

1947

## A testing program in industrial arts.

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A TESTING PROGRAM IN INDUSTRIAL ARTS



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A TESTING PROGRAM IN INDUSTRIAL ARTS

by

Albert R. Studer

A THESIS PRESENTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE

UNIVERSITY OF MASSACHUSETTS

AMHERST, MASSACHUSETTS

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TABLE OF CONTENTS

TABLE OF CONTENTS

|                             |     |
|-----------------------------|-----|
| TABLE OF CONTENTS . . . . . | iii |
| INDEX OF TABLES . . . . .   | vi  |

---

CHAPTER I - INTRODUCTION

|                                               |    |
|-----------------------------------------------|----|
| REASON FOR TESTING PROGRAM . . . . .          | 2  |
| PURPOSES AND ASSUMPTIONS OF TESTING . . . . . | 3  |
| ADVANTAGES OF TESTING PROGRAM . . . . .       | 4  |
| PURPOSES OF THE THESIS . . . . .              | 7  |
| OBJECTIVE OF TESTING PROGRAM . . . . .        | 11 |

CHAPTER II - COMPILING TEST

|                                                         |    |
|---------------------------------------------------------|----|
| COOPERATIVE TESTS . . . . .                             | 13 |
| MAINTAINING HIGH STANDARDS IN INDUSTRIAL ARTS . . . . . | 14 |
| USE OF STANDARDIZED TESTS . . . . .                     | 15 |

CHAPTER III - ADMINISTERING, SCORING, AND RANKING TESTS

|                                                          |    |
|----------------------------------------------------------|----|
| TIME ALLOTTED FOR TEST . . . . .                         | 18 |
| TESTING NEWTON BOYS . . . . .                            | 19 |
| TESTING READING BOYS . . . . .                           | 19 |
| TESTING MALDEN BOYS . . . . .                            | 20 |
| RETESTING IN THE DAY JUNIOR HIGH . . . . .               | 20 |
| TESTING WITH DETROIT MECHANICAL APTITUDE TEST . . . . .  | 20 |
| TESTING 100 DEDHAM EIGHTH GRADE BOYS . . . . .           | 20 |
| RESPONSIBILITY FOR GIVING AND SCORING THE TEST . . . . . | 21 |
| RANKING THE TEST SCORES . . . . .                        | 21 |

CHAPTER IV - ANALYSIS OF TEST RESULTS

|                         |    |
|-------------------------|----|
| ITEM ANALYSIS . . . . . | 24 |
|-------------------------|----|

|                                                                                 |     |
|---------------------------------------------------------------------------------|-----|
| GROUPS USED IN ITEM ANALYSIS . . . . .                                          | 24  |
| RENUMBERING TEST QUESTIONS . . . . .                                            | 31  |
| PROCESS OF ELIMINATION . . . . .                                                | 31  |
| WEIGHING PARTS OF TEST . . . . .                                                | 34  |
| EVALUATION OF TEST BY TWENTY-FIVE GREATER BOSTON<br>SHOP TEACHERS . . . . .     | 36  |
| QUARTILE AND DECILE DISTRIBUTION OF SCORES . . . . .                            | 38  |
| DETERMINING THE RELIABILITY OF THE TEST . . . . .                               | 42  |
| DETERMINING THE VALIDITY OF THE TEST . . . . .                                  | 43  |
| COMPARING THE RELIABILITY AND VALIDITY WITH<br>STANDARDIZED TESTS . . . . .     | 50  |
| ACHIEVEMENT IN INDUSTRIAL ARTS CLASSES AS<br>INDICATED BY SHOP MARKS . . . . .  | 50  |
| <u>CHAPTER V - SUMMARY AND CONCLUSIONS</u>                                      |     |
| SUMMARY OF ANALYSIS RESULTS . . . . .                                           | 53  |
| RELIABILITY OF REVISED INDUSTRIAL ARTS TEST . . . . .                           | 53  |
| VALIDITY OF REVISED INDUSTRIAL ARTS TEST . . . . .                              | 54  |
| NO COMPARISONS MADE OF THE SCHOOLS TESTED . . . . .                             | 55  |
| QUESTIONS NOT USED IN REVISED TEST . . . . .                                    | 55  |
| MANIPULATIVE SKILL TEST . . . . .                                               | 55  |
| OTHER INFLUENCING FACTORS . . . . .                                             | 56  |
| DETROIT MECHANICAL APTITUDE TEST NOT GOOD FOR<br>VALIDITY CORRELATION . . . . . | 56  |
| FUTURE OF REVISED INDUSTRIAL ARTS TEST . . . . .                                | 56  |
| PROBLEMS FOR FURTHER STUDY . . . . .                                            | 57  |
| <u>APPENDICES</u> . . . . .                                                     | 58  |
| <u>BIBLIOGRAPHY</u> . . . . .                                                   | 112 |

LIST OF TABLES

LIST OF TABLES

|                   |                                                                                                                          |    |
|-------------------|--------------------------------------------------------------------------------------------------------------------------|----|
| <u>TABLE I</u>    | . . . ITEM ANALYSIS . . . . .                                                                                            | 25 |
| <u>TABLE II</u>   | . . . NEWTON INDUSTRIAL ARTS TEST - 500 SCORES<br>AVERAGED AND SCORED . . . . .                                          | 32 |
| <u>TABLE III</u>  | . . . NEWTON INDUSTRIAL ARTS TEST - REVISED TEST                                                                         | 35 |
| <u>TABLE IV</u>   | . . . MEAN SCORES OF 6 SECTIONS OF 500 INDUSTRIAL<br>ARTS TESTS COMPARED TO MEAN SCORES OF 100<br>DEDHAM TESTS . . . . . | 36 |
| <u>TABLE V</u>    | . . . QUARTILE & DECILE DISTRIBUTION OF 500<br>INDUSTRIAL ARTS TEST SCORES . . . . .                                     | 39 |
| <u>TABLE VI</u>   | . . . DISTRIBUTION - 100 DEDHAM INDUSTRIAL ARTS<br>TEST SCORES . . . . .                                                 | 40 |
| <u>TABLE VII</u>  | . . . DISTRIBUTION OF 500 INDUSTRIAL ARTS TEST<br>SCORES . . . . .                                                       | 41 |
| <u>TABLE VIII</u> | . . . COMPUTATIONS - INDUSTRIAL ARTS - ODD SCORES<br>RELIABILITY . . . . .                                               | 44 |
| <u>TABLE IX</u>   | . . . COMPUTATIONS - INDUSTRIAL ARTS RETEST -<br>SECOND MARK - RELIABILITY . . . . .                                     | 45 |
| <u>TABLE X</u>    | . . . COMPUTATIONS - 100 DETROIT MECHANICAL<br>APTITUDE TEST SCORES - VALIDTY . . . . .                                  | 47 |
| <u>TABLE XI</u>   | . . . COMPUTATIONS - 200 9TH GRADE INDUSTRIAL<br>ARTS TEST SCORES - VALIDITY . . . . .                                   | 48 |
| <u>TABLE XII</u>  | . . . COMPUTATIONS - 35 MIDDLE DIVISION 8TH<br>GRADE INDUSTRIAL ARTS TEST SCORES -<br>VALIDITY . . . . .                 | 49 |



CHAPTER I

INTRODUCTION

## CHAPTER I

### INTRODUCTION

REASON FOR TESTING PROGRAM. - Since every boy in the Junior High Schools of Newton must take Industrial Arts in the seventh and eighth grades, it was decided to measure their progress by an objective test. A Testing Program in the Junior High School Industrial Arts should be concerned with student progress on a broad scope. Industrial Arts is no longer considered only a manual field. It is a broad exploratory subject embracing many of the manifold arts and sciences of industry.

In some areas the student has actual contact with the tools, projects, and processes of industry. In other areas he is exposed to the many industrial processes through discussions, films, literature, posters, charts, industrial exhibits, and visits to industry. How well the student masters this knowledge and the degree of retention of the subject matter is one of the main objectives of this Testing Program in Industrial Arts. It can also be used as a potential yardstick by the instructor to measure his own teaching.

It is apparent that there is a definite need for more testing in Industrial Arts. There is a very limited selection of standardized tests, and most of them are obsolete because of their antiquity. The United States Office of Education in its Testing Bulletin compares the

amount of testing done in the different high school departments, "It is not especially surprising to note that the mathematics department gives the largest number of tests, 10.5, or that fine arts gives the smallest number, 3.4. The mathematics, science, and commercial departments give the largest number of tests, while the industrial arts, physical education, and fine arts departments give the smallest number."<sup>1</sup> "Teachers are interested in obtaining test results which will predict a pupil's probable success in their subject. While such tests are only available in a few of the departments, it appears that all departments would like such results if they existed. The two departments in which the largest percentage of teachers would like such results are industrial arts and mathematics."<sup>2</sup>

PURPOSES AND ASSUMPTIONS OF TESTING. - The testing movement in education has been one of the most remarkable developments of the last quarter century. Little was done with the measurement of mechanical abilities before World War I. Since that time all types of testing programs have been developed rather extensively. In World War II more tests than ever before were administered for selection and placement of personnel. The writer had considerable experience in testing carpenters for admission to the technical school training program for carpenters at Camp Lee, Virginia.

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1. Lee, J. M. & Segel, D., Testing Practices of High School Teachers, United States Office of Education, Bulletin 1936, No. 9, p. 2.

2. Ibid. p. 31

It has been a common practice for teachers to accept testing uncritically. If a test is printed or typewritten, it has usually been acceptable. Teachers have bought or devised their own tests with very little thought or analysis as to their practical use in a specific educational program. Little or no thought has been given to verify a test to see if it is standardized, and under what circumstances it was standardized. A good test should be objective, reliable, valid, as well as pertinent. On the whole, few teachers have been properly trained to devise an objective test or have learned how to select and use a standardized test form intelligently. The very realistic comment on this point is as follows: "It may be safely said that not all published tests are good, that not all good tests are valid or reliable in the hands of many purchasers, and that not all good tests when properly given contribute effectively to an improvement of teaching."<sup>3</sup>

ADVANTAGES OF TESTING PROGRAM. - Tests of some kind are necessary to encourage progress and raise the standards in any specific field. Industrial Arts is no exception, and to better analyze this progress is one of the fundamental purposes of this thesis.

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3. Osborn, C. L., Epsilon Pi Tau Review, A Symposium on Testing, Ohio State University, Columbus, Ohio, Vol. II, 1931, p. 14

Fryklund gives the following reasons for testing:

1. "To present objective standards to the pupils.

It is well for the learner to know that at a given time he will be held to account for certain achievements in a given course. The necessity for really learning subject content and developing mastery of skills is not always apparent to the learner. The class work of the non-examining instructor is often neglected in favor of the one who does examine. It is an excellent means of coercion to induce study.

2. To measure pupil achievement. Ideational learning and skills should be measured in the shop. This can be done by requiring the learner to react to selected questions, and to perform selected skills which sample the instructional units of the course up to the time of the test. The results should be recorded and comparisons should be made during the progress of the course in order to secure an objective record of achievement.

3. To improve teaching. Tests tend to measure the teacher's method, organization of subject-matter, attempt to diagnose pupil difficulties, and perhaps, last and not least, the teacher's general influence.

A change in method may bring about a change in test results. The organization of subject-matter may be faulty and thus show in low test scores. This may occur when learning units are too large; and, too, it may mean that there is a lack of learning units of any kind. Proper

changes may show improvement in test results. Pupil difficulties and peculiarities can be detected through testing, and remedial measures may be applied. The teacher's general influence in promoting morale deserves special attention when examining test scores. Improvement in any phase of teaching should result in better pupil achievement and better test results.

4. To diagnose pupil difficulties. The program of testing is functioning effectively and most worthily when it is used for diagnostic purposes. All tests cannot be used for this purpose, however. Special attention should be given to detailed analysis when constructing highly effective tests for diagnosis. Tests are valuable for determining the needs of each individual in a given course.

5. To compare one class or one school with another. At the present time newer methods of selecting subject-matter are enabling shop teachers to define units that will provide a means of standardization. The use of standardized tests based upon standardized units will enable comparison of one shop class with another in the same school or in other schools. Whether standardized learning units are desirable remains an unanswered question in shopwork.

6. To provide guidance data. Tests should provide information with respect to abilities and disabilities of the learners. Continued failure is an indication that a learner is not making connections in a given subject.

When remedial measures fail and mental test results verify the opinions of the teachers, it is probable that the school can do little for the learner in a given subject. He should not be encouraged to enter a field that requires an accurate knowledge of a subject in which he is consistently weak. Achievement tests cannot reveal undeveloped tendencies. Tests are based upon experience. The result of experience shows indirectly in the test results, and it is following experience that the tests are used. Guidance data are thus secured.

7. To provide promotional data. So long as promotion depends in a large degree upon accomplishment, tests will be of value in measuring this accomplishment."<sup>4</sup>

PURPOSES OF THE THESIS. - There is a definite need for a testing program in Industrial Arts to evaluate the program of studies in shopwork, to measure retention, and to measure effectiveness of teaching, also for the selection and placement of trade school candidates. Newkirk & Stoddard bear this out with the following: "Testing has reached its greatest proportions in the elementary grades, but it is now very prevalent among high schools, and a large number of fairly well standardized tests are available. Of these a good share extend downward into the junior high school years, and a few have been published in the special

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4. Fryklund, V.C., Epsilon Pi Tau Review, A Symposium on Testing, Ohio State University, Columbus, Ohio, Vol. II, 1931, pp. 27-29

field of industrial arts."<sup>5</sup> The test used was assumed to measure general shop ability. Like most tests, it could be used for educational diagnosis and prognosis. However, it is also valuable for its vocational and social guidance values as well. In these fields, Industrial Arts contributes more than the other subjects of the curriculum.

The limitations of guidance are clearly explained by Abelson in the following paragraph: "The dull children, who have been shown not to succeed well in academic subjects, would then be suited to shop work. Suppose the correlation were about zero. The dull have only an equal chance with the bright of succeeding in shop work, but they have a much poorer chance of succeeding in academic work. Hence, shop work shows the greater promise for them as a group. Suppose, that a distinct positive correlation between shop work and intelligence be found. Superficially, it would seem that since the dull child is likely to do poorer work than the bright in both the academic and the shop work, he might be given either, or none, for that matter. But another consideration enters. The coefficient of correlation indicates relative success. While doing less than the bright, the dull child may still derive some benefit from his schooling. The question then arises, will he derive more benefit from academic work than he will from shop work? Granting that he has received a common basic

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5. Newkirk, L.V. & Stoddard, G.D., The General Shop, p. 134



elementary school training, and that in his after-school life he is more likely to engage in manual than in academic activities, again it seems reasonable to offer shop work rather than academic work to the dull child."<sup>6</sup>

There seems to be no close relation between mechanical ability and environment, and it seems rather conclusive that mechanical ability is largely innate. There appears to be no general factor in mechanical ability. Also, it is not completely specific, in fact, rather definite conclusions were drawn that overlapping factors are at work. Somewhat definite implications for vocational education were drawn.

1. The uniqueness of mechanical ability with respect to abstract intelligence, motor agility, and strength cannot be overemphasized. The possibility of salvaging individuals with low I.Q.'s possessing mechanical ability is so obviously worth following up as to require no further defense.

2. Indications that our present educational program and even the methods of recruiting for industry fail to select for training or employment those best equipped with mechanical ability. A program of industrial education and industrial recruiting based primarily upon a policy of selecting only those definitely possessing mechanical ability is strongly needed.

3. There is no more reason for placing an academic

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6. Abelson, H.H., The Art of Educational Research, p. 40

failure who lacks mechanical ability into an industrial course than there is for forcing a boy with a low I.Q. into an academic high school.

4. The attention of shop teachers may well be directed towards the possibility of improving methods of measuring achievement in shop work. The methods utilized in the building of the quality criterion in the experiment proper might well be incorporated into current practice. Much research is needed by Industrial Arts teachers who are well trained in the techniques of educational measurement towards developing reliable achievement - measuring devices in shop subjects. This movement will furnish the best corrective for the questionable practice encountered from time to time which consists in giving a boy a high grade in a shop course merely as a bribe to manifest interest in that particular shop course.

5. Motivation for a higher degree of skill in manipulating tools and materials will be gained with increased precision in measuring achievement.

6. A policy of permitting the pupils to measure their own products and the products of their classmates opens the way for realizing an important objective, namely, development of critical judgment, with respect to good workmanship."<sup>7</sup>

Newkirk and Greene consider testing essential in

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7. Patterson, Elliott, Anderson, Toops, Heidbreder, and others, "Mechanical Ability", Minnesota Mechanical Ability Tests, p. 302

the following: "The marked increase in the interest in educational measurements on the part of teachers of industrial education is not surprising. It is to be expected of a group of teachers who have had to face the many problems of a new and growing unit of instruction. In many ways the teachers of industrial education are most fortunate. They are working in a new and growing field of instruction which rapidly is becoming organized in the light of modern educational objectives. They have the advantages of all the methods and techniques that have been developed for measurement in other fields. They are in a position to utilize the good and discard the worthless results of earlier efforts. From the standpoint of professional qualifications and classroom efficiency, it is the industrial education teacher's business to understand these well-established principles and their special application and use in their own fields of instruction."<sup>8</sup>

OBJECTIVE OF TESTING PROGRAM. - The primary purpose of this Testing Program in Industrial Arts is to qualify individuals as to their degree of ability in the subject. The preceding references and statements qualify the need for research in this field. Too much emphasis has been placed on the manipulative and not enough on the educational-informational phase of industrial education. As an exploratory subject, this part of industrial education needs greater prominence.

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8. Newkirk & Greene, Tests and Measurements in Industrial Education, p. 2

CHAPTER II

COMPILING TEST

## CHAPTER II

### COMPILING TEST

COOPERATIVE TESTS. - All members of the Industrial Arts Department contributed questions for the test. The teachers in the general wood shops wrote the questions on wood-working and allied industries. The general metal work and the graphic arts teachers contributed in their areas also. There were ten instructors who made up the questions of the test. The original tests had about 200 questions in each area. The original drafts of questions were revised by popular consent of the three groups, and as a result, the product was the Industrial Arts Test that has been used for this research problem.

The program of studies or curriculum guides were used in developing the questions of the test. By using this agenda as the guiding factor, it was intended to increase the potential validity of the test. By making the original test long with the use of 200 questions, the possibility of a high coefficient of reliability was all but assured. It is commonly accepted by authorities on measurement that an objective test should have 100 or more questions to have sufficient reliability to be pertinent as a measuring device.

"The cooperative construction of tests within a department is a very desirable procedure and will result in better constructed test items, more representative items

(for the course concerned), and a larger number of items than in the case when tests are made out for each class by an individual teacher."<sup>1</sup>

"It seems to the writers that an excellent method of improving instruction in a department is to develop cooperative tests to be used by all teachers of indetical subjects. It is encouraging to note that one teacher in six is already using department tests as final examinations."<sup>2</sup>

Tests made on a cooperative basis within a department tend to promote the subject. All teachers have a chance to voice any pet phase or areas of the subject for confirmation by the group. In this way, it establishes the subject as well as the test on a more sound basis. It also tends to promote a greater interest in testing, and the results that accrue from measuring. Strength and weaknesses are made apparent, and it is by this analysis that the most favorable results from testing develop.

MAINTAINING HIGH STANDARDS IN INDUSTRIAL ARTS. - If Industrial Arts teachers and supervisors wish to maintain a high standard of achievement, they must first consider what a test proposes to measure. How effectively does it measure, what does it reveal about the boy, and for what good purposes can the information be used? Does it measure the effectiveness

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1. Lee, J.M. & Segel, D., Testing Practices of High School Teachers, United States Office of Education, Bulletin 1936, No. 9, p. 34

2. Ibid, p. 14

of the instructor's pedagogy?

• Ruch and Stoddard have the following to say:

"It is probably true that any field of knowledge which can be analyzed into its unit skills, knowledge, and abilities to a greater degree, than permits the teaching of its subject-matter by a method better than rule of thumb can be measured by tests with validity as great as that underlying such analysis and such teaching methods."<sup>3</sup>

USE OF STANDARDIZED TESTS. - The use of standardized tests is no longer thought of as an experimental feature. They have proven their place in the every day school program. A track coach would not pick boys with long legs at random for a 100-yard dash. He would first test a heterogeneous group or groups, and then pick his best men. This idea has to be foremost in mind in making up test questions that will tend to discriminate between the high and low students.

Validity. All educational tests and measurement are concerned with reliability and validity. These are the fundamental requirements of a good test if it is to serve its purpose. It is necessary in constructing a test to know if a test question measures the trait it is intended to measure. Also, there should be a high correlation between the test scores secured and proficiency in the

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3. Ruch, G.M. & Stoddard, G.D., "Manipulative Skills",  
Tests and Measurement in High School Instruction,  
p. 7

subject or activity chosen as a criterion.

Reliability. - The second general requirement of a good test is that of reliability. It is said that a test is reliable when it gives consistent results. A test of ability which gives different results at different times is useless as a good test.

The development of psychological testing has pointed out that a few good tests or test elements are more effective than a larger number of mediocre tests. This phase made the choice of test questions a very critical analysis by the department members. Each submitted question had to be weighed and reweighed in view of its effectiveness.

After final selection of the 200 original test questions, a sampling was given to a few boys. Then the questions were put in their estimated order of difficulty. The easiest question was first, and the most difficult was last. In an objective type test, this is known as scaling. The sampling did not give very accurate results as far as the scaling was concerned. This will be shown more clearly in the item analysis of the fourth chapter on "Analysis of Test Results."



CHAPTER III

ADMINISTERING, SCORING AND RANKING TESTS

### CHAPTER III

#### ADMINISTERING, SCORING AND RANKING TESTS

TIME ALLOTTED FOR TEST. - A careful time check was kept on the sampling of the original test. The average time was fifty minutes, so it was decided to limit test time to fifty minutes. A score key was made up using regular answer sheet form, and by folding it into six sections, it was convenient in checking scores. A score box helps to speed up the scoring when there are several tests to correct. These plans helped to increase the efficiency of the administration of the test.

The following set of directions were used in the administration of the test:

#### INDUSTRIAL ARTS TEST

(Allow exactly 50 minutes to complete the test.)

#### DIRECTIONS:

1. Every boy in the junior high school should take this test irrespective of his present or previous industrial arts experience.
2. Note answer sheet. Pupils should write carefully the information requested in the upper left-hand section of the sheet. Note especially the following:
  - a. "Teacher"--pupil should write the name of his present or last industrial arts teacher.
  - b. "Ent. J.H.S. from"--pupil should write only the name of the school, if it were a Newton Public School.  
Otherwise, he should write the name and grade of the school.

c. "M.A. \_\_\_\_\_ C.A. \_\_\_\_\_ I.Q. \_\_\_\_\_" (See box in upper right-hand corner.) Teacher should supply C.A. and I.Q. after the test has been administered and the sheets collected. The M.A. will be computed at the Central Office. The C.A. may be obtained by adding 8 months to the pupil's October first age as recorded in the register. The I.Q. is readily available on sheets prepared by the testing representative in each school.

3. Pupils have taken this type of test many times before. Therefore, no difficulty with the mechanics of administering is expected. Be sure, however, that every pupil understands how to use the answer sheet before giving the signal for the class to start.
4. Once work has begun, the examiner should circulate among the group to see that pupils understand how to record answers.
5. Caution pupils against writing or marking in any way the sheets containing the test items.
6. Allow 50 minutes of net working time.

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TESTING NEWTON BOYS. - All the boys in Newton were tested in 7th, 8th, and 9th grade levels. The test results that this thesis is concerned with are the test results in the Day Junior High School. One hundred 8th grade test results and one hundred 9th grade test results were used which is the approximate total enrollment of boys in those two grades. The directions for the test were used in administering the test. The tests were corrected by the writer and a clerk.

TESTING READING BOYS. - One hundred 8th grade and one hundred 9th grade boys were tested in Reading. The shop program is very similar to the one in Newton, and the scores were about the same. Again the same set of directions were used, and the results were corrected by the same scorers.

TESTING MALDEN BOYS. - One hundred 8th grade boys were tested in Malden. Their shop program is much the same as Newton and Reading; notably a general wood shop, a general metal shop, and a graphic arts shop. Score results here were checked in the usual manner with very little variation from the other scores checked previously. Directions were followed as in the two previous cases.

RETESTING IN THE DAY JUNIOR HIGH. - The same hundred 8th grade boys were retested using the same test and following the same directions. Scoring was done in the same manner as the first testing. These scores are to be used later in this thesis in checking for reliability.

TESTING WITH DETROIT MECHANICAL APTITUDE TEST. - The same hundred 8th grade boys of the Day Junior High were given the Detroit Mechanical Aptitude Test. Test directions were followed from the manual of directions that goes with this test. Scoring was done by the writer and results were used in obtaining a validity correlation in the following chapter.

TESTING 100 DEDHAM EIGHTH GRADE BOYS. - The writer conceived the idea of testing one hundred 8th grade boys who had never been exposed to a shop program. In this way, it is planned to check the value of the test questions as well as the subject matter content. In testing the above boys, those who had had any previous shop experience were eliminated. The one hundred who were left had no formal shop experience in school. The same directions were used with these boys,

and they were scored in the same manner as the other Industrial Arts Tests.

RESPONSIBILITY FOR GIVING AND SCORING THE TEST. - The writer, because of the nature of this study, administered and scored almost all the tests given in this thesis. Those that were scored by others were under his direct supervision, so that the objectivity was constant at all times. Newkirk & Greene have the following to say: "The matter of determining the responsibility for giving and scoring educational tests rests chiefly upon the function the tests are expected to perform. If the tests are of the narrow-function type, closely paralleling the course of study taught by the teacher, they should undoubtedly be given by the teacher himself. If they are designed for survey purposes, they should probably be given by some one representing the administrative office of the school. Since these latter uses of the modern educational test are by far in the minority in most school systems, it is obvious that most of the classroom testing will be done by the classroom teacher."<sup>1</sup>

RANKING THE TEST SCORES. - The 500 scores of the boys whose tests were used in this research are to be found in the following pages. Other reference will be made to the use of these figures, but the next step after scoring was to rank the individuals who took the test and to place their

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1. Newkirk & Greene, Tests and Measurements in Industrial Education, p. 54

scores in descending order. Tiegs & Crawford have the following information: "High ranks signify high scores. Let us note here that in statistical work, it is advisable to let a high rank be represented by a high number, and not by a low one, as in popular practice. Thus, the highest person in a group of 58 students has rank 58, and not rank 1. Consistent following of this standard practice will save much confusion and error."<sup>2</sup>

2. Tiegs, E.W. & Crawford, C.C., "Ranking Tests", Statistics for Teachers, p. 74

CHAPTER IV

ANALYSIS OF TEST RESULTS

## CHAPTER IV

### ANALYSIS OF TEST RESULTS

ITEM ANALYSIS. - The first task of the analysis of the 500 Industrial Arts Tests was to make an item analysis. A master sheet was used to tabulate the results of the 500 scores showing the 200 test items in terms of right, wrong, or blank. The results were added up and checked. They were then changed into percent. For comparison purposes, the percents seemed more accurate because some of the comparisons were made with different size groups. This Item Analysis appears as Table I.

GROUPS USED IN ITEM ANALYSIS. - The four groups used on the item analysis were the original 500 Industrial Arts Test scores. From these results the top 50 (10th decile) and the low 50 (1st decile) were chosen for a check on discrimination. Also an analysis of the 100 Dedham scores on the Industrial Arts Test were used. Some very interesting results were observed in making the comparisons of these four different groups of test results.

In some instances the Dedham boys who had no Industrial Arts in school had almost double the correct number of responses as compared to the Low 50 Scores. These test questions were not considered as good questions. In Test IA, questions 28 and 29, the Top 50 Scorers all had the answers correct. These questions obviously were too easy as the Low 50 Scores averaged 84, and 78 percent correct. The Dedham Scores on these two questions were both 62 percent



TABLE I

ITEM ANALYSIS

Industrial Arts Test Scores - 600 Tests

% Right

% Wrong

% Blank

TEST I A

| 500 Scores |      |      | Top 50 Scores |     |    | Low 50 Scores |    |    | 100 Dedham Scores |    |    |    |
|------------|------|------|---------------|-----|----|---------------|----|----|-------------------|----|----|----|
| R.         | W.   | B.   | R.            | W.  | B. | R.            | W. | B. | R.                | W. | B. |    |
| 1.         | 82.2 | 17.2 | .6            | 90  | 10 | 0             | 84 | 14 | 2                 | 94 | 6  | 0  |
| 2.         | 87.  | 11.2 | 1.8           | 90  | 8  | 2             | 82 | 14 | 4                 | 6  | 56 | 38 |
| 3.         | 82.  | 15.4 | 2.6           | 98  | 2  | 0             | 56 | 38 | 6                 | 67 | 24 | 9  |
| 4.         | 59.8 | 35.4 | 4.8           | 74  | 26 | 0             | 50 | 36 | 14                | 4  | 73 | 23 |
| 5.         | 39.4 | 57.6 | 3.            | 62  | 36 | 2             | 16 | 76 | 8                 | 22 | 57 | 21 |
| 6.         | 35.6 | 56.6 | 7.8           | 48  | 50 | 2             | 20 | 70 | 10                | 11 | 50 | 39 |
| 7.         | 12.2 | 73.2 | 14.6          | 20  | 76 | 4             | 6  | 68 | 26                | 6  | 48 | 46 |
| 8.         | 26.  | 50.2 | 23.           | 58  | 36 | 6             | 14 | 60 | 26                | 14 | 49 | 37 |
| 9.         | 3.2  | 87.4 | 9.4           | 12  | 88 | 0             | 0  | 88 | 12                | 5  | 77 | 18 |
| 10.        | 41.6 | 36.8 | 21.6          | 72  | 24 | 4             | 18 | 46 | 36                | 13 | 51 | 36 |
| 11.        | 41.4 | 54.  | 4.6           | 90  | 10 | 0             | 16 | 78 | 6                 | 29 | 58 | 13 |
| 12.        | 79.  | 10.6 | 10.4          | 98  | 2  | 0             | 66 | 22 | 12                | 26 | 45 | 29 |
| 13.        | 50.8 | 42.6 | 6.6           | 72  | 26 | 2             | 32 | 58 | 10                | 8  | 77 | 15 |
| 14.        | 44.  | 52.  | 4.            | 50  | 50 | 0             | 42 | 50 | 8                 | 4  | 73 | 23 |
| 15.        | 62.2 | 29.  | 8.8           | 86  | 14 | 0             | 26 | 46 | 28                | 32 | 45 | 23 |
| 16.        | 38.6 | 49.8 | 11.6          | 80  | 16 | 4             | 14 | 64 | 22                | 18 | 62 | 20 |
| 17.        | 58.4 | 32.8 | 8.8           | 84  | 16 | 0             | 28 | 50 | 22                | 16 | 59 | 25 |
| 18.        | 24.4 | 41.  | 34.6          | 34  | 64 | 2             | 20 | 40 | 40                | 15 | 39 | 46 |
| 19.        | 51.4 | 44.2 | 4.4           | 72  | 26 | 2             | 52 | 42 | 6                 | 16 | 58 | 26 |
| 20.        | 28.  | 55.  | 17.           | 50  | 44 | 6             | 20 | 56 | 24                | 6  | 38 | 56 |
| 21.        | 12.  | 81.6 | 6.4           | 30  | 70 | 0             | 8  | 80 | 12                | 10 | 69 | 21 |
| 22.        | 54.  | 34.4 | 11.6          | 74  | 22 | 4             | 36 | 46 | 18                | 5  | 53 | 42 |
| 23.        | 52.  | 26.4 | 21.6          | 88  | 10 | 2             | 18 | 44 | 38                | 30 | 29 | 41 |
| 24.        | 16.8 | 56.2 | 27.           | 30  | 66 | 4             | 6  | 58 | 36                | 8  | 57 | 35 |
| 25.        | 52.2 | 31.  | 16.8          | 92  | 8  | 0             | 22 | 48 | 30                | 37 | 32 | 31 |
| 26.        | 14.  | 45.8 | 40.2          | 20  | 60 | 20            | 12 | 36 | 52                | 8  | 33 | 59 |
| 27.        | 39.  | 38.6 | 22.4          | 68  | 30 | 2             | 12 | 50 | 38                | 9  | 52 | 39 |
| 28.        | 95.  | 4.   | 1.            | 100 | 0  | 0             | 84 | 12 | 4                 | 62 | 24 | 14 |
| 29.        | 91.2 | 8.4  | .4            | 100 | 0  | 0             | 78 | 20 | 2                 | 62 | 23 | 15 |
| 30.        | 31.6 | 63.8 | 4.6           | 34  | 64 | 2             | 28 | 62 | 10                | 26 | 33 | 41 |
| 31.        | 26.2 | 54.2 | 19.6          | 52  | 46 | 2             | 14 | 52 | 34                | 18 | 41 | 41 |

TEST I B

|    |      |      |      |    |    |    |    |    |    |    |    |    |
|----|------|------|------|----|----|----|----|----|----|----|----|----|
| 1. | 96.2 | 3.8  | 0.   | 98 | 2  | 0  | 90 | 8  | 2  | 65 | 20 | 15 |
| 2. | 39.8 | 43.6 | 16.6 | 72 | 24 | 4  | 28 | 46 | 26 | 44 | 24 | 32 |
| 3. | 35.0 | 40.2 | 24.8 | 52 | 32 | 16 | 28 | 42 | 30 | 28 | 32 | 40 |

|     | R.   | W.   | B.   | R.  | W. | B. | R. | W. | B. | R. | W. | B. |
|-----|------|------|------|-----|----|----|----|----|----|----|----|----|
| 4.  | 28.8 | 53.8 | 17.4 | 64  | 26 | 10 | 22 | 62 | 16 | 24 | 42 | 34 |
| 5.  | 96.2 | 2.6  | 1.2  | 100 | 0  | 0  | 92 | 4  | 4  | 63 | 14 | 23 |
| 6.  | 58.6 | 35.  | 6.4  | 72  | 28 | 0  | 48 | 46 | 6  | 24 | 33 | 43 |
| 7.  | 65.4 | 27.  | 7.6  | 78  | 20 | 2  | 66 | 20 | 14 | 38 | 19 | 43 |
| 8.  | 76.6 | 18.8 | 4.6  | 100 | 0  | 0  | 62 | 26 | 12 | 53 | 20 | 27 |
| 9.  | 65.2 | 28.4 | 6.4  | 84  | 16 | 0  | 46 | 48 | 6  | 34 | 33 | 33 |
| 10. | 82.4 | 11.2 | 6.4  | 96  | 2  | 2  | 66 | 24 | 10 | 48 | 34 | 18 |
| 11. | 55.6 | 38.8 | 5.6  | 80  | 20 | 0  | 26 | 66 | 8  | 20 | 38 | 42 |
| 12. | 36.8 | 30.4 | 32.8 | 48  | 40 | 12 | 26 | 36 | 38 | 30 | 20 | 50 |
| 13. | 38.  | 57.6 | 4.4  | 64  | 34 | 2  | 20 | 72 | 8  | 9  | 65 | 26 |
| 14. | 49.6 | 29.4 | 21.  | 70  | 30 | 0  | 30 | 42 | 28 | 28 | 13 | 59 |
| 15. | 62.6 | 21.6 | 15.8 | 88  | 12 | 0  | 28 | 44 | 28 | 18 | 30 | 52 |
| 16. | 82.4 | 13.6 | 4.0  | 86  | 12 | 2  | 70 | 20 | 10 | 29 | 23 | 48 |
| 17. | 29.  | 51.2 | 19.8 | 48  | 46 | 6  | 28 | 52 | 20 | 22 | 45 | 33 |
| 18. | 61.6 | 18.8 | 19.6 | 80  | 12 | 8  | 52 | 30 | 18 | 34 | 31 | 35 |
| 19. | 48.6 | 43.4 | 8.   | 48  | 52 | 0  | 52 | 34 | 14 | 46 | 35 | 19 |
| 20. | 36.2 | 45.8 | 18.  | 60  | 36 | 4  | 24 | 52 | 24 | 18 | 37 | 45 |
| 21. | 60.4 | 18.2 | 21.4 | 86  | 12 | 2  | 40 | 26 | 34 | 47 | 18 | 35 |
| 22. | 78.  | 12.2 | 9.8  | 98  | 2  | 0  | 60 | 24 | 16 | 28 | 15 | 57 |
| 23. | 42.  | 47.8 | 10.2 | 36  | 62 | 2  | 30 | 52 | 18 | 13 | 30 | 57 |
| 24. | 27.8 | 43.  | 29.2 | 52  | 38 | 10 | 12 | 48 | 40 | 34 | 19 | 47 |
| 25. | 50.4 | 40.4 | 9.2  | 60  | 38 | 2  | 58 | 30 | 12 | 70 | 12 | 18 |
| 26. | 78.4 | 13.2 | 8.4  | 92  | 8  | 0  | 62 | 20 | 18 | 55 | 11 | 34 |
| 27. | 43.2 | 31.8 | 25.  | 48  | 48 | 4  | 38 | 24 | 38 | 24 | 22 | 54 |
| 28. | 49.8 | 39.2 | 11.  | 66  | 32 | 2  | 40 | 38 | 22 | 29 | 24 | 47 |
| 29. | 70.8 | 23.  | 6.2  | 86  | 14 | 0  | 48 | 36 | 16 | 24 | 21 | 55 |
| 30. | 83.2 | 9.4  | 7.4  | 98  | 2  | 0  | 60 | 18 | 22 | 64 | 12 | 24 |
| 31. | 44.  | 25.  | 31.  | 72  | 24 | 4  | 22 | 34 | 44 | 32 | 19 | 49 |
| 32. | 86.2 | 9.6  | 4.2  | 94  | 6  | 0  | 84 | 4  | 12 | 50 | 10 | 40 |
| 33. | 64.  | 16.6 | 19.4 | 82  | 16 | 2  | 52 | 18 | 30 | 46 | 17 | 37 |
| 34. | 41.6 | 31.2 | 27.2 | 50  | 36 | 14 | 30 | 26 | 44 | 21 | 24 | 55 |
| 35. | 39.6 | 27.8 | 32.6 | 62  | 30 | 8  | 28 | 28 | 44 | 19 | 25 | 56 |
| 36. | 65.6 | 17.8 | 16.6 | 92  | 8  | 0  | 48 | 28 | 24 | 43 | 20 | 37 |

TEST II A

|     |      |      |      |    |    |    |    |    |    |    |    |    |
|-----|------|------|------|----|----|----|----|----|----|----|----|----|
| 1.  | 76.2 | 22.  | 1.8  | 64 | 30 | 6  | 78 | 20 | 2  | 15 | 47 | 38 |
| 2.  | 83.2 | 9.6  | 7.2  | 98 | 0  | 2  | 54 | 24 | 22 | 46 | 27 | 27 |
| 3.  | 21.4 | 49.8 | 28.8 | 42 | 44 | 14 | 10 | 52 | 38 | 10 | 49 | 41 |
| 4.  | 43.  | 39.2 | 17.8 | 78 | 20 | 2  | 20 | 44 | 36 | 20 | 36 | 44 |
| 5.  | 42.8 | 22.6 | 34.6 | 78 | 14 | 8  | 24 | 26 | 50 | 15 | 32 | 53 |
| 6.  | 51.4 | 36.  | 12.6 | 64 | 34 | 2  | 16 | 54 | 30 | 26 | 33 | 41 |
| 7.  | 65.  | 30.  | 5.   | 78 | 20 | 2  | 46 | 44 | 10 | 38 | 42 | 20 |
| 8.  | 38.4 | 40.2 | 21.4 | 82 | 18 | 0  | 18 | 48 | 34 | 36 | 31 | 33 |
| 9.  | 40.4 | 42.2 | 17.4 | 56 | 40 | 4  | 26 | 48 | 26 | 26 | 38 | 36 |
| 10. | 22.4 | 61.2 | 16.4 | 46 | 48 | 6  | 8  | 68 | 24 | 16 | 46 | 38 |
| 11. | 54.6 | 28.6 | 16.8 | 96 | 2  | 2  | 22 | 48 | 30 | 28 | 26 | 46 |
| 12. | 36.6 | 34.  | 29.4 | 78 | 16 | 6  | 24 | 36 | 40 | 22 | 35 | 43 |
| 13. | 36.  | 41.2 | 22.8 | 74 | 20 | 6  | 10 | 54 | 36 | 10 | 42 | 48 |
| 14. | 41.4 | 36.6 | 22.  | 68 | 30 | 2  | 24 | 42 | 34 | 20 | 44 | 36 |
| 15. | 19.2 | 63.6 | 17.2 | 42 | 54 | 4  | 18 | 58 | 24 | 8  | 41 | 51 |
| 16. | 34.6 | 44.  | 21.4 | 54 | 40 | 6  | 24 | 42 | 34 | 18 | 39 | 43 |
| 17. | 44.  | 43.2 | 12.8 | 80 | 20 | 0  | 24 | 48 | 28 | 31 | 44 | 25 |
| 18. | 23.8 | 49.  | 27.2 | 54 | 42 | 4  | 8  | 50 | 42 | 11 | 43 | 46 |

|     | R.   | W.   | B.   | R. | W. | B. | R. | W. | B. | R. | W. | B. |
|-----|------|------|------|----|----|----|----|----|----|----|----|----|
| 19. | 30.8 | 51.4 | 17.8 | 76 | 22 | 2  | 22 | 46 | 32 | 29 | 48 | 23 |
| 20. | 23.  | 52.4 | 24.6 | 38 | 50 | 12 | 24 | 36 | 40 | 27 | 39 | 34 |
| 21. | 24.4 | 38.6 | 37.  | 48 | 40 | 12 | 8  | 38 | 54 | 12 | 39 | 49 |
| 22. | 65.8 | 25.4 | 8.8  | 94 | 6  | 0  | 30 | 44 | 26 | 40 | 30 | 30 |
| 23. | 39.6 | 33.6 | 26.8 | 82 | 12 | 6  | 24 | 38 | 38 | 15 | 31 | 54 |
| 24. | 21.2 | 41.8 | 37.  | 40 | 46 | 14 | 18 | 36 | 46 | 12 | 39 | 49 |
| 25. | 15.2 | 51.  | 33.8 | 20 | 64 | 16 | 14 | 40 | 46 | 3  | 49 | 48 |
| 26. | 34.2 | 42.4 | 23.4 | 38 | 54 | 8  | 20 | 50 | 30 | 27 | 34 | 39 |
| 27. | 13.8 | 60.2 | 26.  | 26 | 72 | 2  | 14 | 50 | 36 | 9  | 45 | 46 |
| 28. | 21.6 | 42.6 | 35.8 | 46 | 40 | 14 | 12 | 42 | 46 | 20 | 31 | 49 |
| 29. | 32.4 | 36.6 | 31.  | 82 | 14 | 4  | 10 | 38 | 52 | 11 | 44 | 45 |
| 30. | 30.8 | 43.  | 26.2 | 62 | 32 | 6  | 14 | 52 | 34 | 18 | 42 | 40 |
| 31. | 41.  | 39.8 | 19.2 | 72 | 24 | 4  | 14 | 54 | 32 | 19 | 41 | 40 |
| 32. | 9.8  | 43.8 | 46.4 | 16 | 62 | 22 | 16 | 26 | 58 | 12 | 30 | 58 |
| 33. | 16.2 | 48.  | 35.8 | 24 | 62 | 14 | 8  | 38 | 54 | 12 | 45 | 43 |
| 34. | 41.6 | 37.2 | 21.2 | 68 | 26 | 6  | 28 | 32 | 40 | 23 | 51 | 26 |
| 35. | 21.6 | 56.8 | 21.6 | 50 | 48 | 2  | 10 | 46 | 44 | 15 | 55 | 30 |

TEST II B

|     |      |      |      |    |    |    |    |    |    |    |    |    |
|-----|------|------|------|----|----|----|----|----|----|----|----|----|
| 1.  | 86.4 | 9.6  | 4.   | 88 | 12 | 0  | 80 | 10 | 10 | 58 | 10 | 32 |
| 2.  | 70.8 | 15.4 | 13.8 | 96 | 4  | 0  | 38 | 26 | 36 | 32 | 24 | 44 |
| 3.  | 56.8 | 34.6 | 8.6  | 84 | 16 | 0  | 38 | 34 | 28 | 34 | 29 | 37 |
| 4.  | 59.8 | 30.4 | 9.8  | 92 | 2  | 6  | 30 | 44 | 26 | 40 | 28 | 32 |
| 5.  | 64.6 | 21.4 | 14.  | 88 | 12 | 0  | 46 | 24 | 30 | 24 | 28 | 48 |
| 6.  | 39.6 | 43.4 | 17.  | 58 | 36 | 6  | 40 | 28 | 32 | 26 | 29 | 45 |
| 7.  | 57.6 | 16.8 | 25.6 | 84 | 12 | 4  | 46 | 12 | 42 | 32 | 19 | 49 |
| 8.  | 68.  | 16.4 | 15.6 | 92 | 6  | 2  | 28 | 34 | 38 | 44 | 20 | 36 |
| 9.  | 66.6 | 15.8 | 17.6 | 94 | 4  | 2  | 28 | 28 | 44 | 40 | 17 | 43 |
| 10. | 51.6 | 22.2 | 26.2 | 74 | 22 | 4  | 36 | 22 | 42 | 29 | 20 | 51 |
| 11. | 36.  | 34.  | 30.  | 68 | 24 | 8  | 20 | 30 | 50 | 24 | 20 | 56 |
| 12. | 45.  | 28.4 | 26.6 | 58 | 32 | 10 | 36 | 24 | 40 | 32 | 17 | 51 |
| 13. | 63.  | 21.  | 16.  | 92 | 6  | 2  | 36 | 32 | 32 | 54 | 21 | 25 |
| 14. | 59.2 | 32.8 | 8.   | 84 | 12 | 4  | 46 | 30 | 24 | 45 | 31 | 24 |
| 15. | 62.8 | 18.  | 19.2 | 80 | 20 | 0  | 36 | 30 | 34 | 38 | 14 | 48 |
| 16. | 59.4 | 24.8 | 15.8 | 80 | 16 | 4  | 36 | 32 | 32 | 52 | 15 | 33 |
| 17. | 40.6 | 28.4 | 31.  | 68 | 20 | 12 | 22 | 30 | 48 | 23 | 28 | 49 |
| 18. | 42.6 | 27.  | 30.4 | 60 | 28 | 12 | 26 | 28 | 46 | 23 | 25 | 52 |
| 19. | 59.2 | 21.8 | 19.  | 78 | 20 | 2  | 42 | 24 | 34 | 44 | 15 | 41 |
| 20. | 28.2 | 46.6 | 25.2 | 36 | 56 | 8  | 22 | 44 | 34 | 19 | 31 | 50 |
| 21. | 29.2 | 36.2 | 34.6 | 38 | 52 | 10 | 22 | 34 | 44 | 14 | 32 | 54 |
| 22. | 57.8 | 18.4 | 23.8 | 90 | 6  | 4  | 44 | 14 | 42 | 43 | 13 | 44 |
| 23. | 20.  | 63.8 | 16.2 | 12 | 88 | 0  | 16 | 56 | 28 | 16 | 38 | 46 |
| 24. | 31.2 | 51.2 | 17.6 | 22 | 74 | 4  | 28 | 40 | 32 | 31 | 29 | 40 |
| 25. | 49.6 | 21.8 | 28.6 | 78 | 16 | 6  | 36 | 16 | 48 | 35 | 15 | 50 |
| 26. | 71.4 | 16.  | 12.6 | 94 | 4  | 2  | 44 | 26 | 30 | 52 | 14 | 34 |
| 27. | 46.8 | 37.8 | 15.4 | 42 | 56 | 2  | 26 | 40 | 34 | 41 | 32 | 27 |
| 28. | 26.8 | 43.4 | 29.8 | 30 | 62 | 8  | 32 | 18 | 50 | 19 | 34 | 47 |
| 29. | 28.2 | 44.4 | 27.4 | 50 | 38 | 12 | 12 | 48 | 40 | 14 | 38 | 48 |
| 30. | 27.4 | 34.4 | 38.2 | 36 | 46 | 18 | 14 | 36 | 50 | 13 | 29 | 58 |
| 31. | 50.  | 28.2 | 21.8 | 70 | 26 | 4  | 34 | 22 | 44 | 44 | 17 | 39 |
| 32. | 80.2 | 6.4  | 13.4 | 98 | 2  | 0  | 50 | 12 | 38 | 65 | 13 | 22 |

|     | R.   | W.   | B.   | R. | W. | B. | R. | W. | B. | R. | W. | B. |
|-----|------|------|------|----|----|----|----|----|----|----|----|----|
| 33. | 44.4 | 25.8 | 29.8 | 76 | 12 | 12 | 34 | 22 | 44 | 24 | 30 | 46 |

TEST III A

|     |      |      |      |    |    |    |    |    |    |    |    |    |
|-----|------|------|------|----|----|----|----|----|----|----|----|----|
| 1.  | 79.4 | 19.  | 1.6  | 94 | 6  | 0  | 78 | 22 | 0  | 70 | 24 | 6  |
| 2.  | 52.2 | 36.4 | 11.4 | 80 | 16 | 4  | 38 | 40 | 22 | 53 | 34 | 13 |
| 3.  | 20.2 | 52.  | 27.8 | 40 | 46 | 14 | 6  | 50 | 44 | 10 | 46 | 44 |
| 4.  | 46.6 | 33.4 | 20.  | 72 | 24 | 4  | 20 | 40 | 40 | 21 | 42 | 37 |
| 5.  | 24.  | 62.6 | 13.4 | 48 | 50 | 2  | 20 | 58 | 22 | 12 | 61 | 27 |
| 6.  | 29.8 | 38.  | 32.2 | 56 | 36 | 8  | 6  | 42 | 52 | 13 | 28 | 59 |
| 7.  | 13.2 | 64.  | 22.8 | 28 | 66 | 6  | 10 | 46 | 44 | 2  | 55 | 43 |
| 8.  | 47.8 | 32.4 | 19.8 | 94 | 6  | 0  | 24 | 48 | 28 | 15 | 39 | 46 |
| 9.  | 52.4 | 19.8 | 27.8 | 82 | 10 | 8  | 24 | 34 | 42 | 12 | 33 | 55 |
| 10. | 68.8 | 18.4 | 12.8 | 98 | 2  | 0  | 34 | 42 | 24 | 26 | 22 | 52 |
| 11. | 48.  | 26.8 | 25.2 | 86 | 12 | 2  | 18 | 40 | 42 | 14 | 37 | 49 |
| 12. | 58.2 | 28.  | 13.8 | 80 | 20 | 0  | 44 | 28 | 28 | 58 | 19 | 23 |
| 13. | 54.4 | 25.4 | 20.2 | 80 | 20 | 0  | 24 | 44 | 32 | 23 | 35 | 42 |
| 14. | 27.  | 40.4 | 32.6 | 56 | 38 | 6  | 12 | 44 | 44 | 5  | 37 | 59 |
| 15. | 38.  | 26.6 | 35.4 | 62 | 30 | 8  | 20 | 34 | 46 | 14 | 22 | 64 |
| 16. | 20.8 | 59.8 | 19.4 | 48 | 50 | 2  | 10 | 54 | 36 | 11 | 56 | 33 |
| 17. | 35.4 | 42.2 | 22.4 | 64 | 28 | 8  | 20 | 50 | 30 | 29 | 35 | 36 |
| 18. | 9.6  | 54.4 | 36.  | 40 | 52 | 8  | 0  | 44 | 56 | 3  | 36 | 61 |
| 19. | 53.4 | 30.2 | 16.4 | 90 | 10 | 0  | 26 | 42 | 32 | 45 | 24 | 31 |
| 20. | 21.8 | 51.6 | 26.6 | 40 | 56 | 4  | 16 | 40 | 44 | 15 | 31 | 54 |
| 21. | 44.8 | 27.4 | 27.8 | 86 | 10 | 4  | 10 | 48 | 42 | 16 | 26 | 58 |
| 22. | 41.4 | 36.6 | 22.  | 78 | 20 | 2  | 26 | 32 | 42 | 25 | 30 | 45 |
| 23. | 33.6 | 28.8 | 37.6 | 74 | 12 | 14 | 24 | 30 | 46 | 7  | 23 | 70 |
| 24. | 57.2 | 19.4 | 23.4 | 92 | 6  | 2  | 18 | 36 | 46 | 33 | 23 | 44 |
| 25. | 18.4 | 57.  | 24.6 | 32 | 60 | 8  | 20 | 36 | 44 | 8  | 41 | 51 |
| 26. | 23.8 | 37.  | 39.2 | 36 | 56 | 8  | 10 | 30 | 60 | 10 | 23 | 67 |
| 27. | 74.4 | 8.4  | 17.2 | 98 | 2  | 0  | 48 | 12 | 40 | 55 | 14 | 31 |
| 28. | 5.4  | 73.8 | 20.8 | 14 | 84 | 2  | 2  | 60 | 38 | 3  | 45 | 52 |
| 29. | 32.8 | 32.4 | 34.8 | 68 | 30 | 2  | 8  | 36 | 56 | 18 | 32 | 50 |
| 30. | 18.6 | 50.6 | 30.8 | 52 | 38 | 10 | 8  | 38 | 54 | 3  | 45 | 52 |

TEST III B

|     |      |      |      |     |    |    |    |    |    |    |    |    |
|-----|------|------|------|-----|----|----|----|----|----|----|----|----|
| 1.  | 79.4 | 16.6 | 4.   | 60  | 28 | 2  | 78 | 14 | 8  | 42 | 12 | 46 |
| 2.  | 48.4 | 29.4 | 22.2 | 66  | 34 | 0  | 20 | 34 | 46 | 21 | 18 | 61 |
| 3.  | 55.8 | 26.2 | 18.  | 82  | 18 | 0  | 22 | 32 | 46 | 27 | 13 | 60 |
| 4.  | 58.6 | 11.  | 30.4 | 92  | 8  | 0  | 34 | 14 | 52 | 16 | 17 | 67 |
| 5.  | 70.6 | 9.8  | 19.6 | 100 | 0  | 0  | 28 | 28 | 44 | 25 | 22 | 53 |
| 6.  | 68.6 | 13.4 | 18.  | 92  | 8  | 0  | 36 | 18 | 46 | 29 | 18 | 53 |
| 7.  | 49.6 | 27.8 | 22.6 | 46  | 54 | 0  | 34 | 14 | 52 | 22 | 15 | 63 |
| 8.  | 50.6 | 27.4 | 22.  | 92  | 6  | 2  | 18 | 32 | 50 | 11 | 26 | 63 |
| 9.  | 38.8 | 30.8 | 30.4 | 60  | 36 | 4  | 24 | 24 | 52 | 23 | 15 | 62 |
| 10. | 39.8 | 32.  | 28.2 | 76  | 22 | 2  | 28 | 24 | 48 | 17 | 25 | 58 |
| 11. | 34.  | 26.8 | 39.2 | 48  | 44 | 8  | 16 | 28 | 56 | 17 | 11 | 72 |
| 12. | 40.4 | 23.2 | 36.4 | 72  | 22 | 6  | 24 | 24 | 52 | 26 | 11 | 63 |
| 13. | 31.8 | 28.2 | 40.  | 58  | 32 | 10 | 18 | 28 | 54 | 14 | 19 | 67 |
| 14. | 33.4 | 32.  | 34.6 | 66  | 34 | 0  | 14 | 38 | 48 | 13 | 18 | 69 |

|     | R.   | W.   | B.   | R. | W. | B. | R. | W. | B. | R. | W. | B. |
|-----|------|------|------|----|----|----|----|----|----|----|----|----|
| 15. | 52.  | 20.8 | 27.2 | 86 | 12 | 2  | 18 | 34 | 48 | 22 | 17 | 61 |
| 16. | 29.4 | 33.4 | 37.2 | 72 | 24 | 4  | 18 | 26 | 56 | 10 | 19 | 71 |
| 17. | 26.4 | 36.6 | 37.  | 46 | 48 | 6  | 20 | 24 | 56 | 14 | 16 | 70 |
| 18. | 35.4 | 31.2 | 33.4 | 60 | 38 | 2  | 20 | 24 | 56 | 7  | 29 | 64 |
| 19. | 25.4 | 43.6 | 31.  | 34 | 60 | 6  | 26 | 20 | 54 | 13 | 21 | 66 |
| 20. | 49.4 | 16.6 | 34.  | 88 | 8  | 4  | 26 | 24 | 50 | 25 | 19 | 56 |
| 21. | 42.6 | 25.2 | 32.2 | 84 | 12 | 4  | 22 | 30 | 48 | 20 | 23 | 57 |
| 22. | 28.6 | 42.  | 29.4 | 52 | 44 | 4  | 18 | 30 | 52 | 12 | 19 | 69 |
| 23. | 49.2 | 19.6 | 31.2 | 86 | 10 | 4  | 30 | 16 | 54 | 18 | 18 | 64 |
| 24. | 30.8 | 31.4 | 37.8 | 68 | 26 | 6  | 20 | 24 | 56 | 13 | 20 | 67 |
| 25. | 38.8 | 32.8 | 28.4 | 60 | 34 | 6  | 24 | 28 | 48 | 19 | 30 | 51 |
| 26. | 46.6 | 21.4 | 32.  | 82 | 12 | 6  | 20 | 24 | 56 | 13 | 21 | 66 |
| 27. | 29.  | 34.4 | 36.6 | 54 | 36 | 10 | 18 | 22 | 60 | 15 | 26 | 59 |
| 28. | 29.  | 27.  | 44.  | 60 | 22 | 18 | 16 | 26 | 58 | 18 | 12 | 70 |
| 29. | 26.4 | 28.6 | 45.  | 64 | 22 | 14 | 10 | 22 | 68 | 10 | 16 | 74 |
| 30. | 17.6 | 41.8 | 40.6 | 36 | 52 | 12 | 6  | 32 | 62 | 6  | 26 | 68 |
| 31. | 54.4 | 13.  | 32.6 | 78 | 14 | 8  | 34 | 14 | 52 | 37 | 7  | 56 |
| 32. | 43.  | 17.4 | 39.6 | 76 | 12 | 12 | 22 | 16 | 62 | 16 | 19 | 65 |
| 33. | 25.4 | 36.4 | 38.2 | 38 | 52 | 10 | 24 | 20 | 56 | 11 | 32 | 57 |
| 34. | 45.  | 15.6 | 39.4 | 76 | 10 | 14 | 24 | 14 | 62 | 25 | 12 | 63 |
| 35. | 42.4 | 19.2 | 38.4 | 78 | 14 | 8  | 28 | 16 | 56 | 22 | 12 | 66 |

right. Guess work is responsible for some of these variations, but in the final scoring, using the formula on the score sheet, those who guess wrong find their scores reduced considerably.

Ruch has the following to say: "Study the percents for the 'good' and 'poor' groups. Reject items where the 'poor' group shows percentages of successes as high as or higher than the 'good' group. Such items do not differentiate abilities. The best items will show the largest differences in successes in favor of the 'good' group."<sup>1</sup>

Orleans and Sealy say the following on analysis: "Analysis involves a determination of the difficulty of each question as a basis for ascertaining (1) the order for which the questions are to be arranged in the test, (2) the difference between the difficulty of the items, to insure accurate measurement, (3) the adequacy of the wording of the questions, (4) the completeness of the scoring key, (5) the clarity of the instructions for taking, for giving, and for scoring the test, and (6) the adequacy of the time allotted for the test.

"The work involved in making this analysis is very great. It includes the elimination of some of the original material and a repetition of the procedure with the revised form. The analysis is necessary if the test is to be a good one. It may be proper to advertise as

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1. Ruch, G. M., The Objective or New-Type Examination, p. 37

standardized a test which is objective and for which standards have been determined, although no analysis of the test has been made; but for the purposes for which a published test is to be used, it should be scientifically constructed."<sup>2</sup>

RENUMBERING TEST QUESTIONS. - The question with the highest percent correct in each section of the test was renumbered #1. The question with the next highest percent correct was renumbered #2, and so on through all the questions throughout all sections of each part of the test. In the event of a tie in the percentages correct, the one with the lower percent wrong was considered to be the easier question. Every question now has been renumbered. The easiest question is number 1, and the most difficult has the highest number in whatever section or part it is in. Table II shows the results of the scaling of the test.

PROCESS OF ELIMINATION. - Any question that eighty percent or more had correct was considered too easy and, therefore, was lacking in discrimination value. Those questions that had twenty or less of a percent correct were too difficult and did not measure sufficiently to warrant their inclusion. By this process of elimination, eleven questions were eliminated from Part I because they were too easy. Five were also eliminated from Part I because they were too difficult. In Part II it was found that three questions were too easy, and five questions were too difficult. In Part III none

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2. Orleans & Sealy, Objective Tests, p. 216

TABLE II

NEWTON INDUSTRIAL ARTS TEST

500 Scores - Averaged and Scaled

| PART I      |             | PART II     |             | PART III    |             |
|-------------|-------------|-------------|-------------|-------------|-------------|
| Test A      | Test B      | Test A      | Test B      | Test A      | Test B      |
| 1. 4-82.2   | 1. 2-96.2   | 1. 2-76.2   | 1. 1-86.4   | 1. 1-79.4   | 1. 1-79.4   |
| 2. 3-87.    | 2. 28-39.8  | 2. 1-83.2   | 2. 4-70.8   | 2. 9-52.2   | 2. 12-48.4  |
| 3. 5-82.    | 3. 33-35.   | 3. 29-21.4  | 3. 16-56.8  | 3. 25-20.2  | 3. 5-55.8   |
| 4. 8-59.8   | 4. 35-28.8  | 4. 8-43.    | 4. 10-59.8  | 4. 12-46.6  | 4. 4-58.6   |
| 5. 18-39.4  | 5. 1-96.2   | 5. 9-42.8   | 5. 7-64.4   | 5. 21-24.   | 5. 2-70.6   |
| 6. 21-35.6  | 6. 18-58.6  | 6. 6-51.4   | 6. 25-39.6  | 6. 19-29.8  | 6. 3-68.8   |
| 7. 29-12.2  | 7. 12-65.4  | 7. 4-65.    | 7. 15-57.6  | 7. 28-13.2  | 7. 9-49.6   |
| 8. 25-26.   | 8. 9-76.6   | 8. 15-38.4  | 8. 5-68.    | 8. 11-47.8  | 8. 8-50.6   |
| 9. 31- 3.2  | 9. 13-65.2  | 9. 13-40.4  | 9. 6-66.6   | 9. 8-52.4   | 9. 20-38.8  |
| 10. 16-41.6 | 10. 5-82.4  | 10. 26-22.4 | 10. 17-51.6 | 10. 3-68.8  | 10. 19-39.8 |
| 11. 17-41.4 | 11. 19-55.6 | 11. 5-54.6  | 11. 26-36.  | 11. 10-48.  | 11. 23-34.  |
| 12. 6-79.   | 12. 31-36.8 | 12. 16-36.6 | 12. 21-45.  | 12. 4-58.2  | 12. 18-40.4 |
| 13. 14-50.8 | 13. 30-38.  | 13. 17-36.  | 13. 8-63.   | 13. 6-54.4  | 13. 25-31.8 |
| 14. 15-44.  | 14. 22-49.6 | 14. 11-41.4 | 14. 12-59.2 | 14. 20-27.  | 14. 24-33.4 |
| 15. 7-62.2  | 15. 15-62.6 | 15. 31-19.2 | 15. 9-62.8  | 15. 15-38.  | 15. 7-52.   |
| 16. 20-38.6 | 16. 6-82.4  | 16. 18-34.6 | 16. 11-59.4 | 16. 24-20.8 | 16. 27-29.4 |
| 17. 9-58.4  | 17. 34-29.  | 17. 7-44.   | 17. 24-40.6 | 17. 16-35.4 | 17. 32-26.4 |
| 18. 26-24.4 | 18. 16-61.6 | 18. 24-23.8 | 18. 23-42.6 | 18. 29- 9.6 | 18. 22-35.4 |
| 19. 13-51.4 | 19. 23-48.6 | 19. 21-30.8 | 19. 13-59.2 | 19. 7-53.4  | 19. 34-25.4 |
| 20. 23-28.  | 20. 32-36.2 | 20. 25-23.  | 20. 30-28.2 | 20. 23-21.8 | 20. 10-49.4 |
| 21. 30-12.  | 21. 17-60.4 | 21. 23-24.4 | 21. 28-29.2 | 21. 13-44.8 | 21. 16-42.6 |
| 22. 10-54.  | 22. 8-78.   | 22. 3-65.8  | 22. 14-57.8 | 22. 14-41.4 | 22. 30-28.6 |
| 23. 12-52.  | 23. 26-42.  | 23. 14-39.6 | 23. 33-20.  | 23. 17-33.6 | 23. 11-49.2 |
| 24. 27-16.8 | 24. 36-27.8 | 24. 30-21.2 | 24. 27-31.2 | 24. 5-57.2  | 24. 26-30.8 |
| 25. 11-52.2 | 25. 20-50.4 | 25. 33-15.2 | 25. 19-49.6 | 25. 27-18.4 | 25. 21-38.8 |
| 26. 28-14.  | 26. 7-78.4  | 26. 19-34.2 | 26. 3-71.4  | 26. 22-23.8 | 26. 13-46.6 |
| 27. 19-39.  | 27. 25-43.2 | 27. 34-13.8 | 27. 20-46.8 | 27. 2-74.4  | 27. 29-29.  |
| 28. 1-95.   | 28. 21-49.8 | 28. 27-21.6 | 28. 32-26.8 | 28. 30- 5.4 | 28. 28-29.  |
| 29. 2-91.2  | 29. 10-70.8 | 29. 20-32.4 | 29. 29-28.2 | 29. 18-32.8 | 29. 31-26.4 |
| 30. 22-31.6 | 30. 4-83.2  | 30. 22-30.8 | 30. 31-27.4 | 30. 26-18.6 | 30. 35-17.6 |
| 31. 24-26.2 | 31. 24-44.  | 31. 12-41.  | 31. 18-50.  |             | 31. 6-54.4  |
|             | 32. 3-86.2  | 32. 35- 9.8 | 32. 2-80.2  |             | 32. 15-43.  |
|             | 33. 14-64.  | 33. 32-16.2 | 33. 22-44.4 |             | 33. 33-25.4 |
|             | 34. 27-41.6 | 34. 10-41.6 |             |             | 34. 14-45.  |
|             | 35. 29-39.6 | 35. 28-21.6 |             |             | 35. 17-42.4 |
|             | 36. 11-65.6 |             |             |             |             |



of the questions had eighty or more percent of correct answers, so no questions were considered too easy. Six questions were eliminated because they were too difficult.

Newkirk and Greene subscribe to the following: "Eliminate the dead weight from the test. Do not include items which are so easy that over eighty percent of the class answer them correctly. Do not include items which are so difficult that less than twenty percent of the class give the correct response. It is probable that test items which are missed by eighty percent or more, or are missed by only twenty percent or less of the class, do not differentiate pupil accomplishment adequately. These items can be determined by short tests during the term before they are put into the final test, or they can be eliminated after the test has been used once."<sup>3</sup>

Referring to Table I, the "Item Analysis" and Table II, "500 Scores - Averaged and Scaled," and using these two sheets and the previous explanation as a guide, we check the first question in Part I, Test A that is best suited for our number 1 test question. Number 12 with the average score of 79 percent correct answers looks like a favorable prospect. Checking number 12 in the Item Analysis sheet, we find that the average with the 500 scores is 79 percent. The average score is 98 percent with the Top 50 Scores. The average score is 66

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3. Newkirk & Greene, Tests and Measurements in Industrial Education, p. 138

percent with the Low 50 Scores. The average for the 100 Dedham Scores is 26 percent. This question has a fair degree of discrimination between Top 50 and Low 50. It shows excellent discrimination between Low 50 and the 100 Dedham Scores. Using these criteria, number 12 qualifies for our revised test number 1 question. Since number 12 was ranked 6th, the next question to be considered has the rank of 7. It is question 15 of the original test. This question is evaluated by the same process as the first one. This process is continued until there are 16 valid questions for Test A. Test B and all the other tests are evaluated in the same manner. Table III shows revision process for entire test.

WEIGHING PARTS OF TEST. - On the original 500 Score Averages, it was found that Part I had a higher average than Part II, and that Part III had the lowest sum of averages. This meant either one of two things; that Part I was the easiest or that our Graphic Arts teachers were doing a better job. Table IV shows this comparison using the percentages of correct answers. The sum of the Dedham score averages proved that Part I was easiest, Part II ranking second in degree of difficulty, and that Part III was most difficult. This ranking of the Parts of the Test is confirmed by the fact that Part I had eleven questions with an average over 80 percent, that Part II had three over 80, and that Part III did not have any over 80 percent correct.

TABLE III

ANSWER SHEET: NEWTON INDUSTRIAL ARTS TEST - FORM A (Exp. 1946)

(Score "A" Tests: R -  $\frac{W}{4}$ ; Score "B" Tests: R - W)

Name                      Revised Test                      Date                     

School                      Grade                      Div.                     

Teacher                      Ent. J.H.S. from                     

Check below the Shop Courses which you have taken in Newton.

- Grade 7 (Required)
- Grade 8 (Required)
- Grade 8 (Elective)
- Grade 9 (Elective)

| Part       | Poss. Score | Number Right | Score |
|------------|-------------|--------------|-------|
| I A        | 31          |              |       |
| I B        | 36          |              |       |
| Total      | 67          |              |       |
| II A       | 35          |              |       |
| II B       | 33          |              |       |
| Total      | 68          |              |       |
| III A      | 30          |              |       |
| III B      | 35          |              |       |
| Total      | 65          |              |       |
| Total Test | 200         |              |       |
| M.A.       | C.A.        | I.Q.         |       |

| PART I          |                 | PART II         |                 | PART III        |                 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Test A          | Test B          | Test A          | Test B          | Test A          | Test B          |
| 1. <u>    </u>  | 1. <u>    </u>  | 1. <u>    </u>  | 1. <u>    </u>  | 1. <u>    </u>  | 1. <u>    </u>  |
| 2. <u>    </u>  | 2. <u>13</u>    | 2. <u>    </u>  | 2. <u>  1</u>   | 2. <u>  8</u>   | 2. <u>10</u>    |
| 3. <u>    </u>  | 3. <u>    </u>  | 3. <u>    </u>  | 3. <u>13</u>    | 3. <u>    </u>  | 3. <u>  4</u>   |
| 4. <u>  3</u>   | 4. <u>17</u>    | 4. <u>  6</u>   | 4. <u>  7</u>   | 4. <u>11</u>    | 4. <u>  3</u>   |
| 5. <u>11</u>    | 5. <u>    </u>  | 5. <u>  7</u>   | 5. <u>  4</u>   | 5. <u>    </u>  | 5. <u>  1</u>   |
| 6. <u>    </u>  | 6. <u>    </u>  | 6. <u>  4</u>   | 6. <u>    </u>  | 6. <u>    </u>  | 6. <u>  2</u>   |
| 7. <u>    </u>  | 7. <u>    </u>  | 7. <u>  2</u>   | 7. <u>12</u>    | 7. <u>    </u>  | 7. <u>    </u>  |
| 8. <u>16</u>    | 8. <u>  3</u>   | 8. <u>13</u>    | 8. <u>  2</u>   | 8. <u>10</u>    | 8. <u>  7</u>   |
| 9. <u>    </u>  | 9. <u>  6</u>   | 9. <u>11</u>    | 9. <u>  3</u>   | 9. <u>  7</u>   | 9. <u>    </u>  |
| 10. <u>  9</u>  | 10. <u>    </u> | 10. <u>    </u> | 10. <u>14</u>   | 10. <u>  2</u>  | 10. <u>17</u>   |
| 11. <u>10</u>   | 11. <u>10</u>   | 11. <u>  3</u>  | 11. <u>    </u> | 11. <u>  9</u>  | 11. <u>    </u> |
| 12. <u>  1</u>  | 12. <u>    </u> | 12. <u>14</u>   | 12. <u>    </u> | 12. <u>  3</u>  | 12. <u>16</u>   |
| 13. <u>  8</u>  | 13. <u>15</u>   | 13. <u>15</u>   | 13. <u>  5</u>  | 13. <u>  5</u>  | 13. <u>    </u> |
| 14. <u>    </u> | 14. <u>11</u>   | 14. <u>  9</u>  | 14. <u>  9</u>  | 14. <u>    </u> | 14. <u>    </u> |
| 15. <u>  2</u>  | 15. <u>  8</u>  | 15. <u>    </u> | 15. <u>  6</u>  | 15. <u>14</u>   | 15. <u>  6</u>  |
| 16. <u>13</u>   | 16. <u>    </u> | 16. <u>16</u>   | 16. <u>  8</u>  | 16. <u>    </u> | 16. <u>    </u> |
| 17. <u>  4</u>  | 17. <u>    </u> | 17. <u>  5</u>  | 17. <u>    </u> | 17. <u>15</u>   | 17. <u>    </u> |
| 18. <u>    </u> | 18. <u>    </u> | 18. <u>    </u> | 18. <u>    </u> | 18. <u>    </u> | 18. <u>    </u> |
| 19. <u>    </u> | 19. <u>    </u> | 19. <u>    </u> | 19. <u>10</u>   | 19. <u>  6</u>  | 19. <u>    </u> |
| 20. <u>14</u>   | 20. <u>16</u>   | 20. <u>    </u> | 20. <u>    </u> | 20. <u>    </u> | 20. <u>  8</u>  |
| 21. <u>    </u> | 21. <u>  9</u>  | 21. <u>    </u> | 21. <u>    </u> | 21. <u>12</u>   | 21. <u>14</u>   |
| 22. <u>  5</u>  | 22. <u>  2</u>  | 22. <u>  1</u>  | 22. <u>11</u>   | 22. <u>13</u>   | 22. <u>    </u> |
| 23. <u>  7</u>  | 23. <u>    </u> | 23. <u>12</u>   | 23. <u>    </u> | 23. <u>16</u>   | 23. <u>  9</u>  |
| 24. <u>    </u> | 24. <u>    </u> | 24. <u>    </u> | 24. <u>    </u> | 24. <u>  4</u>  | 24. <u>    </u> |
| 25. <u>  6</u>  | 25. <u>    </u> | 25. <u>    </u> | 25. <u>16</u>   | 25. <u>    </u> | 25. <u>    </u> |
| 26. <u>    </u> | 26. <u>  1</u>  | 26. <u>    </u> | 26. <u>    </u> | 26. <u>    </u> | 26. <u>11</u>   |
| 27. <u>12</u>   | 27. <u>    </u> | 27. <u>    </u> | 27. <u>    </u> | 27. <u>  1</u>  | 27. <u>    </u> |
| 28. <u>    </u> | 28. <u>    </u> | 28. <u>    </u> | 28. <u>    </u> | 28. <u>    </u> | 28. <u>    </u> |
| 29. <u>    </u> | 29. <u>  4</u>  | 29. <u>17</u>   | 29. <u>    </u> | 29. <u>17</u>   | 29. <u>    </u> |
| 30. <u>    </u> | 30. <u>    </u> | 30. <u>    </u> | 30. <u>    </u> | 30. <u>    </u> | 30. <u>    </u> |
| 31. <u>15</u>   | 31. <u>12</u>   | 31. <u>10</u>   | 31. <u>15</u>   | 31. <u>    </u> | 31. <u>  5</u>  |
|                 | 32. <u>    </u> | 32. <u>    </u> | 32. <u>    </u> |                 | 32. <u>13</u>   |
|                 | 33. <u>  7</u>  | 33. <u>    </u> | 33. <u>    </u> |                 | 33. <u>    </u> |
|                 | 34. <u>    </u> | 34. <u>  8</u>  |                 |                 | 34. <u>12</u>   |
|                 | 35. <u>14</u>   | 35. <u>    </u> |                 |                 | 35. <u>15</u>   |
|                 | 36. <u>  5</u>  |                 |                 |                 |                 |

TABLE IV

Mean Scores of 6 sections of 500 Industrial Arts Tests  
compared to Mean Scores of 100 Dedham Tests

|            |             | 500 Ind. Arts | 100 Dedham |
|------------|-------------|---------------|------------|
| Mean Score | I A         | 46.17         | 22.16      |
| "          | " I B       | 57.49         | 35.39      |
| "          | " II A      | 35.93         | 20.00      |
| "          | " II B      | 50.93         | 34.06      |
| "          | " III A     | 38.38         | 20.97      |
| "          | " III B     | 41.90         | 18.54      |
| Mean Score | I A & B     | 51.83         | 28.78      |
| "          | " II A & B  | 43.43         | 27.03      |
| "          | " III A & B | 40.14         | 19.76      |

In weighing up the revised test, a little juggling of questions had to be administered. The final result was that Part I has 33 questions, each question having an average weight of 51.57 percent. The product of the above two figures is 1701.81 percent. Part II also has 33 questions with an average weight of 51.68 percent. The product of these two numbers is 1705.44 percent. Part III has 34 questions with an average weight of 49.89 percent. The product of these two numbers is 1696.26 percent. This gives all three Parts approximately the same weight and should result in a more equal distribution of scores.

EVALUATION OF TEST BY TWENTY-FIVE GREATER BOSTON SHOP

TEACHERS. - Twenty-five Greater Boston shop teachers were interrogated with a questionnaire letter and a copy of the

test. The letter enclosed was:

27 Priscilla Road

Reading, Mass.

January 15, 1947

Dear Industrial Arts Teacher:

I am writing my Master's Thesis on a Testing Program in Industrial Arts. I am testing the enclosed test for reliability and validity. The time allowed for the test is 50 minutes. It is for use in the shop classes of the 7, 8, and 9th grades.

I would like your opinion of the enclosed test. On the answer sheet will you draw a line through the number of any question or questions that you do not consider good? Will you also indicate your appraisal of the test by writing one of the following in the top margin of the answer sheet: Excellent - Good - Fair - Poor - Ineffectual.

Will you please return test and answer sheet in the enclosed stamped envelope within a week? Any other comments will be appreciated.

Thanking you in advance for your cooperation.

Very truly yours,

Albert R. Studer (Signed)

P. S. I am enclosing a couple of extra answer sheets for use if there are other shop teachers in your system that would care to evaluate test.

The results were not very enlightening and nothing conclusive could be established beyond the point that they agreed that it was a good shop test. Twelve evaluated the test as excellent. Eleven responded that it was good, and two reported that it was fair. No one rated it as poor or ineffectual.

Of the twenty-five teachers questioned, no two or more of them agree on any one question as being a poor test question. There were thirty-two test questions that received an unsatisfactory rating, fairly evenly distributed throughout the test. The fact that no two could agree on any one test question as a poor question leads me to believe that their ratings are definitely invalid. The only alternate possibility is to increase the number of questionnaires, but time does not permit this procedure.

The only possible use for this questionnaire result is when two questions are equal in weight. No two of the questions eliminated by the shop teachers' evaluation were equal in weight, so it was not an effective evaluation.

QUARTILE AND DECILE DISTRIBUTION OF SCORES. - The quartile and decile distribution does not reveal much that can be used in weighing the test questions. It is interesting to note that the mean score is 53.41 and the median score is 51.2. This deviation is not unusual and is attributed to the few exceptionally high scores of a few superior students. Table V shows the numerical distribution of scores according to quartile and decile distribution.

TABLE V

Quartile and Decile Distribution of  
500 Industrial Arts Test Scores

| Interval | Median | Mean   | Percentile     |
|----------|--------|--------|----------------|
| 6.       | 28.5   | 27.04  |                |
| 36.71    | 43.75  | 43.22  | Q1 36.71       |
| 51.2     | 57.9   | 57.65  | Q2 51.2 Mean   |
| 67.17    | 80.66  | 85.72  | Q3 67.17 53.41 |
| 137.     |        |        |                |
| 6.       | 21.8   | 20.74  | D1 26.5        |
| 26.5     | 30.33  | 29.72  | D2 32.66       |
| 32.66    | 36.71  | 35.76  | D3 38.89       |
| 38.89    | 42.18  | 41.58  | D4 45.36       |
| 45.36    | 48.55  | 47.86  | D5 51.2        |
| 51.2     | 53.44  | 52.94  | D6 55.5        |
| 55.5     | 59.4   | 59.02  | D7 62.75       |
| 62.75    | 67.17  | 66.62  | D8 71.71       |
| 71.71    | 77.5   | 77.9   | D9 84.57       |
| 84.57    | 97.5   | 101.94 | D10 137.       |
| 137.     |        |        |                |

The mean score for the Top 50 is 101.94. The mean score for the Low 50 is 20.74. This gives a difference of 81 + in test scores which reveals there is considerable difference in ability. Another comparison that was rather interesting was the mean score for the 100 Dedham tests, which was 21.57, (Table VI). Compare this with our Low 50 of 20.74, (Table V), and there is a difference of less than 1. In other words, the average boy knows as much about shop information without any formal shop program as the lowest 10 percent who have had a definite shop program. This proves rather conclusively that the validity of the test was obtained by following the program of studies.

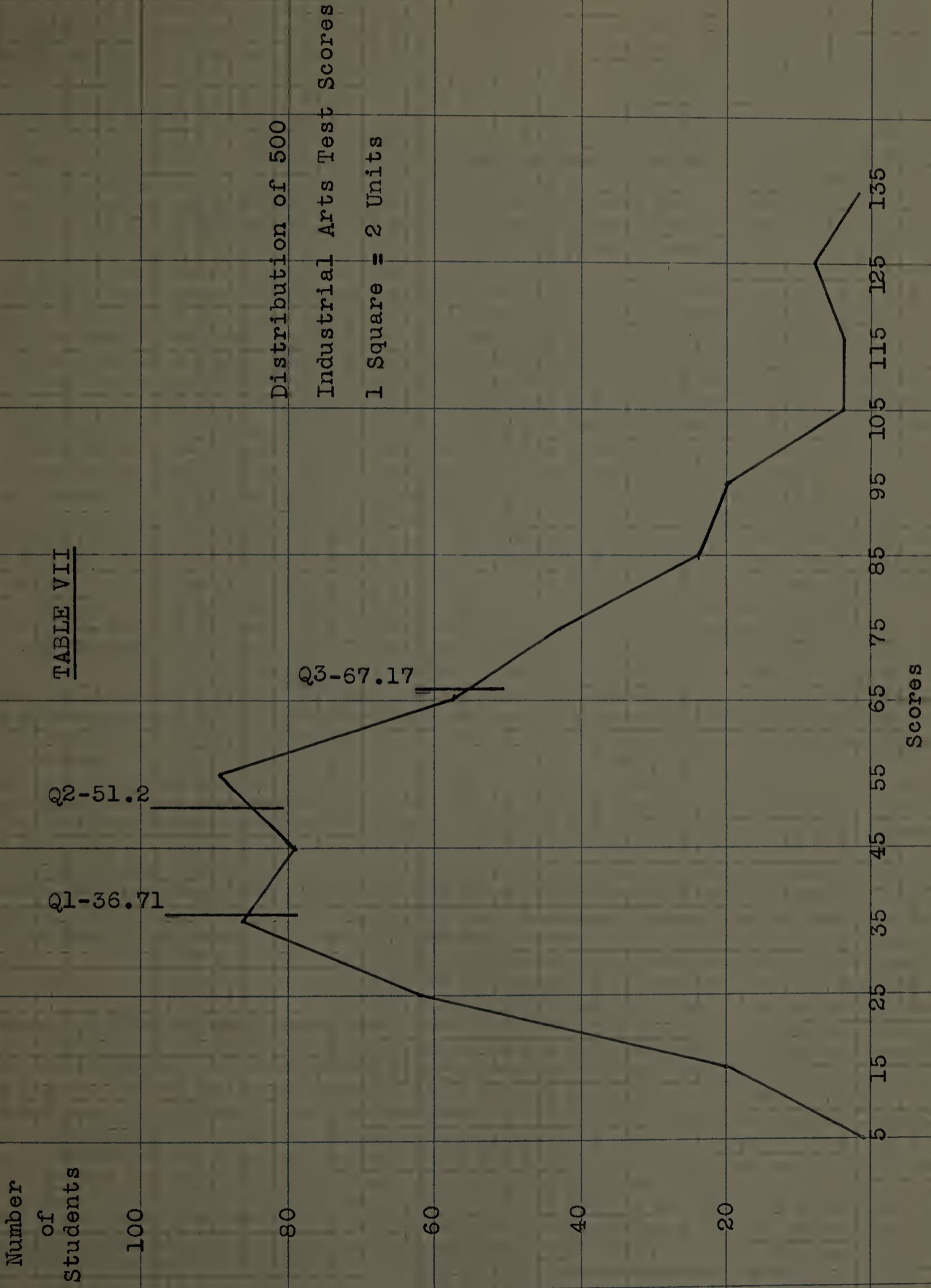
The graphic distribution of the 500 Test Scores is shown by Table VII. This follows the normal distribution curve with variations shown by the unusual students. The scores above 95 are exceptionally high, and these individuals are very proficient students. The variations on the low scores are not so outstanding as they follow the normal curve of distribution.

TABLE VI  
DISTRIBUTION  
100 Dedham Industrial Arts Test Scores

| I.Q.                     | Score      | I.Q.                     | Score      | I.Q.                     | Score      | I.Q.                     | Score |
|--------------------------|------------|--------------------------|------------|--------------------------|------------|--------------------------|-------|
| 141                      | 36         | 111                      | 27         | 98                       | 43         | 88                       | 18    |
| 127                      | 28         | 111                      | 18         | 98                       | 31         | 88                       | 15    |
| 125                      | 43         | 111                      | 12         | 98                       | 20         | 87                       | 26    |
| 122                      | 50         | 110                      | 26         | 98                       | 12         | 87                       | 10    |
| 121                      | 24         | 110                      | 19         | 97                       | 25         | 86                       | 25    |
| 121                      | 24         | 110                      | 5          | 97                       | 23         | 85                       | 8     |
| 119                      | 13         | 108                      | 45         | 97                       | 14         | 83                       | 23    |
| 118                      | 42         | 108                      | 23         | 96                       | 21         | 83                       | 23    |
| 117                      | 23         | 108                      | 21         | 96                       | 27         | 83                       | 15    |
| 117                      | 17         | 107                      | 47         | 96                       | 0          | 82                       | 16    |
| 117                      | 14         | 107                      | 34         | 95                       | 11         | 81                       | 17    |
| 116                      | 24         | 107                      | 26         | 95                       | 21         | 81                       | 15    |
| 116                      | 28         | 107                      | 30         | 95                       | 12         | 80                       | 32    |
| 115                      | 42         | 107                      | 16         | 94                       | 33         | 80                       | 10    |
| 115                      | 31         | 106                      | 30         | 93                       | 38         | 78                       | 7     |
| 115                      | 24         | 106                      | 13         | 92                       | 28         | 76                       | 15    |
| 115                      | 22         | 106                      | 11         | 92                       | 16         | 74                       | 7     |
| 114                      | 34         | 105                      | 14         | 92                       | 11         | 72                       | 6     |
| 114                      | 23         | 104                      | 27         | 91                       | 41         | 70                       | 17    |
| 114                      | 21         | 103                      | 21         | 91                       | 21         | 67                       | 6     |
| 114                      | 20         | 103                      | 10         | 91                       | 18         | 65                       | 17    |
| 114                      | 18         | 102                      | 11         | 90                       | 12         | 60                       | 14    |
| 114                      | 15         | 101                      | 42         | 90                       | 6          | 60                       | 0     |
| 112                      | 49         | 101                      | 14         | 89                       | 30         | 58                       | 16    |
| 111                      | 42         | 101                      | 14         | 89                       | 17         | 56                       | 5     |
| Q <sub>1</sub> Mean 28.3 |            | Q <sub>2</sub> Mean 22.2 |            | Q <sub>3</sub> Mean 21.2 |            | Q <sub>4</sub> Mean 14.5 |       |
|                          | Upper Half |                          |            |                          | Lower Half |                          |       |
|                          | Mean 25.3  |                          | Mean 21.57 |                          | Mean 17.9  |                          |       |



TABLE VII



DETERMINING THE RELIABILITY OF THE TEST. - Reliability is the consistency with which the test measures. In other words, if given a second time do the results vary much? If it is reliable, there is very little variance. Ruch lists these three common methods of finding reliability coefficients:

1. "By correlation of the scores from duplicate or equivalent examinations administered to the same pupils (as in the foregoing discussion). This is ordinarily the most accurate and defensible method.

2. By splitting the results from a single examination into chance halves, correlating the half-scores, and 'stepping up' the resulting coefficient of correlation by means of the Spearman-Brown prophecy formula (to be described later).

3. By repeating the same test or examination after an interval and correlating the results. This is often called the 're-testing coefficient of reliability.' This method should never be employed when the first or second methods are possible."<sup>4</sup>

The first check for reliability made on the Industrial Arts Test using 100 scores (every 5th score) was the odds-even check. The coefficient of correlation was .887, and inasmuch as this was based on one-half the test or 100 odd correlated with 100 even, it was then stepped up

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4. Ruch, G. M., The Objective or New-Type Examination, p. 415

with the Spearman-Brown prophecy formula ( $V_{nn}$ ). This resulted in a coefficient of .94 which is very high. Table VIII shows coefficient of correlation using Pierson product-moment formula.

The second test for reliability was the retest method. One hundred of Day Junior High boys were retested within an eight week period. The two test scores were then correlated and the result was .878, which is fairly high and proves conclusively that the test is reliable. Table IX shows this correlation.

DETERMINING THE VALIDITY OF THE TEST. - Validity is the degree to which a test measures what it is supposed to measure. Validity is the most important single factor in any test. A test that has low degree of validity has very little efficiency. On the contrary, a test with a high degree of validity has a high degree of efficiency.

Hawkes, Lindquist, Mann reveal the following:

"The most important--the all important--characteristic of any test is its validity. The validity of the test depends upon the effectiveness with which it measures that which it is intended to measure, or, otherwise stated, upon the effectiveness with which it accomplishes the purpose it is intended to accomplish. The mistake is frequently made of describing a test as 'valid' or 'invalid' in general, implying an 'all-or-none' characteristic with no specific reference. Validity, on the contrary, is a highly specific concept, and refers to something in which tests differ only



TABLE IX

| Ind. Arts FIRST MARK | Industrial Arts Retest - Second Mark --- Reliability |       |       |       |       |       |       |       |       |       |       | Computations |       |       |       |       |       |       |         |      |    |     |      |      |
|----------------------|------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------------|-------|-------|-------|-------|-------|-------|---------|------|----|-----|------|------|
|                      | 10-14                                                | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69        | 70-74 | 75-79 | 80-84 | 85-89 | 90-94 | 95-99 | 100-104 |      |    |     |      |      |
| 85-89                |                                                      |       |       |       |       |       |       |       |       |       |       |              |       |       | 1     |       |       |       | 1       | 2    | 10 | 20  | 200  | 220  |
| 80-84                |                                                      |       |       |       |       |       |       |       |       |       |       |              |       | 1     |       |       |       |       |         | 2    | 9  | 18  | 162  | 162  |
| 75-79                |                                                      |       |       |       |       |       |       |       |       | 1     |       |              |       |       |       |       |       |       |         | 2    | 8  | 16  | 128  | 88   |
| 70-74                |                                                      |       |       |       |       |       |       |       |       |       |       |              |       | 1     |       |       |       |       |         | 1    | 7  | 7   | 49   | 63   |
| 65-69                |                                                      |       |       |       |       | 1     |       |       |       |       |       |              |       |       |       |       |       |       |         | 2    | 6  | 12  | 72   | 30   |
| 60-64                |                                                      |       |       |       |       |       |       |       |       | 1     |       |              | 1     |       |       |       |       |       |         | 6    | 5  | 30  | 150  | 140  |
| 55-59                |                                                      |       |       |       |       |       |       |       |       | 2     |       |              |       | 1     |       |       |       |       |         | 6    | 4  | 24  | 96   | 112  |
| 50-54                |                                                      |       |       |       |       |       | 1     |       |       |       |       |              |       |       |       |       |       |       |         | 13   | 3  | 39  | 117  | 144  |
| 45-49                |                                                      |       |       |       |       |       |       |       |       | 2     |       |              |       |       |       |       |       |       |         | 9    | 2  | 18  | 36   | 52   |
| 40-44                |                                                      |       |       |       |       |       |       |       |       |       |       |              |       |       |       |       |       |       |         | 6    | 1  | 6   | 6    | 7    |
| 35-39                |                                                      |       |       |       |       |       |       |       |       |       |       |              |       |       |       |       |       |       |         | 14   | 0  | 190 |      |      |
| 30-34                | 1                                                    |       |       |       |       |       |       |       |       |       |       |              |       |       |       |       |       |       |         | 14   | -1 | -14 | 14   | 16   |
| 25-29                |                                                      | 2     | 4     | 3     | 1     | 2     |       |       |       |       |       |              |       |       |       |       |       |       |         | 12   | -2 | -24 | 48   | 54   |
| 20-24                |                                                      | 1     | 1     | 1     | 1     |       |       |       |       |       |       |              |       |       |       |       |       |       |         | 4    | -3 | -12 | 36   | 30   |
| 15-19                |                                                      | 3     | 2     |       |       |       |       |       |       |       |       |              |       |       |       |       |       |       |         | 5    | -4 | -20 | 80   | 72   |
| 10-14                |                                                      |       | 1     |       | 1     |       |       |       |       |       |       |              |       |       |       |       |       |       |         | 2    | -5 | -10 | 50   | 20   |
| f                    | 1                                                    | 6     | 8     | 10    | 12    | 14    | 5     | 9     | 6     | 11    | 6     | 4            | 2     | 1     | 3     | 1     |       |       | 1       | 100  |    | -80 | 1244 | 1210 |
| d                    | -5                                                   | -4    | -3    | -2    | -1    | 0     | 1     | 2     | 3     | 4     | 5     | 6            | 7     | 8     | 9     | 10    | 11    | 12    | 13      |      |    |     |      |      |
| fd                   | -5                                                   | -24   | -24   | -20   | -12   | -85   |       | 18    | 18    | 44    | 30    | 24           | 14    | 8     | 27    | 10    |       |       | 13      | 211  |    |     |      |      |
| fd <sup>2</sup>      | 25                                                   | 96    | 72    | 40    | 12    |       | 5     | 36    | 54    | 176   | 150   | 144          | 98    | 64    | 245   | 100   |       |       | 169     | 1484 |    |     |      |      |

$\text{Cpk} = 1.26$   
 $\text{Cp} = 1.1$   
 $\text{Cpk} = 3.64$   
 $\text{Cpk} = .878$

in degree. If a test is 'valid', it is valid for a given purpose, with a given group of pupils, and it is valid only to the degree that it accomplishes that specific purpose for that specific group."<sup>5</sup>

The first check for validity was to use the scores of 100 8th grade Day Junior High boys. One hundred Detroit Mechanical Aptitude Scores were correlated with the same boys' scores on the Industrial Arts Test. The coefficient received was .61. This is rather low, but not unreasonable when one analyzes the criteria that were used. Table X shows correlations using the Industrial Arts Test Scores and Detroit Mechanical Aptitude Test Scores.

The second test for validity was to correlate shop marks with the Industrial Arts Test Scores. Here the coefficients varied from .20 to .58, depending on the size of the group. The highest coefficient was received when the 200 9th grade test scores were used and correlated with the shop marks. Table XI shows this correlation. The lowest correlation found was .20. In this correlation, 35 middle division, 8th grade Day Junior High boys were used. This correlation is found on Table XII. I might add at this point that the shop marks used were unprejudiced and were the accumulative mark based on at least one year's previous shop experience.

MacQuarrie, in an article on a mechanical ability

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5. Hawkes, Lindquist, Mann, "Validity of a Test," The Construction and Use of Achievement Examinations, p. 21

TABLE X

| 100 Ind. Arts Test Scores | 100 Detroit Mechanical Aptitude Test Scores - Validity |       |       |        |        |        |        |        |        |        |        |        |        | Computations |        |        |        |        |        |     |    |     |                 |     |     |
|---------------------------|--------------------------------------------------------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|--------|--------|--------|--------|--------|-----|----|-----|-----------------|-----|-----|
|                           | 70-79                                                  | 80-89 | 90-99 | 100-09 | 110-19 | 120-29 | 130-39 | 140-49 | 150-59 | 160-69 | 170-79 | 180-89 | 190-99 | 200-09       | 210-19 | 220-29 | 230-39 | 240-49 | 250-59 | f   | d  | fd  | fd <sup>2</sup> | N   |     |
| 85-89                     |                                                        |       |       |        |        |        |        |        | 1      |        |        | 1      |        |              | 1      |        |        |        |        |     | 2  | 10  | 20              | 200 | 100 |
| 80-84                     |                                                        |       |       |        |        |        |        |        | 1      |        |        |        |        |              |        |        |        |        |        |     | 2  | 9   | 18              | 162 | 90  |
| 75-79                     |                                                        |       |       |        |        |        |        |        |        | 1      |        |        |        |              | 1      |        |        |        |        |     | 2  | 8   | 16              | 128 | 64  |
| 70-74                     |                                                        |       |       |        |        |        |        |        |        |        |        | 1      |        |              |        |        |        |        |        |     | 1  | 7   | 7               | 49  | 56  |
| 65-69                     |                                                        |       |       |        |        |        |        |        |        |        | 1      |        |        |              | 1      |        |        |        |        |     | 2  | 6   | 12              | 72  | 66  |
| 60-64                     |                                                        |       |       |        |        |        | 1      |        |        |        |        |        |        | 2            |        |        |        |        |        |     | 6  | 5   | 30              | 150 | 145 |
| 55-59                     |                                                        |       |       |        |        |        | 1      |        |        | 1      | 3      | 1      |        |              | 1      |        |        |        |        |     | 7  | 4   | 28              | 112 | 64  |
| 50-54                     |                                                        |       |       |        |        |        | 2      | 1      | 1      | 2      | 1      | 1      | 1      |              | 2      | 1      | 1      |        |        |     | 12 | 3   | 36              | 108 | 126 |
| 45-49                     |                                                        |       | 1     |        |        |        | 1      | 3      |        |        | 1      | 1      |        | 1            |        |        |        |        |        |     | 9  | 2   | 18              | 36  | -10 |
| 40-44                     |                                                        |       |       |        |        |        | 2      | 2      | 1      | 1      |        |        | 1      |              |        |        |        |        |        |     | 6  | 1   | 6               | 6   | 3   |
| 35-39                     |                                                        |       |       | 1      |        |        | 1      | 2      | 2      | 1      | 2      | 1      | 1      | 1            |        |        |        |        |        |     | 14 | 0   | 191             |     |     |
| 30-34                     | 1                                                      |       |       | 1      |        |        |        | 4      | 1      | 2      | 1      |        |        |              | 1      |        |        |        |        |     | 14 | -1  | -14             | 14  | 10  |
| 25-29                     |                                                        |       |       |        |        |        | 3      | 3      | 1      |        | 2      |        |        |              |        |        |        |        |        |     | 12 | -2  | -24             | 48  | 14  |
| 20-24                     |                                                        |       | 1     |        |        |        | 1      |        |        | 1      |        |        |        |              |        |        |        |        |        |     | 5  | -3  | -15             | 45  | 39  |
| 15-19                     |                                                        |       |       | 1      |        |        |        | 1      |        |        |        |        |        |              |        |        |        |        |        |     | 4  | -4  | -16             | 64  | 40  |
| 10-14                     |                                                        |       |       |        |        |        | 2      |        |        |        |        |        |        |              | 2      |        |        |        |        |     | 2  | -5  | -10             | 50  | 20  |
| f                         | 1                                                      | 0     | 3     | 3      | 4      | 7      | 5      | 12     | 16     | 9      | 9      | 8      | 4      | 4            | 6      | 3      | 4      | 2      |        | 100 |    | -79 | 1244            | 847 |     |
| d                         | -8                                                     | -7    | -6    | -5     | -4     | -3     | -2     | -1     | 0      | 1      | 2      | 3      | 4      | 5            | 6      | 7      | 8      | 9      |        |     |    |     |                 |     |     |
| fd                        | -8                                                     | -7    | -18   | -15    | -16    | -21    | -10    | -12    | 100    | 9      | 18     | 24     | 16     | 20           | 36     | 21     | 32     | 18     | 194    |     |    |     |                 |     |     |
| fd <sup>2</sup>           | 64                                                     | 108   | 108   | 75     | 64     | 63     | 20     | 12     |        | 9      | 36     | 72     | 64     | 80           | 216    | 147    | 256    | 162    | 148    |     |    |     |                 |     |     |

$\sum fd = .94$   
 $\sum fd^2 = 1.12$   
 $\sum fd^3 = 3.33$   
 $r = .61$

TABLE XI

| Shop Marks      | 200 9th Grade Industrial Arts Test Scores - Validity |       |       |       |       |       |       |       |       |        | Computations |         |         |         |      |     |                 |                |     |
|-----------------|------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------------|---------|---------|---------|------|-----|-----------------|----------------|-----|
|                 | 1-10                                                 | 11-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | 91-100 | 101-110      | 111-120 | 121-130 | 131-140 | f    | fd  | fd <sup>2</sup> | f <sup>2</sup> |     |
| 9               |                                                      |       | 1     | 1     | 3     | 5     | 5     | 13    | 9     | 12     | 1            | 1       | 6       | 1       | 58   | 2   | 116             | 232            | 318 |
| 9 -             |                                                      |       | 2     | 1     | 8     | 9     | 5     | 3     | 1     |        |              |         |         |         | 29   | 1   | 29              | 29             | -2  |
| 8 +             |                                                      |       |       | 1     | 1     | 3     | 7     | 4     | 2     | 1      |              |         |         |         | 19   | 0   | 145             |                |     |
| 8               |                                                      | 2     |       | 5     | 4     | 11    | 11    | 2     | 2     |        |              | 1       | 1       |         | 38   | -1  | -38             | 38             | -6  |
| 8 -             |                                                      | 1     | 4     | 4     | 1     | 2     | 2     | 1     |       | 1      |              |         |         |         | 17   | -2  | -34             | 68             | 18  |
| 7 +             |                                                      |       |       | 1     |       | 4     | 2     | 2     | 1     |        |              |         |         |         | 10   | -3  | -30             | 90             | -21 |
| 7               |                                                      |       | 6     | 5     | 4     | 1     |       |       |       |        |              |         |         |         | 17   | -4  | -68             | 272            | 124 |
| 7 -             | 1                                                    | 2     | 7     | 2     |       |       |       |       |       |        |              |         |         |         | 12   | -5  | -60             | 300            | 190 |
| 6 +             |                                                      |       |       |       |       |       |       |       |       |        |              |         |         |         |      |     |                 |                |     |
| 6               |                                                      |       |       |       |       |       |       |       |       |        |              |         |         |         |      |     |                 |                |     |
| 6 -             |                                                      |       |       |       |       |       |       |       |       |        |              |         |         |         |      |     |                 |                |     |
| f               | 1                                                    | 5     | 20    | 20    | 21    | 35    | 33    | 25    | 15    | 13     | 2            | 1       | 8       | 1       | 200  | -23 | 1029            | 621            |     |
| d               | -5                                                   | -4    | -3    | -2    | -1    | 0     | 1     | 2     | 3     | 4      | 5            | 6       | 7       | 8       |      |     |                 |                |     |
| fd              | -5                                                   | -20   | -60   | -40   | -21   | 46    | 33    | 50    | 45    | 52     | 10           | 6       | 56      | 8       | 260  |     |                 |                |     |
| fd <sup>2</sup> | 25                                                   | 80    | 180   | 80    | 21    |       | 33    | 100   | 135   | 208    | 50           | 36      | 392     | 64      | 1404 |     |                 |                |     |

$\sum fd = -23$   
 $\sum fd^2 = 1029$   
 $\sum f^2 = 621$   
 $\sum d^2 = 325$   
 $\sum d = 18$   
 $\sum d^3 = 2.23$   
 $\sum d^4 = .58$



TABLE XII

| Shop Marks      | 35 Middle Division 8th Grade Ind. Arts Test Scores-Validity Computations |       |       |       |       |       |       |       |    |    |      |                 |
|-----------------|--------------------------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|----|----|------|-----------------|
|                 | 11-20                                                                    | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | f  | d  | fd   | fd <sup>2</sup> |
| 9               |                                                                          |       |       | 1     |       |       |       | 1     | 2  | 3  | 6    | 18              |
| 9 -             |                                                                          |       | 2     | 2     | 1     | 1     |       |       | 6  | 2  | 12   | 24              |
| 8 +             |                                                                          |       | 1     | 1     |       | 1     |       |       | 3  | 1  | 3    | 3               |
| 8               |                                                                          | 1     | 3     | 4     | 3     |       |       |       | 11 | 0  | 21   |                 |
| 8 -             |                                                                          |       | 3     | 3     | 2     | 1     |       |       | 9  | -1 | -9   | 9               |
| 7 +             |                                                                          |       |       |       | 2     |       |       |       | 2  | -2 | -4   | 8               |
| 7               |                                                                          |       | 1     | 1     |       |       |       |       | 2  | -3 | -6   | 18              |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
|                 |                                                                          |       |       |       |       |       |       |       |    |    |      |                 |
| f               |                                                                          | 1     | 10    | 12    | 8     | 3     | 0     | 1     | 35 |    | -19  | 80              |
| d               |                                                                          | -2    | -1    | 0     | 1     | 2     | 3     | 4     |    |    | .171 |                 |
| fd              |                                                                          | -2    | -10   | -12   | 8     | 6     | 0     | 4     | 18 |    | .057 |                 |
| fd <sup>2</sup> |                                                                          | 4     | 10    |       | 8     | 12    | 0     | 16    | 50 |    | 1.18 | .20             |

$\frac{19}{35} = .5428$   
 $\frac{171}{35^2} = .171$   
 $\frac{80}{35} = 2.2857$   
 $\frac{80}{35^2} = .057$   
 $\frac{1.18}{.5428} = 2.17$   
 $\frac{1.18}{.057} = 20.68$   
 $\frac{1.18}{2.17} = .54$   
 $\frac{1.18}{20.68} = .057$   
 $\frac{1.18}{.54} = 2.18$   
 $\frac{1.18}{20.68} = .057$

test made these observations: "MacQuarrie pencil-and-paper tests had a reliability of .90. No correlation with group mental scores. The emphasis was on speed. Correlation with unprejudiced shop grades was from .32 to .81."<sup>6</sup>

COMPARING THE RELIABILITY AND VALIDITY WITH STANDARDIZED

TESTS. - From the above the Industrial Arts Test compares rather favorably, in view of the range of coefficients, with the MacQuarrie Test for Mechanical Ability. Comparing the Industrial Arts Test with the Detroit Mechanical Aptitude Test for validations, it is found that the Detroit Test ranges from .63 to .65 using a Detroit Advanced Intelligence Test in the correlation. No rating against shop marks has yet been computed, so the assumption is that the correlation must be low. The reliability correlation of the Detroit Mechanical Aptitude Test was .898.

ACHIEVEMENT IN INDUSTRIAL ARTS CLASSES AS INDICATED BY SHOP

MARKS. - It is quite obvious from the low correlations of shop grades with the MacQuarrie Test and the Industrial Arts Tests that the present basis for determining shop marks is inadequate. This, plus the fact that they did not use these criteria for correlation in the Detroit Mechanical Aptitude Test, makes it quite obvious that shop marks are not very accurate grades of a boy's ability in shop. It may be assumed that shop ability as measured by shop grades should be specific and other factors such as

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6. MacQuarrie, T. W., "A Mechanical Ability Test, " Personnel Journal, p. 329

conduct, attitudes, and social adjustment should be measured objectively and be graded as distinct items in the total eventual grade for Industrial Arts.

CHAPTER V

SUMMARY AND CONCLUSIONS

## CHAPTER V

### SUMMARY AND CONCLUSIONS

SUMMARY OF ANALYSIS RESULTS. - In Chapter IV the questions for the new revised Industrial Arts Test were selected. The time limit was cut in half, or 25 minutes of working time. In addition to these changes, a sample question was placed at the beginning of each test in Part I, namely, A and B. The first questions from the original test were used as sample questions because they were discarded. With a five and a two column answer sheet for each part of the test, efficiency in scoring can be increased by using a masked type of scoring key. This should more than cut the scoring time in half.

RELIABILITY OF REVISED INDUSTRIAL ARTS TEST. - The two coefficients of correlation shown in Tables VIII and IX were .94 and .878. This gives the test a high ratio of reliability. The revised test will be more reliable than the original because the revised test has excluded all questions that were considered too easy, those that received eighty or more percent correct.

The questions that were too difficult were also eliminated--questions that were answered correctly by less than twenty percent of the 500 students tested. The scaling of the test questions in the revised test should also help to increase the reliability. The fact that the easy questions are at the beginning, leading to the more difficult questions

in each part of the test, should improve the performance of the test. In other words, the revised test will be more reliable and, therefore, a more accurate test of the students' knowledge of Industrial Arts.

VALIDITY OF THE REVISED INDUSTRIAL ARTS TEST. - The correlation for the first check for validity, Table X, using the Detroit Mechanical Aptitude Test, was .61. This coefficient is considered fair, assuming that the Detroit test is valid. The other coefficients that were received, Tables XI and XII, were .58 and .20. In these two correlations the Industrial Arts test scores were charted with the shop marks. Using shop marks as a criterion was an exercise of poor judgment, but it definitely proved that shop marks were generally inaccurate. Objectivity should play a greater part in compiling the grades for a student's marks. Conduct and effort should not be substituted for ability in any school subject.

In selecting the questions for the revised test, the validity was improved by discontinuing the poor questions. These defective questions were exposed by the fact that the Dedham boys with no shop experience received higher percentages of correct answers than the boys who were taking the Industrial Arts program in the other schools. This proved that certain questions were ineffectual and had to be discarded. Validity is concerned with how well the test measures that which it is supposed to measure. By this process of eliminating the inferior questions, the revised test will

be more valid than the original Industrial Arts Test.

NO COMPARISONS MADE OF THE SCHOOLS TESTED. - This thesis is primarily concerned with testing the test; that is, establishing the reliability and the validity of the Industrial Arts Test. The purpose was not to find out how well one individual or how one school compared to another, but to sort out the good questions from the useless ones. By using the individual test results of 600 boys, this objective has been achieved.

QUESTIONS NOT USED IN REVISED TEST. - Inasmuch as the original test questions followed the program of studies, those questions that were discarded in favor of the revised test could be used in a short term test or quiz. The revised test should be used as a final test for evaluation in Industrial Arts.

MANIPULATIVE SKILL TEST. - In addition to the revised test, which is inclined to be verbalistic, I would suggest that some practical test combining the use of tools, materials, and equipment be supplemented to the Industrial Arts Test. A poor reader is definitely penalized on this type of test, whereas, when he is tested on the practical as well as the verbal type test, he has a chance to bring up his average. It would also be interesting to see what the correlation would be on these two different types of tests in the same field. Both the above are excellent sources for further research and study.

OTHER INFLUENCING FACTORS. - The factors of interest and industry were not considered in this study, but undoubtedly exert a decided influence on possible success in Industrial Arts. In some areas material shortages impaired instruction. This was especially noticeable during the war, and is still apparent in some of the phases of shop work. The factor of Industrial Arts marks, or grades, as indices to general shop ability, seems to contain some of the effects of attitudes and conduct. More objective means of shop grading are necessary if these marks are to indicate shop ability to an accurate degree.

DETROIT MECHANICAL APTITUDE TEST NOT GOOD FOR VALIDITY

CORRELATION. - The Detroit Mechanical Aptitude Test is scored in a rather inaccurate manner. The wrong answers are not subtracted from the correct answers. Speed and guess-work usually result in a fairly high score on this test. There is such a variance in the two tests, the Detroit stressing speed with no penalty for wrong guesses, and the Industrial Arts Test where speed is not stressed and accuracy is paramount.

FUTURE OF REVISED INDUSTRIAL ARTS TEST. - The Revised Industrial Arts Test is to be given in June to all boys in the Newton System who are taking Industrial Arts at the Junior High level. Results will be checked to insure that all the predictions are accurate. Norms will be established at the 7th, 8th, and 9th grade levels. From the use of the test



results, more accurate final marks will be available.

A better selection of trade school candidates will result, not to mention the elevation of standards in the field of Industrial Arts. All this should tend to promote Industrial Arts to new heights of attainment.

PROBLEMS FOR FURTHER STUDY. - 1. To develop an adequate criterion of shop ability more accurate than the present marking system.

2. Greater variety of tests should be developed in furthering the investigation of what constitutes shop ability.

3. Investiage the factors of interest and industry as related to success in Industrial Arts.

4. The possibility of better guidance through the use of more and better tests in Industrial Arts.

APPENDIX I

RANK OF THE 500 STUDENTS TESTED

RANK OF THE 500 STUDENTS TESTED

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 500  | 162-137                          |                 |                                                 | 8            | 113  |                                 |
| 499  | 160-135                          |                 |                                                 | 9            | 133  |                                 |
| 498  | 157-129                          |                 |                                                 | 9            | 125  |                                 |
| 497  | 156-127                          |                 |                                                 | 8-           | 121  | 76-80                           |
| 496  | 151-124                          |                 |                                                 | 8            | 115  |                                 |
| 495  | 155-123                          |                 |                                                 | 9            | 135  |                                 |
| 494  | 152-123                          |                 |                                                 | 9            | 125  |                                 |
| 493  | 151-122                          |                 |                                                 | 9            | 125  |                                 |
| 492  | 146-122                          |                 |                                                 | 9            | 118  |                                 |
| 491  | 143-121                          |                 |                                                 | 9            | 121  |                                 |
| 490  | 146-116                          |                 |                                                 | 9            | 116  |                                 |
| 489  | 145-116                          |                 |                                                 | 8+           | 121  | 72-72                           |
| 488  | 142-114                          |                 |                                                 | 9            | 112  |                                 |
| 487  | 136-112                          |                 |                                                 | 9            | 134  |                                 |
| 486  | 131-110                          |                 |                                                 | 8-           | 118  |                                 |
| 485  | 142-109                          |                 |                                                 | 8+           | 137  |                                 |
| 484  | 141-108                          |                 |                                                 | 9            | 111  |                                 |
| 483  | 140-103                          |                 |                                                 | 9-           | 106  |                                 |
| 482  | 126-100                          |                 |                                                 | 9-           | 114  |                                 |
| 481  | 117-100                          |                 |                                                 | 9            | 120  |                                 |
| 480  | 138-99                           |                 |                                                 | 8-           | 118  |                                 |
| 479  | 135-99                           |                 |                                                 | 9            | 124  | 68-67                           |
| 478  | 126-99                           |                 |                                                 | 7+           | 112  | 61-65                           |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 477  | 136-98                           |                 |                                                 | 9            | 109  |                                 |
| 476  | 135-97                           |                 |                                                 | 9            | 125  | 66-69                           |
| 475  | 126-97                           |                 |                                                 | 7            | 124  |                                 |
| 474  | 135-96                           |                 |                                                 | 9            | 133  |                                 |
| 473  | 132-96                           |                 |                                                 | 9            | 111  | 66-66                           |
| 472  | 128-96                           |                 |                                                 | 9            | 126  |                                 |
| 471  | 136-95                           |                 |                                                 | 9            | 119  |                                 |
| 470  | 134-95                           |                 |                                                 | 8            | 104  |                                 |
| 469  | 134-95                           |                 |                                                 | 8+           | 102  | 64-70                           |
| 468  | 131-93                           |                 |                                                 | 9            | 142  |                                 |
| 467  | 131-92                           |                 |                                                 | 9            | 116  |                                 |
| 466  | 132-91                           |                 |                                                 | 9            | 107  |                                 |
| 465  | 131-91                           |                 |                                                 | 9            | 128  |                                 |
| 464  | 128-91                           |                 |                                                 | 8+           | 132  |                                 |
| 463  | 111-91                           |                 |                                                 | 9-           | 120  |                                 |
| 462  | 132-90                           |                 |                                                 | 9            | 135  |                                 |
| 461  | 103-90                           |                 |                                                 | 8            | 124  |                                 |
| 460  | 128-89                           |                 |                                                 | 9            | 125  | 63-65                           |
| 459  | 106-87                           | 124-100         | 193                                             | 8+           | 120  |                                 |
| 458  | 127-86                           |                 |                                                 | 8+           | 108  |                                 |
| 457  | 112-86                           | 120-84          | 226                                             | 8+           | 115  |                                 |
| 456  | 128-85                           |                 |                                                 | 7+           | 114  | 62-66                           |
| 455  | 126-85                           |                 |                                                 | 9            | 104  |                                 |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 454  | 120-85                     |              |                                        | 9-        | 119  | 65-55                  |
| 453  | 130-84                     |              |                                        | 9         | 118  | 74-56                  |
| 452  | 128-84                     |              |                                        | 7+        | 108  | 65-63                  |
| 451  | 127-84                     |              |                                        | 9         | 114  |                        |
| 450  | 127-84                     |              |                                        | 9         | 112  |                        |
| 449  | 123-84                     |              |                                        | 8         | 133  |                        |
| 448  | 116-84                     |              |                                        | 8         | 117  | 60-56                  |
| 447  | 106-84                     |              |                                        | 9         | 128  |                        |
| 446  | 116-83                     |              |                                        | 9         | 104  |                        |
| 445  | 101-83                     |              |                                        | 9         | 107  |                        |
| 444  | 124-82                     |              |                                        | 8+        | 120  | 63-61                  |
| 443  | 110-82                     |              |                                        | 9         | 103  |                        |
| 442  | 124-81                     |              |                                        | 9         | 124  |                        |
| 441  | 110-81                     |              |                                        | 9         | 130  | 61-49                  |
| 440  | 106-81                     | 126-86       | 247                                    | 8+        | 119  | 49-57                  |
| 439  | 97-81                      | 111-79       | 168                                    | 8         | 115  |                        |
| 438  | 123-80                     |              |                                        | 8+        | 113  |                        |
| 437  | 102-80                     |              |                                        | 8         | 117  | 49-53                  |
| 436  | 102-80                     |              |                                        | 9         | 105  | 52-50                  |
| 435  | 123-79                     |              |                                        | 9         | 114  |                        |
| 434  | 121-79                     |              |                                        | 7+        | 128  |                        |
| 433  | 120-79                     |              |                                        | 8+        | 113  |                        |
| 432  | 119-79                     |              |                                        | 8         | 114  |                        |
| 431  | 117-79                     |              |                                        | 9         | 114  |                        |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 430  | 109-79                           | 111-67          | 219                                             | 9            | 114  |                                 |
| 429  | 107-79                           |                 |                                                 | 8            | 104  |                                 |
| 428  | 120-78                           | 82-62           | 170                                             | 8-           | 120  | 61-59                           |
| 427  | 120-78                           |                 |                                                 | 9            | 115  | 65-55                           |
| 426  | 119-78                           |                 |                                                 | 9            | 105  |                                 |
| 425  | 124-77                           |                 |                                                 | 9            | 114  |                                 |
| 424  | 121-77                           |                 |                                                 | 9            | 121  |                                 |
| 423  | 121-77                           |                 |                                                 | 9            | 97   |                                 |
| 422  | 120-77                           |                 |                                                 | 8-           | 113  | 59-61                           |
| 421  | 120-77                           |                 |                                                 | 9            | 90   |                                 |
| 420  | 119-77                           |                 |                                                 | 8-           | 134  |                                 |
| 419  | 109-77                           |                 |                                                 | 8            | 121  | 55-54                           |
| 418  | 105-77                           |                 |                                                 | 8            | 129  |                                 |
| 417  | 124-76                           |                 |                                                 | 9            | 121  | 66-58                           |
| 416  | 121-76                           |                 |                                                 | 9            | 128  |                                 |
| 415  | 119-76                           |                 |                                                 | 9-           | 114  |                                 |
| 414  | 119-76                           |                 |                                                 | 9            | 100  |                                 |
| 413  | 118-76                           |                 |                                                 | 8            | 101  |                                 |
| 412  | 112-76                           |                 |                                                 | 8+           | 118  |                                 |
| 411  | 121-75                           |                 |                                                 | 8            | 113  | 57-64                           |
| 410  | 108-75                           |                 |                                                 | 7+           | 109  | 53-55                           |
| 409  | 107-75                           |                 |                                                 | 8            | 112  | 58-49                           |
| 408  | 108-74                           |                 |                                                 | 7+           | 97   | 49-59                           |
| 407  | 92-74                            |                 |                                                 | 8+           | 122  |                                 |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 406  | 117-73                     |              |                                        | 9         | 104  |                        |
| 405  | 116-73                     | 118-82       | 234                                    | 7+        | 130  |                        |
| 404  | 101-73                     |              |                                        | 8         | 95   |                        |
| 403  | 102-72                     |              |                                        | 9         | 115  | 51-51                  |
| 402  | 120-71                     |              |                                        | 9         | 112  |                        |
| 401  | 117-71                     |              |                                        | 8-        | 121  |                        |
| 400  | 117-71                     |              |                                        | 9         | 98   | 58-59                  |
| 399  | 117-71                     |              |                                        | 8+        | 85   |                        |
| 398  | 114-71                     |              |                                        | 8         | 93   |                        |
| 397  | 109-71                     |              |                                        | 9         | 105  |                        |
| 396  | 84-71                      |              |                                        | 9         | 114  |                        |
| 395  | 117-70                     |              |                                        | 8         | 105  | 57-60                  |
| 394  | 107-70                     |              |                                        | 8         | 101  | 53-54                  |
| 393  | 118-69                     |              |                                        | 9-        | 118  |                        |
| 392  | 117-69                     |              |                                        | 8         | 112  |                        |
| 391  | 117-69                     |              |                                        | 8         | 110  |                        |
| 390  | 117-69                     |              |                                        | 8+        | 104  | 59-58                  |
| 389  | 116-69                     |              |                                        | 8+        | 114  | 55-61                  |
| 388  | 110-69                     |              |                                        | 9         | 92   |                        |
| 387  | 105-69                     |              |                                        | 8-        | 98   | 46-59                  |
| 386  | 100-69                     |              |                                        | 7         | 107  |                        |
| 385  | 87-69                      |              |                                        | 9-        | 82   | 48-39                  |
| 384  | 116-68                     |              |                                        | 8+        | 128  |                        |
| 383  | 114-68                     |              |                                        | 9         | 108  |                        |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 382  | 101-68                     |              |                                        | 8+        | 112  |                        |
| 381  | 94-68                      |              |                                        | 9         | 100  | 45-49                  |
| 380  | 117-67                     |              |                                        | 7+        | 118  |                        |
| 379  | 116-67                     |              |                                        | 8+        | 120  |                        |
| 378  | 113-67                     |              |                                        | 9-        | 124  |                        |
| 377  | 107-67                     |              |                                        | 8-        | 118  |                        |
| 376  | 83-67                      | 101-60       | 236                                    | 8+        | 110  |                        |
| 375  | 72-67                      |              |                                        | 8         | 90   |                        |
| 374  | 116-66                     |              |                                        | 9         | 107  |                        |
| 373  | 115-66                     |              |                                        | 9-        | 101  |                        |
| 372  | 96-66                      | 91-39        | 184                                    | 8-        | 108  |                        |
| 371  | 86-66                      |              |                                        | 9-        | 103  |                        |
| 370  | 84-66                      |              |                                        | 9-        | 96   |                        |
| 369  | 117-65                     |              |                                        | 8         | 109  | 60-57                  |
| 368  | 117-65                     |              |                                        | 9         | 84   |                        |
| 367  | 113-65                     |              |                                        | 8+        | 91   |                        |
| 366  | 112-65                     |              |                                        | 8         | 114  |                        |
| 365  | 81-65                      |              |                                        | 8         | 103  | 44-37                  |
| 364  | 114-64                     |              |                                        | 9         | 106  |                        |
| 363  | 111-64                     |              |                                        | 8+        | 108  |                        |
| 362  | 111-64                     |              |                                        | 8         | 106  |                        |
| 361  | 110-64                     |              |                                        | 8+        | 91   |                        |
| 360  | 89-64                      |              |                                        | 8         | 122  |                        |
| 359  | 72-64                      |              |                                        | 8-        | 114  |                        |



| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 358  | 113-63                     |              |                                        | 8-        | 96   |                        |
| 357  | 106-63                     |              |                                        | 7+        | 105  |                        |
| 356  | 101-63                     |              |                                        | 8-        | 115  |                        |
| 355  | 84-63                      |              |                                        | 8         | 111  |                        |
| 354  | 80-63                      | 70-53        | 147                                    | 8+        | 130  |                        |
| 353  | 73-63                      |              |                                        | 8         | 110  | 38-35                  |
| 352  | 113-62                     |              |                                        | 8         | 119  | 63-50                  |
| 351  | 113-62                     |              |                                        | 8         | 104  |                        |
| 350  | 112-62                     |              |                                        | 8-        | 135  |                        |
| 349  | 110-62                     |              |                                        | 9-        | 102  |                        |
| 348  | 106-62                     |              |                                        | 8+        | 104  |                        |
| 347  | 103-62                     |              |                                        | 9         | 106  |                        |
| 346  | 94-62                      |              |                                        | 9-        | 105  |                        |
| 345  | 89-62                      | 92-62        | 206                                    | 9-        | 100  |                        |
| 344  | 108-61                     |              |                                        | 8         | 107  |                        |
| 343  | 108-61                     |              |                                        | 9         | 98   |                        |
| 342  | 104-61                     |              |                                        | 9         | 96   |                        |
| 341  | 102-61                     |              |                                        | 7         | 112  | 53-49                  |
| 340  | 90-61                      |              |                                        | 8         | 113  |                        |
| 339  | 86-61                      |              |                                        | 8         | 129  |                        |
| 338  | 78-61                      | 79-56        | 232                                    | 8-        | 117  |                        |
| 337  | 110-60                     |              |                                        | 7-        | 122  |                        |
| 336  | 109-60                     |              |                                        | 8         | 121  | 57-52                  |
| 335  | 101-60                     | 110-74       | 215                                    | 9-        | 121  |                        |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 334  | 98-60                            |                 |                                                 | 8            | 108  |                                 |
| 333  | 96-60                            | 106-58          | 196                                             | 9-           | 113  |                                 |
| 332  | 85-60                            | 79-64           | 218                                             | 9-           | 111  |                                 |
| 331  | 112-59                           |                 |                                                 | 7+           | 121  |                                 |
| 330  | 110-59                           |                 |                                                 | 9-           | 114  |                                 |
| 329  | 110-59                           | 77-52           | 226                                             | 8+           | 114  |                                 |
| 328  | 110-59                           |                 |                                                 | 9-           | 80   |                                 |
| 327  | 109-59                           |                 |                                                 | 8+           | 104  |                                 |
| 326  | 103-59                           |                 |                                                 | 9-           | 97   |                                 |
| 325  | 97-59                            |                 |                                                 | 8-           | 105  |                                 |
| 324  | 89-59                            |                 |                                                 | 7+           | 110  | 45-44                           |
| 323  | 88-59                            |                 |                                                 | 8            | 110  | 44-44                           |
| 322  | 74-59                            |                 |                                                 | 8            | 133  |                                 |
| 321  | 110-58                           |                 |                                                 | 8            | 110  |                                 |
| 320  | 110-58                           |                 |                                                 | 8-           | 105  |                                 |
| 319  | 109-58                           |                 |                                                 | 7+           | 108  |                                 |
| 318  | 104-58                           |                 |                                                 | 9            | 102  |                                 |
| 317  | 101-58                           |                 |                                                 | 8+           | 110  |                                 |
| 316  | 94-58                            | 88-59           | 189                                             | 8            | 120  |                                 |
| 315  | 81-58                            |                 |                                                 | 8            | 110  | 46-35                           |
| 314  | 74-58                            |                 |                                                 | 9-           | 101  |                                 |
| 313  | 110-57                           |                 |                                                 | 9-           | 106  |                                 |
| 312  | 110-57                           |                 |                                                 | 9            | 104  |                                 |
| 311  | 108-57                           |                 |                                                 | 7            | 80   |                                 |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 310  | 106-57                     |              |                                        | 9         | 45   |                        |
| 309  | 105-57                     |              |                                        | 8         | 118  |                        |
| 308  | 95-57                      |              |                                        | 8+        | 111  |                        |
| 307  | 89-57                      | 93-55        | 178                                    | 7+        | 103  |                        |
| 306  | 87-57                      | 84-61        | 161                                    | 8         | 128  |                        |
| 305  | 68-57                      | 107-84       | 179                                    | 8         | 108  |                        |
| 304  | 64-57                      | 44-30        | 149                                    | 8         | 99   | 31-33                  |
| 303  | 110-56                     |              |                                        | 8         | 97   | 52-58                  |
| 302  | 108-56                     |              |                                        | 8         | 87   |                        |
| 301  | 89-56                      |              |                                        | 8+        | 120  |                        |
| 300  | 112-55                     |              |                                        | 8-        | 107  |                        |
| 299  | 106-55                     |              |                                        | 9         | 123  |                        |
| 298  | 103-55                     |              |                                        | 8+        | 118  |                        |
| 297  | 94-55                      | 112-54       | 170                                    | 8+        | 112  |                        |
| 296  | 69-55                      |              |                                        | 8         | 117  |                        |
| 295  | 73-55                      |              |                                        | 7+        | 91   |                        |
| 294  | 62-55                      |              |                                        | 8         | 113  |                        |
| 293  | 103-54                     |              |                                        | 8         | 97   |                        |
| 292  | 101-54                     | 101-59       | 153                                    | 9         | 84   |                        |
| 291  | 97-54                      |              |                                        | 8-        | 97   |                        |
| 290  | 96-54                      |              |                                        | 8         | 96   |                        |
| 289  | 90-54                      |              |                                        | 8-        | 118  |                        |
| 288  | 87-54                      |              |                                        | 7-        | 116  |                        |
| 287  | 85-54                      |              |                                        | 9-        | 106  |                        |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 286  | 87-54                      |              |                                        | 8         | 100  |                        |
| 285  | 65-54                      | 92-68        | 162                                    | 8         | 116  |                        |
| 284  | 107-53                     |              |                                        | 8         | 104  |                        |
| 283  | 107-53                     |              |                                        | 9         | 100  | 55-52                  |
| 282  | 106-53                     |              |                                        | 9-        | 122  | 55-51                  |
| 281  | 105-53                     |              |                                        | 8         | 121  |                        |
| 280  | 104-53                     |              |                                        | 8         | 128  |                        |
| 279  | 101-53                     |              |                                        | 8+        | 106  |                        |
| 278  | 100-53                     |              |                                        | 9-        | 97   |                        |
| 277  | 98-53                      |              |                                        | 7         | 114  |                        |
| 276  | 88-53                      |              |                                        | 8         | 98   |                        |
| 275  | 80-53                      |              |                                        | 8-        | 97   |                        |
| 274  | 80-53                      |              |                                        | 8         | 87   |                        |
| 273  | 79-53                      | 79-53        | 232                                    | 8+        | 111  |                        |
| 272  | 75-53                      | 101-66       | 214                                    | 9-        | 106  | 40-35                  |
| 271  | 72-53                      |              |                                        | 9-        | 120  | 36-36                  |
| 270  | 66-53                      |              |                                        | 7+        | 85   | 36-31                  |
| 269  | 65-53                      |              |                                        | 9         | 126  |                        |
| 268  | 107-52                     |              |                                        | 9         | 101  |                        |
| 267  | 106-52                     |              |                                        | 8+        | 94   |                        |
| 266  | 93-52                      | 76-57        | 167                                    | 8-        | 117  |                        |
| 265  | 90-52                      |              |                                        | 9-        | 115  | 44-46                  |
| 264  | 89-52                      | 65-55        | 179                                    | 8         | 117  |                        |
| 263  | 87-52                      |              |                                        | 7+        | 99   |                        |
| 262  | 76-52                      |              |                                        | 9-        | 118  | 39-37                  |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 261  | 76-52                      | 82-50        | 143                                    | 8         | 104  |                        |
| 260  | 69-52                      | 91-60        | 245                                    | 8+        | 118  |                        |
| 259  | 67-52                      |              |                                        | 7+        | 97   |                        |
| 258  | 103-51                     |              |                                        | 8         | 101  |                        |
| 257  | 102-51                     |              |                                        | 8         | 112  |                        |
| 256  | 96-51                      |              |                                        | 8         | 91   |                        |
| 255  | 93-51                      |              |                                        | 9-        | 106  |                        |
| 254  | 91-51                      |              |                                        | 7+        | 110  | 48-43                  |
| 253  | 89-51                      |              |                                        | 7+        | 103  |                        |
| 252  | 71-51                      |              |                                        | 7+        | 110  |                        |
| 251  | 68-51                      |              |                                        | 8+        | 107  |                        |
| 250  | 66-51                      | 82-70        | 147                                    | 9-        | 114  | 35-31                  |
| 249  | 59-51                      | 51-43        | 220                                    | 8         | 95   |                        |
| 248  | 106-50                     |              |                                        | 8-        | 116  |                        |
| 247  | 104-50                     |              |                                        | 9         | 103  |                        |
| 246  | 103-50                     |              |                                        | 9-        | 123  |                        |
| 245  | 103-50                     |              |                                        | 9         | 105  |                        |
| 244  | 98-50                      |              |                                        | 7         | 104  |                        |
| 243  | 93-50                      |              |                                        | 8+        | 109  |                        |
| 242  | 93-50                      | 74-49        | 191                                    | 8-        | 104  |                        |
| 241  | 88-50                      |              |                                        | 9         | 114  |                        |
| 240  | 65-50                      |              |                                        | 8-        | 111  | 35-30                  |
| 239  | 63-50                      |              |                                        | 8-        | 97   |                        |
| 238  | 62-50                      | 74-58        | 216                                    | 9-        | 121  | 35-27                  |
| 237  | 61-50                      |              |                                        | 8         | 96   |                        |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 236  | 105-49                           |                 |                                                 | 9-           |      |                                 |
| 235  | 104-49                           |                 |                                                 | 8+           | 101  |                                 |
| 234  | 101-49                           |                 |                                                 | 8+           | 127  |                                 |
| 233  | 101-49                           |                 |                                                 | 8            | 107  | 46-55                           |
| 232  | 92-49                            |                 |                                                 | 8+           | 121  |                                 |
| 231  | 82-49                            |                 |                                                 | 9-           | 101  |                                 |
| 230  | 67-49                            |                 |                                                 | 8            | 99   |                                 |
| 229  | 103-48                           |                 |                                                 | 9-           | 119  |                                 |
| 228  | 102-48                           |                 |                                                 | 7            | 108  |                                 |
| 227  | 102-48                           |                 |                                                 | 7            | 104  | 49-53                           |
| 226  | 101-48                           |                 |                                                 | 7+           | 98   |                                 |
| 225  | 91-48                            |                 |                                                 | 8            | 94   |                                 |
| 224  | 71-48                            | 104-65          | 205                                             | 8            | 115  | 35-36                           |
| 223  | 70-48                            |                 |                                                 | 8-           | 107  | 32-38                           |
| 222  | 63-48                            |                 |                                                 | 8            | 106  |                                 |
| 221  | 58-48                            | 88-59           | 154                                             | 8-           | 91   |                                 |
| 220  | 100-47                           |                 |                                                 | 8            | 116  | 51-49                           |
| 219  | 78-47                            |                 |                                                 | 8+           | 106  |                                 |
| 218  | 56-47                            | 88-57           | 129                                             | 7            | 99   |                                 |
| 217  | 102-46                           |                 |                                                 | 7+           | 121  |                                 |
| 216  | 102-46                           |                 |                                                 | 9            | 103  |                                 |
| 215  | 102-46                           |                 |                                                 | 8-           | 86   |                                 |
| 214  | 101-46                           |                 |                                                 | 7+           | 101  |                                 |
| 213  | 100-46                           | 61-47           | 187                                             | 9-           | 143  |                                 |
| 212  | 89-46                            |                 |                                                 | 7+           | 104  |                                 |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 211  | 80-46                            | 85-48           | 143                                             | 8-           | 97   | 39-41                           |
| 210  | 73-46                            |                 |                                                 | 8            | 94   |                                 |
| 209  | 58-46                            | 64-49           | 94                                              | 8            | 91   |                                 |
| 208  | 51-46                            |                 |                                                 | 8+           | 92   | 33-18                           |
| 207  | 102-45                           |                 |                                                 | 8-           | 99   |                                 |
| 206  | 100-45                           |                 |                                                 | 7+           | 108  |                                 |
| 205  | 99-48                            |                 |                                                 | 7+           | 105  | 43-56                           |
| 204  | 97-45                            |                 |                                                 | 8            | 105  |                                 |
| 203  | 84-45                            | 107-50          | 153                                             | 7-           | 104  |                                 |
| 202  | 81-45                            | 71-47           | 158                                             | 8-           | 114  |                                 |
| 201  | 72-45                            |                 |                                                 | 7            | 100  |                                 |
| 200  | 70-45                            |                 |                                                 | 8            | 95   |                                 |
| 199  | 69-45                            | 57-43           | 121                                             | 8-           | 99   |                                 |
| 198  | 66-45                            |                 |                                                 | 8+           | 123  |                                 |
| 197  | 51-45                            |                 |                                                 | 9-           | 90   |                                 |
| 196  | 102-44                           |                 |                                                 | 7            | 99   |                                 |
| 195  | 99-44                            |                 |                                                 | 8+           | 101  |                                 |
| 194  | 99-44                            |                 |                                                 | 9-           | 91   |                                 |
| 193  | 96-44                            |                 |                                                 | 8            | 94   |                                 |
| 192  | 85-44                            |                 |                                                 | 9-           | 103  |                                 |
| 191  | 72-44                            |                 |                                                 | 8            | 119  |                                 |
| 190  | 72-44                            |                 |                                                 | 8            | 104  |                                 |
| 189  | 72-44                            |                 |                                                 | 7            | 91   |                                 |
| 188  | 96-43                            |                 |                                                 | 9-           | 105  |                                 |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 187  | 95-43                      | 102-48       | 194                                    | 8-        | 110  |                        |
| 186  | 75-43                      |              |                                        | 9-        | 117  |                        |
| 185  | 48-43                      | 61-48        | 161                                    | 8-        | 107  |                        |
| 184  | 111-42                     |              |                                        | 8-        | 106  |                        |
| 183  | 100-42                     |              |                                        | 8         | 110  |                        |
| 182  | 99-42                      |              |                                        | 7         | 104  |                        |
| 181  | 99-42                      | 98-42        | 146                                    | 8-        | 102  |                        |
| 180  | 98-42                      |              |                                        | 9-        | 118  |                        |
| 179  | 98-42                      |              |                                        | 7+        | 88   | 50-48                  |
| 178  | 94-42                      |              |                                        | 9-        | 115  |                        |
| 177  | 88-42                      |              |                                        | 8         | 117  |                        |
| 176  | 79-42                      |              |                                        | 8         | 106  |                        |
| 175  | 64-42                      | 94-38        | 157                                    | 7+        | 99   | 28-36                  |
| 174  | 55-42                      |              |                                        | 9-        | 102  | 30-25                  |
| 173  | 98-41                      |              |                                        | 7         | 97   |                        |
| 172  | 94-41                      |              |                                        | 9         | 98   |                        |
| 171  | 77-41                      |              |                                        | 8-        | 108  |                        |
| 170  | 73-41                      | 75-45        | 134                                    | 8-        | 94   | 34-39                  |
| 169  | 99-40                      |              |                                        | 7         | 93   |                        |
| 168  | 98-40                      |              |                                        | 8         | 86   |                        |
| 167  | 97-40                      |              |                                        | 7         | 97   |                        |
| 166  | 76-40                      |              |                                        | 9-        | 92   |                        |
| 165  | 74-40                      |              |                                        | 6+        | 97   | 37-37                  |
| 164  | 71-40                      |              |                                        | 9-        | 101  |                        |



| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 163  | 64-40                      |              |                                        | 8         | 112  |                        |
| 162  | 49-40                      |              |                                        | 8-        | 102  |                        |
| 161  | 49-40                      | 75-39        | 157                                    | 7         | 89   |                        |
| 160  | 95-39                      |              |                                        | 7+        | 107  |                        |
| 159  | 87-39                      |              |                                        | 7-        | 114  |                        |
| 158  | 77-39                      | 68-29        | 125                                    | 8-        | 106  |                        |
| 157  | 77-39                      |              |                                        | 8-        | 99   |                        |
| 156  | 74-39                      |              |                                        | 8+        | 92   | 36-38                  |
| 155  | 74-39                      |              |                                        | 8         | 84   |                        |
| 154  | 59-39                      | 86-35        | 204                                    | 7         | 90   |                        |
| 153  | 57-39                      | 64-35        | 107                                    | 8-        | 91   | 32-35                  |
| 152  | 43-39                      |              |                                        | 8+        | 101  |                        |
| 151  | 96-38                      |              |                                        | 8         | 102  |                        |
| 150  | 95-38                      |              |                                        | 9         | 99   |                        |
| 149  | 95-38                      |              |                                        | 8         | 88   |                        |
| 148  | 94-38                      |              |                                        | 8         | 115  |                        |
| 147  | 75-38                      |              |                                        | 8-        | 122  |                        |
| 146  | 68-38                      | 73-30        | 153                                    | 8-        | 89   | 32-36                  |
| 145  | 64-38                      |              |                                        | 7         | 101  | 30-34                  |
| 144  | 57-38                      |              |                                        | 8-        | 92   | 32-25                  |
| 143  | 52-38                      |              |                                        | 7+        | 116  |                        |
| 142  | 98-37                      |              |                                        | 8+        | 120  |                        |
| 141  | 95-37                      |              |                                        | 7+        | 87   | 43-52                  |
| 140  | 93-37                      |              |                                        | 7         | 99   |                        |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 139  | 83-37                            |                 |                                                 | 8            | 99   |                                 |
| 138  | 82-37                            | 92-37           | 175                                             | 8-           | 108  | 46-36                           |
| 137  | 82-37                            |                 |                                                 | 7            | 100  |                                 |
| 136  | 79-37                            | 103-55          | 182                                             | 8+           | 100  |                                 |
| 135  | 77-37                            |                 |                                                 | 9-           | 99   |                                 |
| 134  | 60-37                            | 44-32           | 145                                             | 8            | 102  |                                 |
| 133  | 60-37                            | 68-39           | 199                                             | 7+           | 95   |                                 |
| 132  | 58-37                            | 56-37           | 180                                             | 8            | 98   |                                 |
| 131  | 51-37                            |                 |                                                 | 8            | 108  |                                 |
| 130  | 49-37                            | 67-33           | 121                                             | 8-           | 114  |                                 |
| 129  | 47-37                            |                 |                                                 | 7-           | 113  | 27-20                           |
| 128  | 47-37                            | 65-48           | 162                                             | 8            | 96   |                                 |
| 127  | 94-36                            |                 |                                                 | 8-           | 99   |                                 |
| 126  | 89-36                            |                 |                                                 | 8+           | 94   |                                 |
| 125  | 72-36                            |                 |                                                 | 7            | 91   |                                 |
| 124  | 71-36                            |                 |                                                 | 7+           | 91   |                                 |
| 123  | 60-36                            |                 |                                                 | 7            | 111  |                                 |
| 122  | 58-36                            | 89-34           | 155                                             | 8-           | 90   | 30-28                           |
| 121  | 50-36                            | 62-33           | 135                                             | 8-           | 105  |                                 |
| 120  | 94-35                            |                 |                                                 | 8-           | 111  | 42-52                           |
| 119  | 94-35                            |                 |                                                 | 8            | 94   | 43-51                           |
| 118  | 91-35                            |                 |                                                 | 6            | 104  |                                 |
| 117  | 78-35                            |                 |                                                 | 6-           | 109  |                                 |
| 116  | 76-35                            |                 |                                                 | 8-           | 90   | 33-43                           |

| Rank | Industrial Arts Test Score | Retest Score | Detroit Mechanical Aptitude Test Score | Shop Mark | I.Q. | Odd versus Even Scores |
|------|----------------------------|--------------|----------------------------------------|-----------|------|------------------------|
| 115  | 73-35                      |              |                                        | 7         | 107  |                        |
| 114  | 46-35                      |              |                                        | 8-        | 111  |                        |
| 113  | 44-35                      | 55-38        | 163                                    | 8-        | 118  |                        |
| 112  | 93-34                      |              |                                        | 7+        | 94   |                        |
| 111  | 78-34                      | 83-26        | 154                                    | 8-        | 85   |                        |
| 110  | 64-34                      | 85-32        | 105                                    | 8         | 94   |                        |
| 109  | 56-34                      |              |                                        | 8         | 95   |                        |
| 108  | 42-34                      |              |                                        | 8         | 92   |                        |
| 107  | 95-33                      |              |                                        | 7+        | 99   | 49-46                  |
| 106  | 74-33                      |              |                                        | 8-        | 107  | 39-35                  |
| 105  | 51-33                      | 73-39        | 153                                    | 8-        | 112  |                        |
| 104  | 95-32                      |              |                                        | 8         | 100  |                        |
| 103  | 94-32                      |              |                                        | 9-        | 106  |                        |
| 102  | 91-32                      |              |                                        | 7         | 122  |                        |
| 101  | 91-32                      | 90-32        | 165                                    | 7         | 98   |                        |
| 100  | 90-32                      |              |                                        | 7+        | 107  |                        |
| 99   | 89-32                      |              |                                        | 9-        | 89   |                        |
| 98   | 79-32                      |              |                                        | 8         | 79   |                        |
| 97   | 76-32                      | 93-38        | 122                                    | 8-        | 79   |                        |
| 96   | 75-32                      | 72-42        | 153                                    | 8-        | 96   |                        |
| 95   | 70-32                      |              |                                        | 8         | 88   |                        |
| 94   | 55-32                      |              |                                        | 7+        | 99   |                        |
| 93   | 49-32                      | 39-28        | 158                                    | 7+        | 104  |                        |
| 92   | 91-31                      |              |                                        | 8         | 95   |                        |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 91   | 91-31                            | 71-10           | 131                                             | 7            | 85   | 47-44                           |
| 90   | 88-31                            |                 |                                                 | 7            | 82   |                                 |
| 89   | 68-31                            | 88-36           | 186                                             | 8            | 105  | 32-36                           |
| 88   | 68-31                            |                 |                                                 | 8-           | 90   |                                 |
| 87   | 67-31                            | 102-42          | 176                                             | 9-           | 108  |                                 |
| 86   | 66-31                            |                 |                                                 | 7            | 91   |                                 |
| 85   | 59-31                            |                 |                                                 | 7+           | 98   |                                 |
| 84   | 39-31                            | 64-28           | 170                                             | 8            | 100  |                                 |
| 83   | 94-30                            |                 |                                                 | 7+           | 112  | 47-47                           |
| 82   | 90-30                            |                 |                                                 | 7            | 104  |                                 |
| 81   | 86-30                            |                 |                                                 | 7            | 86   |                                 |
| 80   | 82-30                            |                 |                                                 | 9            | 99   |                                 |
| 79   | 79-30                            |                 |                                                 | 9-           | 117  |                                 |
| 78   | 72-30                            |                 |                                                 | 8            | 96   |                                 |
| 77   | 68-30                            | 87-25           | 210                                             | 8            | 96   |                                 |
| 76   | 67-30                            |                 |                                                 | 9-           | 93   |                                 |
| 75   | 59-30                            |                 |                                                 | 8            | 87   |                                 |
| 74   | 53-30                            | 38-32           | 90                                              | 8            | 89   | 27-26                           |
| 73   | 49-30                            |                 |                                                 | 7-           | 93   |                                 |
| 72   | 45-30                            | 34-27           | 70                                              | 7            | 102  |                                 |
| 71   | 88-29                            |                 |                                                 | 8-           | 86   |                                 |
| 70   | 82-29                            |                 |                                                 | 8-           | 111  |                                 |
| 69   | 68-29                            | 79-38           | 185                                             | 8-           | 119  |                                 |
| 68   | 59-29                            |                 |                                                 | 7-           | 113  |                                 |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 67   | 58-29                            |                 |                                                 | 8-           | 96   | 32-26                           |
| 66   | 56-29                            |                 |                                                 | 8-           | 95   |                                 |
| 65   | 47-29                            | 50-31           | 128                                             | 7            | 96   |                                 |
| 64   | 44-29                            | 52-36           | 144                                             | 8-           | 102  |                                 |
| 63   | 43-29                            |                 |                                                 | 8            | 89   |                                 |
| 62   | 90-28                            |                 |                                                 | 8-           | 74   | 44-46                           |
| 61   | 69-28                            | 77-27           | 158                                             | 7            | 81   |                                 |
| 60   | 54-28                            |                 |                                                 | 8            | 80   | 26-28                           |
| 59   | 51-28                            |                 |                                                 | 7-           | 83   |                                 |
| 58   | 41-28                            |                 |                                                 | 8-           | 89   |                                 |
| 57   | 39-28                            |                 |                                                 | 8            | 89   | 20-19                           |
| 56   | 90-27                            |                 |                                                 | 7+           | 99   |                                 |
| 55   | 88-27                            |                 |                                                 | 6+           | 109  |                                 |
| 54   | 57-27                            |                 |                                                 | 8            | 87   | 26-31                           |
| 53   | 52-27                            | 58-29           | 113                                             | 8            | 97   |                                 |
| 52   | 45-27                            | 40-23           | 153                                             | 8            | 80   |                                 |
| 51   | 34-27                            |                 |                                                 | 7            | 104  |                                 |
| 50   | 87-26                            |                 |                                                 | 7            | 114  |                                 |
| 49   | 86-26                            |                 |                                                 | 7+           | 104  |                                 |
| 48   | 82-26                            | 73-17           | 159                                             | 8            | 101  |                                 |
| 47   | 69-26                            | 77-24           | 169                                             | 8            | 100  |                                 |
| 46   | 64-26                            |                 |                                                 | 7-           | 114  |                                 |
| 45   | 57-26                            |                 |                                                 | 8            | 78   |                                 |
| 44   | 44-26                            |                 |                                                 | 7            | 111  |                                 |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 43   | 41-26                            | 46-28           | 181                                             | 8+           | 113  |                                 |
| 42   | 74-25                            | 62-23           | 143                                             | 7+           | 85   |                                 |
| 41   | 67-25                            |                 |                                                 | 8-           | 107  |                                 |
| 40   | 55-25                            |                 |                                                 | 8            | 87   | 32-23                           |
| 39   | 51-25                            | 31-19           | 111                                             | 8-           | 98   |                                 |
| 38   | 39-25                            | 61-23           | 145                                             | 8-           | 67   |                                 |
| 37   | 78-24                            |                 |                                                 | 8-           | 95   |                                 |
| 36   | 70-24                            |                 |                                                 | 8-           | 109  | 36-34                           |
| 35   | 46-24                            | 62-24           | 119                                             | 9-           | 95   |                                 |
| 34   | 42-24                            |                 |                                                 | 9-           | 86   |                                 |
| 33   | 35-24                            |                 |                                                 | 8-           | 98   |                                 |
| 32   | 85-23                            |                 |                                                 | 7-           | 101  |                                 |
| 31   | 85-23                            |                 |                                                 | 8+           | 94   |                                 |
| 30   | 85-23                            |                 |                                                 | 6+           | 79   | 38-47                           |
| 29   | 43-23                            | 29-15           | 91                                              | 8-           | 87   |                                 |
| 28   | 85-22                            |                 |                                                 | 7-           | 103  |                                 |
| 27   | 69-22                            |                 |                                                 | 7            | 85   |                                 |
| 26   | 77-21                            |                 |                                                 | 7-           | 96   | 43-34                           |
| 25   | 64-21                            |                 |                                                 | 7+           | 100  |                                 |
| 24   | 57-21                            |                 |                                                 | 7            | 107  |                                 |
| 23   | 27-21                            |                 |                                                 | 8-           | 117  |                                 |
| 22   | 23-21                            | 56-25           | 147                                             | 8-           | 97   |                                 |
| 21   | 58-20                            | 90-31           | 171                                             | 8-           | 90   |                                 |
| 20   | 82-19                            |                 |                                                 | 7            | 98   |                                 |

| Rank | Industrial<br>Arts Test<br>Score | Retest<br>Score | Detroit<br>Mechanical<br>Aptitude<br>Test Score | Shop<br>Mark | I.Q. | Odd<br>versus<br>Even<br>Scores |
|------|----------------------------------|-----------------|-------------------------------------------------|--------------|------|---------------------------------|
| 19   | 82-19                            |                 |                                                 | 8-           | 97   |                                 |
| 18   | 57-19                            | 67-20           | 150                                             | 8            | 96   |                                 |
| 17   | 54-19                            | 74-17           | 131                                             | 8+           | 90   |                                 |
| 16   | 35-19                            |                 |                                                 | 7-           | 108  |                                 |
| 15   | 33-19                            | 41-19           | 103                                             | 8-           | 83   |                                 |
| 14   | 82-18                            |                 |                                                 | 8            | 87   |                                 |
| 13   | 59-18                            |                 |                                                 | 7-           | 107  |                                 |
| 12   | 52-18                            | 52-22           | 128                                             | 8            | 96   |                                 |
| 11   | 41-18                            | 40-17           | 113                                             | 8-           | 68   |                                 |
| 10   | 20-18                            |                 |                                                 | 8-           | 96   |                                 |
| 9    | 74-17                            |                 |                                                 | 8-           | 94   |                                 |
| 8    | 60-17                            |                 |                                                 | 7-           | 87   | 30-30                           |
| 7    | 22-15                            |                 |                                                 | 8-           | 93   | 13-9                            |
| 6    | 78-14                            |                 |                                                 | 9-           | 95   |                                 |
| 5    | 71-13                            |                 |                                                 | 8            | 92   |                                 |
| 4    | 63-13                            | 52-31           | 136                                             | 8-           | 97   |                                 |
| 3    | 37-12                            | 61-21           | 133                                             | 8-           | 83   |                                 |
| 2    | 34-12                            |                 |                                                 | 7+           | 96   |                                 |
| 1    | 41-6                             |                 |                                                 | 7-           | 85   |                                 |

APPENDIX II

ORIGINAL INDUSTRIAL ARTS TEST



ORIGINAL  
INDUSTRIAL ARTS TEST

PART I GRAPHIC ARTS

A. Multiple Choice Items

Directions: Complete each statement below by writing the number of the best answer on the separate answer sheet.

1. Newsprint is made of  
(1) rags (2) wood pulp (3) hemp (4) matrix (5) flax
2. Type in the school shop is stored in a  
(1) news case (2) California job case (3) Yankee case (4) chase  
(5) double cap case
3. To enter the printing industry you should train in a  
(1) junior high school (2) trade or technical school (3) prep school  
(4) general high school (5) grammar school
4. The printer's system of measure is known as  
(1) decimal system (2) tabular system (3) metric system  
(4) block system (5) point system
5. Type metal is made of  
(1) brass (2) zinc and lead (3) lead, antimony, and tin.  
(4) copper, tin, and iron (5) steel
6. The thinnest space of those listed below is  
(1) a 4-em space (2) a three-em space (3) an en quad  
(4) a 2-em quad (5) an em quad
7. Justification refers to  
(1) tightness of the line of type in the stick (2) spacing between words  
(3) having the paragraph indented properly (4) having type set to the  
correct measure (5) correcting errors
8. The best way to identify a silkscreen printing job is to  
(1) hold it up to the light (2) look through the screen  
(3) dip it in water (4) run your fingers over the surface  
(5) observe the color
9. A man who has completed all of his training in the printing trade is called a  
(1) master printer (2) craftsman (3) journeyman (4) printer's devil  
(5) printer's apprentice
10. When you dust powder onto a printed sheet and hold it over heat it is called  
(1) engraving (2) toasting (3) embossing (4) etching  
(5) raised printing
11. The best grade of writing paper is made from  
(1) wool (2) rayon (3) linen (4) wood pulp (5) silk.
12. The watermark on a sheet of paper can be seen by  
(1) printing on it (2) dipping it in water (3) rubbing it with a spoon  
(4) holding it up to the light (5) holding it over heat

13. A person who sets up type is called a  
(1) compositor (2) make up man (3) pressman (4) typist  
(5) job man
14. Press rollers are made of  
(1) rubber and glycerine (2) plastics (3) gelatin  
(4) synthetic rubber (5) glycerine, glue, and molasses
15. Mimeographing is a form of  
(1) typing (2) writing (3) painting (4) printing (5) shorthand
16. If you were to make one copy with ten thousand words would you  
(1) print it (2) typewrite it (3) silkscreen it (4) mimeograph it  
(5) rex-o-graph it
17. The "father of printing" was  
(1) Edison (2) Caslon (3) Gutenberg (4) Franklin (5) Schaffner
18. In a printer's ream there are  
(1) 200 sheets (2) 400 sheets (3) 500 sheets (4) 300 sheets  
(5) 25 sheets
19. Which of these is a part of a printing press  
(1) bed (2) chair (3) galley (4) fork (5) saucer
20. Which occupies the most space  
(1) one three-em quad (2) four one-em quads (3) five en quads  
(4) one two-em quad (5) two one-em quads
21. Copy is  
(1) a proof (2) a halftone (3) a duplicate (4) a stencil  
(5) the original sheet of directions
22. Forms are locked up with  
(1) grippers (2) staples (3) reglets (4) gauges (5) quoins
23. Bold type is  
(1) slanting (2) thin lined (3) script (4) heavy lined (5) outline
24. Printing was introduced into the United States in  
(1) 1639 (2) 1492 (3) 1540 (4) 1820 (5) 1706
25. Which of the following inks is the cheapest  
(1) bond (2) job (3) silk screen (4) halftone (5) news
26. The fourdrinier machine is used in the manufacture of  
(1) line cuts (2) type (3) paper (4) brass rule (5) glue
27. Raised printing is done by  
(1) cutting with a V-shaped tool (2) dusting compound on a printed job  
and holding it over heat (3) embossing (4) pressing out on the paper  
from the back (5) engraving
28. Rags used for cleaning the press are kept in a safety can to  
(1) keep the shop clean (2) prevent fire (3) avoid smells  
(4) have them handy (5) conserve them

29. To avoid injury while operating the paper cutter  
(1) set the gauge properly (2) talk to your classmates  
(3) raise and lower the handle several times (4) give the machine  
all of your attention (5) stand on a box
30. The correct way to read type in a composing stick is from the  
(1) left to right (2) right to left (3) top to bottom (4) nicks up  
(5) nicks down
31. All Boston daily newspapers are printed from  
(1) linoleum blocks (2) photo-engraving (3) monotype  
(4) line etchings (5) stereoplates

B. TRUE - FALSE ITEMS

Directions: Some of the statements below are true; others are false. On the separate answer sheet mark each true statement plus (+) and each false statement zero (o).

1. Linoleum blocks can be cut out and printed at home.
2. A halftone gets its name from the fact that it can print white, black, and tones in between black and white.
3. When making a halftone, the object is photographed through a screen.
4. A line etching is made up of many small dots.
5. Type should be cleaned with soap and water.
6. A line gauge is used to measure leads and slugs.
7. To prevent an impression when printing, the throw-off lever is used.
8. Printing rollers should not be allowed to stand in contact with anything.
9. Pads of paper are made by cementing the edges together with compound.
10. Printing was first produced from metal type.
11. The compartments in the lower case are of different size because the pieces of type vary in size.
12. A matrix is necessary to reproduce type.
13. All type used in the United States is the same height.
14. A point measures one-twelfth of a pica.
15. The graduations on a composing stick are in inches.
16. A job is tied up by using a square knot.

17. Printing ink is made of color and varnish.
18. The longer ink is ground, the better its quality.
19. Paper can be made from all kinds of rags.
20. Size is added to paper stock so that it can be easily cut.
21. All woven paper is made by machine and all laid paper is made by hand.
22. Quoins, furniture, and a chase are used when locking up a type form.
23. Quoins are generally placed at the top and at the left of a job.
24. The three kinds of printing are surface, intaglio, and relief.
25. A press should be oiled each working day.
26. A bed is the flat part of a press upon which the type form is placed.
27. Body size of type is said to be the distance from the feet to the face.
28. Brass rule is a thin strip of brass the height of type.
29. A composing stick is used in locking up a form.
30. A wire staple is used to fasten the pages of a small booklet together.
31. A letter of one series improperly mixed with those of another series is called a wrong font letter.
32. Type should be placed carefully in the case when being distributed.
33. A "family of type" consists of all the sizes and styles of the same design.
34. A stone proof is taken by hand, with a mallet and proof planer on the imposing stone.
35. Tympan paper is used for taking stone proofs.
36. The best grades of paper are usually watermarked.

PART II GENERAL METALS

A. Multiple Choice Items

Directions: Complete each statement below by writing the number of the best answer on the separate answer sheet.

1. The proper tool used to cut a 4" square of 28 gauge sheet metal is  
(1) a hack saw (2) a cold chisel (3) curved snips  
(4) straight snips (5) bench shears
2. Making a fold means  
(1) punching a hole (2) notching a corner (3) bending the metal  
(4) hammering the metal (5) filing it round
3. A stake is used for  
(1) drilling (2) forming (3) cutting (4) trimming (5) holding metal
4. Tinning a soldering copper means  
(1) to cover it with a piece of tin (2) to file it (3) to coat it with  
solder (4) to heat it (5) to forge it
5. Fluxes are used to make  
(1) paper stick (2) dirty the metal (3) hold the heat (4) make solder  
stick by preventing oxidation (5) grease tools
6. The center punch is used to  
(1) drill a hole (2) cut a square (3) mark a point (4) fold a hem.  
(5) connect metal
7. The best way to use a file is to  
(1) bear down while filing back and forth (2) use it like a saw  
(3) hold the front end near you (4) push forward and lift up on the  
return stroke (5) hit the metal
8. The cold chisel is used  
(1) for driving screws (2) filing a hole (3) cutting metal  
(4) chiseling wood (5) bending metal
9. The thinnest metal in this group is  
(1) 22 gauge (2) 28 gauge (3) 16 gauge (4) 18 gauge (5) 24 gauge
10. To make a 1/8" hole in sheet metal, use a  
(1) nail (2) solid punch (3) center punch (4) reamer  
(5) screwdriver
11. The gauge of metal means  
(1) the distance in from the edge (2) the thickness of metal  
(3) a marking gauge (4) a piece of galvanized iron  
(5) a tool to scratch metal
12. The burr is a  
(1) small hole (2) a kind of bolt (3) a rough edge  
(4) a copper rivet (5) a tinner's rivet

13. Tinning metal means  
(1) a piece of tin (2) to cut a piece of tin to size (3) to coat it with flux (4) to coat it with solder (5) to color it with aluminum paint
14. Half and half refers to  
(1) half turpentine and half linseed oil (2) proportions in making a cleaning solution (3) a kind of flux (4) an alloy in silver coin (5) proportions of tin and lead in solder
15. The bar folder is used to  
(1) curve pieces of metal (2) bend strap iron (3) make a fold up to 2" (4) bend wire (5) fold metal up to 1"
16. A good cleaning solution for soldering is made from water and  
(1) borax (2) soap powder (3) sal ammoniac (4) salt (5) casein powder
17. Galvanized sheet metal is coated with  
(1) tin (2) zinc (3) lead (4) solder (5) nickel plate
18. The kind of rivets commonly used in riveting band iron are  
(1) galvanized iron rivets (2) tubular rivets (3) copper rivets (4) soft iron rivets (5) split rivets
19. An alloyed metal is  
(1) tin (2) copper (3) aluminum (4) lead (5) brass
20. One of these metals should not be used on our emery wheel  
(1) strap iron (2) tool steel (3) angle iron (4) aluminum (5) stainless steel
21. A Jacob's chuck is used to hold  
(1) metal for drilling (2) a rivet set (3) a centerpunch (4) a solid punch (5) a drill
22. In drawing a 7" circle, the compass is set for  
(1)  $3\frac{1}{4}$ " (2) 7" (3)  $3\frac{3}{4}$ " (4)  $2\frac{3}{4}$ " (5)  $3\frac{1}{2}$ "
23. The calipers are used to  
(1) measure the length of pipe (2) lay out a pattern on metal (3) measure the diameter of pipes and iron rods (4) measure the width of a hem (5) mark the center of a hole
24. Rouge bricks are used to  
(1) rub the soldering iron on in tinning (2) build a red brick wall (3) use as stage make-up (4) use on the buffing wheel (5) line the gas furnace
25. The hand seamer is used to  
(1) bend band iron (2) hammer down a seam (3) punch holes by hand (4) groove a seam (5) fold metal by hand
26. A drill vise is used to  
(1) hold a drill in the drill press (2) keep a drill from breaking (3) hold a drill while sharpening it (4) hold metal while drilling (5) hold the drill press on the bench

27. Which term applies to the size of a drill in purchasing  
(1) gauge (2) denominator (3) fraction (4) shank (5) tang
28. A flux which should never be used to solder electrical connections is  
(1) sal ammoniac (2) soldering paste (3) cut acid (4) borax  
(5) rosin
29. Galvanized iron is sold by  
(1) weight per square foot (2) the number of sheets per ton (3) the  
gauge and size of sheet (4) kind of coating on the sheet (5) number  
of coats on the sheet
30. The best way to polish aluminum is by  
(1) polishing with No. 1 emery cloth (2) polishing with No. 1 steel wool  
(3) polishing with No. 1 sandpaper (4) polishing on the buffer  
(5) polishing with a fine oilstone
31. Drill sizes are given according to  
(1) number of twists per inch (2) kind of steel used in manufacturing  
(3) kind of material to be drilled (4) length of drill  
(5) fraction of inch
32. The size of non-electric soldering coppers is given by  
(1) over-all length of soldering copper (2) length of copper point,  
(3) weight of a pair of coppers (4) size of copper bar used in making  
the tip (5) time it takes to heat up
33. Which of these metals does not need to be annealed when hammered into a mold.  
(1) copper (2) aluminum (3) brass (4) silver (5) bronze
34. A smoke pipe for a furnace is best made of  
(1) tin plate (2) galvanized iron (3) zinc (4) copper  
(5) nickel plate
35. Polished copper articles purchased in the store are kept that way by  
(1) shellacking (2) varnishing (3) waxing (4) buffing  
(5) lacquering

B. TRUE - FALSE ITEMS

Directions: Some of the statements below are true; others are false. On the separate answer sheet mark each true statement plus (+) and each false statement zero (o).

1. For accurate work, it is necessary to center punch before drilling metal.
2. A soldering copper must be well tinned.
3. The soldering copper should be heated until it is red hot.
4. Grease or oil on metal will help the solder to stick.
5. The soldering copper should never be filed.
6. Soldering can be done without flux.

7. Sal ammoniac is a good flux.
8. The most commonly used solder is made of half tin and half lead.
9. Soldering paste is used to paste a pattern on metal.
10. A cleaning dip can be made from sal ammoniac and water.
11. Flux in liquid form is best for soldering electrical connections.
12. The soldering copper becomes oxidized when heated in a gas furnace.
13. Enamel paint may be thinned with water.
14. The paint brush should be cleaned with turpentine, then with soap and hot water.
15. The combination snips may be used for cutting either straight or curved lines.
16. The hack saw is used to cut band iron.
17. The finer grades of emery cloth are graded by zeros.
18. The commercial method of transferring patterns is pasting the pattern to the metal.
19. One of the uses of a hem is to strengthen the edge of the metal.
20. A hem is a good joint for sheet metal work.
21. A needle file is the best file to use in filing a 1" hole in a piece of 16 gauge galvanized iron.
22. The rough edge caused by filing is called a burr.
23. To save time in heating the soldering copper, the gas soldering furnace should be turned on full so that the flames come out of the front of the furnace.
24. The hot soldering copper should be quenched in water when you are through using it.
25. Remove the key from the chuck on the drill press before starting the power.
26. A machine should be oiled only when the power is shut off.
27. The teeth of the hack saw should point toward the handle.
28. The mallet is used to strike the cold chisel to prevent mushrooming.
29. The rivet set is used to punch a hole for a rivet.
30. Saw piercing is usually done with a jeweler's saw.
31. Copper is a harder metal than galvanized iron.
32. Aluminum is a lighter weight metal than copper.
33. A coarse grade of steel wool is No. 00.



PART III GENERAL WOODS

A. Multiple Choice Items

Directions: Complete each statement below by writing the number of the best answer on the separate answer sheet.

1. One of these products comes from a tree  
(1) turpentine (2) kerosene (3) linseed oil (4) benzine  
(5) gasoline
2. Which one of these woods makes a good floor for a living room  
(1) poplar (2) basswood (3) cypress (4) oak (5) cedar
3. A nail set is used to set  
(1) corrugated fasteners (2) common nails (3) brads (4) escutcheon  
pins (5) screws
4. Small round wooden pins used in joining two boards edge to edge are called  
(1) splines (2) plugs (3) dowels (4) wedges (5) plies
5. Good paint brushes are made from  
(1) cattle hair (2) vegetable fiber (3) horse hair (4) hog bristles  
(5) tampico
6. In selecting a heavy gauge wire brad you would take  
(1) No. 12 (2) No. 16 (3) No. 18 (4) No. 20 (5) No. 22.
7. White wood may be distinguished by its color which is  
(1) brown (2) green (3) yellow (4) red (5) orange
8. To set the heads of screws flush with the surface of the wood, the following  
tool is used  
(1) countersink bit (2) drill bit (3) auger bit (4) gimlet bit  
(5) bit gauge
9. When planing the surface of a board lengthwise you should use a  
(1) rabbet plane (2) jack plane (3) router plane (4) matching plane  
(5) scraper
10. The tri-square is used to test work for  
(1) length (2) smoothness (3) squareness (4) width (5) depth
11. The tool that is used to hold the auger bit to bore holes is a  
(1) bit gauge (2) center bit (3) bit brace (4) shank (5) sweep
12. Nails are usually purchased by  
(1) gross (2) hundred (3) pound (4) ream (5) thousand
13. Which one of these dimensions of lumber is measured with the grain  
(1) thickness (2) width (3) height (4) depth (5) length
14. The terms lip, nib, and spur apply to  
(1) chisels (2) screw driver (3) auger bit (4) planes (5) files

15. The part of a wood chisel ground to produce a cutting edge is  
(1) bevel (2) ferrule (3) shank (4) tang (5) shoulder
16. Shellac is thinned with  
(1) turpentine (2) kerosene (3) alcohol (4) linseed oil  
(5) paraffin oil
17. Hammer handles are made of  
(1) hickory (2) pine (3) walnut (4) gumwood (5) cedar
18. Which one of these joints is used for fastening the rails to the legs of a table  
(1) miter (2) mortise and tenon (3) butt joint (4) half lap  
(5) box joint
19. Which one of these woods is imported into the United States  
(1) cypress (2) white pine (3) mahogany (4) whitewood (5) walnut
20. Large quantities of shellac are produced in  
(1) The United States (2) Australia (3) Africa (4) India (5) Europe
21. The finest grade of sandpaper listed here is  
(1)  $\frac{1}{2}$  (2) 0 (3) 00 (4) 1 (5) 2
22. Hand saws are sharpened with  
(1) grinding wheel (2) file (3) whetstone (4) emery cloth  
(5) saw set
23. A plane iron is whetted on  
(1) an oilstone (2) a grinding wheel (3) a buffing wheel  
(4) a pumice stone (5) a burnisher
24. The annual growth of a tree is indicated on a cross section by  
(1) medullary ray (2) annual ring (3) bark (4) sapwood (5) cambium
25. The cross cut saw may be distinguished by  
(1) wide teeth (2) chisel shaped teeth, (3) pointed teeth  
(4) flat teeth (5) irregular teeth
26. In selecting a heavy gauge wood screw you would take a number  
(1) 6 (2) 8 (3) 10 (4) 12 (5) 16
27. Brushes used in paint should be cleaned in  
(1) water (2) alcohol (3) turpentine (4) lacquer (5) asphaltum
28. In measuring the length and marking a line you use a  
(1) knife (2) pencil (3) awl (4) marking gauge (5) finger gauge
29. A board foot of lumber contains  
(1) 12 cu. in (2) 24 cu. in (3) 72 cu. in. (4) 144 cu. in.  
(5) 288 cu. in.
30. A water resistant glue is  
(1) fish glue (2) hide glue (3) casein glue (4) vegetable glue  
(5) mucilage

PART III GENERAL WOODS -- continued

B. True - False Items

Directions: Some of the statements below are true; others are false. On the separate answer sheet mark each true statement plus (+) and each false statement zero (o).

1. A sketch may be used for a working drawing.
2. The top view of an object in a drawing is placed at the right of the side view.
3. On a working drawing, the distance between the arrow heads indicates the exact measurement.
4. A stock bill or bill of material contains the measurements for all of the parts of the article to be constructed.
5. Pieces required for a project may be cut from any board in the shop.
6. Suitable pieces for a project may be found in the scrap box.
7. Squaring stock means the making of pieces or parts the required width and length.
8. A rule may be used for squaring a line across a board.
9. A plane iron, when properly adjusted, is parallel to the bottom of the plane.
10. The teeth of a coping saw point toward the handle.
11. A marking gauge is commonly used in laying out a chamfer.
12. In planing the end grain of a chamfer the plane may be used at an angle.
13. A bevel extends entirely across the thickness of the stock at an angle.
14. Sizes of auger bits are marked in 32nds of an inch.
15. It is desirable to reverse the board when boring a hole.
16. An auger bit may be held in the hand drill chuck.
17. In making a horizontal cut across the grain the chisel is held with the bevel down.
18. A finish cut with a chisel is made with the aid of a mallet.
19. The size of a chisel is determined by measuring across the thickness of the blade.
20. The size of a brad is determined by its diameter and length.
21. A brad is a wire fastening having a large flat head.

22. A countersink is used to set a brad below the surface of the wood.
23. A ball peen hammer is a common woodworking tool.
24. The size of a flat head wood screw is determined by measuring the length of the thread.
25. Screws are sold by the pound.
26. A screw driver bit is used in a bit brace.
27. Fish glue is commonly used for outside work.
28. Hide glue is prepared by mixing the flakes with water.
29. Casein glue is a milk product.
30. A butt joint is made by notching two pieces of wood together.
31. Parts of furniture are commonly fastened together with dowel pins.
32. Corners of the picture frame are made with the mitre joint.
33. Better grades of sandpaper are made from quartz.
34. The finer grits of sandpaper are graded by zero.
35. Garnet paper is used for sanding in the furniture industry.

**ANSWER SHEET: NEWTON INDUSTRIAL ARTS TEST - FORM A (Exp. 1946)**

(Score "A" Tests: R -  $\frac{W}{4}$ ; Score "B" Tests: R - W)

Name \_\_\_\_\_ Date \_\_\_\_\_

School \_\_\_\_\_ Grade \_\_\_\_\_ Div. \_\_\_\_\_

Teacher \_\_\_\_\_ Ent. J.H.S. from \_\_\_\_\_

| Part       | Poss. Score | Number Right | Score |
|------------|-------------|--------------|-------|
| I A        | 31          |              |       |
| I B        | 36          |              |       |
| Total      | 67          |              |       |
| II A       | 35          |              |       |
| II B       | 33          |              |       |
| Total      | 68          |              |       |
| III A      | 30          |              |       |
| III B      | 35          |              |       |
| Total      | 65          |              |       |
| Total Test | 200         |              |       |
| M.A. _____ | C.A. _____  | I.Q. _____   |       |

Check below the Shop Courses which you have taken in Newton.


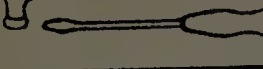
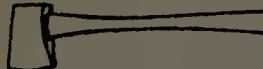
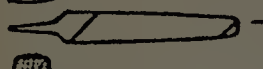

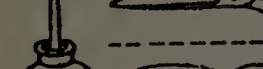







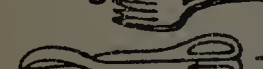

















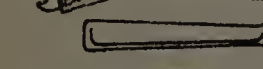





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|---------------------------------------------|---------------------------------------------|
| <input type="checkbox"/> Grade 7 (Required) | <input type="checkbox"/> Grade 8 (Elective) |
| <input type="checkbox"/> Grade 8 (Required) | <input type="checkbox"/> Grade 9 (Elective) |

| PART I    |           | PART II   |           | PART III  |           |
|-----------|-----------|-----------|-----------|-----------|-----------|
| Test A    | Test B    | Test A    | Test B    | Test A    | Test B    |
| 1. _____  | 1. _____  | 1. _____  | 1. _____  | 1. _____  | 1. _____  |
| 2. _____  | 2. _____  | 2. _____  | 2. _____  | 2. _____  | 2. _____  |
| 3. _____  | 3. _____  | 3. _____  | 3. _____  | 3. _____  | 3. _____  |
| 4. _____  | 4. _____  | 4. _____  | 4. _____  | 4. _____  | 4. _____  |
| 5. _____  | 5. _____  | 5. _____  | 5. _____  | 5. _____  | 5. _____  |
| 6. _____  | 6. _____  | 6. _____  | 6. _____  | 6. _____  | 6. _____  |
| 7. _____  | 7. _____  | 7. _____  | 7. _____  | 7. _____  | 7. _____  |
| 8. _____  | 8. _____  | 8. _____  | 8. _____  | 8. _____  | 8. _____  |
| 9. _____  | 9. _____  | 9. _____  | 9. _____  | 9. _____  | 9. _____  |
| 10. _____ | 10. _____ | 10. _____ | 10. _____ | 10. _____ | 10. _____ |
| 11. _____ | 11. _____ | 11. _____ | 11. _____ | 11. _____ | 11. _____ |
| 12. _____ | 12. _____ | 12. _____ | 12. _____ | 12. _____ | 12. _____ |
| 13. _____ | 13. _____ | 13. _____ | 13. _____ | 13. _____ | 13. _____ |
| 14. _____ | 14. _____ | 14. _____ | 14. _____ | 14. _____ | 14. _____ |
| 15. _____ | 15. _____ | 15. _____ | 15. _____ | 15. _____ | 15. _____ |
| 16. _____ | 16. _____ | 16. _____ | 16. _____ | 16. _____ | 16. _____ |
| 17. _____ | 17. _____ | 17. _____ | 17. _____ | 17. _____ | 17. _____ |
| 18. _____ | 18. _____ | 18. _____ | 18. _____ | 18. _____ | 18. _____ |
| 19. _____ | 19. _____ | 19. _____ | 19. _____ | 19. _____ | 19. _____ |
| 20. _____ | 20. _____ | 20. _____ | 20. _____ | 20. _____ | 20. _____ |
| 21. _____ | 21. _____ | 21. _____ | 21. _____ | 21. _____ | 21. _____ |
| 22. _____ | 22. _____ | 22. _____ | 22. _____ | 22. _____ | 22. _____ |
| 23. _____ | 23. _____ | 23. _____ | 23. _____ | 23. _____ | 23. _____ |
| 24. _____ | 24. _____ | 24. _____ | 24. _____ | 24. _____ | 24. _____ |
| 25. _____ | 25. _____ | 25. _____ | 25. _____ | 25. _____ | 25. _____ |
| 26. _____ | 26. _____ | 26. _____ | 26. _____ | 26. _____ | 26. _____ |
| 27. _____ | 27. _____ | 27. _____ | 27. _____ | 27. _____ | 27. _____ |
| 28. _____ | 28. _____ | 28. _____ | 28. _____ | 28. _____ | 28. _____ |
| 29. _____ | 29. _____ | 29. _____ | 29. _____ | 29. _____ | 29. _____ |
| 30. _____ | 30. _____ | 30. _____ | 30. _____ | 30. _____ | 30. _____ |
| 31. _____ | 31. _____ | 31. _____ | 31. _____ |           | 31. _____ |
|           | 32. _____ | 32. _____ | 32. _____ |           | 32. _____ |
|           | 33. _____ | 33. _____ | 33. _____ |           | 33. _____ |
|           | 34. _____ | 34. _____ |           |           | 34. _____ |
|           | 35. _____ | 35. _____ |           |           | 35. _____ |
|           | 36. _____ |           |           |           |           |

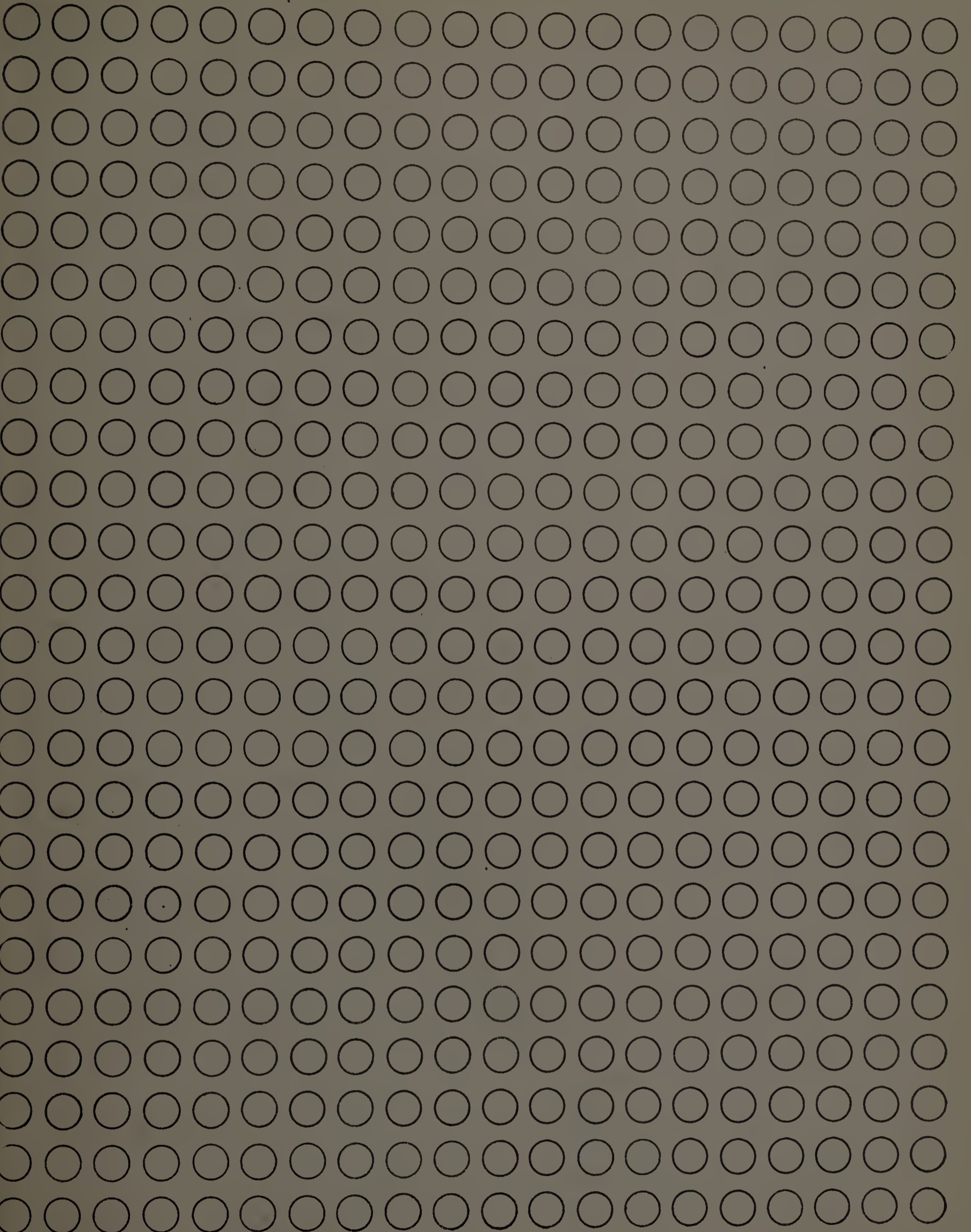
APPENDIX III

DETROIT MECHANICAL APTITUDE EXAMINATION



|                                                                                    |    |                       |                    |                    |                    |
|------------------------------------------------------------------------------------|----|-----------------------|--------------------|--------------------|--------------------|
|    | A  | 1 chisel              | 2 shovel           | 3 hammer           | 4 saw              |
|    | B  | 1 pliers              | 2 screw driver     | 3 pencil           | 4 file             |
|    | 1  | 1 shovel              | 2 saw              | 3 axe              | 4 level            |
|    | 2  | 1 wrench              | 2 file             | 3 pencil           | 4 scythe           |
|    | 3  | 1 bell                | 2 thread           | 3 hat              | 4 thimble          |
|    | 4  | 1 clippers            | 2 knife            | 3 shears           | 4 pliers           |
|    | 5  | 1 light bulb          | 2 oil can          | 3 countersink      | 4 syringe          |
|    | 6  | 1 shears              | 2 tin snips        | 3 pliers           | 4 clippers         |
|    | 7  | 1 wrench              | 2 hammer           | 3 wood clamp       | 4 monkey wrench    |
|    | 8  | 1 needle              | 2 spoon            | 3 nail punch       | 4 glass cutter     |
|    | 9  | 1 teapot              | 2 freezer          | 3 double boiler    | 4 skillet          |
|   | 10 | 1 soldering iron      | 2 masher           | 3 nail punch       | 4 bit              |
|  | 11 | 1 trowel              | 2 shovel           | 3 dibble           | 4 butter knife     |
|  | 12 | 1 bit                 | 2 nail             | 3 countersink      | 4 screw            |
|  | 13 | 1 corkscrew           | 2 can opener       | 3 crochet hook     | 4 glass cutter     |
|  | 14 | 1 water               | 2 faucet           | 3 awl              | 4 hose             |
|  | 15 | 1 pickle fork         | 2 salad fork       | 3 dividers         | 4 can opener       |
|  | 16 | 1 shears              | 2 tin snips        | 3 pliers           | 4 clippers         |
|  | 17 | 1 freezer             | 2 emery wheel      | 3 potato ricer     | 4 egg beater       |
|  | 18 | 1 knife               | 2 outside calipers | 3 micrometer       | 4 dividers         |
|  | 19 | 1 awl                 | 2 nail punch       | 3 glass cutter     | 4 hand drill       |
|  | 20 | 1 masher              | 2 wrench           | 3 gravy ladle      | 4 trowel           |
|  | 21 | 1 slaw cutter         | 2 tool box         | 3 dividers         | 4 miter box        |
|  | 22 | 1 switch              | 2 electric plug    | 3 current          | 4 bulb             |
|  | 23 | 1 potato ricer        | 2 nut cracker      | 3 wood clamp       | 4 sieve            |
|  | 24 | 1 steam gauge         | 2 micrometer       | 3 level            | 4 knife            |
|  | 25 | 1 butter knife        | 2 draw knife       | 3 mallet           | 4 cleaver          |
|  | 26 | 1 hack saw            | 2 back saw         | 3 coping saw       | 4 keyhole saw      |
|  | 27 | 1 "S" wrench          | 2 monkey wrench    | 3 angle wrench     | 4 alligator wrench |
|  | 28 | 1 micrometer          | 2 calipers         | 3 iron clamp       | 4 vise             |
|  | 29 | 1 nail set            | 2 awl              | 3 screw driver     | 4 auger            |
|  | 30 | 1 washing board       | 2 level            | 3 plane            | 4 slaw cutter      |
|  | 31 | 1 buttonhole scissors | 2 tin snips        | 3 clamps           | 4 dividers         |
|  | 32 | 1 pencil holder       | 2 emery wheel      | 3 egg beater       | 4 hand drill       |
|  | 33 | 1 dividers            | 2 micrometer       | 3 outside calipers | 4 inside calipers  |
|  | 34 | 1 wrench              | 2 hand drill       | 3 screw driver     | 4 egg beater       |
|  | 35 | 1 stocking darner     | 2 mallet           | 3 dowel            | 4 wood clamp       |
|  | 36 | 1 plane               | 2 glass cutter     | 3 putty knife      | 4 draw knife       |
|  | 37 | 1 inside calipers     | 2 outside calipers | 3 dividers         | 4 compass          |
|  | 38 | 1 "S" wrench          | 2 monkey wrench    | 3 end wrench       | 4 micrometer       |
|  | 39 | 1 alligator wrench    | 2 angle wrench     | 3 "S" wrench       | 4 pipe wrench      |
|  | 40 | 1 clamp               | 2 vise             | 3 micrometer       | 4 wrench           |





No. Correctly Done..... ÷ 10 = .....

SAMPLE

1-BIGGEST---( )  
 2-NEXT-----( )  
 3-SMALLEST--( )

1

1-BIGGEST---( )  
 2-NEXT-----( )  
 3-SMALLEST--( )

2

1 B-( )  
 2 N-( )  
 3 N-( )  
 4 S-( )

3

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16

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 8( )

A. If an answer is correct put a C in the parentheses; if wrong, put an X.

|                                      |                                 |                                        |
|--------------------------------------|---------------------------------|----------------------------------------|
| 1) $2 + 1 = 3$ ( )                   | 14) $4 \div 4 + 4 = 5$ ( )      | 27) $7 \times 9 \div 3 = 27$ ( )       |
| 2) $7 - 4 = 3$ ( )                   | 15) $8 \times 4 + 4 = 36$ ( )   | 28) $18 \times 2 - 12 = 14$ ( )        |
| 3) $4 \times 2 = 6$ ( )              | 16) $2 + 3 + 18 = 13$ ( )       | 29) $87 \div 3 - 29 = 0$ ( )           |
| 4) $16 + 8 = 24$ ( )                 | 17) $16 \times 2 - 30 = 2$ ( )  | 30) $2 \div 1 \div 1 + 1 = 1$ ( )      |
| 5) $8 \div 4 = 4$ ( )                | 18) $18 \div 2 + 9 = 18$ ( )    | 31) $9 + 9 + 1 - 9 = 28$ ( )           |
| 6) $19 - 8 = 9$ ( )                  | 19) $9 \div 3 \div 3 = 0$ ( )   | 32) $8 \div 1 \div 2 + 4 = 8$ ( )      |
| 7) $29 - 12 = 17$ ( )                | 20) $13 + 9 + 3 = 25$ ( )       | 33) $7 \times 7 - 29 + 20 = 49$ ( )    |
| 8) $48 \div 3 = 16$ ( )              | 21) $19 \times 1 - 1 = 19$ ( )  | 34) $21 \times 3 \div 9 - 7 = 0$ ( )   |
| 9) $39 \times 7 = 213$ ( )           | 22) $9 \div 9 + 9 = 9$ ( )      | 35) $48 - 21 - 9 - 8 = 10$ ( )         |
| 10) $81 - 69 = 22$ ( )               | 23) $14 \times 5 + 14 = 74$ ( ) | 36) $15 \div 5 + 15 - 5 = 10$ ( )      |
| 11) $22 \times 22 = 444$ ( )         | 24) $12 \div 6 \div 2 = 3$ ( )  | 37) $10 \times 10 - 10 - 90 = 0$ ( )   |
| 12) $278 - 139 = 139$ ( )            | 25) $17 \times 2 - 4 = 30$ ( )  | 38) $81 \div 9 - 9 + 1 = 0$ ( )        |
| 13) $117 \div 3 = 35\frac{2}{3}$ ( ) | 26) $99 \div 3 \div 11 = 3$ ( ) | 39) $12 \times 12 \div 12 - 6 = 6$ ( ) |

### Add

|                                                                         |                                                                              |                                                                                       |                                                                                        |                                                                                          |                                                                                          |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| 40) $\begin{array}{r} 12 \\ 27 \\ 84 \\ + 91 \\ \hline 224 \end{array}$ | 41) $\begin{array}{r} 987 \\ 639 \\ 523 \\ + 691 \\ \hline 2840 \end{array}$ | 42) $\begin{array}{r} \$1.18 \\ .78 \\ 2.02 \\ + 19.02 \\ \hline \$24.00 \end{array}$ | 43) $\begin{array}{r} \$ .76 \\ 2.28 \\ 4.10 \\ + 92.11 \\ \hline \$99.25 \end{array}$ | 44) $\begin{array}{r} \$ 6.66 \\ 12.81 \\ 3.01 \\ + 10.09 \\ \hline \$30.57 \end{array}$ | 45) $\begin{array}{r} \$279.99 \\ .68 \\ 8.76 \\ + 17.24 \\ \hline \$306.67 \end{array}$ |
| ( )                                                                     | ( )                                                                          | ( )                                                                                   | ( )                                                                                    | ( )                                                                                      | ( )                                                                                      |

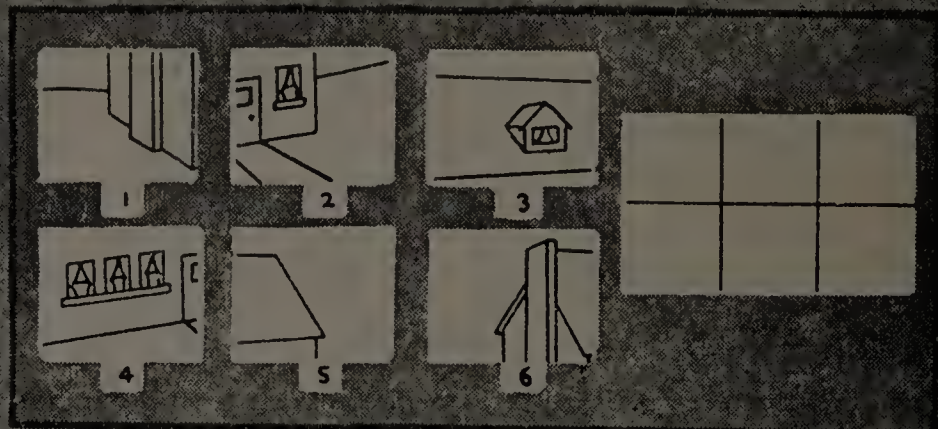
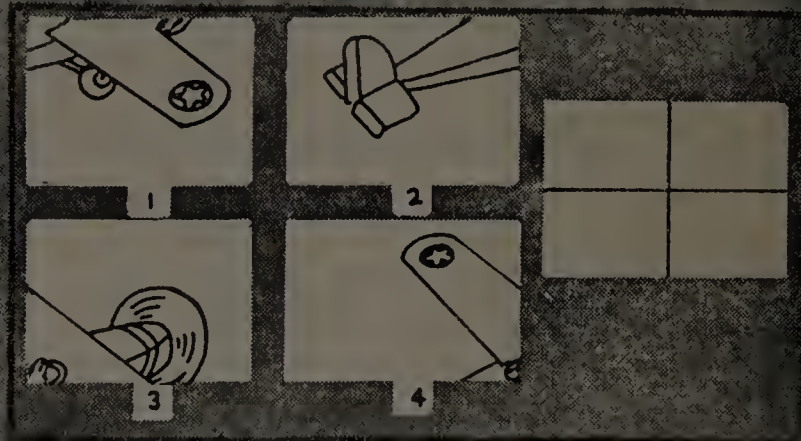
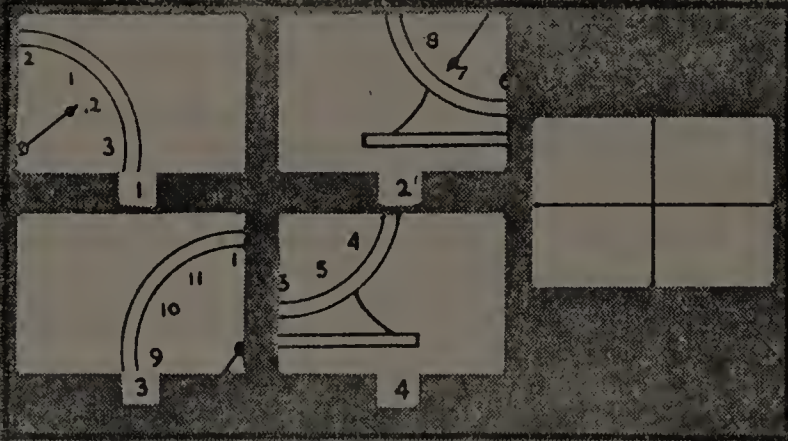
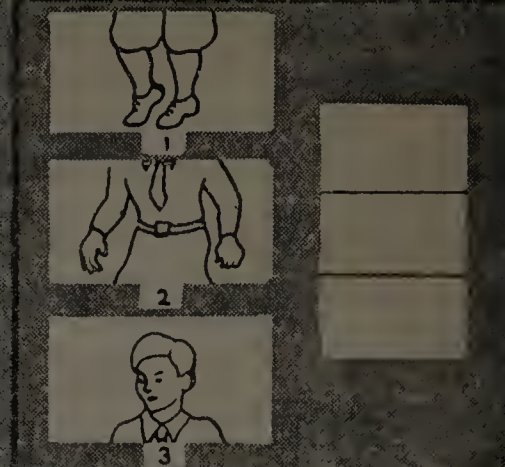
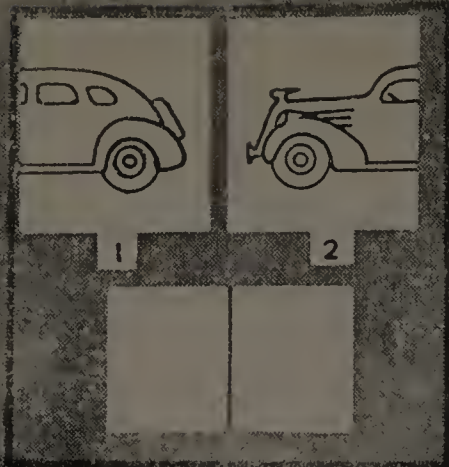
### Subtract

|                                                                            |                                                                            |                                                                                 |                                                                                  |
|----------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| 46) $\begin{array}{r} \$897.84 \\ - 638.98 \\ \hline \$268.66 \end{array}$ | 47) $\begin{array}{r} \$629.46 \\ - 105.15 \\ \hline \$524.31 \end{array}$ | 48) $\begin{array}{r} \$5,792.82 \\ - 4,987.98 \\ \hline \$ 804.84 \end{array}$ | 49) $\begin{array}{r} \$6,043.07 \\ - 1,846.28 \\ \hline \$4,196.79 \end{array}$ |
| ( )                                                                        | ( )                                                                        | ( )                                                                             | ( )                                                                              |

### Multiply

|                                                                             |                                                                               |                                                                                                          |                                                                                                           |
|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| 50) $\begin{array}{r} \$72.81 \\ \times .04 \\ \hline \$2.9124 \end{array}$ | 51) $\begin{array}{r} \$489.10 \\ \times .06 \\ \hline \$289.560 \end{array}$ | 52) $\begin{array}{r} \$978.67 \\ \times .13 \\ \hline 293601 \\ 97867 \\ \hline \$127.2271 \end{array}$ | 53) $\begin{array}{r} \$403.97 \\ \times 7.8 \\ \hline 322876 \\ 282779 \\ \hline \$31506.66 \end{array}$ |
| ( )                                                                         | ( )                                                                           | ( )                                                                                                      | ( )                                                                                                       |

No. Right = .....



| A                                                     | 1 gold             | 2 iron            | 3 steel             | 4 wood           | ( ) |
|-------------------------------------------------------|--------------------|-------------------|---------------------|------------------|-----|
| A A jackknife will cut                                |                    |                   |                     |                  | ( ) |
| 1 A screw driver is used for                          | 1 cutting          | 2 smoothing       | 3 cleaning          | 4 twisting       | ( ) |
| 2 Bread consists chiefly of                           | 1 baking powder    | 2 flour           | 3 soda              | 4 yeast          | ( ) |
| 3 Postum is a kind of                                 | 1 drink            | 2 meat            | 3 soup              | 4 vegetable      | ( ) |
| 4 To change a tire there must be an                   | 1 air pump         | 2 hammer          | 3 screw driver      | 4 jack           | ( ) |
| 5 To thin paint we use                                | 1 alcohol          | 2 gasoline        | 3 kerosene          | 4 turpentine     | ( ) |
| 6 Bacon comes from a                                  | 1 horse            | 2 cow             | 3 pig               | 4 lamb           | ( ) |
| 7 To clean a drain pipe we use                        | 1 oil              | 2 lye             | 3 sand              | 4 soap           | ( ) |
| 8 Sausage is made from                                | 1 mutton           | 2 pork            | 3 rabbit            | 4 venison        | ( ) |
| 9 A brace and bit are used for                        | 1 sanding          | 2 smoothing       | 3 painting          | 4 boring         | ( ) |
| 10 The chief ingredient of an omelet is               | 1 bacon            | 2 eggs            | 3 flour             | 4 ham            | ( ) |
| 11 A fuse is used for                                 | 1 economy          | 2 efficiency      | 3 safety            | 4 speed          | ( ) |
| 12 Putty is used for                                  | 1 cleaning         | 2 finishing       | 3 sharpening        | 4 welding        | ( ) |
| 13 Regular glue is most effective with                | 1 wood             | 2 brick           | 3 leather           | 4 metal          | ( ) |
| 14 Electricity is sold by the                         | 1 ampere           | 2 volt            | 3 kilowatt hour     | 4 square foot    | ( ) |
| 15 An electric doorbell requires                      | 1 current          | 2 fuse            | 3 plug              | 4 switch         | ( ) |
| 16 A buffer is used to                                | 1 grind            | 2 polish          | 3 roughen           | 4 sharpen        | ( ) |
| 17 The number of wires in an electric cord is usually | 1 five             | 2 one             | 3 three             | 4 two            | ( ) |
| 18 Engine is used for                                 | 1 sharpening tools | 2 motor fuel      | 3 cleaning          | 4 lubrication    | ( ) |
| 19 Good house paint costs per gallon                  | 1 50c              | 2 \$1.00          | 3 \$3.00            | 4 \$10.00        | ( ) |
| 20 A spark plug is in the                             | 1 commutator       | 2 cylinder head   | 3 manifold          | 4 piston         | ( ) |
| 21 Glass is usually cut with a                        | 1 chisel           | 2 file            | 3 scissors          | 4 wheel          | ( ) |
| 22 Solder will stick best to                          | 1 glass            | 2 lead            | 3 leather           | 4 wood           | ( ) |
| 23 A meat substitute is                               | 1 spinach          | 2 bacon           | 3 eggs              | 4 candy          | ( ) |
| 24 A carburetor                                       | 1 explodes gas     | 2 measures gas    | 3 mixes air and gas | 4 times spark    | ( ) |
| 25 Kalsomine is a kind of                             | 1 paint            | 2 wall paper      | 3 dish              | 4 plane          | ( ) |
| 26 A window is best cleaned with a                    | 1 brush            | 2 chamois         | 3 cloth             | 4 sponge         | ( ) |
| 27 Emery cloth is used for                            | 1 dresses          | 2 washing dishes  | 3 smoothing         | 4 men's suits    | ( ) |
| 28 A brad is a kind of                                | 1 nail             | 2 rivet           | 3 screw             | 4 bolt           | ( ) |
| 29 A rivet is used for                                | 1 appearance       | 2 smoothness      | 3 elasticity        | 4 strength       | ( ) |
| 30 Steel wool is used for                             | 1 house insulation | 2 sharpening saws | 3 making clothes    | 4 smoothing wood | ( ) |
| 31 Weld means to                                      | 1 fuse together    | 2 bore            | 3 harden            | 4 melt           | ( ) |
| 32 A tool is tempered by                              | 1 compression      | 2 heating         | 3 melting           | 4 welding        | ( ) |
| 33 A lock washer is used with                         | 1 bolts            | 2 nails           | 3 rivets            | 4 screws         | ( ) |
| 34 A dowel is used to                                 | 1 dig with         | 2 smooth          | 3 fasten            | 4 bore           | ( ) |
| 35 To paint enamel we must use a                      | 1 hard brush       | 2 soft brush      | 3 stiff brush       | 4 wire brush     | ( ) |

|    | 1st | 2nd | Direction of 2nd Wheel |   | Rate of 2nd Wheel |        |          |     |
|----|-----|-----|------------------------|---|-------------------|--------|----------|-----|
| A  |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| B  |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 1  |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 2  |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 3  |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 4  |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 5  |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 6  |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 7  |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 8  |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 9  |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 10 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 11 |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 12 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 13 |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 14 |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 15 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 16 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 17 |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 18 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 19 |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 20 |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 21 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 22 |     |     | →                      | ← | 1 faster          | 2 same | 3 slower | ( ) |
| 23 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |
| 24 |     |     | ←                      | → | 1 faster          | 2 same | 3 slower | ( ) |

No. Right, "Direction" = .....

No. Right, "Rate".... = +.....

Score (add)..... = .....

APPENDIX IV

REVISED INDUSTRIAL ARTS TEST

INDUSTRIAL ARTS TEST

PART I GRAPHIC ARTS

A. Multiple Choice Items

Directions: Complete each statement below by placing an X in the square of the number of the best answer on the separate answer sheet.

- S. Newsprint is made of  
(1) rags (2) wood pulp (3) hemp (4) matrix (5) flax
1. The watermark on a sheet of paper can be seen by  
(1) printing on it (2) dipping it in water (3) rubbing it with a spoon  
(4) holding it up to the light (5) holding it over heat
2. Mimeographing is a form of  
(1) typing (2) writing (3) painting (4) printing (5) shorthand
3. The printer's system of measure is known as  
(1) decimal system (2) tabular system (3) metric system  
(4) block system (5) point system
4. The "father of printing" was  
(1) Edison (2) Caslon (3) Gutenberg (4) Franklin (5) Schoeffer
5. Forms are locked up with  
(1) grippers (2) staples (3) reglets (4) gauges (5) quoins
6. Which of the following inks is the cheapest  
(1) bond (2) job (3) silk screen (4) halftone (5) news
7. Bold type is  
(1) slanting (2) thin lined (3) script (4) heavy lined (5) outline
8. A person who sets up type is called a  
(1) compositor (2) make up man (3) pressman (4) typist (5) job man
9. When you dust powder onto a printed sheet and hold it over heat it is called  
(1) engraving (2) toasting (3) embossing (4) etching  
(5) raised printing
10. The best grade of writing paper is made from  
(1) wool (2) rayon (3) linen (4) wood pulp (5) silk
11. Type metal is made of  
(1) brass (2) zinc and lead (3) lead, antimony, and tin  
(4) copper, tin, and iron (5) steel
12. Raised printing is done by  
(1) cutting with a V-shaped tool (2) dusting compound on a printed job  
and holding it over heat (3) embossing (4) pressing out on the paper  
from the back (5) engraving
13. If you were to make one copy with ten thousand words would you  
(1) print it (2) typewrite it (3) silkscreen it (4) mimeograph it  
(5) rex-o-graph it



14. Which occupies the most space  
(1) one three-em quad    (2) four one-em quads    (3) five en quads  
(4) one two-em quad    (5) two one-em quads
15. All Boston daily newspapers are printed from  
(1) linoleum blocks    (2) photo-engraving    (3) monotype  
(4) line etchings    (5) stereotypes
16. The best way to identify a silkscreen printing job is to  
(1) hold it up to the light    (2) look through the screen  
(3) dip it in water    (4) run your fingers over the surface  
(5) observe the color

B. TRUE - FALSE ITEMS

Directions: Some of the statements below are true; others are false. On the separate answer sheet place an X in the square of the correct answer.

8. Linoleum blocks can be cut out and printed at home.
1. A bed is the flat part of a press upon which the type form is placed.
2. Quoins, furniture, and a chase are used when locking up a type form.
3. Printing rollers should not be allowed to stand in contact with anything.
4. A composing stick is used in locking up a form.
5. The best grades of paper are usually watermarked.
6. Pads of paper are made by cementing the edges together with compound.
7. A "family of type" consists of all the sizes and styles of the same design.
8. The graduations on a composing stick are in inches.
9. All wove paper is made by machine and all laid paper is made by hand.
10. The compartments in the lower case are of different size because the pieces of type vary in size.
11. A point measures one-twelfth of a pica.
12. A letter of one series improperly mixed with those of another series is called a wrong font letter.
13. A halftone gets its name from the fact that it can print white, black, and tones in between black and white.
14. Tympan paper is used for taking stone proofs.
15. All type used in the United States is the same height.
16. Size is added to paper stock so that it can be easily cut.
17. A line etching is made up of many small dots.

PART II GENERAL METALS

A. Multiple Choice Items

Directions: Complete each statement below by placing an X on the separate answer sheet in the square of the number of the best answer.

1. In drawing a 7" circle, the compass is set for  
(1)  $3\frac{1}{4}$ " (2) 7" (3)  $3\frac{3}{4}$ " (4)  $2\frac{3}{4}$ " (5)  $3\frac{1}{2}$ "
2. The best way to use a file is to  
(1) bear down while filing back and forth (2) use it like a saw  
(3) hold the front end near you (4) push forward and lift up on the return stroke (5) hit the metal
3. The gauge of metal means  
(1) the distance in from the edge (2) the thickness of metal  
(3) a marking gauge (4) a piece of galvanized iron  
(5) a tool to scratch metal
4. The center punch is used to  
(1) drill a hole (2) cut a square (3) mark a point (4) fold a hem  
(5) connect metal
5. Galvanized sheet metal is coated with  
(1) tin (2) zinc (3) lead (4) solder (5) nickel plate
6. Tinning a soldering copper means  
(1) to cover it with a piece of tin (2) to file it (3) to coat it with solder (4) to heat it (5) to forge it
7. Fluxes are used to make  
(1) paper stick (2) dirty the metal (3) hold the heat  
(4) make solder stick by preventing oxidation (5) grease tools
8. A smoke pipe for a furnace is best made of  
(1) tin plate (2) galvanized iron (3) zinc (4) copper  
(5) nickel plate
9. Half and half refers to  
(1) half turpentine and half linseed oil (2) proportions in making a cleaning solution (3) a kind of flux (4) an alloy in silver coin  
(5) proportions of tin and lead in solder
10. Drill sizes are given according to  
(1) number of twists per inch (2) kind of steel used in manufacturing  
(3) kind of material to be drilled (4) length of drill  
(5) fraction of inch
11. The thinnest metal in this group is  
(1) 22 gauge (2) 28 gauge (3) 16 gauge (4) 18 gauge (5) 24 gauge
12. The calipers are used to  
(1) measure the length of pipe (2) lay out a pattern on metal  
(3) measure the diameter of pipes and iron rods (4) measure the width of a hem (5) mark the center of a hole

13. The cold chisel is used  
(1) for driving screws (2) filing a hole (3) cutting metal  
(4) chiseling wood (5) bending metal
14. The burr is a  
(1) small hole (2) kind of bolt (3) rough edge (4) copper rivet  
(5) tinner's rivet
15. Tinning metal means  
(1) a piece of tin (2) to cut a piece of tin to size  
(3) to coat it with flux (4) to coat it with solder  
(5) to color it with aluminum paint
16. A good cleaning solution for soldering is made from water and  
(1) borax (2) soap powder (3) sal ammoniac (4) salt  
(5) casein powder
17. Galvanized iron is sold by  
(1) weight per square foot (2) the number of sheets per ton  
(3) the gauge and size of sheet (4) kind of coating on the sheet  
(5) number of coats on the sheet

B. TRUE - FALSE ITEMS

Directions: Some of the statements below are true; others are false. On the separate answer sheet place an X in the square of the correct answer.

1. A soldering copper must be well tinned.
2. The most commonly used solder is made of half tin and half lead.
3. Soldering paste is used to paste a pattern on metal.
4. The soldering copper should never be filed.
5. Enamel paint may be thinned with water.
6. The combination snips may be used for cutting either straight or curved lines.
7. Grease or oil on metal will help the solder to stick.
8. The hack saw is used to cut band iron.
9. The paint brush should be cleaned with turpentine, then with soap and hot water.
10. One of the uses of a hem is to strengthen the edge of the metal.
11. The rough edge caused by filing is called a burr.
12. Sal ammoniac is a good flux.
13. The soldering copper should be heated until it is red hot.
14. A cleaning dip can be made from sal ammoniac and water.

15. Copper is a harder metal than galvanized iron.
16. Remove the key from the chuck on the drill press before starting the power.

PART III GENERAL WOODS

A. Multiple Choice Items

Directions: Complete each statement below by placing an X on the separate answer sheet in the square of the number of the best answer.

1. Brushes used in paint should be cleaned in  
(1) water (2) alcohol (3) turpentine (4) lacquer (5) asphaltum
2. The try-square is used to test work for  
(1) length (2) smoothness (3) squareness (4) width (5) depth
3. Nails are usually purchased by  
(1) gross (2) hundred (3) pound (4) ream (5) thousand
4. The annual growth of a tree is indicated on a cross section by  
(1) medullary ray (2) annual ring (3) bark (4) sapwood (5) cambium
5. Which one of these dimensions of lumber is measured with the grain  
(1) thickness (2) width (3) height (4) depth (5) length
6. Which one of these woods is imported into the United States  
(1) cypress (2) white pine (3) mahogany (4) whitewood (5) walnut
7. When planing the surface of a board lengthwise you should use a  
(1) rabbet plane (2) jack plane (3) router plane (4) matching plane  
(5) scraper
8. Which one of these woods makes a good floor for a living room  
(1) poplar (2) basswood (3) cypress (4) oak (5) cedar
9. The tool that is used to hold the auger bit to bore holes is a  
(1) bit gauge (2) center bit (3) bit brace (4) shank (5) sweep
10. To set the heads of screws flush with the surface of the wood, the following tool is used  
(1) countersink bit (2) drill bit (3) auger bit (4) gimlet bit  
(5) bit gauge
11. Small round wooden pins used in joining two boards edge to edge are called  
(1) splines (2) plugs (3) dowels (4) wedges (5) plies
12. The finest grade of sandpaper listed here is  
(1)  $\frac{1}{2}$  (2) 0 (3) 00 (4) 1 (5) 2
13. Hand saws are sharpened with  
(1) grinding wheel (2) file (3) whetstone (4) emery cloth  
(5) saw set.

14. The part of a wood chisel ground to produce a cutting edge is  
(1) bevel (2) ferrule (3) shank (4) tang (5) shoulder
15. Hammer handles are made of  
(1) hickory (2) pine (3) walnut (4) gumwood (5) cedar
16. A plane iron is whetted on  
(1) an oilstone (2) a grinding wheel (3) a buffing wheel  
(4) a pumice stone (5) a burnisher
17. A board foot of lumber contains  
(1) 12 cu. in. (2) 24 cu. in. (3) 72 cu. in. (4) 144 cu. in.  
(5) 288 cu. in.

B. TRUE - FALSE ITEMS

Directions: Some of the statements below are true; others are false. On the separate answer sheet place an X in the square of the correct answer.

1. Pieces required for a project may be cut from any board in the shop.
2. Suitable pieces for a project may be found in the scrap box.
3. A stock bill or bill of material contains the measurements for all of the parts of the article to be constructed.
4. On a working drawing, the distance between the arrow heads indicates the exact measurement.
5. Parts of furniture are commonly fastened together with dowel pins.
6. It is desirable to reverse the board when boring a hole.
7. A rule may be used for squaring a line across a board.
8. The size of a brad is determined by its diameter and length.
9. A ball pein hammer is a common woodworking tool.
10. The top view of an object in a drawing is placed at the right of the side view.
11. A screw driver bit is used in a bit brace.
12. The finer grits of sandpaper are graded zero.
13. Corners of the picture frame are made with the mitre joint.
14. A brad is a wire fastener having a large flat head.
15. Garnet paper is used for sanding in the furniture industry.
16. In planing the end grain of a chamfer the plane may be used at an angle.
17. The teeth of a coping saw point toward the handle.

ANSWER SHEET: NEWTON INDUSTRIAL ARTS TEST - FORM A

(Score "A" Tests:  $R - \frac{W}{4}$ ;      Score "B" Tests:  $R - W$ )

Name \_\_\_\_\_ Date \_\_\_\_\_

School \_\_\_\_\_ Grade \_\_\_\_\_ Div. \_\_\_\_\_

Teacher \_\_\_\_\_ Ent. J.H.S. from \_\_\_\_\_

Check below the Shop Courses which you have taken in Newton.

- |                                             |                                             |
|---------------------------------------------|---------------------------------------------|
| <input type="checkbox"/> Grade 7 (Required) | <input type="checkbox"/> Grade 8 (Elective) |
| <input type="checkbox"/> Grade 8 (Required) | <input type="checkbox"/> Grade 9 (Elective) |

| Part       | Poss. Score | Score |
|------------|-------------|-------|
| I A        | 16          |       |
| I B        | 17          |       |
| Total      | 33          |       |
| II A       | 17          |       |
| II B       | 16          |       |
| Total      | 33          |       |
| III A      | 17          |       |
| III B      | 17          |       |
| Total      | 34          |       |
| Total Test | 100         |       |

| Part I                |   |   |   |   |             |   |     |   |   | Part II               |   |     |   |     |             |   |   |   |     | Part III              |  |  |  |  |             |  |  |  |  |
|-----------------------|---|---|---|---|-------------|---|-----|---|---|-----------------------|---|-----|---|-----|-------------|---|---|---|-----|-----------------------|--|--|--|--|-------------|--|--|--|--|
| Test A                |   |   |   |   | Test B      |   |     |   |   | Test A                |   |     |   |     | Test B      |   |   |   |     | Test A                |  |  |  |  | Test B      |  |  |  |  |
| 1                     | 2 | 3 | 4 | 5 | T           | F | 1   | 2 | 3 | 4                     | 5 | T   | F | 1   | 2           | 3 | 4 | 5 | T   | F                     |  |  |  |  |             |  |  |  |  |
| S.                    |   |   |   |   | S.          |   | 1.  |   |   |                       |   | 1.  |   | 1.  |             |   |   |   | 1.  |                       |  |  |  |  |             |  |  |  |  |
| 1.                    |   |   |   |   | 1.          |   | 2.  |   |   |                       |   | 2.  |   | 2.  |             |   |   |   | 2.  |                       |  |  |  |  |             |  |  |  |  |
| 2.                    |   |   |   |   | 2.          |   | 3.  |   |   |                       |   | 3.  |   | 3.  |             |   |   |   | 3.  |                       |  |  |  |  |             |  |  |  |  |
| 3.                    |   |   |   |   | 3.          |   | 4.  |   |   |                       |   | 4.  |   | 4.  |             |   |   |   | 4.  |                       |  |  |  |  |             |  |  |  |  |
| 4.                    |   |   |   |   | 4.          |   | 5.  |   |   |                       |   | 5.  |   | 5.  |             |   |   |   | 5.  |                       |  |  |  |  |             |  |  |  |  |
| 5.                    |   |   |   |   | 5.          |   | 6.  |   |   |                       |   | 6.  |   | 6.  |             |   |   |   | 6.  |                       |  |  |  |  |             |  |  |  |  |
| 6.                    |   |   |   |   | 6.          |   | 7.  |   |   |                       |   | 7.  |   | 7.  |             |   |   |   | 7.  |                       |  |  |  |  |             |  |  |  |  |
| 7.                    |   |   |   |   | 7.          |   | 8.  |   |   |                       |   | 8.  |   | 8.  |             |   |   |   | 8.  |                       |  |  |  |  |             |  |  |  |  |
| 8.                    |   |   |   |   | 8.          |   | 9.  |   |   |                       |   | 9.  |   | 9.  |             |   |   |   | 9.  |                       |  |  |  |  |             |  |  |  |  |
| 9.                    |   |   |   |   | 9.          |   | 10. |   |   |                       |   | 10. |   | 10. |             |   |   |   | 10. |                       |  |  |  |  |             |  |  |  |  |
| 10.                   |   |   |   |   | 10.         |   | 11. |   |   |                       |   | 11. |   | 11. |             |   |   |   | 11. |                       |  |  |  |  |             |  |  |  |  |
| 11.                   |   |   |   |   | 11.         |   | 12. |   |   |                       |   | 12. |   | 12. |             |   |   |   | 12. |                       |  |  |  |  |             |  |  |  |  |
| 12.                   |   |   |   |   | 12.         |   | 13. |   |   |                       |   | 13. |   | 13. |             |   |   |   | 13. |                       |  |  |  |  |             |  |  |  |  |
| 13.                   |   |   |   |   | 13.         |   | 14. |   |   |                       |   | 14. |   | 14. |             |   |   |   | 14. |                       |  |  |  |  |             |  |  |  |  |
| 14.                   |   |   |   |   | 14.         |   | 15. |   |   |                       |   | 15. |   | 15. |             |   |   |   | 15. |                       |  |  |  |  |             |  |  |  |  |
| 15.                   |   |   |   |   | 15.         |   | 16. |   |   |                       |   | 16. |   | 16. |             |   |   |   | 16. |                       |  |  |  |  |             |  |  |  |  |
| 16.                   |   |   |   |   | 16.         |   | 17. |   |   |                       |   | 17. |   | 17. |             |   |   |   | 17. |                       |  |  |  |  |             |  |  |  |  |
|                       |   |   |   |   | 17.         |   |     |   |   |                       |   |     |   |     |             |   |   |   |     |                       |  |  |  |  |             |  |  |  |  |
| $R - \frac{W}{4} = S$ |   |   |   |   | $R - W = S$ |   |     |   |   | $R - \frac{W}{4} = S$ |   |     |   |     | $R - W = S$ |   |   |   |     | $R - \frac{W}{4} = S$ |  |  |  |  | $R - W = S$ |  |  |  |  |

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