

**CRITERIA FOR SECTIONING GEOMETRY PUPILS
ACCORDING TO ABILITY**

by

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requirements for the degree of**

Master of Arts

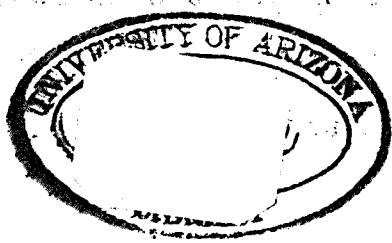
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CONCLUSIONS

This investigation is a study of some of the abilities in predicting geometry success. The Subjects are one hundred twenty-nine pupils of the Tucson High School, found in the first semester of plane geometry. These pupils have been tested for, approximately, six hours per pupil. The results have been analyzed by means of partial and multiple correlation, and it has been found:

1. That each of the abilities investigated show some positive relation to geometry success.
2. That reading ability is a negligible factor in predicting geometry success.
3. That no ability investigated, singly or in combination, shows a sufficient degree of correlation with geometry to justify accurate prediction of geometry success.
4. That the regression equation developed does give a rough method of estimating a pupil's score on the geometry tests.

CHAPTER I.

INDIVIDUAL DIFFERENCES IN ABILITY.

The whole field of tests and measurements is built upon the fact that pupils differ widely in their ability to do school work. A study of physical traits, such as stature, muscular skill and handwriting, and of various mental abilities, such as reading silently, spelling, solving problems in arithmetic, algebra and geometry, reveal a wide variety of scores of the traits measured. If these scores in the different traits are represented graphically, the graphs will show the same general shape. This fact seems to indicate that differences in intellectual ability are as marked, if not more so, as the differences in physical traits of school children. In this regard Rugg states: "School men are agreed on this outstanding fact: children whom we have tried to teach in the same section vary widely in ability. Administrators are asking frankly whether it is not futile to try to fit one course of study and one kind of machinery to such gross differences in capacity."

Rugg, H.R. "A Primer of Graphics and Statistics." P.8

The wide variety in differences in ability found in the same section (or class) is due, first, to the lack of proper measuring instruments for determining the abilities required in the different school subjects, and second, to the lack of proper means of determining these abilities prior to studying the subject.

The writer has attempted to investigate some abilities which might serve as possible sources of predicting geometry success and to establish, if possible, criteria for sectioning geometry pupils according to ability.

ADVANTAGES OF SECTIONING PUPILS ACCORDING TO ABILITY.

The real criterion for sectioning geometry pupils is the ability to do the work. McCall names two advantages of sectioning pupils:

"The first fundamental objective of classifications is to put together those of equal educational status. It is believed that homogeneous groups will make more satisfactory progress, due to the fact that the teacher can teach such a group almost as one pupil. The needs of all pupils then are closely similar. The work can be more exactly adapted to all.

"The second fundamental objective of classification is to put together those who will progress at equal rate. At best, periodic re-classification will be necessary. These will need to be much more frequent if provision is made for equal initial ability only and not for equal rate of progress. Provision should be made for both."

SUMMARY OF PREVIOUS WORK.

There has been only one investigator in this field. In 1918 Minnick made an investigation of abilities fundamental to geometry. This investigation did not attempt to find criteria for sectioning geometry pupils according to ability. So far as the writer has been able to determine the present study is the first and only one in the field.

Minnick, J. H. "An Investigation Of Abilities Fundamental
To Geometry 1918."

CHAPTER II.

SOURCES OF MATERIAL.

Criteria of Success in Geometry.

One of the main difficulties in making an investigation of this type is the lack of proper measuring instruments for determining geometry success. A review of the only standardized geometry test - Minnick's series of geometry tests - shows that:

1. The test material does not cover a wide enough range.
2. The material will not measure the brighter pupils.
3. The method of scoring is too tedious.
4. The reliabilities of the tests are not given.
5. Minnick's tests cannot be shown to be reliable measuring instruments of geometric ability.

The writer has devised five tests to measure geometric accomplishment. The test material is based upon an analysis of text books in geometry. The criteria for selecting the material are:

1. To include as wide a range of geometric operation as possible.
2. To use the material generally taught in the class room.
3. To make the tests objective and easily scored.
4. To reduce to a minimum the amount of writing.
5. To select problems for the best pupils, because of their complex analysis rather than problems which are difficult because of their length.

The tests have been mimeographed and given as standardized tests. They have been given this way for the following reasons:

1. They can be treated in a purely objective way.
2. The conditions of the experiment can be controlled.
3. The tests can be repeated.
4. All the results can be handled statistically.

What the Tests Measure.

There are five geometry tests in all, as follows:

1. Drawing the figure.
2. Stating what is given and what is to be proved.
3. Proof without reason.
4. Proof with reason.
5. Multiple choice.*

* A number of items which make up this test have been taken, with permission, from the Iowa High School Contest Examination.

DRAWING THE FIGURE covers the field of getting a figure to represent the problem. The problems are representative problems and of sufficient range to test the ability of the best pupil as well as that of the poorest pupil.

STATING WHAT IS GIVEN AND WHAT IS TO BE PROVED tests another type of ability. Here the problem is stated and the figure given. The pupil needs to study the statement of the problem and to name in the figure what is given in the problem and to name what is to be proved in the problem.

PROOF WITHOUT REASON is given to determine another type of ability, allowing free play to state a proof without being required to back up each statement with a reason.

PROOF WITH REASON requires logical thinking. The reasons are given at the bottom of the page, for each problem. There is only one problem on a page. The pupil gives his proof and in a parenthesis after each statement he enters the number of the reason which applies to that statement. There is very little writing to do.

THE MULTIPLE CHOICE test covers a number of terms and theorems not covered by the other tests.

The response of the pupils to this type of examination is, indeed, satisfactory. They have expressed their approval, all of them preferring this type of examination to any other.

The Reliability Coefficient for each of the geometry tests is as follows:

1. Drawing the figure.....	.9479
2. Stating what is given and what is to be proved.....	.8646
3. Proof without reason.....	.5310
4. Proof with reason.....	.8136
5. Multiple choice.....	.8946

These tests are divided into halves - one half consists of the even numbered problems or statements, the other half consists of the odd numbered problems or statements. The halves and the total scores have been combined to make up the combined geometry test. This test has a reliability of .890.

Abilities Investigated as Possible Sources of
Prediction of Geometry Success.

The following abilities have been used to furnish
a possible basis for predicting geometry success:

1. Intelligence.
2. Reading ability.
3. Arithmetical ability.
4. Algebraic ability.

The tests used to measure these abilities are:

Otis Self Administering Tests of mental ability.

Higher Examination- Form A. The IQ has
been used as an index of Brightness.

Thorndike-McCall Reading Test-Form 3.

Stanford Achievement Arithmetic Tests- Form A.

a. Arithmetic Computation.

b. Arithmetic Reasoning.

Hotz Algebra Tests- Series A.

The value of each of these tests as measuring instru-
ments of the above abilities depends upon the validity and the
reliability of the tests. The validity of each of the tests for
the measurement of the abilities involved depends upon the manner
in which the material is selected. In regard to his selection of
material, Otis states:

"In selecting items for the Intermediate
and Higher Examinations the Advanced
Examination was drawn upon freely.

An equal number of items of other types, some of which are new, were included in order that the examination might cover a large variety of questions and therefore afford a more comprehensive measure of mental ability. Preliminary editions containing more than enough items were administered to about one thousand high school students in Oakland, California, Rockford, Illinois, and one thousand grammar school pupils in Moorhead, Minnesota. These students were divided in each case, into two groups, a "good group" and a "poor group." The same number were taken from each grade for both groups. The good group constituted the young students, and the poor group the old students. These groups had reached the same average educational status, therefore, but at different rates. Now it is the rate at which the student can progress through school that the mental ability test is chiefly used to predict. Therefore this is believed to be the best criterion by which to judge the validity of each item that goes into the test. The number of times each item was passed by each group was then found, and only those items chosen which showed a distinct gain in

number of passes by the good group over the number of passes by the poor group in spite of the fact that the median age of the good group was over two years less than that of the poor group. Each item justified its inclusion, therefore, because it distinguished between students who progressed slowly and those who progressed rapidly."

The Manual for the Thorndike-McCall Reading Test states nothing in regard to the selection of material included in the test. But in regard to reading ability Thorndike says, in part:

"Understanding a paragraph is like solving a problem in mathematics. It consists of selecting the right elements of the situation and putting them together in the right relations, and also with the right amount of weight or influence, or force for each. The mind is assailed as it were, by every word in the paragraph. It must select, repress, soften, emphasize, correlate and organize, all under the influence of the right mental set or purpose or demand."

Thorndike, E.L. "Reading As Reasoning: A Study Of Mistakes In Paragraph Reading." Journal of Educational Psychology. June 1917.

We may feel confident that the Thorndike-McCall Reading Test is valid because of the knowledge and experience of the authors in this field.

In regard to arithmetical ability the authors of the Stanford Achievement Arithmetic Tests state:

"Test 4- Arithmetic Computation. The selection of problems for the arithmetical computation test was based chiefly upon an analysis of the leading text books in arithmetic. In this manner a collection of eight-seven types of problems in arithmetic was made. These types were then reduced to fifty-six by the combined judgment of the three authors, who rated each type upon the basis of desirability. Three problems of each of the fifty-six types were included in the first try-out, or one hundred eighteen in all. Upon the basis of this try-out, two final forms of forty-seven problems each were constructed, the chief criteria for selection being, (1) the inclusion of as wide a range of distinct types of arithmetical operations as possible; (2) the retention of items known to be generally taught in elementary schools under modern practice; (3) the principle that the necessary difficulty in the upper ranges should be secured by the use of problems involving complex analysis rather than by the use of problems difficult merely because of their length."

"Test 5. Arithmetic Reasoning. The guiding principle in the selection of arithmetical-reasoning problems was that of minimizing the labor and the time necessary for the mere computations involved in reaching a solution. This principle was deemed important for two reasons: (1) The present test should not duplicate the test of arithmetical computations; (2) the method followed permits a more complete measure of the rational processes involved in the solution of the problems. A few problems which involve irrelevant data have been included."

"The original set of problems numbered 233, but these were reduced without further try-out to 144 by the combined ratings for desirability by three judges. The first try-out included three forms of forty-eight problems each, and on the basis of these results two final forms of forty problems each were constructed."

Algebra Tests:

"The scales consist of five different sheets of algebraic exercises designed to measure the ability of pupils in elementary algebra. They are:

1. Addition and Subtraction.
2. Multiplication and Division.
3. Equation and Formula.
4. Graphs.
5. Problems.

"The first two scales, it will be seen, are designed to test the achievement of students in the fundamental operations, involving integral, fractional, and radical expressions; the second two, to test the ability of students in handling the instruments of quantitative thinking; while the last is composed of verbal problems of the type usually stressed in first year algebra."

"The scales were derived from data obtained from tests given to over 16,000 high school students. The schools which cooperated in standardizing the scales varied all the way from the small rural high school to the large cosmopolitan high school. Classes were tested in eighty-four high schools located in the states of Massachusetts,

Connecticut, Rhode Island, New York, Ohio, Wisconsin, Missouri, Oklahoma, Colorado and Washington, and the results subjected to intricate statistical treatment. The difficulty of each exercise, or its position on the scale, was determined by the percentage of pupils solving each exercise correctly."

Teachers' Manual For First Year Algebra Scales. -Hotz. P. 7-8.

Problems making up series A of the Hotz tests are not numbered consecutively. In scoring it has been necessary to re-number and divide each test into two parts, the odd numbered problems making up one part and the even numbered ones making up the other part. All of these tests have been combined into one test by combining all of the odd and all of the even numbered problems- and by combining the total scores. The reliability of the combined tests has been found by treating each half of the combined tests as a separate test.

Reliability Coefficient For Each Test:

Arithmetic-Computation.....	.827
Arithmetic-Reasoning.....	.842
Reading.....	.746
Intelligence (Otis Test).....	.876
Combined Algebra Tests.....	.816

The high reliabilities of these tests show that they are satisfactory measures of the abilities they represent.

CHAPTER III.

TREATMENT OF DATA.

The Correlation of Each of the Tests With Geometry.

Geometry and Arithmetic Computation...	.549
Geometry and Arithmetic Reasoning.....	.543
Geometry and Reading.....	.283
Geometry and Intelligence.....	.505
Geometry and Algebra.....	.596

There is a positive relation between each test and geometry, but this relation, in any case, is not sufficient to justify the use of any of the tests as an accurate means of predicting geometry success. It is interesting to note that, contrary to popular opinion, the relation between geometry and reading is negligible.

Percent of Measurable Differences.

Geometry and Arithmetic Computation...	27.4
Geometry and Arithmetic Reasoning.....	29.0
Geometry and Reading.....	31.4
Geometry and Intelligence.....	33.1
Geometry and Algebra.....	24.0

There is a smaller percent of measurable difference between geometry and algebra than between geometry and either of the other tests. In other words, the correlation between geometry and algebra is higher than between geometry and either of the other tests. This is the conclusion reached from the

correlation coefficient for these two tests. Arithmetic Computation and Arithmetic Reasoning, respectively, are the next in order in their relation to geometry. This is also seen in the coefficients of correlation for each of these tests and geometry. However, reading has a higher correlation with geometry than intelligence has despite the fact that the coefficient of correlation for Geometry and Intelligence is greater than the coefficient of correlation for Geometry and Reading.

CORRELATION BETWEEN THE TESTS.

	Arithmetic-: Computation:	Arithmetic-: Reasoning:	Reading:	Intelligence:	Algebra
Geometry	.549	.543	.283	.505	.596
Arithmetic-: Computation:		.611	.172	.323	.563
Arithmetic-: Reasoning			.249	.390	.581
Reading				.472	.261
Intelligence					.842

Technique Used In Obtaining The Regression Equation.

It is generally recognized that the best tool for the study of educational problems of this type is the partial regression equation. There are several plans for working a partial regression equation, viz, Yule's, Kelley's, Rosenow's, and Huffaker's.

Yule, G. Undy: An Introduction To The Theory Of Statistics, 1919.

Kelley, Truman L.: Chart To Facilitate The Calculations Of Partial Coefficients of Correlations and Regression Equations, 1921.

Rosenow, Curt: The Analysis Of Mental Functions, Psychology Monographs, Vol. XXIV No.5, 1917.

Huffaker, C.L.: A Contribution To The Technique Of Partial Correlations. Journal of Approved Psychology, June 1923.

Huffaker's plan for a six variable problem is used in this study.

Variables.	Reliabilities.
1. Geometry890
2. Arithmetic Computation.....	.827
3. Arithmetic Reasoning.....	.842
4. Reading.....	.746
5. Intelligence.....	.876
6. Algebra.....	.816

Zero Order Coefficients.

$$r_{12} = .549$$

$$r_{13} = .543$$

$$r_{14} = .283$$

$$r_{15} = .506$$

$$r_{16} = .596$$

$$r_{23} = .611$$

$$r_{24} = .172$$

$$r_{25} = .323$$

$$r_{26} = .583$$

$$r_{34} = .249$$

$$r_{35} = .390$$

$$r_{36} = .581$$

$$r_{45} = .472$$

$$r_{46} = .261$$

$$r_{56} = .842$$

Fourth Order Coefficients.

$$r_{12.3456} = .226$$

$$r_{13.2456} = .161$$

$$r_{14.2356} = .035$$

$$r_{15.2346} = .252$$

$$r_{16.2345} = .245$$

The partial regression equation is:

$$x_1 = 1.069x_2 + .922x_3 + .307x_4 + 1.024x_5 + 1.186x_6$$

or, in score form:

$$X_1 = 1.07X_2 + .92X_3 + .31X_4 + 1.02X_5 + 1.19X_6 - 24.792$$

And the total correlation of the composite with the criterion is:

$$R_{1.23456} = .698$$

When reading is eliminated the partial regression equation is:

$$X_1 = 1.064X_2 + .681 X_3 + 1.082X_5 + 1.182X_6 - 11.01$$

And the correlation of the composite with the criterion is:

$$R_{1.2356} = .696$$

From this it is clear that reading has very little value in predicting geometry success.

In this equation

X_1 is the estimated score on the geometry test.

X_2 is the score made on the Arithmetic-Computation test.

X_3 is the score made on the Arithmetic-Reasoning test.

X_4 is the score made on the Intelligence test.

X_5 is the score made on the combined algebra test.

If these scores are known it is possible by use of this equation to give a rough estimate of the possible score on the geometry tests.

LIMITS FOR FAST, NORMAL, AND SLOW PUPILS:

Section.	Score limits for each section.
A	124 and above.
B	93 to 123.
C	up to 92.

Since the mean and P.E. for the criterion are 108 and 15.3, respectively, we obtain the following limits for sectioning pupils:

Section	Limits For Each Section	Percent Of Pupils For Each Section.
A	124 and above	25
E	93 to 123	50
C	Up to 92	25

.....

Illustration showing the application of the Regression Equation:

Pupils	Arith- : metic : Compu- : tation : Score	Arith- : metic : Reason- : ing : Score	Intelli- : gence : Score	Algebra: : Score	Estimated: : Score	Section
22	27	25	54	15	110	B
33	40	33	51	31	146	A
126	26	14	22	13	66	C

APPENDIX.

APPENDIX.

The "Raw Scores" of Each Pupil In Each Measure Used.

Pupil:	Combined: Geometry:	Combined: Algebra	Intelli- gence	Arith- metie Compu- tation:	Arith- metie Reason- ing	Reading
1	89	16	32	32	22	26
2	116	16	39	29	19	29
3	88	15	37	28	24	28
4	115	17	39	32	19	26
5	-	-	35	30	22	28
6	79	19	39	27	26	29
7	119	13	38	36	24	25
8	105	21	40	34	26	29
9	118	22	36	30	26	29
10	88	19	31	30	25	27
11	122	27	53	34	29	31
12	100	19	37	31	23	27
13	90	19	41	29	-	29
14	80	24	38	32	20	30

Pupil:	Combined: Geometry:	Combined: Algebra:	Intelli- gence	Arith- metic Compu- tation:	Arith- metic Reason- ing	Reading
15	-	-	55	24	23	30
16	127	19	54	30	25	30
17	90	17	39	30	21	30
18	98	18	57	31	21	31
19	112	21	49	31	24	31
20	87	20	50	32	28	32
21	156	23	54	37	33	31
22	94	15	33	27	25	29
23	101	22	39	28	26	30
24	111	16	41	27	21	27
25	131	20	43	33	24	28
26	-	20	33	38	27	25
27	127	31	58	39	34	28
28	104	21	39	29	26	28
29	138	18	58	28	25	32
30	137	22	48	41	31	30

Pupil :	Combined: Geometry :	Combined: Algebra :	Intelli- gence :	Arith- metic Compu- tation :	Arith- metic Reason- ing :	Reading
31 :	115 :	24 :	44 :	30 :	23 :	25
32 :	115 :	14 :	- :	32 :	23 :	30
33 :	146 :	31 :	51 :	40 :	33 :	31
34 :	125 :	23 :	47 :	31 :	28 :	32
35 :	142 :	24 :	51 :	30 :	23 :	26
36 :	118 :	18 :	- :	28 :	27 :	31
37 :	127 :	20 :	50 :	39 :	29 :	32
38 :	94 :	19 :	41 :	27 :	24 :	28
39 :	154 :	33 :	45 :	40 :	37 :	30
40 :	125 :	18 :	51 :	36 :	32 :	27
41 :	129 :	21 :	31 :	36 :	29 :	28
42 :	101 :	20 :	53 :	34 :	28 :	28
43 :	119 :	14 :	45 :	38 :	34 :	29
44 :	109 :	19 :	- :	27 :	26 :	27
45 :	113 :	18 :	43 :	31 :	25 :	30

Pupil :	Combined: Geometry :	Combined: Algebra :	Intelli- gence :	Arith- metic Compu- tation :	Arith- metic Reason- ing :	Reading :
46 :	115 :	23 :	48 :	36 :	30 :	30 :
47 :	107 :	17 :	43 :	36 :	18 :	27 :
48 :	- :	17 :	32 :	29 :	19 :	27 :
49 :	- :	- :	29 :	29 :	16 :	29 :
50 :	72 :	- :	41 :	19 :	21 :	28 :
51 :	- :	22 :	33 :	30 :	21 :	28 :
52 :	110 :	20 :	58 :	39 :	29 :	30 :
53 :	81 :	17 :	- :	29 :	21 :	28 :
54 :	94 :	18 :	44 :	31 :	26 :	29 :
55 :	59 :	14 :	41 :	29 :	25 :	28 :
56 :	93 :	22 :	41 :	33 :	27 :	26 :
57 :	121 :	22 :	32 :	39 :	26 :	27 :
58 :	75 :	19 :	49 :	25 :	20 :	30 :
59 :	106 :	18 :	44 :	35 :	29 :	30 :
60 :	145 :	27 :	45 :	36 :	32 :	32 :

Pupil:	Combined: Geometry:	Combined: Algebra:	Intelli- gence	Arith- metic Compu- tation:	Arith- metic Compu- tation:	Reading
61	127	23	35	33	27	27
62	113	17	36	35	27	31
63	77	18	34	32	19	29
64	150	29	48	46	32	32
65	150	32	68	41	31	33
66	144	21	49	33	26	30
67	104	16	38	28	20	27
68	128	19	39	31	20	29
69	-	-	-	31	30	28
70	154	29	61	43	38	31
71	99	17	51	30	23	29
72	115	27	40	41	27	29
73	120	22	46	35	29	30
74	107	22	33	34	25	29
75	-	-	45	32	21	30

Pupil:	Combined: Geometry:	Combined: Algebra:	Intelli- gence	Arith- metic Compu- tation:	Arith- metic Reason- ing	Reading
76	121	22	35	32	25	28
77	89	21	32	29	21	27
78	113	16	37	37	25	31
79	138	27	58	37	35	30
80	102	22	33	30	26	30
81	-	11	-	23	19	30
82	131	32	57	32	23	31
83	93	20	35	38	25	31
84	114	21	36	34	26	29
85	74	15	35	30	18	30
86	78	11	22	29	21	22
87	-	-	64	31	26	31
88	79	18	37	26	24	25
89	69	14	36	24	16	31
90	154	21	48	33	27	29

Pupil :	Combined: Geometry :	Combined: Algebra :	Intelli- gence :	Arith- metic Compu- tation :	Arith- metic Reason- ing :	Reading :
91 :	- :	15 :	46 :	33 :	27 :	30 :
92 :	113 :	20 :	39 :	28 :	25 :	27 :
93 :	- :	- :	44 :	31 :	22 :	31 :
94 :	- :	17 :	39 :	33 :	19 :	32 :
95 :	114 :	20 :	47 :	34 :	21 :	26 :
96 :	110 :	17 :	37 :	33 :	24 :	29 :
97 :	93 :	15 :	25 :	37 :	30 :	30 :
98 :	112 :	18 :	50 :	30 :	22 :	32 :
99 :	- :	- :	- :	21 :	18 :	30 :
100 :	124 :	25 :	51 :	41 :	32 :	26 :
101 :	- :	- :	40 :	33 :	31 :	31 :
102 :	117 :	26 :	52 :	33 :	26 :	30 :
103 :	105 :	27 :	43 :	37 :	28 :	31 :
104 :	88 :	10 :	38 :	27 :	16 :	29 :
105 :	136 :	21 :	48 :	34 :	27 :	30 :

Pupil:	Combined: Geometry:	Combined: Algebra :	Intelli- gence :	Arith- metic : Compu- tation:	Arith- metic : Reason- ing :	Reading
106	39	13	31	32	24	30
107	138	21	38	31	24	30
108	111	21	35	32	29	31
109	98	9	40	24	21	29
110	136	31	42	36	28	27
111	68	24	32	31	24	28
112	118	19	42	32	27	25
113	101	18	36	36	28	27
114	121	21	62	33	25	32
115	116	17	43	22	24	30
116	89	16	36	30	30	27
117	129	15	44	26	22	27
118	78	14	24	38	25	25
119	91	23	38	35	29	29
120	102	17	38	32	26	30

Pupil:	Combined: Geometry:	Combined: Algebra :	Intelli- gence :	Arith- metic : Compu- tation:	Arith- metic : Reason- ing :	Reading
121	94	22	48	39	24	26
122	83	14	43	23	21	28
123	94	17	30	29	21	27
124	120	18	50	35	30	31
125	124	14	48	24	23	28
126	66	13	22	26	14	26
127	102	16	21	29	24	24
128	123	22	52	38	26	31
129	123	25	45	31	25	26

GEOMETRY TEST.

Read this page. Do what it tells you to do.

Do not open this paper or turn it over until you are told to do so. Fill these blanks by giving your name, age, birthday, etc. Write plainly.

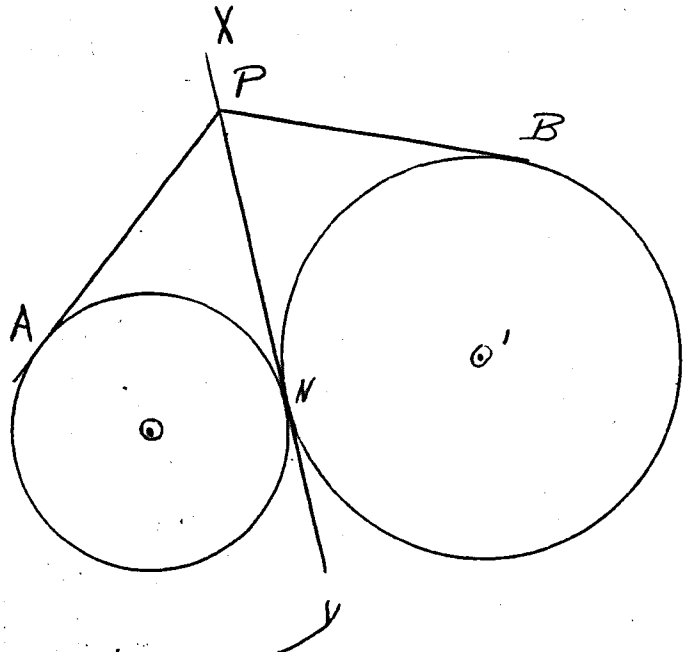
Name.....Age last birthday.....years.
Birthday.....Class.....Date.....19...
School.....City.....

This is a geometry test. On the sheet which you have received are exercises from geometry. When the signal to begin work is given, fold back the cover sheet, read one of the exercises carefully, and then in the space provided draw the figure for the exercise. Then read another and draw the figure for it. Draw the figure as accurately as possible but you need not make actual constructions. Do not attempt to prove the exercise. Simply draw the figure. You may do the exercises in any order you care. You will have thirty minutes in which to complete the work.

Here is a sample problem: Study it.

Theorem I.

If two circles are tangent externally, the tangents to them from any point of the common internal tangent are equal.



Form A.

Draw the figure for the following proposition.

- II. The line drawn from the center of a circle to the point of intersection of two tangents is the perpendicular bisector of the chord joining the points of contact.

Draw the figure for the following proposition.

- II. If two common external and two common internal tangents are drawn to two circles, the line-segments intercepted between the points of contact are equal.

Form A.

Draw the figure for the following proposition.

- III. In a triangle ABC the side BC is bisected at P and AB is bisected at Q. AP is produced to R so that AP equals PR, and CQ is produced to S so that CQ equals QS. Prove that S, B, and R are in a straight line.

Draw the figure for the following proposition.

- IV. The perpendicular drawn from the point of intersection of the medians of a triangle to a line without the triangle is equal to one-third the sum of the perpendiculars from the vertices of the triangle to the line.

Form A.

Draw the figure for the following proposition.

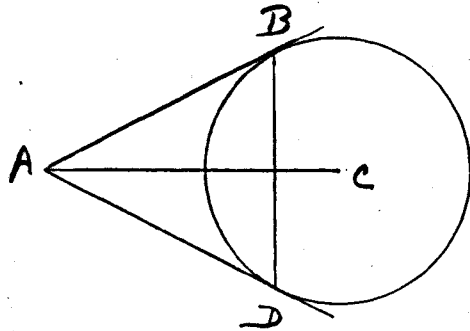
- V. The bisectors of the angles included between the opposite sides (produced) of an inscribed quadrilateral intersect at right angles.

ANSWERS

Form A.

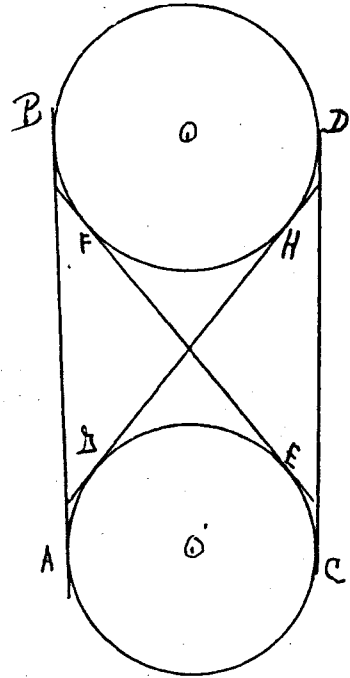
Problem I.

- | | Score |
|------------------------------------|----------|
| 1. Draw circle whose center is C.. | 1 |
| 2. Draw a tangent AB..... | 1 |
| 3. Draw a tangent AD..... | 1 |
| 4. Draw AC..... | 1 |
| 5. Draw BD..... | 1 |
| | <u>5</u> |



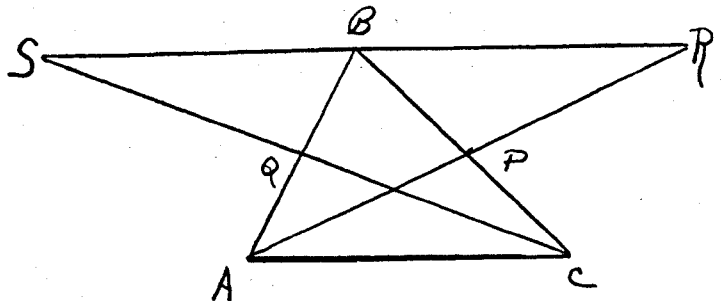
Problem II.

- | | Score |
|---|----------|
| 1. Draw circle O ₁ | 1 |
| 2. Draw circle O ₂ separate from circle O ₁ | 1 |
| 3. Draw a common external tangent AB.. | 1 |
| 4. Draw a common external tangent CD.. | 1 |
| 5. Draw a common internal tangent GH.. | 1 |
| 6. Draw a common internal tangent EF.. | 1 |
| | <u>6</u> |



Problem III.

- | | Score |
|------------------------------------|----------|
| 1. Draw triangle ABC..... | 1 |
| 2. Draw median AP..... | 1 |
| 3. Draw median CQ..... | 1 |
| 4. Produce AP to R so that PR=AP.. | 1 |
| 5. Produce CQ to S so that QS=CQ.. | 1 |
| 6. Draw SBR..... | 1 |
| | <u>6</u> |



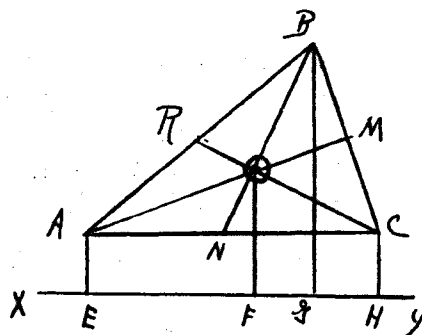
ANSWERS

Form A.

Problem IV.

- | | Score |
|--|----------|
| 1. Draw a scalene triangle ABC..... | 1 |
| 2. Draw medians BN, CR, AN intersecting at some point O..... | 1 |
| 3. Draw XY any line without triangle ABC..... | 1 |
| 4. Draw AE perpendicular to XY..... | 1 |
| 5. Draw OP perpendicular to XY..... | 1 |
| 6. Draw BG perpendicular to XY..... | 1 |
| 7. Draw CH perpendicular to XY..... | <u>1</u> |

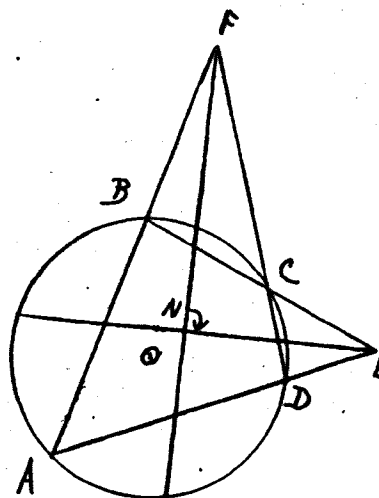
7



Problem V.

- | | Score |
|---|----------|
| 1. Draw circle whose center is O.. | 1 |
| 2. Inscribe the quadrilateral ABCD..... | 1 |
| 3. Produce AB and CD to meet at F.. | 1 |
| 4. Produce BC and AD to meet at E.. | 1 |
| 5. Draw FN, the bisector of angle AFD..... | 1 |
| 6. Draw EN, the bisector of angle BEA meeting FN at some point N..... | <u>1</u> |

6



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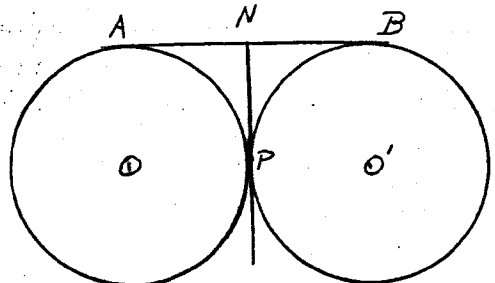
This is a geometry test. On the sheet which you have received are exercises from geometry. When the signal to begin work is given fold back the top sheet, read one of the exercises carefully, and then in the space provided state what is given and what is to be proved in the exercise. Then proceed in the same manner with each of the other exercises. State carefully and exactly what is given and exactly and fully what is to be proved. Do not attempt to prove the exercises. Just state what is given and what is to be proved. You may do the problems in any order that you care. You have thirty minutes in which to complete the work.

Here is a sample exercise:

Theorem: If two circles tangent externally are tangent to a line AB at A and B, their common internal tangent bisects AB.

Given: Circle O and circle O' tangent externally at P.
Circle O tangent to AB at A.
Circle O' tangent to AB at B.
NP is the common internal tangent meeting AB at N.

To Prove That: AN = NB.



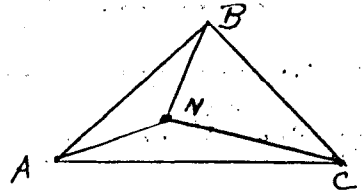
DO NOT TURN OVER THE PAGE UNTIL THE SIGNAL IS GIVEN.

Form B.

State what is given and what is to be proved in the following exercise.

I. Problem: The sum of the distances of any point within a triangle from the three vertices of a triangle is greater than half the sum of the sides.

Given:

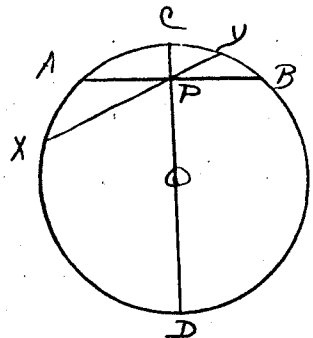


To Prove That:

State what is given and what is to be proved in the following exercise.

II. Problem: The shortest chord that can be drawn thru a given point within a circle is that which is perpendicular to the diameter thru the point.

Given:



To Prove That:

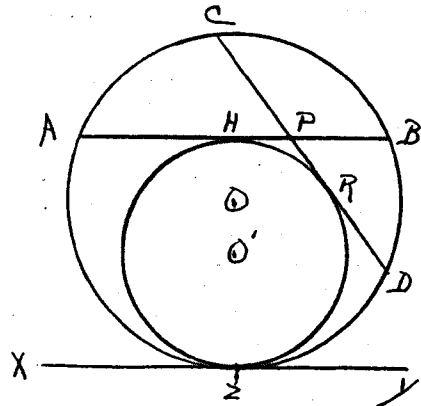
Form B.

State what is given and what is to be proved in the following exercise.

III. Problem: If two circles are tangent internally and chords of the outer circle are drawn tangent to the inner circle, that chord is the greater which is parallel to the common tangent.

Given:

To Prove That:

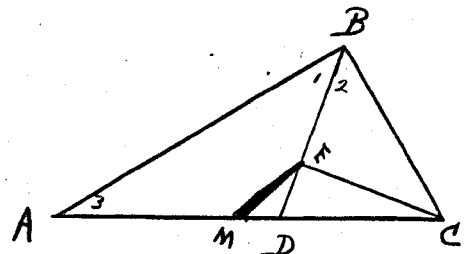


State what is given and what is to be proved in the following exercise.

IV. Problem: If from one extremity of a given side of a triangle a perpendicular is drawn to the bisector of the angle opposite that side, the line connecting the foot of the perpendicular to the mid-point of the given side is equal to one-half the difference of the other two sides of the triangle.

Given:

To Prove That:



Form B.

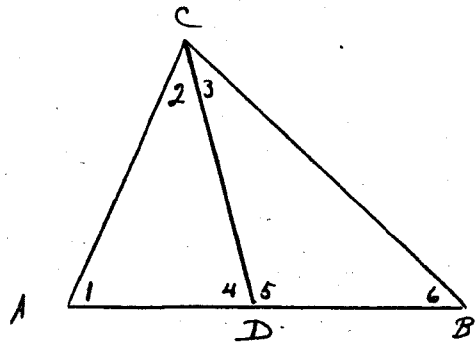
State what is given and what is to be proved in the following exercise.

V. Problem.

The square on the bisector of an angle of a triangle is equal to the product of the sides of this angle diminished by the product of the segments made by the bisector upon the third side of the triangle.

Given:

To Prove That:



Form B.

ANSWERS

Problem I. Given:

- | | |
|---------------------------------------|-------|
| | Score |
| 1. Triangle ABC, any triangle..... | 1 |
| 2. N, any point within triangle ABC.. | 1 |
| 3. NA, NB, NC as drawn..... | 3 |

To Prove That:

- | | |
|---|----------|
| 1. $NA + NB + NC > \frac{1}{2}(AB + BC + AC)$ | <u>1</u> |
| | 6 |

Problem II. Given:

- | | |
|--|-------|
| | Score |
| 1. Circle O. | 1 |
| 2. P, any point within circle O..... | 1 |
| 3. CD, a diameter thru P..... | 1 |
| 4. AB, a chord thru P perpendicular to CD..... | 1 |
| 5. XY, any other chord thru P..... | 1 |

To Prove That:

- | | |
|-----------------|----------|
| $XY > AB$ | <u>1</u> |
| | 5 |

Problem III. Given:

- | | |
|---|-------|
| | Score |
| 1. Circle O and O' tangent internally at Z..... | 2 |
| 2. CD is a tangent to O'..... | 1 |
| 3. CD is a chord of circle O..... | 1 |
| 4. AB is tangent to circle O'..... | 1 |
| 5. AB is parallel to XY..... | 1 |
| 6. XY is the common extreme tangent.. | 1 |

To Prove That:

- | | |
|----------------------------|----------|
| AB is greater than CD..... | <u>1</u> |
| | 8 |

Form B.

ANSWERS

Problem IV. Given:

- | | Score |
|------------------------------------|-------|
| 1. Triangle ABC, any triangle..... | 1 |
| 2. BD bisects angle ABC..... | 1 |
| 3. CE is perpendicular to BD..... | 1 |
| 4. M is the mid-point of AC..... | 1 |
| 5. ME is drawn..... | 1 |

To Prove That:

$$ME = \frac{1}{2} (AB - BC) \dots\dots\dots \underline{1}$$

6

Problem V. Given:

1. Triangle ABC, any triangle.....1
2. Angle ACE, angle of triangle ABC...1
3. CD, the bisector of the angle ACB..1
4. AE, third side of triangle ABC.....1

To Prove That:

$$\overline{CD}^2 = AC \times CB - AD \times DB \dots\dots\dots \underline{1}$$

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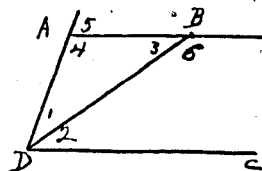
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DIRECTIONS

This is a geometry test. On the following pages are some problems to be proved. The figure for each problem is drawn. What is given is stated. What is to be proved is stated also. There are a number of facts stated about the figure. From all these facts you are to select the ones that prove the problem. Arrange your proof in a logical order. Place your proof in the space provided. Do not give the reasons for your proof. You may work the problems in any order. No other lines need be drawn. You have thirty minutes in which to complete the work.

Here Is A Sample:



Given:

AB is parallel to CD.
AD and DB are transversals.
L 1 equals L 2.

To Prove That:

AD equals AB.

Other Facts:

PROOF.

- AD = AB + DB
- L3 = L2
- L4 + L5 = 180
- L1 + L3 + L4 = 180
- L1 = L3
- L5 = L1 + L2
- L1 = L2

⋮
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Form C.

GEOMETRY TEST

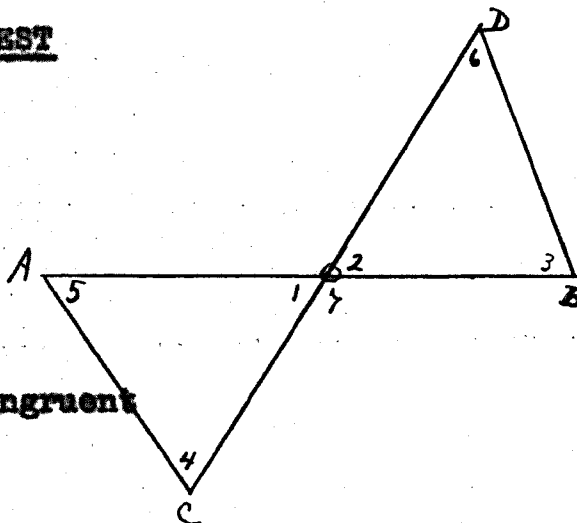
I.

Given:

OB equals OC.
L4 equals L3.

To Prove That:

Triangle AOC is congruent
to triangle BOD.



Other Facts:

PROOF.

- L1 + L7 = 180
- L1 = L2
- L7 = L4 - L5
- OD + DB > OB
- L5 = L4
- L6 + L3 + L2 = 180
- L7 = L5 + L4

: Do not place one figure upon
 : the other.
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Form C.

GEOMETRY TEST

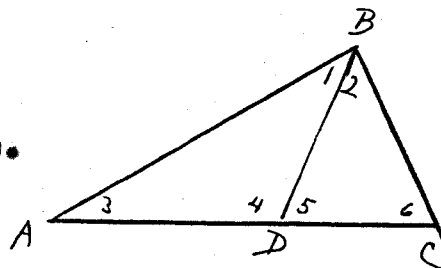
II.

Given:

Triangle ABC is any triangle.
L1 equals L2.

To Prove That;

BC is greater than DC.



Other Facts:

PROOF.

- L1 + L4 + L3 = 180°
- L4 = L2 + L6
- L5 = L1 + L3
- AB + BC > AD + DC
- L5 = L2 + L3
- BD + BC > DC
- L2 + L5 + L6 = 180°
- L5 > L2

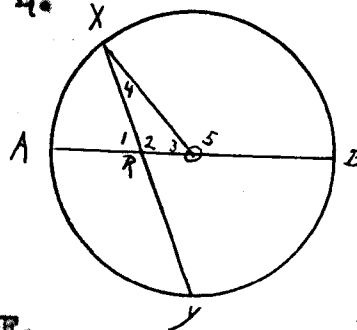
Form C.

GEOMETRY TEST

III.

Given:

Circle O.
 R is any point within Circle O.
 AB is any diameter thru point R.
 XY is any other chord thru
 point R.
 OX is a radius.



To Prove That:

PROOF.

$$L1 = L4 + L3$$

$$L5 + L3 = 180^\circ$$

$$OR + RX \rangle OX$$

$$L5 = L4 + L2$$

$$OR + RX \rangle OR + RA$$

$$OB = OX$$

$$OB = OR + RA$$

Form C.

GEOMETRY TEST

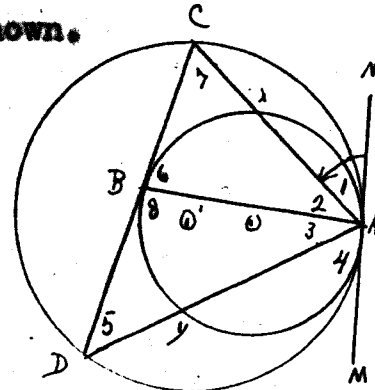
IV.

Given:

Circle O and Circle O' tangent internally at point A.
CD is tangent to Circle O.
AC, AB, and AD are drawn as shown.

To Prove That:

$L2 = L3.$



PROOF.

(Fill in the blank spaces below.)

- 1. L6 is measured by
- 2. L1 + L2 is measured by
- 3. L1 + L2 = L
- 4. L1 = L
- 5. L5 + L3 = L
- 6. L1 + L2 = L3
- 7. L2 = L

Form C.

ANSWERS

Problem I.

		Score
1.	$OA = OB$	1
2.	$L1 = L2$	1
3.	$L4 = L3$	1
4.	Triangle AOC is congruent to triangle DOB.....	1
		4

Problem II.

		Score
1.	$L5 \rangle L1$	1
2.	$L1 = L2$	1
3.	$L5 \rangle L2$	1
4.	$BC \rangle DC$	1
		4

Problem III.

		Score
1.	$XR + RO \rangle XO$	1
2.	$XO = RO + RA$	1
3.	$XR + RO \rangle RO + RA$	1
4.	$XR \rangle RA$	1
		4

Problem IV.

		Score
1.	$L6$ is measured by $\frac{1}{2}$ arc AXB.....	1
2.	$L1 - L2$ is measured by $\frac{1}{2}$ arc AXB.....	1
3.	$L1 - L2 = L6$	1
4.	$L1 = L5$	1
5.	$L5 - L3 = L6$	1
6.	$L1 - L2 = L5 - L3$	1
7.	$L2 = L3$	1
		7

Form D.

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Directions.

Read each question and select the best answer to the question. Record the number of the best answer on the dotted line as shown in the sample below. Time allowed is thirty minutes. Do not waste time on difficult items.

Samples:

1. Geometry is a branch of (1) History, (2) English, (3) Mathematics, (4) Science, (5) Education.

...3...

2. An example of a polygon is a (1) line, (2) a circle, (3) an angle, (4) a triangle, (5) a point.

4
.....

Form D.

Answers

1. A straight line is the shortest distance between two
(1) bisectors, (2) circles, (3) loci, (4) points,
(5) theorems.4..
2. The sum of the angles of a triangle always equals
(1) 60° , (2) 136° , (3) 270° , (4) 120° , (5) 180° 5.
3. The supplement of an angle of 60° is (1) 30° , (2) 90° ,
(3) 120° , (4) 300° , (5) 60° 3.
4. If two straight lines intersect the vertical angles
are (1) adjacent, (2) isosceles, (3) parallel,
(4) equal, (5) reflex4.
5. If one acute angle of a right triangle is 40° , the
other is (1) 20° , (2) 40° , (3) 50° , (4) 90° , (5) 100° 3.
6. A straight line joining any two points in a circum-
ference is called (1) an arc, (2) chord, (3) diameter,
(4) median, (5) radius.....2.
7. The complement of an angle $37\frac{1}{2}^\circ$ is (1) 75° , (2) 56° ,
(3) 89° , (4) $52\frac{1}{2}^\circ$, (5) $37\frac{1}{2}^\circ$ 4.
8. The supplement of an angle of 30° is (1) 40° , (2) 70° ,
(3) 110° , (4) 150° , (5) 170° 4.
9. A circle drawn tangent to the sides of a triangle is
said to be (1) circumscribed, (2) concentric, (3) in-
scribed, (4) intersecting, (5) similar.....3.
10. The side opposite the right angle in a right triangle
is called (1) bisector, (2) hypotenuse, (3) proportional,
(4) transversal, (5) altitude.....2.
11. A figure involving three dimensions is called (1) a line,
(2) a plane, (3) a point, (4) a solid, (5) a vertex.....4.
12. If the equal angles of an isosceles triangle are each
 70° the vertical angle is (1) 20° , (2) 40° , (3) 55° ,
(4) 150° , (5) 220° 2.
13. A figure involving two dimensions is called a (1) line,
(2) plane, (3) point, (4) solid, (5) vertex2.
14. Two lines perpendicular to the same line are (1) per-
pendicular, (2) equal, (3) intersecting, (4) congruent,
(5) parallel5.

15. The complement of an angle 30° is (1) 90° , (2) 60° , (3) 70° , (4) 35° , (5) 30° 2.
16. An arc of a circle is subtended by a (1) chord, (2) tangent, (3) radius, (4) sector, (5) diagonal.....1.
17. If one acute angle of a right triangle is 60° , the other is (1) 45° , (2) 60° , (3) 30° , (4) 120° , (5) 90° ...3.
18. That part of a circle included between two radii and an arc is called a (1) chord, (2) locus, (3) diameter, (4) sector, (5) tangent.....4.
19. Of the angles of a triangle, two are always (1) acute, (2) complementary, (3) obtuse, (4) reflex, (5) right....1.
20. A perpendicular distance from the vertex of a triangle to the base is called the (1) diagonal, (2) median, (3) bisector, (4) altitude, (5) perimeter.....4.
21. A general statement which is accepted as true without proof is called (1) axiom, (2) hypothesis, (3) magnitude, (4) postulate, (5) theorem.....1.
22. The intersection of two planes forms a (1) point, (2) tangent, (3) line, (4) arc, (5) secant.....3.
23. Thru a given point the number of parallels that can be drawn to a given line is (1) infinite, (2) 2, (3) 0, (4) 1, (5) 4.....4.
24. If two parallel lines are cut by a transversal the alternate interior angles are (1) supplementary, (2) equal, (3) complementary, (4) unequal, (5) adjacent.....2.
25. The sum of the angles of a parallelogram always equals (1) 560° , (2) 360° , (3) 180° , (4) 120° , (5) 90° ..2.
26. If one angle of a parallelogram is 80° , a consecutive angle is (1) 20° , (2) 80° , (3) 100° , (4) 180° , (5) 280° 3.
27. The segment of a circle is bounded by (1) an arc and a chord, (2) two radii and an arc, (3) two radii and a chord, (4) two chords and an arc, (5) a diameter and two chords1.
28. The opposite angles of a parallelogram are (1) complementary, (2) conjugate, (3) supplementary, (4) vertical, (5) equal.....5.

Form D.

Answers.

29. Geometry probably originated with the (1) Romans, (2) Phoenicians, (3) Goths, (4) Gauls, (5) Egyptians....5.
30. If the equal angles of an isosceles triangle are each 80° , the vertical angle is (1) 40° , (2) 45° , (3) 100° , (4) 20° , (5) similar.....4.
31. If the sides of two triangles are respectively equal, the triangles are (1) congruent, (2) isosceles, (3) proportional, (4) scalene, (5) similar.....1.
32. A sector is the part of a circle that is bounded by (1) two arcs, (2) two chords and an arc, (3) two radii and an arc, (4) diameter and a chord, (5) semicircle and diameter.....3.
33. The sum of the interior angles of a pentagon equals (1) 90° , (2) 120° , (3) 360° , (4) 720° , (5) 540° 5.
34. Two circles which have one common point are (1) equal, (2) tangent, (3) intersecting, (4) concentric, (5) vertical.....2.
35. Figures which are the same size and shape are said to be (1) complementary, (2) scalene, (3) congruent, (4) inscribed, (5) regular.....3.
36. The locus of points equidistant from a point is an (1) angle, (2) circle, (3) diameter, (4) perpendicular, (5) triangle.....2.
37. A parallelogram inscribed in a circle must be a (1) rhombus, (2) trapezium, (3) rectangle, (4) hexagon, (5) trapezoid.....3.
38. The first compiler of geometry was (1) Aristotle, (2) Demosthenes, (3) Euclid, (4) Herodotus, (5) Xerxes.....3.
39. A quantity whose value remains unchanged is a (1) constant, (2) limit, (3) proportion, (4) ratio, (5) variable.....1.
40. Two tangents drawn from an external point to a circle are, (1) secants, (2) perpendicular, (3) equal, (4) common, (5) parallel.....3.
41. A line and an external point will determine a (1) polygon, (2) circle, (3) plane, (4) solid, (5) bisector..3.
42. If the sides of a right triangle are $6''$, $8''$, $10''$, the median to side $10''$ is (1) $6''$, (2) $9''$, (3) $5''$, (4) $7''$, (5) $4''$5.
- " equals inches.

Form D.

Answers

43. One angle of a regular polygon is 156° . The number of sides of the polygon is (1) 10, (2) 8, (3) 12, (4) 15, (5) 16.....4.
44. In the same circle, chords equidistant from the center are (1) parallel, (2) perpendicular, (3) intersecting, (4) equal, (5) unequal.....4.
45. A line perpendicular to a radius at its extremity on a circle is a (1) diameter, (2) secant, (3) transversal, (4) chord, (5) tangent.....5.
46. The line joining the mid-points of the non-parallel sides of a trapezoid equals one-half the (1) product of the bases, (2) difference of the bases, (3) perimeter, (4) sum of the bases, (5) altitude and the sum of the bases.....4.
47. The diagonals of a parallelogram (1) equal each other, (2) are perpendicular to each other, (3) bisect each other, (4) are parallel, (5) coincide.....3.
48. The line joining two non consecutive vertices of a polygon is a (1) diameter, (2) median, (3) secant, (4) tangent, (5) diagonal.....5.
49. If two parallel lines are cut by a transversal, the alternate exterior angles are (1) supplementary, (2) equal, (3) adjacent, (4) complementary, (5) vertical....2.
50. A quadrilateral that has all sides equal is a (1) trapezium, (2) rhomboid, (3) rhombus, (4) trapezoid, (5) rectangle.....3.

PLAN OF SCORING.

1. Each problem is scored right or wrong.
2. A pupil's score is the total number of problems correct.
3. The answer to each problem is given on the dotted line.

Form E.

GEOMETRY TEST

Name.....Age last birthday.....years.
 Birthday.....Class.....Date.....19...
 School.....City.....

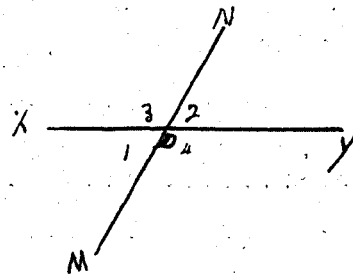
Directions.

This is a geometry test. On the following pages are some geometry problems. The figure is drawn for each problem. What is GIVEN is stated. What is TO BE PROVED is stated also. Read these carefully. The proof is logically arranged in equation form. The left side of each equation is given. The right side of each equation, in most cases, is left blank and the blank is followed by a parenthesis. All of the necessary reasons are given and numbered. You are to fill in the blank spaces to complete the proof. And in the parenthesis after each statement you are to enter the number of the reason that applies in that statement. Only one reason applies in each step of the proof. Get the exact reason. You may work the problems in any order. You have thirty minutes in which to complete the work.

Here is a sample Problem:

Given: The straight lines XY and MN intersecting at point D.

To Prove That: L1 equals L2.



Proof: $L1 - L2 = \text{degrees} \dots \dots \dots \{ \quad \}$
 $L3 + L2 = \text{degrees} \dots \dots \dots \{ \quad \}$
 $L1 - L2 = L3 + L2 \dots \dots \dots \{ \quad \}$
 $L1 = L2 \dots \dots \dots \{ \quad \}$

Reasons.

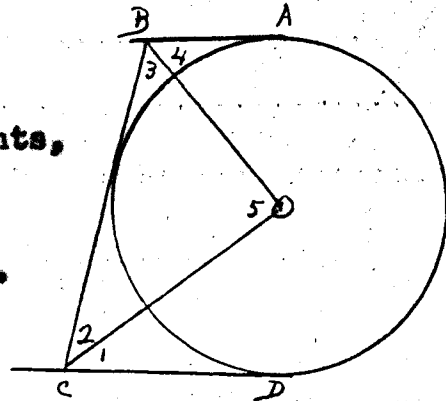
1. If equals are subtracted from equals the remainders are equal.
2. Quantities equal to the same quantity or to each other are equal to each other.
3. The two adjacent angles which one straight line makes with another are together equal to a straight angle.
4. If equals are multiplied by equals the products are equal.
5. If equals are divided by equals the quotients are equal.

Form E.

I.

Given:

Circle O.
AB, BC, and CD are tangents,
BO and CO are drawn.
AB is parallel to CD.



To Prove That: $\angle 5 = 90$ degrees.

Proof:

-
1. $\angle 1 = \angle 2$()
 2. $\angle 3 = \angle 4$()
 3. $2 \angle 2 + 2 \angle 3 = \text{degrees}$()
 4. $\angle 2 + \angle 3 = \text{degrees}$()
 5. $\angle 5 = \text{degrees}$()

Reasons.

1. The sum of three angles of a triangle equals a straight angle.
2. If two parallel lines are cut by a transversal the alternate interior angles are equal.
3. If the sum of two angles of a triangle equals a right angle, the third angle is a right angle.
4. Tangents drawn from an external point to a circle are equal and make equal angles with the line which joins the point to the center of the circle.
5. If equals are divided by equals, the quotients are equal.
6. If two parallel lines are cut by a transversal, the sum of the interior angles on the same side of the transversal are supplementary.

Form E.

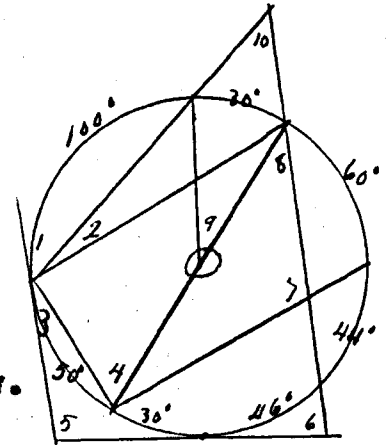
II.

Given:

Circle O.

The arcs are valued as shown.

The angles are numbered as shown.



Required: To fill out the blanks below.

- L1 equalsdegrees ()
- L2 equalsdegrees ()
- L3 equalsdegrees ()
- L4 equalsdegrees ()
- L5 equalsdegrees ()
- L6 equalsdegrees ()
- L7 equalsdegrees ()
- L8 equalsdegrees ()
- L9 equalsdegrees ()
- L10 equalsdegrees ()

Reasons.

1. An angle formed by two chords intersecting within a circle is measured by one-half the sum of the intercepted arcs.
2. An angle formed by two tangents is measured by one-half the difference of the intercepted arcs.
3. An angle formed by two tangents is measured by one-half the sum of the intercepted arcs.
4. An angle formed by a tangent and a chord drawn from the point of contact is measured by one-half the intercepted arc.
5. An inscribed angle is measured by one-half the intercepted arc.
6. An angle formed by two secants is measured by one-half the sum of the intercepted arcs.
7. A central angle is measured by the intercepted arc.
8. An angle formed by a tangent and a secant is measured by one-half the difference of the intercepted arc.
9. An angle formed by two secants drawn from an external point to a circle is measured by one-half the sum of the intercepted arcs.
10. An angle formed by two secants drawn from an external point to a circle is measured by one-half of the difference of the intercepted arcs.

Form E.

III.

Given: Triangle ABC.

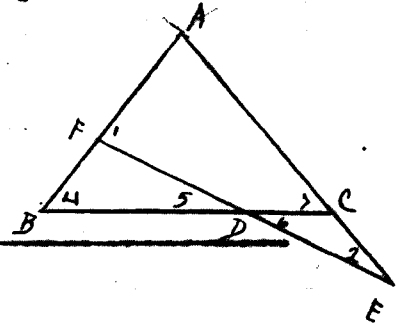
D is any point in the base BC.

AC is extended to E so that CE equals CD.

DE is drawn, meeting AB at F.

$AB = AC$

To Prove That: $L1 = 3L2$.



Proof:

- $L7 = L4$
- $L5 = L6$
- $L6 = L2$
- $L1 = L4 + L5$
- $L1 = L7 + L6$
- $L7 = L6 + L2$
- $L1 = L6 + L2 + L6$
- $L1 = 3L2$

Reasons.

1. In an isosceles triangle the angles opposite the equal sides are equal.
2. If two angles of a triangle are equal, the sides opposite the equal angles are equal.
3. If two straight lines intersect, any two adjacent angles are together equal to a straight angle.
4. An exterior angle of a triangle is greater than either of the opposite interior angles.
5. If equals are subtracted from equals, the remainders are equal.
6. Equals may be substituted for equals in any equation.
7. An exterior angle of a triangle is equal to the sum of the two opposite interior angles.
8. If two straight lines intersect, the vertical angles are equal.

Form E.

ANSWERS

Problem I.

<u>Proof</u>	<u>Score</u>	<u>Reason</u>	<u>Score</u>	<u>Total Score</u>
L2	1	4	1	
L4	1	4	1	
180°	1	6	1	
90°	1	5	1	
90°	1	3	1	
	<u>5</u>		<u>5</u>	10

Problem II.

<u>Proof</u>	<u>Score</u>	<u>Reason</u>	<u>Score</u>	<u>Total Score</u>
50°	1	4	1	
15°	1	5	1	
25°	1	4	1	
65°	1	5	1	
100°	1	2	1	

continued on the following page.

Form E.

ANSWERS

Problem II. continued.

Proof	Score	Reason	Score	Total Score
67°	1	9	1	
112°	1	1	1	
38°	1	5	1	
30°	1	7	1	
48°	1	10	1	
	<u>10</u>		<u>10</u>	<u>20</u>

Problem III.

Proof is given.	Reason	Score	Total score
	1	1	
	8	1	
	1	1	
	4	1	
	6	1	
	4	1	
	6	1	
	6	1	
		<u>8</u>	<u>8</u>

Form E.

ANSWERS.

Problem IV.

Proof	Score	Reason	Score	Total Score
1. $\frac{1}{2}$ arc ANH	1	5	1	
2. L7	1	9	1	
3. L6	1	9	1	
4. L6	1	8	1	
5. L7-L4	1	10	1	
6. L4	1	3	1	
	<u>6</u>		<u>6</u>	12

GRAND TOTAL OF SCORES... 50 points.

-----:-----:-----:-----:-----:-----:-----

Thorndike-McCall Reading Scale

For the Understanding of Sentences

Form 3

Write your name here.....
First name Last name

School..... Grade..... Date.....

How old are you?..... When is your birthday?.....

This is to be a reading contest. You will read paragraphs like this one, and answer questions like those you see below. Answer every question you can. If you come to a question you can't answer skip it and go on. Go back to it later. If you finish before you are told to stop, go back and make sure you have made no mistakes. When possible the answers to the questions must be found in the paragraph. You may read the paragraph as many times as you need to. You will have enough time but don't waste it. Play fair. Don't look at anyone else's paper. You will be told your score later.

- I. Does it say you are to do your best?.....
- II. Does it say you may read the paragraph as often as you need to?.....
- III. Are you to look at anyone else's paper?.....
- IV. When possible, where must you find the answers?.....
.....

As soon as you finish one page do the next. You are to start with the first page. Open paper! Begin!

To the examiner: Distribute test booklets. Have blanks filled. Read the above paragraph aloud while pupils read silently. Read the first question aloud. Have it answered orally and then in writing by pupils. Treat the other three questions similarly. Start pupils. Stop pupils thirty minutes after saying *Begin!* Give no further help.

No. of questions correct..... T score.....

Published by
Teachers College, Columbia University
New York City
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Read this and then write the answers. Read it again if you need to.

Nell's mother went to the store on Water Street to buy ten pounds of sugar, a dozen eggs and a bag of salt. She paid a dollar in all. Nell and Joe went with her. On the way home on Pine Street, they saw a fire-engine with three horses.

1. How many pounds of sugar did Nell's mother buy?.....
.....
2. How much money was spent?.....
3. Where did they see the horses?.....

Read this and then write the answers. Read it again if you need to.

There was once a merchant, who was very, very rich. He had six children, three boys and three girls. His daughters were all beautiful, but the youngest one was the most beautiful of all. From the time she was a small child she had been spoken of as "Beauty." As she grew older this caused a great deal of jealousy on the part of her sisters. But the young girl was not only more beautiful than they were; she was also kinder and more lovable.

4. Was Beauty's father poor?.....
5. Does the story tell how Beauty's brothers looked?.....
6. Which of the merchant's daughters was the handsomest?.....
.....

Do the next page.

Read this and then write the answers. Read it again if you need to.

Fred lives in the country. He likes to hunt and fish, and has a gun that cost sixteen dollars. His sister Grace keeps hens and ducks, and sells the eggs. She is learning to play the piano, and goes to Miss Thomas for a lesson every Saturday. She likes music but Fred doesn't.

7. Are hens the only animals that Grace keeps?.....
8. Is Grace having any lessons outside of school?.....
9. Was the cost of Fred's gun over ten dollars?.....

Read this and then write the answers. Read it again if you need to.

Both before and after Christmas, Bob Adams worked harder than he did in the spring, summer or fall. Only very rarely did he reach home before eleven o'clock; and on every morning except Sunday he was up at six, dressed and done with breakfast by quarter of seven, left the house at ten minutes of seven and reached Mr. Clark's store at ten minutes of eight. In spite of the long hours and hard work, he was happy because his pay had been raised twice.

10. What is the name of the person who is said to have worked very hard?.....
11. At what time did Bob finish breakfast?.....
12. Who was the proprietor of the store where Bob worked?
.....

Do the next page.

Read this and then write the answers. Read it again if you need to.

In the spring men begin to work the soil. Those who have small gardens break up the ground with such tools as spades and forks. Those who live on farms turn the soil over with plows drawn by horses. In these ways the soil is loosened. After the planting is done, the weeds must be killed and the soil must be loosened. In places where little rain falls, other ways of watering the plants must be found.

13. What growing things does the gardener kill?.....
14. What animals draw the plows?.....
15. By whom is the plow used instead of a spade or fork?.....

.....

Read this and then write the answers. Read it again if you need to.

On Monday Dick saw a red fox, a gray squirrel and a black snake in the woods. The next day he saw a brown rabbit and five brown mice in the field. He killed the fox and all the mice, but let the others live.

16. Which animals did Dick kill?.....
17. Where did Dick see the rabbit?.....
18. How many animals did Dick kill?.....

Do the next page.

Read this and then write the answers. Read it again if you need to.

According to the *Kansas City Star*, the wheat farmers of Kansas are too prosperous to trouble themselves about careful harvesting. They do not cut the fields clean. A gleaner 80 years old, after the wheat harvest in Pawnee County last year, went over the wheat-fields with a wagon, a rake, a brush, and a shovel and swept up the wheat left on the ground by the threshers. He gathered nine hundred bushels in forty days and sold it at a dollar a bushel.

19. Name the three tools used by the gleaner.....

20. How much money did he receive for his time and labor and the use of his horse and wagon for the forty days?.....

21. What newspaper reported the story told here?.....
22. What was left on the ground by threshing machines?.....

Read this and then write the answers. Read it again if you need to.

Henry and Sam are eight years old. Edward is nine. Arthur is twelve and Richard is eleven. Henry and Edward play together and like each other very much. They will not play with Sam unless they have to; for neither of them likes him at all. He feels the same way toward them. They both would be very glad to play with Arthur or Richard, but they don't often have the chance; for these boys play with boys of their own age whenever they can.

23. What boys would like to play with Arthur or Richard?.....

24. Copy the words which tell how well Edward likes Henry.

25. Why do Henry and Edward have few chances to play with Richard?.....

Do the next page.

Read this and then write the answers. Read it again if you need to.

For nearly thirty years "Lewis Carroll" was a lecturer on mathematics at Oxford. He studied divinity and occasionally preached, but his shy and retiring nature, together with a tendency to stammer, kept him from the regular ministry. He gave many lectures to audiences made up mainly of children. These lectures were of various sorts, but consisted principally of narratives from his books illustrated by lantern pictures. He invented a number of mathematical games.

26. What do you judge Oxford to be, a man, a church, a hall, a college, or a country?-----
27. What defect in speech had the person whose life is described?

28. In what respect was he like Thomas Edison, Eli Whitney and Morse?-----

Do the next page.

Read this and then write the answers. Read it again if you need to.

There are two methods by which one might make himself acquainted with anything made up of related parts; as, for example, a watch. He might take the watch apart, piece by piece, and while doing so study the details of its structure and the relation of its parts one to another. An operation like this, which begins with the whole and descends to the parts which compose the whole, is called analysis. The word means a taking apart or separating. Or he might begin with the parts, and, after some experiment and study, get an excellent knowledge of the watch by putting its parts properly together. An operation of this kind is called synthesis.

29. What is the opposite of synthesis?-----

30. Name a word that means building a thing up out of its parts.

31. What process will we have if the analytic process is reversed?

Do the next page.

Read this and then write the answers. Read it again if you need to.

COLERIDGE

I see thee pine like her in golden story
 Who, in her prison, woke and saw one day,
 The gates thrown open — saw the sunbeams play
 With only a web 'tween her and summer's glory;
 Who, when the web — so frail, so transitory,
 It broke before her breath — had fallen away,
 Saw other webs and others rise for aye,
 Which kept her prisoned till her hair was hoary.
 Those songs half-sung that yet were all divine—
 That woke Romance, the queen, to reign afresh—
 Had been but preludes from that lyre of thine,
 Could thy rare spirit's wings have pierced the mesh
 Spun by the wizard who compels the flesh,
 But lets the poet see how heav'n can shine.

32. What momentarily brushed away the prisoner's mesh?.....

33. Copy the first word of the line which suggests a chrysalis.

34. What shows the web was diaphanous?.....

35. For the woman, what periodic event kept green hope's life?

FIRST YEAR ALGEBRA SCALES

SERIES A

BY HENRY G. HOTZ

Published by Teachers College, Columbia University. Copyright, 1920, by Teachers College

School.....Date.....City.....County.....

Write your name here.....Age.....

When did you begin to study algebra? Month.....Year.....

ADDITION AND SUBTRACTION

Carefully perform the operations as indicated.

1. $4r + 3r + 2r =$

3. $12b + 6b - 3b =$

5. $7x - x + 6 - 4 =$

9. $(4r - 5t) + (s - 3r) =$

10. $8c - (-6 + 3c) =$

12. $5x - [4x - (3x - 1)] =$

13. $\frac{3c}{4} - \frac{3c}{8} =$

15. $\frac{1}{a-x} - \frac{3x}{a^2 - x^2} =$

18. $3 - \frac{3-2x}{4} - 2x =$

22. $\frac{3-2x}{(x-1)^3} + \frac{x+1}{(x-1)^2} - \frac{1}{(x-1)} =$

23. $\sqrt{20} + \sqrt{45} + \sqrt{\frac{1}{5}} =$

24. $\frac{a}{a-2} - \frac{a-2}{a+2} + \frac{3}{4-a^2} =$

FIRST YEAR ALGEBRA SCALES

SERIES A

BY HENRY G. HOTZ

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School.....Date.....City.....County.....

Write your name here.....Age.....

When did you begin to study algebra? Month.....Year.....

MULTIPLICATION AND DIVISION

Carefully perform the operations as indicated. Reduce all answers to their *simplest* forms.

1. $3 \cdot 7y =$

2. $\frac{12n}{4} =$

3. $2a \cdot 4ab^2 =$

7. $4x \cdot (-3xy^3) =$

9. $\frac{18m^2n - 27mn^2}{9mn} =$

11. $(2a^2 + 7a - 9) \cdot (5a - 1) =$

16. $(-3xy^3)^4 =$

17. $\frac{c^4 - d^4}{(c - d)^2} \cdot \frac{c - d}{c^2 + d^2} =$

20. $\frac{p^2 + 4p - 45}{p^2 + 2p + 4} \cdot \frac{p^3 - 8}{p^2 - 81} \cdot \frac{1}{3pr - 15r} =$

21. $\frac{x^3 + 27}{x^2 + x - 12} \div \frac{3x + 9}{x + 4} =$

22. $64^{\frac{2}{3}} \times 27^{\frac{1}{3}} =$

23. $\frac{3\sqrt{6a}}{2a\sqrt{18}} \cdot \sqrt{12a} =$

FIRST YEAR ALGEBRA SCALES

SERIES A

By HENRY G. HOTZ

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School.....Date.....City.....County.....

Write your name here.....Age.....

When did you begin to study algebra? Month.....Year.....

EQUATION AND FORMULA

Solve the following equations and formulae:

1. $2x = 4.$

2. $7m = 3m + 12.$

4. $5a + 5 = 61 - 3a.$

6. $10 - 11z = 4 - 8z.$

8. $c - 2(3 - 4c) = 12.$

11. The area of a triangle = $\frac{1}{2}bh$, in which

b = length of the base

and h = height of the triangle.

How many square feet are there in the area of a triangle whose base is 10 feet, and whose height is 8 feet?

14. $3m + 7n = 34$
 $7m + 8n = 46$

18. $\frac{x + 3}{x - 2} = \frac{x + 5}{x - 4}.$

19. $p^2 - 5p = 50.$

23. $\frac{6x - 2}{x + 3} - 3 = \frac{3x^2 + 13}{x^2 - 9}.$

24. $S = \frac{1}{2}gt^2$; solve for $t.$

25. $\sqrt{x^2 - 1} - x = -1.$

FIRST YEAR ALGEBRA SCALES

SERIES A

By HENRY G. HOTZ

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School..... Date..... City..... County.....

Write your name here..... Age.....

When did you begin to study algebra? Month..... Year.....

PROBLEMS

Do not work out the answer to the problem—merely *indicate* the answer or *state* the equation in each case.

1. If one coat cost x dollars, how much will 3 coats cost?

Answer.....

2. A man is m years old; how old was he r years ago?

Answer.....

4. A gold watch is worth ten times as much as a silver watch, and both together are worth \$132. How much is each worth?

Equation

5. The distance from Chicago to New York by rail is 980 miles. If a train runs v miles an hour, what is the time required for the run?

Answer.....

7. The total number of circus tickets sold was 836. The number of tickets sold to adults was 136 less than twice the number of children's tickets. How many were sold of each?

Equation.....

8. A rectangular box is d inches deep, w inches wide, and contains r cubic inches. What is its length?

Answer.....

9. The area of a square is equal to that of a rectangle. The base of the rectangle is 12 feet longer and its altitude 4 feet shorter than the side of the square. Find the dimensions of both figures.

Equation.....

(Turn over. There are problems on the other side)

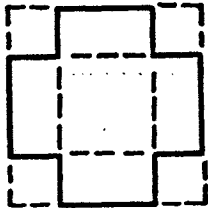
12. A train leaves a station and travels at the rate of 40 miles an hour. Two hours later a second train leaves the same station and travels in the same direction at the rate of 55 miles an hour. Where will the second train pass the first?

Equation.....

13. A merchant has two kinds of tea, one kind costing 50 cents and the other 65 cents per pound. How many pounds of each must be mixed together to produce a mixture of 20 pounds that shall cost 60 cents per pound?

Equation.....

14. An open box is made from a square piece of tin by cutting out a 5-inch square from each corner and turning up the sides. How large is the original square, if the box contains 180 cubic inches?



Equation.....

FIRST YEAR ALGEBRA SCALES

SERIES A

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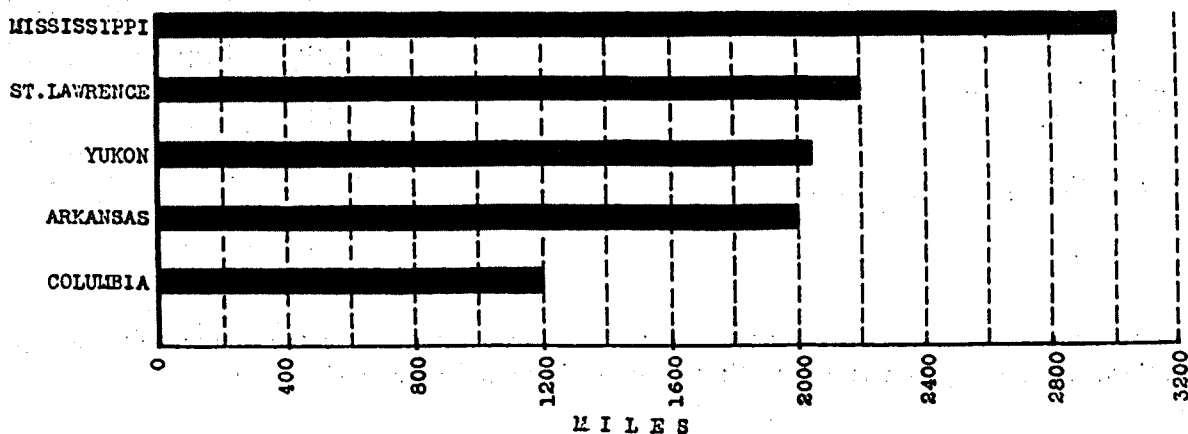
School..... Date..... City..... County.....

Write your name here..... Age.....

When did you begin to study algebra? Month..... Year.....

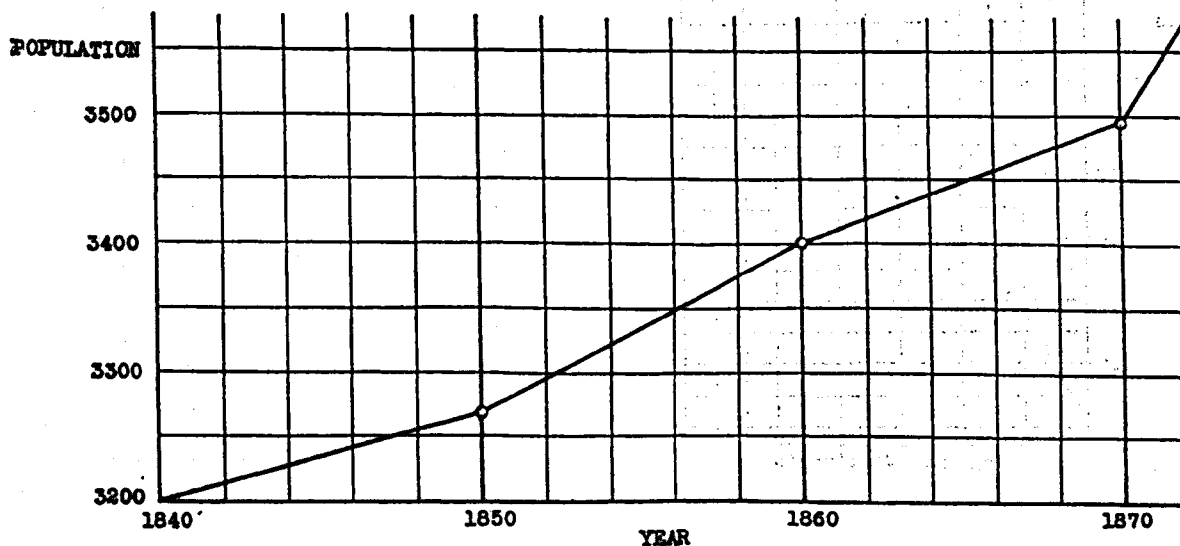
GRAPHS

1. The following diagram represents the length of certain rivers:



How many miles long is the Arkansas river as represented in this diagram?.....

3. This graph indicates the population of a certain town for a period of years:



What was the approximate population of the town in 1856?.....

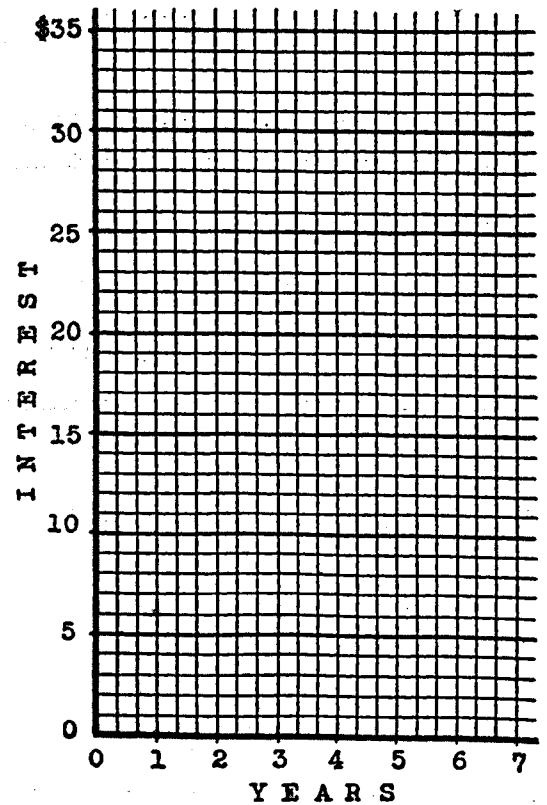
(Turn over)

4. This table gives the interest at 6 per cent on \$100 for a period of years:

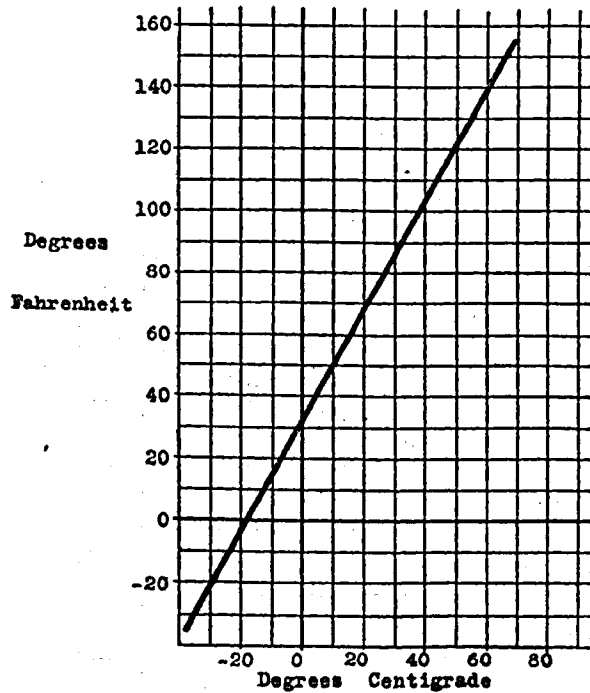
Years	Interest in Dollars
1	6
2	12
3	18
4	24
5	30
6	36

Locate in the adjacent diagram the points corresponding to the above data.

Then connect these points by a line.

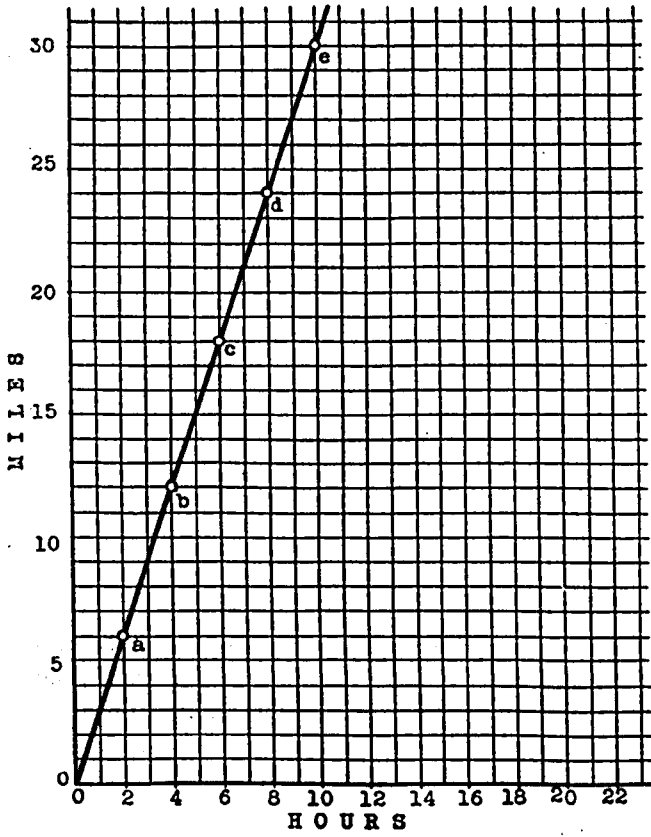


5. The following graph is used to convert degrees of temperature from the Fahrenheit scale (F) to the Centigrade scale (C) and from the Centigrade scale to the Fahrenheit scale:



When it is $+20^\circ$ on the F scale, what is the temperature in degrees on the C scale?

6. This graph represents the distance passed over by a man walking at the rate of 3 miles an hour for a number of hours.



By the conditions of the problem it may be said that the number of miles travelled equals three times the number of hours, or

$$m = 3h$$

That is

$$\text{if } h = 2, \text{ then } m = 6;$$

$$\text{if } h = 4, \text{ then } m = 12;$$

and if $h = 6$, then $m = 18$, etc.

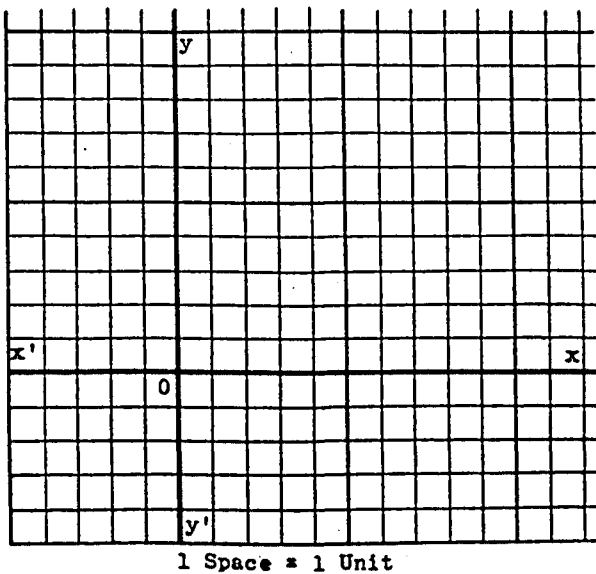
By locating these points, we have a , b , c , d , etc., of the graph.

In the same diagram draw a graph in which

$$m = 2h$$

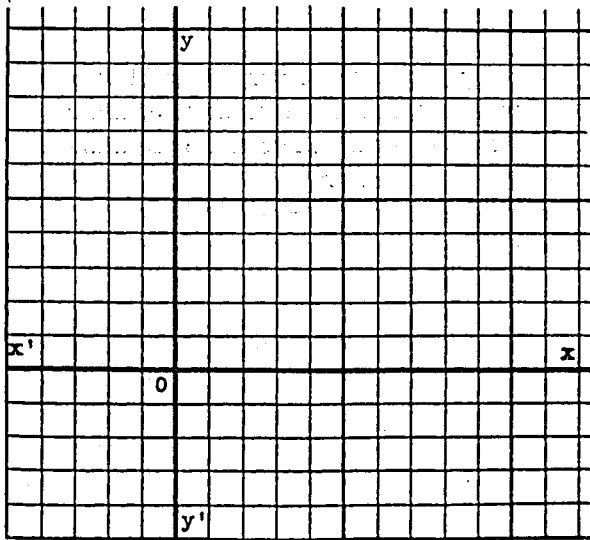
7. Find three pairs of values for x and y in the following equation and then draw the graph of

$$x + y = 5$$



(Turn over)

10. Plot the following equations and find the values of x and y at the point of intersection of the graphs.

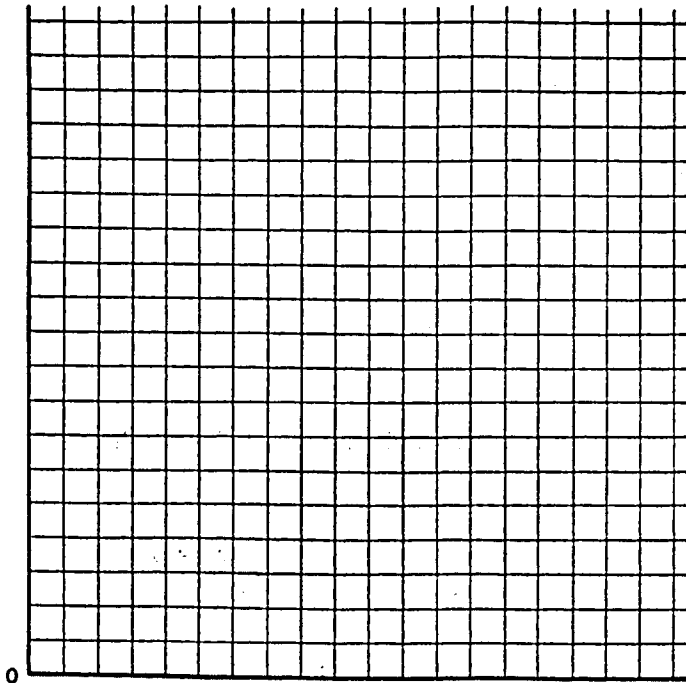


1 Space = 1 Unit

$$x + 4y = 11$$

$$2x - y = 4$$

11. A boy begins work with a weekly wage of \$9 and receives an increase of 25 cents every week. Another boy starts with a weekly wage of only \$6, but receives an increase of 50 cents every week.



Draw a graph which shows the wage of each at the beginning of every week for 15 weeks.

According to this graph when will their wages be the same?

Stanford Achievement Test

By TRUMAN L. KELLEY, GILES M. RUCH, and LEWIS M. TERMAN

ARITHMETIC EXAMINATION: FORM A

FOR GRADES 2-8

Name.....Grade.....Boy or girl.....

Age.....When is your next birthday?..... How old will you be then?.....

Name of school..... Date.....

TEST	SCORE
4. Arithmetic: Computation	
5. Arithmetic: Reasoning	
TOTAL ARITHMETIC SCORE	
ARITHMETIC AGE	

Note. This examination contains all the problems of the Arithmetic Tests (Tests 4 and 5) of the Primary and Advanced examinations. See page 5 of the Manual of Directions for the Stanford Achievement Test.

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PRINTED IN U.S.A.

[1]

To the Examiner: Do not administer this test without first reading carefully the Manual of Directions. The Manual must be ordered extra.

TEST 4. ARITHMETIC: COMPUTATION

Get the answers to these examples as quickly as you can without making mistakes.
Look carefully at each example to see what you are to do.

Begin here.

(1)
 $3 + 2 =$

(2)
 $3 + 4 =$

(3)
Add
 $\begin{array}{r} 2 \\ 5 \\ \hline \end{array}$

(4)
Add
 $\begin{array}{r} 7 \\ 4 \\ \hline \end{array}$

(5)
Add
 $\begin{array}{r} 13 \\ 2 \\ \hline \end{array}$

(6)
Add
 $\begin{array}{r} 17 \\ 2 \\ \hline \end{array}$

(7)
Subtract
 $\begin{array}{r} 4 \\ 2 \\ \hline \end{array}$

(8)
Subtract
 $\begin{array}{r} 7 \\ 4 \\ \hline \end{array}$

(9)
 $2 \times 3 =$

(10)
Add
 $\begin{array}{r} 16 \\ 53 \\ 32 \\ \hline \end{array}$

(11)
Subtract
 $\begin{array}{r} 16 \\ 5 \\ \hline \end{array}$

(12)
Subtract
 $\begin{array}{r} 96 \\ 25 \\ \hline \end{array}$

(13)
Subtract
 $\begin{array}{r} 13 \\ 5 \\ \hline \end{array}$

(14)
Subtract
 $\begin{array}{r} 765 \\ 327 \\ \hline \end{array}$

(15)
Multiply
 $\begin{array}{r} 26 \\ 2 \\ \hline \end{array}$

(16)
Multiply
 $\begin{array}{r} 253 \\ 6 \\ \hline \end{array}$

(17)
Divide
 $2 \overline{)6}$

(18)
Divide
 $4 \overline{)8}$

(19)
Add
 $\begin{array}{r} 684876542 \\ 791654220 \\ 587339364 \\ \hline \end{array}$

(20)
 $6 \div 3 =$

(21)
Add
 $\begin{array}{r} 24 \\ 12\frac{4}{5} \\ \hline \end{array}$

(22)
Multiply
 $\begin{array}{r} 6389 \\ 7 \\ \hline \end{array}$

(23)
Multiply
 $\begin{array}{r} 4679 \\ 68 \\ \hline \end{array}$

(24)
 $2 \overline{)15.8}$

(25)
 $2\frac{7}{8} - 1 =$

Go right on to next page.

TEST 4, CONTINUED

(26)

$$\frac{1}{4} \text{ of } 828 =$$

(27)

$$9\frac{3}{5} - 4\frac{1}{5} =$$

(28)

Subtract

$$\begin{array}{r} 79 \\ 16\frac{3}{8} \\ \hline \end{array}$$

(29)

$$\frac{1}{7} \times 2 =$$

(30)

$$.45 \overline{)27.90}$$

(31)

$$3\frac{6}{7} \div 1\frac{1}{2} =$$

(32)

Multiply

$$\begin{array}{r} 9.72 \\ 21.9 \\ \hline \end{array}$$

(33)

Multiply

$$\begin{array}{r} 697\frac{1}{2} \\ 18 \\ \hline \end{array}$$

(34)

$$\frac{27}{28} \div \frac{6}{7} =$$

(35)

$$4.40 + .00044 + 4400 + .04 =$$

(36)

$$48.76 - 4\frac{9}{10} =$$

(37)

$$\frac{1}{2} + \frac{3}{4} + \frac{1}{8} + \frac{3}{8} + \frac{7}{8} =$$

(38)

$$27.34 + 2\frac{1}{4} + 89.2 + 4\frac{3}{4} =$$

(39)

$$3\frac{1}{4} \times 5\frac{1}{2} \times 3\frac{1}{2} =$$

(40)

$$1\frac{3}{4} + 25.2 + 4\frac{1}{5} + 48.961 =$$

(41)

$$\sqrt{45369} =$$

(42)

$$(4)^3 =$$

(43)

Subtract

$$\begin{array}{r} 8 \text{ yd. } 1 \text{ ft. } 3 \text{ in.} \\ 6 \text{ yd. } 3 \text{ ft. } 9 \text{ in.} \\ \hline \end{array}$$

(44)

Add

$$\begin{array}{r} 5 \text{ yr. } 9 \text{ mo.} \\ 6 \text{ yr. } 7 \text{ mo.} \\ 8 \text{ yr. } 2 \text{ mo.} \\ \hline \end{array}$$

(45)

$$67.36 \div \frac{2}{3} =$$

(46)

Multiply

$$\begin{array}{r} 4 \text{ gals. } 3 \text{ qts. } 1 \text{ pt.} \\ 4 \\ \hline \end{array}$$

(47)

Express as a decimal
to three places

$$\frac{29}{64} =$$

Test 4. Number right $\times 4 =$ Score

TEST 5, CONTINUED

- 22 Henry was marked 87 in geography the first month, 91 the second, and 93 the third month. What was his average grade? *Answer*.....
- 23 If the butcher's scales read one ounce too much on each weighing, how much is a customer overcharged on a pound of steak at 48¢ a pound? *Answer*.....
- 24 At \$1.00 a bushel for potatoes and \$30.00 a car for freight, how much will a 400-bushel carload of potatoes cost? *Answer*.....
- 25 Tom has just 4 weeks' vacation and wishes to spend it in a city which it takes two days to reach by train. How many days can he spend in the city? *Answer*.....
- 26 If a fence rail is 10 feet long, how many rails will it take to reach a mile? *Answer*.....
- 27 Sound travels about 1100 ft. a second. If you see the flash of a cannon and 12 seconds later the sound reaches you, how far away is the cannon? *Answer*.....
- 28 A man had \$5000, from which he received 6 per cent income each year. In addition he earned \$1500 in business. What was his total income for the year? *Answer*.....
- 29 Frank and George buy 300 marbles for 50 cents. Frank pays 35 cents and George 15 cents. How many marbles should George receive? *Answer*.....
- 30 If a watch gains 20 seconds in 24 hours, what fraction of a minute will it gain between noon and 6 P.M.? *Answer*.....
- 31 The heights of 4 boys in a class are 5 feet 10 inches, 5 feet 9 inches, 5 feet 7 inches, and 5 feet 6 inches. What is the average height? *Answer*.....
- 32 An article which formerly sold at 12 cents was raised to 18 cents. What per cent was the price advanced? *Answer*.....
- 33 A broker charges \$25 commission on every sale plus 5 per cent on all over \$200. What would be his commission on a \$500 sale? *Answer*.....
- 34 If 72 per cent of potatoes is water, how many pounds of solid material are there in a ton of potatoes? *Answer*.....
- 35 A man invested \$1000 in each of 3 different bonds. The first paid 8 per cent dividend and the second 6 per cent, but on the third he lost \$5 on each hundred dollars invested. What was his net yearly gain on the three investments? *Answer*.....
- 36 If the circumference of a circle is 12.5664 feet, what is its diameter? *Answer*.....
- 37 The regular price of a certain piece of linen is \$4 per yard. A remnant $1\frac{1}{4}$ yards long is offered at \$2.50. What per cent reduction is made? *Answer*.....
- 38 A man six feet tall casts a shadow 8 feet long at 9 A.M. A telephone pole casts a shadow 100 feet long at the same time. How high is the pole? *Answer*.....
- 39 It costs 43 cents to send a 10-pound parcel post package from New Orleans to Dallas. What will it cost to send an 8-pound package if the cost is 3 cents more on the first pound than on additional pounds? *Answer*.....
- 40 If the hour hand of a clock is 3 inches long and the minute hand is 4 inches long, how far apart are the tips of the two hands at 9 A.M.? *Answer*.....

Test 5. Number right $\times 4 =$ Score

TEST 5. ARITHMETIC: REASONING

Find all the answers as quickly as you can.

Write the answers on the dotted lines.

Use the blank sheets of paper to figure on.

Begin here.

- 1 How many are 3 eggs and 2 eggs? *Answer*
- 2 Mary is 7 years old. How old will she be in 3 years? *Answer*
- 3 A hen had 9 chicks and 3 of them died. How many were left? *Answer*
- 4 Milk costs 8 cents a pint and the milkman is going to raise the price 2 cents. What will it then cost? *Answer*
- 5 If you buy a pencil for 4 cents and pay for it with a dime, how much change should you get? *Answer*
- 6 How many dimes are there in a dollar? *Answer*
- 7 How many eggs are there in 7 nests if each nest has 3 eggs? *Answer*
- 8 How many cents will 8 oranges cost at 3 cents each? *Answer*
- 9 David earned \$3.50 in June, \$2.25 in July, and \$1.50 in August. How much did he earn in all? *Answer*
- 10 Frank bought 3 two-cent postage stamps and 13 one-cent stamps. How much did he pay for all? *Answer*
- 11 Five girls buy a present costing 25 cents. How many cents does each pay? *Answer*
- 12 If a train goes 60 miles in three hours, how far does it go in one hour? *Answer*
- 13 John has saved \$3.75. How many dollars more does he need to buy a pony which costs \$45.75? *Answer*
- 14 A man pays the street-car fare for himself and two friends. If the fare is 7¢, how much change should he receive from a half dollar? *Answer*
- 15 A train which was due at 2 P.M. was $3\frac{1}{2}$ hours late. When did it arrive? *Answer*
- 16 What is the cost of 10 oranges at 2 for 5 cents? *Answer*
- 17 Edward has \$1.67 in the bank and takes out 2 quarters, a dime, and a cent. How much does he have left in the bank? *Answer*
- 18 What is the cost of a $4\frac{3}{4}$ -pound roast at 40 cents a pound? *Answer*
- 19 A boy saved 5 cents a day for two weeks, and 10 cents a day for the next four weeks. How much money does he then have? *Answer*
- 20 A gallon is equal to 231 cubic inches. How many gallons are there in a tank $6 \times 7 \times 11$ inches? *Answer*
- 21 The tax rate in an Eastern city has varied as follows: 1910, 21¢ on each \$100; 1911, 17¢ on each \$100; 1912, 27¢ on each \$100; 1913, 26¢ on each \$100; 1914, 34¢ on each \$100; 1915, 33¢ on each \$100. The highest rate was how many times as great as the lowest? *Answer*

Go right on to next page.

Turn the page to Test 5.

OTIS SELF-ADMINISTERING TESTS OF MENTAL ABILITY

By ARTHUR S. OTIS

Formerly Development Specialist with Advisory Board, General Staff, United States War Department

HIGHER EXAMINATION: FORM A

20

Score.....

Read this page. Do what it tells you to do.

Do not open this paper, or turn it over, until you are told to do so. Fill these blanks, giving your name, age, birthday, etc. Write plainly.

Name.....Age last birthday.....years
First name, initial, and last name

Birthday.....Class.....Date.....192...
Month Day

School or College.....City.....

This is a test to see how well you can think. It contains questions of different kinds. Here is a sample question already answered correctly. Notice how the question is answered:

Which one of the five words below tells what an apple is?

1 flower, 2 tree, 3 vegetable, 4 fruit, 5 animal.....(4)

The right answer, of course, is "fruit"; so the word "fruit" is underlined. And the word "fruit" is No. 4; so a figure 4 is placed in the parentheses at the end of the dotted line. This is the way you are to answer the questions.

Try this sample question yourself. Do not write the answer; just draw a line under it and then put its number in the parentheses:

Which one of the five words below means the opposite of north?

1 pole, 2 equator, 3 south, 4 east, 5 west.....()

The answer, of course, is "south"; so you should have drawn a line under the word "south" and put a figure 3 in the parentheses. Try this one:

A foot is to a man and a paw is to a cat the same as a hoof is to a—what?

1 dog, 2 horse, 3 shoe, 4 blacksmith, 5 saddle.....()

The answer, of course, is "horse"; so you should have drawn a line under the word "horse" and put a figure 2 in the parentheses. Try this one:

At four cents each, how many cents will 6 pencils cost?.....()

The answer, of course, is 24, and there is nothing to underline; so just put the 24 in the parentheses. If the answer to any question is a number or a letter, put the number or letter in the parentheses without underlining anything. Make all letters like printed capitals.

The test contains 75 questions. You are not expected to be able to answer all of them, but do the best you can. You will be allowed half an hour after the examiner tells you to begin. Try to get as many right as possible. Be careful not to go so fast that you make mistakes. Do not spend too much time on any one question. No questions about the test will be answered by the examiner after the test begins. Lay your pencil down.

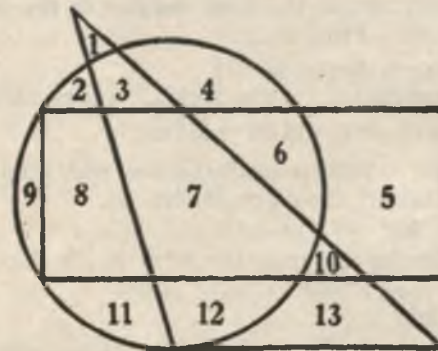
Do not turn this page until you are told to begin.

EXAMINATION BEGINS HERE:

1. The opposite of hate is (?)
1 enemy, 2 fear, 3 love, 4 friend, 5 joy..... ()
2. If 3 pencils cost 5 cents, how many pencils can be bought for 50 cents?..... ()
3. A bird does not always have (?)
1 wings, 2 eyes, 3 feathers, 4 a nest, 5 a bill..... ()
4. The opposite of honor is (?)
1 glory, 2 disgrace, 3 cowardice, 4 fear, 5 defeat..... ()
5. A fox most resembles a (?)
1 wolf, 2 goat, 3 pig, 4 tiger, 5 cat..... ()
6. Quiet is related to sound in the same way that darkness is related to (?)
1 a cellar, 2 sunlight, 3 noise, 4 stillness, 5 loud..... ()
7. A party consisted of a man and his wife, his two sons and their wives, and four children in each son's family. How many were there in the party?..... ()
8. A tree always has (?)
1 leaves, 2 fruit, 3 buds, 4 roots, 5 a shadow..... ()
9. The opposite of economical is (?)
1 cheap, 2 stingy, 3 extravagant, 4 value, 5 rich..... ()
10. Silver is more costly than iron because it is (?)
1 heavier, 2 scarcer, 3 whiter, 4 harder, 5 prettier..... ()
11. Which one of the six statements below tells the meaning of the following proverb? "The early bird catches the worm."
 1. Don't do the impossible.
 2. Weeping is bad for the eyes.
 3. Don't worry over troubles before they come.
 4. Early birds like worms best.
 5. Prompt persons often secure advantages over tardy ones.
 6. It is foolish to fret about things we can't help.
12. Which statement above tells the meaning of this proverb? "Don't cry over spilt milk.".... ()
13. Which statement above explains this proverb? "Don't cross a bridge till you get to it.".... ()
14. An electric light is related to a candle as an automobile is to (?)
1 a carriage, 2 electricity, 3 a tire, 4 speed, 5 glow..... ()
15. If a boy can run at the rate of 6 feet in $\frac{1}{4}$ of a second, how far can he run in 10 seconds?.... ()
16. A meal always involves (?)
1 a table, 2 dishes, 3 hunger, 4 food, 5 water..... ()
17. Of the five words below, four are alike in a certain way. Which is the one not like these four?
1 bend, 2 shave, 3 chop, 4 whittle, 5 shear..... ()
18. The opposite of never is (?)
1 often, 2 sometimes, 3 occasionally, 4 always, 5 frequently..... ()
19. A clock is related to time as a thermometer is to (?)
1 a watch, 2 warm, 3 a bulb, 4 mercury, 5 temperature..... ()
20. Which word makes the truest sentence? Men are (?) shorter than their wives.
1 always, 2 usually, 3 much, 4 rarely, 5 never..... ()
21. One number is wrong in the following series. What should that number be?
1 4 2 5 3 6 4 7 5 9 6 9..... ()
22. If the first two statements following are true, the third is (?) All members of this club are Republicans. Smith is not a Republican. Smith is a member of this club.
1 true, 2 false, 3 not certain..... ()
23. A contest always has (?)
1 an umpire, 2 opponents, 3 spectators, 4 applause, 5 victory..... ()
24. Which number in this series appears a second time nearest the beginning?
6 4 5 3 7 8 0 9 5 9 8 8 6 5 4 7 3 0 8 9 1 ()
25. The moon is related to the earth as the earth is to (?)
1 Mars, 2 the sun, 3 clouds, 4 stars, 5 the universe..... ()
26. Which word makes the truest sentence? Fathers are (?) wiser than their sons.
1 always, 2 usually, 3 much, 4 rarely, 5 never..... ()

27. The opposite of awkward is (?)
 1 strong, 2 pretty, 3 short, 4 graceful, 5 swift..... ()
28. A mother is always (?) than her daughter.
 1 wiser, 2 taller, 3 stouter, 4 older, 5 more wrinkled..... ()
29. Which one of the six statements below tells the meaning of the following proverb? "The burnt child dreads the fire."
 1. Frivolity flourishes when authority is absent.
 2. Unhappy experiences teach us to be careful.
 3. A thing must be tried before we know its value.
 4. A meal is judged by the dessert.
 5. Small animals never play in the presence of large ones.
 6. Children suffer more from heat than grown people. ()
30. Which statement above explains this proverb? "When the cat is away, the mice will play." ()
31. Which statement above explains this proverb? "The proof of the pudding is in the eating." ()
32. If the settlement of a difference is made by mutual concession, it is called a (?)
 1 promise, 2 compromise, 3 injunction, 4 coercion, 5 restoration..... ()
33. What is related to disease as carefulness is to accident?
 1 doctor, 2 surgery, 3 medicine, 4 hospital, 5 sanitation..... ()
34. Of the five things below, four are alike in a certain way. Which is the one not like these four?
 1 smuggle, 2 steal, 3 bribe, 4 cheat, 5 sell..... ()
35. If 10 boxes full of apples weigh 400 pounds, and each box when empty weighs 4 pounds, how much do all the apples weigh?..... ()
36. The opposite of hope is (?)
 1 faith, 2 misery, 3 sorrow, 4 despair, 5 hate..... ()
37. If all the odd-numbered letters in the alphabet were crossed out, what would be the tenth letter not crossed out? Print it. *Do not mark the alphabet.*..... ()
 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
38. What letter in the word SUPERFLUOUS is the same number in the word (counting from the beginning) as it is in the alphabet? Print it..... ()
39. What people say about a person constitutes his (?)
 1 character, 2 gossip, 3 reputation, 4 disposition, 5 personality..... ()
40. If $2\frac{1}{2}$ yards of cloth cost 30 cents, what will 10 yards cost?..... ()
41. If the words below were arranged to make a good sentence, with what letter would the second word of the sentence begin? Make it like a printed capital.
 same means big large the as..... ()
42. If the first two statements following are true, the third is (?) George is older than Frank. James is older than George. Frank is younger than James.
 1 true, 2 false, 3 not certain..... ()
43. Suppose the first and second letters in the word CONSTITUTIONAL were interchanged, also the third and fourth letters, the fifth and sixth, etc. Print the letter that would then be the twelfth letter counting to the right..... ()
44. One number is wrong in the following series. What should that number be?
 0 1 3 6 10 15 21 28 34..... ()
45. If $4\frac{1}{2}$ yards of cloth cost 90 cents, what will $2\frac{1}{2}$ yards cost?..... ()
46. A man's influence in a community should depend upon his (?)
 1 wealth, 2 dignity, 3 wisdom, 4 ambition, 5 political power..... ()
47. What is related to few as ordinary is to exceptional?
 1 none, 2 some, 3 many, 4 less, 5 more..... ()
48. The opposite of treacherous is (?)
 1 friendly, 2 brave, 3 wise, 4 cowardly, 5 loyal..... ()
49. Which one of the five words below is most unlike the other four?
 1 good, 2 large, 3 red, 4 walk, 5 thick..... ()
50. If the first two statements following are true, the third is (?) Some of Brown's friends are Baptists. Some of Brown's friends are dentists. Some of Brown's friends are Baptist dentists.
 1 true, 2 false, 3 not certain..... ()
51. How many of the following words can be made from the letters in the word LARGEST, using any letter any number of times?
 great, stagger, grasses, trestle, struggle, rattle, garage, strangle..... ()
52. The statement that the moon is made of green cheese is (?)
 1 absurd, 2 misleading, 3 improbable, 4 unfair, 5 wicked..... ()

53. Of the five things following, four are alike in a certain way. Which is the one not like these four?
 1 tar, 2 snow, 3 soot, 4 ebony, 5 coal..... ()
54. What is related to a cube in the same way in which a circle is related to a square?
 1 circumference, 2 sphere, 3 corners, 4 solid, 5 thickness..... ()
55. If the following words were seen on a wall by looking in a mirror on an opposite wall, which word would appear exactly the same as if seen directly?
 1 OHIO, 2 SAW, 3 NOON, 4 MOTOR, 5 OTTO..... ()
56. If a strip of cloth 24 inches long will shrink to 22 inches when washed, how long will a 36-inch strip be after shrinking?..... ()
57. Which of the following is a trait of character?
 1 personality, 2 esteem, 3 love, 4 generosity, 5 health..... ()
58. Find the two letters in the word DOING which have just as many letters between them in the word as in the alphabet. Print the one of these letters that comes first in the alphabet..... ()
 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
59. Revolution is related to evolution as flying is to (?)
 1 birds, 2 whirling, 3 walking, 4 wings, 5 standing..... ()
60. One number is wrong in the following series. What should that number be?
 1 3 9 27 81 108..... ()
61. If Frank can ride a bicycle 30 feet while George runs 20 feet, how far can Frank ride while George runs 30 feet?..... ()
62. Count each N in this series that is followed by an O next to it if the O is not followed by a T next to it. Tell how many N's you count.
 N O N T Q M N O T M O N O O N Q M N N O Q N O T O N A M O N O M ()
63. A man who is averse to change and progress is said to be (?)
 1 democratic, 2 radical, 3 conservative, 4 anarchistic, 5 liberal..... ()
64. Print the letter which is the fourth letter to the left of the letter which is midway between O and S in the alphabet..... ()
65. What number is in the space which is in the rectangle and in the triangle but not in the circle? ()




66. What number is in the same geometrical figure or figures as the number 8?..... ()
67. How many spaces are there that are in any two but only two geometrical figures?..... ()
68. A surface is related to a line as a line is to (?)
 1 solid, 2 plane, 3 curve, 4 point, 5 string..... ()
69. If the first two statements following are true, the third is (?) One cannot become a good violinist without much practice. Charles practices much on the violin. Charles will become a good violinist.
 1 true, 2 false, 3 not certain..... ()
70. If the words below were arranged to make the best sentence, with what letter would the last word of the sentence end? Print the letter as a capital.
 sincerity traits courtesy character of desirable and are..... ()
71. A man who is influenced in making a decision by preconceived opinions is said to be (?)
 1 influential, 2 prejudiced, 3 hypocritical, 4 decisive, 5 impartial..... ()
72. A hotel serves a mixture of 2 parts cream and 3 parts milk. How many pints of cream will it take to make 15 pints of the mixture?..... ()
73. What is related to blood as physics is to motion?
 1 temperature, 2 veins, 3 body, 4 physiology, 5 geography..... ()
74. A statement the meaning of which is not definite is said to be (?)
 1 erroneous, 2 doubtful, 3 ambiguous, 4 distorted, 5 hypothetical..... ()
75. If a wire 20 inches long is to be cut so that one piece is $\frac{2}{3}$ as long as the other piece, how long must the shorter piece be?..... ()

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