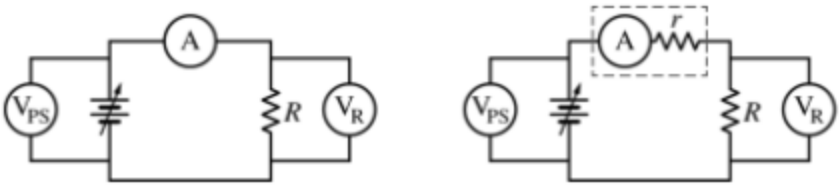
(i) Do you agree or disagree with the student’s prediction about bulb 2 ? Explain your reasoning in words.

(ii) Justify your explanation with a calculation.

(c) While the switch is open, bulb 3 is replaced with an uncharged capacitor. The switch is then closed.

(i) How does the brightness of bulb 1 compare to the brightness of bulb 2 immediately after the switch is closed? Justify your answer.

(ii) How does the brightness of bulb 1 compare to the brightness of bulb 2 a long time after the switch is closed? Justify your answer.



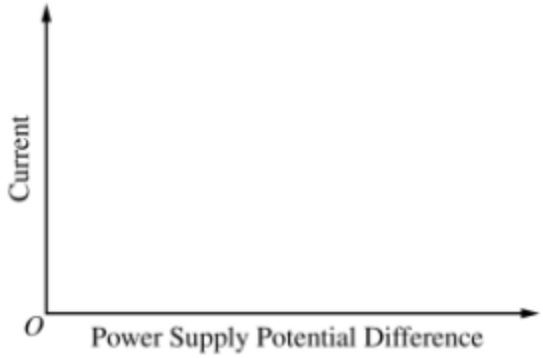
Circuit 1 Circuit 2

3. (12 points, suggested time 25 minutes)

The two circuits shown above contain an ideal variable power supply, an ohmic resistor of resistance R, an ammeter A, and two voltmeters V_{PS} and V_R . In circuit 1 the ammeter has negligible resistance, and in circuit 2 the ammeter has significant internal ohmic resistance r. The potential difference of the power supply is varied, and measurements of current and potential difference are recorded.

(a) The axes below can be used to graph the current measured by the ammeter as a function of the potential difference measured across the power supply. On the axes, do the following.

- Sketch a possible graph for circuit 1 and label it 1.
- Sketch a possible graph for circuit 2 and label it 2.



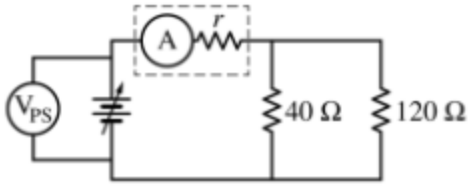
(b) Let ΔV_{PS} be the potential difference measured by voltmeter V_{PS} across the power supply, and let I be the current measured by the ammeter A. For each circuit, write an equation that satisfies conservation of energy, in terms of ΔV_{PS} , I, R, and r, as appropriate.

Circuit 1 Circuit 2

(c) Explain how your equations in part (b) account for any differences between graphs 1 and 2 in part (a).

(d) In circuit 2, $R = 40\ \Omega$. When voltmeter V_{PS} reads 3.0 V, voltmeter V_R reads 2.5 V. Calculate the internal resistance r of the ammeter.

(e) Voltmeter V_R in circuit 2 is replaced by a resistor with resistance 120 Ω to create circuit 3 shown below. Voltmeter V_{PS} still reads 3.0 V.



Circuit 3

(i) Calculate the equivalent resistance R_{eq} of the circuit.

(ii) Calculate the current in each of the resistors that are in parallel.