ABSTRACT OF THESIS

OBJECTIVE TYPE TESTS
FOR THE ELECTRIC UNIT
IN THE INDUSTRIAL ARTS LABORATORY

Submitted by

Hamilton Cross

In partial fulfillment of the requirements

for the Degree of Master of Education

Colorado Agricultural and Mechanical

College

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ABSTRACT

The industrial arts laboratory was introduced in the Chicago public school system in 1937. This subject is offered as an elective major to the ninth-grade boys in the 33 academic high schools. Eight instructional areas are covered by this subject; namely, electricity, metal, housing, ceramics, graphic arts, planning, transportation, and textiles. From one to five instructional areas are taught in each laboratory. There are approximately 75 industrial arts laboratories in the 33 academic high schools in Chicago. Upon completing a year's work in the industrial arts laboratory, each boy has the opportunity of transferring to one of the three technical high schools in Chicago where he may have a variety of shop courses or he may remain in the academic high school where he started his high-school career. One or more shops usually are found in the academic high schools for 10th, 11th, and 12th-grade pupils.

Since industrial arts laboratory is a comparatively new subject in the public high-school curriculum, much of the time of the director, supervisors, and teachers has been spent in planning the course, enriching different

instructional areas, obtaining supplies, tools, and machines. Pupil achievement in this subject has been determined mainly by the traditional written examination, oral quiz, recitation, and written assignments. The lack of suitable objective-test materials has been noticeable in the eight instructional areas of the industrial arts laboratory. The apparent need for the development of objective-type tests in the industrial arts laboratory which would embody the essential characteristics of validity, objectivity, and reliability would be an aid in determining the outcomes of the course. One of the purposes of this study was to construct an objective type test for the electric unit in the industrial arts laboratory.

<u>The problem</u>

What should comprise an objective type test for the electric unit in the industrial arts laboratory?

An analysis of this problem presents the following minor questions.

1. What are the essential topics of information applying to the electric unit in the industrial arts laboratory?

2. How are the sub-topics upon which the test is based to be determined?

3. How is the validity of the test maintained?

4. How shall the test items be formulated?

5. How shall test items for the tentative test be chosen?

6. How shall the most suitable objective form for each item be selected?

7. Is the test objective?

8. How is the time allowance for the test to be determined?

9. What items should be retained in the test and what should be their order?

10. What is the reliability of the test?

Sources of data

The sources of data used in this study were as follows:

1. Eight recognized books in the field of elementary electricity. From these books evolved 15 main topics and 571 sub-topics which gave a total of 586 items which were used as the basis for constructing test questions.

2. A group of five consultants who acted as judges and passed upon the work of the writer in certain phases of this study. This included the validating of the main topics and their sub-topics.

3. An experimental group of 50 ninth-grade pupils in the industrial arts laboratory, Von Steuben high school, Chicago, Illinois, who took the preliminary form of the test.

4. The last sources of data were the teachers and principals of the 18 schools which cooperated in this study, and the 528 pupils from these schools whose scores on the final test forms provided answers to several of the subordinate questions in the problem analysis.

Procedure

The 586 items which were agreed upon by the five men who acted as judges were used for constructing test questions. These items were used to construct the six types of objective type tests used which were:

1. Identification.
2. Recognition and diagram.
3. True-false.
4. Multiple-response.
5. Matching.
6. Completion.

The rough draft of the preliminary test was submitted to a high-school teacher of English who checked the questions for spelling, punctuation, and English structure. This draft of the test was also submitted to a graduate engineer who checked the wording of the questions for ambiguous statements, and to see that not more than one possible answer could be used for each question. Both of these individuals checked the questions to see if they were stated objectively. The development and use of scoring keys was expected to enhance further objectivity.

The experimental group of 50 pupils was given the preliminary form of the test and the time required by the fastest 10 pupils in each part of the test was recorded. The order of difficulty for each test question in each of the six types of tests was determined.

A revised form of the test was constructed based on the results of the preliminary test. Instructions for administering the tests were prepared and the scoring keys revised. The tests were printed and copies mailed to the schools which had agreed to cooperate in this study.

The 528 completed test papers were returned for marking, study, and statistical treatment. Each test paper gave the instructor's estimate of the pupil's quarterly grade for the marking period which preceded the giving of the test. The marks given the 528 pupils by their respective teachers for the work corresponded closely to the normal curve.

A scatter diagram and correlation chart were prepared in order to determine the correlation between the teachers' quarterly grades and the pupils' test scores. By using the Pearson Product-Moment formula this coefficient was found to be +.72.

The scores made by 528 pupils on the revised form of the test ranged from 21 to 286. For computational purposes, test scores ranging from 20 to 295 were used. This included all test scores made and provided for the equal distribution of the scores into five groups with a score range of 55 in each group.

Another scatter diagram and correlation chart was prepared in order to compute the coefficient of reliability using the odd-even halves technique. Again the Pearson Product-Moment formula was used and the coefficient was found to be +.95. Because of the ease with which smaller numbers could be handled statistically, the total incorrect rather than the total correct scores on the odd and even items were used. The reliability coefficient in either case would have been the same. Since this figures represents the coefficient of reliability for a test half as long as the present test, the Spearman-Brown formula was applied to find the coefficient for the entire test. This expanded r was found to be +.97.

The revised form of the test consisted of the following number of test items:

Part I Identification 30 items

Part II Recognition and diagram 10 items

Part III True-false 100 items

Part IV Multiple-response 40 items

Part V Matching 30 items

Part VI Completion 50 items.

When the test was given to the experimental group of 50 pupils the time allowance suitable for each part of the test was found to be as follows:

Part I Identification three minutes, 30 seconds.

Part II Recognition and diagram, three minutes, 50 seconds.

Part III True-false, eight minutes, 40 seconds.

Part IV Multiple response, six minutes, 10 seconds.

Part V Matching, three minutes.

Part VI Completion, six minutes, 50 seconds.

From the findings obtained in carrying out this study it seemed apparent that the revised form of the test possessed the essential qualities desirable in an objective or new-type examination. These qualities include validity, objectivity, reliability, and ease of administering and scoring. The attaining of these qualities in the construction of this test was a major aim of this study.

It is hoped these tests will provide a means of objective measurement of achievement in the electric unit in the industrial arts laboratory in the public high schools in Chicago. The tests should be suitable for a school which gives a course in electricity in the ninth grade.

Aside from meeting the major objectives of this study, the problem has produced the following secondary results:

1. The formulation of the essential topics and sub-topics which pertain to the electric unit in the industrial arts laboratory.

2. An aid which will help teachers of electricity base pupils' marks objectively.

3. An aid to teachers which will assist them in determining pupil achievement.

T H E S I S

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COLORADO AGRICULTURAL AND MECHANICAL COLLEGE

July 20 1947

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY HAMILTON CROSS

ENTITLED OBJECTIVE TYPE TESTS FOR THE ELECTRIC UNIT IN THE INDUSTRIAL ARTS LABORATORY

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION

MAJORING IN INDUSTRIAL ARTS EDUCATION

CREDITS 4

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Chapter I

INTRODUCTION

In the city of Chicago, Illinois, with three and one-half million people and 37 public high schools, an extensive program in the field of industrial arts education is strongly advocated by the school administration. Chicago, being a highly industrialized city, employs many skilled, semi-skilled, and unskilled workers. The people who live in the city represent a variety of nationalities; a majority of these people earn their livelihood by working in various types of labor in which the skill ranges from intricate, highly-skilled trades to unskilled, routine jobs. The public school system has recognized this situation and has tried to construct a program which will best meet the needs of the children of these people. Since only eight per cent of the high-school graduates of the Chicago public schools go to college, the rest of the high-school graduates either take trade training or seek a job.

Chicago has four technical high schools. These four schools accommodate second, third, and fourth-year high-school boys. A few first-year boys who live near a technical high school are allowed to attend. However, the majority of first-year boys attend an academic high school where industrial arts laboratory is offered as an elective major. This subject is required of all boys in academic high schools who expect to transfer to one of the technical high schools.

The industrial arts laboratory was first introduced in the Chicago public school system in 1937. Previous to that time any ninth-grade boy could enter a technical high school. Many boys who entered a large technical high school direct from an elementary school found it difficult to adjust to the new surroundings and new types of school work and discipline. The result was a high mortality rate among the new pupils, many of whom found they did not care for shop work. The technical high schools, with many tools, expensive machines, and expensive equipment, are costly to operate. The high drop-out rate among the new ninth-grade boys made the operation of the school less efficient than had been anticipated. To overcome this situation, the industrial arts laboratory was introduced in the academic high schools. This subject offered the pupil the opportunity to determine his like or dislike for shop work as well as to obtain exploratory experiences and the content material this subject had to offer.

The industrial arts laboratory is a course designed to interpret the trade and industrial world to ninth-grade boys. It is offered as an elective major subject in the 33 academic high schools. Eight instructional areas are covered by this subject; namely, electricity, metal, housing, ceramics, graphic arts, planning, transportation, and textiles. From one to five instructional areas are taught in each laboratory. There are approximately 75 industrial arts laboratories in the 33 academic high schools.

Need

Since the industrial arts laboratory is a comparatively new subject in the high-school curriculum, much of the time of the director, supervisors, and teachers has been spent in planning the course, enriching different instructional areas, and obtaining supplies, tools, and machines. Little time has been available for determining the outcomes, evaluating, and checking the accomplishments of this subject. Objective type tests should be an aid in determining the outcomes of the program. In most instances the traditional type academic test has been used by teachers in the industrial arts laboratory. Since the use of teacher-constructed tests does not give a standard criterion of the work accomplished by the pupil, these tests are of little value in evaluating the program.

The use of objective type tests has been informally discussed by various industrial arts laboratory teachers in Chicago. From these discussions it was usually agreed that well-constructed, objective type tests would be a teaching aid. Since these tests were not available, it seemed that objective type tests for each unit in the industrial arts laboratory should be constructed. One of the purposes of this study is to construct an objective type test for use in the electric unit of the industrial arts laboratory.

The realization of this need has resulted in the following problem.

The problem

What should comprise an objective type test for the electric unit in the industrial arts laboratory?

Analysis of the problem.--An analysis of this problem presents the following minor questions.

1. What are the essential topics of information applying to the electric unit in the industrial arts laboratory?

2. How are the sub-topics upon which the test is based to be determined?

3. How is the validity of the test maintained?

4. How shall the test items be formulated?

5. How shall items for the tentative test be chosen?

6. How shall the most suitable objective form for each item be selected?

7. Is the test objective?

8. How is the time allowance for the test to be determined?

9. What items should be retained in the test and what should be their order?

10. What is the reliability of the test?

Delimitation.--This study will pertain to the electric unit of the industrial arts laboratory in the public schools in Chicago, Illinois.

The term "industrial arts laboratory" includes ninth-grade pupils in the senior high school.

Partial answers to this problem and the minor questions were sought in the review of literature which is presented in Chapter II.

Chapter II

REVIEW OF LITERATURE

Change is typical of life and democratic society. Where change is present progress is possible, but progress does not follow change automatically. The realization of this fact has caused philosophers to describe the desirable goals toward which educational activity should be pointed and has caused curriculum makers to organize courses in keeping with the stated objectives. The evaluation of learning activities has been the subject of much study and a variety of testing procedures has come into being. The results of these investigations bear an interesting relation to the present problem. The literature that related to subordinate question two, How are the sub-topics upon which the test is based to be determined?, is given below.

Newkirk and Greene (17) Tests and Measurements in Industrial Education, 1935, submitted a test which consisted of 99 items. This test was given to students enrolled in several different schools in Iowa. The test consisted of four parts: true-false, procedure arrangement, completion, and multiple choice. The reliability of the test, based on 100 cases, was .84. The findings of this study were as follows:

> 1. Each item should be selected from definite units covering the entire area of the course. This step is closely related to securing high validity.
>
> 2. Make a sampling over a wide range of content and by stating a large number of valid questions in objective forms which are within the mental and educational range of the pupils to be tested. (17:137)

Question four, How shall the test items be formulated?; question five, How shall items for the tentative test be chosen?; and question six, How shall the most suitable objective form for each item be selected?, are closely related and were considered together. Ruch (21), The Objective or New-type Examination, 1929, who has experimented with mental tests and has constructed objective tests, suggested that the following procedures be used to construct tentative test items:

> 1. The type of question to be used in any particular case is a matter of judgment and experience.
>
> 2. In framing preliminary tests 25 to 50 per cent more items should be made than is estimated will be used in the final test.
>
> 3. Good sentence structure is a prime requisite for valid test items.
>
> 4. The length of a test should not be determined until after the preliminary form has been drafted.
>
> 5. A major topic can be broken down into several sub-topics. Test questions can be made from each sub-topic if the sub-topic is of sufficient importance. (21:153-60ff)

Eurich (7) Journal of Educational Psychology, October, 1931, in 1927, gave 99 students at the College of Education, University of Minnesota, four types of tests: essay, completion, multiple-choice, and true-false. Each type covered the same subject matter. The scores of each test were recorded and correlations made. The report of findings included the following:

> 1. If reliable tests are constructed, one of the four types used is probably as adequate as any of the other three for measuring information.
>
> 2. If the composite score on three types of examinations is used as a criterion for estimating the validity of the fourth type, the results indicate that the four types of tests have approximately equal validity.
>
> 3. The multiple choice tests prove to be most reliable. (7:267-78)

Question three, How is the validity of the test maintained?, was partially answered in a study made by Watson and Forlano (25), Journal of Educational Psychology, January, 1935, at Columbia University, when an attempt was made toward determining the validity of some available measures. A total of 629 sample items from 31 tests was submitted to 150 graduate students who acted as judges. The study attempted to select suitable criteria for a test of character. To find suitable criteria, the judges were asked for items of behavior or reputation that were generally accepted as representing good or bad character. The items found which were regarded as clear indicators of desirable or undesirable character can be used as measuring the exisiting criteria. The report of findings included the following:

1. Suitable test items must be representative.

2. Items given a low rating are not necessarily poor.

3. Items rated high can be regarded as criteria.

4. All measures of validity must eventually go back to some standard.

5. Test items are valid to the degree that they correlate with acceptable criteria. (25:1-16)

A study was made by Henry (10), Journal of Educational Psychology, October, 1934, in the Central Technical High School of Toronto, Canada, on the relation of the difficulty of a test item to the validity of the item. One hundred pupils were given a test in physiography which consisted of 108 items. Henry tried to ascertain in the interest of validity whether the test items should be easy, difficult, or of medium difficulty. His report of findings included the following:

1. There is no reliability superiority of any one of the groupings of items according to difficulty over any other grouping.

2. Items passed by all have little validity value but they do serve to encourage pupils.

3. Apart from extreme items, those on which nearly all pass or those on which nearly all fail the difficulty of an item has little to do with its validity.

4. There is little more than a chance difference between the medium and difficult groups. (10:537-41)

The answer to question seven, Is the test objective?, was partially found in the literature reviewed. Odell (18), Traditional Examinations and New-type Tests, 1938, who has written several books on testing, stated in his writing that objectivity was

> . . .that characteristic or quality of a measuring instrument which causes it to yield the same results regardless of the personal equation or subjective influence of the person giving or scoring it. (18:40)

He also stated:

> Wherever persons are able to score tests with a general agreement prevailing among them as to the correctness or incorrectness of all the possible answers, objectivity is present. (18:40)

In the above statements Odell indicated a criterion for assuming the presence or absence of objectivity. The tests which were constructed in this study were scored with keys. This attained the criterion of objectivity as defined by Odell.

The ninth minor question, What items should be retained in the test and what should be their order?, was partially answered in the study made by Senes (22) at Colorado State College in 1939, who constructed a test which was given to 628 students. The original drafting of the test was given to 25 students. Questions which were passed by 95 per cent or failed by 95 per cent were eliminated. The remaining questions were arranged in the order of difficulty. In order to establish further validity and reliability the test was then given to a larger group.

Senes (22) found that the logical sequence for the different parts of the test should be as follows:

1. Identification.

2. Recognition and diagram test.

3. True-false.

4. Multiple-response test.

5. Matching.

6. Completion. (22:52)

Question number 10 in this analysis is What is the reliability of the test? The reliability coefficient of this investigation was determined only after all tests were scored and the coefficient determined according to mathematical formula. The Pearson Product-Moment formula was used in this study.

Partial answer to this question was found in a study made by Anastasi (2), Journal of Educational Psychology, May, 1934, at Columbia University, where she conducted an investigation on the effects of practice upon test reliability. She gave four different tests to a total of 571 individuals. Each person was given a practice test before the actual test was given. A comparison was made of the amount of improvement from test to test. Reliability was figured for each test using the split halves method and parallel forms. Her findings included the following:

1. Repetition of a test does not raise its reliability.

2. The split halves technique yields only one kind of reliability.

3. If discrepancies are found in successive reliability coefficients the probable result from the presence of extraneous disturbing factors is present.

4. A discrepancy in score on successive retests may simply mean that the test is serving its function as an accurate and sensitive index of actual changes in the subject. A reliable thermometer will give different readings on different days.

5. Reliability is found to be higher when computed by the split halves method rather than when computed by parallel forms or a repetition of the same test.

6. The split halves method is considered superior because the conditions are most constant when this method is used. (2:321-23)

Studies in test reliability were made by Remmers and Whistler (20), Journal of Educational Psychology, October, 1934, at Purdue University. In 1933 they gave objective type examinations to a total of 992 students from four instructional departments. Correlations were made to determine reliability when using the split halves of an examination or using equal forms. The findings of this study revealed the following:

1. The odd-even technique will in general yield higher self correlation than will the equivalent forms technique.

2. For any self correlation the correlated parts should be comparable in content and difficulty. (20:537-41)

The correlation of the two halves is based upon the assumption that both halves are equally reliable. By splitting the test there result two comparable forms.

The review of literature indicated that research evidence has been found which related to, or answered, subordinate questions two, three, four, five, six, seven, nine, and 10. Questions for which answers could not be found are the following: One, What are the essential topics of information applying to the electric unit in the industrial arts laboratory?, and eight, How is the time allowance for the test to be determined? It was necessary to secure answers to questions one and eight through research in which original data were collected, evaluated, and interpreted. The materials and methods used in collecting the data which were used to answer questions one and eight are included in the chapter which follows.

Chapter III

METHODS AND MATERIALS

To obtain the data needed for constructing a test for the electric unit in the industrial arts laboratory it was first necessary to determine the content of the course. Since the field of electricity is extremely large, it was necessary to determine what portion of that field was to be covered by the work of ninth-grade pupils in the industrial arts laboratory.

The work done in each unit in the industrial arts laboratory is not covered by any specific text. The teachers of this subject are not bound to any book and the content of that book. A room library is used and the material selected by the teacher from this variety of books is used to cover the work of each unit.

The first problem in constructing the test in elementary electricity was to determine the main topics of instruction that should be covered. These topics were obtained from the following books:

1. Burns, Electricity, A Study of First Principles. (3)
2. Cook, Electrical Projects Boys Like to Make. (4)
3. Dragoo and Dragoo, General Shop Electricity. (5)

4. Esty, Millikan, and McDougal, Elements of Electricity. Chapters on "Magnetism," "Current Electricity," "Elementary Circuits," "Series and Parallel Circuits," "Electric Bells and Signal Systems," and "Storage Batteries." (6)
5. Johnson and Newkirk, Fundamentals of Electricity. (13)
6. Johnson and Newkirk, The Electrical Crafts. (14)
7. Smith, Elementary Industrial Electricity. Chapters I, II, III, IV, V, VIII, X, XI, XIII, and XVII. (23)
8. American Vocational Association Incorporated, Standards of Attainment in Industrial Arts Teaching. (1)

From these books the following topics evolved. These are considered as the main topics of the test. Each main topic was divided into several sub-topics. Test questions were constructed from both the main topics and the sub-topics.

1. Magnetism. 37 sub-topics 1/
2. The transformation of electricity into heat, light, mechanical energy, and chemical energy. 49 sub-topics.
3. The transformation of chemical, heat, light, mechanical, magnetic, and sound energy into

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1/ See Appendix A.

electricity. 64 sub-topics.

4. How electricity is distributed. 37 sub-topics.
5. The kinds of appliances that furnish heat, light, power, communication, and chemical change. 40 sub-topics.
6. Occupational information. 45 sub-topics.
7. Safety measures. 28 sub-topics.
8. Conductors and non-conductors. 32 sub-topics.
9. Terms used in electricity. 73 sub-topics.
10. Protective devices. 37 sub-topics.
11. Electrical controlling devices. 30 sub-topics.
12. Electrical measuring devices. 17 sub-topics.
13. Connections, series and parellel. 27 sub-topics.
14. Splices. 26 sub-topics.
15. Electrical symbols. 35 sub-topics.

The 15 main topics and 571 sub-topics gave a total of 586 items which were used as the basis for constructing test questions.

The original list of items for main topics and sub-topics was submitted to men engaged in the teaching of advanced electricity in the high schools in Chicago 2/. These teachers were contacted personally and asked to approve or disapprove any of the main topics or sub-topics as listed for covering the work of the electric unit in the industrial arts laboratory. These men acted as

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2/ See Appendix B.

evaluators, made additions which they believed pertinent, or deleted any items which, in their opinion, were too advanced or were irrelevant to the subject.

The original list of 15 main topics was not changed by any of the five men who acted as judges; however, substantial changes were made in the list of subtopics.

The list of topics, which contained 586 items, was now used as a basis for constructing test questions. Ruch (21), who is recognized as an authority in the field of test construction, stated, "The type of question to be used in any particular case is a matter of judgment and experience." (21:155)

From this list of items a preliminary test was constructed which consisted of the following:

1. A multiple-response test containing 43 items.
2. A completion test containing 50 items.
3. A true-false test containing 110 items.
4. A matching test containing 30 items.
5. A recognition and diagram test containing 10 items.
6. An identification test containing 30 items.

The rough draft of the preliminary test was submitted to a high-school teacher of English who checked the questions for spelling, punctuation, and English structure. This draft of the test was also submitted to a graduate engineer who checked the wording of the questions for ambiguous statements and also checked to see that not more than one possible answer could be used for each question. Both of these individuals checked the questions to see if they were stated objectively. Newkirk and Greene (17) stated that, "In general, objective-test items are so formulated that only one correct response satisfies the conditions of the exercise." (17:37)

The preliminary form of the test was given to 74 pupils in the 9A semester of industrial arts laboratory at Von Steuben High School in Chicago during April, 1946. Two 40-minute class periods per day for two successive days were allowed the pupils for taking the test, during which time a few pupils were unable to complete the entire test. Some of the testees who took the part of the test given on the first day were absent the second day. Fifty of these completed tests were selected at random for the purpose of carrying out this study. This number seemed to be adequate and was also a convenient number to use for determining the mathematical data required.

A record was kept of the time taken by the 10 fastest pupils for the completion of each part of the test. The time allowance for each part of the final form of the test was to be one minute less than the time taken by the fastest pupil in the experimental group.

The 50 tests, selected from the experimental group, were checked with the scoring key designed for the test. The questions in the test were checked to determine the number of pupils who had missed each question. Those test questions which more than 95 per cent of the pupils had correct, and more than 95 per cent had missed, were eliminated from the final test form. The questions which fell in the five per cent to 95 per cent range were then arranged in order of difficulty for the final test form. The easiest questions were placed at the first part of each test, while the most difficult were placed at the end of each test. The final test was constructed from the results of the test taken by the experimental group. This resulted in a revised test composed of the following questions:

1. An identification test containing 30 items.
2. A recognition and diagram test containing 10 items.
3. A true-false test containing 100 items.
4. A multiple-response test containing 40 items.
5. A matching test containing 30 items.
6. A completion test containing 50 items.

A total of 1,000 of these tests was printed.

Through the director of industrial arts education in Chicago were secured the names of 24 industrial arts teachers who taught the electric unit in the industrial arts laboratory. A letter was sent to each teacher explaining the study which was being made and asking him to participate by giving the test to one or more of his classes. Eighteen teachers replied that they would be able to cooperate in this study. The number of tests requested by each teacher, plus two extra tests for the teacher's personal file, a set of directions for administring the test 3/, and a scoring key 4/ were sent to each teacher by mail or were delivered personally 5/. Those tests sent by mail included a self-addressed, stamped envelope for their return.

Each group of tests sent to the teachers included a set of directions for administering the test. The last paragraph gave instructions to the teacher to mark the pupil's class grade in the space provided on page one of the test. The directions, as given to the teacher on the instruction sheet, for carrying out this part of the work were as follows:

> After the papers have been collected, the teacher is asked to turn to page one of each paper and give the instructor's estimate of the pupil's grade. This grade should be based on the quality of work done by the pupil in the electrical unit up to the time this test was given. This grade could be the pupil's grade for industrial arts laboratory for the last marking period.

This space on page one of the test was formulated as follows:

Teacher's estimate S E G F D (encircle one).

3/ See Appendix C.

4/ See Appendix D.

5/ See Appendix E.

These tests were given in 18 Chicago public high schools in June, 1946, to 528 ninth grade boys who had studied the electric unit in the industrial arts laboratory for two semesters. The completed tests were collected by the teachers and returned for scoring and tabulation.

The results obtained from these data are presented in Chapter IV of this study.

Chapter IV

FINDINGS AND DISCUSSION

Determining and validating the essential topics of information upon which to base the proposed test was the first phase of the present study. Watson and Forlano (25) stated, "All measures of validity must eventually go back to some standard." (25:6)

Essential topics and sub-topics

As a source for securing the type of information required by this study, the pooled judgments of experts in the field were essential. However, in order to assure quality as well as scope in expert judgments, it was necessary that consultants be chosen who had had both extensive and varied experiences. The five men who validated the test items represented a total of more than 75 years of teaching experience in the field of electricity. They had also written several books and magazine articles in the field. These men gave their approval to the essential topics and sub-topics used as a basis for constructing the test. This meets with the accepted procedure for validating test items and answers questions one and two of the problem analysis.

Validity

Ruch (21), as quoted in the review of literature, stated, "Good sentence structure is a prime requisite for a valid test item."

All written test questions were submitted to a high-school teacher of English for approval of the sentence structure. This procedure was followed since it was a means of maintaining validity.

The revised form of the test was sent to 18 teachers, representing 18 different public high schools in the city of Chicago, who had agreed to cooperate in this study by giving the revised form of the test to one or more 9A industrial arts laboratory classes. Only those classes who had studied the electric unit were given the test. After the teacher had administered the test, he was asked to give his estimate of each pupil's quarterly grade, which was to be based on the quality of work done by the pupil in the electric unit up to the time the test was given. If the teacher could not reasonably determine this grade, he was asked to give the pupil's grade for the marking period which preceded the giving of the test. The mark was placed on each test before the test was returned for scoring. The marking system used by the public high schools in Chicago was a five-point system which used the following letters to indicate the pupil's grade: Superior, S; Excellent, E; Good, G; Fair, F; Failure, D.

The marks given the 528 pupils by their respective teachers for the work accomplished in the electric unit in the industrial arts laboratory were as follows: Superior, S, 50; Excellent, E, 132; Good, G, 186; Fair, F, 148; Failure, D, 12. These marks, as given by the 18 teachers who gave the test, produced a curve which was slightly skewed to the high side in the grade markings. In the normal curve, as given by Tiegs and Crawford (24), seven per cent of the pupils make S, or a superior grade, while in this group 10 per cent of the pupils made S. In the normal curve seven per cent make D, or failure; however, in this group only three per cent of the pupils received a grade of D. In the normal curve of distribution 38 per cent of the scores are in the average or G group. The scores on the test in this study showed that 35 per cent made a grade of G. These data are presented in Table 1.

Table 1.--GRADE MARKING, NUMBER AND PERCENTAGE OF PUPILS RECEIVING EACH GRADE, PERCENTAGE IN NORMAL CURVE.

Grade	No. pupils receiving each grade	Percentage of pupils receiving each grade	Percentage in normal curve 1/
Superior S	50	10	7
Excellent E	132	25	24
Good G	186	35	38
Fair F	148	27	24
Failure D	12	3	7
TOTAL	528	100	100

1/ Reference: Tiegs, E. W. and Crawford, C. C. Statistics for Teachers. Boston, Houghton Mifflin Co.,1930. 206 p.

These data seemed to indicate that the grades, given by the 18 teachers who participated in this study, conformed reasonably well to the percentage of grades given in the normal curve of distribution as indicated by Tiegs and Crawford (24). The fact that the curve was skewed slightly to the high side can be explained partially by the effort made by the school administration in Chicago to eliminate as many failures as possible in all high-school subjects.

It was assumed that the 528 pupils taking the test represented a fair sampling of all 9A pupils enrolled in the electric unit in the industrial arts laboratory in the public high schools in Chicago. Since the tests were given to all pupils in a class, a better representation was given than if a select group had been used.

Several factors are involved in determining grades for pupils in the industrial arts laboratory. Most of these factors are of a subjective nature and often reflect the teacher's personal attitude toward the pupil. However, in this sample the teachers' marks conformed reasonably well to the curve of normal distribution.

The scores made on the revised form of the test by 528 pupils ranged from 21 to 286, the average score being 157. Hawkes, Lindquist, and Mann (9) stated, "Try to adjust the difficulty of the whole test so the average score will be about half the possible score. There should be no zero scores or perfect scores." (9:113). Using this criterion, the average score should be 150. Since the average score was 157, which is slightly higher than the average score should be, according to the above statement, it is in agreement with the marks given by the 18 teachers, which were slightly higher than marks which would conform to the curve of normal distribution.

There were 61 pupils whose test scores came within the 156 to 170 test range. This was the largest number of test scores to fall within any test score ranges. This range also contained the average test score of 157. There were 219 test scores which were higher than the test range of 156 to 170 and 248 test scores which were lower than this range.

These data are presented in Table 2.

Table 2.--TEST SCORES MADE BY 528 PUPILS IN THE INDUSTRIAL ARTS LABORATORY IN 18 CHICAGO PUBLIC HIGH SCHOOLS.

Range of scores	Number of pupils in range
276-290	6
261-275	4
246-260	14
231-245	18
216-230	27
201-215	51
186-200	50

Table 2.--TEST SCORES MADE BY 528 PUPILS IN THE INDUSTRIAL ARTS LABORATORY IN 18 CHICAGO PUBLIC HIGH SCHOOLS.--Continued.

Range of scores	Number of pupils in range
171-185	49
156-170	61
141-155	50
126-140	43
111-125	39
96-110	43
81- 95	32
66- 80	30
51- 65	5
36- 50	4
20- 35	2

It is assumed from these data that the test scores conformed to the criterion stated by Hawkes, Lindquist and Mann (9). There were no zero scores and no perfect scores. The average score was within seven points of the midpoint of the test.

A table giving the percentile equivalent of test scores is given in the appendix. 2/

The scores made by 528 pupils on the revised form of the test ranged from 21 to 286. For computational purposes, test scores ranging from 20 to 295 were used.

2/ See Appendix F.

This included all test scores made and provided for the equal distribution of the scores into five groups with a score range of 55 in each group.

Using this procedure, 30 pupils, or six per cent of the total, made scores which fell in the score range of 20 to 75. There were 139 test scores, or 26 per cent, in the score range of 76 to 130. In the score range of 131 to 185, there were 190 test scores, or 34 per cent of the total. There were 137 test scores, or 26 per cent, in the score range of 186 to 240. In the highest range, 241 to 295, there were 32 test scores, or six per cent of the total.

These figures very nearly approximated those found in the curve of normal distribution. The 20 to 75 and 241 to 295 score ranges were comparable to the lowest and highest groupings in the curve of normal distribution. This curve showed seven per cent in each of these two groups, while findings in this test showed six per cent in each group. The 76 to 130 and 186 to 240 score ranges showed 26 per cent of the test scores in each of these two groups. The comparable groups in the curve of normal distribution included 24 per cent in each group. The 131 to 185 score range or the middle group showed 34 per cent, while the middle group in the curve of normal distribution showed 38 per cent.

These data are presented in Table 3.

Table 3.--SCORE RANGE, NUMBER OF PUPILS IN EACH RANGE, PERCENTAGE OF THE TOTAL, AND PERCENTAGE IN THE NORMAL CURVE OF DISTRIBUTION.

Score range	No. of pupils in score range	Per cent of total	Percentage in a normal curve
20- 75	30	6	7
76-130	139	26	24
131-185	190	34	38
186-240	137	26	24
241-295	32	6	7

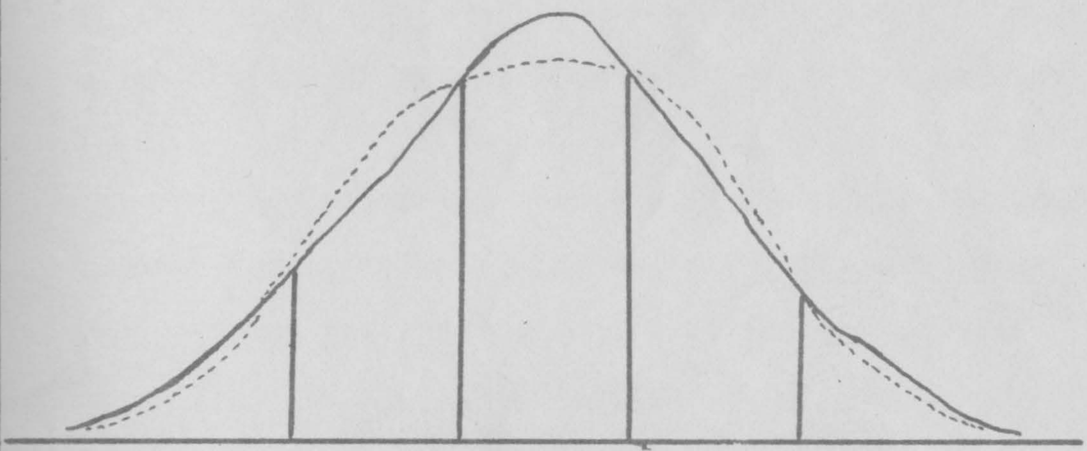
These data seem to indicate that the test scores made by the 528 pupils taking the revised form of the test conformed very closely to the test scores that would be expected from a normal group taking a test in elementary electricity in which adequate instruction had been given. These findings also tend to substantiate the validity of the test.

The data revealed by Table 3 are presented graphically in Figure 1.

Validity on the entire test was estimated by correlating the test scores of 528 pupils who took the revised form of the test with the final grades they received for their work in the electric unit in the 9A semester in the industrial arts laboratory. The grades were given by 18 different teachers.

In order to compute this coefficient, a scatter diagram and coefficient chart were prepared 3/. This

3/ See Appendix G.



Curve of normal distribution

----- Curve produced by 528 scores made on the revised test

Figure 1.--A COMPARISON OF THE CURVE PRODUCED BY 528 TEST SCORES TO THE CURVE OF NORMAL DISTRIBUTION.

method was used as it provided a system of cross checks on the results obtained and thereby assured accuracy in the findings. The data for this chart were obtained from page one of each completed test. The information given at the top of each completed and scored paper included the pupil's test score as well as the teacher's quarterly grade.

To determine this coefficient, the Pearson Product-Moment formula, indicated by Tiegs and Crawford (24), seemed applicable, and is stated as follows:

$$r = \frac{\Sigma fxy - \frac{(\Sigma fx)\ (\Sigma fy)}{N}}{\sqrt{\Sigma fx^2 - \frac{(\Sigma fxy)}{N}}\ \sqrt{\Sigma fy^2 - \frac{(\Sigma fy)^2}{N}}}$$

By substituting the various values as shown on the correlation chart the formula becomes:

$$r = \frac{1310 - \frac{(-190)\ (60)}{528}}{\sqrt{6478 - \frac{(190)^2}{528}}\ \sqrt{528 - \frac{(60)^2}{528}}} = +.72$$

From these figures the correlation between the pupil's grade in the electric unit, 9A semester, in the industrial arts laboratory and the score made on the revised form of the test was computed to be .72 and the probable error as given by Holzinger (12) was .0142.

The correlation chart indicated that the 11 lowest test scores were made by pupils whose final mark, as given by their respective teachers, was no higher than F, which is the lowest passing grade. The chart also indicated that of the 24 highest test scores, 16 of these 24 pupils received a final mark of S, which is the highest marking grade; six received a grade of E, which is the second highest mark; and two received a grade of G, which is the average mark.

The chart also indicated that two boys taking the test and who received grades of D, which is a failing mark, made test scores as high as or higher than two other boys who received grades of S, which was the highest grade given.

Although discrepancies of this kind did appear, the correlation of .72, which was obtained by mathematical formula, is considered to be high.

Selecting and formulating test items and stating the items objectively

A procedure for selecting and formulating test items in an objective form has been suggested by Newkirk and Greene (17) who stated as follows:

> After the major informational topics have been agreed upon in the light of teaching objectives and, when possible, passed upon by other teachers, the items can be expanded and developed into objective test exercises. It is a good policy to use the type of objective exercise which best fits the material, rather than to attempt to make all exercises conform to a single type. . . ." (17:136)

After the 15 essential topics and their subtopics had been listed they were used for constructing test questions in the type of test best suited to each topic. Certain items appeared to be adapted to more than one objective test form, while other items were found to be suited to only one form. After each item had been used in the construction of a test question, it was marked showing in which of the six types of tests the item had been utilized. Using this procedure, 273 test questions were constructed in the six different types of tests. When the test was given to the experimental group it was found that 13 items were either too easy or too difficult and were eliminated from the revised form. The revised form of the test contained 260 questions. The 10 questions which constituted the recognition and diagram section of the revised form of the test were given a score value of five points. Since these questions were answered either by the completion of a circuit diagram or by answering a question which contained several parts, the test questions were weighed and given a score value of five points each. A perfect score on the test was 300.

The test used in this study consisted of six different parts, each representing the accepted form of objective type construction. The six different forms of tests used were adequate to cover the scope of the essential informational topics which formed the basis of the tests. The six types of tests constructed were as follows: (1) identification, (2) recognition and diagram, (3) true-false, (4) multiple-response, (5) matching, (6) completion. These forms are found in the revised test folder 4/.

From the results obtained by the giving and scoring of 528 tests the data obtained seemed to indicate that the test had certain qualities which are desirable in objective type tests. These qualities are validity, objectivity, reliability, and ease of scoring and administration. This phase of the study seemed to indicate the validity of the test items as well as the validity of the entire test.

Objectivity

The question dealing with objectivity of the test was partially answered by Odell (18) who stated that objectivity is

> . . .that characteristic or quality of a measuring instrument which causes it to yield the same results regardless of the personal equation or subjective influence of the person giving or scoring it. (18:18)

He also stated:

> Wherever persons are able to score tests with a general agreement prevailing among them as to the correctness or incorrectness of all the possible answers, objectivity is present. (18:18)

The use of scoring keys, which were developed for the preliminary form of the test and later revised for the final form of the test, provided the essential requisite for maintaining objectivity when scoring.

4/ See Appendix H.

In the case of a few test items it became necessary to modify the scoring key for the final test form, since it was discovered when scoring the tests that more than one response could be given as answers to certain test questions. An example of this can be cited in question 18 in the completion test. The answer to this question could be either positive, plus, or +. The inclusion of all possible correct responses on a scoring key where more than one correct response is indicated tends to enhance the objectivity of a test.

Objectivity was also maintained when a high-school teacher of English critically appraised the test to make certain all questions were clearly stated and conformed to good sentence structure.

Time allowance

The time allowance for the completion of each part of the test was established by administering the test to an experimental group of 50 pupils. The pupil in the experimental group who completed any single type of test in the shortest time and made a reasonable score determined the time allowance for that particular test. The time allowed in each part of the revised form of the test was arbitrarily set at one minute less than the time required by the fastest pupil in the experimental group. Since no pupil was expected to finish any part of the revised test in the alloted time, it became necessary to make the time limit on each part of the test less than the time taken by the fastest pupil in the experimental group. The time was set at one minute. This method conforms to the procedure as given by Monroe (16) who stated: "To measure the rate of work it is necessary either to set a time limit such that practically no pupil can complete all the exercises, or to time each pupil separately." (16:63)

Justifications for setting up the time on this basis were: (a) the length of class periods and thus the time available for giving tests necessitating placing a limit which would not exceed one hour of class time for the test administration; (b) the fact that pupils would work at a faster rate under a definite time limitation, thereby deeming it advisable to motivate pupils to work to their greatest capacity. Fenton and Worcester (8) stated

> When an intelligence test is given, the brighter children finish quickly, the duller take longer. The score is interpreted in terms of its relative position among the scores of a large number of children. (8:30)

The time allowed for each part of the revised form of the test was as follows:

Part I, Identification test. .	three minutes, 30 seconds
Part II, Recognition and diagram test.	three minutes, 50 seconds
Part III, True-false test. . . .	eight minutes, 40 seconds
Part IV, Multiple-response test.	six minutes, 10 seconds

Part V, Matching test. . .three minutes.

Part VI, Completion test. .six minutes, 50 seconds.

When the revised tests were scored, it was found that a few testees had been able to complete Part I, Identification test, and Part II, Recognition and diagram test, in the time allowed. From this it was readily assumed the time allowed on these two parts of the test was too long. A revision of the test would call for a shortening of the time allowance on Parts I and II. No pupils were able to complete Parts III, IV, V, or VI in the alloted time.

The test questions used in the revised form of the test were those which were tried out with an experimental group of 50 pupils. The preliminary draft of the test was submitted to 50 pupils 5/. From the results obtained from this group it was possible to determine the relative difficulty of each test question. Those questions answered correctly by 95 per cent or more of the pupils were eliminated from the revised form of the test since these questions were considered to be too easy. Those questions which were missed by 95 per cent or more of the pupils were eliminated from the revised form of the test since these questions were considered to be too hard. All test questions which fell within the five per cent to 95 per cent range were then arranged in the order of difficulty, the easiest questions being placed at the first part of the test. The test questions

5/ See Appendix I.

which were more difficult, as determined from the experimental group, followed in order. The hardest or most difficult questions were placed at the end of each group of test questions. After the relative difficulty of each test question had been determined from the findings of the experimental group, the questions were arranged in order of increasing difficulty for the purpose of constructing the revised form of the test.

Reliability

The coefficient of reliability on the split halves of the test was determined by mathematical formula. In order to compute this coefficient it was necessary to construct a scatter diagram and correlation chart. This method was used as it provided a system of cross checks on the results obtained and thereby assured accuracy in the findings.

The data needed for the scatter diagram and correlation chart were obtained from the 528 scored tests 6/. The number of odd-numbered questions missed, as well as the number of even-numbered questions missed, was recorded on the first page of each test when the test was scored. Owing to the ease with which smaller numbers could be treated statistically, the total incorrect, rather than the total correct, scores on the odd and even items were used. The coefficient of reliability in either

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6/ See Appendix J.

case would be the same.

The Pearson Product-Moment formula, as given by Tiegs and Crawford (24), was used to determine the coefficient of reliability. The formula is stated as follows:

$$r = \frac{\Sigma fxy - \frac{(\Sigma fx)(\Sigma fy)}{N}}{\sqrt{\Sigma fx^2 - \frac{(\Sigma fx)^2}{N}}\sqrt{\Sigma fy^2 - \frac{(\Sigma fy)^2}{N}}}$$

By substituting the various values as shown on the correlation chart the formula becomes:

$$r = \frac{5212 - \frac{(-333)(-45)}{528}}{\sqrt{5485 - \frac{(-333)^2}{528}}\ \sqrt{5569 - \frac{(45)^2}{528}}} = \frac{5183.6}{(72.6)(74.6)} = +.95$$

Since the test scores were split into odd-even halves for the calculation of the coefficient of reliability, it was necessary to carry the statistical treatment a step further to determine the reliability coefficient for the entire test. The Spearman-Brown formula, as given by Holzinger (11), was used to determine the expanded coefficient. The formula is stated as follows:

$$r = \frac{2r}{1+r} = \frac{1.90}{1.95} = .97$$

By applying this formula, the coefficient of reliability (r) for the entire test was found to be .97.

From the resulting coefficient (r), it became evident that the degree of reliability of the test was extremely high. As Ruch (21) pointed out, a reliability coefficient of .95 to .99 is "Very high; rarely obtained except with long, carefully standardized tests. Long objective tests occasionally reach this level." (21:434)

From the findings obtained in carrying out this study it seemed apparent that the revised form of the test possessed the essential qualities desirable in an objective or new-type examination. These qualities include validity, objectivity, reliability, and ease of administering and scoring. The attaining of these qualities in the construction of this test was a major aim of this study.

It is hoped these tests will provide a means of objective measurement of achievement in the electric unit in the industrial arts laboratory in the public high schools in Chicago. The tests should be suitable for a school which gives a course in electricity in the ninth grade.

Aside from meeting the major objectives of this study, the problem has produced the following secondary results:

1. The formulation of the essential topics and sub-topics which pertain to the electric unit in the industrial arts laboratory.

2. An aid which will help teachers of electricity base pupils' marks objectively.

3. An aid to teachers which will assist them in determining pupil achievement.

Chapter V

SUMMARY

The need of objective type tests in the electric unit of the industrial arts laboratory presented the problem for this study, What should comprive an objective type test for the electric unit in the industrial arts laboratory?

Objective or new-type tests, which are generally considered to be superior to the subjective type of examination, have been used for the past three decades. During this period the objective type tests have been adapted for use in various fields and for various educational purposes. Because the field of industrial arts education seems to be lagging behind other instructional areas in this respect, it was the purpose of this study to construct a valid objective type test which would be an aid in the testing program in the industrial arts laboratory.

To obtain a satisfactory answer to the major problem in this study, it was necessary to find answers to the following subordinate questions, which resulted from an analysis of the major problem.

1. What are the essential topics of information applying to the electric unit in the industrial arts laboratory?

2. How are the sub-topics upon which the test is based to be determined?

3. How is the validity of the test maintained?

4. How shall the test items be formulated?

5. How shall items for the tentative test be chosen?

6. How shall the most suitable objective form for each item be selected?

7. Is the test objective?

8. How is the time allowance for the test to be determined?

9. What items should be retained in the test and what should be their order?

10. What is the reliability of the test?

The 15 essential topics of information for the test were derived from eight books on elementary electricity. The findings in these books also presented the 571 sub-topics. Questions used in the test were constructed from either the essential topics or the sub-topics. These items were validated by five teachers of advanced electricity in the high schools of Chicago. The test was composed of six different objective type forms of questions; namely, identification, recognition and diagram, true-false, matching, multiple-response, and completion. Each item, used for constructing a test question, was utilized in the form where it could best be stated objectively in a clear, concise form. Both the preliminary test and the revised form of the test were scored with scoring keys, which met the prime requisite of an objective test.

The preliminary form of the test was administered to 50 pupils in the 9A semester in Von Steuben High School who were enrolled in the second semester of the industrial arts laboratory and had studied the electric unit. The purpose of giving the test to this experimental group was to determine the time allowance for each part of the final form of the test and to determine the difficulty of each test item. After the results had been obtained from the preliminary test, a revised form of the test was constructed. This revised form of the test consisted of the following forms:

1. Identification test, 30 items
2. Recognition and diagram test, 10 items
3. True-false test, 100 items
4. Multiple-response test, 40 items
5. Matching test, 30 items
6. Completion test, 50 items.

The completed test contained 260 items. In the recognition and diagram part of the test each question was given a value of five points, which made a perfect score on the test equal 300.

The revised form of the test was given to 528 pupils who had studied the electric unit in the industrial arts laboratories in 18 different schools in the Chicago public school system. The tests were administered in each school by the instructor of the industrial arts laboratory in June, 1946.

The validity of the revised form of the test, as determined by correlating the scores the pupils made on the test and the teacher's quarterly class grades, gave a coefficient of .72. The Pearson Product-Moment formula was used to obtain this figure.

The coefficient of reliability for the test was determined by using the Pearson Product-Moment formula. This coefficient (r) was found to be .95. Since the odd-even halves method of computation was used, it became necessary to apply the Spearman-Brown formula to determine the coefficient for the entire test. This expanded (r) was found to be .97.

The industrial arts laboratory is a general shop course given in the 33 academic high schools in Chicago to ninth grade boys, and this study pertains only to the electric unit as covered by this course.

A P P E N D I X

APPENDIX TABLE OF CONTENTS

Appendix A.

MAGNETISM

	M.C.	C	R&D	I	M	T.F.
1. The importance of magnetism						X
2. Uses of magnets						X
3. Magnetic substances	X					
4. Natural magnets		X				
5. Effect of breaking magnets		X				
6. North pole of magnet					X	
7. Magnetic compass	X					
8. The earth as a magnet						X

The above chart illustrates the method used for keeping a record of the topic, its sub-topics, and the type of test in which each was used. Item 1, The importance of magnetism, was used as a test question in the true-false section of the test. The six types of tests used were:

M.C. multiple choice

C. completion

R&D. Recognition and diagram

I. identification

M. matching

T.F. true-false

Appendix B.

The items used for main topics and sub-topics were validated by the following five men.

Sherman R. Cook, A.B., M.A. Columbia University. Teacher of electricity at the Hubbard Branch of Lindbloom High School, Chicago, Illinois. Author of Things Boys Like to Make, Burgess Battery Company, Freeport, Illinois. Author of Electrical Things Boys like to Make, Bruce Publishing Company, Milwaukee, Wisconsin.

Frederick Kulieke Sr. Teacher of Electric Shop at Lane Technical High School, Chicago, Illinois, for 27 years. Teacher of electrical communication for the past 11 years. Has been on the faculty of R.C.A. Institute in Chicago. Collaborator with Mr. Fortune in writing Amateur Radio.

Ernst C. Pritchard, Teacher of Electric Shop at Milwaukee Vocational School, Milwaukee, Wisconsin, for one and one-half years. Teacher of electric shop at Lane Technical High School for 25 years. Head of the department of 11 teachers for 12 years.

C. S. Jones, B.S., E.E. Armour Institute of Technology. Teacher of electricity at Thomas Kelly High School in Chicago, Illinois, for 10 years. Teacher of electricity in Chicago Public Schools for 17 years. Has taught in the summer school session at Illinois Technical Institute.

Wynn McDougal, Head of Department of Electricity, The Pullman Free School of Manual Training for 26 years. Associate member, American Institute of Electrical Engineers. Author of six of a series of lesson booklets published by the American School. Author of numerous articles which have appeared in Industrial Arts and Vocational Education Magazine and in Industrial Education Magazine. Co-author of Elements of Electricity with William Esty and Robert Andrew Millikan.

DIRECTIONS FOR GIVING THE TEST IN ELEMENTARY ELECTRICITY

(Directions for the teacher.)

The usual rules for group test prodedure, standard directions, and standard conditions should be observed when this test is given.

Each pupil should have or be supplied with a well sharpened pencil.

As soon as the tests have been distributed the blanks on the first page should be filled in. The pupil should read the part: INSTRUCTIONS TO STUDENTS. After this has been read the folder should be opened and the page IDENTIFICATION TEST-PART I- should be removed and placed on top. The pupil should read the four lines on the top of this page. READY- START- TIME-3 MINUTES-30 SECONDS.STOP

PART II IS A RECOGNITION AND DIAGRAM TEST. This test starts on the first page, just under INSTRUCTIONS TO STUDENTS. There are 10 questions in this test. Questions 1, 2, 3, are found on page 1. Questions 4, 5, 6, 7 are found on page 2. Questions 8, 9, 10 are found on the remaining loose page in the folder. It is important that the pupils have a clear understanding off the locations of the 10 questions in this test.

READY-START-TIME 3 MINUTES-50 SECONDS. Stop.

Part III IS A TRUE-FALSE TEST. This test starts on page 3. Read directions and note examples.

READY-START-TIME 8 MINUTES-40 SECONDS. STOP.

PART IV IS A MULTIPLE-RESPONSE TEST. This test starts on page 5. Read directions and note examples.

READY-START-TIME 6 MINUTES-10 SECONDS. STOP.

PART V IS A MATCHING TEST. This test starts in the middle of page 6. Read directions and note example.

READY-START-TIME 3 MINUTES. STOP.

PART VI.IS A COMPLETION TEST. This starts in the middle of page 7. Read directions and note example.

READY-START-TIME 6 MINUTES 50 SECONDS. STOP

COLLECT ALL PAPERS.

After the papers have been collected, the teacher is asked to turn to page one of each paper and give the instructor's estimate of the pupil's grade. This grade should be based the quality of work done by the pupil in the electrical unit up to the time this test was given. This grade could be the pupil's grade for Industrial Arts Laboratory for the last marking period.

Appendix D.

KEY FOR SCORING TEST IN ELEMENTARY ELECTRICITY

Page 1

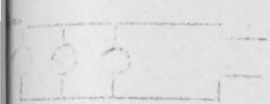
1- short

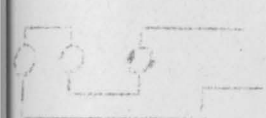
2- open

3- 5/8 1-3/16 1¾

2-3/8 2-15/16

Page 2



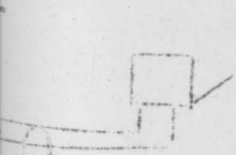


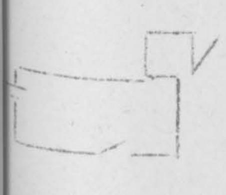
or

4	7- 5
3	3
5	1
1	2
2	4

Loose page

- 3579





Page 8

kilowatt, direct, compass, positive, transformer, direct, air, resistance, 1½, zinc, repel, more, kilowatt, more, more, gauge, armature, zinc, permanent, ohms, distilled, four, electromagnet, larger, television, radio, generator, amperes, natural, volt, silver, conduit, kilovolt, voltmeter, volts, air

two, copper, poor, cleaned, soldered, volts, hydrometer, direct, field, magnet, chemical, electroplating, magnetize, conductors

Page 7

13, 15, 11, 12, 14, 20, 16, 19, 17, 18, 24, 23, 25, 21, 22, 29, 30, 26, 28, 27

4, [illegible], [illegible], 5, 2, 9, 8, 6, 10, 7

Page 6

a, c, a, b, a, b, a, c, b, c, d, a, a, b, b, d, d

Page 5

+, ½, +, 0, 0, 0, 0, 99 0, 0, d, b, b, a, a, a, d, d, a, b, b, d, c, c, c, a, a, c, c, b, a, c, d

Page4

0, 0, 0, +, +, 0, 50 +, +, 0, +, 0, +, 0, 0, +, 0, 50 0, +, 0, 0, 0, 0, +, +, +, 0, +, 70 +, 0, 0, 0, 0, +, +, 0, +, +, 0, 80, +, +, 0, 0, 0, 0, 0, 0, +, 90 0, 0

page3

+, +, +, +, +, +, +, 0, 0, +, 10 +, +, 0, +, 0, +, +, 0, 20 0, +, 0, 0, 0, 0, 0, +, 0, +, 0, 30 0, +, +, +, +, 0, 0, 0, 0, 0 0, +, +, +

Part

1, 14, 30, 26, 8, 10, 19, 2, 6, 7, 13, 1, 25, 18, 20, 17, 21, 29, 23, 9, 28, 27, 16, 12, 15, 5, 3, 4, 22, 24, 11

Appendix E.

The following industrial arts laboratory teachers gave the revised form of the test in their respective schools in the public school system in Chicago.

Brazda, Lumir P.	Bowen High School	2710 E. 89th Street
Carlson, Gustav A.	Wells High School	936 N. Ashland
Dollinger, R.	Medill High School	1326 W. 14th Street
Davison, H.	Sullivan High School	6631 Bosworth
Farnsworth, James E.	Senn High School	5900 Glenwood
Favaro, Anthony	Taft High School	5625 N. Natoma
Fenn, I.	Schurz High School	3601 Milwaukee
Heimberger, Ferdinand	Kelvyn Park High School	4343 Wrightwood
Huber, Louis S.	Calumet High School	8131 S. May
Hunter, R. Ted	Hubbard Branch of Lindbloom High School	6120 S. Hamlin
Kordos, J.	Foreman High School	5100 Belmont
Kosloff, Albert	Franklin Branch of Waller High School	225 W. Goethe
Kunter, Edward	Roosevelt High School	3410 Wilson
Maier, Charles	Corliss High School	132nd and Corliss
Poore, William	Englewood High School	6201 S. Stewart
Siegal, William	Steinmetz High School	3030 N. Mobile
Watters, William	Greeley Branch of Lake View High School	3800 Sheffield
Whigam, William	Waller High School	2007 Orchard

TEST PERCENTILE EQUIVALENTS OF TEST SCORES MADE ON THE OBJECTIVE TEST DESIGNED FOR THE ELECTRIC UNIT IN THE INDUSTRIAL ARTS LABORATORY

N-528

Score	Percentile Equivalents	Score	Percentile Equivalents
280-300	100	151-152	49
260-279	99	149-150	48
255-259	98	147-148	47
150-254	97	146	46
245-249	96	145	45
240-244	95	144	44
235-239	94	142-143	43
230-234	93	140-141	42
227-229	92	138-139	41
224-226	91	136-137	40
221-223	90	134-135	39
218-220	89	133	38
216-217	88	132	37
214-215	87	131	36
212-213	86	129-130	35
210-211	85	127-128	34
209-210	84	126	33
208	83	125	32
206-207	82	124	31
205	81	122-123	30
203-204	80	120-121	29
202	79	116-119	28
201	78	114-115	27
199-200	77	112-113	26
197-198	76	110-111	25
196	75	108-109	24
194-195	74	106-107	23
193-194	73	104-105	22
191-192	72	102-103	21
189-190	71	100-101	20
187-188	70	98-99	19
185-186	69	96-97	18
183-184	68	94-95	17
181-182	67	92-93	16
179-180	66	90-91	15
178	65	88-89	14
177	64	86-87	13
175-176	63	83-85	12
173-174	62	81-82	11
172	61	79-80	10
171	60	76-78	9
169-170	59	73-75	8
167-168	58	69-72	7
166	57	64-68	6
165	56	59-63	5
163-164	55	51-58	4
161-162	54	41-50	3
159-160	53	31-40	2
157-158	52	21-30	1
155-156	51	0-20	0
153-154	50		

Appendix G.

	D	F	G	E	S	f	x	fx	fx^2
276-290				1 (8)	5 (40)	6	8	48	384
261-275				1 (7)	3 (21)	4	7	28	196
246-260			2 (12)	4 (24)	8 (48)	14	6	84	504
231-245			5 (25)	6 (30)	7 (35)	18	5	90	450
216-230			4 (16)	15 (60)	8 (32)	27	4	108	432
201-215			13 (39)	27 (81)	11 (33)	51	3	153	459
186-200	1 (2)	2 (4)	19 (38)	22 (44)	6 (12)	50	2	100	200
171-185		8 (8)	23 (23)	18 (18)		49	1	49	49
156-170	1 (0)	8 (0)	27 (0)	23 (0)	2 (0)	61	0	0	0
141-155		15(-15)	24 (-24)	11 (-11)		50	-1	- 50	50
126-140	1 (-2)	17(-34)	23 (-46)	2 (-4)		43	-2	- 86	172
111-125	2 (-6)	15(-45)	21 (-63)	1 (-3)		39	-3	-117	351
96-110	2 (-8)	22(-88)	18 (-72)	1 (-4)		43	-4	-172	688
81-95	1 (-5)	26(-130)	5 (-25)			32	-5	-160	800
66080	3 (-18)	25(-150)	2 (-12)			30	-6	-180	1080
51-65		5(-35)				5	-7	- 35	245
36-50		4(-32)				4	-8	- 32	256
20-35	1 (-9)	1(-9)				2	-9	- 18	162
f	12	148	186	132	50	528		-190 Efx	6478 Efx^2
y	- 2	- 1	0	1	2				
fy	-24	-148	0	132	100	60	Efy		
fy^2	48	148	0	132	200	528	Efy^2		
fx	-46	-526	- 89	250	221	-190	Efx		
fxy	92	526	0	250	442	1310	Efxy		

$E = \Sigma$

Correlation chart showing the computation of the coefficient of correlation between pupils' test scores and grades given pupils by their respective teachers.

OBJECTIVE TEST FOR THE ELECTRIC UNIT IN INDUSTRIAL ARTS LABORATORY 1.
By H. Cross

Do not write in this space

		Perfect Score	Pupil's Score
Part I	Ident.	30	____
Part II	R & D	50	____
Part III	T-F	100	____
Part IV	M-R	40	____
Part V	Match.	30	____
Part VI	Comp.	50	____
	Total	300	____

Name________________________Div.______

School______________________Date______

Age________Years______Months

Name of Teacher_______________________

Teacher's estimate S E G F D (circle one)

INSTRUCTIONS TO STUDENTS

This is a test of the information you possess about elementary electricity. There are six parts to the test, each of which requires a different type of answer. You will be allowed 32 minutes of writing time for the completion of the entire test. You are not expected to answer completely all parts of the test within the time allowed.

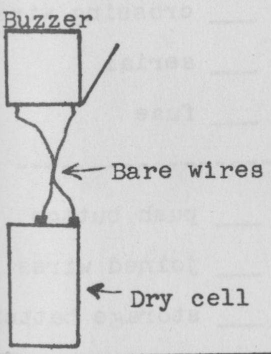
Read carefully the directions given and note the examples.

Do not talk or ask questions during the test. Your time is valuable.

You are now ready to start with part one. Wait for your teacher to give you the signal before doing any writing.

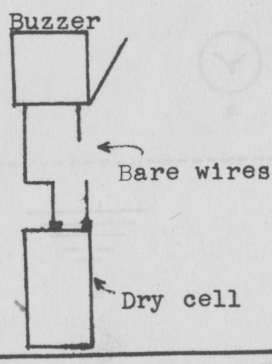
RECOGNITION AND DIAGRAM TEST PART II

1. Check the word which properly describes the trouble in this circuit.



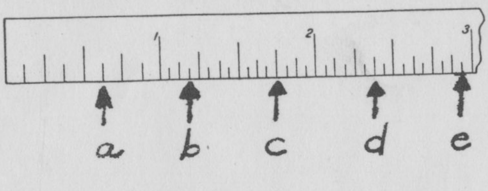
____short
____ground
____open
____out of phase
____blown fuse
____wires too small

2. Check the word which properly describes the trouble in this circuit.



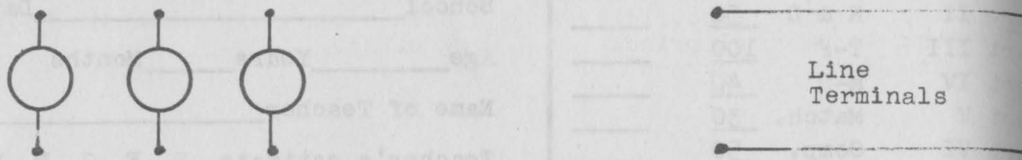
____short
____ground
____open
____out of phase
____blown fuse
____wires too small

3. The drawing below represents a 3 inch section of a ruler. The arrows point to certain measurements on the ruler. In the spaces below the drawing indicate the correct readings in inches and fractions of an inch.

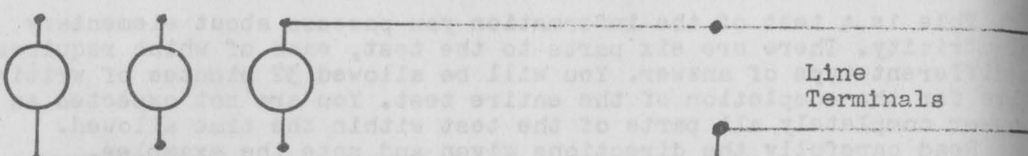


0 to a ____ 0 to b ____ 0 to c ____ 0 to d ____ 0 to e ____

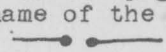
4. The diagram below is to be completed with lines drawn between the dots. The symbols of three receptacles shown below are to be connected in parallel. This combination is to be connected to the two line terminals. No lines are to cross each other.



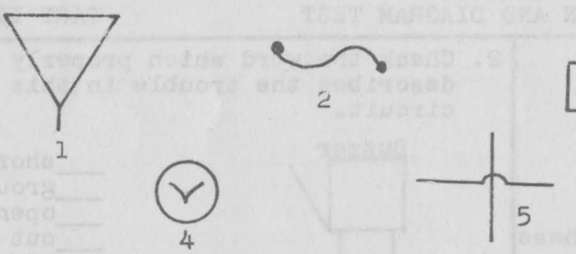
5. The diagram below is to be completed with lines drawn between the dots. The symbols of three receptacles shown are to be connected in series. This combination is to be connected to the two line terminals. No lines are to cross each other. Two lines have been placed in the drawing.



6. The names of the objects the following symbols represent are listed on the right of the page. Place the number of the symbol on the line before the name of the object the symbol represents.
EXAMPLE:

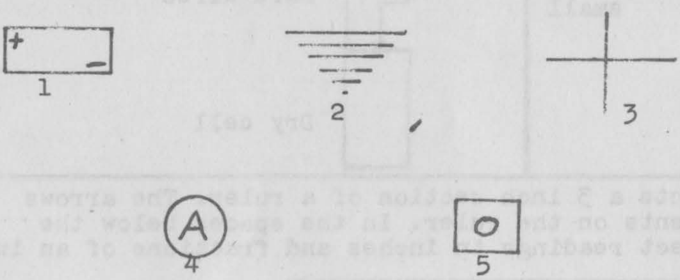

A

a spark gap



___ voltmeter
___ bell
___ crossing wires
___ aerial
___ fuse

7.

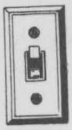


___ push button
___ joined wires
___ storage battery
___ ground
___ ammeter

Thirty illustrations of objects used in elementary electrical
k are shown on this page. The names of the objects are listed
the side of the page but not in their proper order. After the
e of each object write the number which appears under it in
illustration.

	NO.
Underwriter's Knot	
Door Bell	
Bell Transformer	
Plug Fuse	
Porcelain Receptacle	
Cartridge Fuse	
Heater Element	
Plug	
Pull Chain Socket	
Three-way or cube plug in outlet	
Knife Switch S.P.S.T.	
Incandescent Lamp	
Fahenstock Clip	
Western Union Splice	
Tap Splice	
Storage Battery	
Battery Clip	
Wire Gauge	
Ammeter	
Kilowatt-hour meter or watt hour meter	
Motor or Generator	
Push Button Socket	
Volt Meter	
Weatherproof Socket	
Double or two-way socket	
Switch Plate	
Binding Post	
Flat Iron Element	
Hydrometer	
Plug Base	


2


3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5


6


7


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9

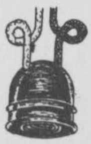

10


11

12


13


14

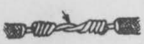

15


16

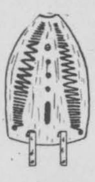

17


18


19


20


21


22


23


24


25


26

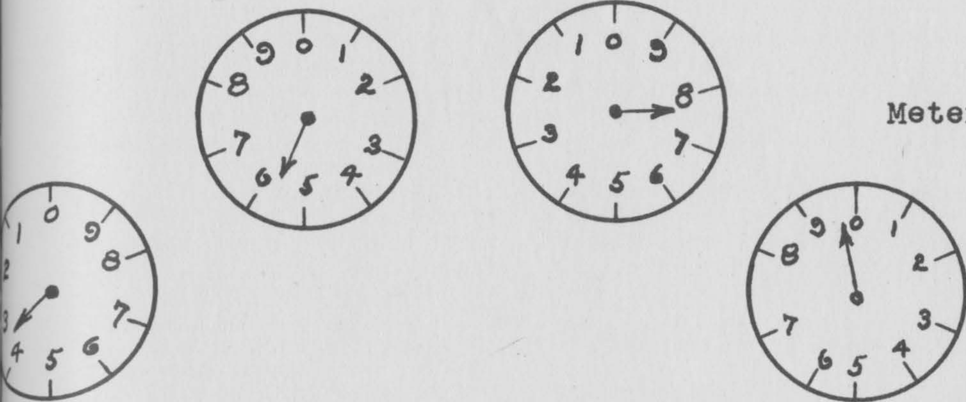

27

28


29

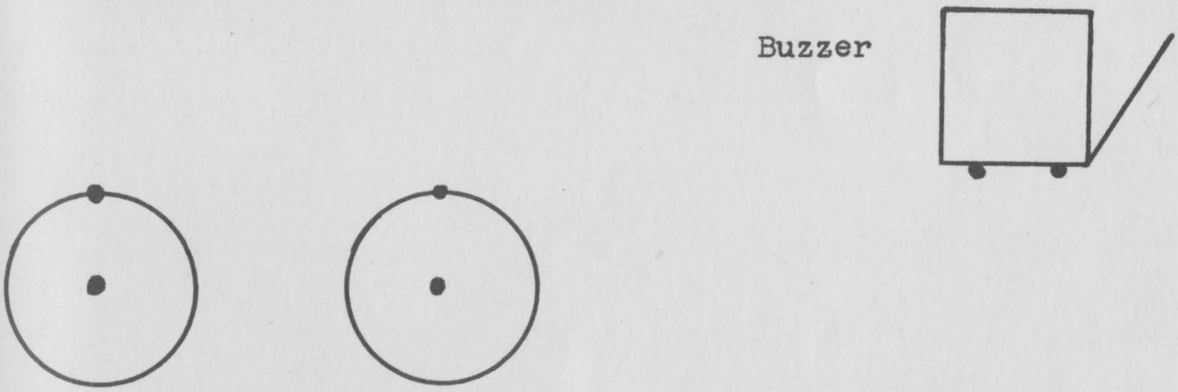

30

8. 1. The dials drawn below represent the four dials as they would be seen on a watt-hour meter. On the line on the right hand side of the page write the correct reading of the watt-hour meter as shown by this illustration.

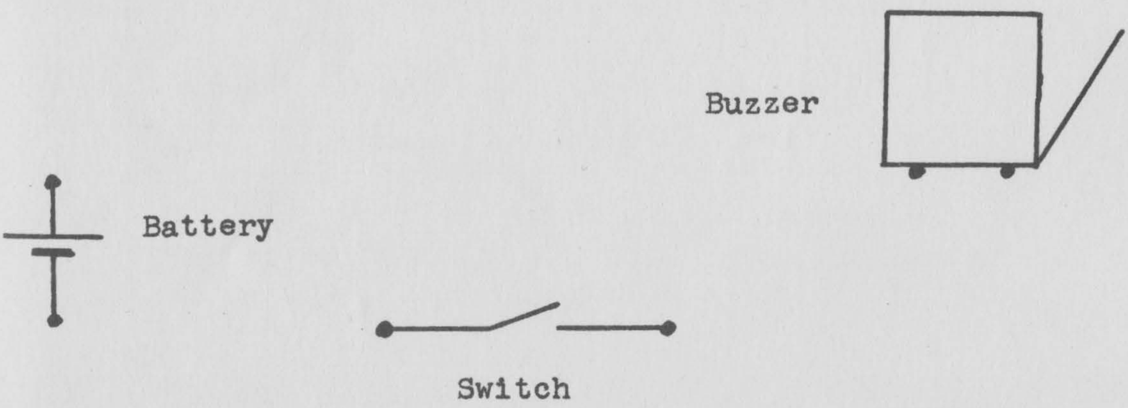


Meter Reading________

9 2. Below is drawn the top view of two dry cell batteries and the symbol for a buzzer. Connect the two batteries in parallel to make the buzzer operate. Make all connections between the dots. No lines are to cross each other.



10. 3. The diagram below is to be completed with lines drawn between the dots. The switch is to control the buzzer. No lines are to cross each other.



TRUE-FALSE

DIRECTIONS: Each of the statements which follows is either true or false. If the statement is TRUE put a plus sign (+) on the line at the left of the statement. If the statement is FALSE put a zero (O) on the line at left of the statement.

EXAMPLE:

\+ A. All electric currents are essentially the same in nature but they may vary in their method of flow.

O B. Brass is a good insulator.

___ 1. A student of electricity should have a clear understanding of the fundamental principles of magnetism.
___ 2. An artificial magnet may be made by inserting a steel bar in a coil of wire carrying a direct current.
___ 3. Broken light or power lines should be avoided as touching them might be dangerous.
___ 4. It is necessary to have a government license to operate a short wave sending or transmitting station.
___ 5. After two wires have been spliced together they should be soldered.
___ 6. When two wires are attached to a socket an Underwriter's knot should be tied inside the cap of the socket.
___ 7. Some magnets have only one pole.
___ 8. The strength of a magnet may be increased by hammering, bending, or twisting.
___ 9. A fuse may be called a safety valve in an electric circuit.
___10. It is a criminal offense to tamper with the light meter which has been placed in the home by the electric company.
___11. Splices should be taped to give insulation to the spliced area.
___12. Broken hammer handles may be safely repaired by winding tape over the broken part.
___13. When a fuse link melts it is said to be blown.
___14. Boric acid is used to make the acid solution of a storage battery.
___15. When replacing a fuse the safe practice is first to turn off the master switch.
___16. Materials which allow an electric current to pass through them readily are called conductors.
___17. A hydrometer is used to test the charge of a storage battery.
___18. Static electricity may be produced by rubbing together certain materials.
___19. Fuse links are made of silver.
___20. The purpose of flux when soldering is to indicate if the soldering copper is hot enough.
___21. A permanent magnet has a magnetic field around it.
___22. The north magnetic pole and the north geographic pole are located at exactly the same place.
___23. Current electricity is electricity at rest.
___24. Cotton is a good insulating material to use on high voltage lines.
___25. Electric clocks are expensive to operate.
___26. A flashlight bulb is an incandescent lamp.
___27. A number 24 wire is twice as large as a number 12 wire.
___28. The strength of a magnet is concentrated at the poles.
___29. A fully charged storage battery weighs more than when discharged.
___30. The exact nature of electricity has been known for many years.
___31. The modern theory concerning the nature of electricity is the electron theory.
___32. Soft iron is easy to magnetize.
___33. Some light bulbs have more than one filament.
___34. The unit called the foot candle is used to measure the amount of illumination at any particular point.
___35. When two insulated wires are spliced together and then soldered they need not be taped if the soldering job has been well done.
___36. A battery charger may be used to recharge a dry cell.
___37. Iron is the best known conductor of electricity.
___38. Fluorescent lamps are free from intense glare.
___39. A bar of copper can be magnetized if held in a magnetic field.
___40. A very poor conductor of electricity is never used in electrical work.
___41. The flow of an electrical current is measured in amperes.
___42. One kilocycle equals one thousand cycles.
___43. Materials through which an electrical current will flow with little resistance are called electrical conductors.

____44. It is impossible for a person to be killed by coming in contact 4
with a 110 volt line.
____45. After a splice has been soldered, and before taping, it is
covered with a layer of grease to prevent corrosion.
____46. Cartridge fuses are used only in street cars and buses.
____47. Glass is frequently used to make insulators for the poles of
a telephone line.
____48. Only distilled water should be added to a storage battery cell.
____49. A file is the best tool to use when cleaning a wire for soldering.
____50. An alternating current is one in which the flow of current
reverses its direction at fixed intervals.
____51. An electric current may be produced either mechanically or
chemically.
____52. Direct current will flow in an open circuit.
____53. A storage battery is a secondary cell.
____54. The fuse most commonly used in branch circuits in the home is
rated at 100 amperes.
____55. Stranded wire is more flexible than one solid wire of the same
total size.
____56. The core of a transformer is made of silver.
____57. A 100 watt lamp bulb draws more current than the average electric
flatiron.
____58. A dry cell battery is a primary cell.
____59. A magnetic compass is always enclosed in a steel case.
____60. A storage battery cell which tests 1.100 would be fully charged.
____61. The volt is the unit of electrical pressure.
____62. The plates of a storage battery are made of copper.
____63. A flashlight battery produces alternating current.
____64. The B.T.U. is a unit of electricity.
____65. The terminal on the rim of a dry cell battery is the positive
terminal.
____66. A person is grounded when he touches a radiator or water pipe
in the home.
____67. The magnetic lines of force about a bar magnet form a continuous
circuit from the north pole to the south pole.
____68. To be an electrical repairman a person must first be an electrical
engineer.
____69. In homes where two or more 115 volt light bulbs are controlled
by a single switch the bulbs are connected in parallel.
____70. The filament of an incandescent lamp operates at a white hot
temperature.
____71. Any electric motor will work on direct current.
____72. 220 volts equals one horse power.
____73. A milivoltmeter is used to measure a million volts or more.
____74. A transformer may be used only on direct current.
____75. A direct current is one in which the direction of the current
is constant.
____76. A bar of steel is said to be saturated once it has been magnetized.
____77. The three cells of a storage battery are connected in series to
produce 6 volts.
____78. The watthour meter is a device for measuring electrical power.
____79. Magnetic lines of force will not pass through a brick wall.
____80. In a magnetic compass, the needle or rotating part, is a permanent
magnet.
____81. The only common magnetic substances are iron and steel.
____82. An induction motor operates on alternating current only.
____83. The ampere hour rating of a new storage battery would be approximatel
750 ampere hours.
____84. The unit of electrical resistance is the watt.
____85. Fuses are never used on circuits carrying 220 volts or more.
____86. The smaller the wire number the smaller the diameter of the wire.
____87. Electricity is considered a luxury.
____88. A converter is used to change watts into volts.
____89. The voltage across the secondary of a transformer may be higher
than the voltage across the primary.
____90. A 115 volt bulb rated at 60 watts would draw 60 amperes of current.
____91. An ohmmeter is used to test the voltage between any two points
on a line.
____92. The modern street cars use an electromagnet to aid in stopping
the car.

___ 93. The instrument used to determine potential difference is called the voltmeter. 5.

___ 94. The strength of a horseshoe magnet is retained longer if a piece of soft iron or keeper is placed across the free ends.

___ 95. A circuit breaker is a device which may be used in place of a fuse.

___ 96. The positive terminal of a battery will attract the south pole of a magnet.

___ 97. Acid flux should always be used when soldering electrical wires.

___ 98. For heating devices and rheostats, good conductors are used.

___ 99. All electric motors have two or more brushes.

___ 100. All wires used in electrical work are covered with a layer of insulation.

MULTIPLE -RESPONSE Part IV

DIRECTIONS: Four choices are given for completing each of the statements below. Select the one that is correct and draw a line underneath it. Then place on the line at the right of the page the letter which appears within the parenthesis in front of the correct choice.

EXAMPLE:

A dry cell battery produces (a) magnetism (b) alternating current (c) direct current (d) grounded current. c

1. To determine the size of a round wire a person should use a (a) ruler (b) voltmeter (c) drill gauge (d) wire gauge. ___
2. A good insulator to put on copper wires carrying 110 volts would be (a) lead (b) rubber (c) tin (d) solder. ___
3. The poles of a magnet are usually located (a) in the center (b) at the ends (c) on the sides (d) outside the magnet. ___
4. The voltage of a battery cell used in a flashlight is (a) 1½ volts (b) 6 volts (c) 110 volts (d) 220 volts. ___
5. All electrical connections that are not fastened by screws or bolts should be (a) soldered (b) hammered (c) fused (d) painted. ___
6. The electric light bulbs which we use for lighting are (a) incandescent lamps (b) infra red lamps (c) ultra violet ray (d) photo electric. ___
7. The core of an electromagnet is usually made of (a) silver (b) gold (c) aluminum (d) soft iron. ___
8. The letters D. C. stand for (a) don't contact (b) direct contact (c) double covered (d) direct current. ___
9. Electrical communication began with the (a) telegraph (b) telephone (c) radio (d) radiophone ___
10. A dry cell battery consists of a zinc can, chemicals, and a center rod made of (a) copper (b) carbon (c) brass (d) glass ___
11. Electricity is transmitted to different places in the city and country on (a) steel towers (b) transmission lines (c) telephone poles (d) silver wires. ___
12. In order to become a journeyman electrician a person must first work as (a) an engineer (b) research worker (c) salesman (d) an apprentice electrician. ___
13. In a dry cell battery the electric current is produced by (a) magnetic action (b) heat action (c) chemical action (d) atomic fission. ___
14. The first practical incandescent lamp was developed by (a) Faraday (b) Franklin (c) Edison (d) Newton. ___
15. Storage batteries are recharged by (a) adding water (b) adding acid (c) battery charger (d) reversing the terminals. ___
16. A magnetic substance is (a) steel (b) copper (c) silver (d) wood ___
17. Good insulation has (a) high resistance (b) low resistance (c) no resistance (d) good conductance ___
18. The proper size fuse for home use in branch circuits (a) 60 cycle (b) 15 ampere (c) 110 volt (d) 500 watt. ___
19. The kind of wire used in electrical heating devices to convert electrical energy into heat is (a) galvanized iron (b) silver (c) nichrome (d) solder. ___
20. Electromagnets are used in (a) light bulbs (b) motors (c) flatirons (d) storage batteries. ___
21. The mathematical relationship which exists between voltage, amperage, and resistance is known as (a) Ohm's law (b) Faraday's discovery (c) Lenz's law (d) regulation formula. ___
22. Unlike magnetic poles (a) repel each other (b) have no effect on each other (c) attract each other (d) produce a neutral pole. ___
23. If a magnetized needle is heated red hot it will (a) stay magnetized (b) have more magnetism (c) reverse polarity (d) loose magnetism ___

24. The end of a compass needle that points north is the (a) north pole (b) south pole (c) compound pole (d) strongest pole. ____
25. An electrical device which steps the voltage down is a (a) wattmeter (b) reversing switch (c) transformer (d) rectifier. ____
26. Fuses are used in wiring installations to (a) prevent overheating of the wires (b) prevent accidental shocks (c) serve as lightning arrestors (d) regulate the voltage. ____
27. If the unlike poles of two magnets are moved so the distance between them is doubled the mutual attraction between the two magnets is (a) more (b) less (c) same (d) no difference. ____
28. A unit of heat is the (a) calorie (b) watt (c) ampere (d) ohm. ____
29. A material which has a very high resistance would be a (a) good conductor of electricity (b) poor conductor of electricity (c) good lightning rod (d) good material for wiring houses. ____
30. A man doing signal maintainance work would probably be working for a (a) railroad (b) garage (c) state highway (d) public utility. ____
31. A good conductor of electricity would be (a) porcelain (b) glass (c) silver (d) air. ____
32. The specific gravity of a fully charged lead cell storage battery should be (a) .275 (b) 1.275 (c) 2.275 (d) 3.275. ____
33. The modern theory concerning the nature of electricity is the (a) positive theory (b) magnetic theory (c) electron theory (d) theory of evolution. ____
34. The unit of measure of the amount of illumination at any particular point is called the (a) watt-hour (b) calorie (c) pyrometer (d) foot-candle. ____
35. 20,000 volts would jump across an air gap of (a) 1 inch (b) 1 foot (c) 2 feet (d) 3 feet. ____
36. The ampere-hour rating of a new storage battery for use in an automobile would be (a) 100 (b) 500 (c) 1,000 (d) 10. ____
37. The number of mils in an inch is (a)100 (b) 1,000 (c) 10,000(d)10. ____
38. A new number 6 dry cell battery should test (a) 5 amperes (b) 25 amperes (c) 50 amperes (d) 100 amperes. ____
39. In electrical work the letter E. stands for (a) ohms (b) mhos (c) watts (d) volts. ____
40. An instrument used for measuring high degrees of heat is a (a) hydrometer (b) micrometer (c) kilometer (d) pyrometer. ____

MATCHING TEST — PART V

DIRECTIONS: Column A contains 30 incomplete statements. The correct completion for these statements may be found in column B. On the line which precedes column B place the number of the partial statement from column A that is needed to make a complete and true statement. The answers to the first five partial statements in column A will be found among the first five in column B.

EXAMPLE:

A. Solder is an alloy of tin and

____ steel
_A_ lead
____ copper

COLUMN A	COLUMN B
1. Radio transmission is based on the fact that sound waves can be changed to	____ neon gas
2. Electrical communication began with	____ a field coil
3. All electric motors have	____ radio waves
4. An electrically operated tubular light which is red in color is filled with	____ the receiving set
5. Static is caused by an electric charge in the atmosphere near	____ the telegraph

---

COLUMN A	COLUMN B
6. A lodestone is a	____ piece of steel
7. A good conductor of electricity is a	____ buzzer
8. An electromagnet may be found in a	____ natural magnet
9. Permanent magnets are made from a	____ south pole
10. Magnets have a north pole and a	____ copper wire

11. The filament of a modern incandescent lamp is made of	___	dry wood
12. The core of an electromagnet is made of	___	zinc
13. A very poor conductor of electricity is	___	tungsten
14. The center rod of a dry cell is made of	___	soft iron
15. The metal container which forms the outside of a dry cell is made of	___	carbon

---

16. Electricity is a strong force that must be carefully handled to insure safety to	___	an electromagnet
17. The most efficient method of magnetizing a piece of steel is with	___	the user
18. Magnetism and electricity are	___	a secondary coil
19. A transformer has a primary coil and	___	a magnetizing coil
20. A solenoid with an iron core inserted in the center is called	___	closely related

---

21. The unit of heat is the	___	ampere
22. The unit of electrical pressure is the	___	ohm
23. The unit of electrical resistance is the	___	kilowatt
24. The unit of electrical current is the	___	calorie
25. 1,000 watts equals one	___	volt

---

26. 3 dry cells connected in series will give	___	115 volts
27. A 3 cell storage battery will produce	___	$1\frac{1}{2}$ volts
28. A 2 cell flashlight will produce	___	$4\frac{1}{2}$ volts
29. A wall outlet in most homes will produce	___	3 volts
30. The large size, No. 6, dry cell produces	___	6 volts

COMPLETION TEST — PART VI

DIRECTIONS: Each of the statements which follows has a word missing. The missing word belongs in the space indicated by the blank line. Place the missing word on the line at the right of the page. Do not write on the blank line in the sentence.

EXAMPLE: Current flows only in a ________ circuit. — closed.

---

1. The earth has ______ magnetic poles. ________
2. The majority of wires used in electrical work are made of___ ________
3. Insulators are very_____ conductors of electricity. ________
4. Wire should always be well______ before attempting to solder. ________
5. Splices in wire should first be_____ then taped. ________
6. Buzzers or door bells used in homes require 6 to 8 _____ for proper operation. ________
7. A ________ is usually used to test the charge of a storage battery. ________
8. Dry cell batteries and storage batteries always produce _____ current. ________
9. Each magnet has about it a magnetic________. ________
10. When a magnetized needle is broken, each part will be found to be a complete______ . ________
11. A dry cell battery produces electricity by______ action. ________
12. When one metal is used to coat another metal by an electrical process the method is called _________. ________
13. Soft iron is easy to_____ and is, therefore, said to be permeable. ________
14. Materials which allow an electric current to pass through readily are called_______. ________

15.The unit by which electricity is bought and sold is the ________hour.
16.Storage batteries are charged from a source which produces ________current.
17.A magnetic______is a small permanent magnet balanced nicely on a needle point so it may adjust its position in accordance with the law of magnetic poles.
18.In a dry cell battery the center terminal is the___terminal.
19.A device used to step the voltage up or down is known as a______.
20.Storage batteries are charged from an electrical source which produces______current.
21.Four dry cell batteries connected in series will produce ______volts.
22.The letter R stands for _______ which is measured in ohms.
23.A new dry cell battery is rated as having ____volts.
24.The metal used to make the outside of a dry cell is_____.
25.In magnetism, like poles _____each other.
26.Long wires have_____resistance than short ones.
27.1,000 watts equals one________.
28.A number 30 copper wire has ____resistance per foot than a number 10 copper wire.
29.Nichrome wire has_____resistance than copper wire.
30.The B & S or American wire _____ is used to determine the size of copper wire.
31.The part of an electric motor which turns or revolves is called the______.
32.A fuse link is made of a strip of_____.
33.Magnets which retain their magnetism for a long period of time are called_______magnets.
34.Resistance is measured in_________.
35.________water is added to a storage battery.
36. To become a journeyman electrician requires_____years of training.
37. When an iron core is wrapped with a coil of wire and a current is sent through the wire an___is made.
38. Number 10 wire is_____ than number 40 wire.
39. The transmission of electrical energy through the air which is converted into pictures is called______.
40. The transmission of electrical energy through the air which is converted into sound is called_______.
41. The device in an automobile whose purpose is to keep the storage battery charged is called the automobile____
42. The flow of an electrical current is measured in_____.
43. Pieces of ore which have the ability to attract iron or steel are known as _______magnets.
44. The unit of electrical pressure is the______.
45. The best conductor of electricity is_______.
46. In a fireproof building all wires are placed in_______.
47. 1,000 volts equals one______.
48. The instrument used to measure electrical pressure is the________.
49. The letter E stands for________.
50. A coil of wire carrying current having an ____ core is known as a solenoid.

OBJECTIVE TEST FOR THE ELECTRIC UNIT IN IND. ARTS LAB.

Do not write in this space

	Perfect Score	Pupil's Score
Part I	42	______
Part II	50	______
Part III	106	______
Part IV	30	______
Part V	20	______
Part VI	______	______
Total	______	______

Name______________Div________

School______________________

Age______yrs.______Months

Date________________________

Name of teacher______________

Instructor's estimate of pupil's grade

S E G F D (circle one)

MULTIPLE-RESPONSE PART I:

DIRECTION: Four choices are given for completing each of the statements below. Select the one that is correct and draw a line underneath it. Then place on the line at the right of the page the letter which appears within the parenthesis in front of the correct choice.

EXAMPLE:

A dry cell battery produces (a)magnetism (b)alternating current (c) direct current (d) grounded current ____c____

1. A magnetic substance is (a) steel (b) copper (c) silver (d) wood. ______

2. Unlike magnetic poles (a) repel each other (b) have no effect on each other (c)attract each other (d) produce a neutral pole. ______

3. If a magnetized needle is heated red hot it will (a)stay magnetized(b)have more magnetism (c)reverse polarity (d)lose its magnetism ______

4. The poles of a magnet are usually located(a) in the center (b) at the ends(c) on the sides (d) outside the magnet. ______

5. The end of a compass needle that points north is the (a)north pole (b)south pole (c) compound pole (d) strongest pole. ______

6. If the unlike poles of two magnets are moved so the distance between them is doubled, the mutual attraction between the two magnets is (a) more (b) less (c) same (d) no difference. ______

7. The core of an electomagnet is usually made of (a)silver (b) gold (c) aluminum (d) soft iron. ______

8. Electromagnets are used in (a) light bulbs (b) motors (c) flat irons (d) storage batteries. ______

9. A unit of heat is the (a) calorie, (b) watt, (c) ampere (d(ohm

10. The kind of wire used in electrical heating devices to convert electrical energy into heat is (a) galvanized iron, (B) silver, (c) nichrone, (d) solder.

11. Storage batteries are recharged by (a) adding water, (b(adding acid (c) battery charger, (d) reversing the terminals.

12. The specific gravity of a fully charged lead cell storage battery should be (a) .275. (b) 1.275. (c) 2,275, (d) 3.275.

13. The ampere-hour rating of a new storage battery for use in an automobile would be (a) 100, (b) 500, (c) 1,000, (d) 10

14. The voltage of a battery cell used in a flashlight is (a) 1½ volts, (b) 6 volts, (c) 110 volts, (d) 220 volts.

15. An instrument used for measuring hight degrees of heat is a (a) hydrometer, (b) micrometer, (c) kelometer, (d) pyrometer.

16. An electrical device which steps the voltage down is a (a(wattmeter, (b) reversing switch, (c) transformer, (d) rectifier.

17. Electricity is transmitted to differnet places in the city and country on (a) steel towers, (b) transmissions lines, (c) telephone poles, (d) silver wires.

18. The electric light bulbs which we use for lighting are (a) incandescent lamps, (b) infra red lamps, (c) ultra violet ray lamps, photo-electric cells.

19. In order to become a journeyman electrician a person mustfirst work as (a) an engineer, (b) in a research laboratory, (c) a salesman of electrical goods, (d) an apprentice electrician.

20. A man doing signal mainteinance work would probably be working for a (a) railroad, (b) automobile manufacturer, (c) State Highway Commission, (d) Public Utility.

22. Wires which have a covering of rubberare known as (a) copper wires, (b) marked wires, (c) insulated wires, (d) ground wires.

22. The proper size fuse for home use in branch circuits is (a) 60 cycle, (b) 15 ampere, (c) 110 volt, (d) 500 watt.

23. All electrical connections that are not fastened by screws or bolts should be (a) soldered, (b) hammered, (c) fused (d) painted.

24. Fuses are used in wiring installations to (a) prevent overheating of the wires, (b)prevent accidental shocks, (c)serve as lightning arrestors, (d) regulate the voltage.

25. To determine the size of a round wire a person should use a (a) ruler, (b)voltmeter, (c)drill gauge, (d)wire gauge.

26. A good conductor of electricity would be (a) porcelain, (b)glass, (c) sil ver (d) air.

27. A good insulator to put on copper wires carrying 110 vol ts would be (a) lead, (b)rubber, (c) tin, (d) solder.

28. A material which has a very high resistance would be a (a) good conductor of electricity,(b) poor conductor of el ectricity. (c) good material for wiring houses, (d) good lightning rod.

29. When making a splice the two copper wires should be (a) well cleaned, (b)oiled, (c)painted, (d) buffed.

30. In electrical work the letter E stands for (a) ohms, (b) mhos, (c) watts, (d) volts.

31. In electrical work the letter ~~X~~ K.W. stands for (a) kilowatts, (b) volts,(c) doubl e covered,(d) direct current.

32. The letters D. C. stand for (a) don't contact, (b) direct contact, (c) double covered, (d) direct current.

33. Electrical communication began with the (a)telegraph, (b) telephone (c) radio (d) radiophone.

34. The fi rst practical incandescent lamp was developed by (a) Faraday, (b) Franklin (c)Edison (d) Newton.

36. 20,000 volts would jump across an air gap of (a) 1 inch (b) 1 foot (c) 2 feet (d) 3 feet.

35. A new number 6 dry cell battery should test (a) 5 amperes (b) 25 amperes(C) 50 amperes (d) 100 amperes.

37. The modern theory concerning the nature of electricity is the (a) positive theory (b)magnetic theory (c) electron theroy (d) theory of evolution.

38. The number of ~~miles~~ MILS in an inch is (a) 100 (b) 1,000 (c) 10,000 (d) 100,000.

39. Good insulation has (a) high resistance (b) low resistance (c) no resistance (d) good conductance.

40. The unit measure of the amount of illumination at any particular point is called the (a) watt-hour (b) calorie (c) pyrometer (d) foot-candle.

41. A dry cell battery consists of a zinc can, chemicals and a center rod made of (a) copper, (b) carbon, (c) brass, (d) glass. ________

42. In a dry cell battery the elctric current is produced by (a) magnetic action, (b) heat action, (c) chemical action, (d) atomic fission. ________

43. The mathematical relationship which exists between voltage, amperage, and resistance is known as (a) Ohm's law, (b) Faraday's discowery, (c) Lenz's law, (d) regulation formula. ________

COMPLETION TEST PART II

DIRECTIONS: Each of the statements which follow has a word missing. The missing word belongs in the space indicated by the blank line. Place the "missing" word on the line at the right of the page. Do not write on the blank line.

Example: Curwent flows only in a __________ circuit. closed

1. Each magnet has about it a magnetic __________. ________

2. Magnets which retain their magnetism for a long period of time are called __________ magnets. ________

3. In magnetism, like poles __________ each other. ________

4. Soft iron is easy to __________ and is, therefore, said to be permeable. ________

5. Pieces of ore which have the ability to attract iron or steel are known as __________ magnets. ________

6. A magnetic __________ is a small permanent magnet, balanced nicely on a needly point so it may adjust its position in accordance with the law of magnetic poles. ________

7. When a magnetized needle is broken, each part will be found to be a complete __________. ________

8. When an iron core is wrapped with a coil of wire and a current is sent through the wire an __________ is made. ________

9. A coil of wire carrying current having an ______ core is known as a solenoid. ________

10. The part of an electric motor which turns or revolves is called the __________. ________

11. __________ water is added to a storage battery. ________

12. A new dry cell battery is rated as having ______ volts. ________

13. In a dry cell battery the center terminal is the ______________ terminal. ______________

14. A ______________ is usually used to test the charge of a storage battery. ______________

15. The transmission of electrical energy through the air which is converted pictures is called__________. ______________

16. The transmission of electrical energy through the air which is converted into sound is called________. ______________

17. The device in an automobile whose purpose is to keep the storage battery charged is called the automobile__. ______________

18. The most commonly used metal for making wires used in electrical work is____________. ______________

19. To become a journeyman electrician electrician requires ____________years of training. ______________

20. The best conductor of electricity is__________. ______________

21. Materials which allow an electric current to pass through readily are called______________. ______________

22. Number 10 wire ~~st~~ is__________ than number 40 wire. ______________

23. Resistance is measured in__________. ______________

24. The unit of electrical pressure is the_________. ______________

25. The flow of an electrical current is measured in____. ______________

26. One thousand volts exquals one____________. ______________

27. One thousand watts equals one ____________. ______________

28. A device used to step the voltage up or down is known as a ______________. ______________

29. Storage batteries are charged from an electrical source which produces__________current. ______________

30. A dry cell battery produces electricity by ______________action. ______________

31. The instrument used to measure electrical pressure is the______________. ______________

32. The unit by which electricity is bought and sold is the____________hour. ______________

33. Four dry cell batteries connected in series will produce______volts. ______________

34. Long wires have ______ resistance than short ones. ______

35. Splices in wire should first be ______ then taped. ______

36. The earth has ______ magnetic poles. ______

37. Insulators are very ______ conductors of electricity. ______

38. When one metal is used to coat another metal by an electrical process the method is called ______. ______

39. Nichrome wire has ______ resistance than copper wire. ______

40. The B & S or American wire ______ is used to determine the size of wire. ______

41. The letter R stands for ______ which is measured in Ohms. ______

42. The letter E stands for ______. ______

43. Dry cell batteries and storage batteries always produce ______ current. ______

44. A number 30 copper wire has ______ resistance per foot than a number 10 copper wire. ______

45. A fuse link is made of a strip of ______. ______

46. Wires should always be well ______ before attempting to solder them. ______

47. Buzzers or door bells used in homes require six to eight ______ for proper operation. ______

48. The metal used to make the outside of a dry cell is ______. ______

49. In a fireproof building all wires are placed in ______. ______

50. Storage batteries are charged from a source which produces ______ current. ______

DIRECT ONS: Each of the statements which follow is either true or false. If the statement is TRUE put a plis sign (+) on the line at the left of the statement. If the statement is FALSE put a zero (0) on the line at the left of the statement.

EXAMPLE:

_+_ A. All electric currents are essentially the same in nature but they may vary in their method of flow.

_0_ B. Brass is a good insulator.

____ 1. Electricity has become an essential public servant.

____ 2. Electricity is considered a luxury.

____ 3. A student of electricity should have a clear understanding of the fundamental principles of magnetism.

____ 4. In a magnetic compass, the needle or rotating part, is a permanent magnetic.

____ 5. A bar of copper can be magnetized if held in a magnetic field.

____ 6. A permanent magnet has a magnetic field around it.

____ 7. Some magnets have only one pole.

____ 8. An artificial magnet may be made by inserting a steel bar in a coil of wire carrying a direct current.

____ 9. The strength of a magnet may be increased by hammering, bending or twisting.

____10. Soft iron is easy to magnetize.

____11. The space about a magnet, in which magnetic lines of forse can be detected, is known as the magnetic field.

____12. The strength of a horseshoe magnet is retained longer if a piece of soft iron or keeper is placed across the free ends.

____13. The only common magnetic substances are iron and steel.

____14. A bar of steel is said to be saturated once it has been magnetized.

____15. The north magnetic pole and the north geographic pole are located at exactly the same place.

____16. The B.T.U. is a unit of electricity.

____17. A flashlight bulb is an incandescent lamp.

____18. Some light bulbs have more than one filament.

____19. A 100 watt lamp bulb draws more current than an electric flatiron.

____20. The unit called the footcandle is used to measure the amount of illumination at any particular point.

____21. Whenever a current of electricity is flowing through a wire, the resistance of the wire transforms some fo the electrical energy into heat.

____22. A fuse may be called a safety valve in an electric circuit.

____23. A penny may be safely substituted for a fuse.

____24. Any electric motor will work on direct current.

____25. All electric motors have two or more brushes.

____26. A dry cell battery is a primary cell.

____27. A storage battery is a secondary cell.

____28. An induction motor operates on alternating current only.

____29. A battery charger may be used to recharge a dry cell.

____30. A hydrometer is used to test the charge of a storage battery.

____31. A storage battery cell which tests 1.100 would be fully charged.

____32. The plates of a storage battery are made of copper.

____33. Boric acid is used to make the acid solution of a storage battery.

____34. Electricity is a form of energy.

____35. The terminal on the rim of a dry cell battery is the positive terminal.

____36. The ampere hour rating of a new storage battery would be approximately 750 ampere hours.

____37. Only distilled water should be added to a storage battery cell.

____38. Broken light or power lines should be avoided as touching them might be dangerous.

____39. A person is grounded when he touches a radiator or water pipe in the home.

____40. If temporary connections work they may be left permanent.

____41. It is a criminal offense to tamper with the light meter which has been placed in the home be the electric company.

____42. It is necessary to have a government license to operate a short wave sending or transmitting station.

____43. A very poor conductor of electricity is never used in electrical work.

____44. Iron is the best known conductor of electricity.

____45. The volt is the unit of electrical pressure.

____46. The flow of an electrical current is measured in amperes.

#

_____47. The three cells of a storage battery are connected in series to produce 6 volts.

_____48. Static electricity may be produced by rubbing together certain materials.

_____49. The unit of electrical resistance is the watt.

_____50. Cartridge fuses are used only in street cars and buses.

_____51. One kilocycle equals 1000 cycles.

_____52. 220 volts equals one horsepower.

_____53. Current electricity is electricity at rest.

_____54. A 115 volt bulb rated at 60 watts would draw 60 amperes of current.

%_____55. A converter is used to change watts into volts.

_____56. When a fuse link melts it is said to be blown.

_____57. Fuse links are made of silver.

_____58. A circuit breaker is a device which may be used in place of a fuse.

_____59. Rubber is a good insulator.

_____60. The fuse most commonly used in branch circuits in the home is rated at 100 amperes.

_____61. Cotton is a good insulating material to use on high voltage lines.

_____62. Push buttons are often used to control door bells or door chimes.

_____63. Fuses are never used on circuits carrying 220 volts or more.

_____64. An ohmmeter is used to test the voltage between any two points in a lime.

_____65. A milivoltmeter is used to measure a million volts or more.

_____66. The watthour meter is a device for measuring electrical power.

_____67. After two wires have been spliced together they should be soldered.

_____68. When two wires are attached to a socket an Underwriter's knot should be tied inside the cap of the socket.

_____69. Acid flux should always be used when soldering electrical wires together.

_____70. When two insulated wires are spliced together and then soldered they need not be taped if the soldering job has been well done.

_____71. A soldering copper must be clean and tinned before soldering a splice.

_____72. A file is the best tool to use when cleaning a wire for soldering.

_____73. Splices should be taped to give insulation to the spliced area.

_____74. A number 24 wire is twice as large as a number 12 wire.

_____75. A transformer may be used only on direct current.

_____76. Materials through which an electrical current will flow with little resistance are called electrical conductors.

_____77. It is impossible for a person to be killed by coming in contact witha 110 volt line.

&_____78. Broken hammer handles may be safely repaired by winding tape over the broken part.

_____79. Stranded wire is more flexible than one solid wire of the same total side.

_____80. Fluorescent lamps are free from intense glare.

_____81. Electric clocks are expensive to operate.

_____82. A flashlight battery produces alternating current.

_____83. Glass is frequently used to make insulators for the poles of a telephone line.

_____84. The positive terminal of a battery will attract the south pole of a magnet.

_____85. When replacing a fuse the safe practive is to first turn off the master switch.

_____86. An electro magnet and a permanent magnet are the same.

_____87. Magnetic lines of force will not pass through a brick wall.

_____88. A magnetic compass is always enclosed in a steel case.

_____89. The magnetic lines of force about a bar magnet form a continuous circuit from the north pole to the south pole.

_____90. The strength of a magnet is concentrated at the poles.

_____91. To be an electric repairman a person must first be an electrical engineer.

____92. The voltage across the secondary of a transformer may be higher than the voltage across the primary.

____93. The core of a transformer is made of silver.

____94. All wires used in electrical work are covered with a layer of insulation.

____95. In homes where two or more 115 volt light bulbs are controlled by a single switch the bulbs are connected in parallel.

____96. After a splice has been soldered,and before taping, it is covered with a layer of grease to prevent corrosion.

____97. A fully charged storage battery weighs more than when discharged.

____98. For heating devices and rheostats,good conductors are used.

____99. Materials which allow an electric current to pass through them readily are called conductors.

____100. The instrument used to determine potential difference is called the voltmeter.

____101. A direct current in one in which the direction of the current is constant.

____102. An alternating current in one in which the flow reverses its direction at fixed intervals.

____103. An electric current may be produced either mechanically or chemically.

____104. Direct current will flow in an open circuit.

____105. The exact nature of electricity has been known for many years.

____106. The modern theory concerning the nature of electricity is the electron theory.

____107. The modern street cars use an electromagnet to aid in stopping the car.

____108. The filament of an incandescent lamp operates at a white hot temperature.

____109. The smaller the wire number the smaller the diameter of the wire.

____110. The purpose of flux when soldering is to indicate if the soldering copper is hot enough.

MATCHING PART V

DIRECTIONS: Column A contains 30 incomplete statements. The correct completion for these statements may be found in column B. On the line which precedes column B place the number of the partial statement from column A that is needed to make a complete and true statement.

The statements are divided into ~~5~~ 6 separate groups as shown by the lines drawn across the page. The correct completion to each partial statement is found within its own group. For example, the answers to the first five partial statements in column A will be found among the first five in column B.

Example:

1. Solder is an alloy of tin and	____ steel
	____ copper
	1 lead

COLUMN A	COLUMN B
1. A lodestone is a	____ piece of steel
2. A good conductor of electricity is a	____ buzzer
3. An electromagnet may be found in a	____ natural magnet
4. Permanent magnets are made from a	____ south pole
5. Magnets have a north pole and a	____ copper wire
6. 3 dry cells connected in series will give	____ 115 volts
7. A 3 cell storage battery will produce	____ $1\frac{1}{2}$ volts
8. A 2 cell flashlight will produce	____ $4\frac{1}{2}$ volts
9. A wall outlet in most homes will produce	____ 3 volts
10. The large size, No. 6, dry cell will produce	____ 6 volts
11. The filament of a modern incandescent lamp is made of	____ dry wood
12. The core of an electromagnet is made of	____ zinc
13. A very poor conductor of electricity is	____ tungsten
14. The center fod of a dry cell is made of	____ soft iron
15. The metal container which forms the outside of a dry cell is made of	____ carbon

1. The unit of heat is the	____	ampere
2. The unit of electrical pressure is the	____	ohm
3. The unit of electrical resistance is the	____	kilowatt
4. The unit of electrical current is the	____	calorie
5. 1000 watts equals one	____	volt

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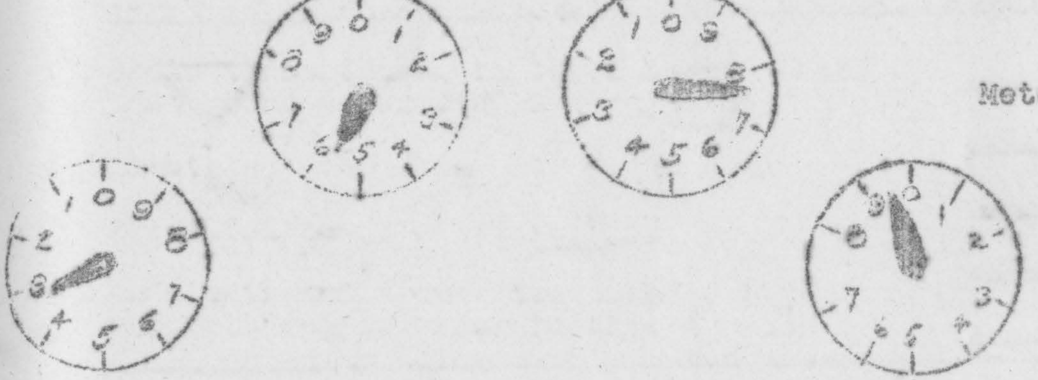
1. Radio transmission is based on the fact that sound waves can be changed to	____	neon gas
2. Electrical communication began with	____	a field coil
3. All electric motors have	____	radio waves
4. An electrically operated tubular light which is red in color is filled with	____	the receiving set
5. Static is caused by an electric charge in the atmosphere near	____	the telegraph

---

1. Electricity is a strong force that must be carefully handled to insure safety to	____	an electro magnet
2. The most efficient method of magnetizing a piece of steel is with	____	the user
3. Magnetism and electricity are	____	a secondary coil
4. A transformer has a primary coil and a	____	a magnetizing coil
5. A solenoid with its core is called	____	closely related

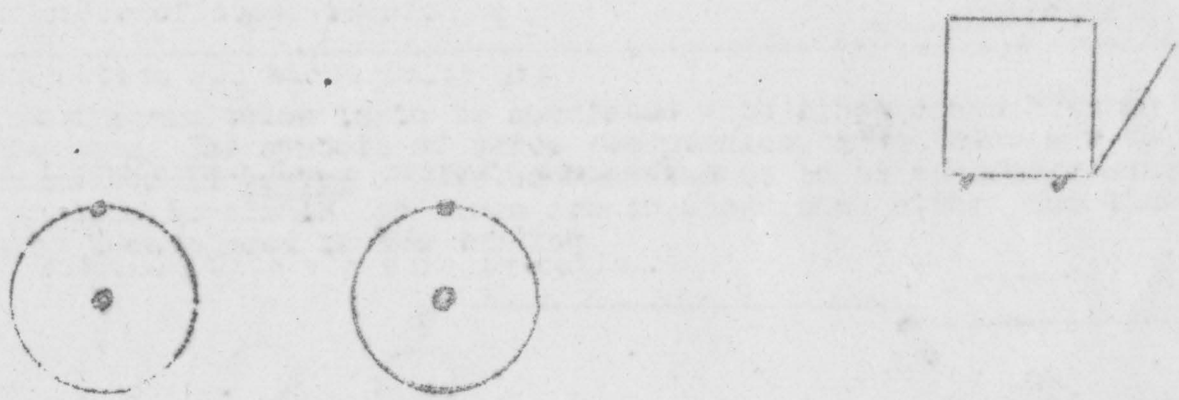
RECOGNITION AND DIAGRAM TEST PART II

1. The dials drawn below represent the four dials as they would be seen on a watt-hour meter. On the line at the right of the page write the correct reading of the watt-hour meter as shown by this illustration.

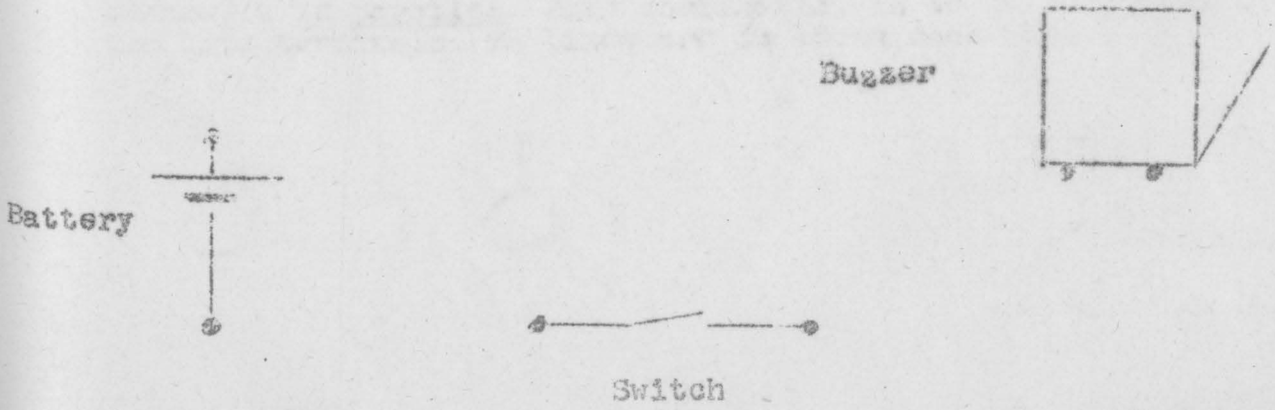


Meteb reading ________

2. Belww is drawn the top view of two dry cell batteries and the symbol for a buzzer. The batteries are to be connected to make the buzzer operate. Connect the two batteries in parallel. Make all connections between the dots. No lines are to cross each other.

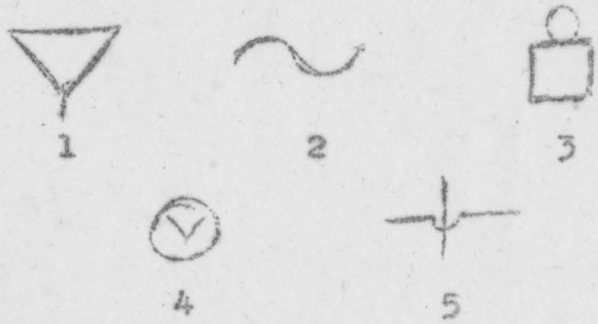


3. The diagram below is to be completed with lines drawn between the dots. The switch is to control the buzzer. No lines are to cross each other.



4. The names of the objects the following symbols represent are listed on the right of the page. Place the number of the symbol on the line before thr name of the object the symbol represents.
EXAMPLE:

A ______A______ spark gap



_____ voltmeter

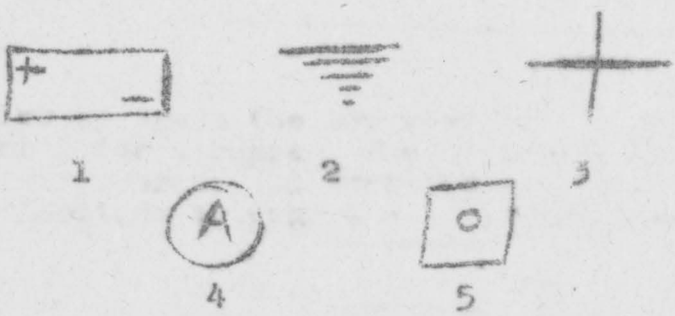
_____ bell

_____ crossing wires

_____ aerial

_____ fuse

5.



_____ push button

_____ joined wires

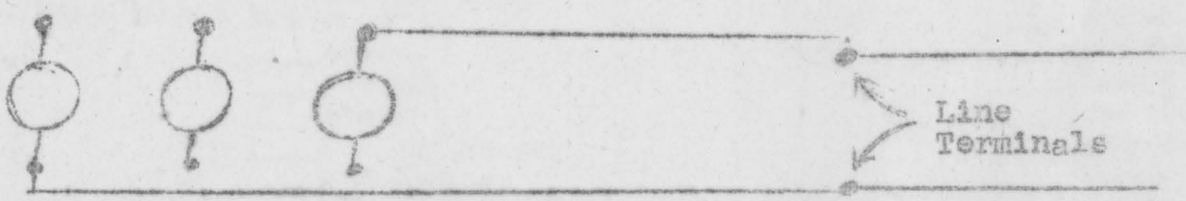
_____ storage battery

_____ grou nd

_____ ammeter

---

6. The diagram below is to be completed with lines drawn between the dots. The symbols of three receptacles shown below are to be connected in <u>series</u> . This combination is to be connected to the two line terminals. No lines are to cross each other. Two lines have been placed in the drawing.



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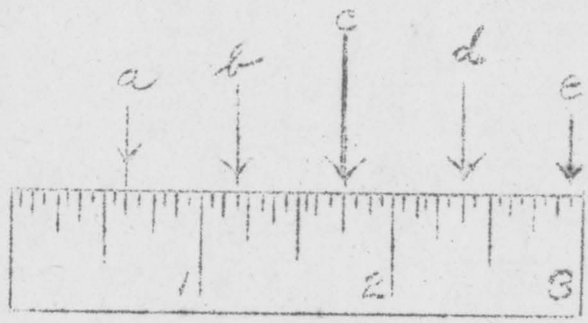
7. The diagram below is to be completed with lines drawn between the dots. The symbols of three receptacles shown below are to be connected in <u>parallel</u>. This combination is to be connected to the two lkne terminals. No lines are to cross each other.

8. The drawing below represents a 3 inch section of a ruler. The arrows point to certain measurements on the ruler. In the spaces below the drawing indicate the correct readings in inches and fractions of an inch.



0 to a ______

0 to b ______

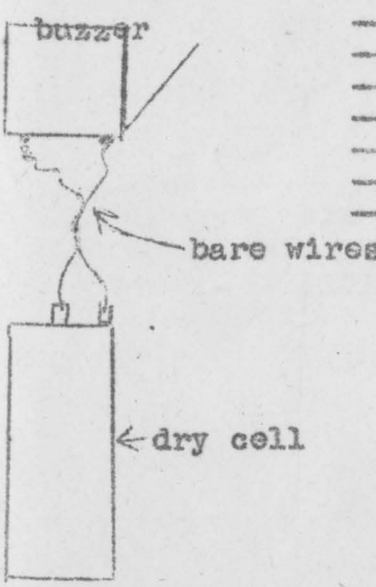
0 to c ______

0 to d ______

0 to e ______

9. Check the word which properly describes the trouble in the circuit shown below.

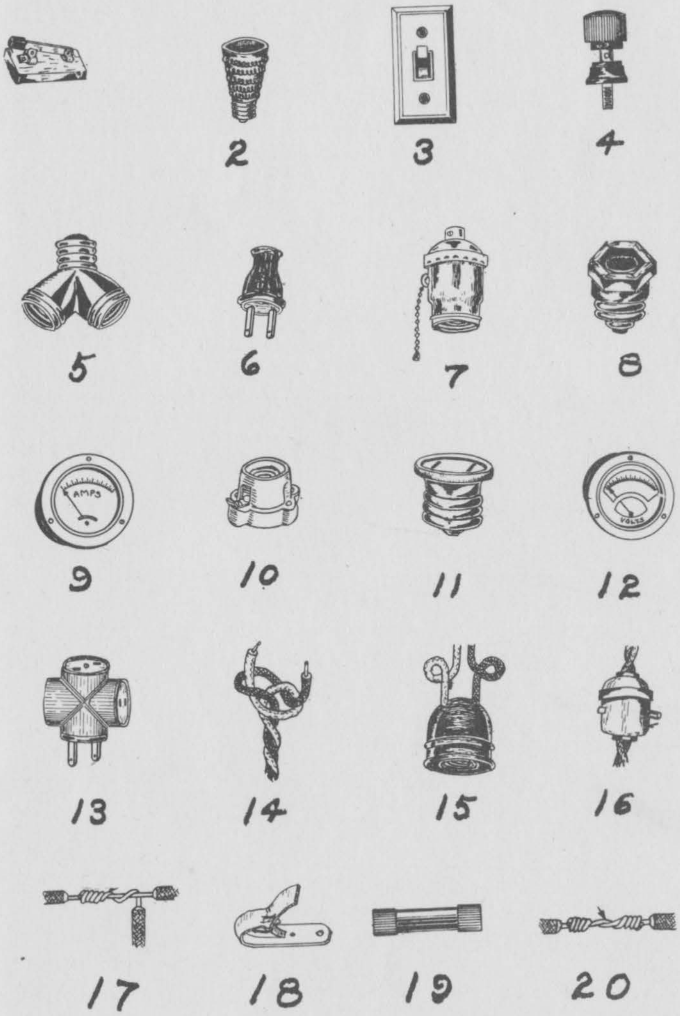
____short
____ground
____open
____out of phase
____unbalanced
____blown fuse
____wires too small



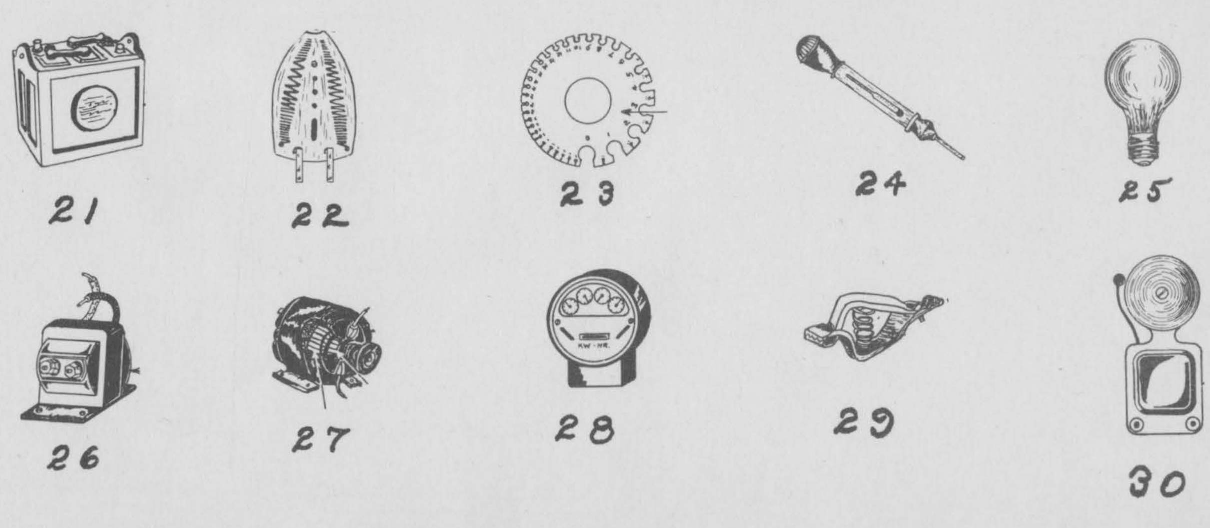
10. Check the word which properly describes the trouble in the circuit shown below.

____short
____ground
____open
____out of phase
____unbalanced
____blown fuse
____wires too sma

Thirty illustrations of objects used in elementary electrical work are shown on this page. The names of the objects are listed on the side of the page but not in their proper order. After the name of each object write the number which appears under it in the illustration.



	NO.
Underwriter's Knot	
Door Bell	
Bell Transformer	
Plug Fuse	
Porcelain Receptacle	
Cartridge Fuse	
Heater Element	
Plug	
Pull Chain Socket	
Three-way or cube plug in outlet	
Knife Switch S.P.S.T.	
Incandescent Lamp	
Fahenstock Clip	
Western Union Splice	
Tap Splice	
Storage Battery	
Battery Clip	
Wire Gauge	
Ammeter	
Kilowatt-hour meter or watt hour meter	
Motor or Generator	
Push Button Socket	
Volt Meter	
Weatherproof Socket	
Double or two-way socket	
Switch Plate	
Binding Post	
Flat Iron Element	
Hydrometer	
Plug Base	



Appendix J.

EVEN

ODD

	0-6	7-13	14-20	21-27	28-34	35-41	42-48	49-55	56-62	63-69	70-76	77-83	84-90	91-97	98-104	105-111	112-118	119-124	125-130	f	x	f x	f x²
125-130																				0	9	0	0
119-124																			1 (8)	1	8	8	64
112-118																	2 (14)	1 (7)		3	7	21	147
105-111														1 (6)		3 (18)	1 (6)			5	6	30	180
98-104														1 (5)	11 (55)	3 (15)				15	5	75	375
91-97													2 (8)	13 (52)	12 (48)	4 (16)				31	4	124	496
84-90											1 (3)	3 (9)	17 (51)	19 (57)	3 (9)					43	3	129	387
77-83											7 (14)	17 (34)	17 (34)	2 (4)		1 (2)				44	2	88	176
70-76									1 (1)	6 (6)	15 (15)	16 (16)	8 (8)							46	1	46	46
63-69								1 (0)	6 (0)	27 (0)	24 (0)	7 (0)	1 (0)							66	0	0	0
56-62							1 (-1)	7 (-7)	18 (-18)	24 (-24)	14 (-14)	3 (-3)								67	-1	-67	67
49-55						3 (-6)	3 (-6)	21 (-42)	17 (-34)	4 (-8)										48	-2	-96	192
42-48					1 (-3)	7 (-21)	20 (-60)	21 (-63)	6 (-18)											55	-3	-165	495
35-41				1 (-4)	7 (-28)	12 (-48)	21 (-84)	5 (-20)	1 (-4)	1 (-4)										48	-4	-192	768
28-34				7 (-35)	5 (-25)	13 (-65)	3 (-15)													28	-5	-140	720
21-27			1 (-6)	4 (-24)	7 (-42)	1 (-6)														13	-6	-78	468
14-20				6 (-42)																6	-7	-42	294
7-13		4 (-32)	3 (-24)																	7	-8	-56	448
0-6		2 (-18)																		2	-9	-18	162
																						-333	5485
f		6	4	18	20	36	48	55	49	62	61	46	45	36	26	11	3	1	1	528			
Y	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9				
f Y	0	-48	-28	-108	-100	-144	-144	-110	-49	0	61	92	135	144	130	66	21	8	9	-45	Σf Y		
f Y²	0	384	196	648	500	576	432	220	49	0	61	184	405	576	650	396	147	64	81	5569	Σf Y²		
f x	0	-50	-30	-105	-98	-146	-166	-132	-73	-30	18	56	101	124	112	51	20	7	8	-333	Σf x		
f x Y	0	400	210	630	490	584	498	264	73	18	112	303	496	560	306	140	56	72			Σf x Y		

Σf x Σf x²

check

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