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The construction and revision of an arithmetic vocabulary test for grades four, five, and six

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Thesis

THE CONSTRUCTION AND REVISION

OF AN ARITHMETIC VOCABULARY TEST

FOR GRADES FOUR, FIVE, AND SIX

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CHAPTER I

INTRODUCTION

1. The Importance of Vocabulary

The past few decades have found much written concerning the value of vocabulary to the student both in school and in his everyday living. The prime importance of this subject to the educator is proved by the quantity of research and literature which is available on vocabulary and word usage. Those who have worked in this field have concluded emphatically that further research is needed as well as the application of some of the existing conclusions.

Effect of vocabulary on achievement and success.-- Experts in the field of vocabulary are agreed that knowledge of word meanings or vocabulary size is a determining factor in the level of general achievement which one can attain and in the success future years will bring. Traxler [1] has written:

> "First, if one wishes to obtain a rapid, fairly valid prediction of general achievement in the elementary grades, a word meaning test appears to be preferable to an intelligence test. Second, the high relationship of word meaning to total achievement suggests that in their attempts to improve the general achievement of elementary school pupils, teachers could well place emphasis on the teaching of vocabulary."

Seashore [2] would agree concerning the importance of vocabulary to school achievement as he states:

> "Vocabulary size is probably the best single index for

1/A. E. Traxler, "The Relationship between Vocabulary and General Achievement in the Elementary School," Elementary School Journal, (February, 1945), 45:331-333.

2/R. H. Seashore, "The Importance of Vocabulary in Learning Language Skills," Elementary English Review, (March, 1948), 25:137-152.

the prediction of achievement in nearly all of the other language skills, e.g. diction, composition, reading, comprehension, reasoning, general intelligence, and even grades in specialized subject matter fields, or scores on school achievement tests."

An extensive vocabulary may accompany outstanding success in fields other than school achievement according to O'Connor [1] who claims that:

"An extensive knowledge of the exact meanings of English words accompanies outstanding success in this country more often than any other single characteristic which the Human Engineering Laboratories have been able to isolate and measure."

Effect of inadequate vocabulary on failure.-- If we can conclude that vocabulary is important to general achievement we must be aware as well that inadequate vocabulary may be the root of many school failures. Durrell [2] points out that:

"Vocabulary problems are the basis for all types of difficulties encountered in middle grade reading. Difficulties in word recognition or in word meaning ordinarily account for inattentive reading, slow reading, poor understanding of details, failure in following directions, confusion in getting the central thought, inability to understand implications, and difficulties in oral and written recall."

Cole [3] also considers vocabulary of prime importance in the comprehension of all types of printed materials. She states: "In all probability, an inadequate vocabulary is the greatest single cause for failure to read with comprehension in either general or technical fields." In another book, Cole [4] adds that: "If a teacher can teach only one phase

1/J. O'Connor, "Vocabulary and Success," Atlantic Monthly, (February, 1934), 153:160-166.

2/D. D. Durrell, "Basic Abilities in Intermediate Grade Reading," Education, (September, 1938), 59:45-50.

3/L. Cole, The Elementary School Subjects, Farrar and Rinehart, New York, 1946, p. 40.

4/L. Cole, Psychology of the Elementary School Subjects, Rinehart and Company, 1934, p. 47.

of reading thoroughly, she will do well to confine herself to a thorough training of vocabulary, thus eliminating the majority of her other troubles."

Seegers [1] feels that since a child's ability to read, to speak, to write, and to think, is inevitably conditioned by his vocabulary and that there is no argument therefore that the fields of vocabulary and word usage are important areas of study.

2. The Importance of Arithmetical Vocabulary

Few would dispute the fact that vocabulary is important in subjects such as reading, language arts, and social studies, but little attention has been paid to the technical vocabulary of science and mathematics. In particular, we oftentimes think of arithmetic wholly as a tool or skill subject and neglect the meanings and understandings which should be end-products of our arithmetic instruction. We must keep in mind that:

> "The quantitative plays a large role in our living. Of the most common words in our language 1 word in 10 is a mathematical term. The proportion becomes 1 in every 4 if we include indefinite quantitative words. But we must not conclude that a child's encountering quantitative terms insures his understanding of the mathematical concepts which the terms denote." [2]

Relation of mathematics vocabulary to success in mathematics.-- It has been pointed out by Eagle [3] that though the correlation of mathematics vocabulary with mental age was lower than the correlation of general

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[1] J. C. Seegers, "Vocabulary Problems in the Elementary School," Elementary English Review, (April-May, 1939), 16:157-166.

[2] The State Education Department, "Teaching Quantitative Language," Letter to Supervisors, Series 10, No. 2, (October, 1956) Albany, New York.

[3] E. Eagle, "The Relationship of Certain Reading Abilities to Success in Mathematics," Mathematics Teacher, (March, 1952), 45:187-192.

vocabulary with mental age, mathematics vocabulary is decidedly more important in relation to success in mathematics. He concludes that:

> "In the light of these results it is recommended that mathematics teachers give much greater emphasis to teaching thorough understandings of the technical terms involved, for the vocabulary constitutes not only the means of communication but it is also very largely the medium of thinking and of problem-solving in this area."

The objectives of present day arithmetic instruction are much broader than those characteristic of the traditional school. Among the functions of arithmetic of today Brueckner [1] includes: "....The development of clear quantitative concepts and meaningful vocabulary." Teachers seem to be in agreement that in order to present and develop arithmetical ideas a student must possess a certain minimum of technical words. Morton [2] claims that it is unfortunate that there is such wide disagreement as to what this vocabulary is and as to how and when it should be developed. Pressey [3] expresses the same thought in different terms:

> "A long time ago it was pointed out that one cannot make bricks without straw, neither can a pupil learn arithmetic (or any other subject) without words -- especially without those words that express the central core of concepts around which algebraic skills and understandings are developed."

Relation of vocabulary difficulties to failure in mathematics.--Since vocabulary is a determining factor in a pupil's success in mathematics, it may be concluded that vocabulary difficulties could well be the source of mathematical failure. Stevenson [4] presents facts relative

1/L. J. Brueckner, Educational Diagnosis, Thirty-fourth Yearbook, National Society for the Study of Education, Part II, 1935, pp. 269-302.

2/R. L. Morton, "Language and Meaning in Arithmetic," Educational Research Bulletin, (November, 1955), 34:197-204.

3/S. L. Pressey, L. C. Pressey and F. R. Barragon, "Essential Vocabulary in Algebra," School, Science and Mathematics, (May, 1932), 32:672-674.

4/P. R. Stevenson, "Difficulties in Problem Solving," Journal of Educational Research, (February, 1925), 11:95-103.

to causes of failure in arithmetic and included among them the inability [1] to read and the lack of general and technical vocabulary. Roling writes:

"Still other pupils fail because of inability to interpret the meaning of the words used. Such words as average, area, rate, ratio, and product were some of the words for which we found very indefinite meanings in the minds of the pupils."

Most children meet their first technical vocabulary in dealing with arithmetic. Teachers must realize that a lack of proper word knowledge handicaps children in connection with their arithmetic studies. Brooks [2] says: "One of the causes of pupil's failure to make sense of his textbook is his failure to recognize certain of the important technical words appearing therein." Mammouth [3] commenting on the same subject states:

"Vocabulary difficulties....are real and are always, they hinder the pupils in their understanding of the full import of the problems to be solved. The words and phrases used are often strictly mathematical and bear a sense peculiar to the subject. When pupils fail to interpret them correctly, they become a source of difficulty."

The importance of arithmetical vocabulary is perhaps best summarized in Schubert's [4] statement:

"Since in reading mathematics, every word is as important as a marriage contract, the teacher must stress the need for slow, meticulous reading. Much of the difficulty in reading mathematical material can be attributed to its vocabulary burden. Technical words like 'quotient, integer,

[1] P. Roling, C. L. Blume and M. S. Morehart, "Specific Causes of Failure in Arithmetic Problems," Educational Research Bulletin, (October, 1924), 3:271-272.

[2] S. S. Brooks, "A Study of the Technical and Semi-Technical Vocabulary of Arithmetic," Educational Research Bulletin, (November, 1926), 5:219-222.

[3] R. A. Mammouth, A. E. Isbell, H. B. Jenkins, and C. E. Pieters, "Vocabulary Difficulties," Educational Research Bulletin, (October, 1924), 3:279-281.

[4] D. G. Schubert, "Formulas for Better Reading in Mathematics," School, Science and Mathematics, (November, 1955), 55:650-652.

exponent and addend' must be clearly understood if a problem employing one or more of them is encountered. In addition to a technical vocabulary, many common words having a special mathematical connotation figure in mathematical problems. Words like 'revolution, base, and plane,' must be understood if a problem employing them is to prove meaningful."

CHAPTER II

STATEMENT OF THE PROBLEM

This study was concerned with the problem of constructing, administering, and revising an arithmetic vocabulary test. The test was written for fourth, fifth, and sixth grade children and the arithmetical vocabulary was therefore taken from textbooks published for these grade levels. It was decided to use only textbooks published since 1950 as most of the major arithmetic series have been rewritten since that year and are more functional than those of preceding years.

1. Definition of Arithmetic Vocabulary

For purposes of this study an arithmetical word as it occurred in arithmetic texts was defined as a word that is essential for the child to read, express, and understand quantitative ideas as a part of specific instruction in arithmetic at the intermediate grade level. It was decided that these words would fall into the following categories: (1) Base words used to represent number figures (hundred, thousand, million, billion); (2) Words used to represent number processes (addition, sum, divide, quotient, remainder); (3) Words used to represent various kinds of measurement (quart, hour, peck, dozen, dollar, mile); and (4) Specialized technical words (graph, perimeter, circle).

2. Justification of the Problem

Changing objectives and outcomes of arithmetic instruction.- - Experts in the field of arithmetic education indicate that a functional vocabulary of the technical terms of arithmetic is essential if the child is to grow in his ability to think quantitatively. The objectives of our arithmetic

instruction have changed and we are no longer merely concerned with computational skills and with problem-solving of the traditional sort. McConnell [1] has written: "Skill in computation is not the only or even the most important outcome of learning in arithmetic, but that growth in the ability to think quantitatively is a primary objective."

Brownell [2] asserts that there are many arithmetic outcomes which are neglected under present practices. He lists the following as one of the important outcomes of arithmetic instruction: "....A meaningful vocabulary of the useful technical terms of arithmetic which designate quantitative ideas and the relationships between them."

Changing evaluation methods.-- Our leading professional writers in the field of arithmetic testing are concerned with the fact that measurement in arithmetic has been limited for the most part to facts and computational skills. We are aware that improvement of instruction is dependent to a great extent upon the type of evaluation used. We must measure all of the desired outcomes of arithmetic instruction. Therefore, as our objectives change, so, too, should our evaluation methods change. Spitzer [3] has said: "Unless our procedures and techniques for evaluation in arithmetic keep pace with the improved instructional procedures, we shall soon find out that improvement is hindered by the means of evaluation that we use." He claims that less progress has been made in the improvement of

1/T. R. McConnell, "Learning Is a Change in the Organization of Behavior," Recent Trends in Learning Theory, Their Application to the Psychology of Arithmetic, Sixteenth Yearbook, National Council of Teachers of Mathematics, 1941, p. 288.

2/W. A. Brownell, "The Evaluation of Learning in Arithmetic," Arithmetic in General Education, Sixteenth Yearbook, National Council of Teachers of Mathematics, 1941, p. 226.

3/H. Spitzer, "Techniques for Evaluating Outcomes of Instruction in Arithmetic," Elementary School Journal, (September, 1948), 49:21-31.

arithmetic tests than has been made in testing in most other subject-matter areas. Glennon [1] agrees by stating: "The lag in the development of adequate methods and devices for measuring growth in understandings and meanings in arithmetic has certain causes that are related to the lag in other aspects of the arithmetic teacher-learning situation."

Sueltz [2] claims that since arithmetic is no longer restricted to common computations and their application to written problems but now includes meaning, understanding, and functional usefulness we therefore need to change our measurement techniques to include not only computations and problems, but also such features as concepts, meanings, understandings, and judgments. He goes one step farther than the aforementioned writers in stating that: "Furthermore, these all should be measured in functional situations."

Need for research in arithmetic vocabulary.-- Wherever you turn in educational literature you will find reference made to the need for more research and work in the field of vocabulary testing. The need for research along this line in the field of arithmetic seems to be even greater than in other areas. Glennon [3] even goes so far as to say:

> "The paucity of research studies in the area of testing for meanings justifies the conclusion that this is one of the most neglected educational problems of the day. The lack of research is the direct result of the general lag in the development of adequate methods and devices for measuring understandings and meanings."

[1] V. J. Glennon, Testing Meanings in Arithmetic, Supplementary Educational Monograph, 1949, Number 70, University of Chicago Press, Chicago, Illinois, pp. 64-74.

[2] B. A. Sueltz, "The Evaluation of Arithmetic," The National Elementary Principal, (October, 1950), 30:24-33.

[3] Op. cit., p. 70.

The arithmetic specialists are not the only ones who would recommend further studies in the field of arithmetic vocabulary. Doctorate studies in vocabulary have been done in other areas and recommendations made by the writers as to possible future research. Wolffer [1] and Early [2] in two companion studies analyzed social studies textbooks and constructed, administered, and evaluated tests of social studies vocabulary in the intermediate grades. They recommended that this same type of study be applied to other subject-matter areas. Friis, [3] having completed a dissertation on the construction and evaluation of a language vocabulary test for the intermediate grades, suggests that it would be advisable to construct tests of specific vocabulary in other subject fields utilizing the functional-type item wherever possible. He claims that:

> "Vocabulary being one of the most important areas determining success in school, any further research or additional instruments to measure the nature and size of pupils' vocabulary would be a worthwhile contribution to education."

As further justification for this study it is the hope of the writer that from the results we may gain an insight into intermediate grade children's vocabulary which is basic to an understanding of intermediate arithmetic. Experts today agree that arithmetic should be taught meaningfully, but we cannot change the subject matter and teaching of arithmetic until we know just what needs to be changed. Only through research and new

[1] W. A. Wolffer, The Construction and Evaluation of a Social Studies Context Vocabulary Test, Unpublished Doctor's Dissertation, Boston University, 1952.

[2] W. L. Early, The Construction and Evaluation of a Social Studies Vocabulary Association Test for Intermediate Grades, Unpublished Doctor's Dissertation, Boston University, 1952.

[3] C. A. Friis, The Construction and Evaluation of a Language Vocabulary Test for the Intermediate Grades, Unpublished Doctor's Dissertation, Boston University, 1954.

measuring devices can we determine this. Hartung [1] says: "Emphasis upon adequate evaluation is one of the surest and most scientific ways of improving instruction." Wrightstone [2] states:

> "Research on instruction in arithmetic has influenced and continues to influence teaching procedures and the content of arithmetic at various grade levels. It is recognized that widespread adoption of research findings in arithmetic instruction is a slow, gradual process but the evidence is clear that research alters practice."

It can be seen that a new instrument to measure the child's mastery of certain arithmetical concepts on an objective basis would be a help to both teacher and pupil alike. This study, therefore, sought to construct, administer, and evaluate an arithmetical vocabulary test; by, (1) defining and locating specific arithmetic vocabulary as it occurred in textbooks in use in school today, (2) constructing and administering this test to school populations, and (3) treating the data collected to ascertain the reliability and validity of the instrument.

1/M. L. Hartung, "A Forward Look at Evaluation," The Mathematics Teacher, (January, 1949), 42:29-33.

2/J. W. Wrightstone, "Influence of Research on Instruction in Arithmetic," The Mathematics Teacher, (March, 1952), 45:187-192.

CHAPTER III

REVIEW OF RESEARCH AND LITERATURE

1. Research in General Vocabulary

The importance of all types of vocabulary has already been stressed as has the need for determining the nature and extent of student's vocabularies. In recent years many experiments have been conducted to determine the extent of and difficulty of certain phases of vocabulary in different subject-matter fields and the results have given us extensive help with our classroom instruction.

Seegers[1] has written a review and synthesis of selected studies dealing with the development of vocabulary and summarizes the research in vocabulary up to 1946 by saying:

> "It is significant that with reference to both testing and development, increasing attention is paid to area and depth of meaning, not simply to single or isolated meanings. The studies clearly show the effect of experience, environment, and stimulus upon the use of language, and the development of vocabulary in particular. If, through concrete experiences or other suitable stimuli, children are encouraged in or made to feel the need of expression, they will use words intelligently."

Studies of the extent and limitations of vocabulary.-- Rinsland[2] points out the fact that our pre-primers, primers and first-grade readers often give lists of and explanations of vocabulary; however, writers of books beyond the third grade seldom give any such information for little is known. Many attempts have been made, however, in recent studies to learn more about the vocabulary of the children at the upper-grade levels. From

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[1] J. C. Seegers, "Recent Research in Vocabulary Research," Elementary English Review, (February, 1946), 16:157-166.

[2] H. D. Rinsland, A Basic Vocabulary of Elementary School Children, The Macmillan Company, New York, 1945.

this research many valuable conclusions have been reached.

Tilley [1] studied the comparative merits of certain standardized vocabulary tests and found many in need of improvement. He concluded that the vocabulary differences between tests is wide and there is great disparity in them.

Corson [2] performed a novel study in an effort to determine individual differences in the extent and level of vocabulary used by intermediate-grade children. A one-reel film was shown to children and then they were asked to write about it. A word count was taken for each individual on (1) the total number of words written to describe ideas gained from the film, (2) the number of different words used that do not appear on the first three levels of the Durrell list, and (3) the number of different words used that do not appear anywhere on the list. It was obvious from this study that intermediate-grade children express their ideas in a very narrow vocabulary range. The words they used were very general rather than dealing with specific meanings. It was also observed that little difference exists in the amount of vocabulary among the lowest quarters of grades four, five, and six and therefore these children need different instruction in many of their subject-matter areas than do the children who write more freely.

Johnson [3] discovered that at the beginning of the intermediate grades

1/H. C. Tilley, A Technique for Determining the Relative Difficulty of Word Meanings Among Elementary School Children, Unpublished Doctor's Dissertation, University of Pittsburg, 1934.

2/H. Corson, Individual Differences in the Extent and Level of Vocabulary Used by Intermediate Grade Children, Unpublished Master's Thesis, Boston University, 1938.

3/M. E. Johnson, Study of the Understanding of Vocabulary of Content Subjects by Children of Grade Five, Unpublished Master's Thesis, Boston University, 1950.

there seems to be a high percentage of failure in the use of vocabulary and concludes that this factor may be due to the rapidly expanding vocabulary of the content subjects and the great demand that these subjects make on the pupil's ability to comprehend what is read.

In using and analyzing the results of certain vocabulary tests Cuff [1] and Cronbach [2] would be in agreement that it is more important to measure word-meanings more precisely rather than to determine how many words a student knows. Cuff says: "Most of the tests are planned to find out how many difficult words one can define, rather than how accurately or how rapidly one can define them." [3]

Studies in determination of word difficulty.-- Along with the foregoing studies of the extent and limitations of vocabulary, there have been many and varied types of studies to determine word difficulty. Outstanding among these are the following:

Dolch [4] took 40 children from grades six and presented 70 words to them. Words not known at all were checked by a zero; doubtful words had a question mark in front of them. After doing this he also gave a multiple-choice test of the 70 words. In comparing the tests, Dolch noted:

> "We have here illustrated a characteristic of objective tests which it is almost impossible to get away from: with some words they aid the pupil and with others they hinder him, doing each in unequal amounts for different words. Consequently, they often fail very decidedly in showing us the true relative difficulty of words. Where large word lists are to be

1/N. B. Cuff, "Vocabulary Tests," Journal of Educational Psychology, (March, 1938), 21:212-220.

2/L. J. Cronbach, "Measuring Knowledge of Precise Word Meaning," Journal of Educational Research, (March, 1943), 36:528-534.

3/N. B. Cuff, op. cit., p. 219.

4/E. W. Dolch, "Testing Word Difficulty," Journal of Educational Research, (September, 1932), 26:23-27.

dealt with, we propose that they first be presented to children in a checking test. From this list a smaller list of doubtful cases will be secured. We propose that this list be then presented to a large number of children first by the checking method and then by the so-called objective method. Each one acts as a check upon the other because the mistakes which one is likely to make are very unlikely to be repeated in the other method."

Elivian [1] also worked with intermediate-grade children in an effort to determine the extent of word perception in silent reading at this grade level. Seventy-three words were taken from the Durrell-Sullivan reading list with the vocabulary load focused at the sixth grade. The words were checked with other word lists and then written into stories. A matching-type test was constructed and given to 126 children in grades five and six. It was found that children could not recognize words that they did not know and that of the words missed on the difficulty test only 41 per cent had been discovered in preliminary reading.

Tilley [2] engaged in an interesting study of the multiple-choice and self-appraisal test. The Stanford Achievement, the Survey Tests of Vocabulary (X and Z), and the Inglis Test of Vocabulary were given to 326 third graders and 1434 seventh-graders. He obtained the following correlations between self-appraisal and the multiple-choice:

Correlations between Self-Appraisal and Multiple-Choice Technics

Words	r	P.E.
Stanford Achievement	.879	$\neq$ .017
Survey X	.877	$\neq$ .015
Survey Z	.936	$\neq$ .008
Inglis Y	.661	$\neq$ .031

[1] J. Elivian, Word Perception and Word Meaning in Silent Reading in the Intermediate Grades, Unpublished Master's Thesis, Boston University, 1938.

[2] H. C. Tilley, "A Technic for Determining the Relative Difficulty of Word Meanings Among Elementary School Children," Journal of Experimental Psychology, (September, 1936), 5:61-64.

He claims:

> "Even when children are requested merely to write the
> difficult words from the printed page, self-appraisal ap-
> peared to be valid enough to indicate word concept diffi-
> culty for children in the elementary school. The grading
> of any list of words according to difficulty found in under-
> standing concepts may be partially done by submitting the
> list to the pupils' judgment. The nature of meaningful
> vocabularies found among groups of elementary school children
> may be determined in an economical manner. Teachers may use
> the technique in determining difficult words which need
> special study in ordinary classroom work."

Effect of simplification of vocabulary on reading comprehension.-- A

completely different type of study in vocabulary was attempted on 1112

sixth-grade pupils by Nolte [1] in Iowa and Illinois. He endeavored to

determine whether simplification of vocabulary would have any effect on

the reading comprehension of intermediate-grade children. He first tested

the pupils' reading of the original material and then retested after

simplifying the vocabulary load. He found no statistically significant

difference between comprehension of selections read in the original form

and those read with reduced vocabularies. There were times, however, when

substitution of less difficult words did aid the pupil in understanding

the material read.

2. Vocabulary Studies in Specific Content Areas
(Other than Arithmetic)

Vocabulary in reading and English.-- "Reading difficulties experien-

ced by intermediate-grade pupils seem to point to the need for determining

the extent to which pupils understand the meaning vocabulary in the content

subjects." [2] Often we think of vocabulary as being connected with a pupil's

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[1] K. F. Nolte, "The Effect of Simplification of Vocabulary on Comprehension
in Reading," Elementary English Review, (April, 1937), 14:119-124.

[2] M. E. Johnson, "The Vocabulary Difficulty of Content Subjects in Grade
Five," Elementary English, (May, 1952), 29:277-280.

reading or English and perhaps that is why more research is available in these fields on vocabulary than in other subject-matter areas. Wilking,[1] in trying to construct and evaluate a measure of reading vocabulary, broke down words into categories using Roget's International Thesaurus. Categories most frequent in children's reading were used. The Gates Primary and Durrell word lists were used as well as the combined word lists from ten third-grade readers for a basic vocabulary. The results were:

Intersheet Reliability Coefficients (Pearson and Multiple) of the

Experimental Reading Vocabulary Test, Form A for 82 Pupils

Sheets	Pearson r's	Sheets (R)	Multiple R's
XY	.71	Rx(YZ)	.62
XZ	.76	Ry(XZ)	.70
YZ	.88	Rz(XY)	.69

The reliability of Form A was computed by using a multiple correlation between scores made on the three sheets of the test on a group of 80 students in the ninth grade. This coefficient of multiple correlation was .70. The validity of the test was found by contructing a criterion test which was empirically observed to be similar to the true reading situation. This was found to have a reliability coefficient of .69. The validity coefficient on three groups, the ninth grade, college freshmen and the two groups combined were .58, .73, and .76 respectively. From these results Wilking[2] states:

> "In conclusion, then, it might be stated that a vocabulary test has been constructed that points the solution of the two problems this investigation has sought to solve. More words have been tested in a given space than heretofore by the method of category testing. The test is a highly valid measure of

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1/S. V. Wilking, Construction and Evaluation of a Measure of Reading Vocabulary, Unpublished Master's Thesis, Boston University, 1940.

2/Ibid., p. 42.

reading vocabulary as compared against the constructed criterion."

An attempt was made by Smith [1] to measure the size of the general English Vocabulary from the elementary grades through high school. Since it represented a very limited sampling it is probably a very rough approximation of general English vocabulary, but it serves its purpose in giving a general idea of the extent of word knowledge.

A thorough examination of the research in the field of reading reveals that failure to comprehend basic words is frequently found among middle-grade pupils and many of them are unprepared by their experiences to understand the new words in other content subjects.

Vocabulary in various subject-matter areas.-- Johnson [2] derived a vocabulary from fifth-grade books and found 1500 words which a fifth-grade child might have difficulty in comprehending. The words were classified into six subject-matter areas. Out of this list, 150 words were taken at random, to be tested by a multiple-choice test, using from one to five meanings per word. Results of the study show that a program of enrichment is needed for the understanding of the textbooks used in the content subjects. Many of the concepts are abstract and the pupils have few previous experiences with which to associate the new ideas. The relative order of difficulty of the subject-matter areas test were:

Subject Matter Area	Per Cent Correct
Arithmetic	67.64
Health	56.41
History	44.33
Geography	42.21
Literature	41.76
Science	38.63

1/M. K. Smith, "Measurement of the Size of General English Vocabulary in Elementary Grades and High School," Genetic Psychology, (November, 1941), 24:311-345.

2/M. E. Johnson, op. cit., p. 76.

<u>General vs technical vocabularies</u>.-- Pressey [1] categorizes the types of vocabulary which children meet as "general" vocabulary of the commonest English words and several "technical" vocabularies. She investigated the technical vocabularies of various school subjects in an attempt to find out what technical words appeared in each subject and to obtain some estimates as to the comparative importance in the subject of each word thus appearing. Pressey read textbooks in 19 elementary and secondary-school subjects three times, carefully scrutinizing them and picking out the technical terms. The word range was from 291 in algebra to 1691 in general science. Summer-school students, essentially teachers of the different subjects, were then asked to check the suitability and importance of each word. From the compiled list, it appeared obvious that pupils encounter special or technical vocabularies in each subject and must be specifically taught the meaning of new terms. Thus the ability to read in the lower grades does not guarantee comprehension of arithmetic problems or of texts in geography, science, or history.

In a follow-up study of Pressey's work, Livingston [2] found that 5,694 words in this technical vocabulary occurred in only one vocabulary list. The average number of vocabularies in which 3217 of the words appeared was 3.3. In the language field, the vocabulary was quite large and overlapped a great deal with other lists. General science, as well, had few words that were not found in other vocabularies. Most of the overlapping, however, was with other sciences out of which general science originated. Although there was considerable overlapping of other technical vocabularies

1/L. C. Pressey, "The Determination of the Technical Vocabulary of the School Subjects," <u>School and Society</u>, (July, 1924) 20:91-96.

2/R. Livingston, "The Interrelationships of Technical Vocabularies of the School Subjects," <u>Educational Research Bulletin</u>, (May, 1936), 3:208-213.

in certain fields, such vocabularies were more or less distinct for each field.

Need for vocabulary development in each school subject.-- Although his prime concern was with the specific vocabulary needs for middle-grade geography, Moody [1] concluded from his research that there is a need for developing a vocabulary in each school subject. He would agree with the two aforementioned authors that pupils of the middle grades are many times unable to acquire the meanings of words they encounter without help and that fundamental terminology can present a serious handicap to the acquisition of meaning in the content subjects.

Similar studies in other areas.-- Studies similar to the one the author has endeavored to undertake in arithmetic have been done in other specific subject-matter areas. Similar studies have been completed by Kershaw [2] in the field of health vocabulary and by Friis [3] in the field of language vocabulary. Thompson's [4] study in the field of music attempted to construct and validate a music vocabulary test for use in securing an inventory of interests and understandings of music, which though it could not be used as a predictive instrument, will aid in the guidance of students of music education.

Wolffer [5] and Early [6] in comparison studies analyzed social-studies

[1] B. D. Moody, Three Diagnostic Tests to Establish Specific Vocabulary Needs for Middle Grade Geography, Unpublished Master's Thesis, Boston University, 1949.

[2] E. C. Kershaw, The Construction and Evaluation of a Health Vocabulary Test for Grades Four, Five, and Six, Unpublished Doctor's Dissertation, Boston University, 1955.

[3] C. A. Friis, op. cit.

[4] C. D. Thompson, The Construction and Validation of a Test of Music Vocabulary, Unpublished Doctor's Dissertation, Boston University, 1953.

[5] W. A. Wolffer, op. cit.

[6] W. L. Early, op. cit.

textbooks and constructed, administered and evaluated tests of social-studies words in the intermediate grades. Both writers concluded that the words were not as well known as was necessary for understanding social-studies concepts. It was also noted that the word list compiled from the social-studies textbooks showed wide variation in the frequency of appearance of the words within a grade and from series to series of the textbooks.

3. Research on Vocabulary Instruction and Development

Need for direct instruction in vocabulary.-- Educators, in general, stress the need for and importance of an adequate vocabulary, both of common English words and of certain technical terms. Examination of the vocabulary research in various content areas, and in arithmetic specifically has proved that the acquisition of this vocabulary is extremely important. This holds true especially in the intermediate grades. What can be done to promote this vocabulary growth? Are the methods we are using to-day in the classroom adequate for maximum progress along these lines? Experts in the field and most of the literature available on vocabulary instruction and development are in unanimous agreement in their conclusions.

A well-known study on the teaching of word meanings was performed by Gray and Holmes. [1] The need for the work was stated as follows:

> "Much evidence has accumulated which supports those who question the adequacy of incidental methods in enlarging meaning vocabularies. In addition, classroom observation show clearly that pupils attach either no meanings or partial or inaccurate meanings to many of the words which they encounter in reading. This is due in part to the fact that the context frequently fails to reveal the meaning of some of the unfamiliar words involved."

[1] W. S. Gray and E. Holmes, The Development of Meaning Vocabularies in Reading, The University of Chicago Press, Chicago, 1938, p. 114.

From this study it was concluded:

> "Pupils of various levels of vocabulary achievement profit from direct instruction in word meaning and that those who rank relatively low in initial achievement are likely to make greater growth as a result of such guidance."

In a separate report of the previous study, Holmes [1] says: "Direct instruction in the meaning and use of unfamiliar words is superior in general to wide, independent reading without such instruction."

Cunningham [2] believes that incidental vocabulary growth does contribute to the pupil's word knowledge but does not lessen the need of meaningful word-building activities in school. He maintains that the:

> "Main essentials in directing vocabulary growth are:
> (1) adoption of the principles of self-activity in learning,
> (2) setting up of individualized procedures, and (3) provision of genuine motivation through worthwhile in-school activities."

Concerning vocabulary instruction and development, Glickeberg [3] offers both critical and constructive suggestions. He claims that the usual methods employed in teaching vocabulary are ineffective. Looking words up in a dictionary is wasted time as far as teaching the meaning of words is concerned. He claims that pupil's use words but do not define them except under teacher compulsion and do not use the single word but the sentence as the means of expression. If we wish to enlarge the vocabulary of our children he suggests that we must know them as individuals, enrich their store of experiences, and encourage participation in classroom discussion.

1/E. Holmes, "Vocabulary Instruction and Reading," Elementary English Review, (April, 1934), 11:103-105.

2/R. A. Cunningham, "Vocabulary Enlargement in the Intermediate Grades," Elementary English Review, (May, 1934), 2:130-132.

3/C. I. Glickeberg, "Dynamics of Vocabulary Building," English Journal, (March, 1940), 29:197-206.

Need for attention in area and depth of meaning.-- Seegers [1] maintains that with reference to both testing and development increasing attention must be paid to area and depth of meaning, not simply to single or isolated meaning. He says:

> "A word is difficult or easy to a child not in proportion to the incidence of its general use, but according to the amount and type of association the child has with the concept for which the word stands. Words are not easy or hard. Concepts are."

Teaching word meaning through context.-- The idea of teaching word meaning through context might help to provide the type of word association suggested above. Contextual clues in the teaching of word meaning are held in higher regard by Artley [2] than by many others in the field. His claim is that such clues may be verbal, experimental, or implied in the author's tone, mood or intent. He concludes:

> "One of the most practical uses of context clues is that of helping the child extend his vocabulary. The dictionary will continue to be a valuable reference book, but its many limitations should be recognized and the pupils led to see that sentence context itself is at times the best clue to a full and complete meaning."

Butler, [3] as well, has done a study in the field of word meaning from context ability. He worked with grades five and six and selected twenty-two words from the Durrell-Sullivan word list. Each of these words was used in narrative and sentence form. Each story had a five word matching test for checking. Children were equated by intelligence and reading capacity and both an initial and delayed test were given. Butler's [4] conclusions

[1] J. C. Seegers, op. cit., p. 160.

[2] A. S. Artley, "Teaching Word-Meaning through Context," Elementary English Review, (February, 1943), 20:68-75.

[3] H. A. Butler, Finding Word Meaning from Context in Grades Five and Six, Unpublished Master's Thesis, Boston University, 1943.

[4] Ibid., p. 88.

were:

"There is a possibility that instruction in specific techniques may improve the ability to find word meaning from context. The findings of the experiment seemed to indicate that there are no consistent differences between sexes in finding word meaning from context." [1]

Other methods for vocabulary growth.-- Durrell [2] indicates different methods and techniques for fostering growth of measureable vocabulary:

"The first and most important way is to drop the level of difficulty of materials to the point where the child is able to read without constant confusion in regard to words.

The second step in the process is to provide direct instruction in the difficult words the child is to encounter in the new material.

The third step in the process is teaching the transfer skills for vocabulary growth through extensive reading. The first of these habits to engender is that of discovering unknown words while the second is that of getting meaning from context."

After analyzing different methods and techniques for fostering growth of meaning vocabulary Crosscup [3] concluded:

"The old polarity of natural versus direct methods of acquiring vocabulary is dissolved in this conception of vocabulary instruction. Direct vocabulary instruction becomes natural. The teaching of the meaning of words becomes an integral element of the teaching of the meaning of the matter which is under consideration."

Strang [4] believes that printed words are usually generalizations as well as symbols. The child learns the meaning of a word by seeing it used in many different situations. In this way his idea of the word expands,

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1/ Loc. cit.

2/ D. D. Durrell, "Basic Abilities in Intermediate Grade Reading," *Education*, (September, 1938), 59:45-50.

3/ R. B. Crosscup, *A Survey and Analysis of Methods and Technics for Fostering Growth of Meaning Vocabulary*, Unpublished Master's Thesis, Boston University, 1940.

4/ R. Strang, "Language Development of Elementary School Children," *Education*, (December, 1951), 72:224-229.

the word acquires general meaning for him and it becomes a concept.

Strang's feelings on the subject of vocabulary growth, as well as those of the experts mentioned previously, would lead us to conclude as Seashore and Morin [1] do: "We may best build the child's vocabulary by helping him to build his own vocabulary."

4. Vocabulary Research and Studies in Arithmetic

Summary of research findings.-- Research on instruction in any field influences the subject content and teaching procedures. In arithmetic the changes have been gradual. This has been due in part to the following conclusions which the author has reached after a careful examination of the research findings in the field of arithmetic, and especially in arithmetic vocabulary. These are:

1. That most of the research in arithmetic vocabulary was done in the twenties and thirties and little has been done since then.

2. That much of the work in arithmetic has been done at the junior-high level and many studies only at secondary-school and college levels, although many of the arithmetic difficulties which students encounter have their basis in the earlier grades.

3. That the conclusions of these studies have not been readily available for use by the arithmetic teachers.

4. That the research available is on a variety of subjects and few duplicates of studies or follow-up studies have been made to make the findings conclusive.

[1] R. H. Seashore and R. E. Morin, "Clearing the Way for Vocabulary Development," _Educational Digest_, (October, 1950), 16:43-45.

Changes in our language.-- As our civilization changes it is evi-
dent that our language must become more highly developed; such changes
have been taking place in our own language in recent years. "It is
becoming increasingly difficult to read as much as ten sentences without
encountering a word which has quantitative connotations." [1] In order to
read meaningfully, the terms we read must be clearly understood. With
the impelling force that we must understand number for the comprehension
of the constantly changing aspects of our environment, there is no doubt
but that pupils must receive more meaningful exposure to an exact and
efficient vocabulary of mathematics. Alice [2] says that:

> "The complete understanding and use of any kind of
> mathematics is dependent upon the individual's ability to
> read. Arithmetic is hard to read and the child has little
> preparation for it when he enters school.
>
> The primary arithmetic book is not the place to en-
> large the child's general vocabulary. It is a place where
> the child should be accustomed to, and feel at ease with,
> the specialized vocabulary of arithmetic."

Need for understanding of arithmetic words.-- Sherer [3] says that
arithmetic is not a separate language but the quantitative aspect of lang-
uage plus symbols for quantitative facts and operations. She agrees with
many others that understanding these quantitative words should precede the
understanding of their abstract arithmetic symbols.

Alexander [4] says that the elementary mathematics teacher needs to

1/A. Dodd, "The Language and Arithmetical Requisites of Clear Thinking,"
Teachers' College Journal, (March, 1955), 26:84-85.

2/Sister M. R. Alice, Materials and Procedures to Develop Reading Effi-
ciency in Mathematics, Supplementary Educational Monograph, University of
Chicago Press, Chicago, 1954, p. 117.

3/L. Sherer, "Some Implications from Research in Arithmetic," Childhood
Education, (March, 1953), 29:320-324.

4/B. F. Alexander, "Language Development in Mathematics through Vocabular-
ies," Mathematics Teacher, (December, 1947), 40:389-390.

recognize the following things:

"1. Reading ability in mathematics is a serious problem.
2. Language development is an actual, not artificial growth.
3. The development of a meaningful vocabulary in mathematics is one measure of his skill as a teacher.
4. Pupils frequently use mathematical terms more or less accurately but often without the real knowledge of their correct meanings.
5. Mathematics as well as other subjects in the program of the school should increase the active vocabulary of each pupil." [1]

Studies at secondary and college level.-- Some studies in arithmetic vocabulary have been done at higher-grade levels but very few are available at the elementary level. As mentioned before, few of these which have been completed were in recent years. In an early study Remmere and Grant [2] attempted to measure the vocabulary load of twelve secondary-mathematics textbooks assuming that the ease with which the pupil acquires the concept of a subject is a function of the textbook's vocabulary load. They also made a comparison between books to compare the technical vocabularies. The results were not too conclusive.

A few years later a number of other studies were made in arithmetic vocabulary at the higher-grade levels. During the spring of 1935 a study was made at the University of Georgia to determine student's knowledge of mathematical vocabulary and to what extent this correlated with a final mathematical examination. The experiment was performed on two groups of freshmen. For one group numbering 141 cases, the correlation was .638, P.E. .033. For the second group numbering 118 students the correlation

[1] Loc. cit.

[2] H. H. Remmere and A. Grant, "The Vocabulary Load of Certain Secondary Mathematics Textbooks," Journal of Educational Research, (October, 1928), 18:203-210.

was .59, P.E. .04. The author concludes:

> "These results show a considerable influence of vocabulary upon achievement in mathematics. Correlations give weight to the hypothesis that a considerable amount of difficulty in mathematics is due to lack of sufficient knowledge of the mathematical terms used." [1]

And, as late as 1955 it was written that: "The opinion is widely held that the deficiencies of college freshmen with mathematics are primarily a result of lack of understanding of requisite mathematical concepts." [2]

In another early study by Buckingham [3] an attempt was made to determine the relationship between vocabulary and ability in first-year algebra in high school. A vocabulary test was constructed consisting of 23 non-technical words, 10 technical mathematical words, and 16 technical algebraic words. The words were used in algebra problems and the students were instructed not to solve the problem but to indicate below the problem what the underscored word meant. The Cooperative Algebra Test was also given. The two tests correlated with a relationship of .38 $\neq$ .05. The mean score of the group in the Cooperative Algebra Test was 41.77 which compared favorably with national norms. Sigma was 15.4 which was 1.4 lower than the national group. The mean score of the vocabulary test was 30.88 with a sigma of 6.28 and a slight skew toward higher scores. Buckingham [4] interprets the results as showing that: "Vocabulary of an advanced degree of difficulty is one problem of the teacher of beginning

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[1] A. L. Edwards, "A Mathematical Vocabulary Test and Some Results of an Examination of University Freshmen," Journal of Educational Psychology, (December, 1936), 27:694-697.

[2] E. A. Habel, "Confusion Resulting from Duplication of Symbolism and Definition in Mathematics," School, Science and Mathematics, (May, 1955), 55:658.

[3] G. E. Buckingham, "The Relationship between Vocabulary and Ability in First Year Algebra," Mathematics Teacher, (February, 1937), 30:76-79.

[4] Ibid., p. 79.

Algebra...."

Studies at lower grade levels.-- Several studies are available on vocabulary research and testing at lower-grade levels but here again few have been done in the last fifteen years so that we could not term them recent. Glennon [1] claims that little has been done with understandings and meanings in arithmetic because there has been a lag due to the following facts:

"1. that arithmetic has taken a changing role in the curriculum.
2. that there has been a great impact of physiological psychology on methods of teaching.
3. that there has been mental security for teachers and supervisors in present methods of telling, drilling, and testing.
4. that arithmetic has been thought of as a series of arbitrary associations, each association being an entity in itself and having no relation to other associations.
5. that presently available tests have infringed upon and striated the aims and objectives of learning in arithmetic.
6. that there has been a lack of a definite list of the understandings and meanings."

An overlook of the available early studies will show what areas were covered then and what need there has been for further research in the same vein. Brooks [2] studied five arithmetic series, analyzed the words, and took out those dealing with numbers, operations with numbers, value, size, quantity, degree, position, shape, money, measurement, commercial terms and directive terms. He had a total of 429 words which occurred in all five times or more or in three textbooks. He included only irregular plurals and present indicative singular of verbs. To help the teacher in finding out what words of this list her class already knew he cut the list

[1] V. J. Glennon, op. cit., p. 70.
[2] S. S. Brooks, op. cit., p. 220.

to 237 words and put each word in a multiple-choice test form.

During the same era an attempt was made to determine the nature of the reading difficulties encountered by first-year junior high school mathematics students in the University High School at the University of Chicago. The instructor in the class noted the difficulties which mathematics students had with mathematics materials and interviewed the students concerning their difficulties. Georges [1] found that reading difficulties caused by mathematical terminology were predominant and that 23.4 per cent of all difficulties were caused by mathematical vocabulary.

Turner [2] did a detailed study of vocabulary of a series of textbooks during the twenties. A record of the words used was kept with the frequency of each. He found 1,266 words ranging in frequency from 1 to 124. He obtained the following results and information from his study:

"1. New words appeared and were repeated many times within two or three pages and then were dropped.
2. Many words were dropped and not used again in the next higher grade.
3. Many new words were added with each new book.
4. Many words were used as instruction words such as find, solve, multiply.
5. Many words were found to have a special meaning for arithmetic such as table, circle, fact."

Pressey [3] engaged in two studies early in the thirties, the results of which added to the available material on arithmetic vocabulary. In one of them tests were given in each grade from third to high school covering 106 technical words in arithmetic, 49 in algebra, and 88 in geometry. The

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1/J. S. Georges, "The Nature of Difficulties Encountered in Reading Mathematics," The School Review, (March, 1929), 37:217-226.

2/J. M. Turner, "A Study of Vocabulary in Arithmetic," Educational Research Bulletin, (October, 1924), 3:291-294.

3/L. C. Pressey and W. S. Moore, "The Growth of Mathematical Vocabulary from Third Grade through High School," School Review, (June, 1932), 40:449-454.

percentage of children in each grade recognizing each word was tabulated. From these data a graph was made for each technical word.

"The writers would like to offer the suggestion that inadequate mastery of fundamental terminology is one of the most important reasons for the difficulty encountered by so many persons of all ages and social strata in dealing with anything of a mathematical nature. They have never mastered the relatively simple, fundamental meanings, and their efforts to build on a shaky foundation have been so futile that they have come to regard mathematics as a subject which can be mastered only by those with a 'genius' for figures." 1/

Pressey and Elam 2/ engaged in further work in arithmetic vocabulary by reviewing the four available vocabulary investigations in the field of arithmetic at that time. They hoped to reduce the words listed in these studies to the essential ones and ended up with 117 technical terms regarded as the core of the arithmetic program, without which no child can progress in the subject. The words were grouped as follows by related meanings:

"I   Notation and Numeration (zero, unit)
II   Operations with Integers (Roman numeral, addition, carry)
III Fractions (cancel, invert, reduce)
IV   Units of Measurement (inch, pound, dollar)
V   Interest and percentage (profit, per cent)
VI   Practical measurements (volume, circle, angle)
VII General (solve, equal, problem)"

The writers then constructed a test using these 117 essential words. They concluded that too little importance is attached to technical vocabulary and that a great deal of the difficulty with and antagonism toward arithmetic is due to a lack of word meaning.

A number of years went by with little work done on arithmetic vocabu-

1/L. C. Pressey and W. S. Moore, "The Growth of Mathematical Vocabulary from Third Grade through High School," School Review, (June, 1932), 40:449-454.

2/L. C. Pressey and M. K. Elam, "The Fundamental Vocabulary of Elementary School Arithmetic," Elementary School Journal, (September, 1932), 33:46-50.

lary research until Grossnickle [1] did a study to find the degree of ac-complishment attained in the mastery of certain concepts by the pupil when he had completed the eighth grade. Sixty-eight different business concepts were taken from seventh and eighth-grade arithmetic texts in 13 different series. These concepts were incorporated into a multiple-choice test with four responses per item and given to 1337 pupils who had completed the eighth-grade. Grossnickle's [2] conclusions were that:

"1. There is no standard phraseology to connote
certain different concepts.
2. No agreement exists among the writers of arithmetic
texts as to what concepts are most essential.
3. There is a need for richer experiences in the uses
and applications of the concepts which must be
provided for the pupil."

The more recent research is very definitely limited and little has been done along the line of this study. It is possible, however, to draw certain conclusions regarding arithmetic vocabulary and the development of that vocabulary from some of these studies.

O'Rourke and Mead [3] investigated the vocabulary difficulties of five textbooks in third-grade arithmetic. The information was accumulated by: "(1) counting and tabulating every word in each book; (2) taking a random sampling of every tenth page, (3) determining the total number of different words for each book, (4) computing the average repetition, (5) checking the list with the Gate's List and the first three thousand on the Thorndike list, (6) numbering and segregating the proper nouns, (7) tabulating all common arithmetical or technical terms to show the number of times such

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[1]/F. E. Grossnickle, "Concepts in Social Arithmetic for the Eighth Grade Level," *Journal of Educational Research*, (March, 1937), 30:475-488.

[2]/*Ibid.*, p. 86.

[3]/E. O'Rourke and C. D. Mead, "Vocabulary Difficulties of Five Textbooks in Third Grade Arithmetic," *Elementary School Journal*, (May, 1941), 41:683-691.

terms appear and the number of pages on which each appears." They concluded that it was essential for publishing companies to employ reading experts to assure proper vocabulary load in their textbooks and that additional care should be taken in the development of the vocabulary for arithmetic textbooks if good teaching was to take place in the classroom.

Johnson [1] conducted a study of the effect of instruction in mathematical vocabulary upon problem-solving in arithmetic. This was performed on seventh-grade children at Niagara Falls, New York. In the experimental group there were 316 pupils and in the control 282 pupils. Data was obtained on (1) ages, (2) mental ages, (3) reading ability, (4) knowledge of mathematical vocabulary prior to the beginning of the experiment, (5) ability in quantitative relationships, (6) problem-solving ability, and (7) ability in fundamental operations. The tests were conducted so that for each word in the vocabulary test there was a problem in the problem test which made use of and required the understanding of that word. The conclusions he arrived at were:

"1. The use of instructional materials in mathematical vocabulary leads to significant growth in the knowledge of the specific terms included in these materials, as well as in the solution of numerical problems involving the use of these terms.

2. The use of vocabulary exercises of a specific nature, such as those employed in this experiment, does not tend to bring about a general improvement in arithmetical learning.

3. There was no evidence to indicate that there is a transfer of training from the learnings of words from the textbook which are taught through the use of practice exercises, to the learning of other words from the textbook which are not so taught and emphasized.

4. The successful use of the remedial exercises of

1/H. C. Johnson, "The Effect of Instruction in Mathematical Vocabulary upon Problem Solving in Arithmetic," Journal of Educational Research, (October, 1944), 38:97-110.

the type used in this experiment does not
necessarily require the guidance and supervision
of a well experienced teacher."

Spache [1] constructed a different type of test having to do with arithmetic reasoning and administered it to 158 children in the fifth and sixth grades. It was interesting, however, to note that a study of the 27 per cent with the lowest scores showed that these same pupils also had lower scores on an arithmetic vocabulary test.

Eagle [2] was concerned in one of his studies with the relation of certain reading abilities to success in mathematics. He determined success in mathematics by averaging the arithmetic reasoning and arithmetic computation scores on the Stanford Achievement Test with semester marks in eighth and ninth-grade mathematics courses, and identified the effects on success in mathematics with (1) mental age, (2) reading comprehension, (3) reading speed, (4) general reading vocabulary, (5) mathematics vocabulary, (6) ability to interpret graphs and (7) ability to interpret algebraic formulas. It was found that mathematics vocabulary, the ability to interpret graphs, and the ability to interpret formulas were the factors most closely related to success in mathematics. There was no evidence that improvement in general reading comprehension or general vocabulary would increase proficiency in mathematics.

Further research needed.-- Summarizing the foregoing report of research and related literature concerned with arithmetic vocabulary, it is evident that more study is needed in this area. "One of the great needs in

1/G. Spache, "A Test of Abilities in Arithmetic Reasoning," Elementary School Journal, (April, 1947), 47:442-445.

2/E. Eagle, "The Relationship of Certain Reading Abilities to Success in Mathematics," The Mathematics Teacher, (April, 1948), 41:175-179.

teaching concepts is to provide opportunities for acquiring a more complete understanding of the terms." [1] More recently in an article Hickerson [2] wrote:

> "It would seem, therefore, that in school we should direct children's attention more to the quantitative nature of the persons, places and things that number represents than to the nature of the number system itself. The best way to gain an understanding of the grammar of number-language is by discovering relationships and by formulating rules and principles based on an analysis of usage."

[1] M. Schreiber, "A Summary of Arithmetic Research," Educational Administration and supervision, (October, 1948), 34:368-372.

[2] J. A. Hickerson, "The Semantics and Grammar of Arithmetic Language," The Arithmetic Teacher, (February, 1955), 11:12-16.

CHAPTER IV

PROCEDURE

1. Source of Vocabulary

The implications of major studies and related literature pertaining to the testing of arithmetical vocabulary reveal more research is needed at the elementary school level. It was with the purposes of developing and revising an arithmetical vocabulary test that this study was organized and completed.

Major arithmetic textbook series.-- The most obvious source of specific arithmetical vocabulary was the arithmetic textbooks currently used in the intermediate grades. A review of textbook catalogues and the general literature concerning elementary school arithmetic revealed the year 1950 as an approximate date of the transition of arithmetic textbooks from the more formal drill approach to the more functional approach generally emphasized today. With this in mind the following ten arithmetic textbook series were chosen from which to obtain a basic arithmetic vocabulary:

Series I

Brueckner, L. J., Merton, E. L., and Grossnickle, F. E.
The New Learning Numbers - Grade 4
The New Exploring Numbers - Grade 5
The New Understanding Numbers - Grade 6
Philadelphia: Winston Co., 1956

Series II

Buswell, G. T., Brownell, W. A., and I. Sauble
Arithmetic We Need - (Grades 4, 5, and 6)
Boston: Ginn and Co., 1955

Series III

The Word of Numbers Series
Carpenter, D., and L. G. Anderson
Step by Step in Arithmetic - Grade 4

Carpenter, D., McMeen, G. H., Anderson, L. G. and E. M. Sauer
        Ideas in Arithmetic - Grade 5
Carpenter, D., and D. L. Pepper
        Making Arithmetic Clear - Grade 6
                    New York: The Macmillan Co., 1957

Series IV

Clark, J. R., Junge, C. W., and H. E. Moser
        Growing in Arithmetic - (Grades 4, 5, and 6)
                    New York: World Book Co., 1956

Series V

Durell, T. J., Hagaman, A. P., and J. H. Smith
        Arithmetic for Today - (Grades 4, 5, and 6)
                    Columbus, Ohio: Merrill, 1953

Series VI

Madden, R., Gager, W. A., and L. S. Beatty
        The Scribner Arithmetic - (Grades 4, 5, and 6)
                    New York: Scribner's Sons, 1955

Series VII

Morton, R. E., Gray, M., Springstun, E., and W. L. Schaaf
        Making Sure of Arithmetic - (Grades 4, 5, and 6)
                    New York: Silver Burdett Co., 1955

Series VIII

McSwain, E. T., Ulrich, L. E., and R. J. Cooke
        Understanding Arithmetic - (Grades 4, 5, and 6)
                    River Forest, Illinois: Laidlaw, 1956

Series IX

Numbers at Work Series
Patton, D. H., and W. E. Young
        Learning to Use Numbers - Grade 4
        How Numbers Work - Grade 5
        What Numbers Can Do - Grade 6
                    Syracuse: Iroquois Publishing Co., 1952

Series X

Wheat, H. G., Kuffman, G., and H. R. Douglass
        Row-Peterson Arithmetic - (Grades 4, 5, and 6)
                    Evanston, Illinois, Row-Peterson, 1957

Definition of arithmetic vocabulary.-- To arrive at a definition of

specific arithmetic vocabulary the arithmetic textbooks were examined care-

fully and the following definition was subsequently established: <u>An</u>
<u>arithmetical word as it occurred in arithmetic texts was a word that is</u>
<u>essential for the child to read, express, and understand quantitative</u>
<u>ideas as a part of specific instruction in arithmetic at the intermediate</u>
<u>grade level.</u>

<u>Word categories.</u>-- By listing a sampling of words from an arith-
metic series certain groupings became obvious. It was decided that the
arithmetic words should fall into the following categories: (1) Base
words; (2) Words used to represent number processes; (3) Words used to
represent various kinds of measurement; and (4) Specialized technical
words.

2. Method of Tabulating

<u>Word count.</u>-- With specific arithmetic vocabulary suitably defined,
the next step was to take a word count of the textbooks to determine more
completely the nature and extent of arithmetic vocabulary as found in these
books.

After careful consideration it was decided to use only the running
words of the text and omit words appearing in titles, captions, indices,
or tables of content. The words were circled in red in order that they
could be tabulated easily. Graph paper was used with blocks for each
letter of the alphabet. In this way it was easy to insert a tally mark in
the appropriate column designated for each word.

After the tabulation of words in one series was completed, it was de-
cided that it would facilitate the tallying to list only irregular plurals
separately and all verb forms as present indicative singular.

The most commonly used series were tabulated first. As the word list
grew, words continually recurred so that by the time the first four series

of texts had been counted it seemed that a saturation point had been
reached, as few new words were being added to the list. After consult-
ation with the writer's advisory committee and experts in the field of
arithmetic, it was decided that a token scanning of the remaining series,
without actually tabulating the words, would complete the list. Grade
five texts were scanned most carefully and particular attention was given
to new words which might occur in the category of measurement.

Total tabulation.-- To complete the tabulation, totals were found
for the number of times each word occurred in each grade of each of the
four series completely tabulated. The total word count yielded 606 words.
Only five new words were added from the other series which were scanned.
The completed list showing raw frequencies and totals appears as Table 1.
Appendix A.

3. Classification of Vocabulary

Need for cutting word list.-- An examination of the completed word
list relative to its proposed use indicated that the total number of 611
words was too large for the type of test contemplated. Some criteria had
to be determined to further reduce the list. Several methods for cutting
were studied.

It was decided to include in the final list for testing purposes only
those words which occurred in two or more series at the same grade level.
A list was made of the words in this category as well as a list of those
which occurred in only one series. By using the latter list and rechecking
the series previously scanned a small number of words were found which
would have occurred in two series at the same grade level, if the words in
these books had been fully tabulated.

Methods for cutting word list.-- It was thought that it would be
advisable to eliminate any words which are presumed to be a part of

children's vocabulary at the end of grade three. A careful check of the completed word list with the International Kindergarten Union List [1] and the Gates [2] Primary Grade Vocabulary List showed that very few words of a purely arithmetical nature are found on these lists and those which do occur, such as square and add, should be tested. Therefore, the idea of eliminating words by this method was discarded.

The author consulted with an expert in the field of arithmetic to determine the best method for cutting down the number of words for the final testing list. After carefully studying the original definition for an arithmetic word it was decided that a number of words, such as accurate, check, process, problem, row and side could be dropped because they could not be considered wholly arithmetical in nature.

It was found that many additional words could be dropped because they duplicated other words. It seemed unnecessary to test for an understanding of the meaning more than once. Included among these were such words as: ten's column, ten's figure, ten's place, cent's worth, missing dividend, missing numerator, nearest cent, and nearest thousand.

The final word list selected for testing numbered 307 words.

4. Construction of the Test

Reclassification of words.-- Only those words which are essential for a child, to read, express, and understand quantitative ideas as a part of specific instruction in arithmetic at the intermediate-grade level were

1/Child Study Commission of the International Kindergarten Union, A Study of the Vocabulary of Children Before Entering First Grade, The International Kindergarten Union, Washington, D.C., 1928.

2/A. I. Gates, A Reading Vocabulary for Primary Grade Children, Bureau of Publications, Teachers College, Columbia, New York, 1926.

kept in the final word list for testing. Originally, these words were categorized as follows: (1) Base words (hundred, thousand); (2) Words dealing with number processes (sum, divide); (3) Words used in measurement (quart, mile); and (4) Specialized technical words (graph, circle). It was decided to construct two balanced forms of the vocabulary test. To facilitate the balancing of these forms categories described were further subdivided as listed in Table 2, Appendix B.

Selection of test item types.-- While previously cited research has employed various techniques of vocabulary testing, no one type has been singled out as the best one to use. A survey of the few arithmetic vocabulary tests available showed that the multiple-choice type test item was most generally used. Since this type of test item lends itself to guessing and does not provide adequately for the functional-type of answer which the author was seeking, it was decided to put as many words as possible in Section I of the test in a different type of test item.

Construction of test items.-- In Section I in both forms, words were placed in related groupings of five, with a choice of seven possible lettered answers for each group. The words in each group were chosen so that it would be difficult for the pupil to identify the answer by a process of elimination or contrast. For each group of five words two distractors were provided in the seven answers. Words dealing with addition and subtraction (subtraction, subtrahend, addend, total) were kept in their own group rather than putting them with such obviously different words as those dealing with the processes of multiplication and division (multiplier, dividend, quotient).

The answers were functional wherever possible. Instead of locating the definition of a word such as dividend, the pupil would actually have to locate the dividend in a selection presented on the test page. It was

felt that this technique of measuring would test a pupil's mastery of the word applicable to a real situation rather than merely testing for verbal definition or solution of a problem as found in most arithmetic tests. For example: to test for the words connected with telling time (minutes to, minutes past, o'clock, quarter of and quarter after) a series of seven clock faces were presented showing different times as possible answers.

In some cases where sample examples were given to illustrate certain processes it was necessary to arrow the seven lettered answers in order for the pupil to avoid confusion. For example: when the word multiplier was tested, the multiplier in a multiplication example was marked with a lettered arrow as a possible answer.

It proved to be a difficult task to find groups of seven words in the same categories to test in each group of items and to obtain five similar words to maintain the proper balance in the second form of the test. It was possible to put 60 items in each form in this type of test item.

Construction of answer sheet.-- Since commercially-prepared answer sheets were not available with seven possible answers, lettered a,b,c,d,e, f, and g, it was necessary to devise a special answer sheet which would be easy for the pupils to use and which would facilitate hand-scoring.

Completion of balanced forms of test.-- Section II and III of each form of the test were similar and contained multiple-choice items with functional responses wherever possible. Four choices of answers were given for each question. In Section II words which were similar were grouped and series of questions referred to a set of diagrams or illustrations. For example: the ordinal numbers tested in each form were placed in a series of questions about the order of books on a bookshelf.

When the answers to the questions could not be found in the illustrations above the series of questions, a set of four lettered answers were

given below the question. The questions and answers in Section III of the test were quite similar with the possible lettered answers given below each question. In each form forty items were put into groups of questions for Section II of the test.

In Sections II and III of the test it was again a difficult task to choose similar words for Form A and Form B and still maintain a balance between the forms.

Final construction of test forms.-- Inasmuch as there had been no test material available comparable to the type the author proposed to use, it became necessary to construct accurate and simplified meanings for each word. Some resource was made to the dictionary and to the arithmetic text-books. As far as possible the instruments were built as power tests with the estimated grade four items presented first in each part of both forms, grade five next, and grade six last. Each section, therefore, commenced with relatively familiar items, and other such items were interspaced throughout the test forms for the purpose of encouraging the child to go as far as possible in the test.

Certain considerations had to be made throughout the actual construction of the test forms. These included: (1) the silent reading ability of fourth grade children, since this was the lowest grade level being tested, (2) the amount of time that public schools would be willing to devote to the testing, and (3) the length of time that children could be expected to work at a task of this nature in one sitting.

The completed test items were submitted to experts in the field of arithmetic and language arts for criticism. Some changes were suggested and the test forms were approved after minor corrections had been made.

Directions for test administration.-- Directions for each section of the test were given in the test booklets. These booklets were prepared

in order that they might be used by more than one class. Copies of Form A and Form B for the initial testing and experimental testing may be found in Appendix C. Each child was given an answer sheet with space for item 1-60, requiring seven possible lettered answers on one side, and space for items 61-150, giving four possible lettered answers for each item on the opposite side of the sheet. Space was also provided on each side for the pupil to answer the sample items. A set of directions as to proper administration of the tests was provided for each teacher. Copies of the answer sheets and directions also appear in Appendix C.

5. Description of the Population Tested

First testing population.-- Contact with several school systems in addition to that in which the writer is employed, indicated that they would be willing to devote time to the proposed testing. On the basis of planned test administration and resultant treatment of data, it became evident that there must be two distinct groups of populations to be tested. The first population would be used for preliminary testing for observation as to needed changes in content or directions. For this preliminary testing the writer chose to use 200 children at the fourth, fifth, and sixth grade level within his supervisory union in order to be able to observe difficulties in administration, estimate timing, and obtain comments from teachers and pupils. The towns chosen were representative communities.

Second testing population.-- The second population was to be tested in order to obtain data for validity indices for the items, and reliability of pupil scores from form to form. This population was to be a representative sampling of children in the intermediate-grades. A goal of one thousand cases was set for final administration of the test. This goal would be broken down into approximately one hundred seventy cases per form, per

grade. Six communities of urban and rural character, representing both industrial and residential areas, were selected. These populations also represented a wide variation of nationalities. It was determined that by testing in all of the schools which house the intermediate-grades in these towns that the set goal of one thousand cases could be reached. On the basis of data obtained from the guidance departments of the various school systems and further testing in some communities, it was determined that the mean intelligence quotients of the pupils tested was 101. These data were obtained from scores on the Otis Quick-Scoring Test.[1]

6. Administration of the Test

<u>Preliminary administration.</u>-- The preliminary administration of the tests was done to the first group described above. From this could be determined the average length of time to take the test and to observe any changes needed in content or directions. Each teacher was asked for her comments, as were the pupils, as to the difficulty of the test and the clarity of the test directions. Table I, which follows, shows the number of classes and children tested by grade and community in the initial testing.

TABLE I

NUMBER OF CHILDREN TESTED PER FORM; PER GRADE
INITIAL TESTING

Grade	Form A Salisbury	Newbury	Form B Salisbury	Newbury	Total Salisbury	Newbury
IV	16	16	17	16	33	32
V	16	16	16	15	32	31
VI	12	13	15	14	27	27
Totals	89		93		182	

[1] Arthur S. Otis, Otis Quick-Scoring Mental Ability Tests (new edition) (Beta test), World Book Company, 1954.

By determining the average amount of time taken by each grade an average time was computed for the forms at each grade level and it was decided to allow approximately 60 minutes of testing time for the test. No time limit was set, however.

Changes after preliminary administration.-- These initial tests and answer sheets were duplicated. Copies of each are included in Appendix C. After completing the initial testing, comments received from the teachers and pupils were considered with the author's own observations and necessary changes were made in the directions and test content. Most of the changes were in clarifying of the directions and spacing of test items rather than in test content.

Preparation of test forms.-- It was a difficult task to find the best method for printing of the final forms since clarity in the illustrations and printing was involved as well as proper spacing. It was finally decided, after trying several printed media, to have the illustrations commercially drawn and the pages typed, photographed and printed. The answer sheets were mimeographed with corresponding answer keys made for ease in scoring.

Population tested.-- The tests were now ready for administration to our second group which represented 42 classrooms in six towns. This represented the entire intermediate-grade population in these communities described as typical, with the exception of one town where only the sixth grade was tested to make up for the small groups at this level in the other communities.

Table II which follows, shows the number of classes and children tested by grade and community.

TABLE II

NUMBER OF CLASSES AND CHILDREN TESTED
BY GRADE AND COMMUNITY

Community	Grade IV		Grade V		Grade VI	
	Classes	Children	Classes	Children	Classes	Children
Hamilton	4	100	4	88	2	61
Ipswich	4	82	4	97	4	88
Manchester	2	57	2	38	2	51
Middleton					2	40
Topsfield	2	55	2	38	2	32
Wenham	2	41	2	52	2	52
Totals	14	335	14	313	14	324

Although, due to absences and some incomplete tests, some of the
samples fell slightly below the desired goal, it seemed that the differ-
ences were not great enough to invalidate the statistical analysis of any
test form. Table III shows the number of cases actually tested per form,
per grade level.

TABLE III

NUMBER OF CHILDREN TESTED PER FORM, PER GRADE

Grade	Form A	Form B	Total
IV	173	162	335
V	159	154	313
VI	164	160	324
Totals	496	476	972

Administration of tests.-- Random and equitable distribution of forms
was insured by arranging every other test as a different form in packaging
them for distribution. A suitable number of answer sheets and a sheet of
teachers' directions was included in each package.

The tests were administered by the classroom teachers to insure, as far as possible, a natural classroom environment. Directions for Sections I and II were read by the children along with the teacher and the sample items done. Since the directions for Section III were similar to those for Section II pupils were allowed to go on to Section III and read the directions silently. Guessing was discouraged since it was desired to determine the status of the children's knowledge of the words tested at the three grade levels. Teachers were permitted to read questions and answers to children who were unable to understand them, since this was a test for meaning and understandings in arithmetic and not a reading test.

It was decided not to make inference to sex differences in this study since the vocabulary of arithmetic is met by all children within the classroom. However, the children were asked to indicate their sex on their answer sheets along with other pertinent data in the event any follow-up study might need such information.

An examination of the answer sheets showed that in most cases the children worked through to the end of the test, especially at the higher grade levels. There were items left unanswered throughout the test indicating that children did not respond to items they did not know.

7. Treatment of Data

The basic treatment of the data was for the purpose of determining the difficulty of all test items and the internal validity indices of the experimental test forms for the selection of test items to be included in two final balanced forms, which would measure the level of arithmetic vocabulary of intermediate-grade children. The assumptions were made that the sampling was random and that comparable groups responded to the test items.

Scoring and item count.-- All tests were handscored for total correct responses and a graphic item count was obtained for the upper and lower twenty-seven per cents of the cases for each test form at each grade level. An item count was taken of the correct responses to each test item and these were analyzed to determine the level of difficulty values. The means and standard deviations were computed for all test forms at all grade levels.

Face validity.-- Face validity may be observed from an examination of the vocabulary tested. All words included are necessary for understanding and expression of quantitative ideas and concepts.

Curricular validity.-- Curricular validity resulted from the method of vocabulary selection in that all words were obtained directly from the children's textbooks. These words obviously are those which children must read and understand as a part of specific arithmetic instruction.

Statistical validity.-- The internal statistical validity was determined by entering Flanagan's Table [1] with the upper and lower twenty-seven per cents passing, from which was obtained the validity index of each item.

Reliability of experimental forms.-- The reliability of each experimental test form was computed by use of the Kuder-Richardson formula #20. [2]

$$r_{tt} = \frac{n}{n-1} \cdot \frac{\sigma t^2 - \sum pq}{\sigma t^2}$$

1/ J. C. Flanagan, "General Consideration in the Selection of Test Items and the Short Method of Estimating the Product-Moment Coefficient from the Tails of the Distribution," Journal of Educational Psychology (December, 1939), 30:674-680.

2/ F. G. Cornell, The Essentials of Educational Statistics, John Wiley And Sons, Inc., New York, 1956, p. 285.

where

r^{tt} = reliability of the total test

n = number of items in the test

σ_t^2 = variance of the total test

p = proportion passing each item

q = proportion failing or 1 - p

Selection of items for final forms.-- The selection of items for the two final forms was based on the validity indices of the items in the experimental forms at the fifth grade level. Equivalent forms were obtained by distributing equally valid items, selecting in descending order those items of highest validity indices.

Estimated reliability for final forms.-- The reliability for the final test forms were estimated by using the Kuder-Richardson formula #20. Since the variance of the total test was not known, it was arrived at by an indirect method derived by Bridges [1] in which this statistic

> ".....can be estimated readily and accurately from data obtained in item analyses based on the upper 27 per cent and lower 27 per cent (or other percentage) of the experimental population. These data are used to obtain the average score of the upper group and the lower group and to fit a normal curve, all by a simple procedure."

Since the data obtained met the requirements of the Bridges technique, the estimated reliabilities of the final test forms were readily computed by the method described.

An analysis of these data and the item composition of the final test forms appear in the following chapter.

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[1] Claude F. Bridges, A Method of Estimating the Distribution of Test Scores from Coefficients of Item Difficulty, Unpublished Paper, World Book Company, 1950.

CHAPTER V

ANALYSIS OF DATA

The purpose of this study was to construct, administer, and revise an arithmetic vocabulary test for grades four, five, and six. For this purpose the information and data collected were analyzed as follows:

1. A classification of all words essential for the child to read, express, and understand quantitative ideas as a part of specific instruction in arithmetic at the intermediate-grade level. Words were categorized as follows: (1) Base words; (2) Words used to represent number processes; (3) Words used to represent various kinds of measurement; and (4) Specialized technical words.

2. Raw frequency of all words in four arithmetic series by book and total frequency by grade level.

3. Token scanning of other major arithmetic series for additional words to be added to completed list.

4. Words taken from completed list for inclusion in test items when they appeared in at least two books at a single grade level.

5. Words regrouped for construction of balanced test forms.

6. Means, standard deviations, and reliabilities of each experimental test form at each grade level.

7. Difficulty per cent passing and internal validity indices of each test item for each test form.

8. Two final balanced forms of the arithmetic vocabulary test each consisting of seventy-five items, with estimated means, standard deviations, and reliabilities.

The total tabulation of arithmetic words as defined yielded 606 words.

Five new words were added, after a token scanning of the other major series, giving a completed word list of 611. These words were checked with the International Kindergarten Union and Gates Primary word lists showing that very few words of an arithmetic nature are found on these lists.

Reclassification of the original word list, dropping duplicated words and those not purely arithmetical in nature, gave a final word list of 307 selected for testing.

An examination of the total word list, Appendix A, indicates a wide variance in the frequency of usage for many words at different grade levels. Some words considered important and essential to an understanding of arithmetic are of low frequency indicating that frequency of usage within a book is insufficient as the sole criterion for determining the relative importance of a word. A number of words generally not accepted by present-day arithmetic experts are still found throughout the major series. Certain words are peculiar to certain authors.

One form of all words which were classified as essential to understanding of arithmetic were tested and they were categorized into groups described in Appendix B. These categories of words were then distributed as equally as possible between two experimental test forms. These forms appear in their initial state and final form in Appendix C.

Two initial forms of the test were administered to 182 children in grades four, five, and six with a nearly equal distribution of test forms at each grade level. After minor corrections and revisions the two final experimental forms of the test were administered to 972 children in grades four, five, and six, again using a nearly equal distribution of test forms at each grade level.

Figure 1 which follows shows the frequency and distribution of scores by form and by grade. Corrected tests were analyzed for measures of central

FREQUENCY POLYGON OF THE DISTRIBUTION OF SCORES
for Grades 4, 5, and 6, Forms A and B
of the Arithmetic Vocabulary Test

Figure 1

scores of pupils
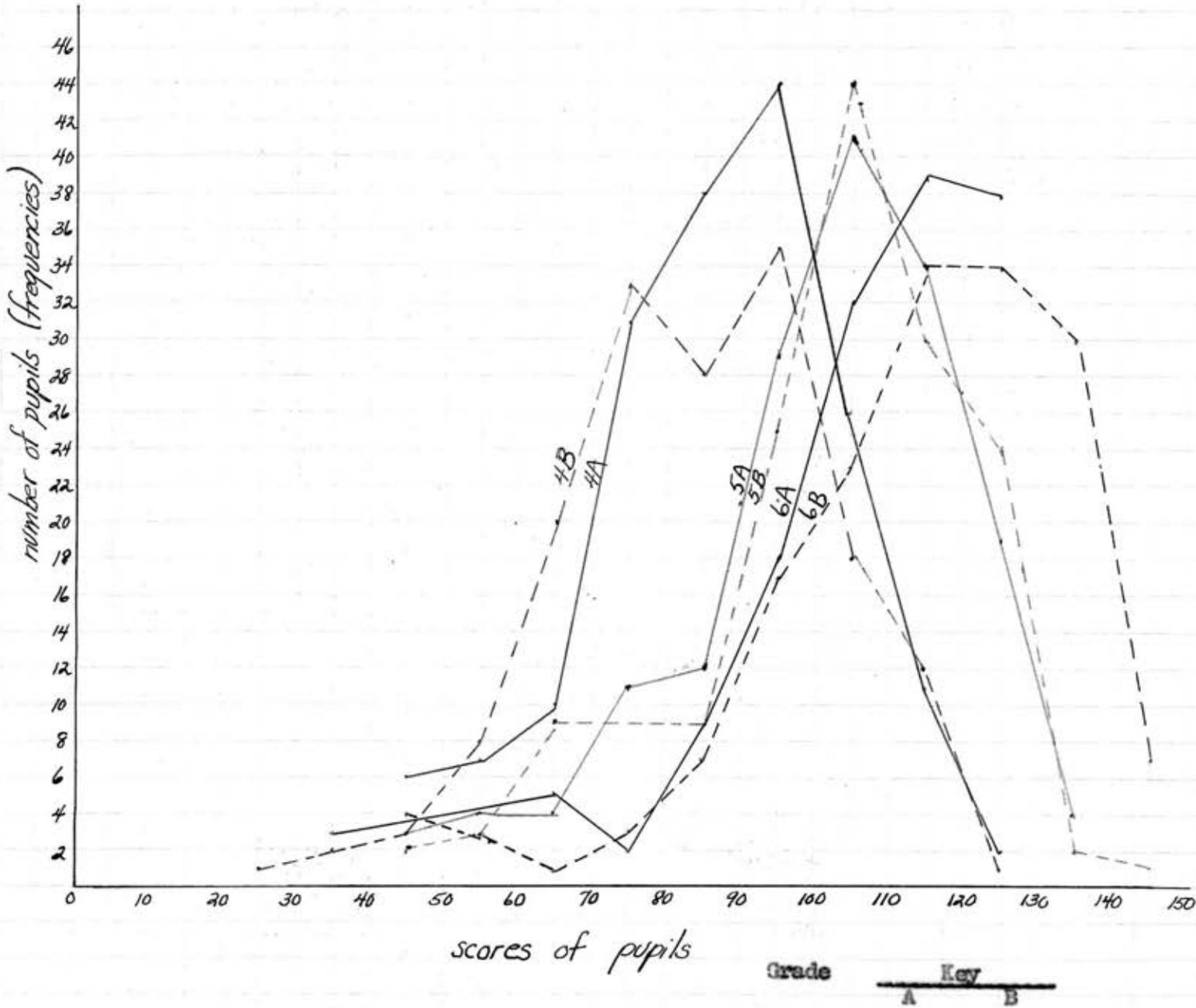
tendency and reliability. These data are reported in the following table.

TABLE IV

STATISTICAL ANALYSIS OF EXPERIMENTAL FORMS
OF AN ARITHMETIC VOCABULARY TEST FOR
GRADES IV, V, AND VI

| Test Form | Grade IV | | | Grade V | | | Grade VI | | |
	Mean	S.D.	Relia-bility	Mean	S.D.	Relia-bility	Mean	S.D.	Relia-bility
A	86.09	16.35	.91	102.11	16.73	.92	109.27	18.58	.94
B	84.15	17.99	.92	102.08	18.89	.95	114.11	19.37	.95

The means and standard deviations for all test forms appear to be approximately equal within each grade and consistent in increases between grades which indicates that the test forms were responded to by comparable groups and implies that the test forms were nearly equal in difficulty. Reliability indices indicate that the test forms measure with a high degree of consistency.

Words included in the test forms were analyzed to determine the per cent passing in the upper and lower groups as well as for the total group at each grade level. Raw scores on each test form were divided into upper and lower twenty-seven per cents.

From these data the per cent passing in the upper and lower groups were compared by entering Flanagan's [1] table to obtain the validity of each item. The percentage passing and validity index of each item were computed for each grade. These data are reported in Table V which follows:

[1] J. C. Flanagan, op. cit.

TABLE V

WORDS TESTED, DIFFICULTY PER CENT AND VALIDITY INDICES BY GRADE

Vocabulary Words Tested	Grade IV		Grade V		Grade VI	
	Difficulty Percent	Validity Index	Difficulty Percent	Validity Index	Difficulty Percent	Validity Index
FORM A						
* addition	89.60	.275	37.85	.610	83.54	.320
sum	83.82	.530	89.94	.225	94.51	.220
* difference	56.65	.445	86.16	.455	90.24	.415
minuend	33.53	.290	59.12	.390	55.49	.400
* column	76.30	.325	89.94	.610	89.63	.580
* plus	79.77	.540	84.91	.495	92.68	.400
terms	24.86	.115	25.79	.230	26.22	.065
multiplication sign	87.28	.280	92.45	.120	95.12	.460
* number	61.27	.320	69.18	.590	65.25	.250
* minus sign	72.83	.575	85.53	.655	85.98	.580
* multiplier	83.39	.370	25.79	.560	89.02	.355
* divisor	89.02	.445	90.57	.470	90.24	.490
* partial product	52.60	.430	62.89	.605	71.34	.505
* quotient	63.01	.480	70.44	.490	76.22	.590
* partial dividend	49.13	.350	61.01	.535	59.76	.530
Roman numeral	98.27	.300	99.37	.110	98.17	.265
* Arabic number	69.94	.270	78.62	.435	84.76	.620
cent	95.95	.445	94.97	.325	92.07	.460
equal	90.17	.470	97.48	.265	94.51	.460
divide	94.80	.280	98.74	.110	95.73	.460
* subtraction family	88.44	.360	89.31	.470	86.59	.505
* reverse	32.37	.335	42.77	.450	43.29	.240
* temperature	90.75	.470	91.82	.445	93.29	.225
doubles	38.15	.380	48.22	.310	45.12	.630
division table	85.55	.480	90.57	.355	89.63	.460
* minutes of	91.33	.610	95.60	.430	95.73	.415
* quarter past	89.60	.510	94.97	.500	96.34	.275
minutes after	89.02	.300	95.60	.340	92.68	.225
* quarter to	88.44	.560	91.82	.540	95.12	.415
half-past	75.72	.445	82.39	.240	77.44	.370
* quarter	71.10	.680	89.31	.570	92.07	.530
mixed number	14.45	.215	61.63	.410	75.00	.340
* improper fraction	41.08	.405	84.91	.475	87.80	.620
incomplete decimal	13.29	.000	30.19	.285	51.22	.280
twenty-fourth	76.30	.565	93.08	.225	94.51	.510
* third	71.68	.690	85.53	.545	89.02	.550
sixths	74.57	.605	84.91	.370	88.41	.270
* fifths	77.46	.580	89.94	.530	92.07	.560
* sevenths	78.03	.615	91.20	.560	93.29	.560
twelfths	83.39	.490	82.39	.265	90.24	.205
weight	77.46	.520	76.10	.250	84.76	.550
square measure	64.74	.710	82.39	.390	82.32	.300
* time	95.95	.415	93.34	.445	94.51	.400
* dry measure	52.04	.440	52.83	.530	7?.73	.550
* speed	75.72	.315	84.91	.530	84.1?	.345

Difficulty Per Cent Means -- Per Cent Passing

(*) Selected for inclusion in final form

Form A	Grade IV		Grade V		Grade VI	
* gallon	80.35	.255	85.53	.430	85.98	.460
* square inch	54.91	.490	72.33	.490	79.88	.530
* feet	55.49	.650	71.07	.515	82.32	.575
* peck	68.21	.540	83.65	.720	85.98	.630
* second	50.29	.460	66.67	.560	73.78	.680
year	89.60	.490	89.94	.310	94.51	.460
* century	89.60	.480	94.97	.460	95.12	.370
* pound	81.50	.440	91.82	.540	91.46	.460
cup	56.65	.380	62.89	.375	62.19	.420
* month	89.60	.590	90.57	.445	92.68	.460
cash account	30.64	.420	27.67	.340	66.46	.465
* deposit	56.65	.460	68.67	.620	74.39	.420
* interest	39.31	.410	47.17	.605	55.49	.500
* cost	66.47	.700	75.47	.720	81.10	.520
balance on hand	23.12	.420	31.45	.470	40.85	.470
* place	50.29	.240	63.52	.385	75.61	.510
thousand	32.95	.190	50.31	.385	49.39	.530
* unit's place	28.32	.420	43.40	.430	61.59	.690
place value	21.39	.340	39.62	.395	48.78	.610
decimal place	30.15	-.290	54.09	.420	72.56	.335
round number	19.65	.040	22.01	-.105	45.12	.235
square	90.75	.245	91.82	.310	93.29	.490
triangle	97.69	.415	98.11	.265	95.73	.275
* square foot	78.61	.355	72.96	.470	79.88	.070
unit	72.83	.205	78.62	.070	84.15	.130
area	21.39	.000	31.45	.165	33.54	.020
* altitude	42.20	.180	51.57	.595	56.71	.580
* perimeter	09.83	-.080	33.96	.520	30.49	.420
diagram	72.83	.235	76.10	.190	67.68	.150
short division	84.39	.440	86.16	.240	84.15	.250
uneven division	63.58	.265	76.10	-.045	71.95	.290
decimal point	56.65	.220	75.47	-.115	83.54	.130
trial divisor	23.12	.360	32.08	.310	28.66	.300
bring down	75.14	.400	89.31	.270	81.71	.485
caret	18.50	.175	25.16	.225	51.83	.370
* half-dollar	80.92	.400	84.91	.490	89.02	.635
* cent's place	77.46	.555	86.79	.490	74.39	.490
* dime's place	78.61	.635	84.81	.160	74.39	.510
* dimes	82.66	.660	90.57	.470	93.29	.490
cent	72.83	.525	78.62	.420	88.41	.490
bar graph	53.18	.100	64.78	.245	78.66	.320
* picture graph	70.30	.470	90.57	.510	95.73	.415
* graph	49.13	.460	59.75	.470	75.61	.290
hour hand	66.47	.140	67.30	.310	73.17	.425
hour	50.87	.310	53.46	.370	57.93	.300
* distance	49.71	.480	61.01	.545	65.24	.360
* scale	31.21	.480	57.86	.695	67.07	.725
width	31.21	.140	37.74	.265	43.90	.350
acre	30.64	-.040	32.70	.235	37.80	.290
rod	16.76	-.195	28.93	.095	45.73	.245
first	83.39	.220	89.94	.400	90.24	.560
eighth	85.55	.260	93.08	.370	92.07	.200
ninth	79.77	.110	88.05	-.105	86.59	.135
third	86.13	.065	94.97	.155	96.34	.460
sixth	90.75	.045	94.97	.370	94.51	.320

Form A	Grade IV		Grade V		Grade VI	
* facts	70.10	.280	90.57	.490	86.59	.620
* numerals	21.97	.135	31.45	.460	50.61	.400
total amount	94.80	.415	98.11	.325	95.12	.510
period	42.77	.430	69.18	.240	62.80	.440
* tally	23.70	.360	21.38	.620	46.34	.440
* odd number	67.05	.595	85.53	.510	85.37	.650
borrow	49.71	.460	52.20	.330	65.24	.350
* subtract	86.71	.440	89.94	.470	89.02	.560
multiplication	81.50	.630	95.60	.375	89.02	.600
* twice	18.50	.480	28.30	.445	28.66	.260
estimate	39.88	.430	59.12	.375	59.15	.430
* money system	85.55	.480	89.94	.470	94.51	.400
* average	58.96	.490	69.81	.520	73.78	.370
cube	73.41	.295	84.28	.135	84.15	.325
* exactly	36.99	.340	66.67	.665	73.17	.400
* evenly	72.83	.450	91.19	.565	90.24	.530
hundred million	75.72	.400	88.68	.335	90.85	.600
horizontal	34.10	.160	49.06	.310	66.46	.430
right angle	23.12	.095	32.70	.265	52.44	.370
day	91.33	.390	97.48	.155	94.51	.460
eleventh	77.46	.400	85.53	.190	84.76	.690
divisible	75.72	.720	95.60	.340	94.51	.275
million	25.43	.205	50.31	.360	57.32	.430
zero	90.17	.210	96.23	.000	93.29	.460
* ten million	34.68	.320	50.94	.540	54.88	.570
volume	40.46	.200	40.25	.030	60.98	.510
* freezing point	60.69	.545	58.49	.475	76.83	.400
equal parts	85.55	.490	96.23	.275	95.12	.460
gross	11.56	.000	26.42	.075	41.46	.350
furlong	05.78	-.085	16.35	.390	18.90	.030
* estimation	38.73	.405	60.38	.435	65.85	.550
net weight	12.72	.085	14.47	-.105	22.56	.100
* halves	87.28	.610	94.97	.460	94.51	.460
equivalent	33.53	.330	52.83	.420	63.41	.575
nautical mile	16.76	.040	26.42	.300	29.27	.340
rate	49.71	.220	54.09	.380	53.66	.310
ton	28.90	.335	42.77	.410	46.95	.565
* yard	43.35	.390	50.94	.460	59.76	.530
numerator	50.29	.150	77.99	.280	81.71	.625
reduce	31.79	.395	92.45	.275	88.41	.550
decimal	09.25	-.130	16.98	.000	21.95	.240
cancellation	10.98	-.490	11.95	.265	37.80	.530
simplest form	30.06	.330	61.01	.370	76.83	.705
hundredth	45.09	.580	82.39	.290	78.66	.450
hundred thousandths	09.83	.130	21.38	.120	42.68	.440
higher terms	09.25	.210	35.22	.180	45.73	.520
unequal fraction	20.23	.095	51.57	.360	65.24	.615
* smallest common denominator	05.78	.120	45.28	.550	53.66	.570
* term (fraction)	13.29	-.060	50.94	.485	56.10	.310
* decimal form	45.66	.420	71.36	.460	88.41	.400

TABLE V

WORDS TESTED, DIFFICULTY PER CENT AND VALIDITY INDICES BY GRADE

Vocabulary Words Tested	Grade IV		Grade V		Grade VI	
	Difficulty Percent	Validity Index	Difficulty Percent	Validity Index	Difficulty Percent	Validity Index
FORM B						
* subtraction	72.21	.190	82.47	.570	83.75	.470
* subtrahend	58.02	.380	65.58	.590	67.50	.530
* addend	65.41	.580	84.42	.540	86.25	.570
total	82.71	.685	87.01	.640	87.50	.620
* remainder	72.22	.480	84.42	.670	86.88	.665
* minus	59.87	.520	75.32	.450	79.38	.630
* division sign	85.18	.590	90.26	.470	93.13	.265
factor	25.42	.420	38.31	.300	46.25	.310
digit	39.50	.260	26.62	.210	47.50	.575
* plus sign	75.30	.595	87.01	.570	87.50	.620
* multiplicand	35.80	.425	42.86	.490	58.13	.490
* dividend	66.67	.475	78.57	.500	86.25	.610
* product	57.85	.540	67.53	.550	65.63	.340
* remainder	82.09	.615	85.71	.400	87.50	.370
* partial product	51.23	.530	65.58	.640	71.88	.635
* Roman number	93.20	.400	90.91	.520	98.75	.265
* Arabic numeral	55.55	.310	71.43	.755	90.00	.560
* dollar	95.06	.355	91.16	.520	98.75	.110
* equal	75.92	.530	89.61	.590	93.13	.370
* multiply	83.95	.580	90.91	.570	96.88	.375
* subtraction family	78.40	.250	79.87	.590	90.63	.275
* magic square	77.16	.540	85.06	.590	91.25	.540
timetable	61.11	.260	81.82	.425	85.63	.600
* double	38.89	.315	47.40	.480	52.50	.380
* division table	83.33	.290	83.12	.555	89.38	.470
* minutes to	88.27	.355	81.82	.520	95.00	.375
minutes past	86.42	.340	84.82	.360	93.75	.430
o'clock	75.31	.155	82.47	.180	86.88	.105
* quarter of	84.57	.560	91.56	.500	94.38	.375
* quarter after	80.86	.615	90.86	.540	93.13	.430
* mixed decimal	35.19	.220	68.83	.520	76.88	.675
* proper fraction	40.06	.470	77.92	.620	80.63	.630
* decimal fraction	20.99	.320	53.60	.525	74.38	.495
* whole number	69.14	.585	83.12	.650	93.75	.340
* twentieth	74.07	.500	85.71	.680	90.00	.540
half	94.44	.370	96.75	.340	100.00	.000
* fourth	92.60	.530	88.31	.570	97.50	.780
* eighth	72.22	.600	79.87	.460	91.88	.400
* ninth	63.58	.530	79.87	.445	86.88	.460
sixteenth	77.77	.635	90.26	.390	96.88	.325
temperature	91.98	.170	96.10	.300	98.12	.155
liquid measure	82.72	.470	80.52	.330	94.38	.520
* dozen	86.42	.560	96.10	.430	93.13	.325
linear measure	49.38	.215	41.56	.220	62.50	.180
* hundredweight	82.72	.410	88.31	.540	93.13	.430

Difficulty Per Cent Means -- Per Cent Passing

(*) Selected for inclusion in final form

Form B	Grade IV		Grade V		Grade VI	
* square feet	48.77	.430	71.43	.660	85.00	.655
* inch	58.02	.410	76.62	.690	92.50	.540
* bushel	69.14	.620	83.77	.680	91.25	.540
pint	41.36	.595	41.56	.390	59.38	.290
minute	42.59	.215	32.47	-.030	44.38	.030
* leap year	62.35	.585	79.87	.500	91.88	.460
* decade	28.40	.390	44.81	.630	59.38	.600
* quart	80.86	.720	85.71	.445	91.25	.540
* week	88.27	.630	93.51	.520	97.50	.265
* ounce	75.93	.500	91.56	.470	91.88	.625
* budget	11.73	.460	24.68	.480	37.50	.560
* value	62.35	.625	77.92	.730	85.00	.690
* interest	24.69	.500	40.26	.635	85.75	.630
* deposit slip	30.86	.465	43.51	.430	55.63	.550
* tax	52.47	.565	73.38	.570	81.88	.620
ten	31.48	.290	37.66	.400	33.75	.525
* hundred	53.70	.260	64.29	.705	72.50	.600
* one	53.70	.320	62.98	.685	78.13	.720
* ten thousand	43.21	.300	52.60	.515	70.63	.510
* whole number	13.58	.205	38.31	.525	53.13	.560
rounded	19.14	.070	28.57	.230	52.50	.560
circle	93.83	.415	96.75	.155	98.75	.265
* rectangle	64.81	.465	70.78	.480	79.38	.630
unit of measure	70.99	.400	80.52	.420	86.88	.600
square mile	94.44	.370	96.75	.400	95.63	.340
section	14.81	-.320	34.82	-.150	96.88	.290
height	46.30	.330	49.35	.300	75.63	.565
diameter	22.84	.290	35.06	.390	41.88	.685
figure (diagram)	20.99	.105	15.58	.180	16.25	.030
long division	87.04	.260	94.81	.000	97.50	.580
cent point	53.70	.350	70.13	.355	90.63	.510
trial quotient	29.01	.260	44.16	.400	51.25	.660
annex zeros	18.52	-.045	24.68	.065	37.50	.370
point off	17.90	-.200	27.92	.055	78.75	.530
even division	48.77	.260	55.19	.300	65.00	.290
* quarter (25¢)	82.10	.480	91.56	.470	91.25	.470
dollar	90.74	.500	95.45	.150	96.88	.375
* dollar's place	83.33	.355	91.56	.500	93.75	.560
nickel	62.35	.395	85.06	.085	91.25	.590
penny	82.10	.425	95.45	.300	95.00	.375
circle graph	56.79	.380	67.53	.340	85.63	.570
* pictograph	64.81	.295	79.87	.670	93.13	.400
linegraph	43.20	.115	62.34	.340	73.12	.480
minute hand	51.85	.350	62.34	.290	62.50	.470
miles-an-hour	53.09	.400	67.53	.405	72.50	.360
revolution	39.51	.400	56.49	.360	60.00	.520
* scale drawing	30.25	.340	53.25	.530	65.00	.695
length	37.04	.280	47.40	.290	60.63	.490
* square rod	17.90	.045	29.22	.460	56.25	.610
* dimension	48.15	.450	80.52	.635	88.13	.620
second (place)	80.86	.450	87.66	.335	92.50	.315
* fourth "	83.95	.450	89.61	.445	95.00	.490
tenth "	83.33	.375	92.21	.370	94.38	.370
fifth "	85.80	.340	87.66	.215	93.75	.445
seventh "	81.48	.380	87.66	.165	91.25	.490

Form B	Grade IV		Grade V		Grade VI	
* sign	82.09	.475	93.51	.445	96.88	.325
figures (numbers)	88.88	.295	90.91	.310	88.13	.610
amount	82.09	.280	86.36	.400	88.75	.390
* count	78.39	.250	91.56	.590	93.13	.265
counter	22.22	.160	31.17	.210	41.25	.150
* even number	84.57	.675	92.86	.570	95.00	.460
carry	55.56	.160	55.19	.030	48.13	.120
add	90.74	.530	98.05	.265	96.25	.460
* division	46.29	.330	59.74	.475	73.75	.755
times	69.75	.170	72.08	.070	85.00	.280
estimate	37.04	.185	51.95	.250	52.50	.640
* money	20.37	.435	39.61	.620	60.00	.570
group	75.31	.370	82.47	.330	79.38	.070
average	26.54	.420	36.36	.365	51.25	.620
billion	64.20	.275	82.47	.330	82.50	.680
* depth	79.01	.695	91.56	.590	91.88	.540
rectangular	66.05	.355	72.08	.380	84.38	.410
* foot	80.86	.580	85.06	.625	94.38	.460
* exact	41.98	.530	70.12	.590	80.63	.460
* change (money)	85.19	.320	90.91	.470	94.38	.430
* oven	75.31	.535	87.01	.625	91.88	.400
* vertical	30.86	.130	43.50	.450	73.12	.450
angle	22.22	.210	44.81	.160	63.75	.510
* surface	36.42	.220	49.35	.530	68.75	.320
* hundred thousand	22.22	.045	58.44	.470	57.50	.575
* weigh	67.28	.550	83.12	.660	88.75	.620
boiling point	30.25	.150	48.05	.445	73.12	.470
* degree	56.79	.360	65.58	.460	80.63	.200
* mile	30.86	.260	48.05	.445	68.75	.370
* fathom	46.30	.400	72.08	.615	80.00	.475
ream	17.28	.000	33.77	.120	35.63	.200
knot	37.65	.395	59.74	.430	73.75	.510
barrel	17.90	.320	23.37	-.035	28.13	.020
whole	68.52	.490	85.71	.425	88.75	.190
* placeholder	47.53	.605	69.48	.615	68.75	.410
invert	45.68	.290	35.06	-.120	11.25	.420
* lowest terms	40.74	.140	87.66	.510	91.25	.520
fractional part	60.49	.785	85.71	.360	85.00	.610
* common denominator	19.14	.135	62.99	.630	72.50	.565
like fraction	21.60	.210	60.39	.330	53.13	.510
denominator	37.65	.395	70.13	.400	83.13	.600
* common fraction	59.26	.440	83.11	.555	90.00	.400
* fifteenth	63.58	.585	89.61	.570	91.88	.460
* thousandth	58.41	.505	88.96	.470	90.91	.200
round off	16.05	.000	29.87	.040	50.00	.550
* unlike fraction	32.72	.400	70.78	.540	65.63	.580
ratio	11.73	.000	20.12	.000	28.13	.290
cancel	13.58	.130	12.33	.120	31.25	.130
millionth	07.41	.225	13.64	.100	53.13	.610
percent	07.41	-.275	01.30	.325	20.00	.260

An examination of Table V shows that there was a general tendency for the difficulty per cent to increase from grade to grade. Occasional deviations from this pattern appear and may be the result of chance or inadequate textbook presentation or classroom instruction.

Two balanced forms were constructed by selecting items based on validity indices in descending order of value, as obtained on the experimental test forms at the fifth grade level. A total of 150 items were selected. These items ranged from .755 to .430 in validity indices and are starred (*) in Table V.

The following table shows the item composition, including validity indices and percentages passing, of these balanced forms.

TABLE VI

COMPOSITION OF TWO BALANCED FORM OF AN ARITHMETIC
VOCABULARY TEST ESTIMATED FROM GRADE FIVE DATA

FINAL FORM I				FINAL FORM II		

ITEMS SELECTED FROM EXPERIMENTAL FORM A

Item		Validity	Total Per cent Passing	Item		Validity	Total Per cent Passing
49	peck	.720	83.65	59	cost	.720	75.47
115	exactly	.665	66.67	92	scale	.695	57.86
105	tallying	.620	21.38	10	minus sign	.665	85.53
5	column	.610	89.94	57	deposit	.620	66.67
58	interest	.605	47.17	1	addition	.610	37.85
9	number	.590	69.18	13	partial product	.605	62.89
31	quarter (f)	.570	89.31	72	altitude	.595	51.57
116	evenly	.565	91.19	11	multiplier	.560	25.79
39	seventh (f)	.560	91.20	50	second (time)	.560	66.67
148	smallest common denominator	.550	45.28	91	distance	.545	61.01
				53	pound	.540	91.82
				15	partial dividend	.535	61.01
39	third (f)	.545	85.53				
29	quarter to	.540	91.82	38	fifth (f)	.530	89.94
125	ten million	.540	50.94	45	speed	.530	84.91
44	dry measure	.530	52.83	73	perimeter	.520	33.96

TABLE VII (Continued)

FINAL FORM I				FINAL FORM II			

ITEMS SELECTED FROM EXPERIMENTAL FORM A

Item		Validity	Total Per cent Passing	Item		Validity	Total Per cent Passing
113	average (v)	.520	69.81	106	odd number	.510	85.53
48	feet	.515	71.07	27	quarter past	.500	94.97
87	picture graph	.510	90.57	14	quotient	.490	70.44
6	plus	.495	84.91	81	half dollar	.490	84.91
47	square inch	.490	72.33	101	fact	.490	90.57
82	cent's place	.490	86.79	149	term	.485	50.94
127	freezing point	.475	58.49	33	improper fraction	.475	84.91
12	divisor	.470	90.57	21	subtraction family	.470	72.96
60	cost	.470	31.45	69	square foot	.470	72.96
84	dime	.470	90.57	88	graph	.470	59.75
108	subtract	.470	89.94	112	money system	.470	89.94
52	century	.460	94.97	102	numeral	.460	31.45
133	halves	.460	94.97	138	yard	.460	50.94
150	decimal form	.460	71.36	22	reverse	.450	42.77
3	difference	.455	86.16	43	time	.445	93.34
23	temperature	.445	91.82	110	twice	.445	28.30
55	month	.445	93.08	17	Arabic number	.435	78.62
131	estimation	.435	60.38	26	minutes of	.430	95.60
46	gallon	.430	85.53	63	units (place)	.430	43.40

ITEMS SELECTED FROM EXPERIMENTAL FORM B

Item		Validity	Total Per cent Passing	Item		Validity	Total Per cent Passing
57	value	.730	77.92	17	Arabic numeral	.755	71.43
63	one	.685	62.98	62	hundred's place	.705	64.29
47	inch	.690	76.62	35	twentieth	.680	85.71
48	bushel	.680	83.77	87	pictograph	.670	79.87
5	remainder	.670	84.42	46	square feet	.660	71.43
14	difference	.640	85.71	126	weigh	.660	83.12
58	interest	.635	40.26	34	whole number	.650	83.12
15	partial product	.640	65.58	52	decade	.630	44.81
95	dimensions	.635	80.52	118	foot	.625	85.06
139	common denominator	.630	62.99	32	proper fraction	.620	77.92
121	even	.625	87.01	130	fathom	.615	72.08
2	subtrahend	.590	65.58	112	money	.620	39.61
21	subtraction family	.590	79.87	135	place holder	.615	69.48
19	equal	.590	89.61	104	count	.590	91.56
22	magic square	.590	85.06	119	exact	.590	70.12
				116	depth	.590	91.56
				20	multiply	.570	90.91

TABLE VI (Continued)

FINAL FORM I	FINAL FORM II

ITEMS SELECTED FROM EXPERIMENTAL FORM B

Item		Validity	Total Per cent Passing	Item		Validity	Total Per cent Passing
1	subtraction	.570	82.47	60	tax	.570	73.38
10	plus sign	.570	87.01	143	fifteenth (f)	.570	89.61
37	fourth (f)	.570	88.31	142	common fraction	.555	83.11
106	even number	.570	92.86	13	product	.550	67.53
25	division table	.555	83.12	3	addend	.540	84.42
30	quarter after	.540	90.86	45	hundred-weight	.540	88.31
146	unlike fraction	.540	70.78	92	scale drawing	.530	53.25
124	surface	.530	49.35	16	Roman number	.520	90.91
65	whole number	.525	38.31	26	minutes to	.520	81.82
33	twentieth (f)	.525	52.20	54	week	.520	93.51
18	dollars	.520	91.16	64	ten thousand	.515	52.60
31	mixed decimal	.520	68.83	29	quarter of	.500	91.56
137	lowest terms	.510	87.66	83	dollar's place	.500	91.56
12	dividend	.500	78.57	56	budget	.480	24.68
51	leap year	.500	79.87	109	division	.475	59.74
11	multiplicand	.490	42.86	55	ounce	.470	91.56
24	doubles	.480	47.40	120	change (money)	.470	90.91
68	rectangle	.480	70.78	144	thousandth (f)	.470	88.96
7	division sign	.470	90.26	38	eighth (f)	.460	79.87
81	quarter (money)	.470	91.56	128	degree	.460	65.58
125	hundred thousand	.470	58.44	122	vertical	.450	43.50
94	square rod	.460	29.22	53	quart	.445	85.71
6	minus	.450	75.32	101	sign	.445	93.51
39	ninth (f)	.445	79.87	59	deposit slip	.430	43.51
97	fourth (f)	.445	89.61				
129	mile	.445	48.05				
43	dozen	.430	96.10				

(f) means fraction (v) means verb

In order to analyze and evaluate the balanced test forms, the writer found estimated means by summing up the difficulty percentages in the upper and lower 27 per cents for each item retained and dividing these totals by one hundred. The estimated means were plotted on an Otis Normal Percentile Chart on which a step interval scale of five had been set up. By connecting these plotted means and extending the line, it was possible to determine the standard deviation for each of the balanced test forms, by dividing the difference between the two points by two. The standard deviation thus obtained was substituted in the Kuder-Richardson formula #20, [1] to determine the estimated reliability of the balanced test forms. These data are reported in the following table.

TABLE VII

ESTIMATED RESULTS OBTAINED FROM EVALUATION OF
TWO BALANCED FORMS OF AN ARITHMETIC VOCABULARY
TEST FOR GRADES IV, V, AND VI

Test Form	Mean	S.D.	Reliability
I	53.75	11.00	.91
II	54.33	11.15	.91

It can be seen from the table above that the theoretical means and standard deviations are approximately the same. This would indicate that the two forms are nearly equal in difficulty. Since the reliabilities are

1/F. G. Cornell, op. cit., p. 285.

the same for both forms, the writer would expect the tests to measure with a high degree of consistency.

From examination of the Otis Normal Percentile Chart in Appendix D, it is possible to read the theoretical distribution of scores, including mean, sigma, and percentile ranks for the new test forms. Theoretical distributions can be obtained with available data for grades four and six by the same method as that used for grade five.

CHAPTER VI
SUMMARY AND CONCLUSIONS

1. Summary

The purpose of this study was to construct, administer, and revise an arithmetic vocabulary test for grades four, five, and six. To accomplish this, two test forms, each consisting of one hundred and fifty items, were constructed to measure children's understanding of arithmetic word meanings. These meanings were tested in functional settings wherever possible. Nine hundred and seventy-two tests were administered to a random sampling of children in the fourth, fifth, and sixth grades in six representative communities.

All test items were analyzed for the purpose of constructing two final balanced test forms which classroom teachers could use in diagnosis and remedial instruction concerning the arithmetic vocabulary needs of children.

Difficulty per cents and internal validity indices for each test item and total test form reliability for experimental and final test forms were computed and reported.

2. Findings

Status of vocabulary tested.— The following results prove that generally speaking the understanding of arithmetic vocabulary increases with each grade at the intermediate grade level. Deviations from this may be due to the fact that certain words introduced in the fourth and fifth grades are not retaught at the sixth grade level.

1. Of the 300 different word meanings tested in this study, only 26 such words were mastered by 90 per cent or more of the population sampled

at the fourth grade level, 61 at the fifth grade level and 98 at the sixth grade level.

2. Test words mastered by 80 - 89 per cent of the population sampled numbered 56 at the fourth grade level, 69 at the fifth grade level, and 64 at the sixth grade level.

3. Words mastered by 75 - 79 per cent of the population tested numbered 28 at the fourth grade level, 19 at the fifth grade level, and 17 at the sixth grade level.

Analysis of arithmetic vocabulary.— From a careful analysis of the vocabulary list developed in this study the following observations were noted:

1. There is a wide variance in the frequency and use of arithmetic words in textbooks within a grade, and from series to series. Such words as addend, subtrahend, and multiplicand which one would expect to be a part of an intermediate grade child's arithmetic vocabulary are never used in some of the major series.

2. There is a wide diversity of use of certain terms connected with measurement. For example, words such as depth, breadth, and girth occur in few series and words such as furlong, fathom, hundredweight, kilometer, and micron are still introduced in other series.

3. Many words and terms are unique to specific series and authors. Examples of these are "decimal mixed numbers," "basic subtraction fact," "Golden Rule of Fractions," and "what-part-of-number."

4. Such words as term and factor which are necessary for an understanding of algebra are never introduced in the intermediate grades in most series.

5. The significance of words essential for expressing and understanding quantitative ideas cannot be determined by frequency of use alone.

3. Educational Implications

1. There is no agreement among the authors of intermediate arithmetic textbooks concerning the important technical terms in arithmetic.

2. The statistical analysis of the data obtained in this study indicates that the functional-type vocabulary test can be used to determine the status of the arithmetic vocabulary of children for instructional purposes.

3. Most classroom teachers need specific instruction in the administration of tests such as that developed in this study.

4. Specific instruction, either direct or indirect, in arithmetic vocabulary is essential for success in intermediate grade arithmetic.

5. Reading experts could be called upon for help in developing a more consistent vocabulary in arithmetic textbooks.

4. Conclusions

1. There is a wide variance in the frequency of usage of many arithmetic words at the intermediate grade level.

2. The means and standard deviations for all test forms appear to be approximately equal within each grade and consistent in increases between grades which indicates that the test forms were responded to by comparable groups and implies that the test forms were nearly equal in difficulty.

3. There was a general tendency for the difficulty per cent to increase from grade to grade which suggests that the understanding of arithmetic vocabulary increases with each grade at the intermediate grade level.

4. Theoretical means and standard deviations for the balanced forms are approximately equal which indicates that the two forms are nearly equal in difficulty.

5. The estimated reliabilities are the same for each of the final

balanced forms which indicates that they would be expected to measure with a high degree of consistency.

6. Items selected for the two final balanced forms have a comparable range of validity indices from .720 to .430.

CHAPTER VII

SUGGESTIONS FOR FURTHER RESEARCH

After carefully analyzing the data from this study the writer suggests the following as possible areas for further research and study:

1. The construction, administration, and evaluation of the balanced test forms suggested in this study.

2. The construction of other paired forms of an arithmetic vocabulary test from the data obtained in this investigation, using items with validity indices less than .430.

3. The construction of separate arithmetic vocabulary tests for grades four and six, utilizing the data included in this study.

4. A study to compare the words and expressions used in arithmetic instruction from grade to grade and from series to series.

5. Determine the reliabilities of final test forms I and II by comparing with reliabilities of arithmetic achievement tests and intelligence tests.

6. A comparison of arithmetic vocabulary word list developed in this study with existing spelling word lists to determine how many of these technical words are introduced through spelling instruction.

7. A comparison of items in the experimental forms developed in this test with items contained in standardized vocabulary tests.

8. A comparison with the results obtained on the final tests with those obtained in the usual type of arithmetic item in order to compare the value of the functional-type item.

9. An investigation in the area of science to compare the use and frequency of words obtained in this study with those in science textbooks.

10. Instructing controlled and experimental groups using the tests developed in this study as a basis for comparison of the effectiveness of instruction between groups at each of grades four, five, and six.

11. A study to investigate arithmetic words with multi-meanings.

12. An investigation to determine the arithmetic vocabulary as presented in junior high school mathematics texts.

13. A study to determine how many arithmetic words introduced in the intermediate grade level are re-taught at the junior high school level.

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APPENDIX A

TABLE 1.

WORD FREQUENCY COUNT FOR FOUR SERIES OF ARITHMETIC TEXTBOOKS

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
abacus	6	2	52		4	37	5	16	1			31
acre									41			
add	99	136	102	117	105	92	92	119	92	217	212	187
addend	9	22	17		9	13						
adding by endings						1						
addition	20	87	13	28	42	40	27	49	47	13	1	2
addition fact	11	2	2		4	6		1	2	6	3	2
addition family	5		2			2						
all together				20	8							
altitude											3	
altogether						13	1	1		50	10	15
annex zeros						10			7			1
anno Domini (A.D.)		2	6						1		7	1
annual							1	1	2			1
answer	145	139	142	257	257	256	71	137	250	246	155	143
approximate								9	4			1
approximately									7			4
Arabic notation			2									
Arabic number		4	2				5					
Arabic numeral					7				1		3	2
Arabic system											1	
area		12	23		31	83		72	44			57
arithmetic						2	5	15	1	7	6	2
average (n.)(a.)	27	80	57	36	88	93	26	86	120	21	64	62
average (v.)	2	7	5	1			1	7	5		14	28
balance		1						4				
balance on hand												7
bargraph		6	3		4	7		2			3	1
basic addition fact			1		1							
basic multiplication fact					1							
basic subtraction fact			1									
B. C.		2	5				3		1		3	
below zero											1	
best form		14			4							
better form		3										
billion			3			25			7		12	7
billion's place			1									
boiling point											3	2
borrow	23	29	25	1	1	6				20	15	10
breadth									2			
bring down	2	8	3	1	4	1	5	8	1	46	16	10
budget						5			16			
bushel	19	33	31		28	22	14	22	64	23	80	62
calorie								18	8			
cancel			7			4			4			19
cancellation			9			4			1			4
caret						5			1			
carry	28	26	16	2	2	3	34	19	21	48	18	17

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
cash account												6
cash on hand												8
cent	13	24	18	247	159	68	255	289	192	40	198	134
centigrade								10				
centimeter									1			
cent point	4			7	21	3						
cent sign										2		
cent's column				4								
cent's place								1				
cent's worth				2	2							
century		14	13			4					19	6
change (n.)		1		44	25	4	34	18	8	9	27	8
chart		14		2	26		32	24	19		1	2
circle	20	42	10	41	44	34	39	146	57	47	14	52
circle graph						4			5			
circumference									8			
column	60	41	13	26	17	24	20		3	15	25	24
common denominator		19	40		10	18		2	4		6	17
common denominator method			11			5						
common fraction		10	36		6	30		12	25		12	12
common fractional part						1						
cord									1			
count	43	23	13	63	65	34	54	20	28	43	14	3
counter				9	4							
counting number			3									
cross out					1							
cube						3		2				
cubic feet						21						
cubic foot						8						
cubic inch						38						
cubic yard						15						
cup	20	17	20	8	23	83	3	12	39	19	29	28
cupful		1		2								
curved line graph								1				
daily						2	1	3	3		2	2
day	60	87	80	98	70	56	63	78	65	148	164	90
decade			3									
decimal		14	80	8		81		1	22		23	69
decimally						1						
decimal equivalent			8									1
decimal factor			2									
decimal form			1		1	3		2	10		1	3
decimal fraction		14	31		5	5		23	46		14	24
decimal mixed number											7	5
decimal number			3									
decimal number system			1									
decimal part			8									
decimal place		1	22			31			20			33
decimal point		19	40		10	67	13	16	49		26	63
decimal system						1		1	4			

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
degree	8	8	1	3	9		7	6	3	8	18	11
denominator	11	51	50		45	50		17	33		64	87
deposit (n.)						5						
deposit (v.)						2	9					
deposit book						1						
depositor						1						
deposit slip						4						
depth								2	2			5
diagram		15	10	3	56	22	1		4			12
diameter								1	8			
difference	7	25	6	23	33	21	9	18	33	16	27	33
digit					6	9		4	5			
digit number					2	10						
dime	7	12	1	89	18	9	16	29	11	26	17	2
dimension		8	7		11	36		9	8		1	16
dime's column				5								
dime's place		1						1				
distance around			1		1	2						
divide	190	233	179	238	97	229	177	80	191	292	283	307
dividend	25	23	58		24	31			1		32	52
dividing by_ helping number				6								
divisible			10						54			1
division	22	54	84	91	176	166	32	40	1	15	15	24
division fact	68	15	5	9	9	5	25	4		12	4	2
division sign				1						1		1
division table	5	8	3	4		1						
divisor	37	34	72		30	35		5	15	24	29	51
dollar	14	35	7	102	132	68	55	23	38	56	78	43
dollar's column				2								
dollar sign	2	7	3	7	19	2	5	1		16	17	9
dollar's place		1						1				
dollar's worth				2	2	1		1			1	
dot map								1	5			
double (n.)	9	2	6			2		2	6			2
double (v.)		2		1	4	3		2				
down payment								5				
double time								1				
dozen	16	34		91	97	64	29	96	40	14	54	58
dry measure	7				2	1		1		3		
dry quart											1	2
eighth (f.)	25	23	6	1	67	5	12	25	14	29	49	27
eighth (p.)						3	1				1	2
eighteenth (p.)											1	
eleventh (p.)							1				1	
equal	93	127	123	69	106	86	70	55	41	112	115	87
equally	7	36	12	46	54	19	19	10	3	1	17	1
equal part		36		35	36	37	18	15	13	25	35	31
equal sign				1						2		
equal-sized							3					

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
equivalent			14									1
estimate (n.)	32	29							10		7	4
estimate (v.)	9	83	47	109	108	108	7	3	24		12	26
estimated quotient									5			
estimation						1			18			
even			6			1			1		2	19
even division							3	3				
evenly		1		1	1		12	6		30	5	
even number		4		4	7		6	5			4	
even up							3					
exact		25		5	9	6	1	14	8	3	3	6
exactly									2	15	6	1
example	238	445	301	208	249	283	162	132	228	375	334	263
fact	52	32	13	38	30	18	108	5	2	49	8	13
factor	11	38	106		1							
Fahrenheit									1			
fathom									1			
feet	53	146	137	148	320	254	73	184	148	56	115	238
fifteenth (f.)		1										1
fifteenth (p.)											1	
fifth (f.)	15	13	4		21	3	7	1	2		17	19
fifth (p.)	8	5			17	16	4			2	5	7
fifties					3						1	
figure (n.)	55	54	50	22	64	41	42	29	39	105	133	104
figure (v.)											2	
figure (diagram)				2	9	42					15	21
— figure number				5	24	10			1			1
— figure quotient					1						1	1
first	6	51	19	35	97	56	97	69	70	56	99	86
fluid ounce									2			
foot	19	22	27	23	47	41	35	24	19	16	15	31
fourteenth (p.)											1	
fourth (f.)	25	33	5	49	63	11	31	60	27	46	38	32
fourth (p.)	12	3	1	13	6	16	7			12	8	10
fraction	44	181	208	15	122	130	25	120	131	33	261	233
fractional equivalent			1									
fractional part		19	4		5	5	1	8	9		13	19
fractional part division			7									
fractional unit		66	61									
fraction bar			1									
fraction column		5										
fraction form		1										
freezing point											4	3
from (−)	18	35	1	73	34	32	5	9	12	60	54	73
furlong		2							1			
gallon	22	46	66	49	55	77	30	50	83	58	44	83
geometric figure				8								
girth									4			
glass				23	5							2

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
Golden Rule of Fractions		2										
gram			4									
graph (n.)			24		11	44		15	16		8	13
graph (v.)												1
gross					9				3			
gross weight									1			
group (n.)	5	101	56	14	42	36	150	35	22	79	55	29
group (v.)							10	4				
grouping							2					
gunge								1				
guide figure								1				
half	4	10	11	60	45	29	41	40	40	35	45	37
half-dollar	2	8		16	5	6	13	6	4	11	4	4
half-million												1
half-past	2	1		4				1	1		2	
halves	3	18	6	19	45	5	11	10	10	15	22	16
height		4	14	18	10	1	18	10	19		9	7
helping fact				3	7							
helping number						2						
higher terms		5	2									
hint system				11	24	1						
horizontal				6								
horizontal bar graph			6									
hour	18	111	90	78	314	239	33	162	178	28	111	173
hour hand				1						3	2	
hourly						1						
hour's column												1
how-many-times number		4	19									
hundred	111	102	60	42	17	14	123	54	23	104	79	63
hundred billion			1									
hundred million			2									
hundred million's place			1					2				
hundred's column	3			1			2				2	2
hundred's figure		4										
hundred's partial product		1	1									
hundred's place	6	1	3	1	3	2	24	11	6	24	25	8
hundredth		14	52		18	45		32	58		39	26
hundred thousand	3	1	3	8	5			2	1	3	3	1
hundred thousand's place	4	3							1	2	1	1
hundred thousandth			1									
hundredth's column			2									
hundredth's place			4	1		1		2	8		1	
hundredweight						3						
Imperial gallon			3									
improper fraction		22	32		25	24		7	13		31	35
in all		24		34	39	19	22	16	7	47	29	34
inch	50	105	21	202	360	416	131	284	314	111	214	327
income									4			
incomplete decimal									2			1

VOCABULARY WORD	SERIES I Grades 4	5	6	SERIES II Grades 4	5	6	SERIES III Grades 4	5	6	SERIES IV Grades 4	5	6
interest						1			16			
inversion			10									
invert			11			9						12
key fact			6	1	2	1						
kilometer			3									
kilowatt									3			
knot									1			3
leap-year		3	1	9	7	1				4	9	5
least common denominator												13
left-over	5		4	31	20	1	20	2		43	3	1
length	15	28	47	9	22	87	13	33	28	5	17	49
like decimal									1			
like fraction	8	18	3		3	4		8	7		11	6
linear measure	5											
linear unit			1									
line graph		3	4			6					4	3
liquid measure	5								1	2		
liquid quart		1									1	2
long division			3		3						1	
long hand				2								
lower terms	2	10	2		1			1			6	2
lowest terms	12	30	14		22	19		31	15		56	34
magic square				1			10	13	8			
mark off								1				
mean									3			
measure (n.)	2	27	39	2	9	45	32	19	11	9	16	19
measure (v.)	9	7	33	17	31	35	18	40	27	23	33	53
measurement		10	16	1		2		3	3		3	4
measuring cup			2	1						4		
measuring spoon			1							1		
measuring stick				7								
micron			1									
midnight				1			6			3		
mile	31	167	144	37	210	142	42	149	158	79	182	196
mileage											1	2
miles an hour		17	14	4	52	55	1	19	50	2	15	32
mill									1			
million		18	10		32	48	8	15	23	12	29	29
million's place			12				1			1		1
millionths												
minuend		14	17		11	7						
minus	12	28	2		2	7		1		5	4	2
minus sign				3						1	1	2
minute	36	49	72	150	107	159	48	103	130	27	56	86
minute hand				3				4		7	8	1
minute marks		1		1								
minutes after				6	1							
minutes before	3										1	

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
minute's column												1
minutes of				4	1						2	1
minutes past	4									4	4	1
minutes till											1	
minutes to												3
missing dividend		1										
missing divisor		2										
missing fact							5					
missing factor		2										
missing figure								1				
missing number		13		29	29	15	15	11	22	1	3	6
missing numerator					3	3		2	6		4	3
missing quotient		2										
missing term												1
mixed decimal		1	15			2		6	8			1
mixed fraction		1										
mixed number		37			39	61		11	14		35	48
money	12	29	62	58	61	83	45	37	25	72	66	52
money system			12					1				
month	27	37	27	19	33	46	6	18	26	45	50	37
monthly								1	6			
monthly payment								8	3			
multiplicand	15	15	34		5	11						
multiplication	4	14	26	50	35	32	42	35	40	7	5	4
multiplication circle	1											
multiplication fact	57	6	30	12	5	6	9	2	2	11	1	1
multiplication sign		1								1	1	
multiplication table	5	2		4	5	2						
multiplier	18	22	44		8	11		2	5		26	18
multiply	144	139	194	161	67	155	108	93	200	133	233	288
nautical mile									5			8
nautical miles per hour												1
near double		2										
nearest billion												1
nearest cent					9							1
nearest dollar		3			5				6			1
nearest foot												2
nearest half million												4
nearest hundred		5	1			1			10			7
nearest hundredth						3						1
nearest hundred thousand												8
nearest inch								3	6			2
nearest mile									6			
nearest million			3			3			1			5
nearest minute									3	1		
nearest one									1			
nearest pound						1			2		1	

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
nearest ten		1	1						6			
nearest ten dollars		3										
nearest ten million									3			2
nearest tenth			5			8			9			9
nearest ten thousand									1			1
nearest thousand		5	5			8			3			7
nearest thousandth			5						8			1
nearest whole number			13		5	1			1			2
net weight		3				1			2			
nickel	7	7		23	20	9	19	7	1	8	5	
nineteenth											1	
ninth (p.)	2						1					
ninth (f.)	5		1									
noon				3	2	1	10	1	2	4		1
normal		2						4	2		2	2
number (n.)	331	333	365	312	295	367	480	295	323	386	316	341
number (v.)			3	3	3		2	2	1			
number fact				4	1	1	15	1				
number family				11	2							
number letter			1									
number line		22	49									
number story	3											
number system						2	4		3			1
number truth				8	2							
numeral		2				1					4	2
numerator	12	28	33		32	21		11	23		54	48
o'clock	6		6	14					5	2	12	11
odd												
odd number			2	4	6	20	15	5	1		5	41
one	104	89	77	33	4		225	159		71	94	
one's column		1	2	1	1		3		96	2	7	5
one's figure	4	6			2		1					
one's place	17	12	12	8	12	2	58	44	28	55	72	14
ounce	25	27	115	44	74	112	9	30	98	16	39	75
ounce's column			2									
parallel line				2								
part	93	124	146	51	88	110	88	128	107	66	106	140
partial product	74	15	38		12	6		1	2		14	10
partial dividend		35	29								4	1
part unit			1									
payment								2	2			
peck	27	6	33		27	20	11	4	29	27	31	39
peck's column			1									
penny	3			42	14	6	18		9	3	36	7
per cent						41						
perimeter		11	4		32	17	8	24	24		12	28
period	5	3	2					2	3			
pictograph		7										
picture graph			6			3			1		2	6
pint	19	14	12	17	12	22	74	28	52	62	38	30

VOCABULARY WORD	SERIES I Grades 4	5	6	SERIES II Grades 4	5	6	SERIES III Grades 4	5	6	SERIES IV Grades 4	5	6
pint (dry)		2										
place	34	22	58	5	7	39	10	15	72	14	27	50
— place decimal						12		2	2			4
— place decimal fraction									3			
— place divisor			1						2		2	3
place holder	5						3	10	9		1	6
— place multiplier									1			
— place number	16	11	24	19	14	7	5	21	21	18	15	19
— place quotient			1					1				
place value		7	6				4	22	13		4	1
— place whole number								6	2			
plus	9	22	3	17	2	8			1		2	1
plus sign				1						3	1	2
point			2			1			2	26	31	7
point off		1	2			5		1	11			8
pound	67	203	235	278	316	296	71	133	331	71	230	252
pound's column			3									
problem	113	105	85	70	87	60	188	67	42	120	88	61
process	5	5	2					2	4		7	3
product	103	100	197		24	30	108	68	129	56	87	81
profit									1			
prime number				2								
proper fraction		13	9		12	30	3	7			13	8
quantity								2	2			
quart	69	37	77	90	79	57	50	62	98	80	64	85
quarter (f.)	2	1		22	32	4		68	22	8	3	25
quarter (25¢)	5	10		29	26	11	28	14	7	10	12	
quarter after				4				1				
quarter before	1			4								
quarter of				4							2	
quarter past	1			1				1				
quarter section												1
quarter to								1				
quarter's worth				1								
quart's column			1									
quotient	101	224	134		114	103	65	111	160	96	79	120
quotient figure	6	62	35		70	29	3	4	38		33	37
quart (dry)		2										
rate		24		19	56	91	2	28	42		14	16
ratio			30									
ream									3			
receipt									1			
rectangle	12	35	24	24	102	88	11	25	20	20	12	38
rectangular		1	1		1	7						
reduce	9	12	14		30	22		35	21		58	43
reduction (fraction)								3	2			
reduction (price)									3			
reference measure		5	7									

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
regroup							13	5	4			
related addition fact			13									
related division example		2										
related division fact			1									
related multiplication example		2										
related multiplication fact	2	1										
related number							5					
related number fact		2										
related subtraction fact			3									
relation		13										
remainder	45	72	64	39	56	12	92	66	32	126	87	71
reverse (n.)		1	1				28					
reverse fact							2					
revolution									2			2
right angle				4								
rod			8			25		1	3		10	33
Roman number	8		2	3		4		1				
Roman numeral		10	3	17	13	10	9	2	3	20	10	7
Roman notation			2									
Roman system			1				3		1			
round (v.)		18	60			2						48
round number			5					1	10			1
rounded number		7							1			
round off			1			20			30			
row	71	151	82	61	71	39	184	79	54	96	33	35
ruler	2	15	9	12	23	18	4	30	30	22	20	14
scale		11	19		48	26		23	11		7	5
scale drawing		3	5		5	4		7	8		1	7
sea mile						1						
second (p.)	14	31	15	13	51	23	11	10	5	17	26	31
second (time)	12	15	20	20	8	26	15	22	48		22	23
second hand		2										
section									4			4
semi-circle				1								
seventeenth (f.)												
seventh (p.)	1					3	2			1	1	2
seventh (f.)	6							1				
short division			12								8	5
sign	4	9	10	7	3	4	13	3	8	9	5	10
simpler fraction										1		
simplest form						7		15	9			3
sixteenth (p.)								2	1		1	
sixteenth (f.)		10	3		11						6	11
sixth (p.)	4	1			4	38	2			3	2	4
sixth (f.)	12	9	1	12	47	4	4	2	3	16	40	16
slide rule					12							
smallest common denominator		3	8		4	6			1			2

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
solution			3		15	21		1	2	16	27	18
solve	35	24	32	14	31	19	1	10	36		10	31
speed		33	44	1	9	8	31	96	63	22	18	38
square	9			6	50	118						22
square feet		29	9		65	52		7	19			
square foot		5	5		13	14		11	7			10
square inch		11	16		35	26		25	15			42
square measure								5				1
square mile			15			7			21			20
square rod						6			3			7
square unit		1	1			2						
square yard		27	12		35	38		17	12			15
standard						4		9			1	1
standard time								2	4			
standard weight								2	1			
subtract	115	125	103	69	101	69	51	113	65	129	161	168
subtraction	21	33	15	31	43	43	30	35	30	6	7	7
subtrahend	6	5	6		10	8						
subtraction fact	6	2	7	5	9	3		1	2	5	5	5
subtraction family	3	2	2									
subtracting pair			2									
sum	55	56	55	61	61	44	55	96	72	97	76	85
surface		3	2	2	2	2	1	2	7		1	8
table	86	26	39	26	22	28	5	12	22	4	2	5
tablespoon		3	7	2	2	3			10			10
take away				1								
taken away	1											
tax								5	6			8
teaspoon			7	2				1	10	7	4	5
teaspoonful						2						
teen number	1	3	3									
temperature	13	24	8	14	10	10	14	22	15	14	29	23
ten	173	191	120	147	19	22	277	191	64	86	120	42
ten billion			1									
ten million			2									
ten million's place			1									
ten's column	2		1	2		1	5			2	8	5
ten's figure	6	9	4	1	3		5					
ten's partial product		3	1									
ten's place	13	10	11	15	22	5	49	34	11	42	56	15
ten's product		1										
tenth (f.)	3		98		66	46	1	118	139		43	60
tenth (p.)		38				1					3	
ten thousand	3	2	2	1	4					2	1	1
ten thousand's place	3									2	1	2
ten thousandth			2									12
tenth's column			1									
tenth's figure			2									
tenth's place			6			4		8	9		4	2
term	2	21	15		1			9	17		14	18

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
third (f.)	5	20	11	16	52	34	7	3	7	17	37	26
third (p.)	9	11	7	7	17	11	15	8	3	10	19	20
thirteenth (f.)											1	
thirties											1	
thirtieth (f.)											1	
thirty-first (p.)											1	
thousand	58	43	22	33	50	23	46	22	9	50	38	28
thousand's column	1		1									
thousand's figure		1										
thousand's period	5		1									
thousand's place	6	2	3				5	4	3	8	6	4
thousandth			17			20			22			18
thousandth's place			4						3			
time		7	4	16	22	26	40	54	57	59	62	66
time-rate-distance-problem				1								
times		69	23	61	74	107	15	24	48	20	35	55
times sign		7										
time table				1								
time-telling problem				2								
tolerance									2			
ton	17	5	14	21	17	20	6	13	16		16	18
total (n. & a.)			31	6	12	28	41	61	63	12	14	27
total (v.)			1									
total amount		2							10	1	15	15
total cost			4	9	8	3	24	25	8		13	9
total number		43	4	3	2	5	27	12	6		9	16
trial divisor											10	9
trial quotient		2	3								1	
triangle				13			3	2		5	6	6
triangular												2
twelfth (p.)											1	
twelfth (f.)		6			20	5			8		15	14
twenties											1	
twentieth (f.)		1										2
twentieth (p.)											1	
twenty-fifth (p.)											1	
twenty-first (f.)											1	
twenty-fourth (f.)			1									3
twenty-second (p.)											1	
twice		10	4	9	7	19	2	2	2	7	1	3
unequal		1	1		2							
uneven						3						
uneven division		4	7				1	5	2			
unit	8	19	31	1	7	12		10	6		7	7
United States gallon			2									
unit of measure	3	9	7			15		7	3		15	9
unit's figure				1								
unlike denominator									1			
unlike fraction		11	2		1	2		2	7		6	4
value (n.)	11	25	12	3	9	23	19	69	66		16	

VOCABULARY WORD	SERIES I Grades			SERIES II Grades			SERIES III Grades			SERIES IV Grades		
	4	5	6	4	5	6	4	5	6	4	5	6
value (v.)			1						5			40
vertical bar graph			4									1
volume						20						
watt									5			
week	61	57	39	103	75	69	53	37	54	55	67	58
weekday	1											
weekly						8	1	7	11		3	5
weigh		24		25	48	51	25	49	60	41	70	87
weight		16	20	11	8	31	13	31	47	6	40	33
what-part-of-number		1	19									
whole	20	110	26	32	89	28	27	69	71	51	78	41
whole number	3	32	102		20	53		24	47		40	72
whole quotient		4										
whole story	25		4									
width	5	10	12	1	8	29	3	15	11	1	10	21
word problem		4										
yard	48	132	89	139	357	226	49	58	125	58	87	105
yardstick	2		2		3		1	1		1	3	1
year	16	80	67	43	62	97	45	51	61	32	90	41
yearly									13		3	2
zero	9	28	6	22	51	30	50	21	40	57	56	55

APPENDIX B

TABLE 2

FINAL WORD LIST FOR TESTING

ADDITION
add
addend
addition
addition family
carry
column
magic square
plus
plus sign
sum
term
total

SUBTRACTION
borrow
difference
minuend
minus
minus sign
remainder
subtract
subtraction
subtraction family
subtrahend

DECIMAL FRACTIONS
decimal
decimal fraction
decimal place
decimal point
incomplete decimal
mixed decimal
per cent
round (v)
round number
rounded number
round off

MULTIPLICATION
factor
multiplicand
multiplication
multiplication sign
multiplication table
multiplier
multiply
partial product
product
times
twice

DIVISION
annex zeros
bring down
cancel
cancellation
caret
divide
dividend
divisible
division
division sign
division table
divisor
even division
long division
partial dividend
point off
quotient
remainder
short division
trial divisor
trial quotient
uneven division

WHOLE NUMBERS
Arabic number (al)
billion
digit
double (n)
eighth
eleventh
even number
fifth
figure
first
fourth
hundred
hundred thousand
hundred million
million
ninth
number
numeral
one
odd number
period
place holder
reverse
Roman number
Roman numeral
second
seventh
sixth
ten
ten million
ten thousand
tenth
third
thousand
units
whole
whole number
zero

COMMON FRACTIONS
proper fraction
quarter
ratio
reduce
seventh
simplest form
sixth
sixteenth
smallest common
  denominator
tenth
ten thousandth
term
third
thousandth
twelfth
twentieth
twenty-fourth
unlike fraction

U.S. MONEY
balance on hand
amount
budget
cash account
cent
cent point
cent's place
change
cost
deposit (n)
deposit (v)
deposit slip
dime
dime's place
dollar
dollar's place
dollar sign
half-dollar
interest
money
money system
nickel
penny
quarter
tax
total amount
value

COMMON FRACTIONS
common denominator
common fraction
denominator
eighth
fifth
fifteenth
fourth
fractional part
half
halves
higher terms
hundredth
hundred thousandth
improper fraction
invert
like-fraction
lowest terms
millionth
mixed number
ninth
numerator

NOT CLASSIFIED
answer
average (n)
average (v)
count
counter
equal
equal part
equivalent
estimate (n)
estimate (v)
estimation
even
evenly
exact
exactly
example
fact
group
number (v)
place
place value
sign
solve
solution
value (n)
value (v)
unequal

GRAPHIC REPRESENTATION
bargraph
circlegraph
graph (n)
line graph
pictograph
picture graph
scale
scale drawing
table

GEOMETRIC FIGURES
angle
circle
cube
diagram
figure (diagram)
horizontal
rectangle
rectangular
right angle
square
surface
triangle
vertical

MEASUREMENT
acre
altitude
area
barrel
boiling point
bushel
century
cup
day
decade
degree
depth
diameter
dimension
distance
dozen
dry measure
fathom
feet
foot
freezing point
furlong
gallon
gross

MEASUREMENT	MEASUREMENT
half-past	quarter after
height	quarter of
hour	quarter to
hour hand	quarter past
hundredweight	rate
inch	ream
knot	revolution
leap-year	rod
length	second (time)
linear measure	section
liquid measure	speed
measure (n)	square feet
measure (v)	square foot
measurement	square inch
mile	square measure
miles-an-hour	square mile
minute	square rod
minute hand	square yard
minutes after	tally
minutes of	temperature
minutes past	time
minutes to	timetable
month	time zone
nautical mile	ton
net weight	unit
o'clock	unit of measure
ounce	volume
peck	week
perimeter	weigh
pint	weight
pound	width
quart	yard
	year

APPENDIX C

Grades 4, 5, 6

Section I

Directions: This test is made up of three sections. In section I there are groups of five words or expressions with seven possible answers above them lettered a,b,c, d,e,f and g. There is only one answer for each word or a total of 5 answers for each group of five words. In each of the groups of five words there are two extra answers which do not belong to any of the words.

On your answer sheet you will find numbers that are the same as the numbered words or expressions on your test. To the right of each number are seven spaces marked a,b,c,d,e,f,g. These are your answer spaces. They are the same as the lettered answers in your test booklet. Fill in the space which is the same as the correct answer for the numbered word. Fill in the whole space which you choose with a heavy mark.

Do not guess. If you do not know the answer to a word, skip it and go on to the next word. Keep going and finish all 60 of the words in Section I.

This is not a speed test. Take as much time as you need.

If you wish to change an answer, do so, but be sure to erase the _first_ answer completely.

In Section I some of the answers are marked with arrows and some are just lettered as you will see in the sample test item below.

Do this sample test item with your teacher.

a.	b.	c.	d.	e.	f.	g.
2	3	4	10	5	↓	↓
					6	9

1. two		
2. three	**Answer Sheet**	a b c d e f g
3. four	1.	
4. five	2.	
5. ten	3.	
	4.	
	5.	

When you have finished with all 60 words in section I and have filled in all the answers which you know on this side of your answer sheet, Stop. Do not turn the page of the test booklet. You may go over Section I while you are waiting for your classmates to finish.

```
 53|4|  ← a
 60|5|  ← b
 14|3|  ← b
 1281  ← c
```

```
 56 ← d
 23 ← e
 33 ← f
      g
```

1. addition example

2. sum

3. difference

4. minuend

5. column

$$a \quad b$$
$$6 + 4 = 10$$
$$c$$

$$d$$
$$7 - 3 = 4$$

$$e$$
$$3 \times 2 = 6$$
$$f$$

$$g$$
$$16 \div 2 = 8$$

6. plus

7. terms

8. multiplication sign

9. number

10. minus sign


```
   27 ← a
 × 31 ← b
   27 ← c
  81  ← d
  837
```

```
        17 ← f
 31)543
     31  ← g
     233
     217
      16
```

11. multiplier

12. divisor

13. second partial product

14. quotient

15. first partial dividend

a. XII   b. ¢   c. 82   d. #   e. x   f. ÷   g. %

16. Roman numeral

17. Arabic number

18. means "cents"

19. means "per cent"

20. means "to divide"

a		b		c	d	e	f	g	
1×2=2×1		City	Temp	1+1=2	1×2=2	8+5=13	2÷2=1	name	12
3×2=2×3		Chicago	72°	2+2=4	2×2=4	18+5=23	4÷2=2	James	84
4×3=3×4		New York	76°	3+3=6	3×2=6	28+5=33	6÷2=3	Mary	67
5×3=3×5		Boston	70°	4+4=8	4×2=8	38+5=43	8÷2=4	Joan	75
6×3=3×6		St. Louis	81°	5+5=10	5×2=10	48+5=53	10÷2=5	Tom	80
		Los Angeles	86°					Anne	71

21. addition family

22. multiplication table

23. temperature table

24. table of reverses

25. table of weights
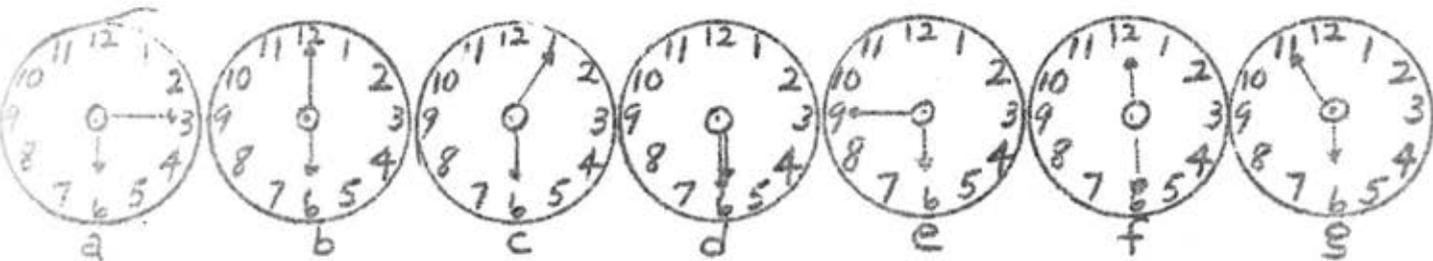
26. 5 minutes of 6

27. quarter past 6

28. 5 minutes after 6

29. quarter to 6

30. half-past 6

$$\frac{1}{24}$$
a

$$\frac{6}{5}$$
b

$.33\frac{1}{3}$
c

$3\frac{1}{2}$
d

$$\frac{1}{4}$$
e

$.2400$
f

6.25
g

31. one quarter

32. mixed number

33. improper fraction

34. incomplete decimal

35. one twenty-fourth
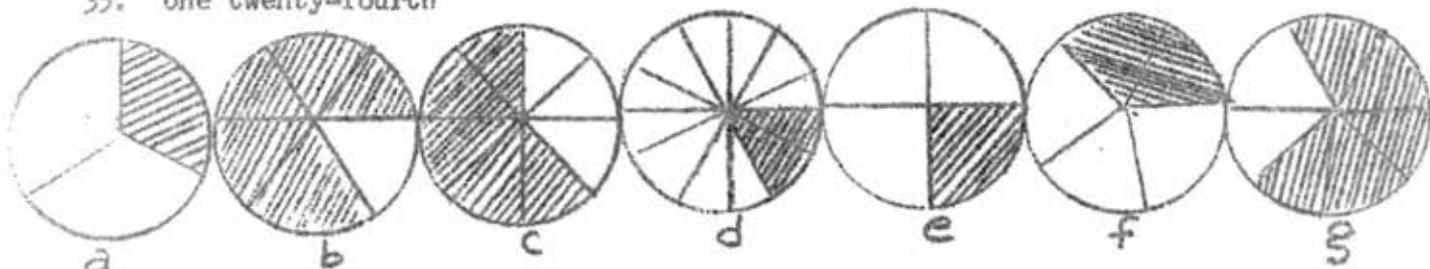
a   b   c   d   e   f   g

36. one third of the circle shaded

37. five sixths of the circle shaded

38. two fifths of the circle shaded

39. five sevenths of the circle shaded

40. two twelfths of the circle shaded
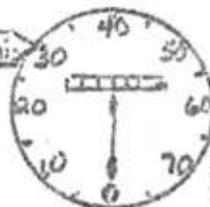
a   b   c   d   e   f   g

41. measure of time

42. dry measure

43. speed

44. measure of weight

45. square measure

a. ice cream for 12 persons
b. amount of coffee in lunch box
c. surface of a page in a book
d. time for an arithmetic lesson
e. the height of a flagpole
f. apples at a roadside stand
g. time for 100 yard dash

46. gallon

47. square inches

48. feet

49. peck

50. seconds

a. 100 years
b. 365 days
c. 16 ounces
d. 10 years
e. ¼ quart
f. 30 days
g. 1 pint

51. year

52. century

53. pound

54. cup

55. month

a. the price of an article
b. an estimate of what one expects to spend
c. the amount of money one has available
d. an overdrawn account
e. to put money into a bank
f. amount paid for the use of money by the person
   to whom the money is loaned
g. a record of money received and money spent

56. cash account

57. deposit

58. interest

59. cost

60. balance on hand

Section II

Directions: In this section of the test there are groups of questions about
drawings or numbers above them. There are only four possible answers for each
question lettered a, b, c, and d. There is only one correct answer for each
question which you will find under the drawings or numbers or in the choices
of answers under the questions.

You will fill in the space which is the same as the correct answer just
as you did in Section I. Turn your answer sheet over and find number 61. This
is where you will start after we do the sample test item.

Take your time. Do not guess. Check your work. You may go on to Section
III when you complete Section II. When you have finished you may check your work
in Section III and wait for your classmates to finish.

Do the sample test item with your teacher.

| 16.2 | | 04.3 | | 06.5 | | 11.2 |
| a. | | b. | | c. | | d. |

Gasoline Pump Meters

1. Which meter above has a 3 in the tenth's place?

2. How many numbers are there in each meter?

a. 3   b. 2   c. 1   d. 4

Answer Sheet   a b c d
1.
2.
3.
4.
5.

Form A - Section II

| 42601.6 | 01240.1 | 90646.5 | 80252.0 |
| a. | b. | c. | d. |

Automobile Speedometers

61. Which speedometer shows a 6 in the tenth's place?

62. Which speedometer shows a 2 in the thousand's place?

63. Which speedometer shows a 1 in the unit's place?

64. What is the place value of the 0 in speedometer a?

    a. no tens b. no ones c. no hundreds d. no tenths

65. How many decimal places are found in each speedometer?

    a. 4 b. 1 c. 5 d. 6

66. What would speedometer c above be to the nearest round number?

    a. 90600 b. 90646 c. 90647 d. 90640
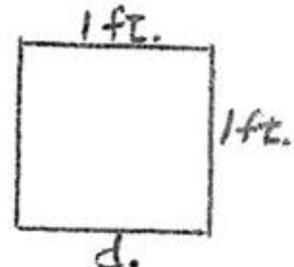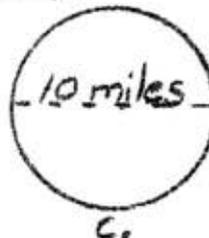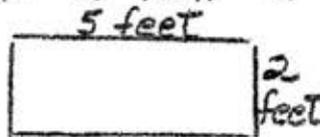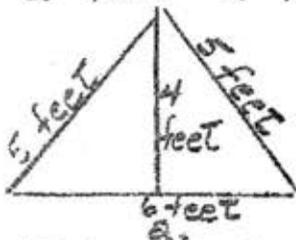
67. Which of the above drawings is a square?

68. Which of the above drawings is a triangle?

69. Which of the above drawings shows a square foot?

70. Which of the above drawings is not measured is the same units?

71. What is the area of diagram b?

    a. 7 square feet b. 10 square feet c. 14 feet d. 10 feet

72. What is the altitude in drawing a?

    a. 4 feet b. 5 feet c. 6 feet d. 16 feet

73. What are the above drawings called?

    a. photographs b. scale drawings c. charts d. diagrams

74. What is the perimeter of drawing b?

    a. 7 feet b. 5 feet c. 10 square feet d. 14 feet

$$4\overline{)648} \quad 162$$
$$a$$

$$24\overline{)8.73} \quad .36$$
$$7.$$
$$\overline{153}$$
$$\underline{144}\quad b.$$
$$9$$

$$25\overline{)175} \quad 7$$
$$\underline{175}$$
$$c.$$

$$2.4\overline{)8.6.4} \quad 3.$$
$$\underline{72}$$
$$\overline{144}$$
$$\underline{144}$$
$$d.$$

75. Which of the above examples is short division?

76. Which of the above is an uneven division?

77. Which example above contains decimal points?

78. In example c above what would the trial divisor be?

   a. 2   b. 7   c. 17   d. 25

79. In example b above to obtain the second partial dividend 153 what number do you bring down?

   a. 15   b. 3   c. 5   d. 1

80. In problem d above what does the caret ($\wedge$) do?

   a. shows the new position of the decimal after multiplying divisor and dividend by 10
   b. it changes the dividend and divisor to whole numbers
   c. it takes the decimal point out
   d. it changes the value of the quotient

$$\$2.00 \quad \$.52 \quad \$1.25 \quad \$1.00$$
$$a. \quad\quad b \quad\quad c. \quad\quad d.$$

81. Which of the above is equal to 4 half-dollars?

82. Which of the above has a 2 in the cent's place?

83. Which of the above has a 2 in the dime's place?

84. How many dimes does d equal?

   a. 5   b. 10   c. 100   d. 20

85. How many cents does c equal?

   a. 125   b. 25   c. 50   d. 100

My Weight Chart

date	weight
Sept. 15	80 lbs.
Oct. 15	81 lbs.
Nov. 15	83 lbs.
Dec. 15	83 lbs.
Jan. 15	85 lbs.
Feb. 15	86 lbs.

a.

Pupils with Library Cards
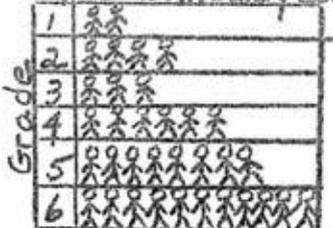
b. ☥ = 1 pupil

Books We Like

c.
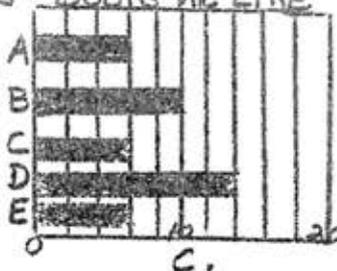
Tom's Arithmetic Scores

d.

86. Which of the above is a bar graph?

87. Which of the above is a picture graph?

88. Which of the above is **not** a graph?

89. In which clock is the hour hand pointing to 7?

90. What does the number in the center of the speedometer measure?

    a. speed   b. miles per hour   c. distance per hour   d. distance in miles

91. When the minute hand of the clock makes one complete revolution how much time has gone by?

    a. 60 seconds   b. one hour   c. one day   d. 12 hours

scale
$\frac{1}{8}$ in. = 1 rod

Mr. Brown's Garden
10 rods
16 rods
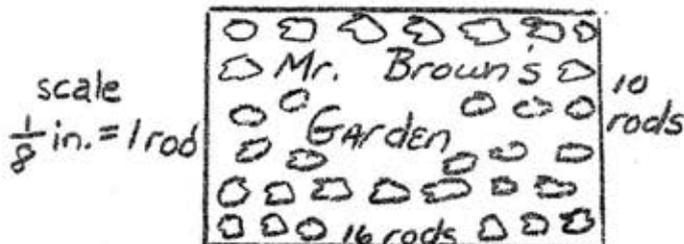
92. How much would **1 inch** in the drawing above be equal to according to scale?

    a. 2 rods   b. 8 rods   c. 4 rods   d. 2 feet

93. What is the width of the garden plot?

    a. 10 rods   b. 16 rods   c. $2\frac{1}{2}$ inches   d. 26 rods

94. The area of this garden would be 160 square rods. What is this equal to?

    a. 480 square yards   b. 1 square mile   c. 1 acre   d. 1600 square feet

95. Which of the following is nearest to one rod?

    a. $16\frac{1}{2}$ feet   b. 5 yards   c. 10 feet   d. 30 yards

Reading from left to right:

96. In which of these places is the book <u>Little Women</u>?

    a. Tenth   b. Third   c. Second   d. First

97. In which of these places is <u>Babe Ruth</u>?

    a. Eighth   b. Seventh   c. Third   d. Ninth

98. In which of these places is <u>Moby Dick</u>?

    a. Eighth   b. Second   c. Ninth   d. Tenth

99. Which book is in third place on the shelf?

    a. <u>Babe Ruth</u>   b. <u>Robinhood</u>   c. <u>Little Women</u>   d. <u>Tom Sawyer</u>

100. Which book is in sixth place on the shelf?

    a. <u>Tom Sawyer</u>   b. <u>Little Men</u>   c. <u>Heidi</u>   d. <u>Black Beauty</u>

Directions: In this section of the test there is a choice of four answers for each question just as there was in the section which you have just finished. There is only one correct answer for each question. Begin with number 101 and fill in the lines under the correct letter for your answer. Do not guess. Take your time. Check your work when you have finished.

```
┌──────────┐        ┌──────────┐
│ X X X    │        │ X X X X  │
│ X X      │        │ X        │
└──────────┘        └──────────┘
```
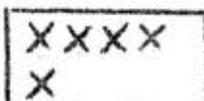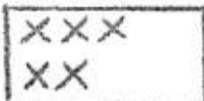
101. Which one of these addition facts is not shown by either of the pictures above?

    a. 3 + 2 = 5   b. 4 + 1 = 5   c. 1 + 4 = 5   d. 2 + 2 = 4

102. How would you write eight thousand four hundred thirty-six using numerals?

    a. 4836   b. 8436   c. 8CCCXXXVI   d. 80436

103. John spent 5¢ for a popsicle, 3¢ for gum and 10¢ for marbles. What was the total amount he spent?

    a. 8¢   b. 15¢   c. 18¢   d. 13¢

104. In the number 483,264,841 what is the hundred's period?

    a. 800   b. 841   c. 264   d. 483

105.   Boys ʜʜ ʜʜ ‖   Girls ʜʜ ʜʜ ‖‖

    Harry counted the number of boys and girls in his classroom as above. What is this called?

    a. graphing   b. scoring   c. tallying   d. adding

106. Which of the following is not an odd number?

    a. 17   b. 101   c. 1   d. 18

107. In which of the following examples do you borrow 1 ten?

    a. 433   b. 629   c. 874   d. 678
       182   137   395   282
       ───   ───   ───   ───
       615   166   479   396

108. You know how much Mrs. Smith weighs and how much her son Timmy weighs. How can you find how much more Mrs. Smith weighs than Timmy?

    a. add   b. subtract   c. multiply   d. divide

109. If you know the cost of one bushel of apples what is the quickest way to find the cost of 14 bushels?

    a. addition   b. subtraction   c. multiplication   d. division

110. Which bird is twice as tall as the chicken?

chicken   a. goose   b. hen   c. duck   d. pigeon

111. Bob is asked to find the difference between $12.06 and $2.98. What should he estimate as the answer?

    a. $10   b. $11   c. $9   d. $15

112. Which of the following numbers is written in the money system?

    a. 8:32   b. 84.32   c. $84.32   d. 84$ 32¢

113. What must we do in order to average seven numbers?

    a. add the seven numbers   b. multiply the seven numbers together and divide by seven   c. add the seven numbers together and divide by seven   d. Find the middle number of the seven

114. Which of the following figures is a cube?

    a.   b.   c.   d

115. Which one of the following fractions does not exactly equal one-half?

    a. $\frac{4}{8}$ b. $\frac{14}{29}$ c. $\frac{400}{800}$ d. $\frac{3\frac{1}{2}}{7}$

116. Which of the following division examples does not come out evenly?

    a. $16 \div 2$ b. $16 \div 4$ c. $16 \div 6$ d. $16 \div 8$

117. Which of the following numbers is a hundred million?

    a. 100,000   b. 100,000,000   c. 10,000   d. 10,000,000

118 Which of the following lines is horizontal?
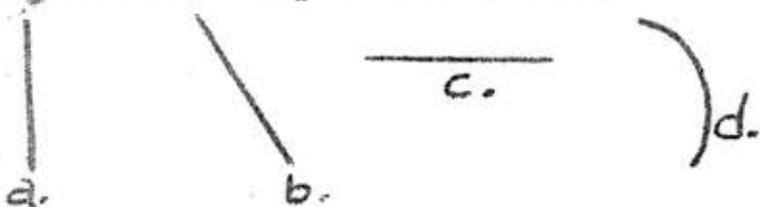
119. Which of the following figures is a right angle?
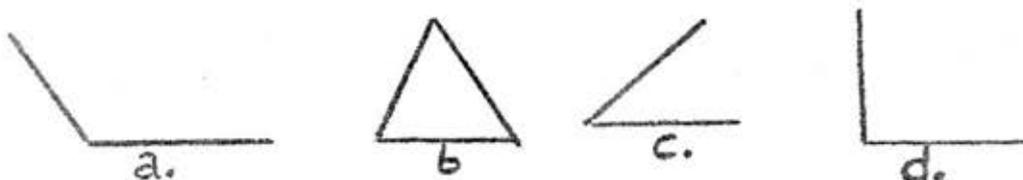
120. Ann visited her cousin for 2 weeks. How many days did she stay?

    a. 7   b. 21   c. 13   d. 14

121. What is the eleventh month of the year?

    a. September   b. October   c. November   d. December

122. Which of the following numbers is <u>not</u> divisible by 4?

    a. 16   b. 8   c. 24   d. 18

123. What would 6,743,650 be rounded off to the nearest million?

    a. 6,800,000   b. 7,000,000   c. 6,000,000   d. 7,743,000

124. Which of the following is a zero?

    a. 4.   b. .3   c. 0.   d. -.2

125. If you were asked to write ten million in figures, how many zeros would you use?

    a. 6   b. 7   c. 8   d. 10

126. Joan needs to know the volume of a box she is using to pack cookies in. What does volume mean?

    a. the area of   b. the depth of the   c. the amount the box   d. the net
      the bottom   box   will hold   weight of
                                                               the box

127. On a Farhenheit thermometer what is the freezing point of water?

a. 0°   b. 32°   c. 100°   d. 212°

128. Which of the following figures is <u>not</u> divided into equal parts?

129. The fifth grade used a gross of pencils during the school year? How many pencils did the class use?

a. 288   b. 5 for each pupil   c. 144   d. 500

130. If you were to go to a horse race you might hear the announcer refer to the length of the track in furlongs. What is a furlong?

a. the distance around the track   b. one-half mile   c. one-eighth of a mile   d. one-sixth of a mile

131. Which of the following is the best estimation for 4362 plus 3948?

a. 7000   b. 8000   c. 9000   d. 10000

132. Jimmy read on a can of peas that the net weight was 14 ounces. What does the net weight mean?

a. the weight of the peas   b. the weight of the can   c. the weight of the peas plus the weight of the can   d. the weight of the peas minus the weight of the liquid

133. Which pie is divided into halves?

134. Jay learned in science that if he were on the moon his weight would only be equivalent to 14 pounds on earth. What does this mean?

a. his weight on the moon would equal 14 pounds   b. his weight would be minus 14 pounds   c. he would add 14 pounds to his weight on earth   d. his weight would be the same on earth and on the moon

135. John's brother who is in the Navy wrote that his ship had gone 250 nautical miles in one day. What does nautical mile mean?

    a. the same as a land mile   b. about $\frac{1}{7}$ less than a land mile   c. twice as much as a land mile   d. about $\frac{1}{7}$ more than a land mile

136. Sally's father said the average rate of his car was 40 miles per hour. What does this rate mean?

    a. the number of gallons of gas the car uses   b. the distance the car travels   c. the speed of the car   d. the time for travelling one mile

137. How many 100 pound bags of coal would it take to make one ton?

    a. 20   b. 2   c. 200   d. 2000

138. Jack ran the 100 yard dash in the school field day. How many feet did he run?

    a. 300   b. $33\frac{1}{3}$ c. 10   d. 1000

139. In which of the following fractions is the numerator 3?

    a. $\frac{13}{14}$ b. $\frac{4}{3}$ c. $\frac{3}{4}$ d. $\frac{20}{30}$

140. How do we write any decimal?

    a. write the numerator and show the denominator by the position of the point   b. write the denominator and show the numerator by the position of the point   c. write the numerator over the denominator   d. write the number with a point in front of it

141. Which of the following fractions needs to be reduced?

    a. $\frac{2}{7}$ b. $\frac{1}{8}$ c. $\frac{11}{12}$ d. $\frac{3}{15}$

142.

$$\frac{4}{5} \times \frac{3}{8} = \frac{3}{10}$$

In doing the above example Peter used cancellation before he multiplied. What does this mean?

    a. he inverted the fraction   b. he divided the numerator and denominator by 4   c. he crossed out the 4 and 8   d. he reduced the fractions $\frac{4}{5}$ and $\frac{3}{8}$

143. Which of these fractions is in simplest form?

   a. $\frac{4}{10}$ b. $\frac{50}{100}$ c. $\frac{6}{7}$ d. $\frac{3}{18}$

144. How would you write one hundredth as a common fraction?

   a. $\frac{1}{100}$ b. .01   c. $\frac{100}{1}$ d. $\frac{.01}{100}$

145. How would you write six hundred thousandths as a decimal?

   a. $\frac{6}{100,000}$ b. .006   c. .0006   d. .00006

146. Which of the following fractions shows $\frac{5}{10}$ in higher terms?

   a. $\frac{1}{2}$ b. $\frac{5}{100}$ c. $\frac{10}{20}$ d. $\frac{15}{20}$

147. Which of the following are unequal fractions?

   a. $\frac{5}{10}$, $\frac{1}{2}$ b. $\frac{3}{8}$, $\frac{3}{4}$ c. $\frac{1}{6}$, $\frac{2}{12}$ d. $\frac{3}{10}$, $\frac{30}{100}$

148. What is the smallest common denominator for $\frac{1}{4}$, $\frac{1}{3}$, and $\frac{1}{8}$?

   a. 24   b. 12   c. 3 x 4 x 8   d. 8

149. What are the terms of a fraction?

   a. the reductions that need to be made   b. the value of the fraction   c. the size of the denominator   d. the numerator and the denominator

150. Which of the following is written in decimal form?

   a. 2:10   b. 4ft. 3in.   c. 43%   d. 3.1416

Section I

Directions: This test is made up of three sections. In section I there are groups of five words or expressions with seven possible answers above them lettered a,b,c, d,e,f and g. There is only one answer for each word or a total of 5 answers for each group of five words. In each of the groups of five words there are two extra answers which do not belong to any of the words.

On your answer sheet you will find numbers that are the same as the numbered words or expressions on your test. To the right of each number are seven spaces marked a,b,c,d,e,f,g. These are your answer spaces. They are the same as the lettered answers in your test booklet. Fill in the space which is the same as the correct answer for the numbered word. Fill in the whole space which you choose with a heavy mark.

Do not guess. If you do not know the answer to a word, skip it and go on to the next word. Keep going and finish all 60 of the words in Section I.

This is not a speed test. Take as much time as you need.

If you wish to change an answer, do so, but be sure to erase the first answer completely.

In Section I some of the answers are marked with arrows and some are just lettered as you will see in the sample test item below.

Do this sample test item with your teacher.

a.	b.	c.	d.	e.	f.	g.
2	3	4	10	5	↓	↓
					6	9

1. two
2. three
3. four
4. five
5. ten

Answer Sheet   a b c d e f g
1.
2.
3.
4.
5.

When you have finished with all 60 words in section I and have filled in all the answers which you know on this side of your answer sheet, Stop. Do not turn the page of the test booklet. You may go over Section I while you are waiting for your classmates to finish.

Form B - Section 1

$$\begin{array}{r} 56 \\ 23 \\ \hline 79 \end{array}$$ ← a ← b ← c

$$\begin{array}{r} 56 \\ 23 \\ \hline 33 \end{array}$$ ← d ← e ← f ← g

1. subtraction example

2. subtrahend

3. addends

4. total

5. remainder

$$\underset{c}{\overset{a\quad b}{6 + 4}} = 10 \qquad \overset{d}{7 - 3} = 4 \qquad \underset{f}{\overset{e}{3 \times 2}} = 6 \qquad \overset{g}{16 \div 2} = 8$$

6. minus

7. division sign

8. factors

9. digit

10. plus sign

$$\begin{array}{r} 27 \\ \times 31 \\ \hline 27 \\ 81 \\ \hline 837 \end{array}$$ ← a ← b ← c ← d

$$\begin{array}{r} 17 \\ 31{\overline{)543}} \\ 31 \\ \hline 233 \\ 217 \\ \hline 16 \end{array}$$ ← e ← f ← g

11. multiplicand

12. dividend

13. product

14. remainder

15. first partial product

$\overline{XII}$	$=$	12	$\times$	¢	$\div$	#
a	b	c	d	e	f	g

16. Roman number

17. Arabic numeral

18. means "dollars"

19. means "equal to"

20. means "to multiply"

a	b	c	d	e	f	g
$1+1=2$ $2+2=4$ $3+3=6$ $4+4=8$ $5+5=10$	1 17 16 6 14 8 7 11 10 12 13 5 15 3 4 18	Boston 7:45 Lynn 8:16 Saugus 9:04 Salem 10:21 Beverly 10:10 Gloucester 10:37	$1\times2=2\times1$ $3\times2=2\times3$ $4\times2=2\times4$ $5\times2=2\times5$ $6\times2=2\times6$	$2\div2=1$ $4\div2=2$ $6\div2=3$ $8\div2=4$ $10\div2=5$	$8-5=3$ $18-5=13$ $28-5=23$ $38-5=33$ $48-5=43$	City temp Chicago 72° New York 76° Boston 71° St. Louis 81

21. subtraction family

22. magic square

23. timetable

24. table of doubles

25. division table

a   b   c   d   e   f   g
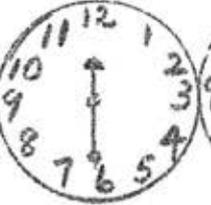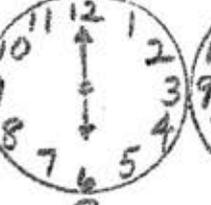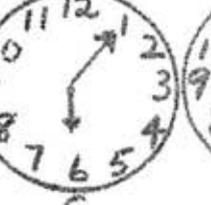
26. 5 minutes to 6

27. 5 minutes past 6

28. 6 o'clock

29. quarter of 6

30. quarter after 6

8 $\frac{6}{5}$ $\frac{1}{2}$ 6.43 $\frac{1}{20}$ $4\frac{1}{2}$ $.20$

a   b   c   d   e   f   g

31. mixed decimal

32. proper fraction

33. decimal fraction

34. whole number

35. one twentieth

a   b   c   d   e   f   g
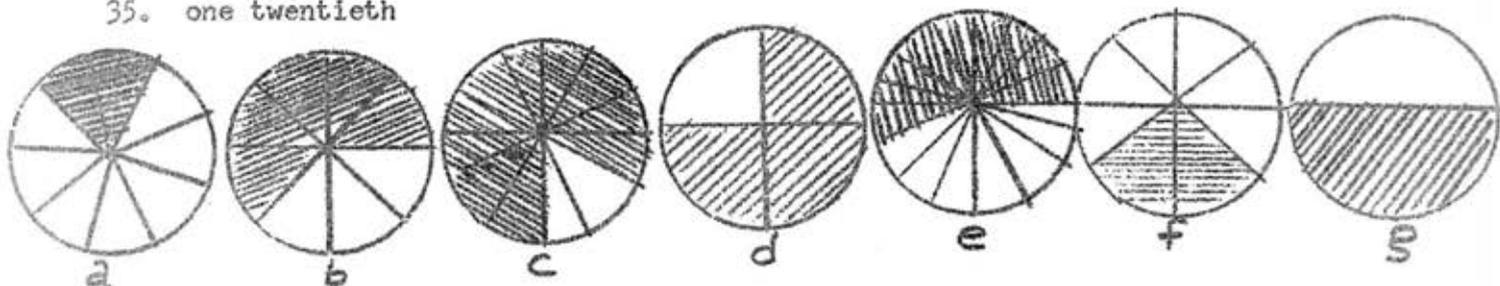
36. one-half of the circle shaded

37. three fourths of the circle shaded

38. five eighths

39. two ninths

40. nine sixteenths
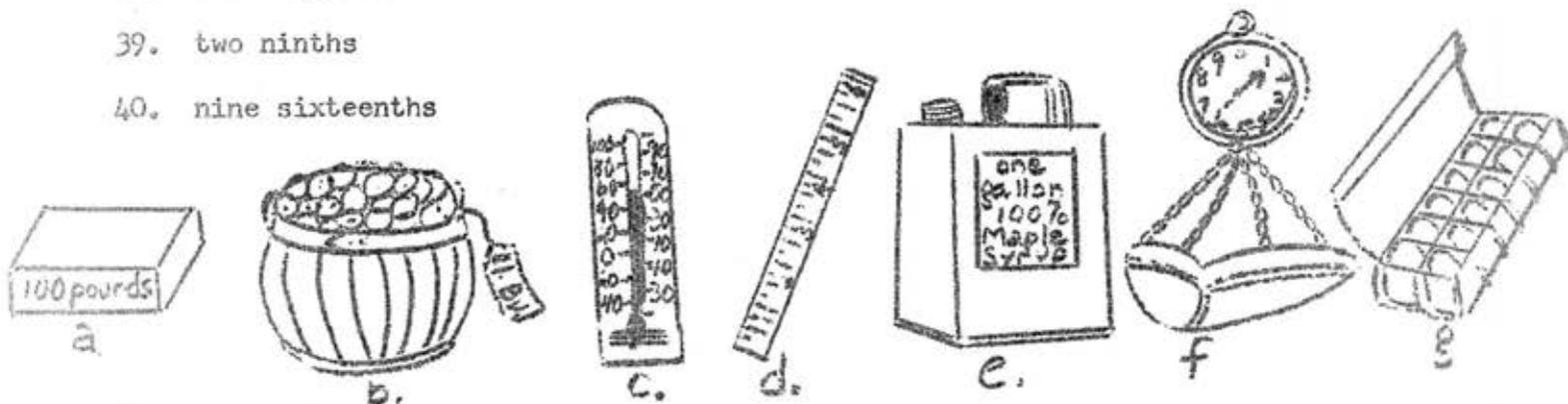
100 pounds
a.   b.   c.   d.   one gallon 100% Maple Syrup e.   f   g

41. temperature

42. liquid measure

43. dozen

44. linear measure

45. hundredweight ~~square measure~~

a. the amount of coffee in a man's lunch box
b. size of a vegetable garden
c. potatoes at the store
d. time for running 100 yard dash
e. ice cream for 12 persons
f. time for arithmetic lesson
g. boy's belt size

46. square feet

47. inches

48. bushel

49. pint

50. minutes

a. 366 days
b. 365 days
c. 1/16 pound
d. 10 years
e. 7 days
f. 2 pints
g. 100 years

51. leap year

52. decade

53. quart

54. week

55. ounce

a. the worth of any object
b. a record of how much a person wishes to put in the bank
c. a money charge laid upon persons or property for public purposes
d. a record of money received and spent
e. money paid for the use of money by the person to whom the money is loaned
f. a sum of money put into a bank
g. an estimate of what one expects to spend

56. budget

57. value

58. deposit

59. deposit slip

60. tax

Section II

Directions: In this section of the test there are groups of questions about drawings or numbers above them. There are only four possible answers for each question lettered a, b, c, and d. There is only one correct answer for each question which you will find under the drawings or numbers or in the choices of answers under the questions.

You will fill in the space which is the same as the correct answer just as you did in Section I. Turn your answer sheet over and find number 61. This is where you will start after we do the sample test item.

Take your time. Do not guess. Check your work. You may go on to Section III when you complete Section II. When you have finished you may check your work in Section III and wait for your classmates to finish.

Do the sample test item with your teacher.

16.2	04.3	06.5	11.2
a.	b.	c.	d.

Gasoline Pump Meters

1. Which meter above has a 3 in the tenth's place?

2. How many numbers are there in each meter?

    a. 3   b. 2   c. 1   d. 4

Answer Sheet a b c d
1.
2.
3.
4.
5.

42601.6	01240.1	90762.5	80353.0
a	b	c	d

Automobile Speedometers

61. Which speedometer above shows a 6 in the ten's place?

62. Which speedometer above shows a 2 in the hundred's place?

63. Which speedometer above shows a 2 in the One's place?

64. Which speedometer above shows a zero in the ten thousand's place?

65. How many places are there in the whole number part of each speedometer?

    a. 1   b. 4   c. 6   d. 5

66. What would the number in speedometer a be rounded to the nearest whole number?
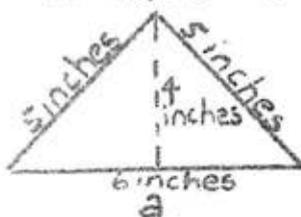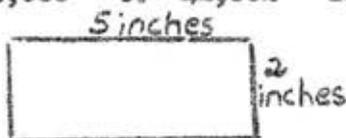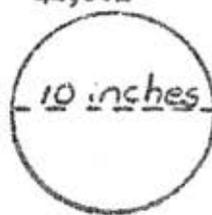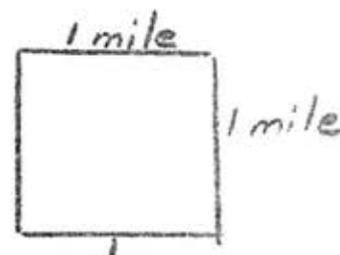
    a. 43,000   b. 42,600   c. 42,602   d. 42,601

67. Which of the above drawings is a circle?

68. Which of the above drawings is a rectangle and not a square?

69. In which of the above drawings is the unit of measure not inches?

70. Which of the above drawings shows a square mile?

71. What is a square mile called?

    a. an acre   b. a rod   c. a block   d. a section

72. What is the height of drawing a?

    a. 4 inches   b. 5 inches   c. 6 inches   d. 10 inches

73. What might we call the above drawings?

    a. photographs   b. scale drawings   c. charts   d. figures

74. What is the 10 inch line on drawing c called?

    a. radius   b. circumference   c. diameter   d. semi-circle

Form B - Section II

4)24
a

28)1.98
b

4.28
× 1.2
c

.016)9.6
d

75. Which of the division examples above could be done without using long division?

76. Which example above contains a cent point?

77. In example b what would you use as your trial quotient?

    a. 9   b. $1.98   c. 28   d. 2

78. In example d in order to multiply both divisor and dividend by 1000 what must you do?

    a. move the points to the left   b. make the divisor and dividend both two-place numbers   c. annex two zeros in the dividend   d. move the point one place in both the divisor & dividend

79. In example c above how many places will you point off in the answer?

    a. 2   b. 3   c. 1   d. 5

80. How can you tell an example is an even division?

    a. It has no decimal point   b. it can be done by short division   c. it has an even-number divisor   d. it has no remainder

$2.00
a

$.52
b

$1.25
c

$1.00
d

81. Which of the above is equal to 8 quarters?

82. Which of the above is one dollar?

83. Which of the above has a 2 in the dollar's place?

84. How many nickels does d equal?

    a. 20   b. 10   c. 40   d. 15

85. How many pennies does c equal?

    a. 25   b. 50   c. 125   d. 100

Pupils with Library Cards
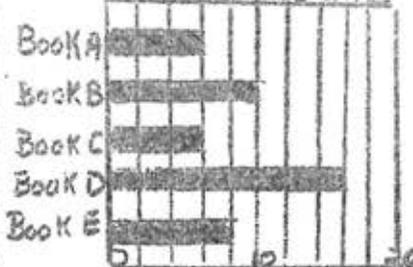
Books We Like

Tom's Arithmetic Scores
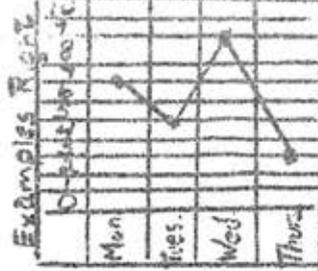
How Mary Spends Her Day

2 ♀ = 1 pupil

a

b

c

d

86. Which of the above is a circle graph?

87. Which of the above is a pictograph?

88. Which of the above is a line graph?
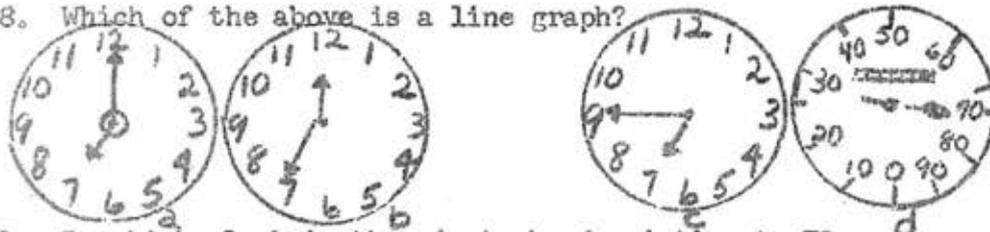
89. In which clock is the minute hand pointing to 7?

90. In the speedometer in what unit is the speed of the auto measured?

    a. miles   b. miles per minute   c. in miles-an-hour   d. in hours

91. When the minute hand of a clock makes a full turn in an hour's time how far do we say it has gone?

    a. 60 seconds   b. one day   c. one revolution   d. one half-circle

Mr. Brown's Garden — 10 rods
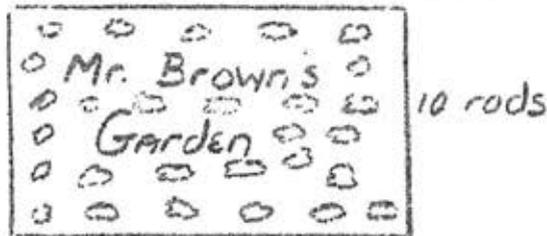
scale ½ in. = 1 rod   16 rods

92. In the scale drawing above how much would 1 inch be equal to?

    a. 2 rods   b. 8 rods   c. 4 rods   d. 2 feet

93. What is the length of the garden plot?

    a. 4 inches   b. 16 rods   c. 10 rods   d. 26 rods

94. The garden covers an area of one acre. How many square rods is this?

    a. 100   b. 160   c. 1000   d. 16

95. What would you list as the dimensions of this garden plot?

    a. 16 rods by 10 rods   b. 16 rods   c. 10 rods   d. ½ inch = 1 rod

Reading from left to right:

96. On the bookshelf above which book is in the second place?

    a. Moby Dick   b. Robinhood   c. Fairy Tales   d. Little Women

97. What is the fourth book called?

    a. Tom Sawyer   b. Little Women   c. Little Men   d. Heidi

98. What book is the tenth on the shelf?

    a. Little Women   b. Moby Dick   c. Alice in Wonderland   d. Black Beauty

99. Which place is Heidi in?

    a. Fourth   b. Sixth   c. First   H. Fifth

100. Which place is Little Men in?

    a. Third   b. Seventh   c. Fourth   d. Sixth

101. How does a sign help you?

    a. it helps you   b. it tells you   c. it tells you   d. it checks the
       add   what to do   what the ans-   answer
                                          wer is

102. How would you write eight dollars and thirty-four cents in figures?

    a. $834   b. 8.34   c. $8.34   d. 8.34¢

103. Which of the following is an amount?

    a. a cow and a   b. a sum of   c. a suit   d. a house not
       horse   money   paid for

104. If you said each set of numbers out loud, which would be counting?

    a. 3-8-4-1   b. 4-0-8-0   c. 1-2-3-4   d. 10-14-18-20

105.

Mary's class in arithmetic used strips of squares like those above to help in learning addition and subtraction facts. What are these called?

    a. square inches   b. addends   d. counters   d. flash cards

106. Which of the following is not an even number?

    a. 20   b. 17   c. 104   d. 6

107. In which of these addition examples do you carry a ten?

    a. 43   b. 352   c. 241   d. 147
       71   104   163   235
      114   456   404   382

108. Henry worked on a farm three days picking apples and earned $2.52 the first day, $3.01 the second day and $2.75 the third day. How can you find how much he earned in all?

    a. add   b. subtract   c. multiply   d. divide

109. If you know the cost of 14 bushels of apples, what is the quickest method to find the cost of one bushel?

    a. addition   b. subtraction   c. multiplication   d. division

110. Which bird is 3 times as tall as the chicken?

chicken   a. duck   b. pigeon   c. goose   d. hen

111. Bob is asked to find the difference between $12.06 and $2.98. Which of the following would be the best estimate?

    a. $10   b. $11   c. $9   d. $15

112. Which number means the most money?

    a. $364   b. $85.79   c. $359.43   d. $101.02

113. Which of the following groups of marbles can be divided into 2 equal smaller groups?

114. What is the average of any nine numbers?

    a. a number which is the sum of the nine numbers   b. the middle number of the nine   c. the number which is obtained by multiplying all nine numbers together and dividing by nine   d. a number which is obtained by adding all nine numbers together and dividing by nine

115. Which of the following is a billion?

    a. 1,000,000   b. 10,000,000   c. 1,000,000,000   d. 100,000,000

116. The gym teacher said we should always know the depth of a pool before swimming in it. What is its depth?

    a. how wide the   b. how deep the   c. how much area   d. how long the
       pool is   pool is   the pool covers   pool is

117. Which of the following shapes is not rectangular?

118. Harry built a boat model a foot long. How many inches long did he make it?

    a. 24   b. 1   c. 12   d. 10

119. Which of the following is not an exact equal of $\frac{1}{2}$?

    a. $\frac{100}{200}$ b. $3\frac{1}{7}$ c. $\frac{5}{10}$ d. $\frac{3}{8}$

120. Joe bought an arrowhead from Ed for 75¢. He gave Ed one dollar. How much change should Ed give Joe?

    a. 75¢   b. $1.00   c. 50¢   d. 25¢

121. Which of the following divisions does not come out even?

    a. $16 \div 2$ b. $16 \div 4$ c. $16 \div 3$ d. $16 \div 1$

122. Which of the following is a vertical line?

123. Which of the drawings below is an angle?
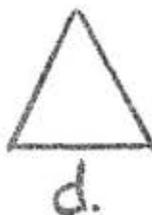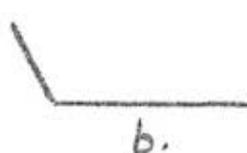
124. Which has the largest number of surfaces?

    a. a piece of string   b. a ball   c. a sheet of   d. a brick
                                            paper

125. How would you round off 850,621 to the nearest hundred thousand?

    a. 850,000   b. 900,000   c. 950,621   d. 9,000,000

126. Which of the following packages weighs the most?

    a. [6 ounces]   b. [1 pound]   c. [8 ounces]   [30 ounces]
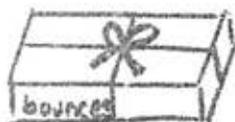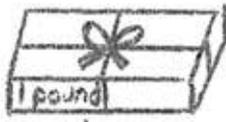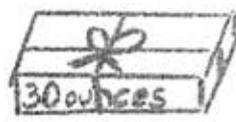
127. What is the boiling point of water on a Fahrenheit thermometer?

    a. 32   b. 100   c. 212   d. 0

128. The thermometer below shows the temperature. What do the numbers stand for?

    a. the number of degrees   b. the number of Fahrenheit   c. the amount of heat   d. the amount of cold

129. Henry is running in the mile race at the track meet. How far must he run in feet?

    a. 5000   b. 5820   c. 5280   d. 1000

130. Sailors use the term fathom on board ship. What does fathom measure?

    a. how deep the water is   b. how fast the ship is traveling   c. how many nautical miles traveled   d. how many miles you you have traveled

131. When your teacher orders arithmetic paper for your class she asks for reams. What does ream mean?

    a. the number of packages   b. the number of pieces   c. a package containing 500 sheets   d. a package containing 1000 sheets

132. John's brother in the Navy used the term knot in a letter to the class. What are knots used to measure?

    a. the distance to the nearest land   b. the time it will take to reach land   c. the depth of the water   d. the speed of the ship

133. Mary's father delivers oil by the barrel to her school. About how many gallons does a barrel contain?

    a. 55   b. 30   c. 100   d. 10

134. Sam won a prize at the fair for eating two whole pies. Which picture below shows what he ate?

a.

b.

c.

d.

135. In the number 407 the zero is used as a placeholder. What does this mean?

a. zero is the only place-holder in the number

b. there are no tens in the ten's place

c. the zero does not need to be in the number

d. there are no hundreds in the hundred's place

136. In which case has the fraction $\frac{8}{6}$ been inverted?

a. $\frac{11}{3}$ b. $\frac{4}{3}$ c. $\frac{6}{8}$ d. $\frac{16}{12}$

137. Which of the following fractions is reduced to lowest terms?

a. $\frac{6}{8}$ b. $\frac{50}{100}$ c. $\frac{3}{6}$ d. $\frac{2}{7}$

138. In one week only 2 days were sunny. What fractional part of the week was sunny?

a. $\frac{5}{7}$ b. $\frac{7}{7}$ c. $\frac{2}{7}$ d. $\frac{1}{7}$

139. Which of the following is a common denominator for $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{8}$?

a. 12   b. 8   c. 24   d. 16

140. Which of the following are like fractions?

a. $\frac{1}{4}$, $\frac{1}{6}$ b. $\frac{1}{10}$, $\frac{1}{100}$ c. $\frac{3}{7}$, $\frac{7}{9}$ d. $\frac{5}{8}$, $\frac{7}{8}$

141. In which fraction is the denominator 3?

a. $\frac{13}{14}$ b. $\frac{14}{13}$ c. $\frac{3}{8}$ d. $\frac{1}{3}$

142. How do we write five-tenths as a common fraction?

a. $\frac{10}{5}$ b. $\frac{5}{10}$ d. $\frac{.5}{10}$ d. .5

143. How would you write one fifteenth as a fraction?

    a. $\frac{1}{15}$ b. .15   c. $\frac{15}{1}$ d. $1\frac{1}{15}$

144. Which of the following is one thousandth written as a common fraction?

    a. .001   b. $\frac{1}{100}$ c. $\frac{1}{1000}$ d. $\frac{1000}{1}$

145. How would you round off .06357 to the nearest ten thousandth?

    a. .064   b. .0636   c. .0635   d. .00007

146. Which of the following are unlike fractions?

    a. $\frac{1}{5}$, $\frac{1}{5}$ b. $\frac{1}{3}$, $\frac{2}{3}$ c. $\frac{6}{10}$, $\frac{8}{10}$ d. $\frac{7}{8}$, $\frac{8}{7}$

147. There are 14 boys and 16 girls in the fifth-grade class. How would you write this as a ratio?

    a. 14 x 16   b. $\frac{14}{16}$ c. 16 - 14   d. 14 + 16

148. In the example, $\frac{4}{5} \times \frac{3}{8} = \frac{3}{10}$, Jim had to cancel before he could multiply. What does cancel mean?

    a. to cross out 4 and 8   b. to divide both numerator and denominator by 4   c. to reduce the fraction   d. to invert the fraction

149. How would you write one millionth as a decimal?

    a. .0001   b. .000001   c. .0000001   d. $\frac{1}{1000000}$

150. How would you write .018 as a per cent?

    a. 1.8%   b. .018%   c. .18%   d. 1.8

arithmetic vocabulary test

prepared for Grades 4,5,& 6.

Directions: This test is made up of three sections. In section I there are groups of five words or expressions with seven possible answers, lettered a,b,c,d,e,f and g, above or beside them. There is only one answer for each word or a total of 5 answers for each group of five words. In each group of five words there are two extra answers which do not belong to any of the words.

On your answer sheet you will find numbers that are the same as the numbered words or expressions on your test. To the right of each number are seven spaces marked a,b,c,d,e, f,g. These are your answer spaces. They are the same as the lettered answers in your test booklet. Fill in the space which is the same as the correct answer for the numbered word.

Do not guess. If you do not know the answer to a word, skip it and go on to the next word. If you wish to change an answer, be sure to erase the first word completely. Keep going and finish all 60 of the words in Section I. Take as much time as you need to finish the test.

In section I some of the answers are marked with arrows and some are just lettered as you will see in the sample test items below.

Do these sample items with your teacher.

```
  534 ◄── a        1 subtraction
  605 ◄── b        2   example
  142              3 subtrahend
 1281 ◄── c        3 column
                   4 total
                   5 remainder
```

```
   56 ◄── d
   23 ◄── e
   ── ◄── f
   33 ◄── g
```

a $\frac{1}{24}$ b $\frac{6}{5}$

c $33\frac{1}{3}$ d $3\frac{1}{2}$

6 mixed decimal
7 proper fraction
8 decimal fraction
9 improper fraction
10 one twenty-fourth
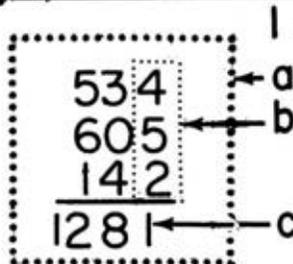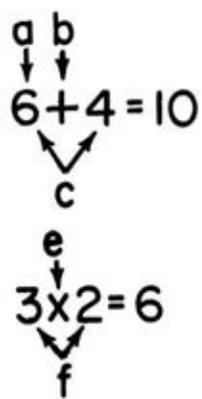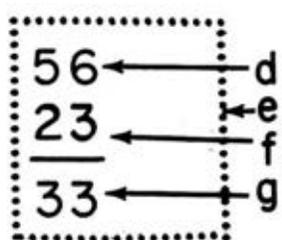
e $1\frac{1}{4}$ f .2400

g 6.25

I addition example

```
  53 4  ←— a
  60 5  ←— b
  14 2
  1281  ←— c
```

2 sum

3 difference

4 minuend

5 column

```
  56 ←——— d
  23 ←——— e
  ―――      f
  33 ←——— g
```

```
a b
6+4=10
    c
```

```
e
3×2=6
    f
```

6 plus

7 terms

8 multiplication sign

9 number

10 minus sign

```
  d
7−3= 4
```

```
  g
16÷2=8
```

```
  27 ←——— a
× 31 ←——— b
  27 ←——— c
  31 ←——— d
 837
```

11 multiplier

12 divisor

13 second partial product

14 quotient

15 first partial dividend

```
            e
            ↓      17 ←——— f
      31)543
            31  ←——— g
           233
           217
            16
```

```
a        b
XII      =

c        d
12       X
```
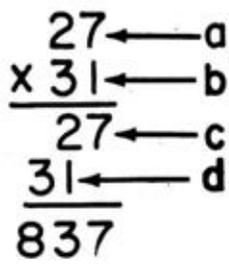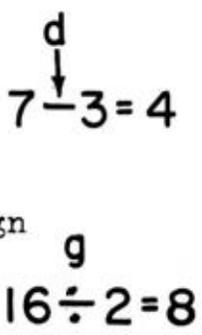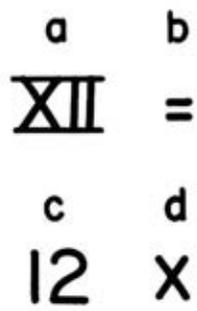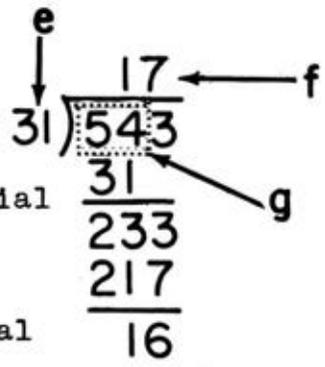
16 Roman numeral

17 Arabic number

18 means "cents"

19 means "equal"

20 means "to divide"
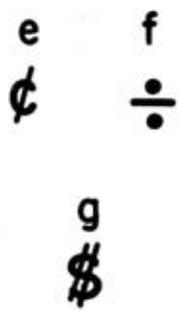
```
e        f
¢        ÷

         g
         $
```

a

| 1+1 = 2 |
| 2+2 = 4 |
| 3+3 = 6 |
| 4+4 = 8 |
| 5+5 = 10 |

b

1	17	16	6
14	8	7	11
10	12	13	5
15	3	4	18

c

	LEAVES
Boston	7:45
Lynn	8:16
Saugus	9:04
Salem	10:01
Beverly	10:10
Gloucester	10:37

21 subtraction family

22 reverse table

23 temperature table

24 table of doubles

25 division table

a   **b**

26 5 minutes of 6

27 quarter past 6

a $\frac{1}{24}$ **b** $\frac{6}{5}$ **c** $.33\frac{1}{3}$ **d** $3\frac{1}{2}$ **e** $\frac{1}{4}$ **f** $.2400$ **g** 6.25

31 one-quarter

32 mixed number

33 improper fraction

34 incomplete decimal

35 one twenty-fourth
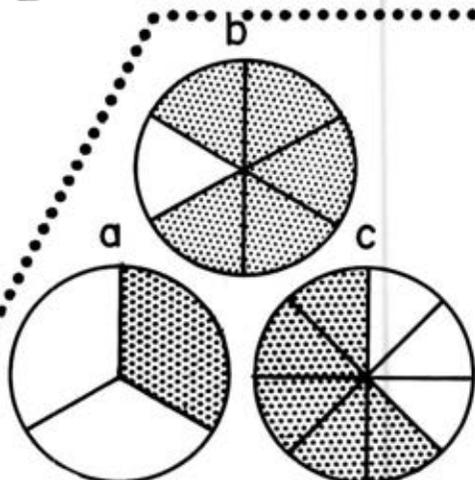
d	e	f	g
			CITY temperature
1X2=2X1	2÷2=1	8-5=3	
3X2=2X3	4÷2=2	18-5=13	Chicago 72°
4X2=2X4	6÷2=3	28-5=23	NewYork 76°
5X2=2X5	8÷2=4	38-5=33	Boston 70°
6X2=2X6	10÷2=5	48-5=43	St.Louis 81°

c   d   e   f

28   5 minutes after 6

29   quarter to 6

30   half-past 12

g

d   e

36 one-third of the circle shaded

37 five-sixths of the circle shaded

38 two-fifths of the circle shaded

f   g

39 five-sevenths of circle shaded

40 two-twelfths of the circle shaded

a   b

41 measure of weight

42 square measure

43 measure of time

44 dry measure

45 speed
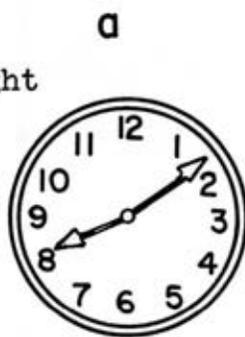
46 gallon

47 square inches

48 feet

49 peck

50 seconds

51 year

52 century

53 pound

54 cup

55 month

56 cash account

57 deposit
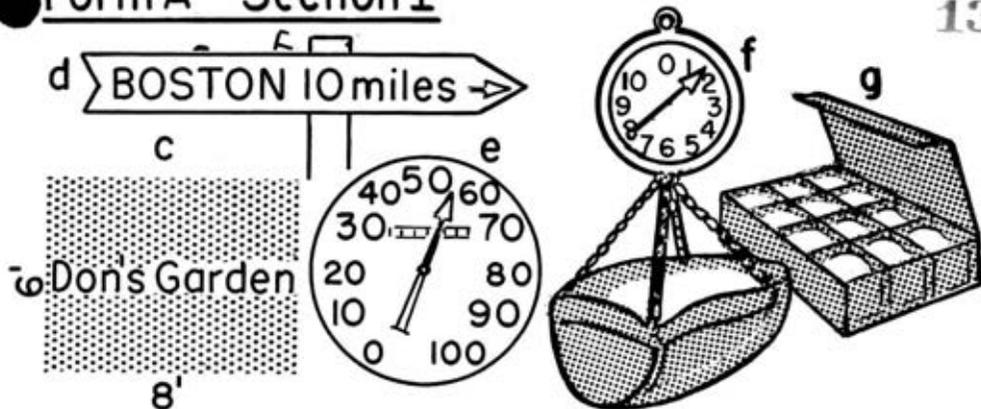
58 interest

59 cost

60 balance
on hand

d $\rangle$ BOSTON 10 miles →

c

6 Don's Garden

8'

40 50 60
30 70
20 80
10 90
0 100

f

g

a icecream for 12 persons
b amount of coffee in lunch box
c surface of a page in a book
d time for an arithmetic lesson
e the height of a flagpole
f apples at a roadside stand
g time for 100 yard dash

a 100 years
b 365 days
c 16 ounces
d 10 years
e $\frac{1}{4}$ quart
f 30 days
g 1 pint

a the price of an article
b an estimate of what one expects to spend
c the amount of money one has available
d an overdrawn account
e to put money into a bank
f amount paid for the use of money by
the person to whom the money is loaned
g a record of money received and money spent

Section II

Directions: In this section of the test you will see that there are groups of questions about drawings or numbers above or beside them. There are only four possible answers for each question which you will find under the drawing or numbers or in the choices of answers under the questions.

You will fill in the space which is the same as the correct answer just as you did in Section I. Turn your answer sheet over and find number 61. This is where you will start after we do the sample test item.

Take your time. Do not guess. Check your work. You may go on to Section III when you complete Section II. When you have finished you may checkyour work in Section III and wait for your classmates to finish.

Do the sample test item with your teacher.

a	b	c	d
16.2	14.3	06.5	11.2

Gasoline Pump Meters

3. Which meter above has a 3 in the tenth's place?

4. How many figures are there in each meter?

a 3   b 2   c 1   d 4

a	b	c	d
42601.6	01240.1	90646.5	80353.0

Readings on an Automobile Speedometer

61 Which reading shows a 6 in the tenth's place?

62 Which reading shows a 2 in the thousand's place?

63 Which reading shows a 1 in the units place?

64 What is the place value of the 0 in speedometer a?

    a no tens   **c** no hundreds
    b no ones   **d** no tenths

65 How many decimal places are found in each speedometer?

    a 4 **b** 1 **c** 5 **d** 6

66 What would speedometer c above be to the nearest round number?

  a 90,600 **b** 90,646 **c** 90,647 **d** 90,640

a	b	c	d

5feet

2'

5feet **4 feet** **5feet**

6feet

-10miles-

1 foot

1 foot
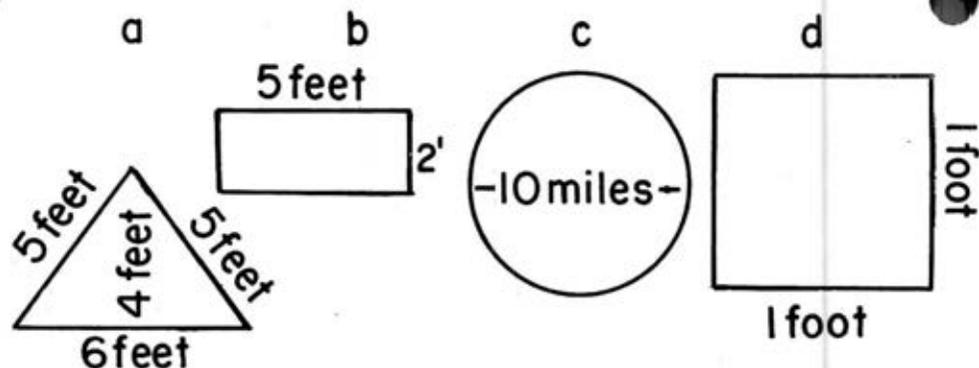
67 Which of the above drawings is a square?

68 Which of the above drawings is a triangle?

69 Which of the above drawings represents a square foot?

70 Which of the above drawings is not measured in the same units as the others?

71 What is the area of diagram b?

    a. 7 square feet   c. 14 feet
    b. 10 square feet   d. 10 feet

72 What is the altitude in drawing a?
    a 4 feet   c 6feet
    b 5 feet   d 16feet

73 What is the perimeter of drawing b?

a 7 feet **b** 5 feet   **c** 10 square feet **d** 14 feet

74 What are the above drawings called?

a photographs **b** scale drawings **c** charts **d** diagrams

a	b	c	d

```
     162        $ .36         7           3.
  4)648     24)$8.73     25)175      24,)8.6,4
              72            175           72
             153                         144
             144                         144
              9
```

75 Which of the above examples is a short division example?

76 Which of the above is an uneven division?

77 Which example above contains decimal points?

78 In example c above what would the trial divisor be?

   a 2   b 7   c 17   d 25

79 In example b above to obtain the second partial dividend 153 what number do you bring down?

   a 15   b 3   c 5   d 1

80 In problem d above what does the caret(∧) do?

   a shows the new position of the decimal after multiplying divisor and dividend by 10.

   b it changes the dividend and divisor to whole numbers

   c it takes the decimal point out

   d it changes the value of the quotient

a	b	c	d
$2.00	$.52	$1.25	$1.00

81 Which of the above is equal to 4 half-dollars?

82 Which of the above has a 2 in the cent's place?

83 Which of the above has a 2 in the dime's place?

84 How many dimes does d equal?

a 20   b 10   c 40   d 15

85 How many cents does c equal?

a 25   b 50   c 125   d 100
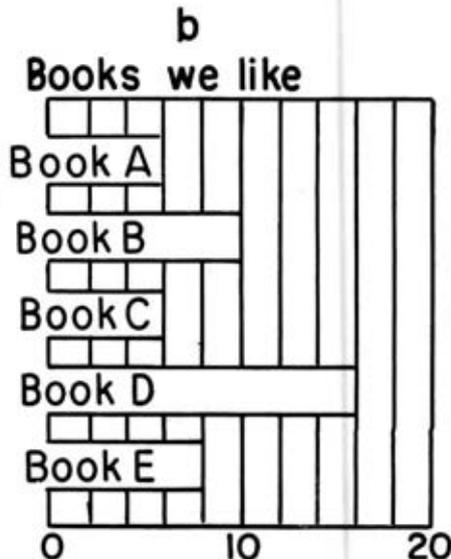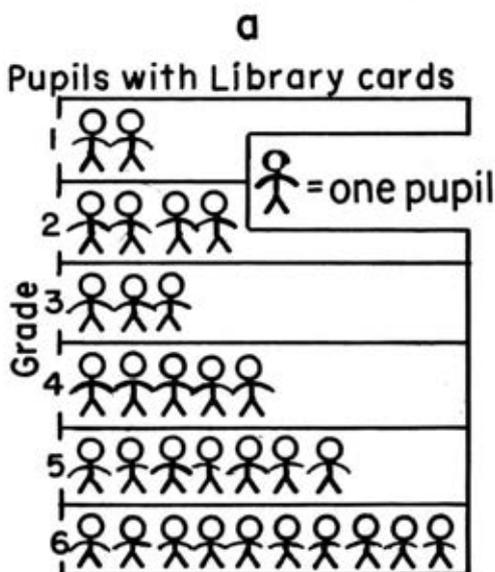
a	b
Pupils with Library cards	Books we like

86 Which of the above is a bar graph?

87 Which of the above is a picture graph?

88 Which of the above is not a graph?

a   b   c   d

89 In which clock is the hour hand point-
ing to 7?

90 When the minute hand of the clock makes
one complete revolution how much time
has gone by?

     a 60 seconds **b** one hour **c** one day **d** 12 hours

91 What does the number in the center of
the speedometer measure?

     a speed   **c** distance per hour
     b miles per hour **d** distance in miles

c
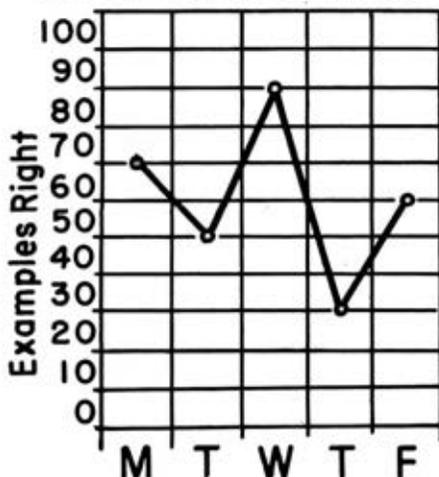
Tom's arithmetic scores

d

My weight chart

DATE	WEIGHT
Sept.15	80 lbs
Oct. 15	81 lbs
Nov. 15	83 lbs
Dec. 15	83 lbs
Jan. 15	85 lbs
Feb.15	86 lbs

Mr. Brown's Garden

10 rods

Scale:
1/8 inch = 1 Rod

16 rods

92 In the scale drawing above, how much would 1 inch be equal to?

    a 2 rods **b** 8 rods **C** 4 rods **d** 2 feet

93 What is the width of the garden plot?

    a 10 rods **b** 16 rods **C** $2\frac{1}{2}$ inches **d** 26 rods

94 The area of this garden would be 160 square rods. What is this equal to?

    a 480 square yards **C** 1 acre
    b 1 square mile   **d** 1600 square feet

95 Which of the following is nearest to one rod?

    a $16\frac{1}{2}$ feet   **C** 10 feet
    b 5 yards   **d** 30 yards

Little Women | Fairy Tales | ROBIN HOOD | Tom Sawyer | HEIDI | Black Beauty | Little Men | BABE RUTH | MOBY DICK | Alice in Wonderland

Reading from Left to Right

96 In which of these places is the book Little Women?

  a Tenth   **c** Second
  b Third   **d** First

97 In which of these places is Babe Ruth?

  a Eighth   **c** Third
  b Seventh   **d** Ninth

98 In which of these places is Moby Dick?

  a Eighth   **c** Ninth
  b Second   **d** Tenth

99 Which book is in the third place on the shelf?

  a Babe Ruth   **c** Little Women
  b Robinhood   **d** Tom Sawyer

100 Which book is in sixth place on the shelf?

  a Tom Sawyer   **c** Heidi
  b Little Men   **d** Black Beauty

Form A - Section III

Directions: In this section of the test there is a choice of four answers for each question just as there was in the section which you have just finished. There is only one correct answer for each question. Begin with number 101 and fill in the lines under the correct letter for your answer. Do not guess. Take your time. Check your work when you have finished.

```
┌─────────┐     ┌─────────┐
│ X X X   │     │ X X X X │
│ X X     │     │ X       │
└─────────┘     └─────────┘
```

101 Which one of these addition facts is not shown by either of the pictures above?

a 3+2=5   b 4+1=5   c 1+4=5   d 2+2=5

102 How would you write eight thousand four hundred thirty-six using numerals?

a 4836   b 8436   c 8CCCXXXVI   d 80436

103 John spent 5¢ for a popsicle, 3¢ for gum and 10¢ for marbles. What was the total amount he spent?

a 8¢   b 15¢   c 18¢   d 13¢

104 In the number 483,264,841   what is the hundred's period?

a 800   b 841   c 264   d 483

BOYS ///// ///// // GIRLS ///// ///

105 Harry counted the number of boys and girls in his classroom as above. What is this called?

a graphing   b scoring   c tallying   d adding

106 Which of the following is not an odd number?

a 17   b 101   c 1   d 18

107 In which of the following examples do you borrow 1 ten?

```
a 433    b 629    c 874    d 678
  182      137      395      282
  ───      ───      ───      ───
  615      166      479      396
```

108 You know how much Mrs. Smith weighs
and how much her son Timmy weighs. How
can you find how much more Mrs. Smith
weighs than Timmy?

a add b subtract c multiply d divide

109 If you know the cost of one bushel of
apples what is the quickest way to find
the cost of 14 bushel?

a. addition   c. multiplication
b. subtraction   d. division

110 Which bird is twice as tall as the
chicken?

a   b   c   d

111 Bob is asked to find the difference be-
tween $12.06 and $2.98. What should
he estimate as the answer?

a $10   b $11   c $9   d $15

112 Which of the following numbers is
written in the money system?

a 8:32 b 84.32 c $84.32 d 84$32¢

113 What must we do in order to average
seven numbers?

a add the seven numbers
b multiply the seven numbers to-
gether and divide by seven
c add the seven numbers together
and divide by seven
d find the middle number of the seven

114 Which of the following figures is a cube?

a   b   c   d

115 Which one of the following fractions
     does not exactly equal one-half?

a $\frac{4}{8}$ b $\frac{14}{29}$ c $\frac{400}{800}$ d $\frac{3\frac{1}{2}}{7}$

116 Which of the following division example
     does not come out evenly?

a $16 \div 2$ b $16 \div 4$ c $16 \div 6$ d $16 \div 8$

117 Which of the following numbers is a
     hundred million?

a 100,000 b 100,000,000 c 10,000 d 10,000,000

118 Which of the following lines is horizontal?

a   b   c   d

119 Which of the following figures is a
     right angle?

a   b   c   d

120 Ann visited her cousin for 2 weeks. How many days did she stay?

a 7   b 21   c 13   d 14

121 What is the eleventh month of the year?

a September   b October   c November   d December

122 Which of the following numbers is not divisible by 4?

a 16   b 8   c 24   d 18

123 What would 6,743,650 be rounded off to the nearest million?   d 7,743,000

a 6,800,000   b 7,000,000.   c 6,000,000

124 Which of the following is a zero?

a 4.   b .3   c 0.   d −.2

125 If you were asked to write ten million in figures, how many zeros would you use?

a 6   b 7   c 8   d 10

126 Joan needs to know the volume of a box she is using to pack cookies in. What does volume mean?

a the area of the bottom
b the depth of the box
c the amount the box will hold
d the net weight of the box

127 On a Farhenheit thermometer what is the freezing point of water?

a 0°   b 32°   c 100°   d 212°

128 Which of the following figures is not divided into equal parts?
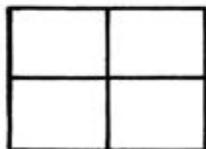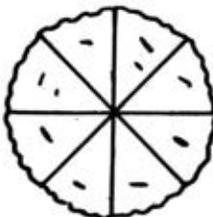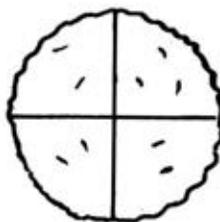
a   b   c   d
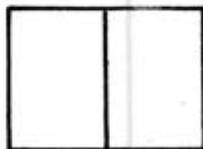
A

129 The fifth grade used a gross of pencils during the school year. How many pencils did the class use?

a 288   **b** 5 for each pupil   **c** 144   **d** 500

130 If you were to go to a horse race you might hear the announcer refer to the length of the track in furlongs. What is a furlong?

a the distance around the track
b one-half mile
c one-eighth of a mile
d one-sixth of a mile

131 Which of the following is the best estimation for **4362** plus **3948** ?

a 7000 **b** 8000 **c** 9000 **d** 1000

132 Jimmy read on a can of peas that the net weight was 14 ounces. What does net weight mean?

a the weight of the peas
b the weight of the can
c the weight of the peas plus the weight of the can
d the weight of the peas minus the weight of the can

133 Which pie is divided into halves?

a   b   c   d

134 Jay learned in science that if he were on the moon his weight would only be equivalent to 14 pounds on earth. What does this mean?

    a his weight on the moon would equal 14 pounds

    b his weight would be minus 14 pounds

    c he would add 14 pounds to his weight on earth

    d his weight would be the same on earth and on the moon

135 John's brother who is in the Navy wrote that his ship had gone 250 nautical miles in one day. What does nautical mile mean?

    a the same as a land mile

    b about 1/7 less than a land mile

    c twice as much as a land mile

    d about 1/7 more than a land mile

136 Sally's father said the average rate of his car was 40 miles per hour. What does this rate mean?

    a the number of gallons of gas the car uses

    b the distance the car travels

    c the speed of the car

    d the time for travelling one mile

137 How many 100 pound bags of coal would it take to make one ton?

    a 20   **b** 2   **c** 200   **d** 2000

138 Jack ran the 100 yard dash in the school field day. How many feet did he run?

    a 300   **b** $33\frac{1}{3}$ **c** 10   **d** 1000

139 In which of the following fractions is the numerator 3?

    a $\frac{13}{14}$ **b** $\frac{4}{3}$ **c** $\frac{3}{4}$ **d** $\frac{30}{30}$

140 Which of the following fractions can be reduced?

    a $\frac{2}{7}$ **b** $\frac{1}{8}$ **c** $\frac{11}{12}$ **d** $\frac{3}{15}$

141 How do we write any decimal?
write the numerator and show the
a denominator by the position of the point
b write the denominator and show the
numerator by the position of the point
c write the numerator over the denominator
d write the number with a point in front
of it

142 In doing the above example $\frac{4}{5} \times \frac{3}{82} = \frac{3}{10}$
Peter used cancellation before he multiplied
What does this mean?
a he inverted the fraction
b he divided the numerator and denominator by 4
c he crossed out the 4 and 8
d he reduced the fractions $\frac{4}{5}$ and $\frac{3}{8}$

143 Which of these fractions is in simplest form?

a $\frac{4}{10}$ b $\frac{50}{100}$ c $\frac{6}{7}$ d $\frac{3}{18}$

144 How would you write one hundredth as a common
fraction?   a $\frac{1}{100}$ b .01   c $\frac{100}{1}$ d $\frac{.01}{100}$

145 How would you write six hundred thousandths
as a decimal? $\frac{6}{}$
a .006   b .0006   c $\overline{100,000}$ d .00006

146   Which of the following fractions
shows $\frac{5}{10}$ in higher terms?
a $\frac{1}{2}$ b $\frac{5}{100}$ c $\frac{10}{20}$ d $\frac{15}{20}$

147 Which of the following are unequal fractions?
a $\frac{5}{10}, \frac{1}{2}$ b $\frac{3}{8}, \frac{3}{4}$ c $\frac{1}{6}, \frac{2}{12}$ d $\frac{3}{10}, \frac{30}{100}$

148 What is the smallest common denominator for $\frac{1}{3}, \frac{1}{4}, \frac{1}{8}$?
a 24   b 12   c 3x4x8   d 8

149 What are the terms of a fraction?
a the reductions that need to be made
b the value of the fraction
c the size of the denominator
d the numerator and the denominator

150 Which of the following is written in
decimal form?
a 2:10   b 4ft 3in   c 43%   d 3.1416

arithmetic vocabulary test

prepared for Grades 4, 5, & 6.

Directions: This test is made up of three sections. In section I there are groups of five words or expressions with seven possible answers, lettered a,b,c,d,e,f and g, above or beside them. There is only one answer for each word or a total of 5 answers for each group of five words. In each group of five words there are two extra answers which do not belong to any of the words.

On your answer sheet you will find numbers that are the same as the numbered words or expressions on your test. To the right of each number are seven spaces marked a,b,c,d,e, f,g. These are your answer spaces. They are the same as the lettered answers in your test booklet. Fill in the space which is the same as the correct answer for the numbered word.

Do not guess. If you do not know the answer to a word, skip it and go on to the next word. If you wish to change an answer, be sure to erase the first word completely. Keep going and finish all 60 of the words in Section I. Take as much time as you need to finish the test.

In section I some of the answers are marked with arrows and some are just lettered as you will see in the sample test items below.

Do these sample items with your teacher.

$$534 \leftarrow a$$
$$605 \leftarrow b$$
$$142$$
$$\overline{1281} \leftarrow c$$

1 addition example
2 sum
3 difference
4 minuend
5 column

$$56 \leftarrow d$$
$$23 \leftarrow e$$
$$\overline{33} \leftarrow f$$
$$ \leftarrow g$$

a $\dfrac{1}{24}$ b $\dfrac{6}{5}$
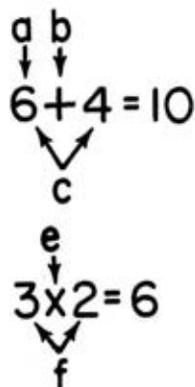
6 one-quarter
7 mixed number
8 improper fraction
9 incomplete decimal
10 one twenty-fourth

e $\dfrac{1}{4}$ f .2400

c $.33\dfrac{1}{3}$ d $3\dfrac{1}{2}$
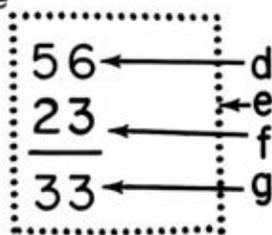
g 6.25
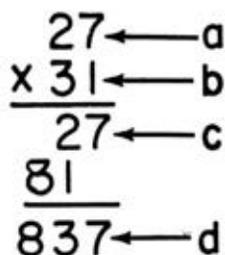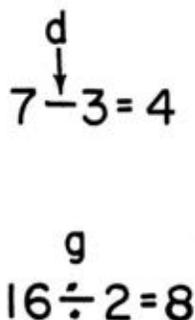
1 subtraction example
2 subtrahend
3 addends
4 total
5 remainder

$$56 \quad \begin{matrix}\leftarrow a\\ \to b\end{matrix}$$
$$23$$
$$\overline{79} \leftarrow c$$

$$56 \leftarrow d$$
$$23 \begin{matrix}\leftarrow e\\ \to f\end{matrix}$$
$$\overline{33} \leftarrow g$$

a b
$$6+4=10$$
c

e
$$3\times2=6$$
f

6 minus
7 division sign
8 factors
9 digit
10 plus sign

d
$$7-3=4$$

g
$$16\div2=8$$

$$27 \leftarrow a$$
$$\times 31 \leftarrow b$$
$$\overline{27} \leftarrow c$$
$$81$$
$$\overline{837} \leftarrow d$$

11 multiplicand
12 dividend
13 product
14 remainder
15 first partial product

$$17 \leftarrow e$$
$$31\overline{)543} \leftarrow f$$
$$31$$
$$\overline{233}$$
$$217$$
$$\overline{16} \leftarrow g$$

a   b
XII   =

c   d
12   X

16 Roman number
17 Arabic numeral
18 means "dollars"
19 means "equal to"
20 means "to multiply"

e   f
¢   ÷

g
$

a

1+1 = 2
2+2 = 4
3+3 = 6
4+4 = 8
5+5 = 10

b

1	17	16	6
14	8	7	11
10	12	13	5
15	3	4	18

c

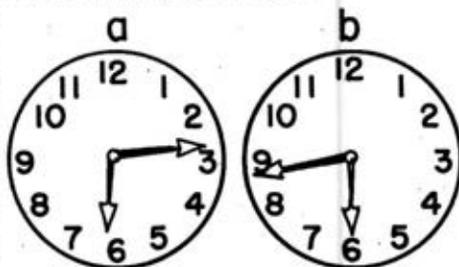|	LEAVES
Boston	7:45
Lynn	8:16
Saugus	9:04
Salem	10:01
Beverly	10:10
Gloucester	10:37

21 subtraction family

22 magic square

23 timetable

24 table of doubles

25 division table

a   b

26 5 minutes to 6

27 5 minutes past 6

a	b	c	d	e	f	g
8	$\frac{6}{5}$	$\frac{1}{2}$	6.43	$\frac{1}{20}$	$4\frac{1}{2}$	.20

31 mixed decimal

32 proper fraction

33 decimal fraction

34 whole number

35 one-twentieth

d	e	f	g	
			CITY	temperature
1X2=2X1	2÷2=1	8-5=3		
3X2=2X3	4÷2=2	18-5=13	Chicago	72°
4X2=2X4	6÷2=3	28-5=23	New York	76°
5X2=2X5	8÷2=4	38-5=33	Boston	70°
6X2=2X6	10÷2=5	48-5=43	St. Louis	81°

c   d   e   f

g

28   6 o'clock

29   quarter of 6

30   quarter after 6

d   e   36 one-half of the circle
                    shaded
               37 three-fourths of the
                    circle shaded
               38 five-eighths of the
                    circle shaded
          f   39 two-ninths of
          g   circle shaded
               40 nine-sixteenths
                    of the circle
                    shaded
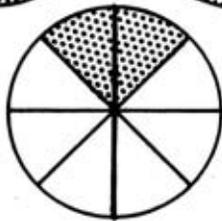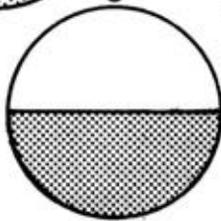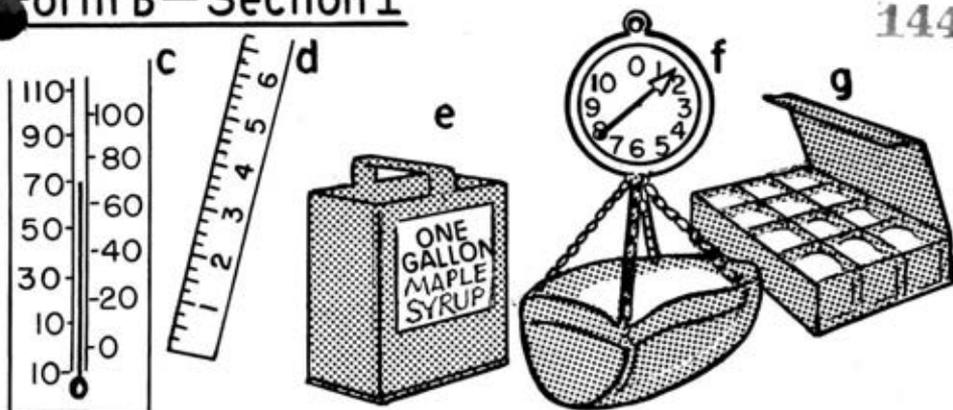
	a	b

41 temperature

42 liquid measure

43 dozen

44 linear measure

45 hundredweight

100 pounds   1 BU.

· ·

46 square feet

47 inches

48 bushel

49 pint

50 minutes

· ·

51 leap year

52 decade

53 quart

54 week

55 ounce

· ·

56 budget

57 value

58 interest

59 deposit slip

60 tax

c **d** **e** **f** **g**

ONE GALLON MAPLE SYRUP

a the amount of coffee in a man's lunch box
b size of a vegetable garden
c potatoes at the store
d time for running 100 yard dash
e ice cream for 12 persons
f time for arithmetic lesson
g boy's belt size

a 366 days
b 365 days
c 1/16 pound
d 10 years
e 7 days
f 2 pints
g 100 years

a the worth of any object
b a record of how much a person wishes to put in the bank
c a money charge laid upon persons or property for public purposes
d a record of money received and spent
e amount paid for the use of money by the person to whom the money is loaned
f a sum of money put into the bank
g an estimate of what one expects to spend

Section II

Directions: In this section of the test you will see that there are groups of questions about drawings or numbers above or beside them. There are only four possible answers for each question which you will find under the drawing or numbers or in the choices of answers under the questions.

You will fill in the space which is the same as the correct answer just as you did in Section I. Turn your answer sheet over and find number 61. This is where you will start after we do the sample test item.

Take your time. Do not guess. Check your work. You may go on to Section III when you complete Section II. When you have finished you may checkyour work in Section III and wait for your classmates to finish.

Do the sample test item with your teacher.

a	b	c	d
16.2	14.3	06.5	11.2

<u>Gasoline Pump Meters</u>

3. Which meter above has a 3 in the tenth's place?

4. How many figures are there in each meter?

a 3   b 2   c 1   d 4

a	b	c	d
42601.6	01240.1	90762.5	80353.0

Readings on an Automobile Speedometer

61 Which reading shows a 6 in the ten's place?

62 Which reading shows a 2 in the hundred's place?

63 Which reading shows a 2 in the one's place?

64 Which reading shows a zero in the ten thousand's place?

65 How many places are there in the whole number part of each speedometer?

    a 1   b 4   c 6   d 5

66 What would the speedometer reading of 42601.6 be rounded to the nearest whole number?
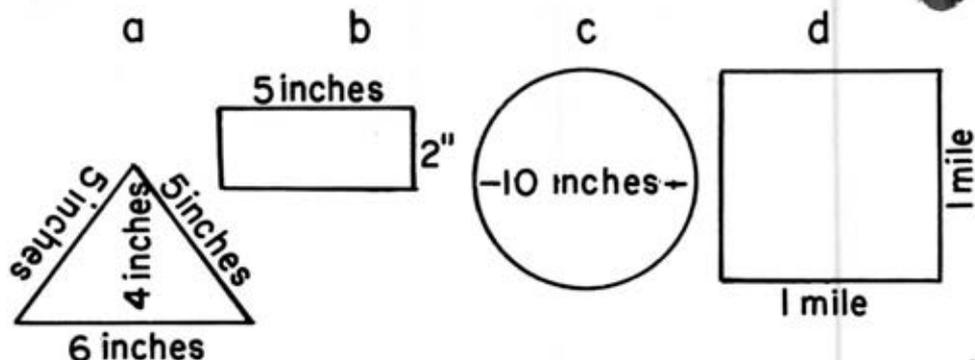
    a 43,000 b 42,600 c 42,602 d 42,601

a	b	c	d

a – triangle: 5 inches, 5 inches, 4 inches, 6 inches

b – rectangle: 5 inches, 2"

c – circle: ⟵10 inches⟶

d – square: 1 mile, 1 mile

67 Which of the above drawings is a circle?

68 Which of the above drawings is a rectangle and not a square?

69 In which of the above drawings is the unit of measure <u>not</u> inches?

70 Which of the above drawings represents a square mile?

71 What is a square mile called?

a. an acre   b. a rod   c. a block   d. a section

72 What is the height of drawing a?

a   4 inches   c   6 inches
b   5 inches   d   10 inches

73 What is the 10 inch line on drawing c called?
a radius   b circumference   c diameter   d semi-circle

74 What might we call the above drawings?

a photographs   b scale drawings   c charts   d figures

a   b   c   d

$4\overline{)24}$ $28\overline{)\$1.98}$ $\begin{array}{r}4.28\\\times 1.2\end{array}$ $.016\overline{)9.6}$

75 Which of the division examples above could
     be done without using long division?

76 Which example above contains a cent point?

77 In example b what would you use as
     your trial quotient?
     a 9   b $1.98   c 28   d 2

78 In example d in order to multiply both
     divisor and dividend by 1000
     what must you do?

     a move the points to the left
     b make the divisor and dividend
            both two-place numbers
     c annex two zeros in the dividend
     d move the point one place in both
            the divisor & dividend

79 In example c above, how many places
     will you point off in the answer?
     a 2   b 3   c 1   d 5

80 How can you tell an example is
     an even division?

     a it has no decimal point
     b it can be done by short division
     c it has an even number divisor
     d it has no remainder

$$\overset{a}{\$2.00} \qquad \overset{b}{\$.52} \qquad \overset{c}{\$1.25} \qquad \overset{d}{\$1.00}$$

81 Which of the above is equal to 8 quarters?

82 Which of the above is one dollar?
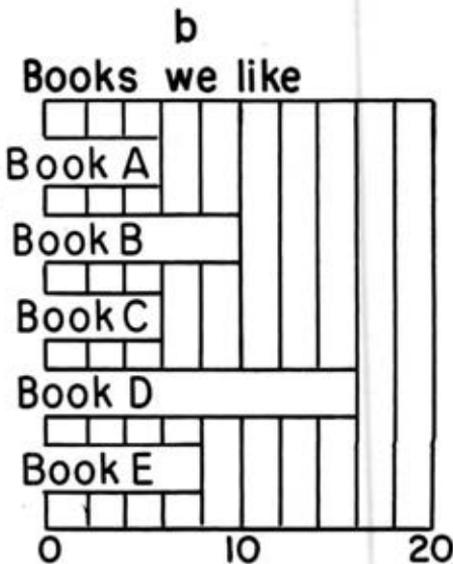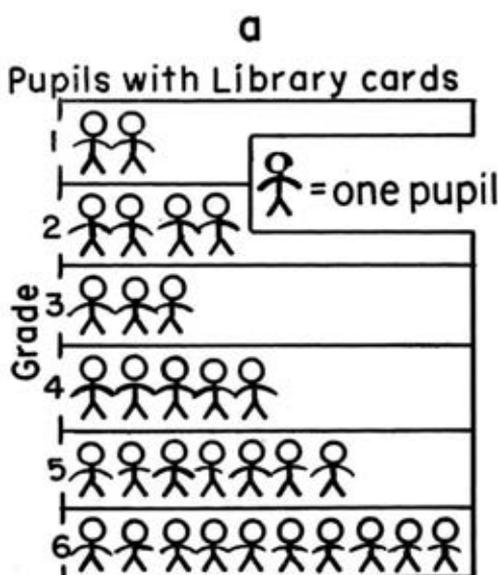
83 Which of the above has a 2 in the dollar's place?

84 How many nickels does d equal?
   a 20   b 10   c 40   d 15

85 How many pennies does c equal?
   a 25   b 50   c 125   d 100

a
Pupils with Library cards

= one pupil

b
Books we like

86 Which of the above is a circle graph?

87 Which of the above is a pictograph?

88 Which of the above is a line graph?

a   b   c   d

89   In which clock is the minute hand
pointing to 7 ?

90   In the speedometer, in what unit is the
speed of the auto measured?

    a miles   **c** in miles-an-hour
    b miles per minute **d** in hours

91   When the minute hand of a clock makes a full
turn in an hour's time, how far do we say
it has gone?

    a 60 seconds   **c** one revolution
    b one day   **d** one half-circle

        c   d

Tom's arithmetic scores

How Mary spends her day

Sleep 9 hours

School 6 hours

Play 7 hours

Meals 2

Examples Right: 100 90 80 70 60 50 40 30 20 10 0

M T W T F

Mr. Brown's Garden · 10 rods

16 rods

Scale: $\frac{1}{8}$ inch = 1 Rod

92 In the scale drawing above, how much would 1 inch be equal to?

    a 2 rods   b 8 rods   c 4 rods   d 2 feet

93 What is the length of the garden plot?

    a 4 inches b 16 rods c 10 rods d 26 rods

94 The garden covers an area of one acre. How many square rods is this?

    a 100   b 160   c 1000   d 16

95 What would you list as the dimensions of this garden plot?

    a 16 roas by 10 rods   c 10 rods

    b 16 rods   d $\frac{1}{4}$ inch = 1 rod
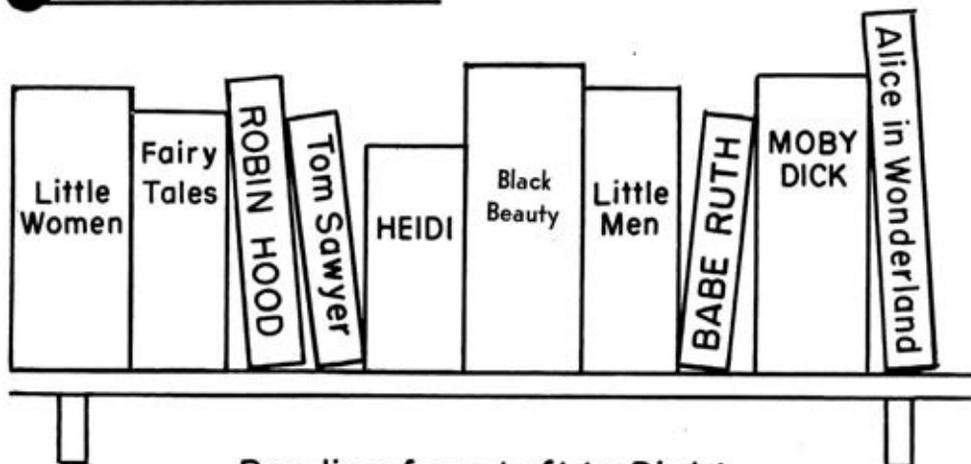
Little Women | Fairy Tales | ROBIN HOOD | Tom Sawyer | HEIDI | Black Beauty | Little Men | BABE RUTH | MOBY DICK | Alice in Wonderland

Reading from Left to Right

96 On the bookshelf above which book is in the second place?

    a Moby Dick   c Fairy Tales
    b Robinhood   d Little Women

97 What is the fourth book called?

    a Tom Sawyer   c Little Men
    b Little Women   d Heidi

98 What book is the tenth on the shelf?

    a Little Women   c Alice in Wonderland
    b Moby Dick   d Black Beauty

99 Which place is Heidi in?

    a Fourth   c First
    b Sixth   d Fifth

100 Which place is Little Men in?

    a Third   c Fourth
    b Seventh   d Sixth

Form B - Section III

Directions: In this section of the test there
is a choice of four answers for each question
just as there was in the section which you
have just finished. There is only one correct
answer for each question. Begin with number
101 and fill in the lines under the correct
letter for your answer. Do not guess. Take
your time. Check your work when you have
finished.

101 How does a sign help you?

  a it helps you add
  b it tells you what to do
  c it tells you what the answer is
  d it checks the answer

102 How would you write eight dollars and thirty-four cents in figures?

  a $834   **b** 8.34   **c** $8.34   **d** 8.34c

103 Which of the following is an amount?

  a. a cow and a horse
  b. a sum of money
  c. a suit
  d. a housenot paid for

104 If you said each set of numbers out loud, which would be counting?

  a 3-8-4-1 **b** 4-0-8-0 **c** 1-2-3-4 **d** 10-14-18-20

105

| | | | | | | 8 |

| | | | | | | 9 |

Mary's class in arithmetic used strips of squares like those above to help in learning addition and subtraction facts. What are these called?

  a square inches **b** addends **c** counters **d** flash cards

106 Which of the following is not an even number?

  a 20   **b** 17   **c** 104   **d** 6

107 In which of these addition examples do you carry a ten?

  a 43+71=114 **b** 352+104=456 **c** 241+163=404 **d** 147+235=382

108 Harry worked on a farm three days picking apples and earned $2.52 the first day, $3.01 the second day and $2.75 the third day. How can you find how much he earned in all?
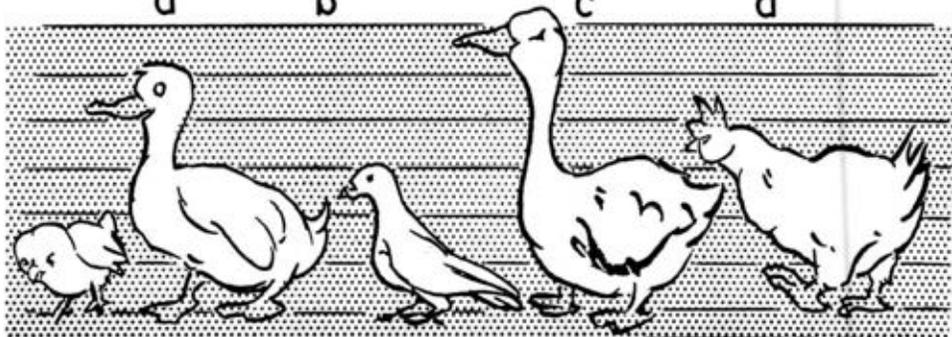
    a   add   **b**   subtract   **c** multiply **d** divide

109 If you know the cost of 14 bushels of apples, what is the quickest method to fins the cost of one bushel?

    a   addition   **c**   multiplication
    b   subtraction   **d**   division

110 Which bird is 3 times as tall as the chicken?

    a   **b**   **c**   **d**

111 Bob is asked to find the difference between $12.06 and $2.98. Which of the following would be the best estimate?

    a $10   **b** $11   **c** $9   **d** $15

112 Which number means the most money?

    a $364.   **b** $85.79   **c** $359.43 **d** $101.02

113 Which of the following groups of marbles can be divided into 2 equal smaller groups?

    a   **b**   **c**   **d**

114 What is the average of any nine numbers?

a   a number which is the sum of the nine numbers
b   the middle number of the nine
c   the number which is obtained by multiplying
    all nine numbers together and dividing by 9
d   a number which is obtained by adding all nine
    numbers together and dividing by nine
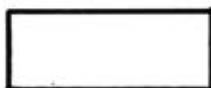
115 Which of the following is a billion?

a 1,000,000   b 10,000,000
        c 1,000,000,000   d 100,000,000

116   The gym teacher said we should always
      know the depth of a pool before swimming
      in it. What is its depth?

      a   how wide the pool is
      b   how deep the pool is
      c   how much area the pool covers
      d   how long the pool is

117   Which of the following shapes is not
      rectangular?

      a   b   c   d

118 Harry built a boat model a foot long.
    How many inches long did he make it?

    a 24   b 1   c 12   d 10

119 Which of the following is not an exact
    equal of $\frac{1}{2}$?

    a $\frac{100}{200}$ b $\frac{3\frac{1}{2}}{7}$ c $\frac{5}{10}$ d $\frac{3}{8}$
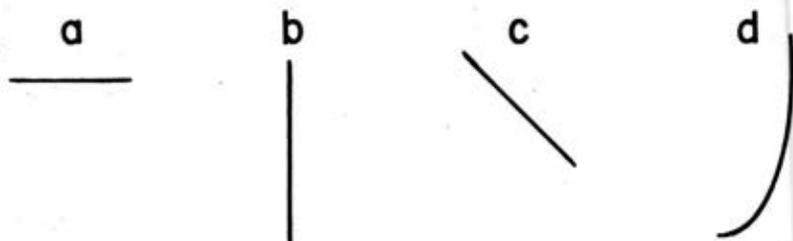
120 Joe bought an arrowhead from Ed for 75¢. He gave Ed one dollar. How much change should Ed give Joe?

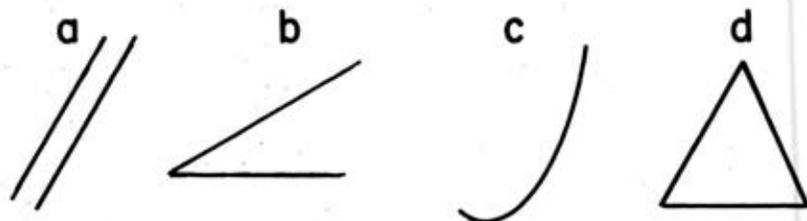a 75¢   b $1.00   c 50¢   d 25¢

121 Which of the following divisions does **not** come out even?

a 16÷2   b 16÷4   c 16÷3   d 16÷1

122 Which of the following is a vertical line?

a   b   c   d

123 Which of the drawings below is an angle?

a   b   c   d

124 Which has the largest number of surfaces?

a   a piece of string   c a sheet of paper
b   a ball   d a brick

125 How would you round off 850,621 to the nearest hundred thousand?

a 850,000 b 900,000 c 950,621 d 9,000,000

126 Which of the following packages weighs the most?

a   b   c   d

8 ounces   1 pound   6 ounces   30 ounces

127 What is the boiling point of water on a Fahrenheit thermometer?

a 32°   b 100°   c 212°   d $2.12

128 The thermometer shows the temperature. What do the numbers stand for?

   a the number of degrees
   b the number of Fahrenheit
   C the amount of heat
   d the amount of cold

129 Henry is running in the mile race at the track meet. How far must he run in feet.

a 5000   b 5820   c 5280   d 1000

130 Sailors use the term fathom on board ship. What does fathom measure?

   a how deep the water is
   b how fast the ship is traveling
   C how many nautical miles traveled
   d how many miles you have traveled

131 When your teacher orders arithmetic paper for your class she asks for reams. What does ream mean?

   a the number of packages
   b the number of pieces
   C a package containing 500 sheets
   d a package containing 1000 sheets

132 John's brother in the Navy used the term knot in a letter to the class. What are knots used to measure?

   a the distance to the nearest land
   b the time it will take to reach land
   C the depth of the water
   d the speed of the ship

133 Mary's father delivers oil by the barrel to her school. About how many gallons does a barrel contain?

a 55   b 30   c 100   d 10

134 Sam won a prize at the fair for eating two whole pies. Which picture below shows what he ate?

a   b   c   d
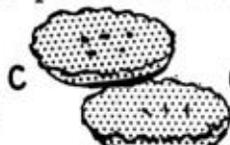
135 In the number 407 the zero is used as a placeholder. What does this mean?

a zero is the only placeholder in the number
b there are no tens in the ten's place
c the zero does not need to be in the number
d there are no hundreds in the hundred's place

136 In which case has the fraction $\frac{8}{6}$ been inverted?

a $\frac{11}{3}$ b $\frac{4}{3}$ c $\frac{6}{8}$ d $\frac{16}{12}$

137 Which of the following fractions is reduced to lowest terms?

a $\frac{6}{8}$ b $\frac{50}{100}$ c $\frac{3}{6}$ d $\frac{2}{7}$

138 In one week only 2 days were sunny. What fractional part of the week was sunny?

a $\frac{5}{7}$ b $\frac{5}{7}$ c $\frac{2}{7}$ d $\frac{2}{5}$

139 Which of the following is a common denominator for $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{8}$?

a 12   b 8   c 24   d 16

140 Which of the following are like fractions?

a $\frac{1}{4}$, $\frac{1}{6}$ b $\frac{1}{10}$, $\frac{1}{100}$ c $\frac{3}{7}$, $\frac{7}{9}$ d $\frac{5}{8}$, $\frac{7}{8}$

141 In which fraction is the denominator 3?

a $\frac{13}{14}$ b $\frac{14}{13}$ c $\frac{3}{8}$ d $\frac{1}{3}$

142 How do we write five-tenths as a common fraction?

a $\frac{10}{5}$　　b $\frac{5}{10}$　　c $\frac{.5}{10}$　　d .5

143 How would you write one fifteenth as a fraction?

a $\frac{1}{15}$　　b .15　　c $\frac{15}{1}$　　d $1\frac{1}{15}$

144 Which of the following is one thousandth written as a common fraction?

a .001　　b $\frac{1}{100}$　　c $\frac{1}{1000}$　　d $\frac{1000}{1}$

145 How would you round off .06357 to the nearest ten thousandth?

a .064　　b .0636　　c .0635　　d .00007

146 Which of the following are unlike fractions?

a $\frac{4}{5},\frac{1}{5}$　　b $\frac{1}{3},\frac{2}{3}$　　c $\frac{6}{10},\frac{8}{10}$　　d $\frac{7}{8},\frac{8}{7}$

147 There are 14 boys and 16 girls in the fifth-grade class. How would you write this as a ratio?

a 14×16　　b $\frac{14}{16}$　　c 16−4　　d 14+16

148 In the example $\frac{14}{5} \times \frac{3}{82} = \frac{3}{10}$ Jim had to cancel before he could multiply. What does cancel mean?

a to cross out 4 and 8
b divide both numerator and denominator by 4
c to reduce the fraction
d to invert the fraction

149 How would you write one millionth as a decimal?

a .0001　　b .000001　　c .0000001　　d $\frac{1}{1000000}$

150 How would you write .018 as a percent?

a 1.8%　　b .018%　　c .18%　　d 1.8

APPENDIX D

By Arthur S. Otis

Grade or group	No. of cases		Measure (Examination)	Form	Date	Examiner	Graphs by	School	City
Variable I			An Arithmetic Vocabulary Test	I					
Variable II			An Arithmetic Vocabulary Test	II					

Variable I				Variable II				PERCENTILE SCALE
Score intervals	Freq-'ncies	Sub-totals	Per cents	Score intervals	Freq-'ncies	Sub-totals	Per cents	

Variable II Score intervals:

75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
0-4

Percentile scale markings: .1 .2 .3 .4 .5 1 2 3 4 5 10 20 30 40 50 60 70 80 90 95 96 97 98 99 .5 .6 .7 .8 99.9

Means of 40.43 and 67.34, Form I
and means of 40.79 and 68.19, Form
II, for lower and upper 27% are
plotted at the 11th and 89th
percentiles respectively.

| dian | | | | Median | | | | |

Standard Deviation Scale   −3 σ   −2 σ   −σ   M   +σ   +2 σ   +3 σ