A STATEMENT OF THE OBJECTIVES FOR TEACHING PLANE GEOMETRY AND MEANS OF TESTING FOR THESE OBJECTIVES

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A STATEMENT OF THE OBJECTIVES FOR TEACHING PLANE GEOMETRY AND MEANS OF TESTING FOR THESE OBJECTIVES

by

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A STATEMENT OF THE OBJECTIVES FOR TEACHING PLANE GEOMETRY AND MEANS OF TESTING FOR THESE OBJECTIVES

AN INTRODUCTION

The effective teaching of geometry in our secondary schools is seriously handicapped by the haziness of the objectives for teaching the course. Too few administrators have a clear concept of the place of geometry in the high school curriculum; too few teachers know exactly why they are teaching geometry and for what changes in pupil behavior they are working; and too few students have any idea of the purposes and aims of the course. This often leads to a lack of appreciation on the part of the administration of the place of geometry in the curriculum, a confusion of purpose on the part of the classroom teacher, and an indifference toward the subject on the part of the student.

It is true that at times objectives are agreed upon and set down in writing, but often these are more of a defense for teaching geometry than vital goals of the classroom. Too often they are stated in broad general phrases, and not interpreted in terms of specific pupil behavior. We may agree upon objectives and still continue to work in the same old way, not teaching by them and not testing for them. We may say in defense of geometry that it cultivates the habit of independent logical thinking, and still continue to teach model proofs, and test for memory. But surely an objective has no value unless it transforms the teaching of the classroom.

As Mc Call points out, "Measurement is indispensable to the growth of scientific education."[1] And measurement in itself has no value, unless we know what we are measuring and are measuring for attainment of the same goals we hope to achieve. It is my belief that we will actually never teach for the objectives we adopt until accurate means are developed for measuring pupil achievement along the lines of these same objectives. Unless we can test for these, we can never be certain of what we are accomplishing. Unless we can test for these, the students will never actually make the stated objectives their objectives. Until then they will be hollow phrases incapable of realization.

Therefore, in order to have effective teaching of geometry in the classroom we must

1. carefully select the objectives for which we are teaching,
2. analyze these objectives in terms of desired changes in student behavior, and
3. devise means of testing each of these objectives.

1W. A. McCall. How to Measure in Education. The Mac Millan Company, New York, 1923. Pp. 91.

HISTORY OF OBJECTIVES

From the very beginning two great aims have stood out in the teaching of geometry--the teaching of geometry for knowledge and the teaching of geometry as a way of thinking.

The conditions of our world led man to an early discovery of the common geometric relationships. To survey his fields he needed a method of laying off a perpendicular. To buy and sell land, he must know of area. In the exchange of agricultural products, a knowledge of volume became necessary. To navigate the sea successfully, he learned properties of plane figures and spherical surfaces. The early Egyptians found value in geometry in the field of mensuration. The Nile overflowed its banks each year and surveying was necessary to reestablish boundary lines. In the construction of the pyramids and temples geometry proved its usefulness in architecture. In Babylonia also, practical geometry was developed at an early date, and was studied for its usefulness in the practical affairs of the ancient world.

Demonstrative geometry, as a logical system of reasoning, developed in Greece. Here geometry was studied for its own sake, and valued for the beauty and perfection of deductive reasoning. It was considered as having value for "the training of the mind and the cultivation of the soul."[2] Hence, among the Greeks we may say that after its early development, geometry was studied as a form of logic or method of reasoning rather than for its practical use.

The Romans were chiefly interested in geometry for the practical applications. But some leaders believed it beneficial in the training of an orator.

The Arabs studied geometry for its practical applications to astronomy and surveying. They also considered it an aid to the study of algebra and physics.

The medieval church schools and universities did not consider geometry very important, and so taught it merely for the purpose of mensuration and surveying. But with the coming of scholasticism, geometry was again studied to sharpen the logical faculties of the mind. With the rise of modern European countries, geometry was taught chiefly for its disciplinary values with some emphasis upon practical applications.

By the eighteenth century geometry was taught to prepare students for the technical colleges and universities where geometry was needed for the study of advanced mathematics and science.

In Great Britain and the United States the disciplinary function of mathematics was dominant until the beginning of

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[2] J. Shibbi. Recent Developments in the Teaching of Geometry. Maple Press Company, York, 1932. Pp. 201-202.

the twentieth century. In 1877 G. A. Wentworth declared, "Mathematical training is not so much the attainment of information as the discipline of the mental faculties."[3] In 1893 the following statement appeared in the report of the committee of ten: "Geometry possesses remarkable qualifications for quickening and developing creative talent. Whatever the training (in independent geometrical work) may accomplish for him geometrically, there is no student whom it will not brighten and strengthen intellectually as few exercises can."[3] In the latter half of the nineteenth century the secondary schools of both Great Britain and the United States taught geometry to prepare pupils for college and for the study of science and advanced mathematics.

Since the beginning of the present century the aims and values of the teaching of geometry have been under almost constant discussion, and repeated revision. They have been tuned to the spirit of the times and harmonized with the new points of view of education. The statement of these objectives has changed from the passive to the active voice. And the student is no longer thought of as a piece of clay which we must mold into the desired form, but as an active participant thinking and planning for himself. Mathematicians have been awakened from their

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[3] J. Shibbi. Recent Developments in the Teaching of Geometry. Maple Press Company, York, 1932. Pp. 203-204.

thoughtless acceptance of the geometric objectives of past ages, and have been searching anew for the real objectives of teaching geometry in the world of today.

In 1912 came the report of the Committee of Fifteen emphasizing the need for the reconsideration of our objectives and stressing such points as the function concept, space intuition, accuracy and precision of thought and expression, logic in the everyday affairs of life, personal pleasure, and an appreciation of and control over forms existing in the material world.

In 1923 came a report from the National Committee on Mathematical Requirements -- a report revolutionary in the field of the teaching of mathematics, entitled, "The Reorganization of Mathematics in Secondary Education." True--the report followed the traditional division of the aims of mathematics into three general classes -- practical, disciplinary, and cultural. But there was a vitalizing and broadening in the defining of these aims. There was a shifting of the emphasis, a fresh appraisal of the relative importance that was far from traditional. And above all there was the daring spirit of the committeemen who challenged many of the tenets of the past, and blazed the trail to the future. These men threw out a daring statement for 1923 when they said that the practical aims may without danger be given secondary position in seeking to formulate the general point of view which should govern the teacher. They declared that the primary purposes of the teaching of mathematics should be to develop those powers of understanding and of analyzing relations of quantity and of space which are necessary to an insight in and control over our environment and an appreciation of the progress of civilization in its various aspects, and to develop those habits of thought and of action which will make these powers effective in the life of the individual. Furthermore, they stated that all topics, processes, and drills which do not directly contribute to the development of these powers should be eliminated. There is dynamite in that statement even today after years have elapsed.

The fifteenth yearbook of the National Council of Teachers of Mathematics entitled, "The Place of Mathematics in Secondary Education," restated the general philosophy and outlook of the 1923 report. The objectives were developed with special care. First there was consideration of the objectives of education as a whole; then a statement of the particular objectives of secondary education. These the committee classified as follows:

1. Ability to think clearly.
   a. gathering and organizing data
   b. representing data
   c. drawing conclusions
   d. establishing and judging claims of proof
2. Ability to use information, concepts, and general principles.
3. Ability to use fundamental skills.
4. Desirable attitudes.
   a. respect for knowledge
   b. respect for good workmanship
   c. respect for understanding
   d. social-mindedness
   e. open-mindedness
5. Interests and appreciations.
6. All other objectives.

Finally the committee attempted to show how the teaching of mathematics fitted into this general pattern and contributed to each of these aims.

In 1940 the committee on the Function of Mathematics in General Education (a committee of the Progressive Education Association) upheld a different point of view in their report, "Mathematics in General Education." Instead of trying to fit mathematics into each of the objectives of general education, this committee spoke of the special role of mathematics, and believed that mathematics was most valuable because of the unique contribution it had to offer. Their emphasis was upon mathematics as a means of developing techniques of reflective thinking. They called attention to the fact that with specialization had come an increasing mathematization of all fields, and believed emphasis should be placed upon those concepts basic to problem solving which are crucial in democracy, and pervasive in mathematics.

In "Nature of Proof" Harold P. Fawcett declared that demonstrative geometry was no longer justified on the grounds that it was necessary in order to give the student knowledge of geometrical facts, as all of these can be gained through an informal approach to geometry based upon observation, measurement, and construction. He believed the most important values to be derived from the study of geometry were an understanding of the nature of proof, a familiarity with postulational thinking, and an ability to use it not only in geometry but in every field of thought.

PROPOSED OBJECTIVES

Today the objectives advanced for the teaching of geometry are numerous. Between different groups there is much disagreement as to these objectives, and as to their relative importance. Thus I have found my attempt to list these objectives an almost impossible task. I have limited this more intensive study to the last twenty-five years. I have secured these objectives from many sources of which the most fruitful have been professional magazines, yearbooks of educational groups, geometry text-books, and professional books on the teaching of mathematics. I have attempted to avoid repetition of the same objective expressed in different forms, and have taken the liberty of rewording them into brief compact statements. The list of these objectives follows.

1. To familiarize students with the great basic propositions.
2. To familiarize students with properties of common geometric forms.
3. To teach model proofs and develop memory.
4. To discipline the mental faculties.
5. To learn the facts of mensuration.
6. To secure a thorough understanding of measurement.
7. To develop a sense of form.
8. To exercise powers of spatial imagination.
9. To sense relationships and dependencies.
10. To develop functional thinking.

11. To prepare students for college.
12. To prepare students for work in advanced mathematics and science.
13. To develop proficiency in the use of the straightedge and compass.
14. To learn useful constructions.
15. To draw artistic designs.
16. To develop clear and accurate expression.
17. To give knowledge of the historical development of mathematics.
18. To appreciate the power of geometry in the development of civilization.
19. To appreciate beauty in the geometric forms of nature, art, and industry.
20. To think naturally, logically, and systematically.
21. To learn the form of rigorous deductive reasoning.
22. To withhold judgment until sufficient evidence is given.
23. To check authority and verify results.
24. To analyze complex situations into simpler parts.
25. To develop an inquiring or questioning type of mind.
26. To see the need for assumptions, definitions, and undefined terms behind every body of logic.
27. To cultivate the habit of independent investigation.
28. To make the student critical of his own and other's reasoning.

29. To show usefulness of system and order as help in memory and understanding.

30. To develop urge to check and prove everything.

31. To follow directions exactly.

32. To teach respect for good workmanship.

33. To develop persistence in the face of difficulty.

34. To develop moral and spiritual ideals as reverence and honesty.

35. To make pupils more open-minded.

36. To teach neatness.

37. To increase unwillingness to let a mistake go uncorrected.

38. To teach the student how to study.

39. To become aware of and insist upon precision.

40. To learn the practical applications of geometry.

41. To provide pleasure.

42. To develop new types of recreational activities.

ANALYSIS

In studying and analyzing these objectives there are several facts which may be noted. First of all, there are some few of these objectives with which I heartily disagree. For example, objective number three, to teach model proofs and develop memory, is contrary to the nature of geometry. Geometry is a creative subject -- not one built upon memory and blind following of directions. Others of the objectives, as number thirty-two, to teach respect for good workmanship, and number thirty-six, to teach neatness, certainly represent desirable traits. But these are general objectives of education which apply to all subjects in the curriculum. Geometry should make its contribution. But these objectives in themselves are surely not the important ones for teaching geometry as all could be acquired by some other means. Other objectives listed, as number fifteen, to draw artistic designs, seem to me to be merely by-products of the course, and not objectives in themselves. But most confusing of all is the large number of objectives. No teacher can successfully teach for forty-two objectives. For efficiency we must select a small group of vital objectives and concentrate on these.

FOUR OBJECTIVES PROPOSED

Which objectives are then of the most vital importance in the teaching of geometry? I would like to present four objectives and to defend my choice by telling why I consider these of the greatest importance.

First, through the study of geometry the student should learn to think critically. This objective is important both to the individual from a personal viewpoint, and to our democratic state whose judgments and decisions are the judgments and decisions of its citizens.

It is valuable for any individual to be able to analyze his life problems, and arrive at a correct solution. It is important to know when somebody else is using incorrect reasoning and arriving at a false conclusion. Political parties, advertisers, pressure groups, salesmen, religious groups, and labor unions, all at times advance propaganda and attempt to do the individual's thinking for him; or perhaps to indoctrinate the individual without allowing him to think at all. As civilization becomes more and more complicated, it is increasingly important that the individual, for his own protection and happiness, be able to think critically.

Since our government is a democracy, its nobility, its success, and its efficiency depend upon the reasoning ability of its citizens. The founders of our republic were aware of the relationship between education and democracy, for good citizenship is not just a matter of obeying the law, but thinking critically about political issues, and contributing to the solution of social problems.

Perhaps in war time, we realize more than ever that the strength of a democracy depends upon its individuals. A good citizen must be critical of sources of information of news. He must be on his guard against snap judgments. He must think logically and not be a target for propaganda advanced by subversive groups.

Morris Raphail Cohen declares that, "Surely it is good for a democracy that its citizens shall constantly ask their governors to give a rational account of their stewardship, that men and women shall demand that new proposals as well as the established institutions should defend themselves before the bar of Reason."[4]

A second objective for the study of geometry is to develop the ability and desire to use language clearly and precisely. We cannot discuss any topic intelligently unless definitions for all important terms are agreed upon. We must appreciate the necessity of using words exactly to present our own thoughts clearly. We must be able readily to understand the written and spoken language of others. For careful thinking in any field of activity involves using language clearly and precisely. And

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[4] Edward M. Glaser. An Experiment in the Development of Critical Thinking. Bureau of Publications, Teachers College, Columbia University, 1941. Pg. 1.

nowhere is correct language more necessary than in geometry. Every word must have a definite and specific meaning. One word misused may destroy the entire meaning of a proposition or corollary. It is for this reason that geometry has a unique function to fulfill in teaching the use of language. Fawcett presents the hypothesis that the language of mathematics as a medium of communication may be used as a means of improving all communication. Such fundamental concepts in geometry should be studied as will help the student develop the ability and the desire to express his own thoughts more clearly, and to understand written and spoken language more readily.

In the third place, the study of geometry will enable the student to appreciate better the world in which we live. Geometry should be studied for its cultural value. Centuries ago Plato said, "God eternally geometrizes." Nature is filled with geometry. The bees may never have proved that regular hexagons fill a plane space without overlapping or leaving space between them, but for centuries they have been making hexagonal honey cells. Geometric forms are in evidence all about us. The sun and moon and planets are spherical; and before life existed on the earth, the bodies of the solar system were whirling about the sun in ellipses. The trunks of trees and stems of plants are circular, snowflakes are hexagonal or triangular pattern, and crystals of various substances take the form of hexagonal prisms, octahedrons, and cubes.

The student should have an appreciation of what geometry has done for our pleasure, comfort, convenience, and progress. Geometry is used in design and decoration. Many commercial articles such as wall paper, cloth, rugs, vases, watches, curtains, bedspreads, compacts, furniture, and clothing make use of geometric designs because of their beauty and simplicity. Mechanical drawing, art, and surveying are all based upon geometry. Architecture is a field most fertile, for geometry is involved in every part of a building. The floor, the walls, the windows, and the doors are all geometric forms. Triangles, circles, hexagons, squares, and other geometric figures are used freely in decoration of public buildings, churches, and cathedrals. Modern transportation, bridges, tunnels, and irrigation reservoirs would be impossible without geometric calculations. The applications of geometry are increasing day by day.

In order to understand and appreciate this great world in which we live, a knowledge of geometry is essential. It should be taught so as to show the student how basic it is in comprehending certain elements in the civilization they are to share.

And finally, geometry should be taught so as to put new meaning into arithmetic and algebra, and to lay a foundation for advanced mathematics, the sciences, and specialized vocational training. I feel this objective has probably been overemphasized in the past in that it was considered the central objective and crowded the others out. However, I feel that it has a vital place among the objectives, and am somewhat concerned that in many modern discussions this objective has been entirely omitted. Surely geometry should put additional meaning into the other branches of mathematics already studied. Surely we should familiarize students with facts and principles about form and space, and the great basic propositions needed as a foundation for a study of advanced mathematics, the sciences, and specialized vocational training. The geometry teacher has an obligation here which should not be overlooked.

SUMMARY OF PROPOSED OBJECTIVES

In summarizing, the chief objectives I am proposing for the teaching of geometry are to help the student

1. to think critically,
2. to develop the ability and desire to use language clearly and precisely,
3. to appreciate better the world in which we live, and
4. to put new meaning into arithmetic and algebra, and to lay a foundation for advanced mathematics, the sciences, and specialized vocational training.

MEANS OF ACHIEVING THESE PROPOSED OBJECTIVES

Deciding upon the four major objectives for the teaching of geometry should not be the end, but the beginning. Often in the past we have stopped here, believing that somehow the objectives would work themselves out if we but agreed upon them. Objectives to be effective cannot be stated and then forgotten, but must be kept constantly in mind by the administrators, teachers, and students.

The students should be active participants in the plan. This implies a great deal more than being told a few times through the year of the valuable training they are getting from the course. Is it too much to assume that the same students whom we believe are capable of understanding plane geometry, are also capable of understanding the goals of the course and helping plan means for attaining these and evaluating their progress toward achieving them? I believe the students should be let in on the whole plan. Each individual student should know the values he may hope to achieve from the course. As different parts of the work are undertaken, he should realize to which objectives of the course they are contributing. He should be urged to help plan ways of making the course more efficient toward achieving these ends. Furthermore, he is entitled to know from time to time the progress he is making along each of these objectives. For only when the student becomes an enlightened participant, in place of a blind worker, can we hope to attain maximum achievement.

How are we to teach so as to attain these objectives? A whole book might be written simply outlining plans and methods to be followed in the classroom. But if a teacher followed the book carefully, would he then be sure that his teaching was actually contributing to these objectives? Could he then feel satisfied with the progress he was making?

I strongly believe that real progress cannot come until we find means of testing each one of the objectives. The teacher and the students must be able to measure from time to time the growth of achievement along the definite goals for which they are working. Only then can they be sure of what they are really accomplishing. And so I believe that finding accurate means of measuring pupil achievement along the lines of the four proposed objectives is absolutely essential if they are to be of any value. I believe that the forming of such tests is the most important single thing which can be done toward bringing about their achievement. Material to be covered, class procedure, methods, and plans, important as they are, will more or less take care of themselves once we clearly see our goal, and can measure our progress toward it.

Having decided then that we must devise tests for our objectives, let us think once more of our four proposed objectives, which were:--to help the student

1. to think critically,
2. to develop the ability and desire to use language clearly and precisely,
3. to appreciate better the world in which we live, and
4. to put new meaning into arithmetic and algebra, and to lay a foundation for advanced mathematics, the sciences, and specialized vocational training.

Looking at them from this viewpoint, we immediately see that they are stated in rather general terms. But we cannot test for these until we have broken them down into concrete changes in pupil behavior. For each objective let us ask ourselves, "What changes should this objective bring about in the student? In what ways will he react differently at the end of the course than at the beginning?" Only when thus broken down in terms of pupil behavior can we test for an objective.

So the remainder of this paper will consist of two parts--a careful analysis of each objective in terms of student behavior, and suggested tests for measuring these changes. Because of the necessary limit of the scope of this paper, and because the traditional tests have measured the fourth objective better than the other objectives, this detailed study will be limited to the first three of the proposed objectives. Therefore the tests which follow must not be considered as a complete appraisal of geometry, but merely as tests of the first three objectives. The fourth objective is important and tests for this objective must be included in any well balanced program of testing.

BEHAVIOR PATTERN FOR OBJECTIVE ONE
TO THINK CRITICALLY

What does this general objective mean, interpreted concretely in terms of pupil behavior? What changes will there be in the student because he has taken plane geometry? At the end of the course he should be able:

1. to recognize problems in life situations,
2. to find the hidden assumptions in arguments,
3. to distinguish between important and irrelevant factors in any situation,
4. to recognize dependencies and relationships,
5. to associate general statements with specific instances,
6. to understand the nature of proof,
7. to distinguish between correct and incorrect reasoning,
8. to draw conclusions and identify the types of thinking used,
9. to be consistent in his thinking,
10. to examine statements critically to see if arguments are sound and based on accepted facts, and
11. to have a scientific system for solving his own problems.

UNIT ONE

TO RECOGNIZE PROBLEMS IN LIFE SITUATIONS

DIRECTIONS. Below are given facts from certain real life situations. What problems do these facts present to you? Make a very careful exact statement of each of the problems involved.

1. A certain high school now has a student body of about 800 members, and still continues the traditional student council of 12 members. These representatives consist of the presidents of each class, and two representatives elected by each class. There are approximately 125 Seniors, 150 Juniors, 225 sophomores, and 300 freshmen. There are 24 homerooms. The student council is taking over more and more responsibility. What problems are involved?

2. In an industrial area a certain high school building was built for a maximum of 500 students. There are a gymnasium, a library, 16 classrooms, and 250 lockers. There are now over 800 students enrolled, and 26 teachers employed. What problems are involved?

3. The Junior class of a certain high school consists of 150 members. They will present their class play April 13th and 14th. They are planning their J-Hop for April 28th. What mathematical problems are involved?

4. The school board of a certain high school recently ruled that its athletic program must be self supporting. What are the mathematical problems involved?

5. The student council of a certain high school wishes to sponsor a magazine sale to raise funds for the purchase of shades for the windows in the gymnasium so that movies can be shown during the daytime. What mathematical problems are involved?

6. Mr. John T. Siebert has decided to paint his house this spring. What are the mathematical problems involved?

7. Mr. Henry Thompson runs a small commercial cannery. He wishes to place his order now for the paper which will be required for labels for the coming season. What is the mathematical problem involved?

8. One of the requirements for a certain rank in the Girl Scouts used to be to make an accurate construction of the American flag. What are the mathematical problems involved?

9. Our government recently constructed a large office building in Washington. They wished to cut the cost of a square foot of space to a minimum. They also wished the distance between the offices to be such as would provide the swiftest passage between them. For engineering reasons straight walls were desired. What mathematical problems were involved?

UNIT TWO

TO FIND THE HIDDEN ASSUMPTIONS IN ARGUMENTS

DIRECTIONS. Back of the statement in each of the following exercises there are hidden assumptions. In some cases there may be only one, in others there are several. State clearly in the space below the assumption or assumptions upon which each exercise is based.

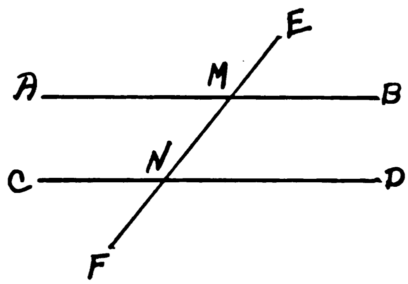
1. Lines AB and CD will not meet no matter how far they are produced. Therefore the lines are parallel.

2. If two parallel lines are cut by a transversal, the interior angles on the same side of transversal are supplementary but not equal.

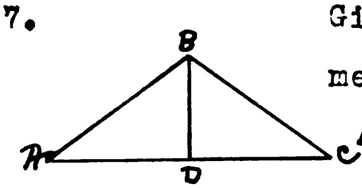
3. In a triangle the sum of the squares of two sides is equal to the square of the third.

4. The sum of the interior angles of a pentagon is 540 degrees.

5. Each interior angle of a convex hexagon contains 120 degrees.

6. 

EF is a transversal cutting lines AB and CD at M and N. Therefore ∠ BNM = ∠ DMF.

7. 

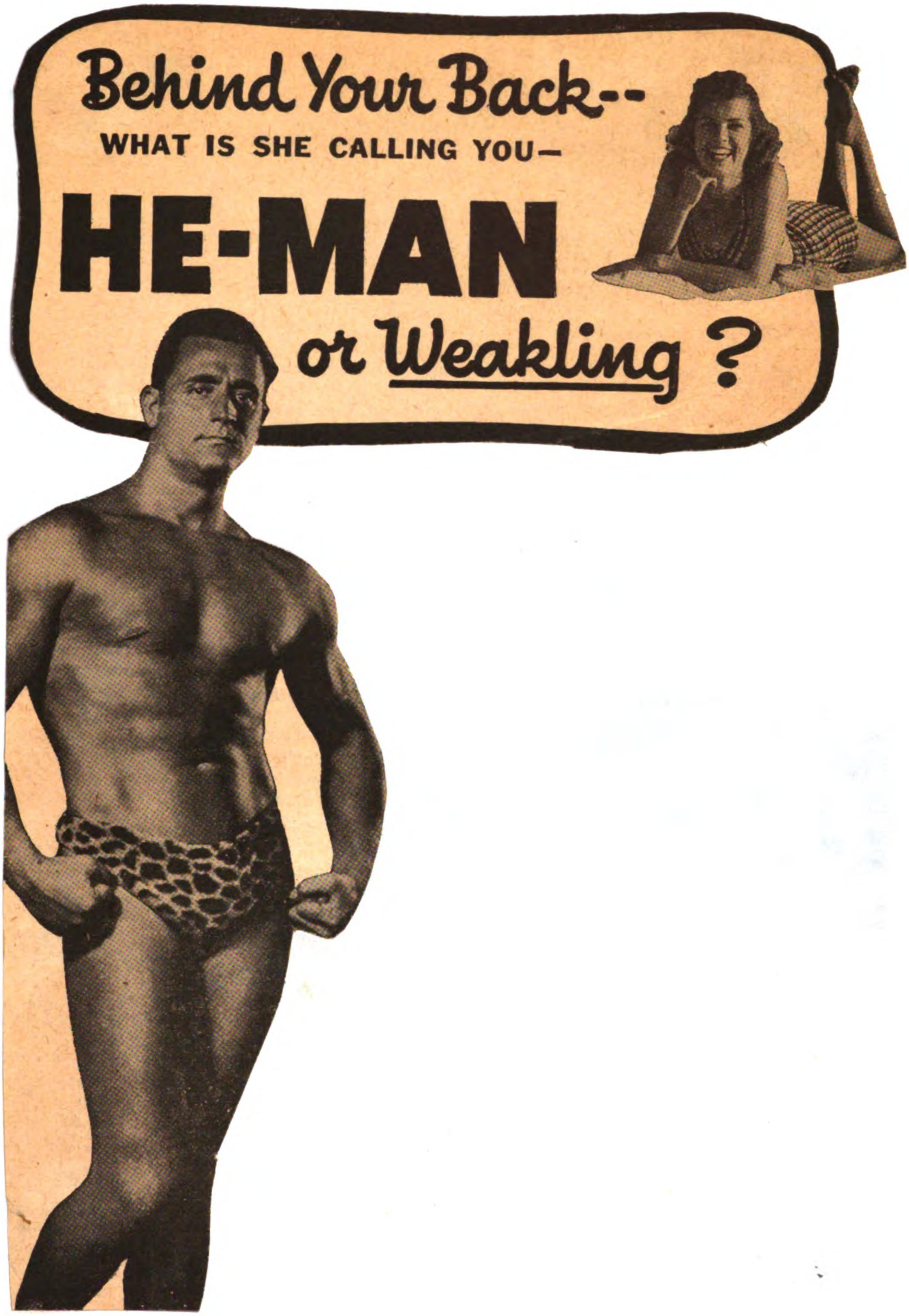
Given △ ABC with the bisector of ∠ B meeting AC at D. We can prove that △ ABD ≅ BDC because two right triangles are congruent if a leg and an acute angle of one is equal to a leg and an acute angle of the other.

8. Eventually, why not now? Gold Medal Flour.

9. We buy only furniture manufactured in Grand Rapids.

10. REDUCE 3 to 5 Pounds a Week Yet EAT Plenty!

11.



12.

HE'S ENGAGED !

She's Lovely! She uses Pond's!

13.

GET RID OF FAT . . . PITCH IN, HELP WIN!

Reduce The Ry-Krisp Way

Mrs. A. is fat. She can't work like other women—excess fat drains her energy. She should try the Ry-Krisp reducing plan for normally overweight and enjoy Ry-Krisp as bread. Each delicious double-square wafer has only about 23 calories.

Mrs. D. is slim. She works all day, is a Nurse's Aide at night. Like many smart women, she keeps in trim and stays slim the sensible Ry-Krisp way.

FREE! Ry-Krisp reducing plan for normally overweight. Address Ry-Krisp, 21 Checkerboard Square, St. Louis, Mo.

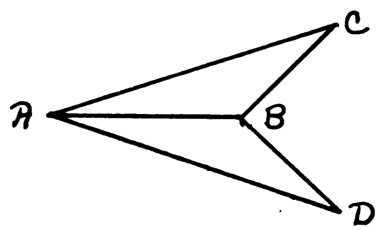
Mrs. S. is smart. She always has Ry-Krisp handy for her family. She knows this tempting whole grain bread with its rich rye flavor always makes a hit. She knows it's good for them, too! Try Ry-Krisp! It comes in crisp, ready-to-eat slices; grand to serve as crackers, toast, or bread.

UNIT THREE

TO DISTINGUISH BETWEEN IMPORTANT AND IRRELEVANT FACTORS IN ANY SITUATION

DIRECTIONS. In each exercise there is a general statement or question followed by four particular statements. Part of these are important and part are irrelevant to the problem or question. If you feel a statement is important, circle the "IMP"; if you feel the statement is irrelevant, circle the "IRR."

I. AB bisects $\angle$ CAD, and AC = AD. Prove $\triangle$ACB $\cong$ $\triangle$ABD.



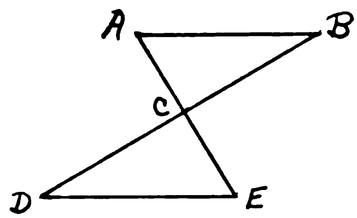
IMP IRR 1. If two sides and the included angle of one triangle are respectively equal to two sides and the included angle of another triangle, the triangles are congruent.

IMP IRR 2. Parts of a bisected angle are equal.

IMP IRR 3. If two angles and the included side of one triangle are respectively equal to two angles and the included side of another triangle, the triangles are congruent.

IMP IRR 4. $\angle$BAD = 37 degrees.

II. AE and BD are line segments which bisect each other at C. Prove AB || DE.



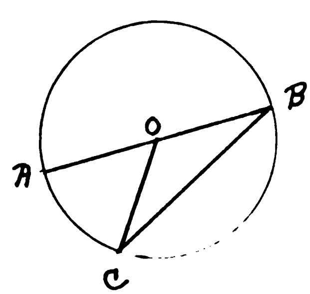
IMP IRR 1. Corresponding parts of congruent figures are equal.

IMP IRR 2. If two parallel lines are cut by a transversal, the corresponding angles are equal.

IMP IRR 3. Parts of a bisected line segment are equal.

IMP IRR 4. If two sides and the included angle of one triangle are respectively equal to two sides and the included angle of another triangle, the triangles are congruent.

III. AB is a diameter of circle O. Prove $\angle ABC = \frac{1}{2} \angle AOC$



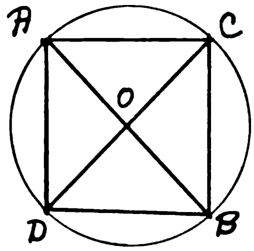
IMP IRR 1. In any circle a central angle is equal numerically in degrees to its intercepted arc.

IMP IRR 2. In any circle an inscribed angle is equal numerically in degrees to $\frac{1}{2}$ its intercepted arc.

IMP IRR 3. AO = 3".

IMP IRR 4. $\angle O = 30$ degrees.

IV. AB and CD are diameters of circle O. Prove that quadrilateral ACBD is a parallelogram.



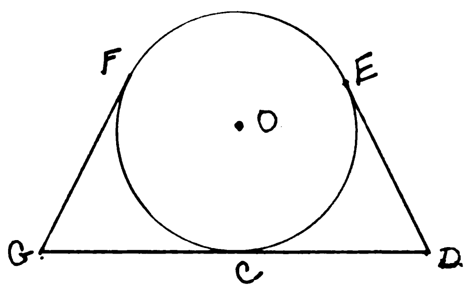
IMP IRR 1. ∠AOC is supplementary to ∠DOA.

IMP IRR 2. ∠AOC = ∠DOB.

IMP IRR 3. If the diagonals of a quadrilateral bisect each other, the figure is a parallelogram.

IMP IRR 4. A square is a parallelogram which has two adjacent sides equal and one angle a right angle.

V. FG, GD, and DE are tangent to circle O at F, C, and E respectively. Prove that GD = FG + DE.



IMP IRR 1. Two tangents to a circle from a point outside a circle are equal.

IMP IRR 2. An angle formed by two tangents, intersecting outside a circle, is equal numerically in degrees to one-half the difference of the intercepted arcs.

IMP IRR 3. If equals are added to equals, the results are equal.

IMP IRR 4. If equals are subtracted from equals, the results are equal.

VI. Should the Junior class sell Christmas cards this year?

IMP IRR 1. In past years at our high school money has been made through the sale of Christmas cards.

IMP IRR 2. The Christmas cards come in boxes.

IMP IRR 3. A Christmas card salesman was at our school last week.

IMP IRR 4. Due to the war emergency, the Juniors should substitute a bond selling campaign or some activity directly relating to the war effort.

VII. Should I complete high school?

IMP IRR 1. High school students advance further than those without a high school education.

IMP IRR 2. Lloyd Smith graduated from high school and everybody knows how dumb he is.

IMP IRR 3. My mother needs my help and I could get a job if I dropped out of school.

IMP IRR 4. I like our school yells.

VIII. How much money should I spend on clothes?

IMP IRR 1. The cost of clothing has increased greatly in the last two years.

IMP IRR 2. My job requires me to make a good appearance at all times.

IMP IRR 3. The new hats are certainly odd this season.

IMP IRR 4. Our government is asking us to buy only what is necessary.

UNIT FOUR

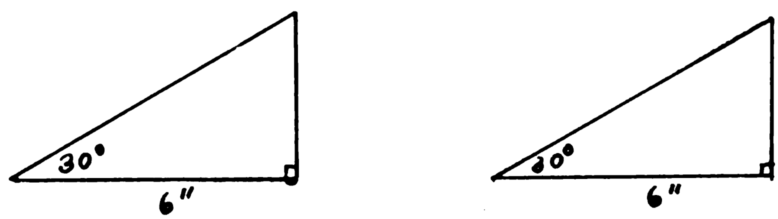
TO RECOGNIZE DEPENDENCIES AND RELATIONSHIPS

PART ONE

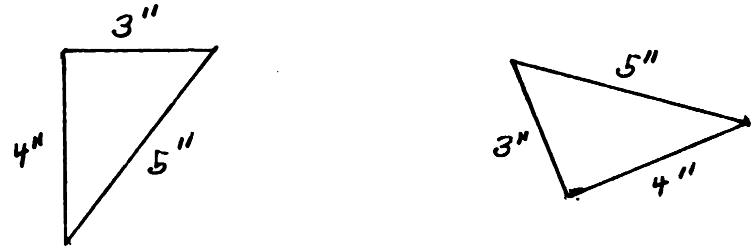
DIRECTIONS. In each of the exercises below there are two figures. If the figures are equal (but not congruent) circle the "E", if the figures are similar (but not congruent) circle the "S", if the figures are congruent circle the "C", if the figures possess none of these relationships circle the "N". Decide each case on the basis of the evidence given rather than on the basis of the appearance of the figures. (Note: ∟ will be used to indicate a right angle.)

E S C N 1.

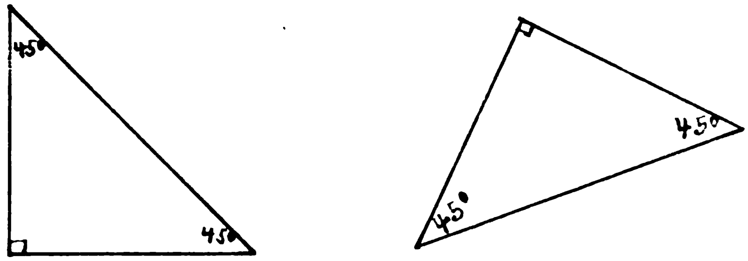
E S C N 2.



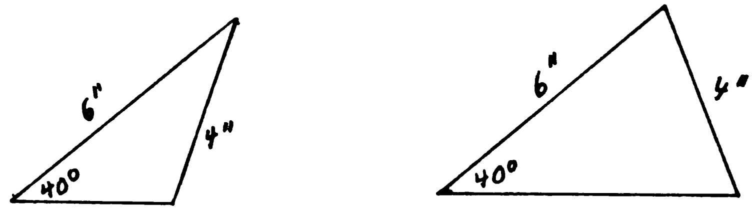
E S C N 3.



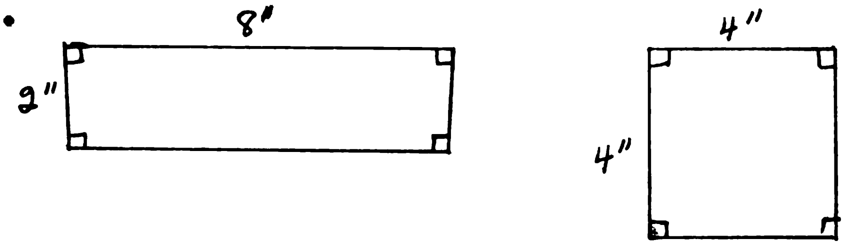
E S C N 4.



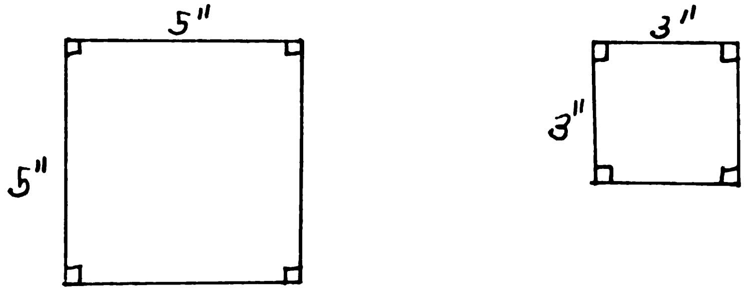
E S C N 5.



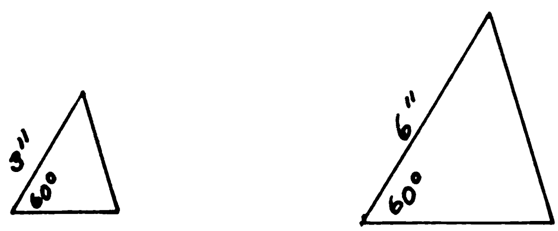
E S C N 6.



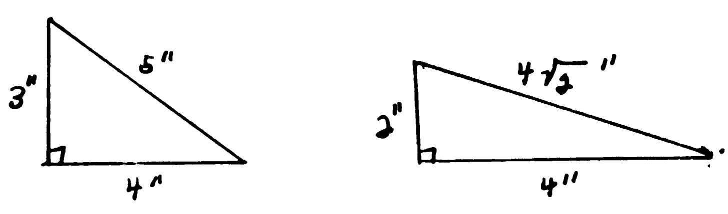
E S C N 7.



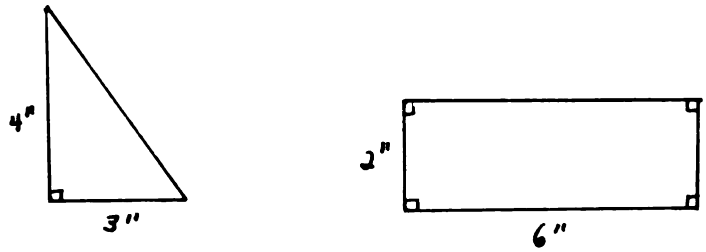
E S C N 8.



E S C N 9.



E S C N 10.



PART TWO

DIRECTIONS. In each exercise below underline the answer which will make the statement correct.

1. If the altitude of a triangle is doubled, the area is ($\frac{1}{2}$, 2, 1/3, 4) times the area of the original triangle.

2. If AB equals BC in triangle ABC, and other parts of the triangle are allowed to vary, as $\angle$ A increases $\angle$ B will (increase, decrease) and $\angle$ C will (increase, decrease).

3. The value of an angle inscribed in a circle depends upon (the size of the circle, its intercepted arc, the length of its sides).

4. A straight line is related to a line segment as a circle is to (a chord, a diameter, a radius, an arc, a center).

5. Circle O has a radius of 5". If the radius is doubled, the circumference of the second circle is (2, $\frac{1}{2}$, 4, $\frac{1}{4}$, 5, 1/5, 25, 1/25) times the circumference of original circle.

6. If the radius of a circle with 3" radius is doubled, the area of the second circle is (2, 3, $\frac{1}{2}$, 1/3, 6, 1/6, 1/4, 4) times the area of the original circle.

7. If $\angle$ A and $\angle$ B are supplementary, as $\angle$ A increases $\angle$ B (increases, decreases).

8. The sum of the angles of any regular polygon depends on (the size of the polygon, the number of sides, the radius of the inscribed circle).

9. If in $\triangle$ ABC, side AB is 5", AC is 6", and BC is 4", the largest angle is ($\angle$ A, $\angle$ B, $\angle$ C) and the smallest angle is ($\angle$ A, $\angle$ B, $\angle$ C).

10. A straight angle is related to a right angle as a semi-circle is to a (circle, arc, quadrant, circumference).

11. If each side of a square is doubled, the area of the second square is ($\frac{1}{2}$, 2, $\frac{1}{4}$, 4, 1/8, 8) times the original square.

12. If $\angle$ A and $\angle$ B are vertical angles, as $\angle$ A increases $\angle$ B (increases, decreases).

13. If two lines are parallel to a third, they are (oblique, parallel, perpendicular) to each other.

14. If in a given circle a chord increases in length, its distance from the center (increases, decreases).

15. If the base and altitude of a triangle are both doubled, the area of the second triangle is ($\frac{1}{2}$, $\frac{1}{4}$, 2, 3, 4, 8, 16) times the area of the original triangle.

16. The area of a circle depends on its (radius, location, chords, degrees).

17. If the central angle of a circle increases, its inter-cepted arc (increases, decreases).

18. The radius of a circle is 4". If the radius is doubled, the diameter of the new circle is (2, 4, $\frac{1}{2}$, $\frac{1}{4}$) times the diameter of the original circle.

19. If two lines are perpendicular to a third line, they are (oblique, parallel, perpendicular) to eech other.
20. As the number of sides of a regular polygon increases, the value of each interior angle (increases, decreases).
21. If the opposite angles of a quadrilateral are equal, the opposite sides are (perpendicular, equal, parallel), and the consecutive angles are (equal, complementary, supplementary).
22. In △ ABC, ∠ C is a right angle. As ∠ A increases, ∠ B (increases, decreases).

UNIT FIVE

TO ASSOCIATE GENERAL STATEMENTS WITH SPECIFIC INSTANCES

DIRECTIONS. In the left column are general statements; in the right column are specific instances. You are to match these. In the blank at the left, place the number corresponding to the statement in the right column.

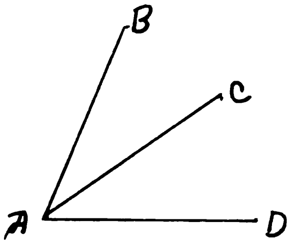
PART ONE

___. If two straight lines intersect the vertical angles are equal.

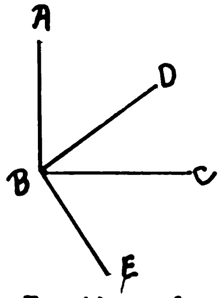
___. Base angles of an isosceles triangle are equal.

___. If two parallel lines are cut by a transversal, the alternate interior angles are equal.

___. Corresponding parts of congruent figures are equal.

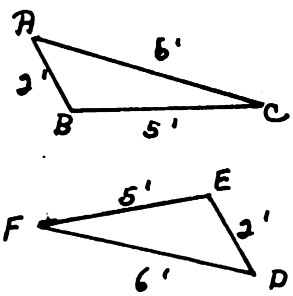
1. 

AC bisects $\angle$ ABD. Therefore $\angle$ BAC = $\angle$ CAD.

2. 

$\angle$ ABC and $\angle$ DBE are right angles. Therefore $\angle$ ABD = $\angle$ CBE.

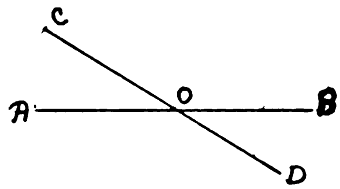
3. In the above figure of exercise 2, $\angle$ ABC = $\angle$ DBE.

4. 

In the figures at the left, $\angle$ C $\angle$ F.

___. Complements of the same or equal angles are equal.

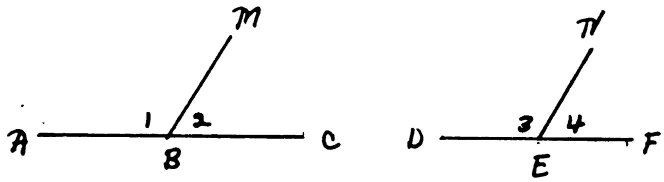
5.



AB and CD are straight lines intersecting at O. $\angle AOC = \angle DOB$.

___. If two angles of one triangle are equal respectively to two angles of another triangle, the third angles are equal.

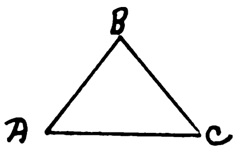
6.



AC and DF are straight lines. $\angle 1 = \angle 3$. Therefore $\angle 2 = \angle 4$.

___. Central angles which intercept equal arcs are equal.

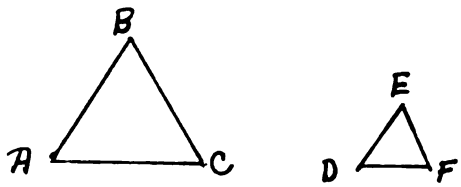
7.



If AB = BC, $\angle A = \angle C$.

___. Angles inscribed in the same segment of a circle are equal.

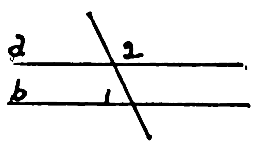
8.



If $\angle A = \angle D$ and $\angle B = \angle E$, $\angle C = \angle F$.

___. If two parallel lines are cut by a transversal, the alternate exterior angles are equal.

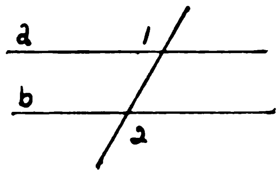
9.



a is parallel to b. $\angle 1 = \angle 2$.

____. Parts of a bisected angle are equal.

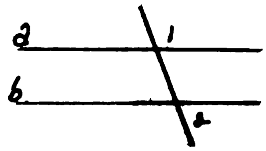
10.



a is parallel to b. ∠1 = ∠2.

____. Supplements of the same or equal angles are equal.

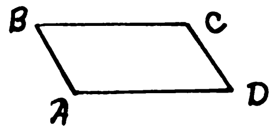
11.



a is parallel to b. ∠1 = ∠2.

____. In the same circle or equal circles inscribed angles intercepting the same or equal arcs are equal.

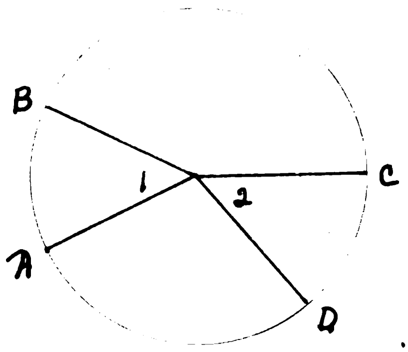
12.



AB is equal and parallel to CD in quadrilateral. Therefore ∠B = ∠D.

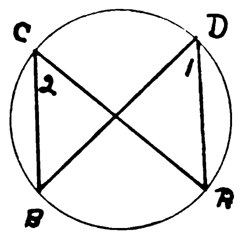
____. If two parallel lines are cut by a transversal, the corresponding angles are equal.

13.



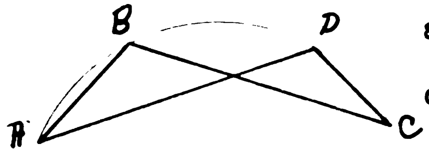
$\widehat{AB}$ and $\widehat{CD}$ are equal arcs of circle O. Therefore ∠1 = ∠2.

___. Opposite angles of a parallelogram are equal.

14. 

In diagram to the left 1 = 2.

___. All right angles are equal.

15. 

AC is an arc of a circle. ABC = ADC.

PART TWO

___. At most American high schools students receive the same rights, privileges, and honors regardless of their race.

1. Wayne County is meeting its quota of 5,500 pints of blood per week to the Red Cross Blood Bank.

2. It was unbelievable that Mr. Gene Diedrich, Superintendent of the Lapeer Methodist Sunday School, should commit such a crime.

___. Most of the workers in war plants have been very well paid.

3. Of course Mr. Dwight Corbin, being a patriotic man, does not complain about his income tax.

___. The high school youth of America are doing their part toward winning the war.

4. Leroy Bell, a negro student at Williamsburg, is captain of the debate team and star forward on the basketball team.

___. The President of the United States deserves the respect of the American people.

___. A few Americans complain bitterly over certain shortages in consumer goods.

___. The public expects good conduct of a church worker.

___. Honesty is the best policy.

___. Citizens on the home front are contributing greatly to the war effort.

___. A good citizen is always able to accept responsibility and to contribute his share.

5. According to Supt. M. L. McCoy, "Wayne High School students are annually supplying more than one million man hours, absolutely vital and essential to the rapid winning of the war."

6. No, David, you shouldn't keep the purse you found in the hall. Turn it in to the high school principal.

7. George Bowers, worker at Willow Run, has a good income.

8. The local press chastised the citizens for booing in the local theater when the president's picture flashed on the screen. And this was done even though it was a campaign year and the paper was of the opposite party.

9. Utica has passed a law requiring all youth between 17 and 18 to be off the streets before 10:00 p.m.

___. Many communities have been passing laws hoping to curb juvenile delinquency.

10. Mrs. Ashley became very angry when she could buy no soap powder in Plymouth last Wednesday.

UNIT SIX

TO UNDERSTAND THE NATURE OF PROOF

DIRECTIONS. Answer each question completely and carefully in the space below.

1. Is an assumption necessarily true? Explain.

2. State three geometric statements which are accepted without proof.

3. State three geometric statements which are proven.

4. How might indirect reasoning be used to determine what hour George has geometry?

5. Are the conclusions reached by indirect reasoning always valid? Explain.

6. How might inductive reasoning be used to prove that all members of the Oxford High School Band own their instruments?

7. Are the conclusions reached by inductive reasoning always valid? Explain.

8. How might deductive reasoning be used to prove that John Thomas, a graduate of Dearborn High School, completed a course in American history?

9. Are the conclusions reached by deductive reasoning always valid? Explain.

10. How might analogy be used to prove that Dr. Irwin Woodbury can help Mrs. Floyd Winter?

11. Are the conclusions reached by analogy always valid? Explain.

12. State the converse: "If two angles are equal, their complements are equal."

13. State the inverse: "If it is good weather, we will have a picnic."

UNIT SEVEN

TO DISTINGUISH BETWEEN CORRECT AND INCORRECT REASONING

DIRECTIONS. In each exercise you are to accept the assumptions. You are not to decide whether the assumptions are true, or whether the conclusions are true. You are merely to decide whether the reasoning used is valid. If the reasoning is valid, circle the "V"; if the reasoning is not valid, circle the "N". The conclusions are underlined to distinguish them from the assumptions.

V N 1. Only Boy Scouts marched in the parade. Dick Jackson marched in the parade. Dick Jackson was a Boy Scout.

V N 2. "Diz" Trout is pitching at Brigg's Stadium today. I saw "Diz" Trout today. Therefore I was at Brigg's Stadium.

V N 3. Geometry classes are held in rooms 111 and 114. John has a class in 114. Therefore John takes geometry.

V N 4. A state capitol should be located in the central part of a state. Boston is the capitol of Massachusetts. Therefore Boston is located in the central part of the state.

V N 5. Dresses of good quality are expensive. This dress is expensive. Therefore this dress is of good quality.

V N 6. Rochester is north of Detroit. Oxford is north of Rochester. Therefore Oxford is north of Detroit.

V N 7. If a man lives in Astar, he lives in Stithero. If a man lives in Stithero, he lives in Astar.

V N 8. If a man lives in Astar, he lives in Stithero. <u>If a man does not live in Astar, he does not live in Stithero</u>.

V N 9. If a man lives in Astar, he lives in Stithero. <u>If a man does not live in Stithero, he does not live in Astar</u>.

V N 10. If one has an Elgin watch, he has a good time piece. John's watch is not an Elgin. <u>Therefore John's watch is not a good time piece</u>.

V N 11. All classes in 208 are Chemistry classes. George Cushing has a class in 208. <u>George Cushing is enrolled in Chemistry</u>.

V N 12. There are five members in the Smith family. Mrs. Smith is 42 years old; Donald Smith is 10; Margaret Smith is 16; and Mr. Smith is 44. <u>We conclude that there is no one in the Smith family under nine years of age</u>.

V N 13. All high school graduates are well educated. All well educated people speak good English. <u>Therefore all high school graduates speak good English</u>.

V N 14. Oxydol makes clothes whiter than any other soap powder. Mrs. Jones has the whitest clothes on the street. <u>Therefore Mrs. Jones uses Oxydol</u>.

V N 15. There are three schools in Oxford. Washington School was built in 1926. Monroe School was built in 1931. Lincoln School was built in 1938. <u>All schools in Oxford have been built in the last twenty years</u>.

V N 16. Dick lives one block from Bob. Bob lives two blocks from Jarvis. Therefore Dick lives three blocks from Jarvis.

V N 17. All non-resident students must pay a tuition to attend Romeo High School. Julius Hunt is a non-resident student of Romeo High School. Therefore Julius Hunt must pay tuition.

V N 18. Jack Stover played football and broke his arm. If I play football, I will break my arm.

V N 19. The Morenci High School closes Friday, June 18th. The Juniors and Seniors are having a picnic the last Monday of school. The freshmen are having their picnic the last Tuesday of school, while the sophomores are having their picnic the last Wednesday of the school year. Therefore all the classes in our high school are having a picnic the last week of school.

V N 20. Margaret is older than Helen. Hazel is younger than Helen. Geraldine is older than Margaret. Geraldine is older than Helen.

UNIT EIGHT

TO DRAW CONCLUSIONS AND IDENTIFY THE TYPES OF THINKING USED

DIRECTIONS. In each of the following exercises there are a number of given facts from which you are to draw a conclusion if possible. Underneath the exercise to the left check the type of reasoning you used in reaching your conclusion--inductive, deductive, or indirect. Then write your conclusion in the space to the right. If no conclusion is possible from the given facts, indicate this by a check to the left and leave the space to the right blank.

I. Students at Lenoy High School having a B average in any subject, and having a 90% attendance in the class are excused from the semester examination in that class. Mildred received 3 A's and 2 B's for her five monthly marks in geometry this semester.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

II. There are no new teachers this year in the Jefferson School at Roxenburg. There are no new teachers this year in the Franklin School at Roxenburg. These are the only two schools in Roxenburg.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

III. Horace, a member of the Camera Club, is 15 years of age. Alice, a member of the Camera Club, is 14 years of age. Benjamin, a member of the Camera Club, is 15 years of age.

Herbert, a member of the Camera Club, is 16 years of age.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

IV. The Tigers defeated the Indians 8 to 5. The Indians defeated the Senators 5 to 2. The Tigers play the Senators next week.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No Conclusion

V. If $x = 2$, $y = 8$. If $x = 3$, $y = 12$. If $x = 4$, $y = 16$. If $x = 5$, $y = 20$. (Limit conclusion, if any, to these four examples.)

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

VI. I am going to the "Sweater Swing" Friday. Which one of my sweaters shall I wear--the white, green, red, or blue one? The white one is soiled and it is too late to clean it. The red has become stretched out of shape. The green is the wrong shade to go with the plaid skirt I am wearing.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

VII. Marjorie Phillips attends Sunday School in Roxenburg. There are three Sunday Schools. The Methodist Sunday School is at 9:30; the Baptist at 10:00; and the Congregational at 12:00. Only the Baptist and Congregational churches are across the bridge on the south side of town. Marjorie told me yesterday that she was sometimes delayed by the traffic on the south side bridge, but she was always home for a twelve o'clock dinner.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

VIII. There are five boys in the Tiger Patrol--Floyd, William, Jack, Robert, and Preston. Floyd is a first class scout. William is a first class scout. Preston is a first class scout. Jack is a first class scout. Robert is a first class scout.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

IX. All Juniors and Seniors at Wayne High School are required to take physical fitness. Marilyn Tucker is a Junior at Wayne High School.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

X. All the clerks at Kem's Hardware are paid 75 cents per hour. John Jones clerks at Kem's Hardware.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XI. a and b are two straight lines lying in a plane. a does not intersect b.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XII. No married women teach at Ahmes High School. Bernice Henderson teaches at Ahmes High School.

___ Inductive   Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XIII. There are three Sunday Schools in Roxenburg. The Congregational Sunday School is holding its Christmas program Friday evening, December 23rd. The Methodist Sunday School is having a Christmas entertainment on December 23rd at eight o'clock. The Baptist program for Christmas is the Friday before Christmas at 7:30 p.m.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XIV. Gerald Bailey takes geometry second hour. There are three geometry classes the second hour. George Thompson says he is not in his class which is taught by Mr. Pendill. Miss Norcross told me Gerald was not in her class. The other class is taught by Mr. Keith.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XV. A pair of Gold Cross shoes costs $6.50. I have just spent $6.50.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XVI. Edward did not earn more money than Jim last week. Jim did not earn more money than Edward last week.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XVII. Allan takes mechanical drawing. Yesterday I looked in Mr. Kennedy's class and he was not there. I asked Mr. Severance and he said Allan was not in any of his classes. The only other mechanical drawing class is taught by Mr. Ennis.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XVIII. All Juniors at Wayne High School are required to take American history. Lucille Wilson is a Junior at Wayne High School.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XIX. The Freshman class of Jonesville High School gave $26 to the Red Cross. The Sophomore class gave $35 to the Red Cross. The Junior and Senior classes each gave $50 to the Red Cross.

___ Inductive Conclusion if any

___ Deductive

___ Indirect

___ No conclusion

XX. All members of our football team are invited to a banquet to be given by the Rotary Club. Tom Nyberg is a member of our football team.

___ Inductive	Conclusion if any
___ Deductive	
___ Indirect	
___ No conclusion	

UNIT NINE

TO BE CONSISTENT IN HIS THINKING

DIRECTIONS. The way to score well on this test is to be strictly honest. This is a free country and you have a right to your opinions. Each statement below is such that some people honestly believe it is true, and others equally sincere believe it false. If you believe a statement true, circle the "T"; if you believe it false, circle the "F".

T F 1. Negroes should be prevented from migrating into northern communities more rapidly than they can be readily assimilated.

T F 2. High school students should be allowed complete freedom in choosing whatever subjects they believe will be the most beneficial.

T F 3. Of course, the allies should have bombed Rome. It was a military target.

T F 4. President Roosevelt should have a fourth term if it is the will of the American people.

T F 5. During war such frills as interscholastic high school athletics should be abolished to make room for more essential training, as physical fitness and preinduction courses.

T F 6. Americans should gladly share their food with people of other countries who are harder hit by the war than we.

T F 7. Since men are drafted into our armed forces, it is only fair for labor also to be drafted.

T F 8. Our young people should have the same right to stay out evenings as the adults in the community.

T F 9. Rationing of some kind is the best method for dividing scarce goods in war time.

T F 10. Our school assembly programs should be continued because they are cultural.

T F 11. The allies should not have bombed Rome because of its religious and cultural heritage.

T F 12. Interscholastic high school sports should be continued during war time to keep up civilian morale.

T F 13. A curfew should be established for all youths between 10 and 18 to decrease juvenile delinquency.

T F 14. Our constitution should be amended to limit the term of president to two terms.

T F 15. Our school assemblies should be abolished for the students are often restless and inattentive.

T F 16. Certain subjects should be required of every high school graduate.

T F 17. Even in time of war, an American citizen should have the right to work where and when he wishes.

T F 18. Rationing should be abolished as it leads to the black market and other corrupt practices.

T F 19. Negroes should be permitted to live wherever they wish.

T F 20. Why should Uncle Sam be looked upon as Santa Claus? We should feed our own civilians and soldiers, and other countries should do the same.

UNIT TEN

TO EXAMINE STATEMENTS CRITICALLY TO SEE IF ARGUMENTS ARE SOUND AND BASED ON ACCEPTED FACTS

DIRECTIONS. Below are samples of everyday reasoning. Discuss. State whether or not the argument is correct. Give reason for your conclusion. Make complete explanation.

1. "Oh," exclaimed Mrs. Davis, "I feel just terrible! The doctor said to take one of these tablets every two hours. I'll take two every hour instead. I want to get well as quickly as possible."

2. The Senior class of Lake Orion High School had a perfect attendance last Thursday. Mary Henderson has been enrolled as a senior at Lake Orion High School for the last three months; so she must have been in school Thursday.

3. A patriotic lady writing to the Detroit News Letter Box shortly after the rationing of canned goods complained, "Surely the government is making a mistake in rationing canned goods. How can I and my neighbors continue to give such a large number of tin cans to the scrap metal drive?"

4. ALBANY, N. Y.—(U.P.)—It was bound to happen.

A bus driver, who stopped at the end of the line before starting his next trip, stepped off the vehicle to smoke a cigaret.

A woman and a man got on the bus. Soon he heard an argument in progress.

"What is wrong lady?" he asked.

"I put three dimes in the coin box and he put in only one," she replied vehemently as she stared at the man seated across the aisle.

"The fare," the driver explained, "is one dime."

"But," said the woman, "it clearly says on the outside of the bus, 'Seats 30; stands 10.' That means if you want a seat it costs 30 cents, standing room 10 cents. And he," pointing her finger at the male passenger, "is sitting."

"Lady," explained the bus driver, "that refers to the capacity of the bus, not the fare."

5. Students seldom do good work the day before the Christmas holidays. Therefore school should be closed one day earlier.

6. Brown's Variety Store started advertising four months ago in the Radcliffe Gazette. Its sales this month are 20% higher than they were four months ago. Advertising in the Radcliffe Gazette surely pays well.

7. Help your body to eliminate the natural way. Buy Serutan. Read backwards, it spells "nature's".

8. "Oh, my dear," said Mrs. Grant to Mrs. Forbush, "we must hurry and buy our winter's supply of soap before the hoarders get it all."

9. I killed dear old Tabby last Wednesday evening. That very night my brother died in Texas. I shall never kill a pet again.

10. The following appeared as a part of an editorial in "The State Journal" (Lansing newspaper) on July 6, 1944.

> An old game has been revived and is being used to show that the war will end in 1944. You take any of the principal war leaders, add his birth year, nis age, the year in which he took office and the number of years in office and the answer is 3888. Dividing the total by two, the answer is 1944.

11. John laid the four kings of a standard deck of playing cards on the table before me. I picked up one--it was the king of spades. I turned over the second; it was the king of diamonds. I looked at another; it was the king of hearts. So without looking at the fourth card I knew it was the king of clubs.

12. I know it to be a fact that Samuel Washington, a negro, attacked a white woman. Therefore all negroes in our community are bad citizens.

13. Mr. Cruden asserted, "Every good citizen should invest at least 10% of his earnings in war bonds. I am a good citizen, but I don't believe I'll need to invest much money in war bonds because so many others are doing it."

14. Nalda is a student at Plymouth High School. She is not a freshman. She is not a Senior. Therefore she is a Junior.

15. Do not vote for Grimes for Senator. He is a Lutheran.

16. People who doubt these statements are dumb. But you, my friends, are intelligent so you will believe what I have to say.

17. Shortly after the race riot in Detroit in the summer of 1943 the following editorial appeared in the Detroit News.

A Riot Picture Explained

The photograph showing a white rioter slapping a Negro held by two members of the Detroit police force was published by a great many newspapers and at least one magazine of national circulation.

It was a fine news photograph, but either carelessly or unscrupulously edited. The picture shows, on moderately close examination, that one of the two patrolmen is reaching forward to grasp or restrain the white rioter. His hand and arm are half-hidden in shadow but visible—a detail significantly explanatory of the action.

It was a detail that could be overlooked, however, and that, being overlooked, made the picture an accusative, more appealing and even "better" picture. It became then a picture of two cops holding a victim helpless, so that a fourth man might hit him, and so it was published all over the country. The caption appended by the magazine referred to read:

> Rioter slaps a Negro who is being held by two policemen, while a large gang of white hoodlums surges in from behind. Throughout the riot the Detroit police were tougher on Negroes than whites. Etc.

Truth often fails to catch up with falsehood, but it is our hope at least to give it a chance. The News yesterday printed the sequel to this story. The white rioter in the picture was found to be one George Miller, a character with a police record including larceny and counterfeiting. He was arrested, identified by one of the two patrolmen in the picture, tried and sentenced to 90 days for assault.

The patrolman, Paul Gyslvic of Central Station, explained why Miller was not arrested at the time: Both officers were fully occupied with assisting the Negro riot victim, who had been stabbed and would have fallen, had they let go of him.

This unfortunate picture has contributed to an impression, especially outside Detroit, that police conduct in the riots was marked by partiality.

18. I know John Norris is a Boy Scout because he is twelve years of age and Boy Scouts must be at least twelve years old.

19. I had forgotten whether $C = \pi d$ or πr, so for an answer on my test I did not know whether to use 7" or 14". I put down 7". When my paper was returned, it was marked wrong. Therefore I know that 14" was the correct answer.

20. When Mrs. Emery Tienken's neighbors have a party she cannot sleep. She told me this morning that she slept scarcely a wink all last night. Her neighbors must have been having another one of their noisy parties.

UNIT ELEVEN

TO HAVE A SCIENTIFIC SYSTEM FOR SOLVING HIS OWN PROBLEMS

Below is an outline of steps for problem solving which may be helpful to you.

1. State your problem.
2. Define necessary terms.
3. State any assumptions you use.
4. Collect data (facts, figures, details), read, conduct interviews.
5. Investigate similarities to other problems.
6. Study all information secured.
7. Formulate possible solutions.
8. Give your conclusion and evidence to support it.
9. Test conclusion.

I. For this exercise your problem is "The Attendance Problem in our Local Schools." State definitely how you would study this problem in an effort to improve conditions. The outline above will be helpful. You do not actually need to conduct the investigation, but indicate concretely what you would do, and how you would do it. Place work on another sheet.

II. While the preceding exercise was theory, this is to be actual practice. Choose any local or school problem (as recreation, curfew ruling, school assemblies, movies). Do not merely tell what to do, but actually do it. The above outline will help. Study the problem, and investigate it. Decide on the best solution. Hand in a careful report stating step by step what you have done, and include the actual definitions, assumptions, and data. Give your conclusion and evidence to support it. If possible, test solution; if not, indicate how it could be done.

BEHAVIOR PATTERN FOR OBJECTIVE TWO

TO DEVELOP THE ABILITY AND DESIRE TO USE LANGUAGE CLEARLY AND PRECISELY

Breaking this general objective into concrete changes in pupil behavior, at the end of a course in plane geometry a student should be able:

1. to select the significant words and phrases in any statement that need defining,
2. to recognize the properties of a good definition,
3. to define words clearly,
4. to understand written and spoken language more readily,
5. to be precise and exact in statements,
6. to give directions which can be easily followed,
7. to seek a genuine understanding of definitions not possible by memorization,
8. to understand the importance of a single word in making a correct statement, and
9. to appreciate the importance of using language clearly and precisely.

UNIT TWELVE

TO SELECT THE SIGNIFICANT WORDS AND PHRASES IN ANY STATEMENT THAT NEED DEFINING

DIRECTIONS. Underline the words in each statement which need a particular definition to limit their meaning in the given context. The last ten examples are actual clippings from magazines and newspapers.

1. Tom and I have said goodbye to frills for the duration.

2. The student council of Lincoln High School adopted the following resolution: "Resolved that all students with good standings should be excused from final examinations."

3. The diagonals of a regular pentagon divide each other in extreme and mean ratio.

4. Waste can't be tolerated.

5. School letters should be awarded for outstanding achievement in school.

6. Two triangles are similar if their corresponding sides are proportional.

7. Our high school gymnasium is used free by school groups, community groups pay a fee, and other groups may not use it at all.

8. On a recent ration list, sausage has the following point values per pound--dry sausage 9, semi-dry sausage 7, group 1 fresh smoked and cooked sausage 6, group 2 fresh smoked and cooked sausage 5, group 3 fresh smoked and cooked sausage 4, group 4 fresh cooked and smoked sausage 3.

9. On the same ration list, processed butter was valued at 4 points per pound, and all other butter at 10 points per pound.

10. The area of a semicircle on the hypotenuse of a right triangle equals the sum of the areas of the semicircles on the legs.

11. **Farm Workers Get Deferment**

12. ENCHANTING is the word for Carolee Arnold! Whether she's gracing a social function in Washington, where her father served in Congress for 8 years, or whether she's getting right down to earth on one of the family's mid-west farms—her artless, chiseled beauty is captivating. Her pale gold hair is like cornsilk, her eyes azure blue, her complexion wild-rose sweet!

13. ***Sociologists Want to Know What Makes Zoot Suiter Zoot***

14. Let's GO to

BOB-LO

5 SAILINGS DAILY

10 A. M., 2:00 P. M., 4:00 P.M.
6:00 P. M.
Fares, 85c—Children, 35c

SATURDAY MOONLIGHT
8:45 P. M. . . . Fares $1.25

CA. 0130

15. Absentees to Be Drafted

16.

ARE YOU A NIBBLER?

17.

I MAY BE CUTE — BUT I'M NOT IMPRACTICAL!

18.

DON'T TRUST CHEAP SUBSTITUTES!

19. Citizens of St. Clair Pledge Loyalty

20.

UNIT THIRTEEN

TO RECOGNIZE THE PROPERTIES OF A GOOD DEFINITION

DIRECTIONS. A good definition should possess the following properties:

1. The term should be placed in its class.
2. It should be distinguished from all other members of its class.
3. The term should be defined in words simpler than the term being defined.
4. The definition should be concise.

If the definition possesses these properties of a good definition, circle the "+"; if it does not possess these properties, circle the "-". At the right side and following each definition are numbers corresponding to the four properties of a good definition as listed above. In each exercise in which you circle the "-", also circle the number (or numbers) corresponding to the property (or properties) of a good definition lacking in the given exercise.

\+ - 1. A triangle is a three-sided polygon.

1 2 3 4

\+ - 2. Geometry is a subject taught in our high school.

1 2 3 4

\+ - 3. Interest is where money is paid for the use of money. 1 2 3 4

\+ - 4. A stream of electrons passing through a conductor is an electric current. 1 2 3 4

\+ - 5. A parallelogram is a geometric figure which has its opposite sides equal and parallel, its opposite angles equal, and its consecutive angles supplementary. 1 2 3 5

\+ - 6. A sentence is a group of words expressing a complete thought. 1 2 3 4

\+ - 7. Democracy is a form of government.

1 2 3 4

\+ - 8. Similar triangles are triangles which are similar.
1 2 3 4

\+ - 9. Circles in the same plane with the same center are concentric circles.
1 2 3 4

\+ - 10. A ballad is a form of poetry.
1 2 3 4

\+ - 11. Centrifugal force is where all parts of a whirling body go outward.
1 2 3 4

\+ - 12. Cohesion is the sticking together of the same kind of molecules.
1 2 3 4

\+ - 13. A parallelogram is a geometric figure.
1 2 3 4

\+ - 14. An adjective is a word which modifies a noun or pronoun.
1 2 3 4

\+ - 15. A triangle is a three sided polygon all of whose sides are straight having three vertices and three angles whose sum is 180 degrees.
1 2 3 4

\+ - 16. A straight line which intersects a circle in two points is a secant.
1 2 3 4

\+ - 17. A socialized recitation is a recitation which is socialized.
1 2 3 4

+ - 18. A violin is a musical instrument.

1 2 3 4

+ - 19. An angle is when two lines meet at a point.

1 2 3 4

+ - 20. Friction is the resistance to movement of one object upon the surface of another.

1 2 3 4

UNIT FOURTEEN

TO DEFINE WORDS CLEARLY

DIRECTIONS. Certain words are underlined in each of the following statements. Define these words in any manner that will give the statements one definite meaning. It is not necessary to recall the local situation or remember anything you have read. There is more than one possible answer in each case. But remember the words must be defined so as to give each statement an exact meaning.

I. Honor students at our school are excused from required study halls.

1. Honor students

II. Extra gasoline should be given to all families not within walking distance of their victory gardens.

2. Walking distance

3. Victory gardens

III. According to the Wayne High School salary schedule, teachers who are the sole support of a family receive $200 extra each year.

4. Sole support of a family

IV. Criminals should lose their citizenship.

5. Criminals

V. The sophomores held a class meeting Friday.

6. Sophomores

7. Class meeting

VI. The Strand Theater ad reads, "Evening rates - adults $.40; kiddies $.11."

8. Adults

9. Kiddies

VII. Qualified members of the football team will be awarded with the school letter.

10. Qualified members of the football team

VIII. Last evening's headline in the Detroit News read, "Roosevelt issues warning to neutrals."

11. Neutrals

IX. Each school club must have a sponsor.

12. School club

13. Sponsor

X. Mr. Charles Brown believes that the residences of Negroes should be restricted to certain sections of our city.

14. Negroes

UNIT FIFTEEN

TO UNDERSTAND WRITTEN AND SPOKEN ENGLISH MORE READILY

DIRECTIONS. Each of the following exercises involves a construction. Follow the directions exactly and place your construction in the space provided below.

I. 1. Draw a circle with center at O and any convenient radius.

2. Draw any diameter AB.

3. Determine C, the midpoint of AO.

4. Determine D, the midpoint of BO.

5. With C as a center and OC as a radius, draw a semicircle $\widehat{OA}$.

6. With D as a center and OD as a radius, draw a semicircle $\widehat{OB}$, such that semicircle $\widehat{OA}$ and semicircle $\widehat{OB}$ are on opposite sides of $\widehat{AB}$.

II. 1. Draw a line segment XY.

2. With X as center and 2" as radius, strike an arc intersecting XY at Z.

3. With X as vertex and one side XZ construct an angle of 45 degrees. Label the other side XT.

4. With X as vertex and one side XZ, construct another angle of 45 degrees on the opposite side of XZ. Label the other side XS.
5. With X as center and a radius of 1½", strike an arc intersecting XT at W.
6. Draw WZ.
7. With X as center and a radius of 1½", strike an arc intersecting XS at V.
8. Draw VZ.

III. 1. Construct a rectangle.
2. At one vertex place the tenth letter of the alphabet.
3. At a consecutive vertex place the fifth letter from the end of the alphabet.
4. Place the letter K at the vertex which is opposite the vertex designated in step 2. With K as center and segment between K and vertex designated in step 3 as radius,construct a circle.

5. At the unlabeled vertex draw three concentric circles such that one circle intersects the rectangle at two points, one circle intersects the rectangle at one point, and the other circle intersects the rectangle at no points.

UNIT SIXTEEN

TO BE PRECISE AND EXACT IN STATEMENTS

DIRECTIONS. After each number there are five suggested ways of finishing the statement given. More than one may be partly right. You are to select the BEST one. Draw a ring around the letter to the right which corresponds to the best answer.

1. An obtuse angle is

   A) an angle which is not a right angle.

   B) an angle greater than a right angle.

   C) an angle less than a straight angle.

   D) an angle which is not acute.

   E) an angle more than a right angle and less than a straight angle. Answer.....A B C D E

2. An equilateral triangle does not have

   A) three angles.

   B) one obtuse angle.

   C) three equal sides.

   D) two acute angles.

   E) three vertices.

   Answer.....A B C D E

3. A tangent

   A) touches a circle at one point.

   B) is a straight line which intersects a circle at at least one point.

   C) is a line which intersects a circle at two and only two points.

   D) is a straight line which touches a circle at one and only one point.

E) is a straight line passing through the center of a circle.

Answer....A B C D E

4. Two triangles are not necessarily congruent if

A) three sides of one are respectively equal to three sides of the other.

B) two sides and the included angle of one are respectively equal to two sides and the included angle of the other.

C) two sides and an angle of one are respectively equal to two sides and an angle of the other.

D) two angles and a side of one are respectively equal to two angles and a side of the other.

E) two angles and the included side of one are respectively equal to two angles and the included side of the other.

Answer....A B C D E

5. A parallelogram is

A) a figure having opposite sides parallel.

B) a quadrilateral with all sides parallel.

C) a quadrilateral with all sides equal and the opposite sides parallel.

D) a quadrilateral with the opposite sides parallel.

E) a quadrilateral having two sides parallel.

Answer....A B C D E

6. If two

   A) parallel lines are cut by a transversal, the alternate interior angles are equal.

   B) lines are cut by a transversal the alternate interior angles are equal.

   C) lines are parallel, the alternate interior angles are equal.

   D) lines are cut by a transversal, the interior angles are equal.

   E) lines are cut by a transversal, the alternate angles are equal.

Answer....A B C D E

7. The locus of points equidistant from the extremities of a line segment

   A) is perpendicular to the segment.

   B) is parallel to the segment.

   C) intersects the segment obliquely.

   D) bisects the segment.

   E) is the perpendicular bisector of the segment.

Answer....A B C D E

8. If two parallel lines are cut obliquely by a transversal, two angles are not equal if

   A) they are alternate interior angles.

   B) they are interior angles on the same side of transversal.

   C) they are alternate exterior angles.

   D) they are vertical angles.

E) they are corresponding angles.

Answer....A B C D E

9. An acute triangle has

A) all sides equal.

B) three acute angles.

C) one obtuse and two acute angles.

D) one acute angle.

E) one right and two acute angles.

Answer....A B C D E

10. A rectangle is not always

A) a square.

B) a parallelogram.

C) a plane figure.

D) a polygon.

E) a quadrilateral.

Answer....A B C D E

11. A circle

A) is a closed curved line.

B) is a closed curve lying in a plane.

C) is a closed curved line which lies in a plane and all points of which are equidistant from a point within it called a center.

D) is a curved line, lying in a plane, all points of which are equidistant from a fixed point.

E) is a closed line all points of which are equidistant from another point.

Answer....A B C D E

12. If two lines lie in the same plane

A) they are parallel.

B) they are parallel or perpendicular.

C) they are perpendicular.

D) they intersect.

E) they are parallel or they intersect.

Answer....A B C D E

13. A square is not a

A) polygon.

B) trapezoid.

C) rectangle.

D) quadrilateral.

E) parallelogram.

Answer....A B C D E

14. In any right triangle

A) the hypotenuse is equal to the sum of the legs.

B) the square of the hypotenuse is equal to the sum of the squares of the legs.

C) the square of the hypotenuse is equal to the difference of the squares of the legs.

D) the square of the hypotenuse is equal to the sum of the legs.

E) the hypotenuse is equal to the difference of the squares of the legs.

Answer....A B C D E

15. If a line segment

A) intersects two sides of a triangle, it divides these sides into segments which are proportional.

B) is parallel to one side of a triangle, it divides the other two sides into segments which are proportional.

C) is parallel to one side of a triangle and intersects the other two sides, it divides these sides into segments which are proportional.

D) is parallel to one side of a triangle and intersects the other two sides, it divides these sides into equal segments.

E) is perpendicular to one side of a triangle and intersects the other two sides, it divides these sides into segments which are proportional.

Answer....A B C D E

16. A parallelogram does not necessarily have

A) opposite angles equal.

B) opposite sides parallel.

C) opposite sides equal.

D) opposite sides equal and parallel.

E) diagonals equal.

Answer....A B C D E

17. An exterior angle of a polygon is

A) any angle outside of the polygon.

B) formed by two sides.

C) formed by two sides extended.

D) formed by a side of a polygon and an adjacent side extended.

E) formed by a side of a polygon and another side extended.

Answer....A B C D E

18. An isosceles triangle does not always have

A) three equal sides.

B) three vertices.

C) two equal angles.

D) two acute angles.

E) three angles.

Answer....A B C D E

19. A quadrilateral can never be a

A) square.

B) rhombus.

C) hexagon.

D) parallelogram.

E) rectangle.

Answer....A B C D E

20. Adjacent angles are angles

A) which have a common side.

B) which are next to each other.

C) which have a common vertex and a common side lying between them.

D) whose sum is 90 degrees.

E) whose sum is 180 degrees.

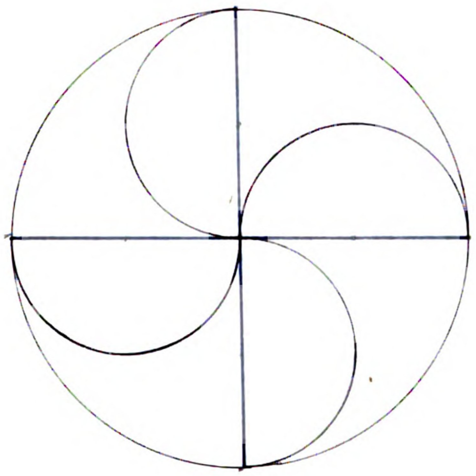
Answer....A B C D E

UNIT SEVENTEEN

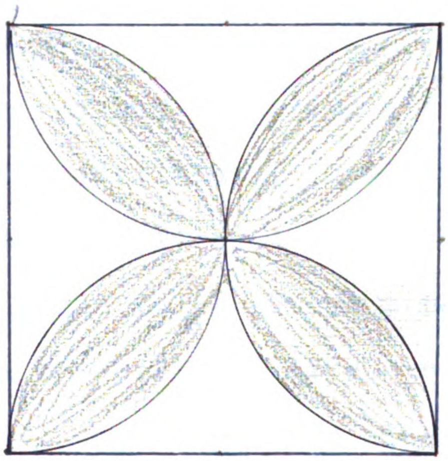
TO GIVE DIRECTIONS WHICH CAN BE EASILY FOLLOWED

DIRECTIONS. This test consists of two exercises. A simple construction is illustrated for each. You are to write the directions for each construction step by step on a separate sheet of paper. Then hand each set of directions to two students--one who has never studied geometry, and one who has studied geometry but is not in this class. If they have trouble, revise your directions and try again. You are to hand in your sheets of directions and the constructions by the students you asked to cooperate with you.

1.



2.



UNIT EIGHTEEN

TO SEEK A GENUINE UNDERSTANDING OF DEFINITIONS NOT POSSIBLE BY MEMORIZATION

DIRECTIONS. If the statement is true, place a circle around "T"; if the statement is false, place a circle around "F".

T F 1. A square is always a rectangle.

T F 2. A rectangle is always a square.

T F 3. A rectangle is always a quadrilateral.

T F 4. A square is always a polygon.

T F 5. A parallelogram is always a polygon.

T F 6. A trapezoid is always a quadrilateral.

T F 7. A parallelogram is always a quadrilateral.

T F 8. A rhombus is always a parallelogram.

T F 9. A parallelogram is always a square.

T F 10. A square is always a quadrilateral.

T F 11. A parallelogram is always a rectangle.

T F 12. A square is always a parallelogram.

T F 13. A polygon is always a quadrilateral.

T F 14. A rhombus is always a quadrilateral.

T F 15. A quadrilateral is always a square.

T F 16. A quadrilateral is always a rectangle.

T F 17. A rhombus is always a rectangle.

T F 18. A trapezoid is always a parallelogram.

T F 19. A quadrilateral is always a polygon.

T F 20. A rectangle is always a parallelogram.

UNIT NINETEEN

TO UNDERSTAND THE IMPORTANCE OF A SINGLE WORD IN MAKING A CORRECT STATEMENT

DIRECTIONS. Each of the following statements is incorrect in the present form. But each statement can be made correct by the insertion of a single word. Place a "^" between the two words where the inserted word belongs, and write the required word directly above it.

1. If two lines are cut by a transversal, the corresponding angles are equal.
2. Corresponding parts of triangles are equal.
3. The sum of the interior angles of any polygon of n sides is (n - 2) straight angles.
4. The sides of a parallelogram are equal.
5. A central angle of a circle is equal numerically in degrees to its arc.
6. Lines intercept proportional segments on all transversals.
7. The acute angles of a triangle are complementary.
8. If two straight lines intersect, the angles are equal.
9. If two lines are cut by a transversal so that a pair of interior angles are equal, the lines are parallel.
10. The area of a triangle is equal to the product of its base and altitude.
11. The sum of the angles of any convex polygon, formed by extending the sides in succession equals 360 degrees.
12. A line perpendicular to a radius at its extremity is tangent to the circle.
13. An angle in a circle is equal numerically in degrees to one-half its intercepted arc.

14. An exterior angle of a triangle is greater than either interior angle.
15. Every point on the bisector of a segment is equidistant from the ends of the segment.
16. The angles of a parallelogram are supplementary.

UNIT TWENTY

TO APPRECIATE THE IMPORTANCE OF USING LANGUAGE CLEARLY AND PRECISELY

DIRECTIONS. Answer each question carefully and completely. Use your own ideas.

I. One of the objectives for the study of geometry is to develop the ability and desire to use language clearly and precisely. List fields of work and phases of living in which you think this objective particularly important.

II. Certain legislators of one of our states grew tired of different approximations given pi and so proposed a bill which would set its value permanently at 3 1/7. What is your reaction to this legislation?

III. "Juvenile delinquency in Stratsburg has increased in the proportion of three to two in the past year," stated Judge Brown. What evidence do you find to show that he was unfamiliar with mathematical terms?

IV.

It is already apparent that the word "Fascist" will be one of the hardest-worked words in the Presidential campaign. Henry Wallace called some people Fascists in a speech, and next day up jumped Harrison Spangler, the Republican, to remark that if there were any Fascists in this country you would find them in the New Deal's palace guard. It is getting so a Fascist is a man who votes the other way. Persons who vote *your* way, of course, continue to be "right-minded people."

The clipping at the left is an excerpt from "The New Yorker". What problem does this present? How is it connected with the objective we are considering?

V. What properties do you think an income tax blank and accompanying directions should possess?

VI. The following is a part of an article appearing in the July, 1943, copy of "Common Sense". The article is entitled "What is a Puerto Rican?" and is simply signed "Corporal." Read the following carefully so you will be able to comment on it.

I work in a filler replacement pool at a staging area in southern Virginia. The pool consists of four companies. All Negroes are segregated into one company. My job is classification; I am the non-com in charge of a section in the pool Adjutant's Office, which is responsible for classifying men according to the military duties for which their background and training best qualify them. As part of this work, we handle the Soldier's Qualification Card, his basic personnel record. Included on these cards is a notation of race: white, Negro, Indian, Eskimo, and so forth.

One day, while thumbing through the cards of the Negroes in the colored company, I came across one on which the notation was not "Negro" but "Puerto Rican." Now, my dealings with Puerto Ricans have been limited to my acquaintance with one of the Puerto Rican boys in my own, white, company. My ethnic knowledge of them was limited to a belief—apparently well-founded—that they are in varying degrees a mixture of white, Indian, and Negro.

Anyway, I yanked this card from the file and showed it to my officer, the Adjutant of the pool, inquiring guilelessly whether a Puerto Rican was indeed a Negro. My lieutenant, a liberal New York attorney, was perplexed. Segregation is officially part of Army policy, but is a Puerto Rican a Negro? He didn't know, so very unhappily, he called in the Executive Officer of the Pool. This officer, a cavalry lieutenant, was firm about his beliefs. Whites must go with whites, Negroes with Negroes. "It's very simple," he said. But *is* a Puerto Rican a Negro? The Executive Officer didn't know. He called in the pool Commander. The three officers discussed the matter and got nowhere. Finally, the Executive Officer decided to rely on scientific authority. "Let's call in the pool surgeon," he said. So the pool surgeon was summoned and the delicate situation explained to him. He could give them no scientific satisfaction, but he did make a sound suggestion. "Let's find out what the man *looks* like." A capital idea. So they called in the Puerto Rican's company commander. They explained the situation and asked, "What does Private R . . . look like?" The company commander thought a moment and said, "Well, he's as dark as most of the other boys, but . . . " a thought hit him, "he speaks with an accent!"

By this time the officers had become disconcerted, and aware of how foolish their predicament was. But the matter had to be settled. Finally, the Executive Officer thought of checking the man's military record to find out with what kind of outfits he had been connected. The records showed that he had been inducted in Harlem and sent to a Negro outfit. So that question was disposed of.

But one more question, this time from the pool Commander. "Is he happy where he is?" The company commander said that he believed so. "Well, then, leave him where he is unless he complains."

And so, on the side of the street where I live, a Puerto Rican is classified as "white" and lives in our barracks. On the other side of the street, where I work, a Puerto Rican is classified as "Negro" and is assigned to a colored company. One looks just as dark as the other.

What connection do you see between this article and the objective we are considering? What difficulties does it present? What point does it illustrate? Give any personal comment on the article you care to make.

VII. What are the dangers which come from a careless use of words?

VIII. At the 1942 Kiwanis Convention held in Saginaw, Michigan, Father Cairnes of Monroe stated, "The common denominator of religion is zero." Is the mathematical use of terms in this statement correct? Give an explanation of your answer.

BEHAVIOR PATTERN FOR OBJECTIVE NUMBER THREE

TO APPRECIATE BETTER THE WORLD IN WHICH WE LIVE

Interpreting this objective concretely in terms of pupil behavior, at the end of the course in plane geometry the student should be expected:

1. to possess a knowledge of the history of geometry,
2. to be alert to the geometric properties of objects about him,
3. to be familiar with common geometric applications,
4. to recognize geometric forms wherever found,
5. to perform simple geometric constructions,
6. to create geometric designs for life situations, and
7. to realize how basic geometry really is to our civilization.

UNIT TWENTY-ONE

TO POSSESS A KNOWLEDGE OF THE HISTORY OF GEOMETRY

DIRECTIONS. In each statement there are one or more sets of parentheses. In each set underline the word or phrase which would make the statement true.

1. The thinking of the Egyptians in geometry differed from the Greeks in that the Egyptians did (more, less) abstracting and generalizing.
2. Pythagoras was a (Greek, Egyptian, Roman, Chinese) philosopher who lived in the sixth century (A.D., B.C.)
3. Non-Euclidean forms of geometry were advanced by (Thales, Lobachewski, Bolyai, Plato, Hippocrates, Riemann).
4. Egyptian geometry was based on (experiment, reasoning).
5. During the Middle Ages the (deductive, inductive) method of thinking flourished.
6. Geometry is called "the gift of the Nile" because (of its many angles and curves, its mouth is triangular, by overflowing its banks it forced man to find ways of measuring land, all the great geometricians lived on its banks.)
7. Over the door of (Gauss's, Plato's, Euclid's, Eudoxus') academy was written, "Let no one destitute of geometry enter here."
8. The word Geometry comes from two (Egyption, Greek, Roman) words.
9. The meaning of these words was (logic and reason, to measure the earth, to draw angles, shadows of the pyramids).

10. The Greeks (failed, succeeded) in improving upon the Egyptian method of thinking.

11. Pythagoras became the central figure of a secret association called (Pythagoreans, Geometers, Mathematicians) whose emblem was (a parallelogram, a hexagon, a six-pointed star).

12. (Riemann, Plato, Archimedes, Euclid) is reputed to have said, "God eternally geometrizes."

13. (Plato, Euclid) was born before (Plato, Euclid).

14. The oldest record of man's development and use of geometry is found in (The Elements, Rhind Papyrus, Ahmes Papyrus, The Whetstone of Witte).

15. (Aristotle, Thales, Euclid, Herodotus) is called "the father of Greek geometry" because he began to make of geometry a deductive science.

16. (Thales, Plato, Euclid, Aristotle, Archimedes) was the author of the "Elements".

17. The principal use made of geometry by the ancient Egyptians was in the field of (law, scholastic training, mensuration).

18. The three famous problems of antiquity were (squaring the circle, trisecting the circle, cubing the circle, duplication of cube, duplication of angle, bisection of the angle, trisection of the angle.)

19. Euclidean geometry is (the only form, one of several forms) of plane geometry.

20. Euclid's contribution to Geometry was largely (discovery and original proof of propositions, collection and organization of propositions).

UNIT TWENTY-TWO

TO BE ALERT TO THE GEOMETRIC PROPERTIES OF OBJECTS ABOUT HIM

DIRECTIONS. Answer each question in the blank (_____) provided below the question.

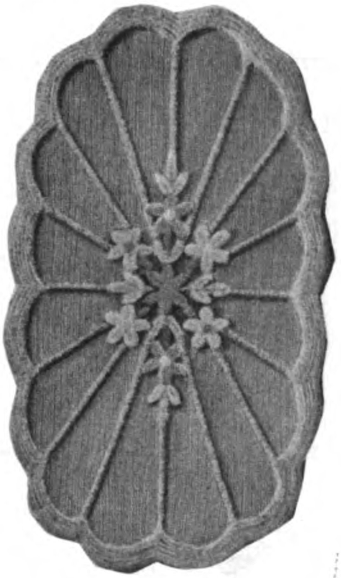
I. Below are six symmetrical objects. In each case the object possesses point symmetry, line symmetry, or both point and line symmetry. Place the type of symmetry each possesses before the corresponding number.

1.

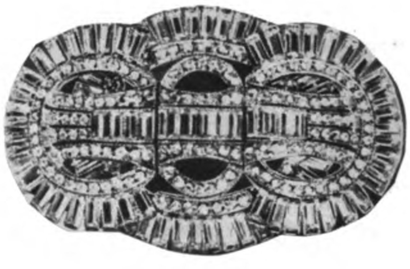
2.

3.

4.



5.



6.

Answer ________________ 1

________________ 2

________________ 3

________________ 4

________________ 5

________________ 6

II. List three capital letters which are good illustrations of parallel lines cut by a transversal.

Answer ________________ 7

________________ 8

________________ 9

III. If a coin rolled along the edge of a rule, what is the locus of the center of the coin?

Answer ________________ 10

IV. What is the path traced by the end of a minute hand of a clock during an hour?

Answer ________________ 11

V. What is the locus of a point on the handle of a pencil sharpener?

Answer ________________ 12

VI. What vegetable when sliced illustrates concentric circles?

Answer ________________ 13

VII. Give an example in nature of a hexagon.

Answer ________________ 14

VIII. What kind of an angle do the hands of a watch make at 5:30?

Answer _________________ 15

At 7:00?

Answer _________________ 16

IX. What frequently found on machines are good examples of tangents?

Answer _________________ 17

X. In what sport does some of the equipment represent concentric circles?

Answer _________________ 18

XI. What kind of lines do a pair of railroad tracks illustrate?

Answer _________________ 19

XII. Are all lines perpendicular to a given vertical line horizontal?

Answer _________________ 20

XIII. Are all lines perpendicular to a given horizontal line vertical?

Answer _________________ 21

XIV. What example in industry can you give of tangent circles?

Answer _________________ 22

XV. What kind of a line is formed when a piece of paper is folded in a sharp crease?

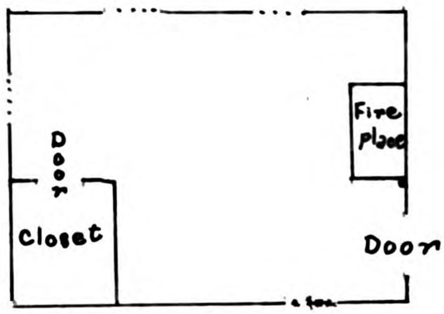
Answer _________________ 23

UNIT TWENTY-THREE

TO BE FAMILIAR WITH COMMON GEOMETRIC APPLICATIONS

DIRECTIONS. Each example is a practical illustration of the use of geometry. Fill in the blanks of each exercise.

1. A plan of a bedroom is shown below.



Scale 1" 8'

The width of the room door is ______ feet.

The width of the closet door is ______ feet.

The length of the entire room is ______ feet.

2. A surveyor knows the longest side of a triangular lot lies opposite the ___________ angle of the lot.

3.

If one point is directly north of another point, do they have the same latitude? _____________

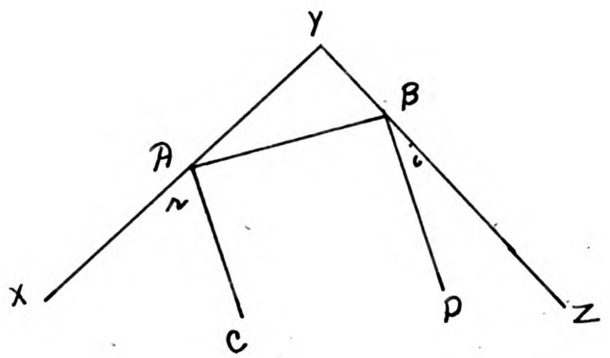
If one point is directly west of another point, do they have the same latitude?

____

Does an arc degree of latitude vary in length in different places on the earth? ________. Does an arc degree of longitude? ________.

4. A ship in distress gives its position as 135°W. longitude and 40°N. latitude. Place "x" for ship's position on map above.

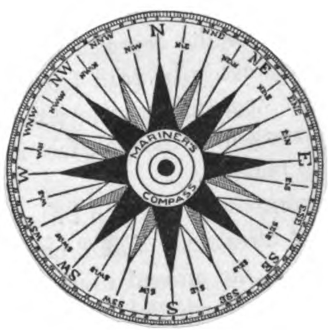
5.



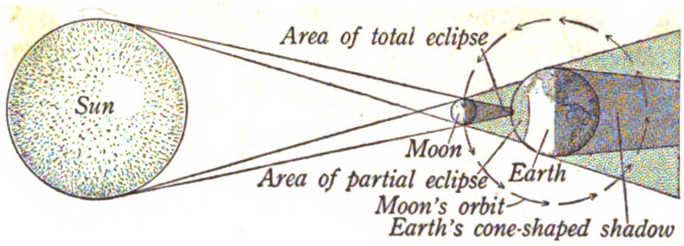
Two plane mirrors XY and YZ are set at right angles, and the angle of incidence (∠ i) equals 35 degrees. Then the value of the angle of reflection (∠ r) would be ________ degrees.

6. I wish to take a photograph of an object 20 feet high so that the image will be 4 inches high. I am using a 6 inch focal length. Therefore I must stand _____ feet from the object.

7.



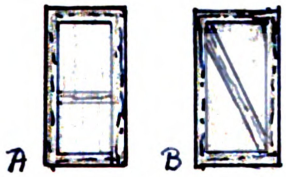
A mariner's compass is divided into 32 equal angles of ____ degrees. An angle of ____ degrees lies between a fire E. by N. of observer and a forest tower S. W. by S.

8. 

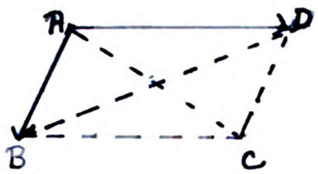
Geometry is used in study of eclipses. __________ lines indicate the extent of the eclipse.

9. A major triad in the diatonic scale consists of any three notes whose vibrations have the ratio 4:5:6. If the first note is 288, the other two are _______ and _______ vibrations.

10. Below are two doors. Of the two doors, door _____ is the more rigid.

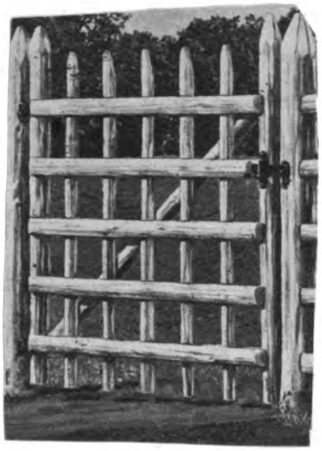


11. A carpenter is copying a triangle. He has made two angles equal to the two angles of the copy, and one side equal to one side of copy. Does he necessarily have an accurate copy? __________

12. 

The directions and magnitudes of two forces acting from the same point are represented to scale by AB and AD. Their combined effect in magnitude and direction is equivalent to __________, which is called the ____________ force.

13. A diagonal piece was nailed on to this gate to make it ____________.



14. A _________ ft. board is needed to put a diagonal brace on a box cover 3 ft. by 4 ft.; a _________ ft. board is needed to put a brace on a gate 5 ft. by 12 ft.

15. A man rows with a force of 5 miles an hour at right angles to the current of the stream which is 2 miles an hour. The actual speed of the boat will be ________ miles per hour.

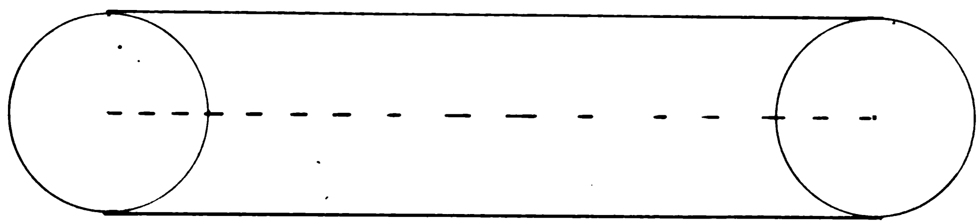
16. Two tones are harmonious if the ratio of the frequencies of their vibrations may be expressed by two of the simple numbers 1, 2, 3, 4, 5, or 6.

	Middle C	D	E	F	G	A	B	C
Ratio of vibrations compared with middle C	1	9/8	5/4	4/3	3/2	5/3	15/8	2

Do C and E chord? _______. A and B? ________.

17. Will 50 feet of fence enclose a larger area when in the shape of a square, an equilateral triangle, or a circle? __________________.

18. Two pulleys are 25 inches apart, and each has a radius of 3 inches. It will take a belt _______ inches long to go around the two pulleys.

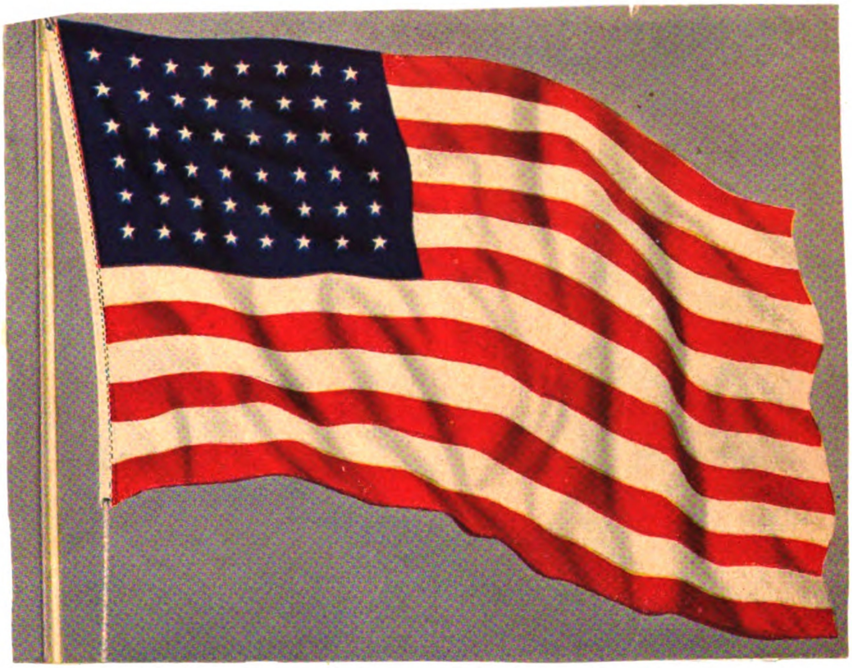


UNIT TWENTY-FOUR

TO RECOGNIZE GEOMETRIC FORMS WHEREVER FOUND

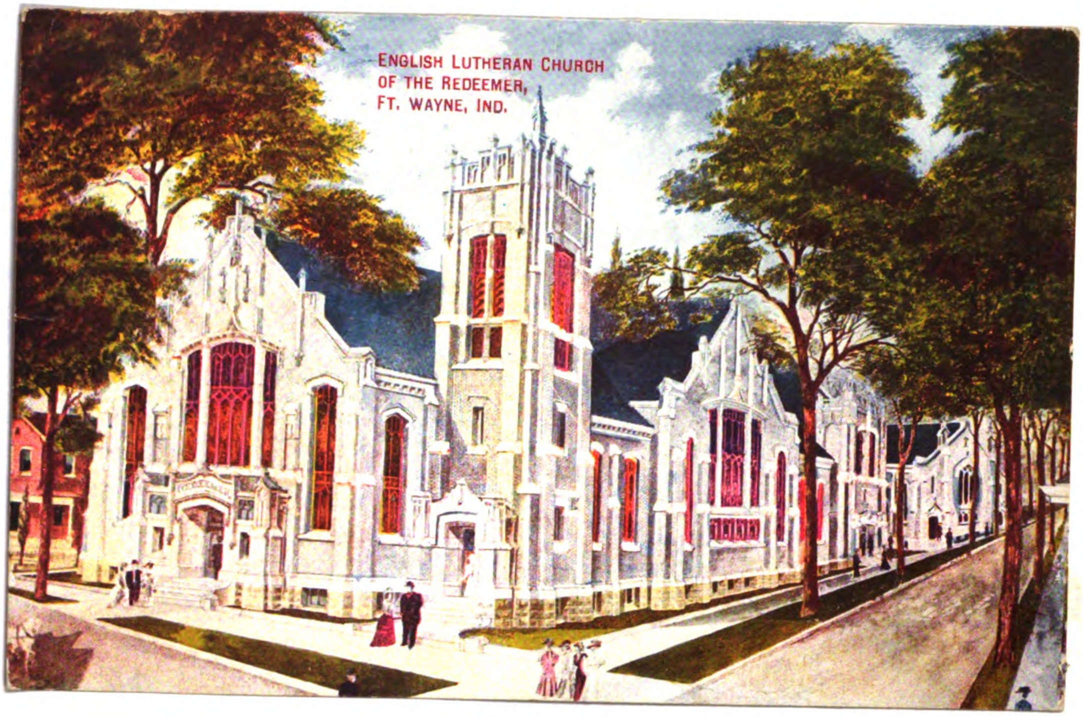
DIRECTIONS. Each example contains an illustration. In the space below write what you see in the illustration which is geometric. Be complete.

1.



2.

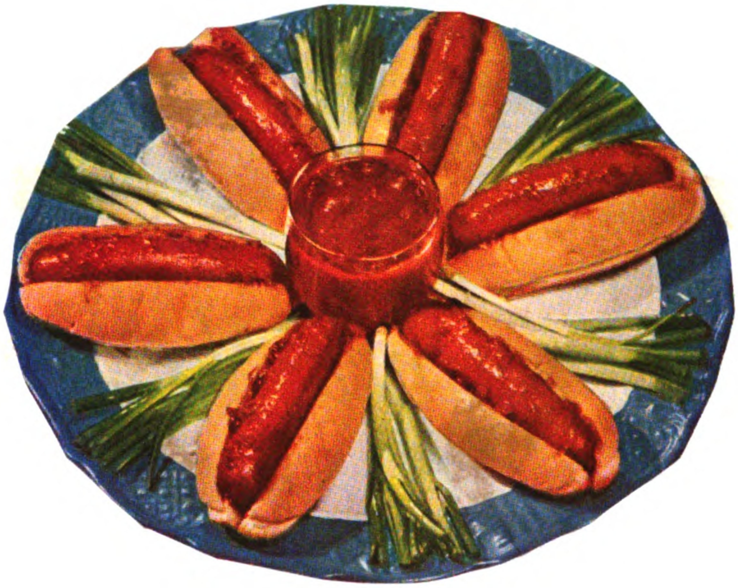
3.



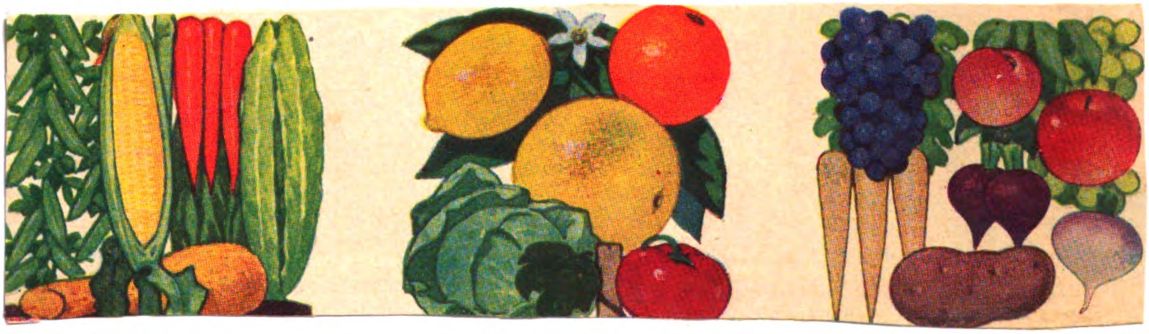
4.

5.

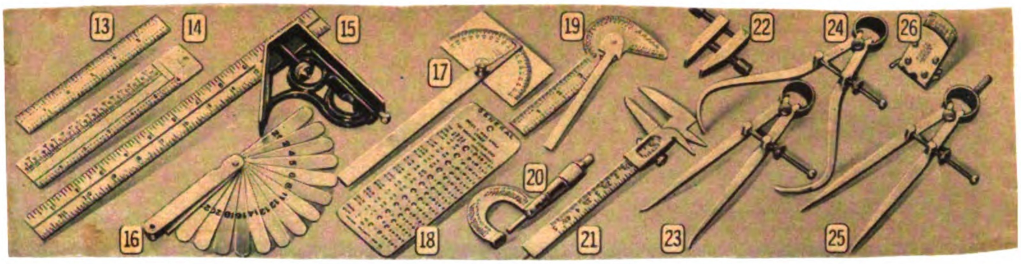
6.



7.



8.



9.

10.

W
WESTINGHOUSE

Delta

COLUMBIA RIVER
LABORE ET HONORE
PACKERS' ASSOCIATION

SOF-TRED

Pacific

11.

UNIT TWENTY-FIVE

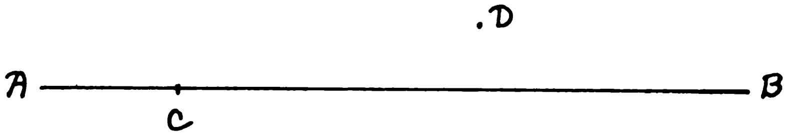
TO PERFORM SIMPLE GEOMETRIC CONSTRUCTIONS

<u>DIRECTIONS</u>. Make the construction for each exercise in the sapce below.

1. Construct an angle at A equal to angle B.

2. Construct a six-pointed star.

3. Construct a perpendicular to AB at C; also a perpendicular to AB through D.

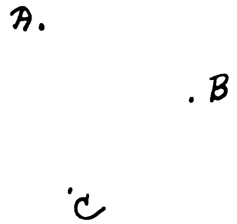


4. Construct a line parallel to AB through C.

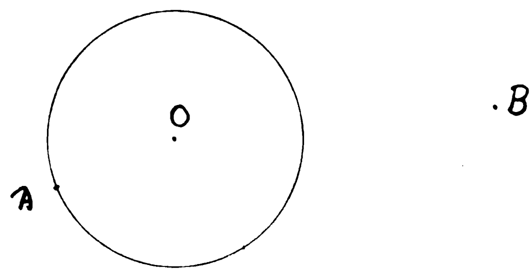
5. Construct a right triangle with legs 1½" and 2".

6. Divide AB into five equal parts.

7. Construct a circle passing through points A, B, and C.



8. Construct a tangent to circle O at A; also two tangents to circle O passing through B.



9. Construct the mean proportional between m and n.

10. Construct a parallelogram with one angle 60 degrees, and two adjacent sides 3" and 2".

UNIT TWENTY-SIX

TO CREATE GEOMETRIC DESIGNS FOR LIFE SITUATIONS

DIRECTIONS. You are to make three original geometric designs of practical use. The following list is suggestive only.

1. Rug.
2. Bedspread.
3. Quilt.
4. Emblem.
5. Trademark.
6. Label.
7. Flower garden.
8. Landscaping.
9. Book covers.
10. Clothing.
11. Stained glass window.
12. Lunch cloth.
13. Building.
14. Monument.
15. Upholstering.
16. Border.
17. Set of dishes.
18. Wall paper.
19. Cloth.
20. Linoleum.

UNIT TWENTY-SEVEN

TO REALIZE HOW BASIC GEOMETRY REALLY IS TO OUR CIVILIZATION

DIRECTIONS. Express your own thoughts clearly and in detail. Be original and be complete.

I. 1. Why is the triangle important to carpentry?

2. Why is the circle important to transportation?

3. Why is the tangent important to industry?

4. Why is area important to the housewife and farmer?

5. Why is similarity important to map making and scale drawings?

6. Why is proportion important to chemistry, physics, and engineering?

7. Why is the Pythagorean Theorem important to designers, plumbers, and mechanics?

8. Why are polygons important to pattern designers?

II. How is geometry related to each of the following fields?

1. Art.

2. Nature.

3. Drafting.

4. Architecture.

5. Engineering.

6. War.

7. Surveying.

8. History.

9. Recreation

10. Full enjoyment of living.

CONCLUSION

These twenty-seven tests present a great variety -- not only of areas tested, but also of form and structure. This variety was neither desired on the one hand, nor was any attempt made to avoid it on the other. For tests are made to test objectives, and form is a secondary matter. In formulating a test, the focus of attention should be on the purpose for which the test is being made, rather than any preconceived pattern. It is true that some of the twenty-seven tests are not of the standard objective types, but can all of the objectives for teaching a course ever be measured by limiting tests to certain types? Is the apparent inadequacy of the standard objective type of tests for measuring certain objectives any reason why we should cease investigating and conclude that there are some objectives which cannot be tested? It is the belief of the writer that the development of tests for certain objectives has been impeded by the belief that a good test must have a certain form. Because of the ease and accuracy of scoring, objective tests should be used when possible, but when they are inadequate other methods should be employed.

Some of the material included in these tests is of local significance and current interest. This is necessary if the material is to have real meaning to the high school pupil. This will at times necessitate the rewriting of certain sections of the tests, but the value to be gained from having the material of vital interest is worth the revision necessary.

Lest these tests appear to give too much emphasis to what some may term "non-geometric" material, let us recall that these tests are for only three of the four proposed objectives. The fourth objective -- to put new meaning into arithmetic and algebra, and to lay a foundation for advanced mathematics, the sciences, and specialized vocational training -- is very important and would be tested by tests composed of what has been traditionally regarded as geometrical material. Furthermore these tests are not intended to indicate the ratio of class time to be spent upon geometric and "non-geometric" material. It is my belief that training in traditional geometrical material will develop abilities which can be used in other fields; and that the introduction of a limited amount of "non-geometrical" material will broaden the students' outlook and insure a greater transfer and application of geometry.

The writer would like to acknowledge the inadequacy of some of the tests submitted. They are not to be considered as models, but merely as samples of what can be done. Yet imperfect as they are, they are to be preferred to the widespread neglect of attempting in any manner to test for these objectives.

The purpose of this paper is not to devise perfect tests, but to present a method which can be used to improve mathematics instruction in any classroom. This method is -- first, to formulate the chief objectives for the course; second, to interpret these objectives in terms of changes in student behavior; and third, to devise means of testing for each of these changes. And so to summarize the central idea of this report--formulated objectives will not actually become the classroom objectives of either students or teachers until tests can be devised and used for measuring these same objectives.

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KEY TO TESTS

WITH COMMENTS AND EXPLANATIONS

UNIT ONE

Maximum Score - 27

This test calls for the clear statement of problems based on given data. If the analysis is excellent, score each section three points, average two points, poor one point, and if omitted or entirely incorrect no points.

UNIT TWO

Maximum Score - 39

This is a type of test where there is a variety of answers, and is rather difficult to score. The scorer must keep an open mind, and consider all possibilities. Score each exercise one, two, or three points. Two points indicates an average acceptable answer, and is the score which should be given in most cases. Three points indicates an excellent answer showing insight and careful statement. One point indicates a poor answer, but an answer which deserves some credit.

It is impossible to provide a set of answers for this test. The following is merely a sample of acceptable answers.

1. Lines AB and CD are in the same plane.

2. The interior angles are not right angles.

3. The triangle is a right triangle.

4. The pentagon is convex.

5. The hexagon is equiangular.

6. AB and CD are parallel lines.
7. BD is perpendicular to AC.
8. Every person will at some time use Gold Medal Flour.
9. Furniture manufactured in Grand Rapids is of superior quality.
10. People like to eat plenty.
    Many people wish to reduce.
11. Women like strong muscular men.
    Men wish women to admire them.
12. Every girl wishes to become engaged.
    The girl became engaged because she used Pond's cream.
    All who use Pond's cream will become lovely; and all lovely girls will become engaged.
13. Every citizen wishes to do his part.
    Fat people cannot work as efficiently as slim people.
    Any person can reduce by eating Ry-Krisp, and thus do more to help the war effort.

UNIT THREE

Maximum Score - 32

Score by giving one point for each part correctly circled. The key below shows the correct answer which should be circled.

I.	II.	III.	IV.
1. IMP	1. IMP	1. IMP	1. IRR
2. IMP	2. IRR	2. IRR	2. IRR
3. IRR	3. IMP	3. IRR	3. IMP
4. IRR	4. IMP	4. IMP	4. IRR

V. 1. IMP	VI. 1. IMP	VII. 1. IMP	VIII. 1. IMP
2. IRR	2. IMP	2. IRR	2. IMP
3. IMP	3. IRR	3. IMP	3. IRR
4. IRR	4. IRR	4. IRR	4. IMP

UNIT FOUR

Maximum Score - 37

In part one for each letter correctly circled one point is given. In part two for each answer correctly underlined one point is given.

In part one the letter indicated below should be circled.

1. C	5. N	9. E
2. C	6. E	10. N
3. C	7. S	
4. S	8. N	

The correct answers in part two are to be underlined. They are below.

1. 2
2. decrease, increase
3. its intercepted arc
4. an arc
5. 2
6. 4
7. decreases
8. the number of sides
9. B, A
10. quadrant
11. 4
12. increases
13. parallel
14. decreases
15. 4
16. radius
17. increases
18. 2
19. parallel
20. increases
21. equal, parallel, supplementary
22. decreases

UNIT FIVE

Maximum Score - 25

One point is given for each correct answer. Answers in correct order are below.

Part One	Part Two
5	4
7	7
9	5
4	8
2	10
8	2
13	6
15	1 or 5
10	3
1	9
6	
14	
11	
12	
3	

UNIT SIX

Maximum Score - 35

The first eleven questions should be scored in the following manner--two points for the average correct answer, three points for a very good answer, and one point for a poor answer which is partly correct. The last two questions are scored one point each. Answers to the last two questions follow.

12. If two angles have equal complements, the angles are equal.
13. If it is not good weather, we will not have a picnic.

UNIT SEVEN

Maximum Score - 20

One point is given for each letter correctly circled. The letter which should be circled is given below.

1. V	6. V	11. V	16. N
2. N	7. N	12. N	17. V
3. N	8. N	13. V	18. N
4. N	9. V	14. N	19. V
5. N	10. N	15. V	20. V

UNIT EIGHT

Maximum Score - 50

One point is given in each exercise that is checked correctly in the left hand column. Score two points for each correctly stated conclusion.

I. No conclusion
II. Inductive
This year there are no new teachers in the schools in Roxenburg.
III. No conclusion
IV. No conclusion
V. Inductive
$y = 4x$ for examples given.
VI. Indirect
I shall wear my blue sweater.
VII. Indirect
Marjorie Phillips attends the Baptist Sunday School.
VIII. Inductive
All the boys in the Tiger Patrol are first class scouts.
IX. Deductive
Marilyn Tucker is required to take physical fitness.
X. Deductive
John Jones is paid 75 cents per hour.
XI. Indirect
a and b are parallel lines.
XII. Deductive
Bernice Henderson is not married.
XIII. Inductive
All the Sunday Schools in Roxenburg are having their Christmas programs on Friday, December 23rd.
XIV. Indirect
Gerald Bailey takes geometry from Mr. Keith.
XV. No conclusion
XVI. Indirect
Edward and Jim earned the same amount of money last week.
XVII. No conclusion
XVIII. Deductive
Lucille Wilson is required to take American History.

XIX. Inductive
All classes of Jonesville High School contributed to the Red Cross.

XX. Deductive
Tom Nyberg is invited to a banquet to be given by the Rotary Club.

UNIT NINE

Maximum Score - 10

This test was not to test for beliefs, but consistency in thinking. The statements are so paired that if one statement is true, another cannot be true. Start with a score of 10 and subtract one point for every impossible combination of answers. In general for each combination of numbers below, one should be marked true and one false. In no case is it correct to have both marked true. In a few cases marked by a "*" a pupil could be doing consistent thinking and have both marked false. This is possible but not probable. The scorer may count these correct, but if possible it would be better to question these few pupils personally to ascertain whether or not they were thinking consistently. The pairs of numbers follow.

1 & 19 *

2 & 16

3 & 11

4 & 14 *

5 & 12

6 & 20

7 & 17

8 & 13 *

9 & 18

10 & 15 *

UNIT TEN

Maximum Score - 60

In each case give two points for the average correct answer, three points for an exceptionally good answer, and one point for a poor answer worthy of some credit.

Numbers 2, 11, and 19 are correct.

UNIT ELEVEN

Maximum Score - 60

The scorer will have to rely strongly on his own judgment for scoring this test. Care should be taken to make the scoring as objective as possible. In part one give a maximum of twenty points. Following the nine steps of the outline give points as follows:

Steps 1, 2, and 3	0 - 5 points
Step 4	0 - 5 points
Steps 5 and 6	0 - 5 points
Steps 7, 8, and 9	0 - 5 points

For part two give a maximum of forty points. In regard to the nine steps of the outline give points as follows:

Steps 1, 2, and 3	0 - 10 points
Step 4	0 - 10 points
Steps 5 and 6	0 - 10 points
Steps 7, 8, and 9	0 - 10 points

Discrimination as to number of points to be given should be based on thoroughness and quality of work.

UNIT TWELVE

Maximum Score - 40

The maximum score is obtained by giving two points for each exercise. Here again judgment by scorer will have to be used. Those words or phrases first listed should be underlined, and those enclosed in parentheses may be underlined.

1. frills (duration)
2. good standings (final examinations)
3. regular pentagon, extreme and mean ratio (diagonals)
4. waste, tolerated
5. outstanding achievement
6. similar, corresponding sides, proportional
7. school groups, community groups
8. dry sausage, semi-dry sausage, groups 1, 2, 3, and 4
9. processed
10. area, semicircle, hypotenuse
11. farm workers (deferment)
12. enchanting, artless, chiseled, captivating (azure)
13. sociologists, zoot suiter, zoot
14. children (passport, visa, re-entry permit)
15. absentees (drafted)
16. nibbler
17. cute, impractical
18. cheap substitutes
19. loyalty (pledge)
20. real protection (finer pleasure)

UNIT THIRTEEN

Maximum Score - 32

Give one point for each symbol or number correctly circled. The answers which should be circled are given below.

1. +	6. +	11. -, 1	16. +
2. -, 2	7. -, 2	12. +	17. -, 3
3. -, 1	8. -, 3	13. -, 2	18. -, 2
4. +	9. +	14. +	19. -, 1
5. -, 4	10. -, 2	15. -, 4	20. +

UNIT FOURTEEN

Maximum Score - 28

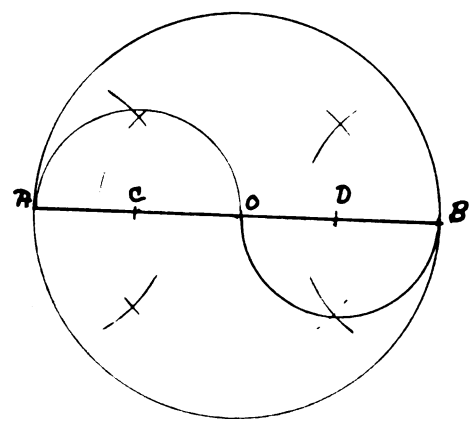
Give two points for each correct definition. Remember the definition must be limiting, and any definition which gives exact meaning to the statement is to be counted as correct. In general the definitions are to be considered as right or wrong. At the discretion of the scorer in some few instances one point might be given for a definition.

UNIT FIFTEEN

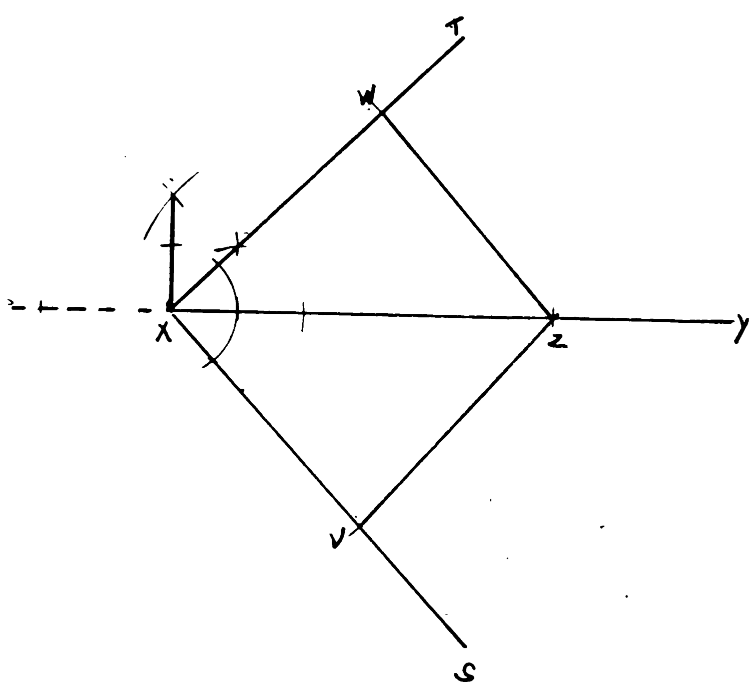
Maximum Score - 25

Give one point for each step of each exercise correctly done. Give two points extra if the entire exercise is correct.

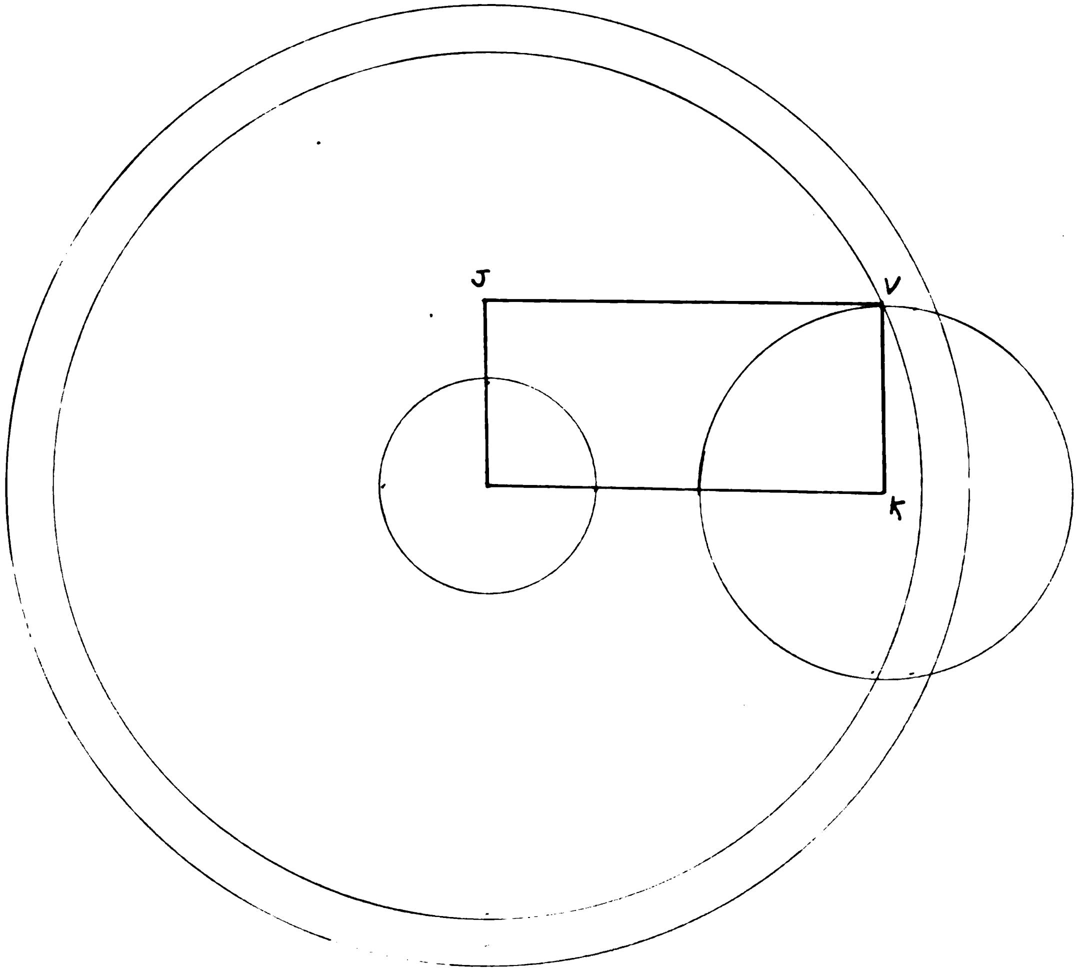
1.



2.



3.



UNIT SIXTEEN

Maximum Score - 20

Give one point for each correctly circled letter. The letters which should be circled are listed below.

1. E	6. A	11. C	16. E
2. B	7. E	12. E	17. D
3. D	8. B	13. B	18. A
4. C	9. B	14. B	19. C
5. D	10. A	15. C	20. C

UNIT SEVENTEEN

Maximum Score - 20

The two exercises are each to be scored on a sliding scale extending from 0 to 10 points. The scorer should be as objective as possible.

UNIT EIGHTEEN

Maximum Score - 20

In scoring allow one point for each letter circled correctly. The letters which should be circled are given below.

1. T	6. T	11. F	16. F
2. F	7. T	12. T	17. F
3. T	8. T	13. F	18. F
4. T	9. F	14. T	19. T
5. T	10. T	15. F	20. T

UNIT NINETEEN

Maximum Score - 16

Give one point for each correct insertion. The word which should be inserted is underlined below.

1. If two parallel lines are cut by a transversal, the corresponding angles are equal.
2. Corresponding parts of congruent triangles are equal.
3. The sum of the interior angles of any convex polygon of n sides is (n - 2) straight angles.
4. The opposite sides of a parallelogram are equal.
5. A central angle is equal numerically in degrees to its intercepted arc.
6. Parallel lines intercept proportional segments on all transversals.
7. The acute angles of a right triangle are complementary.
8. If two straight lines intersect, the vertical angles are equal.
9. If two lines are cut by a transversal so that a pair of alternate interior angles are equal, the lines are parallel.
10. The area of a triangle is equal to one-half the product of its base and altitude.
11. The sum of the exterior angles of any convex polygon, formed by extending the sides in succession equals 360 degrees.
12. A line perpendicular to a radius at its outer extremity is tangent to the circle.
13. An angle inscribed in a circle is equal numerically in degrees to one-half its intercepted arc.
14. An exterior angle of a triangle is greater than either opposite interior angle.

15. Every point on the perpendicular bisector of a segment is equidistant from the ends of the segment.
16. The consecutive angles of a parallelogram are supplementary.

UNIT TWENTY

Maximum Score - 40

Again the scorer must use his own judgment, and strive to make scoring as objective as possible. For each exercise grade on a sliding scale extending from 0 to 5 points.

UNIT TWENTY-ONE

Maximum Score - 29

In scoring allow one point for each correct answer underlined. The correct answers are given below.

1. less
2. Greek, B. C.
3. Lobachewski, Bolyai, Reimann
4. experiment
5. deductive
6. by overflowing its banks it forced man to find ways of measuring land
7. Plato's
8. Greek
9. to measure the earth
10. succeeded
11. Pythagoreans, a six-pointed star
12. Plato
13. Plato, Euclid
14. Rhind Papyrus
15. Thales
16. Euclid
17. mensuration
18. squaring the circle, duplication of cube, trisection of the angle.
19. one of several forms.
20. collection and organization of propositions

UNIT TWENTY-TWO

Maximum Score - 23

Give one point for each correct answer as placed on the right side. Numbers below correspond to answers and not exercises.

1. point and line
2. line
3. point
4. point and line
5. line
6. point
7-8-9. E, F, H, N, Z (any three)
10. straight line parallel to the edge of a ruler
11. circle
12. circle
13. onions
14. some snowflakes, honey cells (any one example)
15. acute
16. obtuse
17. belts
18. archery
19. parallel
20. yes
21. no
22. gears
23. straight line

UNIT TWENTY-THREE

Maximum Score - 27

In scoring allow one point for each blank filled in correctly.

1. $2\frac{1}{2}$', 2', 16'
2. largest
3. no, yes, yes, no
4. (dot placed on map)
5. 55 degrees
6. 30' 6"
7. $11\frac{1}{4}$ degrees, 135 degrees
8. tangent
9. 360, 432
10. B
11. yes
12. AC, resultant

13. rigid
14. 5, 13
15. 5.38
16. yes, no
17. circle
18. 68.8

UNIT TWENTY-FOUR

Maximum Score - 33

Score each average correct answer two points, each detailed answer three points, and each incomplete answer one point.

UNIT TWENTY-FIVE

Maximum Score - 50

In each exercise allow three points for the correct method, and two, one, or no additional points for careful work and accuracy.

UNIT TWENTY-SIX

Maximum Score - 120

For each of the original designs, grade the work as follows.

Originality	0 - 10 points
Accuracy of constructions ...	0 - 15 points
Neatness	0 - 5 points
Beauty of finished product ..	0 - 10 points

UNIT TWENTY-SEVEN

Maximum Score - 54

Score each average correct answer two points, each outstanding answer three points, and each poor answer one point.