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ABSTRACT

A self-instructional system is presented designed to teach high school students fundamental concepts of electricity and how they are applied in daily life. In six lessons, the student attends to a self-paced slide and tape presentation and makes written responses in the workbooks. A supplementary application problem, requiring the assembly of some electrical equipment, is provided upon completion of the lessons. The pretest and four post-tests, used for the student's self-evaluation, is included here, as are studies of the system's field tests. Those studies indicate that the system is effective in teaching the desired concepts and that it was liked by both students and teachers. (The programed material is not included in this booklet.) (JK)

Technical Report No. 1

Research and Evaluation Division

A Self-Instructional System in Electricity

Northwest Regional Educational Laboratory
400 Lindsay Building · 710 S.W. Second Avenue · Portland, Oregon 97204

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PREFACE

This document is the first in a series of technical reports to be issued by the Research and Evaluation Division of the Northwest Regional Educational Laboratory. The reports will be published to provide people outside the Laboratory, e.g., funding personnel, potential users and professional colleagues, with data to indicate the quality of Laboratory products.

This first report is a brief description, analysis and history of a self-instructional system in electricity. Laboratory work on the system has been done in the program to improve instruction in small schools.

Authors of the report are Mark M. Greene, Staff Specialist, Research and Evaluation Division, and Chester A. Hausken, Coordinator, Small Schools Program.

J. E. Seger, Director
Research and Evaluation
Division

CONTENTS

DESCRIPTION OF THE SYSTEM

Instructional Objectives

The purpose of the instructional system in electricity is to teach high school students fundamental concepts of electricity and how they are applied in daily life. Following are the objectives of the instructional system:

To describe electricity as a form of energy and show the ways in which electrical energy is transmitted and used

To describe how electrical circuits are made and how they are used

To describe the characteristics of parallel circuits

To show the relationship between voltage, amperage and resistance in a circuit by learning Ohm's Law and use of the Ohm meter, volt meter and ammeter

To describe the relationships between electrical energy, work and power

To demonstrate the practical application of the information presented

To provide an application experience of the material presented.

Instructional Equipment and Materials

The self-instructional system in electricity utilizes the following equipment and materials:

Console cabinet (container for Audion and Carousel)

Audion (tape deck)

Carousel (slide projector)

Two-inch Buhl lens for Carousel projector

Three-foot adapter cord for Carousel projector

Energized wiring board and connectors

Eighteen Carousel holders containing instructional slides

Eighteen Audion cartridges with spoken script to match slides in trays

Two student workbooks*

Pretest and posttest for Lessons 1-3; Posttest Lessons 4-6

Four kits (crystal tuner, code oscillator, transistor radio and battery charger)

Additional materials (soldering iron--Ungar 766 cord/handle and Ungar pyramid tips; 2 lbs. solder).

The slides used in the system are arranged in Carousel holders. Tapes are enclosed in plastic cartridges for use in the Audion tape deck. Each lesson utilizes approximately three slide trays and three cartridges. The energized wiring board, known as the breadboard, gives the student an opportunity to practice manually the resolution of problems involving resistance, voltage, current and circuitry. Following lesson six, each student assembles the materials found in one of the four kits.

* Hill, Edwin K., Frank G. Nelson and Gerald F. Brunner. Basic Electricity Books I and II. Pullman: Department of Education, Washington State University, 1968.

Instructional Procedures

In working through the system the student attends to a self-paced slide and tape presentation, i. e., he can stop the slides and tapes at any time in order to study the information. During the presentation the student is required to make written responses in the workbooks. A supplementary application problem is provided upon completion of the six lessons.

The student's self-evaluation is accomplished with one pretest and four posttests: a combined test for lessons 1-3 and individual tests for lessons 4, 5 and 6. Copies of the tests are in Appendix A through E. An examination of them may provide a clearer understanding of the specific instructional content of the system.

STUDIES OF THE SYSTEM

Hill Study

The original developmental work on the self-instructional electricity system was done at Washington State University by Dr. Edwin K. Hill. Hill summarized his study of the system in the project report. *

The Hill study centered about the performance of thirty students who worked through the first three lessons of the electricity system. The study sample consisted of nineteen boys and eleven girls, grades 3 to 12, whose median grade level was 7.5. For purposes of analysis, Hill arrayed his data into three groups corresponding to measured aptitude level. The design of the study consisted of pre and post measures of achievement with the system's tests serving as criteria.

* Hill, Edwin K. The Development and Testing of an Experimental, Polysensory Self-instructional System Designed to Help Students Acquire Basic Electric Occupational Competencies. Final Report No. 19. Pullman: Department of Education, Washington State University, 1968. (ERIC DOC ED 021 141).

Hill reported that the average gain, i. e., pre vs. post, was 43.6 percent of the total possible across all groups of pupils. Hill also found that there was no significant (Chi Square) relationship between amount of gain and grade level. These findings imply that children across all of the tested grade levels demonstrated substantial informational gain after use of the system.

Northwest Regional Educational Laboratory Field Test Data

Achievement Data

The electricity system was available during the academic years 1968-69 and 1969-70 to students at eight rural high school test sites located throughout Oregon, Washington, Alaska, Montana and Idaho. In that time period approximately 130 students began work on the system. Presently available records indicate that eighty-two students went through all six lessons. Relatively complete test data is available on 22 of those students. That data is the basis for the following analysis.

The 22 students included 21 boys and 1 girl. Their grade level distribution was as follows:

Grade level	Number
12	4
11	1
10	5
9	4
8	4
7	4

For purposes of the present analysis, the data were grouped into three categories corresponding to grades 7-8, 9-10 and 11-12.

As previously noted, the students were given a pre- and posttest covering the material in lessons 1-3. The students also were given posttests for lessons 4, 5 and 6. Appendices A through E contain the tests given to the students.

Table 1 summarizes the mean achievement levels of the three groups of students on the achievement tests. It also summarizes the standard deviation associated with each of the calculated means. Inspection of Table 1 reveals that:

1. Substantial informational gains were evidenced for all groups. This finding is supported by comparison of group performance on the pretest and posttest for lessons 1-3.
2. The 11th and 12th grade students performed at slightly higher levels than the other two groups. There was no significant difference, however, in performance among the groups on any single test.
3. The 11th and 12th grade students performed slightly more consistently than did the other groups in two out of the three tests. This finding derives from the examination of the standard deviations of the test scores of the three groups. Again, however, there

was no statistical difference among groups in performance variations.

Figure 1 depicts the achievement data of the three groups in percentage of the total possible scores. The fine dotted line indicates the mean performance of the entire group of students. The gain between pre- and posttests for lessons 1-3 is evident in Figure 1, which indicates that student achievement on the posttests averaged about 75 percent across all items. If the performance of only 9th through 12th grade students is considered, then the mean achievements on the posttests for lessons 1-3 and 4, 5 and 6 would average about 80 percent.

An alternative way of considering achievement gain is presented in Table 2. It indicates the percentage of gain made by each group on the posttest for lessons 1-3, using the pretest score as a base. Again, it is evident that there is little variation among groups in the amount of gain demonstrated.

Affective Data

During the spring of 1969, an opinion survey was conducted among students and teachers using the electricity system at the eight rural high school test sites. Students were polled about their attitudes toward the system. One question asked was, "Would you recommend this system to your friends?" Ninety-five of the 102 respondents, or 93.1 percent, replied in the affirmative.

Another question asked was, "Would you be interested in taking another course using a system like this one?" Seventy-five of the 79 respondents, or 94.9 percent, replied in the affirmative. These data would seem to indicate positive student acceptance of the system.

The teacher/managers of the electricity system were asked to respond to an opinion questionnaire at the same time student attitudes were polled. One question asked was, "Would you recommend this system to other teachers?" All eight respondents answered in the affirmative. This finding would seem to indicate positive teacher acceptance of the system.

Summary

Achievement data available from the Hill study and the Northwest Regional Educational Laboratory's rural test sites indicate that students demonstrate substantial gains in knowledge through the use of the self-instructional system in electricity. No significant differences in achievement levels were noted for students in grade levels 7-12, although available data were limited. Attitudes of students and teachers toward the system were found to be quite positive.

TABLE 1--MEAN ACHIEVEMENT OF THREE STUDENT GROUPS (1968-1970)

Student grade level	No.	Pretest 1-3 (20 items)		Posttest 1-3 (20 items)		Summary of unit tests 4-6 (50 items)	
		MN[a]	SD[b]	MN	SD	MN	SD
11-12	5	8.4	2.3	15.4	3.05	41.2	5.02
9-10	9	8.3	4.44	15.2	2.16	40.2	5.63
7-8	8	5.6	3.81	13.0	2.26	37.8	8.0
	22						

[a] Mean achievement

[b] Standard deviation

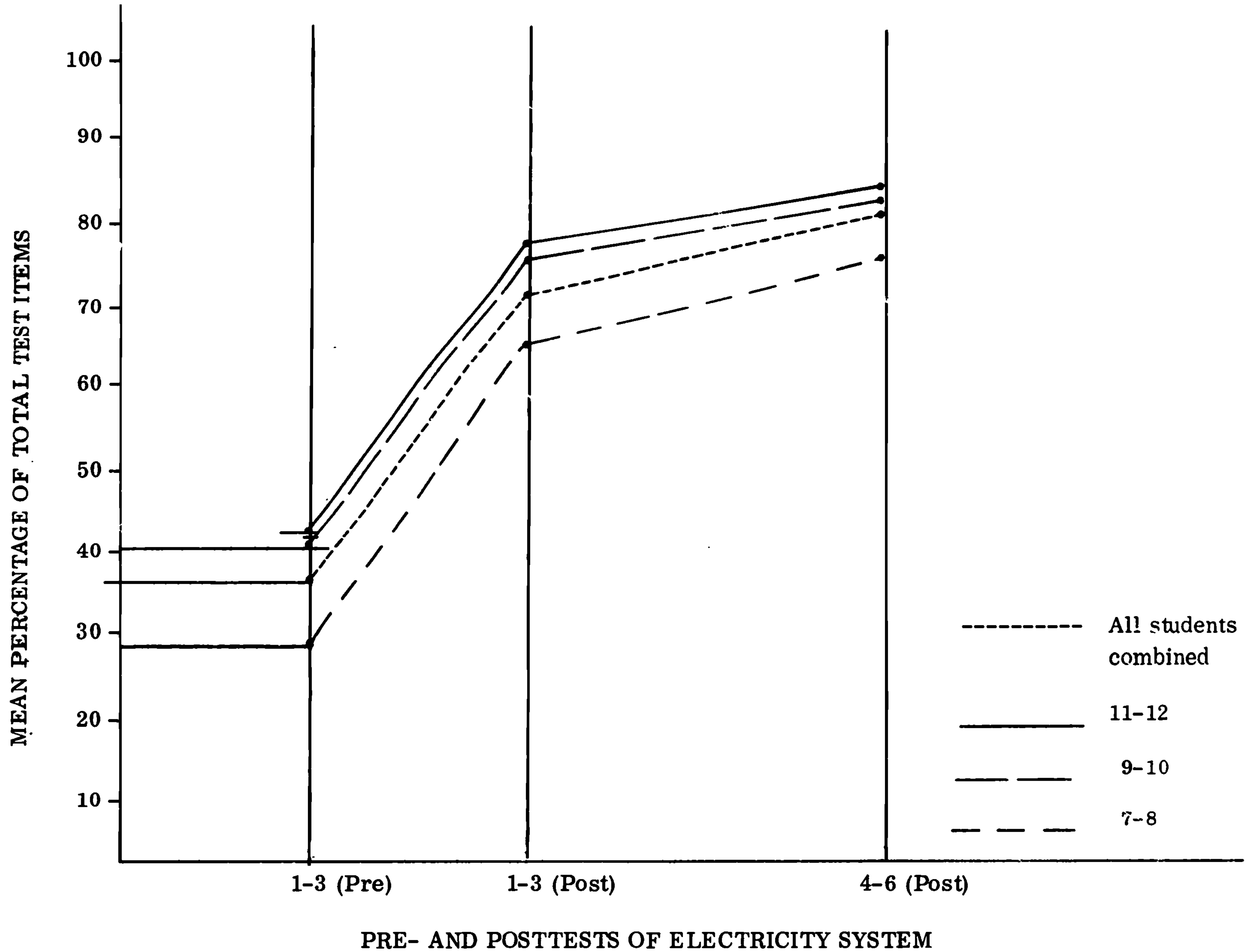


Figure 1. The mean achievement levels of three student groups. (1968-1970)

TABLE 2--PERCENT ACHIEVEMENT OF THREE STUDENT GROUPS (1968-1970)

Student grade level	N	Percent gain on pretest vs. posttest 1-3
11-12	5	.54
9-10	9	.54
7-8	8	.43
	22	

EDUCATIONAL SPECIFICATIONS OF THE SYSTEM

Systems focus:	Introductory material in electricity at senior high or junior high school level
Instructional mode:	Self-instructional with provisions for practice with wiring board and electrical kits
Student performance:	Measured by achievement tests and based on available data, students have averaged about 75 percent accuracy of total test items; completion time for all six lessons has ranged from one to thirty weeks per student with a modal reported time of two weeks (N=68).

HISTORY OF THE SYSTEM

Dr. Gordon McCloskey of Washington State University (Pullman) initiated a Vocational-Technical Education Research and Development Project in 1966. The project identified and defined clusters of capabilities essential for occupations often chosen by youth who do not complete college. Also identified were the psychological, sociological and economic factors that influenced students to seek educational programs for training in skills essential for employment. The information from the project supplied the basis for the design of prototype vocational instructional materials.

The Elementary and Secondary Education Act of 1965 gave further impetus to the Vocational Project with funds available under Title III and the involvement of the Northwest Regional Educational Laboratory, established under Title IV. Cooperative efforts resulted in the identification, development and field testing of vocational instructional systems for plastics, speech, welding, Spanish, mathematics analysis, physical science and electricity.

Personnel directly involved in the electricity project include:

Washington State University: Gordon McCloskey, Arnold Gallegos, Edwin Hill, Frank Nelson, Gerald Brunner and Dennis Gillis.

Northwest Regional Educational Laboratory: Chester Hausken, Walter Hartenberger, Ray Jongeward, Mark Greene, Al Selinger, Mary Ganzel and Gail Murphy.

APPENDIX A

BASIC ELECTRICITY PRETEST, LESSONS 1-3

APPENDIX A: BASIC ELECTRICITY PRETEST, LESSONS 1-3

(To be administered by the teacher prior to any instruction regarding Basic Electricity)

Name______________________________ Date______________________________

The purpose of this experiment is to discover how well this system of instruction helps students learn. So we can discover how much you learn by this system, we need information about what you know before you use the system.

Write your name and the date in the spaces provided at the top of this page.

This test is composed of twenty incomplete sentences. Read each question carefully. From the answers listed below each question, select the one you believe to be correct. Write the letter that corresponds with the answer you select in the blank space in each sentence.

Example:

1. The purpose of this experiment is to determine what __c__ you now possess regarding basic electricity.

   a. interest   c. knowledges
   b. materials   d. equipment

Since the correct answer is "knowledges," you would write the letter "c" in the blank space above.

If you have not studied electricity before, you will probably be quite uncertain about correct ways to complete many of the questions. That is OK. So, do the best you can; but do not worry if you are not sure which answer is correct.

If you are not fairly sure about what answer is correct for any sentence, simply skip that sentence and go on to the next one. Please do not guess.

Return the test to the instructor when you have completed all the questions.

1. Energy may be defined as the ______.

   a. strength of a force
   b. capacity to do work
   c. motion for a force
   d. amount of work done

2. Electricity is the most efficient form of energy for ______.

   a. doing all types of work
   b. its cost
   c. small jobs
   d. transmission over long distances

3. Four common forms of energy are ______.

   a. light, hydraulic, heat, mechanical
   b. electricity, steam, wind, lightning
   c. watts, amps, volts, ohms
   d. coal, wood, oil, gasoline

4. Energy conversion is ______.

   a. the storing of energy
   b. how energy is used
   c. changing one form of energy to another form
   d. the result of energy

5. An example of energy conversion is ______.

   a. a charged battery
   b. burning wood
   c. water flowing in a pipe
   d. automobile tires turning against the road

6. Current flow may be defined as ______.

   a. the movement of protons from one point to another
   b. the movement of resistance in a wire
   c. movement of electrical energy from one place to another
   d. the changing of electrical energy to another form

7. An electrical conductor is ______.

   a. an electrical generator
   b. a material that permits the flow of electrical energy
   c. a material that opposes the flow of electrical energy
   d. a source of electrical energy

8. Opposition to current flow is called ______.

   a. voltage
   b. amperage
   c. wattage
   d. resistance

9. A load will convert electrical energy to ______.

   a. voltage and resistance
   b. heat and light
   c. electrical power
   d. usable mechanical energy

10. If one of the loads in a series circuit were to be replaced by a load of a different value, ______.

   a. voltage will increase
   b. current flow will be the same
   c. the total resistance of the circuit will be reduced
   d. current flow will change

11. Voltage will be equal at all points in a ______.

   a. series/parallel circuit
   b. parallel circuit
   c. series circuit
   d. parallel/series circuit

12. The total resistance of a series circuit is ______.

   a. equal to the sum of the individual resistances
   b. found by adding the current flowing in each branch
   c. smaller than any individual resistance
   d. equal to the sum of the individual resistances divided by the number of resistances involved

13. The electrical pressure consumed in a resistance is called ______.

a. potential difference
b. voltage drop
c. resistance drop
d. current lag

14. The total current flowing in a parallel circuit is equal to ______.

a. current flow at any point in the circuit
b. the sum of the currents flowing in the different branch circuits
c. zero at all times
d. the mathematical difference between the circuit voltage and resistance present in the circuit

15. The total resistance of a parallel circuit is ______.

a. equal to the sum of the individual resistances
b. found by adding the current flowing in each branch
c. smaller than any individual resistance
d. equal to the sum of the individual resistances divided by the number of resistances involved

16. An electrical circuit made up of several branch circuits is known as a ______.

a. parallel circuit
b. combination circuit
c. series circuit
d. integrated circuit

17. Current flow will vary in different parts of a ______.

a. series circuit
b. electrical circuit
c. integrated circuit
d. parallel circuit

18. The sum of the voltage drops in a series circuit will ______.

a. be zero
b. will increase as voltage is decreased
c. equal the applied voltage
d. equal the current flow

19. The total resistance of a circuit composed of three resistances of 1, 2, 3 ohms respectively connected in parallel is _____.

a. 2 ohms
b. 6 ohms
c. .545 ohms
d. .75 ohms

20. Current flow is measured in _____.

a. volts
b. amperes
c. watts
d. ohms

APPENDIX B

BASIC ELECTRICITY POSTTEST, LESSONS 1-3

APPENDIX B: BASIC ELECTRICITY POSTTEST, LESSONS 1-3

(To be administered by the teacher after instruction has been given on Basic Electricity)

NAME ______________________ DATE ______________________

The purpose of this test is to determine how well this system of instruction has helped students learn.

Write your name and the date in the spaces provided at the top of this page.

This test is composed of twenty multiple-choice questions. Read each question carefully. From the answers listed below each question, select the one you believe to be correct. Circle the letter that corresponds with the answer you select.

Example:

1. The purpose of this test is to determine:

   a. what interest you have
   b. the basic skills you have
   c. what electrical knowledge you possess
   d. the time spent on the program

Since the correct choice is "what electrical knowledge you possess," you would circle "c" in the list of choices below the question.

If you are not fairly sure about what answer is correct for any sentence, simply skip that sentence and go on to the next one. Please do <u>not</u> guess.

Return the test to the instructor when you have completed all the questions.

1. The movement of electrical energy from one place to another is called:

   a. resistance
   b. current flow
   c. voltage
   d. wattage

2. The most efficient form of energy for transmission over long distance is:

   a. heat
   b. hydraulic
   c. mechanical
   d. electricity

3. Energy is the:

   a. capacity to do work
   b. strength of a force
   c. amount of work done
   d. motion of a force

4. Voltage will be equal everywhere in a:

   a. series circuit
   b. parallel circuit
   c. series/parallel circuit
   d. parallel/series circuit

5. A material that permits the flow of electrical energy is a:

   a. electrical source
   b. electrical generator
   c. electrical condenser
   d. electrical conductor

6. If one of the loads of a series circuit were replaced by a load of a different value:

   a. current flow will be the same
   b. current flow will change
   c. voltage will increase
   d. the total resistance of the circuit will be reduced

7. A parallel circuit is:

   a. made up of one continuous path
   b. a combination of loads, one after the other
   c. made up of several branch circuits
   d. a one-wire circuit

8. The sum of the voltage drops in a series circuit will:

   a. equal the current flow
   b. be zero
   c. increase as voltage is decreased
   d. equal the applied voltage

9. The total resistance of a parallel circuit composed of three resistances of 2, 3, 4 ohms is:

   a. 4.5 ohms
   b. 1.083 ohms
   c. .545 ohms
   d. 9 ohms

10. Voltage drop is:

   a. electrical pressure consumed by a resistance
   b. a lag in current caused by resistance
   c. the potential difference of a source
   d. the amount of resistance in a circuit

11. Opposition to current flow is called:

   a. wattage
   b. amperage
   c. voltage
   d. resistance

12. The total resistance of a parallel circuit is:

   a. found by adding the current flowing in each branch
   b. equal to the sum of the individual resistances
   c. equal to the sum of the individual resistances divided by the number of resistances involved
   d. smaller than any individual resistance in the circuit

13. Current flow will vary in different parts of a:

a. integrated circuit
b. series circuit
c. parallel circuit
d. electrical circuit

14. Current flow is measured in:

a. ohms
b. watts
c. volts
d. amperes

15. Total resistance of a series circuit is:

a. smaller than any individual resistance in the circuit
b. equal to the sum of the individual resistances divided by the number of resistances involved
c. found by adding the current flowing in each branch
d. equal to the sum of the individual resistances

16. A load will convert electrical energy to:

a. voltage and resistance
b. heat and light
c. electrical power
d. usable mechanical energy

17. The total current flow of a parallel circuit is equal to:

a. the mathematical difference between the circuit voltage and resistance present
b. the sum of the currents flowing in the different branch circuits
c. zero at all times
d. current flow at any point in the circuits

18. Burning wood is an example of:

a. energy conversion
b. energy consumption
c. creation of energy
d. energy transmission

19. Four common forms of energy are:

    a. coal, wood, oil, gasoline
    b. electricity, steam, wind, lightning
    c. watts, amps, volts, ohms
    d. light, hydraulic, heat, mechanical

20. The changing of energy from one form to another is:

    a. energy conservation
    b. energy transmission
    c. energy creation
    d. energy conversion

APPENDIX C

TEST--LESSON 4

APPENDIX C: TEST--LESSON 4

1. Current flow through a resistance is measured in:

   a. volts
   b. amperes
   c. ohms
   d. electrons

2. Voltage is measured by a:

   a. multiplier
   b. shunt
   c. multiplier resistor
   d. voltmeter

3. The pressure that forces or pushes electrons through an electrical circuit is called:

   a. current
   b. voltage
   c. resistance
   d. wattage

4. EMF means:

   a. electromechanical force
   b. electromotive force
   c. electromechanical flux
   d. effective measuring factor

5. To increase the current in a circuit without changing the resistance you must:

   a. increase the voltage
   b. decrease the voltage
   c. increase the ohms
   d. none of these

6. Current will flow between two points in a circuit when:

   a. the difference of potential between the two points is zero
   b. a difference of potential exists between the two points
   c. the circuit is open
   d. only chemical or mechanical actions are present

7. According to the accepted concept, electric current is:

   a. the electron at rest
   b. an organized flow of electrons
   c. the movement of atoms
   d. the movement of protons

8. The <u>most</u> accurate statement is that current flow requires:

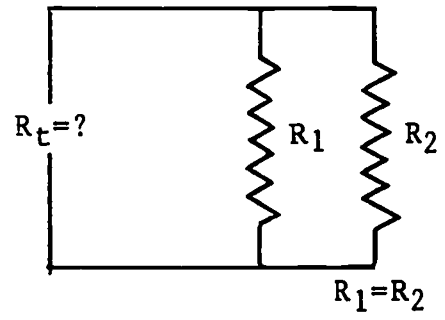
   a. a switch in the circuit
   b. a variable resistor in the circuit
   c. a very high voltage in the circuit
   d. a voltage source

9. The unit of current called "ampere" means:

   a. 1/2 coulomb of charge passing a point per second
   b. 2 coulombs of charge passing a point per second
   c. 1 coulomb of charge passing a point per second
   d. 6 coulombs of charge passing a point per second

10. The circuit in Diagram B has two equal resistors in parallel. The value of R_t is:

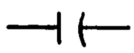
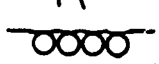
   a. $R_1 + R_2$
   b. $R_1 - R_2$
   c. $\frac{R_1}{2}$
   d. $R_1 \times R_2$



11. The unit of measurement of resistance is the:

a. volt
b. ohm
c. ampere
d. watt

12. The symbol that illustrates resistance is:

a. 
b. 
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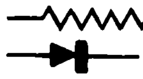
d. 

13. The circuit with three unequal values of resistors connected in series would have:

a. three times the resistance of the smallest value of resistance
b. the same value of current throughout the circuit
c. three separate paths for current
d. three values of current in the circuit

14. The function of resistance is:

a. to provide additional circuit elements
b. the control of the amount of current flowing
c. the control or the direction of current flow
d. the control of the polarity of the voltage

15. The opposition to electron flow that is found in every circuit is called:

a. resistance
b. conductance
c. electromotive force
d. wattage

16. Which of the following is not a good insulator in wet weather?

a. glass
b. rubber
c. plastic
d. wood

17. The factor that does <u>not</u> affect the resistance offered by a conductor is:

   a. the length
   b. the temperature
   c. the thickness
   d. the insulation

18. Which of these statements is true?

   a. the greater the current passing through a thin wire, the less the heat in the wire
   b. the voltage drop across a resistance of 100 ohms, 2 watts, is greater than the voltage drop across a resistance of 100 ohms 1/4 watt, if the current is the same through both

19. If we decrease the resistance in a DC circuit, we can expect the current to ________________ if applied voltage remains constant.

   a. increase
   b. decrease
   c. remain constant
   d. drop to zero

20. The resistance of a bulb that uses 120 volts and 3 amperes is:

   a. 36 ohms
   b. 4 ohms
   c. 3.6 ohms
   d. 40 ohms

21. Ohm's law is properly stated:

   a. $E = \frac{R}{I}$

   b. $E = \frac{I}{R}$

   c. $I = \frac{E}{R}$

   d. $I = \frac{W}{R}$

22. Explain what you think is the best way to keep from blowing fuses in your home.

23. What resistance must a cigar lighter have to cause a current of 5 amperes to flow in a 6 volt circuit?

24. How much current will flow in a series circuit which contains two resistors of 325 ohms and 700 ohms and are connected across a 60 volt source?

25. How much current will flow through a 36 ohm resistance if the pressure is 110 volts?

APPENDIX D

TEST--LESSON 5

APPENDIX D: TEST--LESSON 5

Multiple Choice: Place the letter of the best answer in the blank to the left of the number.

1. How long would a 100 watt light bulb have to burn to use a kilowatt hour of electrical power?

   a. 10 hours
   b. 1 day
   c. 10 days
   d. 1 hour

2. The wattage of a light bulb that uses 120 volts and 2 amperes is:

   a. 24 watts
   b. 240 watts
   c. 6 watts
   d. 60 watts

3. The word "watt" is an electrical term that:

   a. refers to the temperature of a conductor
   b. is the unit of electrical power
   c. distinguishes a conductor from an insulator
   d. indicates unknown qualities in the circuit

4. Watt is the unit:

   a. work
   b. electrical power
   c. Joules
   d. Coulombs

5. A 100 watt bulb will use 100 volts and:

   a. 2 amperes
   b. 1.2 ampere
   c. 1 ampere
   d. 10 amperes

6. A transformer has 100 turns in the primary and 20 turns in the secondary. If we apply 50 volts to the primary, the secondary voltage should be:

   a. 500 volts
   b. 250 volts
   c. 10 volts
   d. 5 volts

7. In a step-up transformer:

   a. there are more turns in the primary than in the secondary winding
   b. there are less turns in the primary than in the secondary winding
   c. there are an equal number of turns in the primary and secondary winding

8. When an alternating electric current passes through the primary of a transformer, it induces in the secondary:

   a. a direct current
   b. a pulsating direct current
   c. an alternating current

9. Increasing the current in a wire:

   a. increases flux line density
   b. decreases flux line density
   c. has no effect on flux line density
   d. creates two magnetic fields

10. The magnetic field of a magnet can also be called:

   a. kinetic energy
   b. lines of force
   c. induced magnetism

11. The area in which a magnet exerts its force is called:

   a. the perimeter
   b. the magnetic field
   c. the flux density
   d. the magnero

12. A conductor can be placed in a magnetic field but there will be no voltage induced into it unless:

 a. the field is a varying one
 b. the conductor is part of a complete circuit
 c. the field is part of an electrostatic system
 d. current flows in the conductor

13. A device for transforming mechanical energy into electrical energy is:

 a. rectifier
 b. motor
 c. galvanometer
 d. generator

True or False:

14. To find the wattage of a circuit, the voltage is multiplied by the current.

 a. True
 b. False

15. Power is sold by the kilowatt hour.

 a. True
 b. False

Fill in:

16. The machine used to produce electricity is called the _____.

17. What kind of electricity do we get from a transformer, alternating current or direct current?

APPENDIX E

TEST--LESSON 6

APPENDIX E: TEST--LESSON 6

1. Point-to-point wiring consists of:

   a. terminals connected by strips of copper on plastic sheets
   b. components inserted in holes through copper dots
   c. terminals connected by wire or components

2. Printed circuits consist of:

   a. terminals connected by insulated wire or components
   b. components inserted in holes through copper dots
   c. terminals connected by strips of copper on plastic sheets

3. A component is fastened to a terminal with a secure mechanical connection because:

   a. the soldered connection will be better
   b. no solder connection is needed
   c. vibrations might loosen it

4. Components and wire that are coated with a thin layer of solder are said to be:

   a. tinned
   b. soldered
   c. cleaned

5. The proper size of soldering tool for soldering components and printed circuits is:

   a. 10 to 15 watts
   b. 25 to 35 watts
   c. 50 to 100 watts

6. Soldering is done more quickly and easily when the soldering tool is:

   a. high voltage
   b. clean and tinned
   c. bright copper

7. The proper flux for electrical circuits is:

   a. acid
   b. sal ammonia
   c. rosin

8. The solder is heated to its melting point by:

   a. touching it to the soldering pencil
   b. touching it to the heated point
   c. the action of the acid flux