Current Electricity:

Electric current is the flow of an electric charge through a substance.

Objectives:

- To understand potential difference, charge, current, electric power, electrical energy, and resistance.
- To be able to solve problems involving the aforementioned quantities.
- To understand and apply Ohm's law.
- To understand the conditions required for current.
- To understand the differences between (and formulas around) series and parallel circuits.
- To be able to draw circuit diagrams and schematics of circuits with light bulbs or resistors in series or parallel. See reference table for circuit symbols.
- To be able to put voltmeters and ammeters in the correct places in schematic diagrams, and to use them correctly.
- To calculate total resistance of multiple resistors in series or parallel.
- To calculate the resistance of a conductor from resistivity, length, and cross-sectional area of the conductor.
- To understand the difference between resistance and resistivity and the effects of temperature of the resistor.

Current Electricity Formulas:

$$I = \frac{\Delta Q}{\Delta t}$$

$$R = \frac{V}{I}$$

$$R = \frac{\rho L}{A}$$

$$P = VI = I^2R = \frac{V^2}{R}$$

$$E = Pt = VIt = I^2Rt = \frac{V^2Rt}{t}$$

For Series Circuits:

$$V_t = V_1 + V_2 + V_3 + \cdots$$

$$I_t = I_1 = I_2 = I_3 = \cdots$$

$$R_t = R_1 + R_2 + R_3 + \cdots$$

For Parallel Circuits:

$$V_t = V_1 = V_2 = V_3 = \cdots$$

$$I_t = I_1 + I_2 + I_3 + \cdots$$

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$

Concepts to Watch Out For:

- Resistance determines current, not the other way around.
- Resistivity does not equal resistance!!
- Resistance of a conductor is *not* affected by external factors (except for temperature).
- Longer conductors have a greater resistance
- Shorter conductors have less resistance
- Thinner conductors have greater resistance
- Thicker conductors have less resistance
- Coulombs are a fundamental unit, amperes are derived.
- Remember that electrons flow from negative to positive.
- Current flowing into a junction *must equal* the current leaving that junction.
- The equivalent resistance in parallel is smaller than the smallest resistor in the circuit.
- The more resistors added in parallel the lower the equivalent resistance.
- Power is measured in watts
- Energy is measured in Joules
- In order to function properly, ammeters must be placed in series. Voltmeters must be placed in parallel.

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING

PHYSICS

Current Electricity NOTES:

Notice. . .

A scientific or graphing calculator, a centimeter ruler, a protractor, and a copy of the *2002 Edition Reference Tables for Physical Setting/Physics*, which you may need to answer some questions in this examination, must be available for your use while taking this examination.

The use of any communications device is strictly prohibited when taking this examination. If you use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.

PS/PHYSICS

Part A

Answer all questions in this part.

Directions (1–31): For *each* statement or question, write on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

1 What is the resistance at 20°C of a 1.50-meter-long aluminum conductor that has a cross-sectional area of 1.13×10^{-6} meter^2?

(1) 1.87×10^{-3} Ω
(2) 2.28×10^{-2} Ω
(3) 3.74×10^{-2} Ω
(4) 1.33×10^{6} Ω

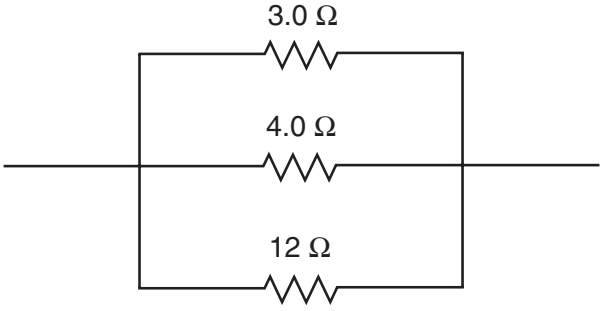
2 The resistance of a 60.-watt lightbulb operated at 120 volts is approximately

(1) 720 Ω
(2) 240 Ω
(3) 120 Ω
(4) 60. Ω

3 An immersion heater has a resistance of 5.0 ohms while drawing a current of 3.0 amperes. How much electrical energy is delivered to the heater during 200. seconds of operation?

(1) 3.0×10^{3} J
(2) 6.0×10^{3} J
(3) 9.0×10^{3} J
(4) 1.5×10^{4} J

4 The diagram below represents part of an electric circuit containing three resistors.



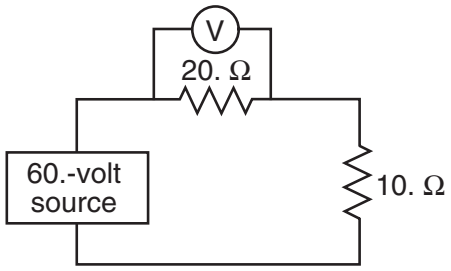
What is the equivalent resistance of this part of the circuit?

(1) 0.67 Ω
(2) 1.5 Ω
(3) 6.3 Ω
(4) 19 Ω

5 Two identical resistors connected in series have an equivalent resistance of 4 ohms. The same two resistors, when connected in parallel, have an equivalent resistance of

(1) 1 Ω
(2) 2 Ω
(3) 8 Ω
(4) 4 Ω

6 In the circuit represented by the diagram below, what is the reading of voltmeter *V*?



(1) 20. V
(2) 2.0 V
(3) 30. V
(4) 40. V

7 What is the resistance at 20.°C of a 2.0-meter length of tungsten wire with a cross-sectional area of 7.9×10^{-7} meter^2?

(1) 5.7×10^{-1} Ω
(2) 1.4×10^{-1} Ω
(3) 7.1×10^{-2} Ω
(4) 4.0×10^{-2} Ω

8 A 6.0-ohm resistor that obeys Ohm's Law is connected to a source of variable potential difference. When the applied voltage is decreased from 12 V to 6.0 V, the current passing through the resistor

(1) remains the same
(2) is doubled
(3) is halved
(4) is quadrupled

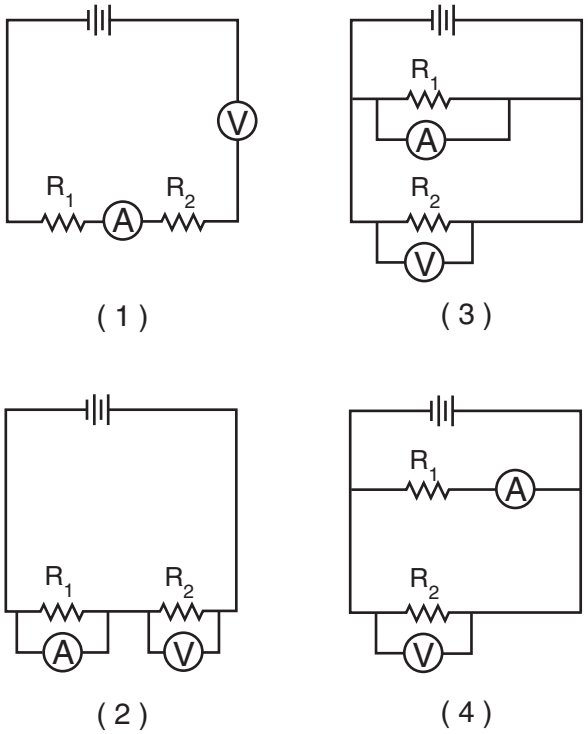
9 What is the current through a wire if 240 coulombs of charge pass through the wire in 2.0 minutes?

(1) 1 A
(2) 2 A
(3) 0.5 A
(4) 0.008 A

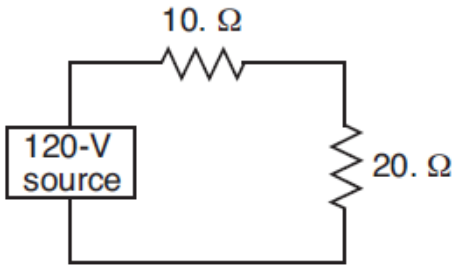
10 An electric circuit consists of a variable resistor connected to a source of constant potential difference. If the resistance of the resistor is doubled, the current through the resistor is

(1) halved
(2) doubled
(3) quartered
(4) quadrupled

11 In which circuit represented below are meters properly connected to measure the current through resistor R_1 and the potential difference across resistor R_2?



12 The diagram below represents a circuit consisting of two resistors connected to a source of potential difference.



What is the current through the 20.-ohm resistor?

(1) 0. A
(2) 6 A
(3) 1 A
(4) 4. A

13 Circuit *A* has four 3.0-ohm resistors connected in series with a 24-volt battery, and circuit *B* has two 3.0-ohm resistors connected in series with a 24-volt battery. Compared to the total potential drop across circuit *A*, the total potential drop across circuit *B* is

(1) one-half as great
(2) twice as great
(3) the same
(4) four times as great

14 How much total energy is dissipated in 10. seconds in a 4.0-ohm resistor with a current of 0.50 ampere?

(1) 2.5 J
(2) 5.0 J
(3) 10. J
(4) 20. J

15 Moving a length of copper wire through a magnetic field may cause the wire to have a

(1) potential difference across it
(2) lower temperature
(3) lower resistivity
(4) higher resistance

16 Which change decreases the resistance of a piece of copper wire?

(1) increasing the wire's length
(2) increasing the wire's resistivity
(3) decreasing the wire's temperature
(4) decreasing the wire's diameter

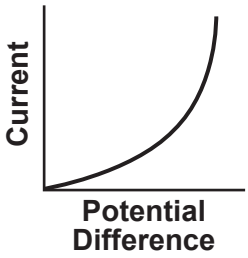
17 The watt•second is a unit of

(1) power
(2) energy
(3) potential difference
(4) electric field strength

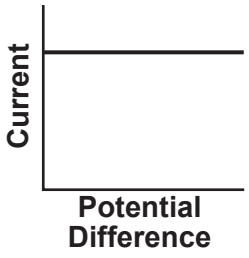
18 A 3.6-volt battery is used to operate a cell phone for 5.0 minutes. If the cell phone dissipates 0.064 watt of power during its operation, the current that passes through the phone is

(1) 0.018 A
(2) 5.3 A
(3) 19 A
(4) 56 A

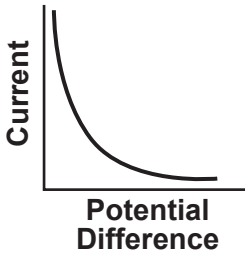
19 The resistance of a circuit remains constant. Which graph best represents the relationship between the current in the circuit and the potential difference provided by the battery?



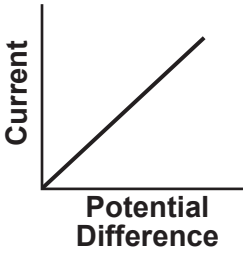
(1)



(3)

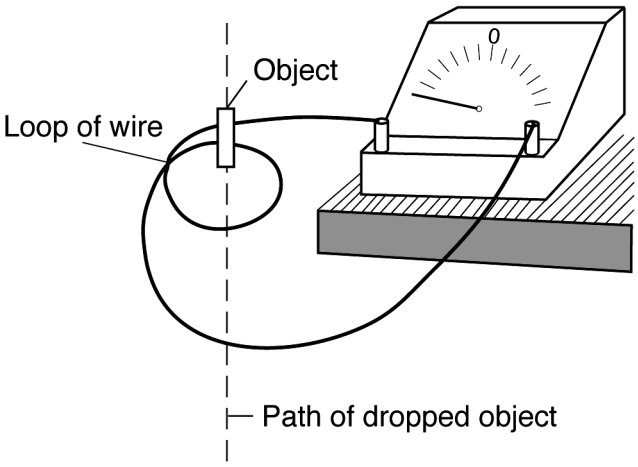


(2)



(4)

20 A small object is dropped through a loop of wire connected to a sensitive ammeter on the edge of a table, as shown in the diagram below.



A reading on the ammeter is most likely produced when the object falling through the loop of wire is a

(1) flashlight battery
(2) bar magnet
(3) brass mass
(4) plastic ruler

21 A 3-ohm resistor and a 6-ohm resistor are connected in parallel across a 9-volt battery. Which statement best compares the potential difference across each resistor?

(1) The potential difference across the 6-ohm resistor is the same as the potential difference across the 3-ohm resistor.
(2) The potential difference across the 6-ohm resistor is twice as great as the potential difference across the 3-ohm resistor.
(3) The potential difference across the 6-ohm resistor is half as great as the potential difference across the 3-ohm resistor.
(4) The potential difference across the 6-ohm resistor is four times as great as the potential difference across the 3-ohm resistor.

22 An electron moving at constant speed produces

(1) a magnetic field, only
(2) an electric field, only
(3) both a magnetic and an electric field
(4) neither a magnetic nor an electric field

23 What is the resistance of a 20.0-meter-long tungsten rod with a cross-sectional area of 1.00×10^{-4} meter^2 at 20°C?

(1) $2.80 \times 10^{-5}\ \Omega$
(2) $1.12 \times 10^{-2}\ \Omega$
(3) 89.3 Ω
(4) 112 Ω

24 An MP3 player draws a current of 0.120 ampere from a 3.00-volt battery. What is the total charge that passes through the player in 900. seconds?

(1) 324 C
(2) 108 C
(3) 5.40 C
(4) 1.80 C

[OVER]

25 A radio operating at 3.0 volts and a constant temperature draws a current of 1.8×10^{-4} ampere. What is the resistance of the radio circuit?

(1) $1.7 \times 10^{4}\ \Omega$
(2) $3.0 \times 10^{1}\ \Omega$
(3) $5.4 \times 10^{-4}\ \Omega$
(4) $6.0 \times 10^{-5}\ \Omega$

26 During a laboratory experiment, a student finds that at 20° Celsius, a 6.0-meter length of copper wire has a resistance of 1.3 ohms. The cross-sectional area of this wire is

(1) $7.9 \times 10^{-8}\ m^2$
(2) $1.1 \times 10^{-7}\ m^2$
(3) $4.6 \times 10^{0}\ m^2$
(4) $1.3 \times 10^{7}\ m^2$

27 A net charge of 5.0 coulombs passes a point on a conductor in 0.050 second. The average current is

(1) 8.0×10^{-8} A
(2) 1.0×10^{-2} A
(3) 2.5×10^{-1} A
(4) 1.0×10^{2} A

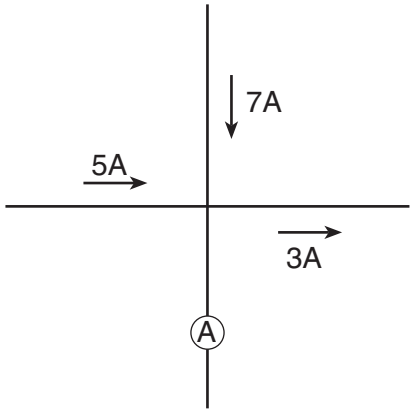
28 If several resistors are connected in series in an electric circuit, the potential difference across each resistor

(1) varies directly with its resistance
(2) varies inversely with its resistance
(3) varies inversely with the square of its resistance
(4) is independent of its resistance

29 Which particle would produce a magnetic field?

(1) a neutral particle moving in a straight line
(2) a neutral particle moving in a circle
(3) a stationary charged particle
(4) a moving charged particle

30 The diagram below shows currents in a segment of an electric circuit.



What is the reading of ammeter *A*?

(1) 1 A
(2) 5 A
(3) 9 A
(4) 15 A

31 An electric dryer consumes 6.0×10^{6} joules of electrical energy when operating at 220 volts for 1.8×10^{3} seconds. During operation, the dryer draws a current of

(1) 10. A
(2) 15 A
(3) 9.0×10^{2} A
(4) 3.3×10^{3} A

Part B–1

Answer all questions in this part.

Directions (32-41): For *each* statement or question, write on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

32 The current through a lightbulb is 2.0 amperes. How many coulombs of electric charge pass through the lightbulb in one minute?

(1) 60. C
(2) 2.0 C
(3) 120 C
(4) 240 C

33 A 330.-ohm resistor is connected to a 5.00-volt battery. The current through the resistor is

(1) 0.152 mA
(2) 15.2 mA
(3) 335 mA
(4) 1650 mA

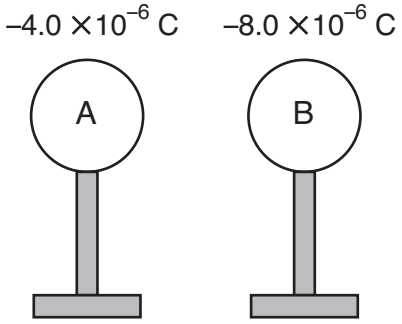
34 Pieces of aluminum, copper, gold, and silver wire each have the same length and the same cross-sectional area. Which wire has the *lowest* resistance at 20°C?

(1) aluminum
(2) copper
(3) gold
(4) silver

35 What is the current in a wire if 3.4×10^{19} electrons pass by a point in this wire every 60. secon

(1) 1.8×10^{-18} A
(2) 3.1×10^{-11} A
(3) 9.1×10^{-2} A
(4) 11 A

36 Two identically-sized metal spheres on insulating stands are positioned as shown below. The charge on sphere *A* is -4.0×10^{-6} coulomb and the charge on sphere *B* is -8.0×10^{-6} coulomb.



37 To increase the brightness of a desk lamp, a student replaces a 50-watt incandescent lightbulb with a 100-watt incandescent lightbulb. Compared to the 50-watt lightbulb, the 100-watt lightbulb has

(1) less resistance and draws more current
(2) less resistance and draws less current
(3) more resistance and draws more current
(4) more resistance and draws less current

38 The current in a wire is 4.0 amperes. The time required for 2.5×10^{19} electrons to pass a certain point in the wire is

(1) 1.0 s
(2) 0.25 s
(3) 0.50 s
(4) 4.0 s

39 Which combination of units can be used to express electrical energy?

(1) $\frac{\text{volt}}{\text{coulomb}}$
(2) $\frac{\text{coulomb}}{\text{volt}}$
(3) volt•coulomb
(4) volt•coulomb•second

40 The total amount of electrical energy used by a 315-watt television during 30.0 minutes of operation is

(1) 5.67×10^{5} J
(2) 9.45×10^{3} J
(3) 1.05×10^{1} J
(4) 1.75×10^{-1} J

41 An electric motor has a rating of 4.0×10^{2} watts. How much time will it take for this motor to lift a 50.-kilogram mass a vertical distance of 8.0 meters? [Assume 100% efficiency.]

(1) 0.98 s
(2) 9.8 s
(3) 98 s
(4) 980 s

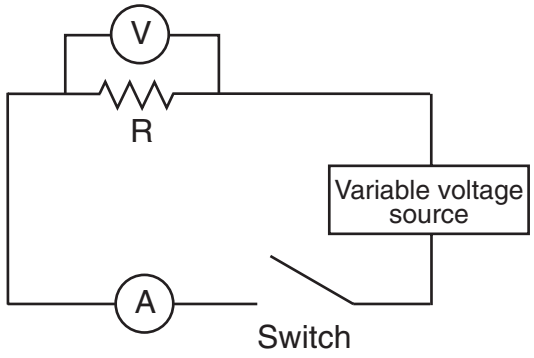
Part B–2

Answer all questions in this part.

Directions (42–57): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 42 through 46 on the information, circuit diagram, and data table below.

In a physics lab, a student used the circuit shown to measure the current through and the potential drop across a resistor of unknown resistance, *R*. The instructor told the student to use the switch to operate the circuit only long enough to take each reading. The student's measurements are recorded in the data table.



Data Table

Current (A)	**Potential Drop** (V)
0.80	21.4
1.20	35.8
1.90	56.0
2.30	72.4
3.20	98.4

Directions (42-46): Using the information in the data table, construct a graph on the grid *in your answer booklet,* following the directions below.

42 Mark an appropriate scale on the axis labeled "Potential Drop (V)." [1]

43 Plot the data points for potential drop versus current. [1]

44 Draw the line or curve of best fit. [1]

45-46 Calculate the slope of the line or curve of best fit. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 47 through 50 on the information below.

A 15-ohm resistor and a 20.-ohm resistor are connected in parallel with a 9.0-volt battery. A single ammeter is connected to measure the total current of the circuit.

47-48 In the space *in your answer booklet*, draw a diagram of this circuit using symbols from the *Reference Tables for Physical Setting/Physics*. [Assume the availability of any number of wires of negligible resistance.] [2]

49-50 Calculate the equivalent resistance of the circuit. [Show all work, including the equation and substitution with units.] [2]

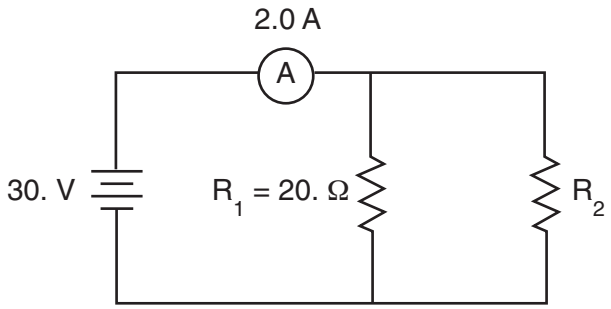
51-52 The heating element in an automobile window

has a resistance of 1.2 ohms when operated at 12 volts. Calculate the power dissipated in the heating element. [Show all work, including the equation and substitution with units.] [2]

53-54 A 25.0-meter length of platinum wire with a cross-sectional area of 3.50×10^{-6} meter^2 has a resistance of 0.757 ohm at 20°C. Calculate the resistivity of the wire. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 55 through 57 on the information below.

A 20.-ohm resistor, R_1, and a resistor of unknown resistance, R_2, are connected in parallel to a 30.-volt source, as shown in the circuit diagram below. An ammeter in the circuit reads 2.0 amperes.



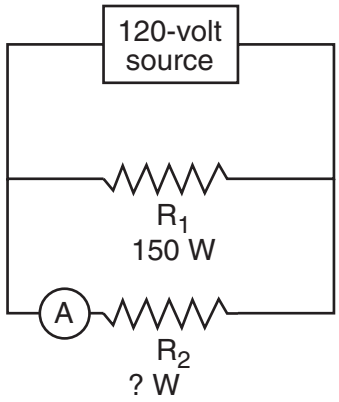
55 Determine the equivalent resistance of the circuit. [1]

56-57 Calculate the resistance of resistor R_2. [Show all work, including the equation and substitution with units.] [2]

Part C

Answer all questions in this part.

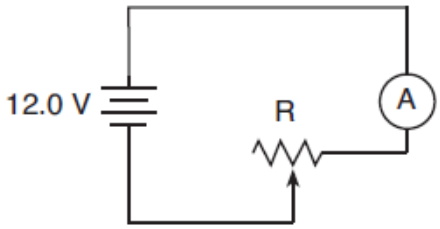
58-59 The diagram below shows two resistors, R_1 and R_2, connected in parallel in a circuit having a 120-volt power source. Resistor R_1 develops 150 watts and resistor R_2 develops an unknown power. Ammeter A in the circuit reads 0.50 ampere.



58-59 Calculate the amount of charge passing through resistor R_2 in 60. seconds.[Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 60 through 62 on the information and diagram below.

A circuit contains a 12.0-volt battery, an ammeter, a variable resistor, and connecting wires of negligible resistance, as shown below.



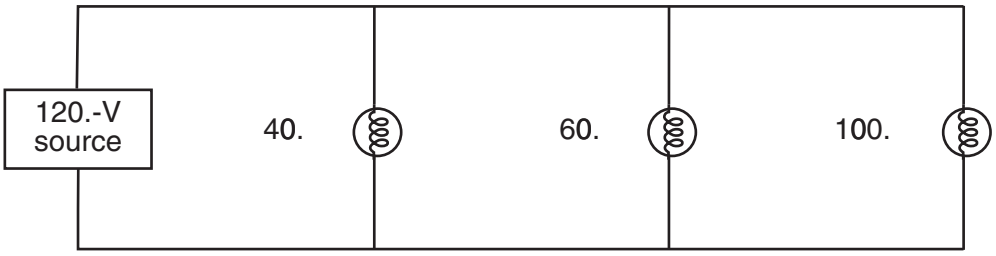
The variable resistor is a nichrome wire, maintained at 20.°C. The length of the nichrome wire may be varied from 10.0 centimeters to 90.0 centimeters. The ammeter reads 2.00 amperes when the length of the wire is 10.0 centimeters.

60 Determine the resistance of the 10.0-centimeter length of nichrome wire. [1]

61-62 Calculate the cross-sectional area of the nichrome wire. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 63 through 67 on the information and circuit diagram below and on your knowledge of physics.

Three lamps are connected in parallel to a 120.-volt source of potential difference, as represented below.



63-64 Calculate the resistance of the 40.-watt lamp. [Show all work, including the equation and substitution with units.] [2]

65 Describe what change, if any, would occur in the power dissipated by the 100.-watt lamp if the 60.-watt lamp were to burn out. [1]

66 Describe what change, if any, would occur in the equivalent resistance of the circuit if the 60.-watt lamp were to burn out. [1]

67 The circuit is disassembled. The same three lamps are then connected in series with each other and the source. Compare the equivalent resistance of this series circuit to the equivalent resistance of the parallel circuit. [1]

Base your answers to questions 68 through 72 on the information below and on your knowledge of physics.

A student constructed a series circuit consisting of a 12.0-volt battery, a 10.0-ohm lamp, and a resistor. The circuit does *not* contain a voltmeter or an ammeter. When the circuit is operating, the total current through the circuit is 0.50 ampere.

68 In the space *in your answer booklet*, draw a diagram of the series circuit constructed to operate the lamp, using symbols from the *Reference Tables for Physical Setting/Physics*. [1]

69 Determine the equivalent resistance of the circuit. [1]

70 Determine the resistance of the resistor. [1]

71–72 Calculate the power consumed by the lamp. [Show all work, including the equation and substitution with the units.] [2]

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The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

ANSWER SHEET

Student . . . . . Sex: ☐ Male ☐ Female Grade . . . . .

Teacher . . . . . School . . . . .

Record your answers to Part A and Part B–1 on this answer sheet.

Part A

1 . . . . . 13 . . . . . 25 . . . . .

2 . . . . . 14 . . . . . 26 . . . . .

3 . . . . . 15 . . . . . 27 . . . . .

4 . . . . . 16 . . . . . 28 . . . . .

5 . . . . . 17 . . . . . 29 . . . . .

6 . . . . . 18 . . . . . 30 . . . . .

7 . . . . . 19 . . . . . 31 . . . . .

8 . . . . . 20 . . . . .

9 . . . . . 21 . . . . .

10 . . . . . 22 . . . . .

11 . . . . . 23 . . . . .

12 . . . . . 24 . . . . .

Part A Score

Part B–1

32 . . . . .

32 . . . . .

34 . . . . .

35 . . . . .

36 . . . . .

37 . . . . .

38 . . . . .

39 . . . . .

40 . . . . .

41 . . . . .

Part B–1 Score

Write your answers to Part B–2 and Part C in your answer booklet.

The declaration below should be signed when you have completed the examination.

I do hereby affirm, at the close of this examination, that I had no unlawful knowledge of the questions or answers prior to the examination and that I have neither given nor received assistance in answering any of the questions during the examination.

Signature

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

ANSWER BOOKLET

Student . . . . . Sex: ☐ Male ☐ Female

Teacher . . . . . .

School . . . . . Grade . . . . .

Answer all questions in Part B–2 and Part C. Record your answers in this booklet.

Part	Maximum Score	Student's Score
A	31	
B–1	10	
B–2	11	
C	5	

Total Written Test Score (Maximum Raw Score: 85)

Final Score (From Conversion Chart)

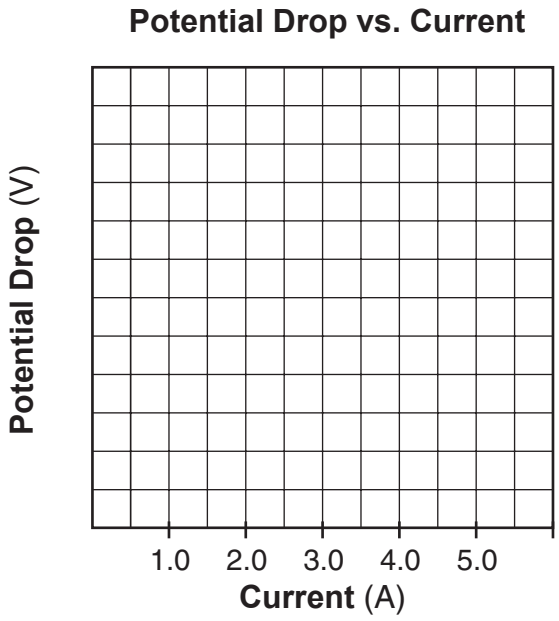
Raters' Initials:

Rater 1 . . . . . **Rater 2** . . . . .

Part B–2

For Raters Only

42-43-44



45-46

42 ☐

43 ☐

44 ☐

45 ☐

46 ☐

[OVER]

For Raters Only

47-48

47

48

49

49-50

50

51-52

51

52

53-54

53

54

55 _____ Ω

56-57

For Raters Only

55 ☐

56 ☐

57 ☐

Part C

For Raters Only

58-59

58 ☐

59 ☐

60 _____ Ω

60 ☐

61-62

61 ☐

62 ☐

63-64

63 ☐

64 ☐

65 _____

_____

65 ☐

66 _____

_____

66 ☐

67 _____

_____

67 ☐

For Raters Only

68

68 ☐

69 ☐

70 ☐

69 _____Ω

70 _____Ω

71-72

71 ☐

72 ☐