A CONTROLLED STUDY OF TWO METHODS OF TEACHING GENERAL SCIENCE IN THE SECONDARY SCHOOL

A THESIS

SUBMITTED TO THE DEPARTMENT OF EDUCATION AND THE GRADUATE COUNCIL OF THE KANSAS STATE TEACHERS COLLEGE OF EMPORIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

BY

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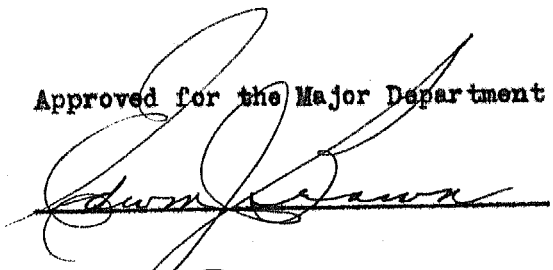

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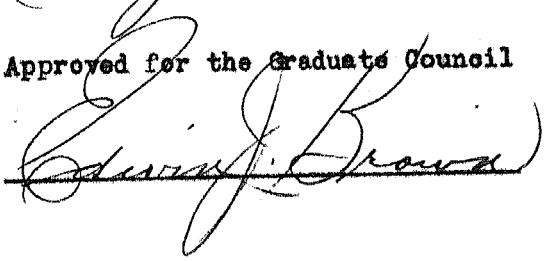

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CHAPTER I

INTRODUCTION

The Nature of the Study

This is an experimental study in methods of teaching general science. It is generally understood that any course in general science carries with it some laboratory and experimental work. In this study the plan is to set up two classes in general science, teaching one class by the laboratory method and the other by the lecture method. Since in most science classes some laboratory work is included in teaching the subject, this study is made in an attempt to compare, if possible, the achievement of a class taught entirely by the lecture method with that of a class taught by the laboratory method. In this study two general science classes in the Belleville High School, Belleville, Kansas, were used, one meeting daily at ten o'clock and the other at eleven. The ten o'clock class which was the "laboratory" class met in the laboratory, and the "lecture and recitation" class was held in a regular class room.

Previous Studies

A thorough search was made to find any previous studies on this subject, but it seems that laboratory and experimental work has been accepted as being necessary in teaching a course in general science, largely perhaps because the authors of textbooks have suggested that method of teaching.

General Science is usually taught in most high schools by a combination of lecture and class demonstration or lecture and pupil demonstration

methods. There seem to have been no studies made to determine experimentally the value of the various methods of teaching the subject. Most writers of science textbooks seem to favor some experiments in the teaching of a course in general science.

The following quotation expresses the opinion of Harry A. Carpenter and George C. Wood:[1]

> This book is organized into a small number of units, each unit presenting a unified picture of some phase of the pupils' environment. Each unit is composed of a series of topics, developed in logical order, an understanding of which comprises a complete grasp of the larger unit divisions.
>
> Problem solving abilities are cultivated by general problems into which each topic is analyzed. Each general problem may include a number of experimental problems (laboratory work) field research problems, or projects for independent choice and individual or group solving.

In the preface of the State-adopted textbook for General Science in the State of Kansas, Hunter and Whitman[2] say:

> A sufficient number of demonstrations are given so that schools not provided with laboratories for individual work will not suffer seriously from lack of experimental investigations.

Powers, Neuner, and Bruner[3] in A Survey of Science, a book they have written for a general science textbook, make the following statement in the preface:

> The aids to learning at the end of each chapter guide the pupil to further learning through direct observation and experimentation.

---

[1] Harry A. Carpenter and George C. Wood, Our Environment, Allyn and Bacon, Boston, 1937, p. iii.

[2] George W. Hunter and Walter G. Whitman, Problems in General Science, American Book Company, Boston, 1934, p. vi.

[3] Samuel R. Powers, Elsie Flint Neuner, and Herbert B. Bruner, A Survey of Science, Ginn and Co., Boston, 1934, p. vii.

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The following statement is taken from the preface of Science,[4] a book used for a textbook by a number of high schools outside of Kansas:

> The demonstrations, exercises, and experiments have been purposely placed in close proximity to the discussion of each topic, so that the pupil may grasp immediately the relation between what he reads and what he sees or does.

In Science, a regularly published magazine, the following statement is found.[5]

> The teacher-pupil demonstration has replaced the individual experimentation to a marked degree in the Junior high school. A great increase in the use of demonstration is also desirable in specialized science courses.

The authors of most of the science books studied by the researcher are agreed that there should be some experimentation. This may be performed by the pupils in groups or the teacher-pupil demonstration. Most authors suggest that experimentation and direct observation of demonstrations are aids to learning science.

Ruth Rickerd Harris[6] made an experimental study in the field of mathematics dealing with the use of colored chalk in teaching plane geometry. The study was made to determine the value of colored chalk in teaching the course. She used two well controlled classes in the Emporia High School for the experiment. The conclusion of the study was that there was no appreciable difference in the results accrued from the study.

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[4] Ira C. Davis, and Richard W. Sharpe, Science, Henry Holt and Co., New York, 1936, p. iii.

[5] Elsie Flint Weaver, Science, n. s. Vol. 78, p. 364, October 20, 1933.

[6] Ruth Rickerd Harris, An Experimental Study Dealing with the Use of Colored Chalk in Teaching Plane Geometry, an Unpublished Master's Thesis, Kansas State Teachers College, Emporia, Kansas, June, 1930.

Scope of the Study

The scope of the study includes two general science classes taught in the Belleville High School for the purpose of comparing two widely different methods of teaching general science to mixed classes.

Purpose of the Study

The purpose of the study was to determine, if possible, any difference in the learning results of the two different methods of teaching. Economy of effort, pleasure in learning, interest in subject, and other less tangible results were not neglected.

Method of Procedure

The enrollment of the two classes was twenty-seven and twenty-eight respectively. From these two classes twenty pairs were obtained. The students were paired on four points: (1) intelligence quotient, (2) sex, (3) age, and (4) previous scholastic achievement. The intelligence quotient was obtained from scores on the New (Revised) Army Alpha Intelligence Test. The test was given by the instructor to both classes at the second regular meeting of the classes. The tests were scored by the researcher and the instructor. The records in the principal's office of the Belleville Senior High School were used in determining age and sex. The General Science Scale arranged by August Dvorak was given to determine the achievement scores. This test was given by the instructor at the third regular meeting of the classes. Of the forty pupils (twenty pairs) used in the experiment twenty-four were girls and sixteen were boys.

While the control of the experiment leaves something to be desired (as what experiment does not), for an experiment of this nature where normal

class room working conditions must be considered, no better control could be worked out. The complete control was:

1. The pairing of students as to age, sex, intelligence quotient, and achievement scores.
2. Same teacher taught both classes.
3. Same textbook was used.
4. Same material was covered in the textbook each day.
5. No home work was required.
6. Same tests were taken by both groups on the same day.

The laboratory class used a workbook, Problems in General Science, made up by the authors of the text, and the textbook, Problems in General Science. This class performed all the experiments in the workbook and textbook. The class worked in groups of four with the help of the instructor. The instructor also performed some demonstrations that were too difficult for the groups to work. The textbook was followed in all experiments, and all textbook material was covered in the general discussion.

In the lecture and recitation class a textbook was used, but no laboratory work was done. Diagrams, charts, and illustrations in the text were studied in view of laboratory work; and the textbook material was covered carefully by the lecture-class recitation technique, with the instructor leading the discussion, as he did in the laboratory discussion. This study was carried through the entire school year with the method of teaching for each class being reversed at the semester close. The class that was the "laboratory" class the first semester became the "lecture and recitation" class the second semester, and the "lecture and recitation class" became the "laboratory class." The textbook is divided into twenty units. The first ten units were covered the first semester and the last ten units, the

second semester. The authors of the text have compiled tests, well standardized, covering each unit; and these tests were given each class on the same day after the close of each unit. The tests were printed forms, and the pupil's answers were written on the same sheet with the tests.

TABLE I

PAIRING OF THE PUPILS IN THE TWO CLASSES

	Lecture Class				Experimental Class			
Pair No.	Name of Pupil	C. A.	I. Q.	Achievement Score	Name of Pupil	C. A.	I. Q.	Achievement Score
1	M.T.	192	81	89	T.F.	192	83	89
2	E.N.	186	108	92	D.M.	183	109	92
3	K.B.	186	109	94	A.E.	188	105	88
4	S.N.	184	85	79	V.H.	183	79	84.5
5	R.G.	189	96	90	R.W.	181	98	86
6	B.S.	184	96	93	A.W.	181	99	86
7	D.S.	177	105	86	M.B.	187	107	90
8	N.H.	171	111	90	E.S.	168	113	92.5
9	B.W.	180	120	90	M.W.	180	118	88
10	W.O.	176	100	89	D.S.	174	102	91
11	C.S.	179	117	93.5	D.C.	179	115	98
12	B.S.	181	84	87.5	D.D.	181	82	86
13	B.H.	178	126	88.5	D.V.	171	123	91.5
14	I.P.	185	83	85	E.S.	192	83	87
15	D.C.	189	111	95	R.W.	192	110	100
16	F.K.	179	92	85	F.K.	169	92	84
17	L.S.	181	114	88	R.T.	183	114	91
18	W.H.	186	103	88	J.S.	192	107	98
19	H.K.	192	83	95.5	G.K.	176	89	85.5
20	R.C.	170	113	94	J.W.	159	113	98.5
Median		184	104	89.5		181	106	89.5
Mean		182.2	101.8	89.6		180.5	102	90.3
Range		170-192	83-126	79.5-95.5		159-192	79-123	84-100
S. D.		11	21.5	8		16.5	22	8

Read table thus: Pair 1 shows the initials of the pupil, the chronological age, the intelligence quotient, and achievement score in the lecture and experimental classes.

Table I shows the pairing of the two groups as to age, intelligence quotient, and achievement scores. This last was a pre-test of general science material given prior to taking the course.

The greatest individual variation in members of pairs is found in pair number eighteen, with a difference of ten points in achievement score and a difference of four points in intelligence quotient. The difference is in favor of the member of the experimental class the first semester. One of the pairs that has the least variation in its members is pair number nine. This pair is made up of identical twin girls. These pairs will receive special attention throughout the study.

CHAPTER II

PRESENTATION OF DATA FROM TESTS, FIRST SEMESTER

The data that follow have been obtained from the scores made on the standardized tests, Mastery Tests in General Science, by George W. Hunter--one of the authors of the text (Problems in General Science) used in this study--and Roy A. Knapp. The tests cover only the material found in the text and the laboratory book used in the study. The first ten units of the textbook were studied the first semester and the next ten the second semester. After each unit had been completed by the two groups, each took the test over that unit. This plan was followed until each group had taken the ten tests the first semester. At the end of the semester the groups were reversed, as was previously stated; and each group was tested over the next ten units, using the same plan as was followed the first semester.

Table II presents the ten units over which tests were given the first semester. These tests are compiled and published by the American Book Company. The name of the publication is Mastery Tests in General Science, Set X.

The data are presented in the form of tables and graphs. The median in each group is used as a measure of central tendency, and the quartile deviation as measures of dispersion and variation.

TABLE II

TEST FOR THE FIRST SEMESTER OF WORK

Column I Test Number	Column II Name of Unit Test Covers
I	How to Control Our Environment
II	Air in the Service of Man
III	Foods and How We Use Them
IV	How to Use and Control Fire
V	How Water Serves Man
VI	Our Clothing: Its Source and Care
VII	Light
VIII	Personal Health and Our Environment
IX	Electricity and Its Uses
X	Homes and How They are Made

Read Table thus: Read across the page. Column I gives the number of the test, and Column II the name of the unit the test covers.

Results of Test I

In Table III, on the following page, the score made by each pupil in Test I is shown. The pupil's initials were used rather than the entire name. "M. T." is paired with "T. F." and so on down the page.

The per cent is taken on the basis of one hundred per cent in all the tables that follow. Since the tests are standardized, the results should have some reliability.

TABLE III

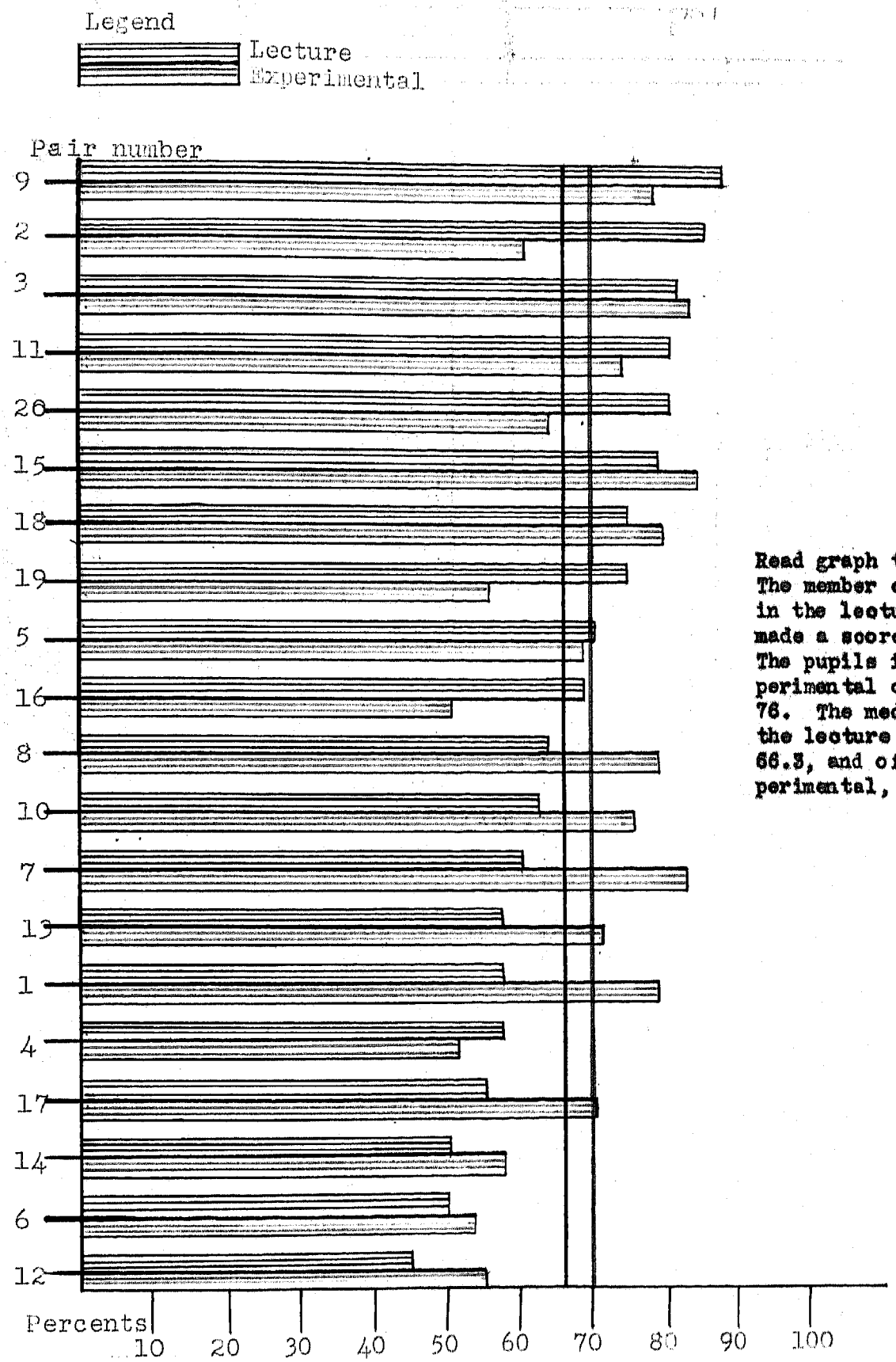
SCORES MADE BY PUPILS IN TEST I
(HOW TO CONTROL OUR ENVIRONMENT)

LECTURE			EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	58.00	T.F.	79.72
2	E.N.	83.78	D.M.	60.82
3	K.B.	81.08	A.E.	82.43
4	S.N.	56.76	V.H.	51.35
5	R.C.	70.27	R.W.	69.46
6	B.S.	50.00	A.W.	54.05
7	D.S.	60.81	M.B.	82.43
8	N.H.	63.51	E.S.	78.33
9	B.W.	86.49	M.W.	76.89
10	W.O.	62.16	D.S.	74.32
11	C.S.	79.73	D.C.	82.45
12	B.S.	45.95	D.D.	55.41
13	B.H.	58.11	D.V.	71.62
14	I.P.	50.40	E.S.	56.75
15	D.C.	78.24	R.W.	83.78
16	F.K.	69.13	F.K.	50.00
17	L.S.	54.54	R.T.	70.27
18	W.H.	74.32	J.S.	54.14
19	H.K.	74.32	G.K.	77.03
20	R.C.	79.73	J.W.	64.86
	Median	66.03		70.09
	Mean	66.86		68.07
	Q.D.	10.80		11.46
	Range	45-86		50-83

Read Table thus: In Pair 1, pupil "M.T." scored 58%; pupil "T.F.," the other half of the pair, scored 79.72%. Read in like manner for succeeding pairs.

Figure 1 shows the ranking of each pair of pupils in Test I with each other and also with the other pairs.

The test that was given over this unit will be found at the end of the discussion of this unit.



Read graph thus: The member of pair 9 in the lecture class made a score of 86. The pupils in the experimental class made 76. The median of the lecture class was 66.3, and of the experimental, 70.9.

Figure 1

Ranking of Pupils in Test 1
(Scores of pupils in lecture class in descending order)

The highest per cent made was eighty-six, and it was made in the lecture class. The highest per cent in the experimental class was seventy-six. Forty-five was the lowest per cent, and it also was made in the lecture class. The lowest per cent in the experimental group was fifty-five. The median of the lecture class was sixty-six and three-tenths, and of the experimental class, seventy and nine-tenths.

The per cents of fourteen pupils in the experimental group exceeded the per cents of the pupils in the lecture class with whom they were paired, while in the lecture class six pupils exceeded the pupils with whom they were paired in the experimental group.

In pair number nine, one of the pairs that showed the least variation in achievement, intelligence quotient, and age--which were the controls for the pairing--the member of the lecture group exceeded the member of the experimental group by ten per cent; in pair eighteen, the pair that had the greatest variation, the member of the lecture group exceeded the member of the experimental group by twenty per cent. He was the lowest of the two in the control.

In this test the median of the experimental class exceeded the median of the lecture class by four per cent. Statistically, this means that the chances are seventy-six out of a hundred that the difference is significant.

Since there is some difference in the results of the two groups, the material covered by the test is considered to determine if nature of material might be a factor that made the difference. Much of the material covered by this test included the study of matter and energy. In the study of matter the experimental class spent much time in experimenting with substances, elements, and compounds. It was in this part of the test that the experimental

class exceeded the lecture class. This would indicate that the experimental method of teaching would be favored in teaching material of this nature, while it was not better and was a waste of time for other material in the unit. The interest that was created by the experiments may have been a factor in favor of the experimental group.

NAME CLASS DATE RATING

HOW TO CONTROL OUR ENVIRONMENT

UNIT I SET X · TEST I

DIRECTIONS. The sentences below have missing words in them. You are to supply the missing words, placing them in the corresponding numbered space to the right of the sentence.

1. Our (1) ____ is everything that surrounds us.
2. (2) ____ is the ability to do work.
3. There are five forms of energy: (3) ____, (4) ____, (5) ____, (6) ____, and (7) ____.
4. The smallest particle of gold containing all the properties of gold is (8) ____ (9) ____.
5. The chemist makes three important classes of compounds: (10) ____, (11) ____, and (12) ____.
6. A change in which there is a new grouping of atoms is called a (13) ____ (14) ____.
7. Science is based on (15) ____, not (16) ____.
8. Anything that (17) ____ a plant to live in its particular (18) ____ is called an adaptation.
9. A (19) ____ is the sum total of what we learn about a thing through our senses.
10. (20) ____ is the step in an experiment when we test our conclusions.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )
11.	----------	( )
12.	----------	( )
13.	----------	( )
14.	----------	( )
15.	----------	( )
16.	----------	( )
17.	----------	( )
18.	----------	( )
19.	----------	( )
20.	----------	( )

NAME CLASS DATE RATING

UNIT I SET X TEST II

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

	Answers	Score
1. Your environment consists of:		
(*a*) only those things which have grown naturally.	*a.* _____	( )
(*b*) everything which surrounds you.	*b.* _____	( )
(*c*) only those things which are necessary for life.	*c.* _____	( )
(*d*) everything in the world.	*d.* _____	( )
(*e*) only those things which man has made.	*e.* _____	( )
2. Factors of our environment which all living things need are:		
(*a*) clothing	*a.* _____	( )
(*b*) milk	*b.* _____	( )
(*c*) heat	*c.* _____	( )
(*d*) air	*d.* _____	( )
(*e*) water	*e.* _____	( )
3. Man has been able to change the factors of his environment because:		
(*a*) he is capable of understanding the natural factors of his environment.	*a.* _____	( )
(*b*) he is the only living thing with a brain.	*b.* _____	( )
(*c*) he is the only living thing which uses his brain.	*c.* _____	( )
(*d*) he has used his mind to control the natural factors of his environment.	*d.* _____	( )
(*e*) he has observed and studied the natural factors of his environment.	*e.* _____	( )
4. We know that electricity is a form of energy because:		
(*a*) it can be used to run a washing machine.	*a.* _____	( )
(*b*) it cannot be seen.	*b.* _____	( )
(*c*) it was discovered by Franklin.	*c.* _____	( )
(*d*) it can be used to move street cars.	*d.* _____	( )
(*e*) it has the ability to do work.	*e.* _____	( )

5. Man knows for sure that:
   (*a*) matter cannot be changed into energy. *a.* _____ (
   (*b*) ether is a weightless medium between the particles of all matter. *b.* _____ (
   (*c*) radio waves travel through ether. *c.* _____ (
   (*d*) energy can be used to move matter. *d.* _____ (
   (*e*) he understands all of the factors of his environment. *e.* _____ (

6. Water is classed as a compound because:
   (*a*) it cannot be divided into anything but water. *a.* _____ (
   (*b*) it is a necessity for all kinds of life. *b.* _____ (
   (*c*) its molecules are made up of more than one kind of atom. *c.* _____ (
   (*d*) it is a natural factor in our environment. *d.* _____ (
   (*e*) it is a substance which takes up space. *e.* _____ (

7. Compounds:
   (*a*) are made from more than one kind of atom. *a.* _____ (
   (*b*) are acids if they have a sour taste. *b.* _____ (
   (*c*) which change red litmus blue are acid. *c.* _____ (
   (*d*) which have a sharp stinging taste are called salts. *d.* _____ (
   (*e*) may be divided up into two or more elements. *e.* _____ (

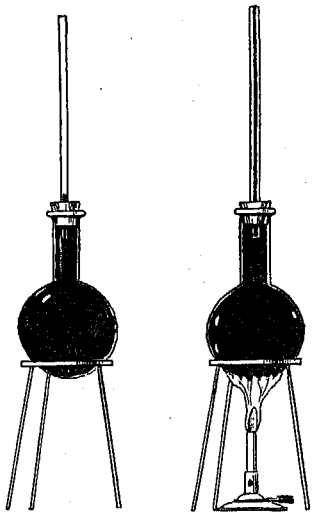
8. A physical change:
   (*a*) is made in paper when it is cut up. *a.* _____ (
   (*b*) is made when milk becomes sour. *b.* _____ (
   (*c*) is made when wood is changed into sawdust. *c.* _____ (
   (*d*) is one in which the molecules are the same after the change as they were before. *d.* _____ (
   (*e*) is made when iron rusts. *e.* _____ (

NAME CLASS DATE RATING

UNIT I SET X TEST III

DIRECTIONS. The sentences below have missing words in them. You are to supply the missing word, placing it in the corresponding numbered space to the right of the sentence.

The flasks shown in the diagram are filled with water, a form of (1) ____. Heat is applied. This is a form of (2) ____. As the water is heated it expands and is forced to (3) ____ in the tube. Whenever water is lifted against the force of gravity (4) ____ is done. Energy is defined as the ability to do (5) ____. When heat was applied (6) ____ was done, thus we have proof that heat is a form of (7) ____. If the flask was filled with air and a small balloon tied over the opening and then heat applied as before, the air would (8) ____ and cause the balloon to become larger. In both of these experiments it was necessary to have a form of (9) ____ applied to (10) ____ before anything could be moved.

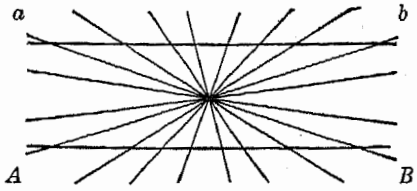


Answers	Score
1. ----------	(
2. ----------	(
3. ----------	(
4. ----------	(
5. ----------	(
6. ----------	(
7. ----------	(
8. ----------	(
9. ----------	(
10. ----------	(

NAME CLASS DATE RATING

UNIT I SET X TEST IV

DIRECTIONS. Examine the diagrams carefully, read your sentences, put your answers in the space to the right, and then fill out the blanks in the sentences. A total of 5 points is given for correct answers of the problem below.



Answers **Score**

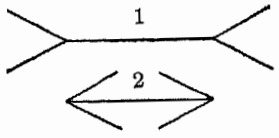
1. Are the lines *ab* and *AB* curved or straight? 1. _____ ( )

I think the lines *ab* and *AB* are _____

_____

because _____

_____.



2. Which of the horizontal lines, 1 or 2, is longer? 2. _____ ( )

I believe the line _____ is longer because _____.

Results of Test II

(Air in the Service of Man)

In Table IV the per cent made by each pupil of each pair is shown. The pupils are arranged in the same manner as in the other charts.

The highest per cent was eighty-two and was made by a pupil in the lecture class, while the highest per cent made in the experimental class was sixty-two. The lowest per cent was thirty-seven and was also made by a pupil in the lecture class. The lowest per cent in the experimental class was forty-eight.

The per cents of ten pupils in the lecture class exceeded those of pupils in the experimental class with whom they were paired; in the other ten pairs the pupils of the experimental class exceeded those in the lecture class. The median of the lecture class was sixty-eight and that of the experimental, sixty-two.

In pair number nine where the "control" was most perfect the pupil in the lecture class exceeded the pupil in the experimental class by eight per cent, while in pair eighteen where the "control" showed most variation the per cents were nearly the same.

Graph 2 shows the ranking of each pair of pupils in Test II with each other and with the other pairs. It also shows the medians of each class.

In the test over the second unit (Air in the Service of Man), the median in the lecture class exceeded that in the experimental class by a margin of nearly six per cent. Statistically a difference of six per cent means that the chances are seventy-eight out of a hundred that the difference is significant. All of the experiments that were performed by the lecture group are shown in the text and illustrated by drawings. They are the type

of experiment that can be illustrated by drawings and explained by the instructor. When these same experiments were performed in the experimental class most of the pupils failed to study the illustration in the text and depended upon one or two members of the group in which they were working to perform the experiment. If it were possible for the author to have illustrated the experiments in unit one as he did in unit two the results may have been different.

The results of this test would indicate that where material is such that the experiments can be well illustrated and explained by the author of the text there is no need for class-room experimentation, and that a duplication of the experiment that is well illustrated in the text is a waste of time even though the interest on the part of some pupils is greater. The greatest danger in group experimentation is that usually the leader of the group is the only one that gets what should be gained from the experiment. In this test most of the pupils in the experimental class with the higher scores were leaders of their group, where they were working in groups of three or four.

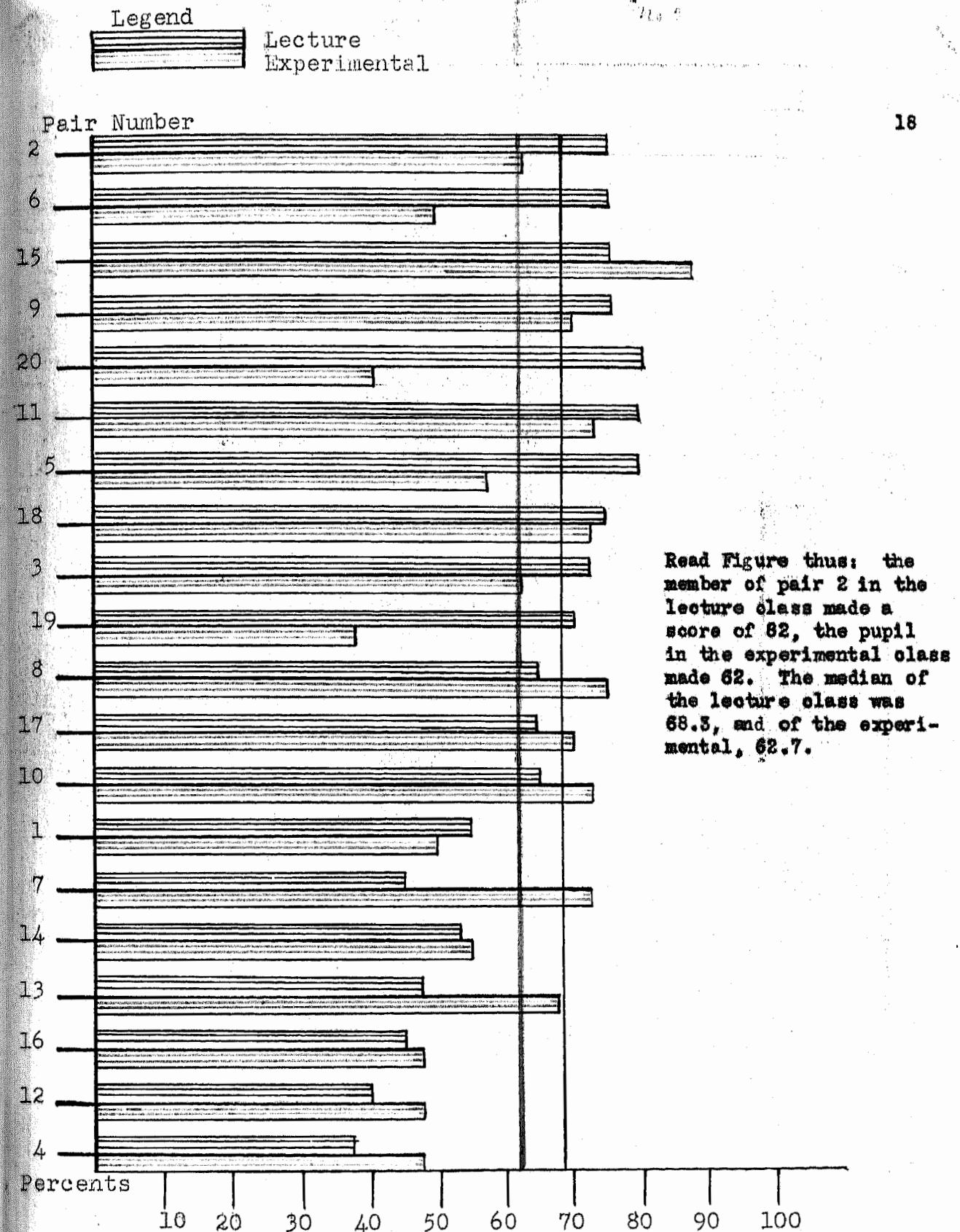
TABLE IV

SCORES MADE BY PUPILS IN TEST II

(AIR IN THE SERVICE OF MAN)

	LECTURE		EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	55.00	T.F.	50.63
2	E.N.	82.28	D.M.	62.28
3	K.B.	73.41	A.E.	63.29
4	S.N.	37.97	V.H.	48.10
5	R.G.	77.22	R.W.	58.24
6	B.S.	82.28	A.W.	46.84
7	D.S.	54.43	M.B.	72.15
8	W.H.	68.35	E.S.	74.68
9	B.W.	81.71	M.W.	69.62
10	W.O.	63.29	D.S.	72.41
11	C.S.	78.26	D.C.	72.16
12	B.S.	41.77	D.D.	47.98
13	B.H.	48.23	D.V.	67.09
14	I.P.	54.43	E.S.	55.82
15	D.C.	82.28	R.W.	87.34
16	F.K.	45.07	F.K.	46.84
17	K.S.	64.56	R.T.	69.62
18	W.H.	74.31	J.S.	73.67
19	H.K.	68.35	G.K.	36.21
20	R.C.	79.75	J.W.	49.49
	Median	68.03		62.07
	Mean	65.59		60.72
	Q.D.	12.04		12.09
	Range	37-82		36.87

Read Table thus: In Pair 1, pupil "M.T." scored 55%; pupil "T.F." the other half of this pair scored 50.63%. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 2 in the lecture class made a score of 82, the pupil in the experimental class made 62. The median of the lecture class was 68.3, and of the experimental, 62.7.

Figure 2

Ranking of Pupils in Test II (Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

AIR IN THE SERVICE OF MAN

UNIT II SET X TEST I

DIRECTIONS. The sentences below have missing words in them. You are to supply the missing word, placing it in the corresponding numbered space to the right of the sentence.

1. The gaseous envelope surrounding the earth is the (1) ____.
2. The process of gas burning is called (2) ____.
3. When anything combines with oxygen, it is called (3) ____.
4. When we raise our ribs and lower the (4) ____, thus (5) ____ the chest cavity, we make an (6) ____.
5. In deep breathing we remove the (7) ____ air from the lungs.
6. Air presses down on the earth with a pressure of about (8) ____ (9) ____ to the square (10) ____.
7. The Magdeburg hemispheres were held together by (11) ____ (12) ____.
8. The fact that air can be compressed shows that it is (13) ____.
9. The fact that a bell cannot be heard in a vacuum proves that (14) ____ carries sound.
10. Sound is caused by (15) ____ which travel through the air.
11. Sound travels at the rate of about (16) ____ feet per (17) ____.
12. The greater the number of (18) ____ per second the higher will be the (19) ____.
13. In wind instruments vibrating columns of (20) ____ produce sound.

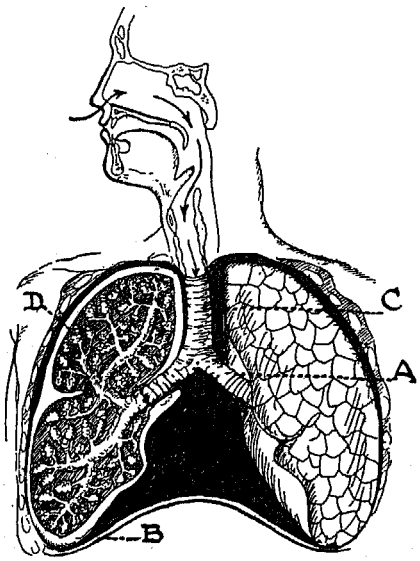
	Answers	Score
1.	____	( )
2.	____	( )
3.	____	( )
4.	____	( )
5.	____	( )
6.	____	( )
7.	____	( )
8.	____	( )
9.	____	( )
10.	____	( )
11.	____	( )
12.	____	( )
13.	____	( )
14.	____	( )
15.	____	( )
16.	____	( )
17.	____	( )
18.	____	( )
19.	____	( )
20.	____	( )

NAME CLASS DATE RATING

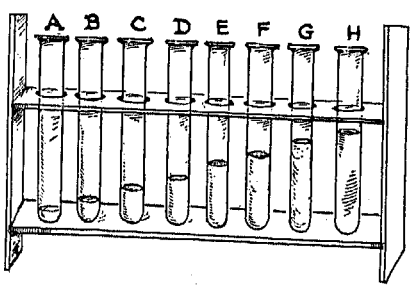
UNIT II SET X TEST II

DIRECTIONS. Place the missing words in the corresponding numbered spaces at the right.

This diagram shows the breathing apparatus of man. The muscular wall which has much to do with breathing is called the (1) ____ and is shown in the diagram by the letter (2) _____. When this muscle contracts, it becomes lower in position and this makes the chest cavity (3) ____, and the lungs become filled with (4) ____ due to the outside (5) ____ pressure. This step in the breathing process is called (6) _____. Upon entering the lungs, air first passes through the mouth or nose, and then through the windpipe lettered (7) ____ to the (8) ____ tubes lettered (9) ____ and on to the air sacs lettered (10) _____. The walls of these air sacs are lined with tiny blood tubes called (11) _____. The (12) ____ from the air passes through the thin walls of the air sacs into the (13) ____ stream and thence to all parts of the (14) _____. The process by which air is forced from the lungs is called (15) _____. This process is caused by the relaxation of the (16) _____.



If you were to blow into the test tubes, you would get the highest pitched note from tube lettered (17) _____. The lowest pitched note would come from tube (18) _____. Tube (19) ____ would have fewer vibrations per second than tube B, and tube F would have (20) ____ vibrations than tube H.



Answers	Score
1. ----------	( )
2. ----------	( )
3. ----------	( )
4. ----------	( )
5. ----------	( )
6. ----------	( )
7. ----------	( )
8. ----------	( )
9. ----------	( )
10. ----------	( )
11. ----------	( )
12. ----------	( )
13. ----------	( )
14. ----------	( )
15. ----------	( )
16. ----------	( )
17. ----------	( )
18. ----------	( )
19. ----------	( )
20. ----------	( )

NAME CLASS DATE RATING

UNIT II SET X TEST III

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

A. 1100 ft. per second
B. Ether
C. Oxygen
D. Humidity
E. Violin
F. Inspiration
G. Irregular vibrations
H. Overtone
I. Pipe organ
J. Rise
K. Air
L. Ear drum
M. Echo
N. Inner ear
O. 1100 ft. per minute
P. Caisson
Q. Nitrogen
R. Vibrations
S. Combustion
T. Carbon dioxide
U. Harmonica
V. Expiration
W. Fall
X. Change in pitch
Y. 1100 miles per hour
Z. Regular vibrations

	Answers	Score
1. The gas which can be detected by the lime water test.	1. _____	( )
2. The cause of stuffiness in an unventilated room.	2. _____	( )
3. The process of pushing the air from the lungs.	3. _____	( )
4. The approximate speed of sound in air.	4. _____	( )
5. A device which allows men to lay a foundation below water level.	5. _____	( )
6. What the mercury in a barometer would do if carried up to a high mountain.	6. _____	( )
7. Oxidation taking place so rapidly that light and heat are given off.	7. _____	( )
8. The gas which makes up about 78% of the air.	8. _____	( )
9. The gas which causes iron to rust.	9. _____	( )
10. Occurs when sound is reflected.	10. _____	( )
11. A reed musical instrument.	11. _____	( )
12. The cause of noise.	12. _____	( )
13. The source of all sound.	13. _____	( )
14. The common medium for the transferring of sound.	14. _____	( )
15. The part of the ear most easily destroyed.	15. _____	( )
16. The cause of music.	16. _____	( )

NAME CLASS DATE RATING

UNIT II SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true, and *no* after the others. All, any, or none of the completions may be statements.

	Answers	Score
1. We know that air is a form of matter:		
(*a*) because it takes up space.	*a.* _____	( )
(*b*) because it has never been seen.	*b.* _____	( )
(*c*) because it exerts pressure.	*c.* _____	( )
(*d*) because it has weight.	*d.* _____	( )
(*e*) because it may be used to fill automobile tires.	*e.* _____	( )
2. The presence of air in water may be proved by:		
(*a*) the ability of fish to live in water.	*a.* _____	( )
(*b*) small bubbles which leave water when heated.	*b.* _____	( )
(*c*) the ability of man to swim in water.	*c.* _____	( )
(*d*) pouring the water over a bottle of soil.	*d.* _____	( )
(*e*) using a microscope to see the air in the water.	*e.* _____	( )
3. We know that oxygen is needed for burning:		
(*a*) because wood or paper burns easily.	*a.* _____	( )
(*b*) because a fire will not burn in carbon dioxide.	*b.* _____	( )
(*c*) because burning is called oxidation.	*c.* _____	( )
(*d*) because gasoline will not burn in a space from which oxygen has been removed.	*d.* _____	( )
(*e*) because oxygen comes from decaying vegetable matter.	*e.* _____	( )

Answers Score

4. Carbon dioxide:
   (*a*) is used by trees in their growth. *a.* ------- ( )
   (*b*) will cause a milky color to occur in lime water. *b.* ------- ( )
   (*c*) comes from the breath of animals. *c.* ------- ( )
   (*d*) comes from burning wood. *d.* ------- ( )
   (*e*) comes from decaying apples. *e.* ------- ( )

5. Oxidation:
   (*a*) is called combustion when it takes place rapidly. *a.* ------- ( )
   (*b*) is called rusting when oxygen joins with iron. *b.* ------- ( )
   (*c*) is called decaying when oxygen slowly unites with wood. *c.* ------- ( )
   (*d*) continually takes place in our bodies while we are alive. *d.* ------- ( )
   (*e*) refers to the collection of oxygen in bottles. *e.* ------- ( )

6. Air is caused to enter and leave our lungs:
   (*a*) by a process called expiration. *a.* ------- ( )
   (*b*) by the suction of the blood. *b.* ------- ( )
   (*c*) by the beating of the heart. *c.* ------- ( )
   (*d*) by the movement of the diaphragm. *d.* ------- ( )
   (*e*) by the action of a large muscle which lies below the chest cavity. *e.* ------- ( )

Results of Test III

(Foods and How We Use Them)

In Table V the results of Test III are shown. The pupils are arranged in the same manner as in previous charts.

The highest per cent was eighty-five, made by a pupil in the lecture class, while the highest per cent made in the experimental class was seventy-two. The lowest per cent was twenty-seven, in the experimental class; the lowest per cent in the lecture class was thirty-three.

Thirteen pupils in the lecture class exceeded the pupils with whom they were paired in the experimental class. One pair made the same per cent, and six pupils in the experimental class exceeded the pupils with whom they were paired in the lecture class. The median of both classes was fifty-eight.

In pair number nine the pupil in the experimental class exceeded the pupil in the lecture class by a margin of five per cent, and in pair eighteen the pupil in the lecture class exceeded the pupil in the experimental class. In pair eighteen the pupil in the lecture class is low in the control scores.

Figure 5 shows the ranking of each pair of pupils. There was no difference in the medians of the two classes. The test over this unit included a number of the same figures that were in the textbook. The test was built around these figures and textbook material that was explained fully by diagrams and figures, and this shows again that material of this nature need not be worked out experimentally.

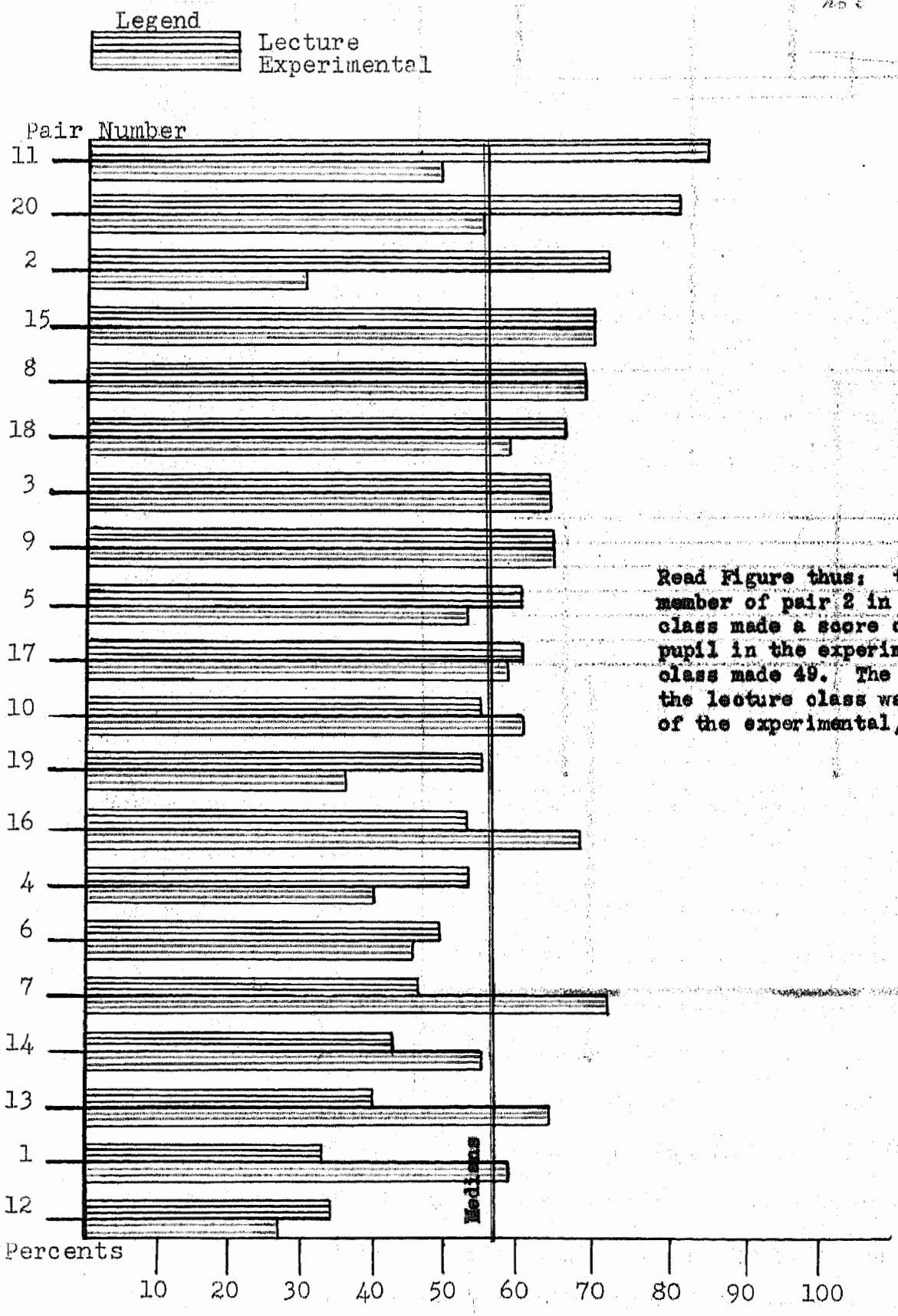
TABLE V

SCORES MADE BY PUPILS IN TEST III

(FOODS AND HOW WE USE THEM)

	LECTURE		EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	34.04	T.F.	59.26
2	E.N.	76.52	D.M.	40.74
3	K.B.	64.35	A.E.	64.19
4	S.N.	53.09	V.H.	41.98
5	R.G.	46.91	R.W.	53.09
6	B.S.	50.62	A.W.	46.91
7	D.S.	46.91	M.B.	72.81
8	N.H.	69.14	E.S.	69.14
9	B.W.	64.32	M.W.	69.14
10	W.O.	55.56	D.S.	60.49
11	C.S.	85.19	D.C.	49.13
12	B.S.	33.33	D.D.	27.16
13	B.H.	41.97	D.V.	64.11
14	I.P.	43.21	E.S.	55.55
15	D.C.	70.37	R.W.	70.37
16	F.K.	54.32	F.K.	68.64
17	L.S.	60.50	R.T.	58.02
18	W.H.	66.67	J.S.	58.02
19	H.K.	55.56	G.K.	37.46
20	R.C.	81.48	J.W.	55.56
	Median	58.00		58.00
	Mean	58.39		56.08
	Q.D.	8.98		8.08
	Range	33-85		27-72

Read Table thus: In Pair 1, pupil "M.T." scored 34.04%; pupil "T.F.," the other member of the pair, scored 59.26%. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 2 in the lecture class made a score of 85, the pupil in the experimental class made 49. The median of the lecture class was 58, and of the experimental, 58.

Figure 3

Ranking of Pupils in Test III
(Foods and How We Use Them)
(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

FOODS AND HOW WE USE THEM

UNIT III SET X TEST I

DIRECTIONS. The sentences below have missing words in them. You are to supply the missing words, placing them in the corresponding numbered space to the right of the sentences.

1. Foods are substances which supply (1) ____ material, (2) ____, or both to living things.
2. The (3) ____ is the source of energy for the making of plant (4) ____.
3. Mineral substances are found in (5) ____ and many fruits or (6) ____.
4. (7) ____ are health regulating substances.
5. (8) ____ are units of living matter out of which the (9) ____ of plants and animals are built.
6. Foods are oxidized in the body in order to do (10) ____.
7. The (11) ____ are cutting teeth.
8. A gram of (12) ____ or a gram of (13) ____ liberate 4.1 Calories of heat when oxidized.
9. Dietary requirements differ according to the (14) ____, (15) ____, and (16) ____ of the individual.
10. Digestive (17) ____ secrete enzymes.
11. Blood contains soluble (18) ____.
12. Yeasts cause (19) ____.
13. Microörganisms growing on food may be controlled by keeping food at a temperature below (20) ____ degrees Fahrenheit.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )
11.	----------	( )
12.	----------	( )
13.	----------	( )
14.	----------	( )
15.	----------	( )
16.	----------	( )
17.	----------	( )
18.	----------	( )
19.	----------	( )
20.	----------	( )

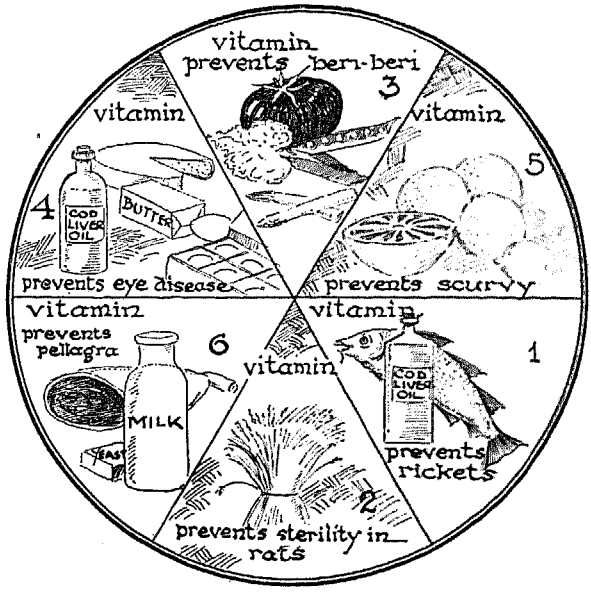
NAME CLASS DATE RATING

UNIT III SET X TEST II

DIRECTIONS. You are to fill in the numbered spaces to the right with the correct answers.

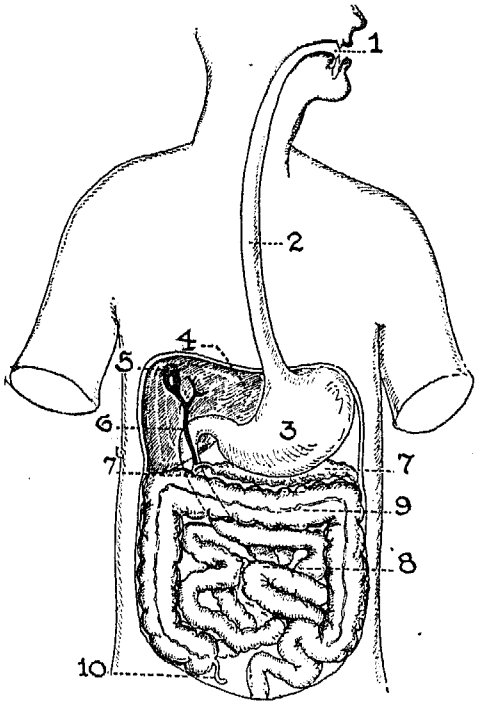
Study the figure carefully. Then fill in the letter needed to make a correct diagram.

builds resistance against respiratory diseases and



Answers	Score
1. _____	( )
2. _____	( )
3. _____	( )
4. _____	( )
5. _____	( )
6. _____	( )

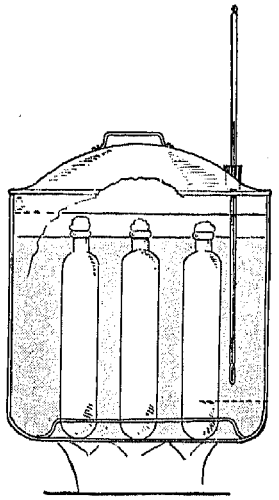
Study the figure carefully. Then place in the spaces to the right the name of each structure shown.



Answers	Score
1. _____	( )
2. _____	( )
3. _____	( )
4. _____	( )
5. _____	( )
6. _____	( )
7. _____	( )
8. _____	( )
9. _____	( )
10. _____	( )

Answers Score

Examine the diagram carefully. Then fill out the numbered blanks below, so as to make sense. Place the missing words in the spaces to the right.



This is a section through a Pasteurizing outfit. Warm water should be placed in the tin, the bottles of milk to be Pasteurized placed in the water, a (1) ____ inserted and the apparatus placed over a slow fire. To Pasteurize the milk it should remain at (2) ____ degrees (3) ____ for about (4) ____ (5) _____.

1. ---------- ( )
2. ---------- ( )
3. ---------- ( )
4. ---------- ( )
5. ---------- ( )

NAME CLASS DATE RATING

UNIT III SET X TEST III

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

A. Hydrogen
B. Capillaries
C. Carbohydrates
D. Carbon dioxide
E. Dr. Manson
F. A small calorie
G. Inorganic
H. Chloroplasts
I. Veins
J. Iodine
K. Organic
L. Nitrogen
M. Arteries
N. Fehling's solution
O. Proteins
P. Enzyme
Q. A large calorie
R. Cells
S. Stomach
T. Nitric acid
U. Oxygen
V. Louis Pasteur
W. Fats
X. Starch
Y. Nutriments
Z. Small intestine

	Answers	Score
1. The structural units of the body in which food is oxidized.	1. _____	( )
2. The amount of heat necessary to warm four pounds of water 1 degree F.	2. _____	( )
3. The class of food which liberates the greatest amount of heat per pound.	3. _____	( )
4. The class of food to which sugars and starches belong.	4. _____	( )
5. The substance in the saliva which changes starches into sugars.	5. _____	( )
6. The part of the digestive tract where most of the proteins are digested.	6. _____	( )
7. The part of the digestive tract from which most of the food is absorbed into the blood stream.	7. _____	( )
8. The man who first associated bacteria with the spoiling of foods.	8. _____	( )
9. The kind of blood vessels which carry the blood from the body to the heart.	9. _____	( )
10. The group of foods which comes from non-living things.	10. _____	( )
11. Used in the test for starch.	11. _____	( )
12. The kind of food used for body repair and growth.	12. _____	( )
13. The bodies containing the green coloring matter in leaves.	13. _____	( )
14. The chief food product manufactured in the green leaf.	14. _____	( )
15. The general name for all food substances.	15. _____	( )
16. What the green leaf takes from the air in manufacturing food.	16. _____	( )

NAME CLASS DATE RATING

UNIT III SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

	Answers	Score
1. Substances like beef, apples, and potatoes are called foods because:		
(*a*) they grow in great abundance.	*a.* -------	( )
(*b*) they are classed as organic matter.	*b.* -------	( )
(*c*) they supply building material for the body.	*c.* -------	( )
(*d*) they are easily digested by the body.	*d.* -------	( )
(*e*) they furnish a supply of energy for the body.	*e.* -------	( )
2. The human body and the engine are alike because:		
(*a*) both burn fuel within themselves.	*a.* -------	( )
(*b*) both are able to do work.	*b.* -------	( )
(*c*) both release energy through the oxidation of organic matter within themselves.	*c.* -------	( )
(*d*) both use more energy while working than while resting.	*d.* -------	( )
(*e*) both are built from materials which differ from the fuel burned.	*e.* -------	( )
3. Different people require varying amounts of food per day:		
(*a*) if they differ in age.	*a.* -------	( )
(*b*) if they differ in environment.	*b.* -------	( )
(*c*) if they differ in sex.	*c.* -------	( )
(*d*) if they differ in the amount and kind of work they are doing.	*d.* -------	( )
(*e*) if they differ in size.	*e.* -------	( )

Answers Score

4. Other factors being favorable, bacteria multiply and grow readily when:
   (*a*) the temperature is 48 degrees F. — *a.* _____ ( )
   (*b*) there is a moderate amount of moisture present. — *b.* _____ ( )
   (*c*) there is plenty of light. — *c.* _____ ( )
   (*d*) the temperature is 212 degrees F. — *d.* _____ ( )
   (*e*) the temperature is 65 degrees F. — *e.* _____ ( )

5. Proteins should supply a portion of the daily diet because:
   (*a*) they furnish the best source of heat and energy for the body. — *a.* _____ ( )
   (*b*) they are chiefly found in the leafy vegetables. — *b.* _____ ( )
   (*c*) they furnish building material for bodily repair and growth. — *c.* _____ ( )
   (*d*) they furnish the best supply of vitamin D. — *d.* _____ ( )
   (*e*) they are chiefly digested in the stomach. — *e.* _____ ( )

6. It is important to know the fuel value of our food because:
   (*a*) we can then judge correctly the right amount of food to eat. — *a.* _____ ( )
   (*b*) we can then regulate the temperature of our bodies better. — *b.* _____ ( )
   (*c*) it is helpful in preserving foods.
   (*d*) we can then decrease or increase our food supply to suit our bodily activity. — *c.* _____ ( ) *d.* _____ ( )
   (*e*) it is valuable in saving fuel in cooking. — *e.* _____ ( )

Results of Test IV

(How We Use and Control Fire)

Table VI shows the per cent made by each pupil of each pair in Test IV. Figure 4 shows the ranking of each pair of pupils in Test IV with each other and the other pairs. It also shows the medians of each class.

The highest per cent score was eighty-three and was made by a pupil in the "lecture" class, while the highest per cent made in the experimental class was eighty-two, a difference of only one per cent in the two high per cents. The lowest per cent was forty-five and was made in the experimental class. The lowest score in the lecture class was fifty-one.

The per cents of eleven pupils in the lecture class exceeded the eleven pupils with whom they are paired in the experimental class; in the other nine pairs the pupils in the experimental class exceeded those in the lecture class.

In pair number nine the pupil in the lecture class exceeded the pupil in the experimental class by twelve per cent, and in pair eighteen the pupil in the lecture class exceeded the pupil in the experimental class by five per cent.

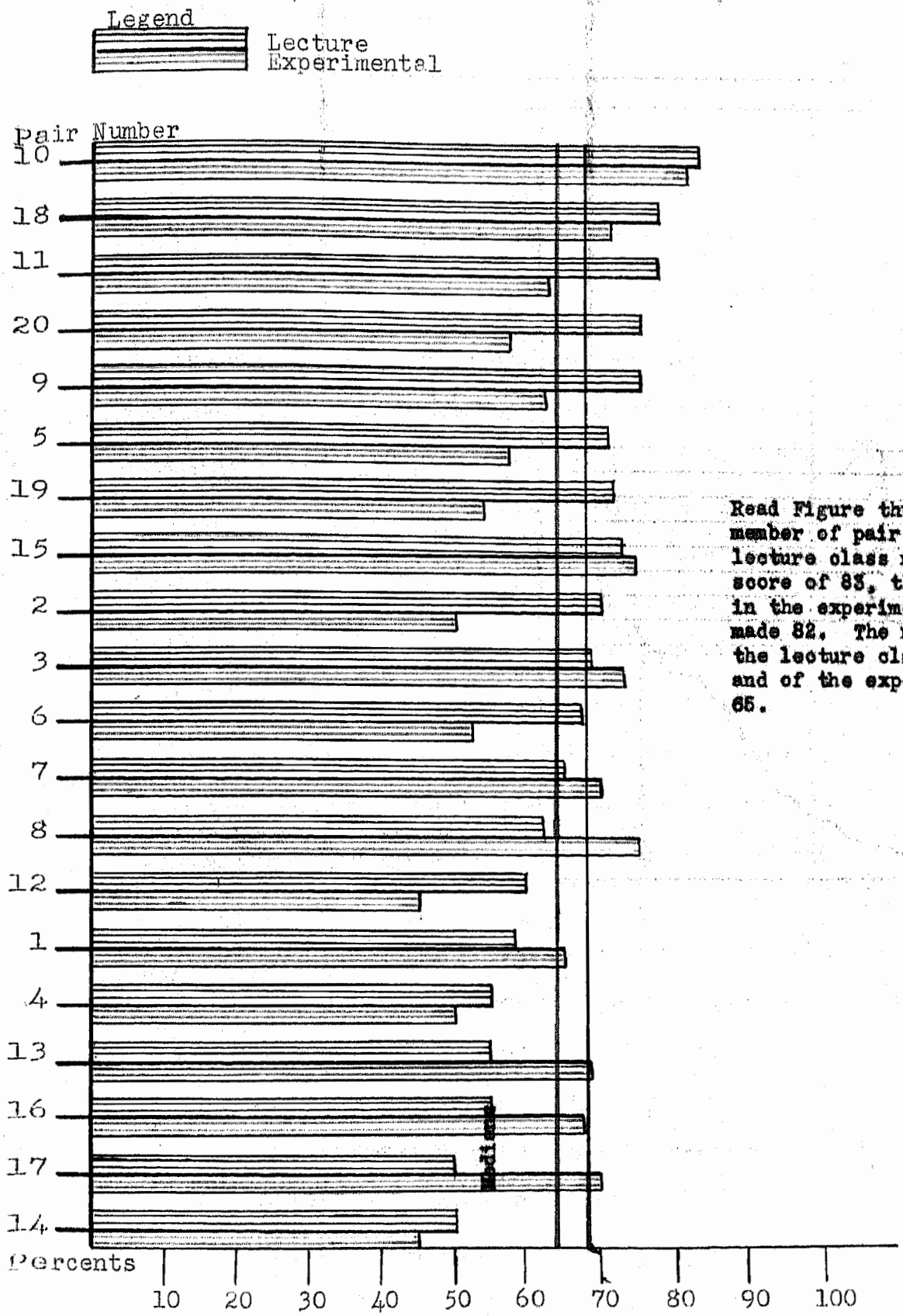
The median of the lecture group exceeded that of the experimental group by three per cent. This test included four figures that were shown in the text and explained by the author. The experimental class worked each of them out in the laboratory, while the lecture class spent more time studying the diagrams and figures. The results were in favor of the lecture group. This would indicate that there is a waste of time by the laboratory group when they work out experiments that are illustrated by diagrams and figures. Other than the material mentioned above the test covered mostly textbook material.

TABLE VI

SCORES MADE BY PUPILS IN TEST IV
(HOW WE USE AND CONTROL FIRE)

LECTURE			EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	58.01	T.F.	66.28
2	E.N.	70.93	D.M.	50.00
3	K.B.	68.60	A.E.	74.42
4	S.N.	56.98	V.H.	52.35
5	R.G.	73.26	R.W.	58.14
6	B.S.	67.44	A.W.	53.49
7	D.S.	65.12	M.B.	72.94
8	N.H.	63.95	E.S.	75.58
9	B.W.	75.58	M.W.	63.95
10	W.O.	83.72	D.S.	82.22
11	C.S.	76.74	D.C.	64.18
12	B.S.	60.04	D.D.	45.35
13	B.H.	55.82	D.V.	69.79
14	I.P.	51.16	E.S.	45.33
15	D.C.	72.09	R.W.	74.42
16	F.K.	55.81	F.K.	68.84
17	L.S.	52.33	R.T.	71.88
18	W.H.	77.91	J.S.	72.09
19	H.K.	73.26	G.K.	54.74
20	R.C.	76.74	J.W.	59.50
	Median	68.00		65.1
	Mean	66.79		63.75
	Range	51-83		45-82
	Q.D.	8.44		10.94

Read Table thus: In Pair 1, pupil "M.T." made a score of 58.01%; pupil "T.F.," the other member of the pair, made 66.28%. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 10 in the lecture class made a score of 83, the pupil in the experimental class made 82. The median of the lecture class was 68, and of the experimental, 65.

Figure 4

Ranking of Pupils in Test IV (How We Use and Control Fire)
(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

HOW WE USE AND CONTROL FIRE

UNIT IV SET X TEST I

DIRECTIONS. Indicate which of the following statements are *true* or *false* by *marking out* the reply you do *not* want. T equals True. F equals False.

		Answers		Score
1.	Combustible materials are inflammable.	1. T	F	( )
2.	All oxidation is combustion.	2. T	F	( )
3.	The intensity of heat is called temperature.	3. T	F	( )
4.	The kindling point is the point at which a substance will take fire.	4. T	F	( )
5.	The head of a match has a higher kindling point than the wood.	5. T	F	( )
6.	Convection is the process of carrying heat by currents in gases or liquids.	6. T	F	( )
7.	A radiator is so called because it is made of bright material.	7. T	F	( )
8.	Hard coal has more gaseous material in it than soft coal.	8. T	F	( )
9.	The process of changing a liquid to a gas and then back to a liquid is called distillation.	9. T	F	( )
10.	Coke is a by-product left over in the manufacture of gas.	10. T	F	( )
11.	The process of making gas by destructive distillation of coal produces water gas.	11. T	F	( )
12.	Conduction is a movement of molecules.	12. T	F	( )
13.	Radiation by heat occurs better from rough than from smooth surfaces.	13. T	F	( )
14.	The thermometer is based on the principle that heated surfaces contract and chilled surfaces expand.	14. T	F	( )
15.	Galileo's thermometer was made exactly like the modern thermometer.	15. T	F	( )
16.	Normal body temperature is 89.6° Centigrade.	16. T	F	( )
17.	The freezing point of water on the Fahrenheit thermometer is 0 degrees.	17. T	F	( )
18.	A unit of heat is called the calorie.	18. T	F	( )
19.	The hotwater heating system makes use of the principle of convection in order to transfer heat from the radiator to the air of the room.	19. T	F	( )
20.	The principle of insulation is used in the fireless cooker.	20. T	F	( )

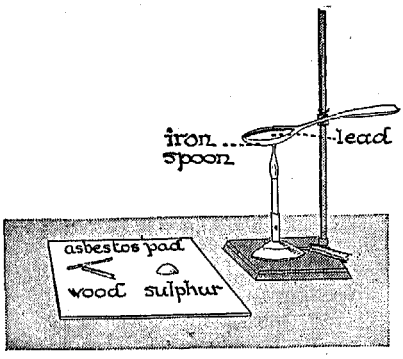
NAME CLASS DATE RATING

UNIT IV . SET X TEST II

DIRECTIONS. The sentences below have missing words in them. You are to supply the missing words, placing them in the corresponding numbered space to the right of the sentences.

Answers Score

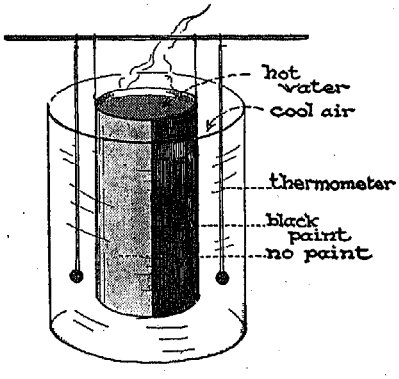
Study the diagram carefully. Then fill out the following sentences, supplying the missing words in the same numbered spaces at the right.



If we place a sulphur match end and a bit of the wood of a match on a piece of asbestos cloth, heat a piece of lead to the melting point and pour it on the asbestos sheet so that it touches both the wood and the sulphur match, the (1) ____ ignites while the (2) ____ does not. This shows that the (3) ____ has a lower kindling temperature than (4) ____ and shows why we use it in making (5) ____.

1. ---------- ( )
2. ---------- ( )
3. ---------- ( )
4. ---------- ( )
5. ---------- ( )

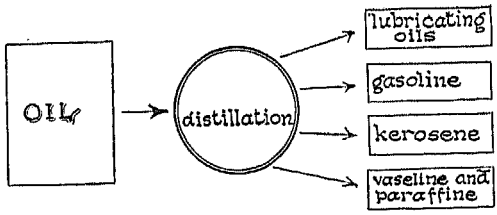
Study the diagram carefully. Note that there are two jars, the inner filled with hot water. In this experiment we find that the thermometer next the black paint will register (6) ____ than the one on the side where there is (7) ____ paint because the (8) ____ radiates the (9) ____ from the (10) ____ in the inner jar.



6. ---------- ( )
7. ---------- ( )
8. ---------- ( )
9. ---------- ( )
10. ---------- ( )

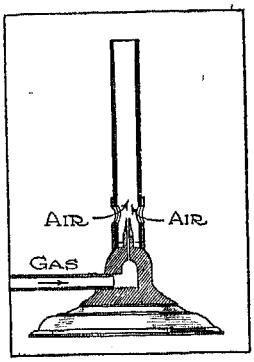
Answers Score

Study the diagram carefully. Then fill out the following sentences, supplying the missing words in the



same numbered spaces at the right. The first product to be separated is (11) ____ and the other products come off in the following order, (12)____, (13) ____, (14) _____.

Study the diagram carefully. Then fill out the following sentences, supplying the missing words in the same numbered spaces at the right.



If the air holes in the Bunsen burner are closed, the flame is (15) ____ colored. If a paper is passed rapidly over the flame, it becomes coated with (16)_____. This shows that the gas is not completely (17) _____. If now, the air is turned in until the gas burns with a (18) ____ colored flame, it will be found to be much (19) _____. This is because (20) ____ unites with the gas to make complete (21) _____.

11. _____ ( )
12. _____ ( )
13. _____ ( )
14. _____ ( )
15. _____ ( )
16. _____ ( )
17. _____ ( )
18. _____ ( )
19. _____ ( )
20. _____ ( )
21. _____ ( )

NAME CLASS DATE RATING

UNIT IV SET X TEST III

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

A. Chemical energy
B. Heat
C. Fractional distillation
D. 100 degrees C.
E. Carbon dioxide
F. Combustion
G. Insulator
H. Radiation
I. Temperature
J. Hydrogen
K. Electrical energy
L. 212 degrees C.
M. Carbon monoxide
N. Small calorie
O. Energy
P. Nitrogen
Q. Convection
R. Inflammable
S. Expands
T. Conduction
U. 100 degrees F.
V. Mechanical energy
W. Destructive distillation
X. Oxygen
Y. Contracts
Z. Helium

	Answers	Score
1. A name often applied to combustible materials.	1. _____	( )
2. An element which is in every fuel.	2. _____	( )
3. The method of heat transfer where the heat energy is passed from molecule to molecule.	3. _____	( )
4. What the degree of hotness or coldness of an object is called.	4. _____	( )
5. The name commonly applied to the non-conductor of heat.	5. _____	( )
6. The method of heat transfer by which the sun's heat reaches the moon.	6. _____	( )
7. What almost all matter does when heat is removed from it.	7. _____	( )
8. The temperature at which water boils at or near sea level.	8. _____	( )
9. The amount of heat required to warm one gram of water one degree centigrade.	9. _____	( )
10. The form of energy from which heat is transformed when materials burn.	10. _____	( )
11. The process of separating liquids having different boiling points.	11. _____	( )
12. What heat is a form of.	12. _____	( )
13. A very poisonous, odorless gas which comes from burning fuels.	13. _____	( )
14. What the unit "calorie" is used to measure.	14. _____	( )
15. The part of the air which is always present while a fire is burning.	15. _____	( )

NAME CLASS DATE RATING

UNIT IV SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. In a stove in which there is a damper in pipe, draft in lower door, and check draft in upper door the reason for opening the check draft, closing the draft, while leaving the damper open might be because:
   (*a*) the fire was burning too briskly and needed slowing down. *a.* ------- ( )
   (*b*) it would make the stove a better conductor. *b.* ------- ( )
   (*c*) it would stop the convection currents in the room. *c.* ------- ( )
   (*d*) it would stop the carbon monoxide which had been coming into the room. *d.* ------- ( )
   (*e*) the fire was being smothered because of lack of oxygen. *e.* ------- ( )

2. Destructive distillation of coal is an important process because:
   (*a*) it yields a cheaper gas than natural gas. *a.* ------- ( )
   (*b*) it furnishes us with our best source of peat. *b.* ------- ( )
   (*c*) it is the best method of producing coke. *c.* ------- ( )
   (*d*) the by-product tar is a valuable source of aniline dyes and colors. *d.* ------- ( )
   (*e*) it furnishes a way to produce gas when natural gas is not available. *e.* ------- ( )

3. Piles of oily rags are especially liable to spontaneous combustion because:
   (*a*) the oil slowly oxidizes. *a.* ------- ( )
   (*b*) the rags are poor conductors of heat. *b.* ------- ( )
   (*c*) the heat is held in the rags. *c.* ------- ( )
   (*d*) the kindling temperature of oily rags is relatively low. *d.* ------- ( )
   (*e*) the rags receive much heat from surrounding objects by radiation. *e.* ------- ( )

Answers Score

4. Water is one of the best fire extinguishers that can be used because:
   (*a*) it cools the burning substance below the kindling temperature. *a.* _____ ( )
   (*b*) it is inflammable. *b.* _____ ( )
   (*c*) it is wet. *c.* _____ ( )
   (*d*) it is heavier than oil. *d.* _____ ( )
   (*e*) much of it is changed into steam which in turn smothers the fire. *e.* _____ ( )

5. A well-made fireless cooker will keep foods at a cooking temperature for a long period of time because:
   (*a*) foods cooked this way do not lose their flavor. *a.* _____ ( )
   (*b*) the heat energy cannot get out of the cooker. *b.* _____ ( )
   (*c*) the fireless cooker is insulated with a poor heat conductor. *c.* _____ ( )
   (*d*) the cold cannot get into the cooker from the outside. *d.* _____ ( )
   (*e*) the food is cooking so rapidly when put into the cooker that it cannot stop. *e.* _____ ( )

6. Heat appears when a fuel burns because:
   (*a*) that is the best way to create energy. *a.* _____ ( )
   (*b*) the fuel was heated up to start it burning. *b.* _____ ( )
   (*c*) fire is always hot. *c.* _____ ( )
   (*d*) oxidation always releases energy in the form of heat. *d.* _____ ( )
   (*e*) the chemical energy of the fuel is being changed into heat energy. *e.* _____ ( )

Results of Test V

(How Water Serves Man)

Table VII shows the per cent made by each pupil of each pair in Test V. Figure 5 shows the ranking of each pair of pupils in Test V with each other and with the other pairs. It also shows the medians of each class.

The highest per cent was eight-eight, made by a pupil in the lecture class, while the highest per cent in the experimental class was eighty-six. The lowest per cent was thirty-three, and it also was made by a pupil in the lecture class. The lowest per cent in the experimental class was forty-five.

The per cents of ten pupils in the lecture class exceeded the per cents of the pupils with whom they were paired in the experimental class. The pupils in one pair made the same per cent, and nine pupils in the experimental exceeded the nine with whom they were paired in the lecture class.

In pair number nine the pupil in the lecture class exceeded the pupil in the experimental class by three per cent; and in pair eighteen the pupil in the experimental group exceeded the pupil in the lecture class, but by a margin of five per cent.

The median of the lecture class exceeded that of the experimental class by nine per cent. Ten per cent is a significant difference. This would indicate, then, that the difference in the two medians in this test is much more than chance.

The test that covered this unit had a total of seventy-five points. Forty-nine points of the test were regular textbook material, and the other twenty-six points covered three experiments that were included in the unit. In checking the test papers of the two groups it was found that the lecture

group exceeds the experimental in the part of the test that covered the three experiments, as well as the regular textbook material. This indicates rather clearly that when experiments are well illustrated by figures they need not be actually performed in the laboratory, and that when they are there is a waste of time and the efficiency of the class is cut down.

TABLE VII

SCORES MADE BY PUPILS IN TEST V
(HOW WATER SERVES MAN)

LECTURE			EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	77.07	T.F.	65.55
2	E.N.	81.11	D.M.	63.33
3	K.B.	86.66	A.E.	67.77
4	S.N.	56.67	V.H.	58.89
5	R.G.	88.88	R.W.	65.56
6	B.S.	70.00	A.W.	60.00
7	D.S.	67.78	M.B.	68.88
8	N.H.	67.78	E.S.	75.56
9	B.W.	81.11	M.W.	78.89
10	W.O.	78.89	D.S.	65.00
11	C.S.	80.00	D.C.	80.00
12	B.S.	72.44	D.D.	71.11
13	E.H.	65.55	D.V.	71.11
14	I.P.	55.56	E.S.	64.66
15	D.C.	74.44	R.W.	81.11
16	F.K.	56.11	F.K.	57.78
17	K.S.	33.33	R.T.	78.89
18	W.H.	81.11	J.S.	86.67
19	H.K.	75.56	G.K.	58.33
20	R.C.	82.22	J.W.	45.56
	Median	75.00		66.06
	Mean	71.64		68.12
	Range	33-88		45-86
	Q.D.	7.22		7.78

Read Table thus: In Pair 1, pupil "M.T." made a score of 77.07; pupil "T.F.," the other member of the pair, made 65.55%. Read in like manner for succeeding pairs.

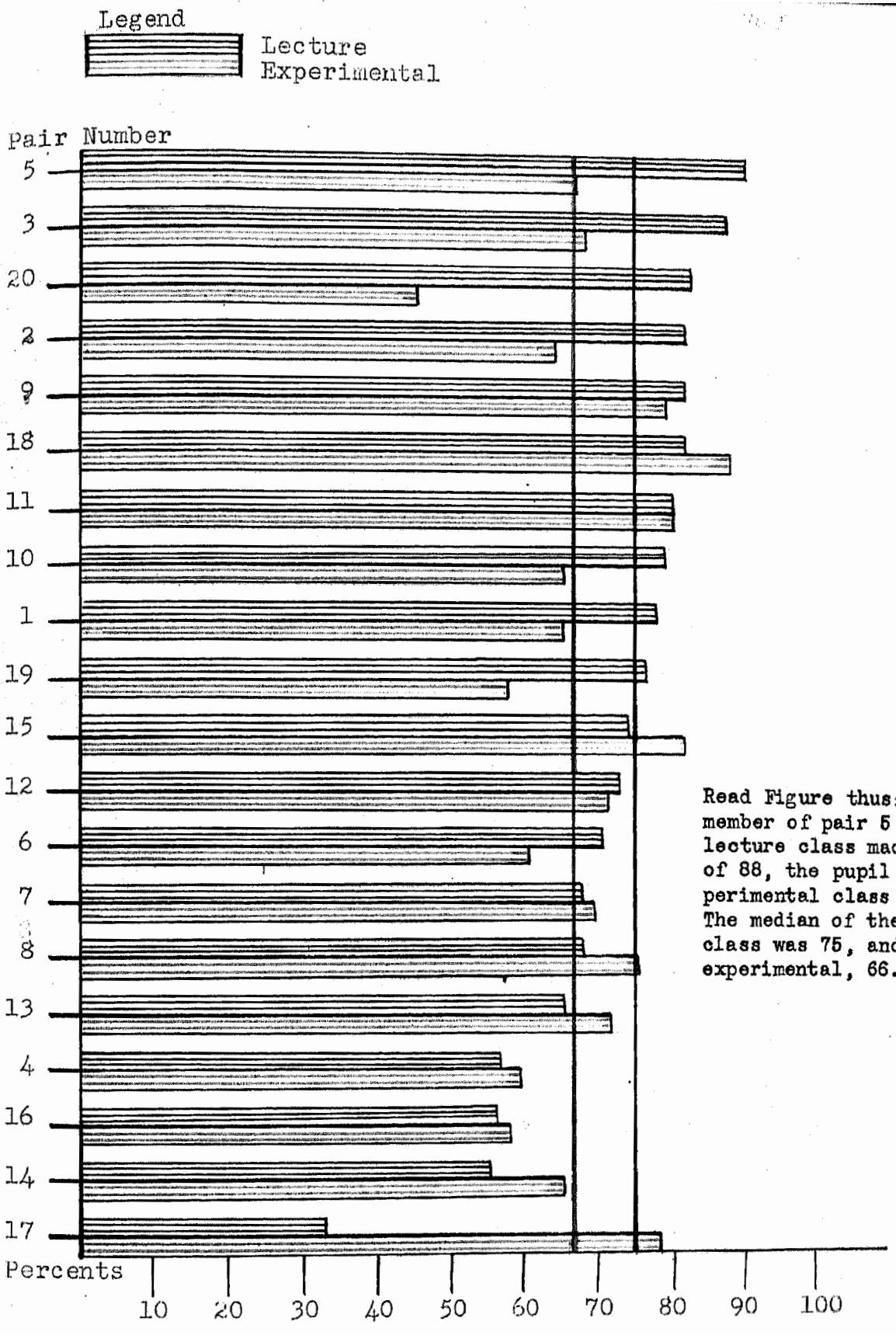


Figure 5

Ranking of Pupils in Test V (How Water Serves Man)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

HOW WATER SERVES MAN

UNIT V SET X TEST I

DIRECTIONS. Indicate which of the following statements are *true* or *false* by *marking out* the reply you do *not* want. T equals True. F equals False.

	Answers		Score
1. Pure water comes from the clouds.	1. T	F	( )
2. Green leaves give off much moisture to the air.	2. T	F	( )
3. An impervious layer is one through which water can easily flow.	3. T	F	( )
4. Soft water comes from springs in limestone regions.	4. T	F	( )
5. Water containing dirt or mud held in suspension is dangerous to health.	5. T	F	( )
6. Organic matter may be removed from water by boiling it.	6. T	F	( )
7. A faucet filter is an easy and safe method of removing impurities from water.	7. T	F	( )
8. A cubic foot of water weighs 62.4 pounds.	8. T	F	( )
9. The statement that "water seeks its own level" is true.	9. T	F	( )
10. Air presses down on water with a force of 33 pounds to the square inch.	10. T	F	( )
11. The lift pump will raise water about 28 feet.	11. T	F	( )
12. A faucet usually drips because it needs a new washer.	12. T	F	( )
13. Filter beds make water absolutely safe to drink.	13. T	F	( )
14. Typhoid fever rarely comes from water supplies unless the chlorinator gets out of order.	14. T	F	( )
15. Reservoirs are useful to kill germs in water as well as to store it.	15. T	F	( )
16. We should protect our watersheds from pollution since bacteria causing harmful diseases get into water supplies in this way.	16. T	F	( )
17. Untreated sewage, if exposed to the air, is harmless.	17. T	F	( )
18. Many cities drink dilute sewage.	18. T	F	( )
19. Trees help conserve our water supply.	19. T	F	( )
20. The soil of arid regions is rich in plant foods, which may be utilized if irrigation is used.	20. T	F	( )

NAME CLASS DATE RATING

UNIT V SET X TEST II

DIRECTIONS. In the test below you will find a list of words above a list of statements. You must pick out from the list of words some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right.

A. North	I. Oxygen	Q. Air pressure	Y. Artesian
B. Chlorine	J. Spring	R. Sewage	Z. West
C. Rheumatism	K. South	S. Erosion	AA. Smallpox
D. Impervious rock	L. Sulphate of aluminum	T. Faucet	BB. Salt
E. About 30 feet	M. Typhoid fever	U. East	CC. About 15 feet
F. Tides	N. Sand	V. Hard	DD. Gravity
G. Switch	O. Suction	W. Nitrogen	EE. Gauge
H. Soft	P. About 60 feet	X. Palatable	

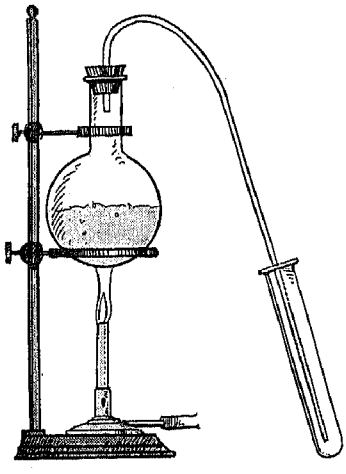
	Answers	Score
1. The part of the United States in which one finds the most irrigation projects.	1. _____	( )
2. The process of soil being worn away by wind and water.	2. _____	( )
3. Body and household wastes diluted in water.	3. _____	( )
4. A liquid chemical often used to kill bacteria in the city water supply.	4. _____	( )
5. A disease which may easily be contracted by drinking contaminated water.	5. _____	( )
6. The greatest possible distance that could exist between the water level and the lower valve of a lift pump, provided the pump will actually pump water.	6. _____	( )
7. The material through which city water is most commonly filtered.	7. _____	( )
8. The force which causes water to move from mountain reservoirs into homes in the valley below.	8. _____	( )
9. The force which causes water to rise into a lift pump.	9. _____	( )
10. A device used for controlling the flow of water in a pipe.	10. _____	( )
11. A word meaning agreeable to the taste.	11. _____	( )
12. A self-flowing well of relatively great depth.	12. _____	( )
13. The gas which joined with hydrogen in proper proportions forms water.	13. _____	( )
14. What water might reasonably be called which has been distilled.	14. _____	( )

NAME CLASS DATE RATING

UNIT V SET X TEST III

DIRECTIONS. The sentences below have missing words in them. You are to supply the missing words, placing them in the corresponding numbered space to the right of the sentence.

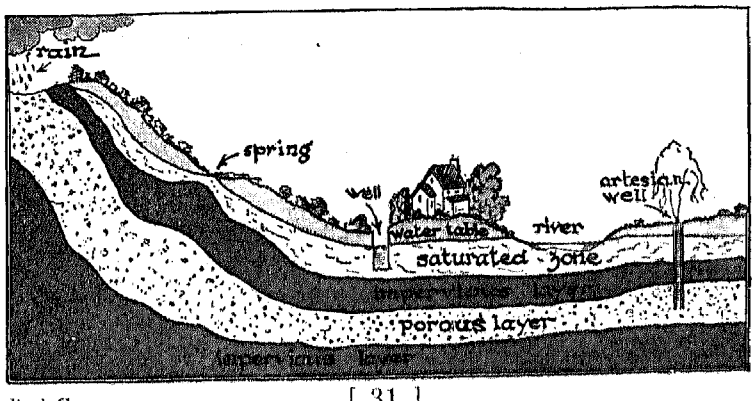
Examine each diagram carefully. Fill in the missing words in the corresponding numbered spaces to the right.



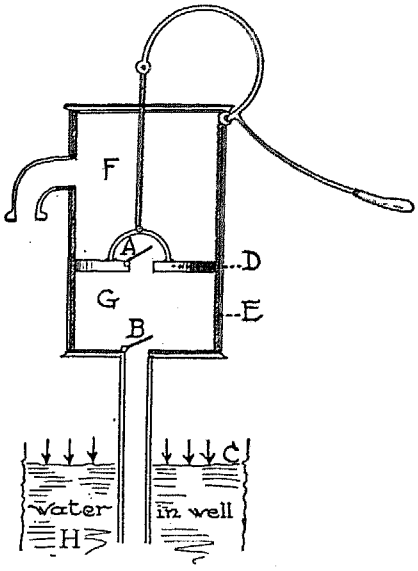
In the flask is placed water, red ink, and about 3 teaspoonfuls of sugar. The flask is heated to boiling and the steam is passed off through a long tube into a test tube or beaker which should be placed in a dish of cold water. Drops of water will (1) ____ in the test tube and will show no signs of (2) ____ or (3) _____. The water obtained is (4) ____ and has been obtained by a process called (5) _____.

Water gets into the ground from the (6) ____ and slowly passes through (7) ____ soil until it comes to an (8) ____ layer through which it cannot pass. As it flows down hill under this layer it gains pressure. A (9) ____ spring or (10) ____ well is accounted for in this way.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )



This is a diagram to show the action of a (11) ____ pump. In the diagram the cylinder is indicated by



letter (12) ____ and the piston by letter (13) _____. Valve (14) ____ is always closed when D is moving upward, and valve (15) ____ is always closed when D moves downward. As D moves upward on its first stroke, a partial vacuum is produced at (16) _____. The (17) ____ pressure on the water at (18) ____ will then force that water up through valve (19) _____. As D is lowered, valve (20) ____ closes, and the water in space (21) ____ is forced up through valve (22) _____. Upon the next upward stroke of D the water above it is (23) ____ while the space below is filled with more water from (24) ____ by means of the (25) ____ pressure at (26) _____.

Answers	Score
11. ----------	( )
12. ----------	( )
13. ----------	( )
14. ----------	( )
15. ----------	( )
16. ----------	( )
17. ----------	( )
18. ----------	( )
19. ----------	( )
20. ----------	( )
21. ----------	( )
22. ----------	( )
23. ----------	( )
24. ----------	( )
25. ----------	( )
26. ----------	( )

NAME CLASS DATE RATING

UNIT V SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. In a lift pump, the lower valve cannot be more than 33 feet above the level of the water because:
   (*a*) of the amount of minerals dissolved in deep well water. *a.* _____ ( )
   (*b*) the weight of the air is insufficient to balance a higher column of water. *b.* _____ ( )
   (*c*) the pump would have to make a perfect vacuum before water would be raised that high. *c.* _____ ( )
   (*d*) nature does not abhor a vacuum above 33 feet. *d.* _____ ( )
   (*e*) the pressure of the air at sea level is about 15 pounds per square inch and the pressure of a column of water 33 feet high is 15 pounds per square inch also. *e.* _____ ( )

2. When river or lake water is used for a city water supply it should be both filtered and chlorinated because:
   (*a*) chlorination alone will not remove the sediment. *a.* _____ ( )
   (*b*) filtration alone will not remove all harmful bacteria. *b.* _____ ( )
   (*c*) the use of both methods will remove all dissolved minerals. *c.* _____ ( )
   (*d*) soft water makes a better lather than hard water. *d.* _____ ( )
   (*e*) the use of both methods will keep the water from evaporating for a greater length of time. *e.* _____ ( )

3. Water from artesian wells is seldom used for a large city water supply because:
   (*a*) the water so often contains harmful bacteria. *a.* _____ ( )
   (*b*) the water contains so much sediment. *b.* _____ ( )
   (*c*) the water generally contains dissolved minerals. *c.* _____ ( )
   (*d*) the supply of water from wells would be sufficient. *d.* _____ ( )
   (*e*) the water is generally very hard. *e.* _____ ( )

Answers Score

4. Distillation might be used to make ocean water fit to drink because:

(a) the boiling would kill any harmful bacteria that might be present. a. _____ ( )

(b) the dissolved salt will not vaporize at the temperature of boiling water. b. _____ ( )

(c) the heat destroys the salt and minerals in the water. c. _____ ( )

(d) only the water evaporates and is condensed again in a separate vessel. d. _____ ( )

(e) the process is the same as nature uses in the water cycle. e. _____ ( )

5. It is the obligation of every good citizen to be careful in drinking water about which he knows nothing because:

(a) he might contract a disease which would start an epidemic in his community. a. _____ ( )

(b) he might be in severe pain for a few hours. b. _____ ( )

(c) he might be unable to eat his regular meals for a few days. c. _____ ( )

(d) he might cause his parents much inconvenience, expense, and loss of valuable time. d. _____ ( )

(e) he might cause considerable community expense trying to find the cause of his illness. e. _____ ( )

6. The cycle of water in nature occurs because:

(a) heat causes water from bodies of water to evaporate into the air. a. _____ ( )

(b) air currents carry the water vapor up to great heights. b. _____ ( )

(c) water vapor will condense when sufficiently cooled. c. _____ ( )

(d) the salt in the ocean does not evaporate with the water. d. _____ ( )

(e) gravity pulls the drops of condensed water vapor to the earth's surface. e. _____ ( )

Results of Test VI

(Our Clothing)

Table VIII shows the per cent made by each pupil in Test VI. Figure 6 shows the ranking of each pair of pupils in Test VI with each other and with the other pairs. It also shows the medians in each class.

The highest per cent, eighty-six, was made by a pupil in the lecture class, while the highest score made in the experimental class was seventy-six. The lowest per cent, fifty, was also made in the lecture class. The low per cent in the experimental class was fifty-two.

The per cents of ten pupils in the lecture class exceeded the per cents of ten pupils in the experimental class with whom they were paired, and the other ten pupils in the experimental class exceeded the other ten in the lecture class with whom they were paired.

In pair nine the pupil in the lecture class exceeded the pupil in the experimental class by eleven per cent, and in pair eighteen the pupil in the lecture class exceeded the pupil in the experimental class by eight per cent.

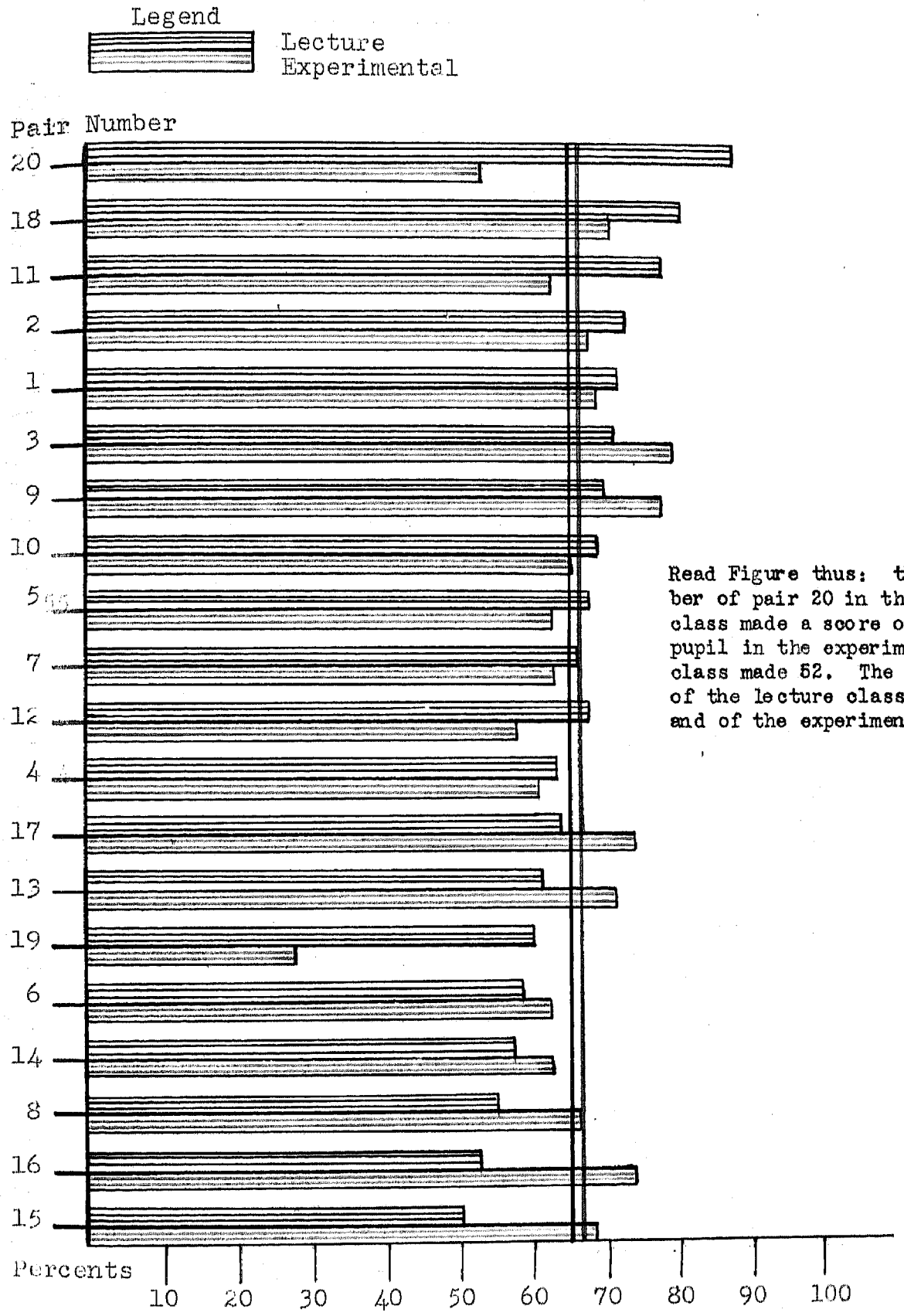
In this test the medians of the two classes were nearly the same, the difference being only one per cent. Since this is not a significant difference, the results of the test would indicate there is little difference in the methods of teaching. As far as this study can show this unit may be taught by either method with practically the same results.

TABLE VIII

SCORES MADE BY PUPILS IN TEST VI
(OUR CLOTHING)

	LECTURE		EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	71.25	T.F.	68.75
2	E.N.	72.50	D.M.	66.66
3	K.B.	70.00	A.E.	76.25
4	S.N.	63.75	V.H.	61.25
5	R.G.	67.50	R.W.	62.50
6	B.S.	58.75	A.W.	62.50
7	D.S.	65.00	M.B.	62.50
8	N.H.	55.00	E.S.	66.25
9	B.W.	70.00	M.W.	76.25
10	W.O.	68.75	D.S.	65.00
11	C.S.	77.50	D.C.	61.25
12	B.S.	65.00	D.D.	57.50
13	B.H.	61.25	D.V.	72.50
14	I.P.	56.22	E.S.	62.50
15	D.C.	50.00	R.W.	68.75
16	F.K.	53.95	F.K.	73.75
17	K.S.	63.50	R.T.	73.75
18	W.H.	78.75	J.S.	70.00
19	H.K.	60.00	G.K.	28.75
20	R.C.	86.25	J.W.	52.50
	Median	65.00		66.04
	Mean	65.74		64.40
	Range	50-86		52-76
	Q.D.	5.63		5.31

Read Table thus: In Pair 1, pupil "M.T." made a score of 71.25%; pupil "T.F.," the other member of the pair, made 68.75%. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 20 in the lecture class made a score of 86, the pupil in the experimental class made 52. The median of the lecture class was 65, and of the experimental, 66.4.

Figure 6

Ranking of Pupils in Test VI (Our Clothing)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

OUR CLOTHING: ITS SOURCES AND CARE

UNIT VI SET X TEST I

DIRECTIONS. Indicate which of the following statements are *true* or *false* by *marking out* the reply you do *not* want. T equals True. F equals False.

	Answers		Score
1. Our clothing comes from plants and animals.	1. T	F	( )
2. Wool fiber appears scaly under the microscope.	2. T	F	( )
3. Cotton fibers appear to be smooth under the microscope.	3. T	F	( )
4. Felt is formed from cotton fibers.	4. T	F	( )
5. Rayon and silk both are formed by the silkworm.	5. T	F	( )
6. The skins of young sheep and goats are used for making gloves.	6. T	F	( )
7. Rubber is the bark of a tree.	7. T	F	( )
8. Sweating is a means of cooling the body.	8. T	F	( )
9. Eating ice cream when one is hot cools the skin.	9. T	F	( )
10. The body loses heat by conduction, convection, and radiation.	10. T	F	( )
11. Dark clothes are warmer than light ones because they absorb the sun's rays instead of reflecting them.	11. T	F	( )
12. Soft water can dissolve grease.	12. T	F	( )
13. Water containing calcium carbonate cannot be softened.	13. T	F	( )
14. Hard water comes from sandy soil.	14. T	F	( )
15. Ammonia will often remove acid stains.	15. T	F	( )
16. Use alcohol to remove blood stains.	16. T	F	( )
17. Bleaching is a chemical action.	17. T	F	( )
18. A direct dye can be held in a cloth without the use of chemicals.	18. T	F	( )
19. Dry cleaning is best performed at home with gasoline.	19. T	F	( )
20. Bleaching powder should never be used on silk.	20. T	F	( )

NAME CLASS DATE RATING

UNIT VI SET X TEST II

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

A. Hydrogen peroxide
B. Poor conductors
C. Celluloid
D. Mordant
E. Permanently
F. Solvent
G. Coal tar
H. Evaporation
I. Bleaching
J. Rayon
K. Gin
L. Rabbit
M. Carbon tetrachloride
N. Cambric
O. Hemp
P. Perspiration
Q. Temporarily
R. Cell
S. Good convectors
T. Bleaching powders
U. Congo red
V. Cellulose
W. Good conductors
X. Ermine
Y. Fox

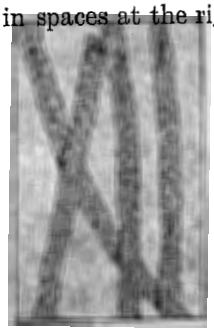
	Answers	Score
1. A compound very useful in removing oil from fabrics.	1. _____	( )
2. A kind of plant fiber used in making rope.	2. _____	( )
3. The kind of hard water which may be softened by boiling.	3. _____	( )
4. The machine used for removing cotton seeds from cotton fibers.	4. _____	( )
5. A kind of fur commonly used in making felt for hats.	5. _____	( )
6. The substance from which most artificial dyes are obtained.	6. _____	( )
7. What the woody substance in plants is called.	7. _____	( )
8. The name given to artificial silk.	8. _____	( )
9. The process by which the skin of the human body is cooled.	9. _____	( )
10. The process by which light-colored fabrics may be made pure white.	10. _____	( )
11. A substance which will combine with the dyestuff to produce a fixed color.	11. _____	( )
12. A liquid which will dissolve other elements or compounds.	12. _____	( )
13. The kind of clothes through which heat does not easily pass.	13. _____	( )
14. A compound which may be used in bleaching wool or silk.	14. _____	( )
15. A kind of cloth made from cotton.	15. _____	( )

NAME CLASS DATE RATING

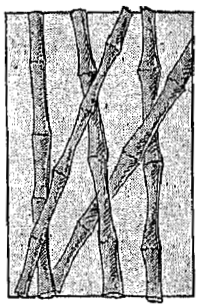
UNIT VI SET X TEST III

DIRECTIONS. Study each diagram carefully before filling out the blanks at the right.

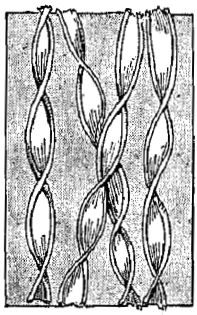
The diagrams represent the appearance of certain fibers under the compound microscope. Fill in spaces at the right the words that belong to the numbers.



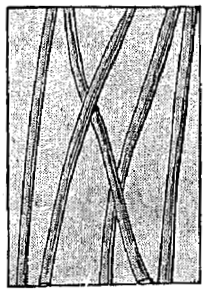
1



2

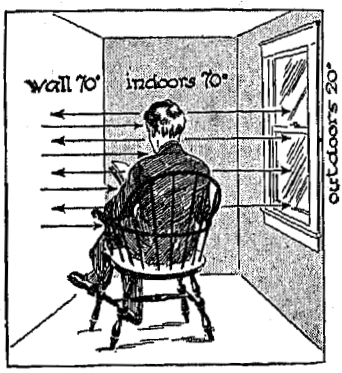


3



4

Study the diagram and fill out the numbered blanks in the corresponding numbered spaces at the right.



The side toward the window will be (5) ____ because of greater (6) ____ by (7) ____ of heat on that side. Actual radiation may be the same from (8) ____ sides of the body but the wall returns more (9) ____ by (10) ____ than does the window.

Solve the following problem by placing the appropriate words in the numbered spaces at the right.

You wish to make soap. For this purpose you must have (11) ____ and (12) _____. Heat the (13) ____ from the solution of (14) ____ in it, add hot water from time to time. If now common (15) ____ is added, the soap will separate and come to the surface.

	Answers	Score
1.		( )
2.		( )
3.		( )
4.		( )
5.		( )
6.		( )
7.		( )
8.		( )
9.		( )
10.		( )
11.		( )
12.		( )
13.		( )
14.		( )
15.		( )

NAME CLASS DATE RATING

UNIT VI SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. Fabrics made from pure silk:
   (*a*) may be identified by holding a piece of moist, red litmus paper in the smoke given off by a burning sample. *a.* _____ ( )
   (*b*) should never be bleached by the use of chlorine. *b.* _____ ( )
   (*c*) may be dissolved in a solution of sulphur dioxide. *c.* _____ ( )
   (*d*) contain a large percentage of cellulose. *d.* _____ ( )
   (*e*) give the odor of burning feathers when burned. *e.* _____ ( )

2. Wool bathing suits are considered more hygienic than those of other materials because:
   (*a*) wool is a poorer conductor of heat than most other fabrics. *a.* _____ ( )
   (*b*) woolen fibers are stronger than fibers of other fabrics. *b.* _____ ( )
   (*c*) the best kind of bathing suits on the market are made of wool. *c.* _____ ( )
   (*d*) wool does not lose its absorbed moisture by evaporation as rapidly as most other materials. *d.* _____ ( )
   (*e*) wool absorbs moisture more rapidly than other fibers. *e.* _____ ( )

3. Carbon tetrachloride can be used satisfactorily to:
   (*a*) remove ink spots from a white linen handkerchief. *a.* _____ ( )
   (*b*) remove iron rust stain from a white silk dress. *b.* _____ ( )
   (*c*) remove an olive oil spot from a dark woolen dress. *c.* _____ ( )
   (*d*) remove a syrup spot from a blue serge coat. *d.* _____ ( )
   (*e*) remove a butter spot from a silk tie. *e.* _____ ( )

4. Soap:
   (*a*) might be made from cottonseed oil and lye. *a.* _____ (
   (*b*) in its finished state always contains some free fat and free lye. *b.* _____ (
   (*c*) which is to be used for washing silks and woolens should be made from an acid rather than a lye. *c.* _____ (
   (*d*) can be used to prevent particles of oil from rising to the surface of the water in which it is mixed. *d.* _____ (
   (*e*) is an emulsion of fat and lye. *e.* _____ (

5. Rayon fibers:
   (*a*) would be as good as silk fibers for making a strong fishing line. *a.* _____ (
   (*b*) would be better than silk fibers for making underwear for use in a hot climate. *b.* _____ (
   (*c*) will absorb water more quickly than silk fibers. *c.* _____ (
   (*d*) will hold as much water as silk fibers. *d.* _____ (
   (*e*) might be manufactured from wheat straw. *e.* _____ (

6. Fabrics made from cotton:
   (*a*) are of animal origin. *a.* _____ (
   (*b*) give the odor of burning feathers when burned. *b.* _____ (
   (*c*) are composed of cellulose. *c.* _____ (
   (*d*) will dissolve in a 5% sodium hydroxide solution. *d.* _____ (
   (*e*) absorb perspiration more rapidly than wool fabrics. *e.* _____ (

NAME CLASS DATE RATING

UNIT VI SET X TEST V

DIRECTIONS. After considering the facts given below, mark all conclusions which might be satisfactory with *yes* and all which would be unsatisfactory with *no*.

A. A farmer has several gallons of blue and yellow paint.
B. He wishes to paint his house white.
C. He does not have the money to purchase new paint.
D. He noticed that his wife used bluing in washing clothes to make yellow clothes a pure white color.
E. He read in a paper that blue and yellow are complementary colors.
F. He looked in an encyclopedia and found that complementary colors are any two colors which when added together give white light.

	Answers	Score
1. Paint his house blue with the intentions of covering it with a coat of yellow paint so that the final result would be white.	1. -------	( )
2. Mix together his blue and yellow paint to get white paint.	2. -------	( )
3. Ask his neighbor what he would do and act upon his advice.	3. -------	( )
4. Refer to his encyclopedia to find whether mixing paints give the same results as mixing lights.	4. -------	( )
5. Experiment with the mixing of blue and yellow lights.	5. -------	( )
6. Experiment by mixing a small sample of the two kinds of paint to see whether it would be white.	6. -------	( )
7. Try mixing a small sample of his little girl's blue and yellow water colors to see if it would produce white.	7. -------	( )

DIRECTIONS. Indicate which of the following conclusions might be reached from the data. One and only one of the three is correct. If A is correct, indicate by showing the test to be used. If either B or C is correct, indicate by a ×.

A merchant wishes to tell whether a piece of cloth is pure wool or if it contains some cotton. He knows the following facts:

1. Wool burns with the odor of burning feathers.
2. Cotton burns with the odor of burning rags.
3. Wool will dissolve in a lye solution.
4. Cotton does not dissolve in a solution of lye.
5. Cotton will absorb moisture more quickly than wool.
6. The smoke from burning wool will turn red litmus paper blue.
7. The smoke from burning cotton will turn blue litmus paper red.
8. A microscope is not available.

	Answers	Score
A. The data above is sufficient. Write in space at the right the *number* or *numbers* of the data given that the merchant would use.	A. -------	( )
B. There is a test which might be used, but the above data is not sufficient.	B. -------	( )
C. It is impossible to distinguish cotton from wool when they are woven into the same cloth.	C. -------	( )

Results of Test VII

(Light)

Table IX shows the per cent made by each pupil in Test VII, while Figure 7 shows the ranking of each pair of pupils with each other and with the other pairs. It also shows the medians of each class.

The highest per cent was eighty-four, and it was made by a pupil in the lecture class. The highest score in the experimental class was seventy-four, ten per cent less than the high per cent in the lecture class. The lowest per cent, forty-two, was made in the experimental class; the lowest score in the lecture class was fifty per cent.

The per cents of thirteen pupils in the lecture class exceeded the per cents of the thirteen pupils with whom they were paired in the experimental class. For one pair the per cents were the same, and six pupils of the experimental class exceeded the six with whom they were paired in the lecture class.

In pair number nine (identical twins) the pupils made the same per cent on the test, while in pair eighteen the pupil in the experimental class exceeded the pupil in the lecture class fourteen per cent.

The median of the lecture class exceeded the median of the experimental class by six per cent. This difference is not a significant difference, but is likely to be a little more than chance.

The reading material in this unit included many new terms, and these terms were included in the test. In considering the two methods of teaching it is possible that material of this nature would be given more attention in a lecture class.

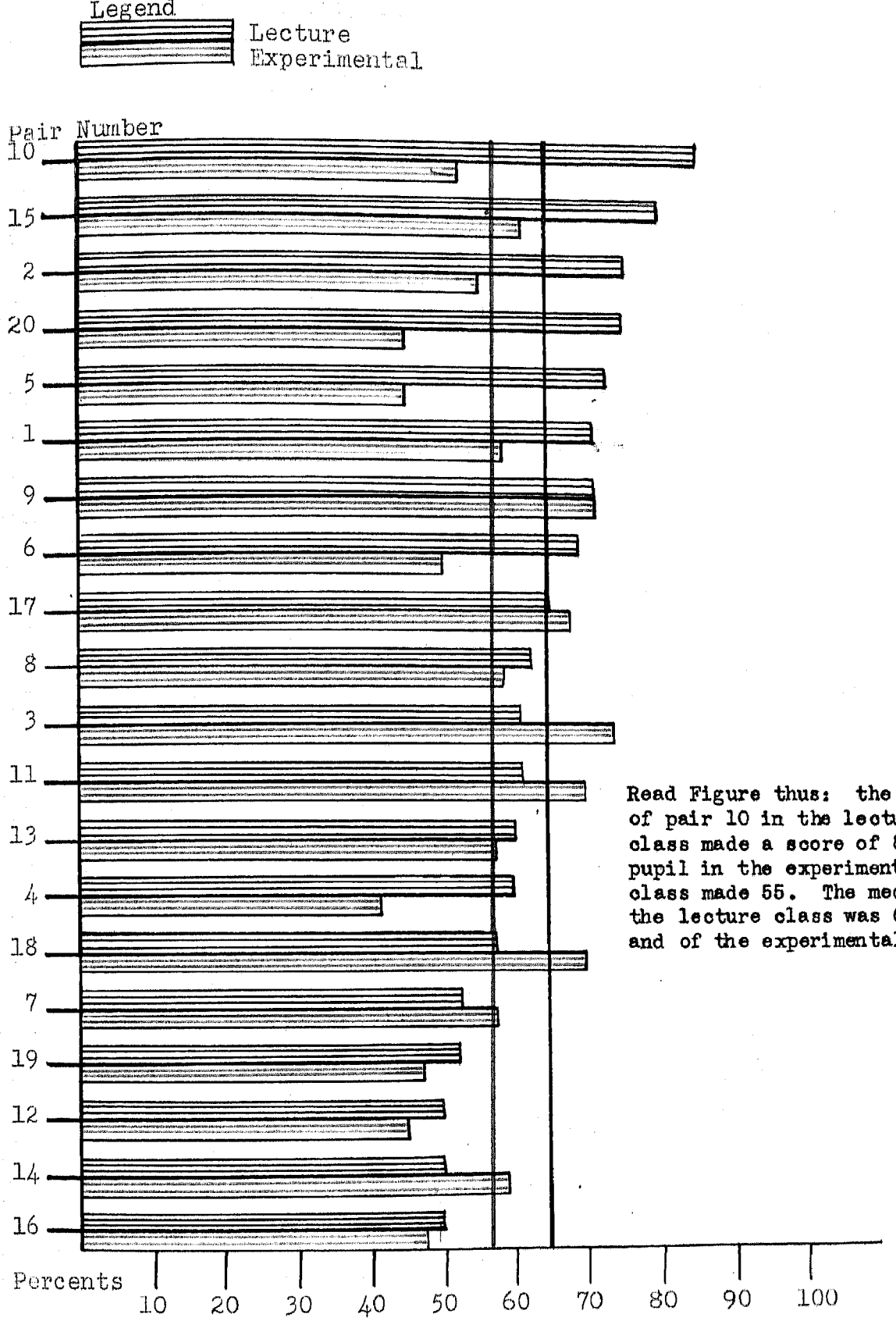
Experiments that were peformed by the experimental class were well illustrated and explained in the text. The results of this study would indicate that the experimental class had failed to spend enough time on textbook material in their study of this unit.

TABLE IX

SCORES MADE BY PUPILS IN TEST VII
(LIGHT)

	LECTURE		EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	71.43	T.F.	58.57
2	E.N.	74.28	D.M.	54.29
3	K.B.	61.43	A.E.	74.28
4	S.N.	60.00	V.H.	42.86
5	R.G.	72.86	R.W.	45.71
6	B.S.	68.59	A.W.	50.00
7	D.S.	53.53	M.B.	57.14
8	N.H.	62.86	E.S.	58.57
9	B.W.	71.43	M.W.	71.43
10	W.O.	84.29	D.S.	55.71
11	C.S.	61.54	D.C.	70.00
12	B.S.	50.00	D.D.	45.71
13	B.H.	60.00	D.V.	58.57
14	I.P.	50.00	E.S.	54.29
15	D.C.	78.57	R.W.	61.43
16	F.K.	50.00	F.K.	47.14
17	K.S.	64.29	R.T.	67.14
18	W.H.	57.11	J.S.	71.43
19	H.K.	52.89	G.K.	48.65
20	R.C.	74.29	J.W.	45.71
	Median	62.01		56.04
	Mean	63.45		56.93
	Range	50-84		42-74
	Q.D.	8.46		8.16

Read table thus: In Pair 1, pupil "M.T." made a score of 71.43%; pupil "T.F." the other member of the pair made 58.57%. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 10 in the lecture class made a score of 84, the pupil in the experimental class made 55. The median of the lecture class was 62.1, and of the experimental, 56.4.

Figure 7

Ranking of Pupils in Test VII (Light)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

LIGHT

UNIT VII SET X TEST I

DIRECTIONS. In the test below you will find a list of words above a list of statements. You must pick out from the list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentences.

A. Opaque	I. Red	Q. 186,000 miles per hour	X. Unreal
B. Illumination	J. Incandescent	R. Candle power	Y. Near sightedness
C. 186,000 miles per second	K. Radiate	S. Transparent	Z. Huyghens
D. Ultra-violet rays	L. Tungsten	T. Reflection	AA. Thorium
E. Foot candle	M. Real	U. Violet	BB. Infra-red rays
F. Translucent	N. Astigmatism	V. Blue	CC. 186,000 feet per minute
G. Black	O. Newton	W. Platinum	DD. Far sightedness
H. Refraction	P. Lens		

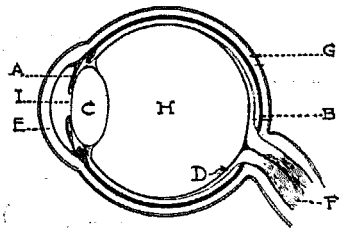
	Answers	Score
1. An object such as glass which transmits practically all light.	1. _____	( )
2. The color given by the longest light wave which affects our sight.	2. _____	( )
3. A mineral commonly used for making electric light filaments.	3. _____	( )
4. A defect of the eye caused by an eyeball which is too long.	4. _____	( )
5. To give off in rays.	5. _____	( )
6. The kind of image which cannot be received by a screen.	6. _____	( )
7. White hot or glowing with heat.	7. _____	( )
8. The bending of a beam of light.	8. _____	( )
9. The great English scientist who first believed light consisted of small particles given off at great speed.	9. _____	( )
10. The speed of light in air.	10. _____	( )
11. A substance through which no light passes.	11. _____	( )
12. The color of objects which absorb the most sunlight.	12. _____	( )
13. The unit used in measuring the intensity of light at a certain point.	13. _____	( )
14. The part of a camera which causes the image to focus.	14. _____	( )
15. The part of the sunlight which causes sunburn.	15. _____	( )

NAME CLASS DATE RATING

UNIT VII SET X TEST II

DIRECTIONS. Study the diagrams carefully, then fill in the blank spaces at the right.

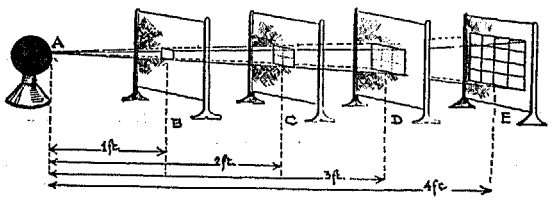
Name the parts of the eye by putting the letter opposite the name.



	Answers	Score
1. Optic nerve	1. _____	( )
2. Retina	2. _____	( )
3. Fluid	3. _____	( )
4. Iris	4. _____	( )
5. Lens	5. _____	( )
6. Sclerotic	6. _____	( )
7. Pupil	7. _____	( )
8. Choroid	8. _____	( )
9. Cornea	9. _____	( )

If a 144-candle power lamp is placed at A, the illumination at B will be (10) ____ foot-candles, at C, (11) ____ foot-candles, at D, (12) ____ foot-candles, and at E, (13) ____ foot-candles.

	10. _____	( )
	11. _____	( )
	12. _____	( )
	13. _____	( )



NAME CLASS DATE RATING

UNIT VII SET X TEST III

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers **Score**

1. In making an electric lamp:
   (*a*) all oxygen is removed from the bulb to prevent oxidation of the filament. *a.* _____ ( )
   (*b*) frosted glass is used because it transmits diffused light. *b.* _____ ( )
   (*c*) a material must be chosen for the filament which offers no resistance or opposition to the flow of electricity. *c.* _____ ( )
   (*d*) tungsten is often used for the filament because it can be raised to a very high temperature without melting or breaking. *d.* _____ ( )
   (*e*) the bulb is often filled with nitrogen because it aids the filament in burning. *e.* _____ ( )

2. A blue serge suit:
   (*a*) gets its color from the light waves which it reflects. *a.* _____ ( )
   (*b*) reflects only the blue rays from the light. *b.* _____ ( )
   (*c*) will look black in artificial light which contains only blue light waves. *c.* _____ ( )
   (*d*) absorbs all of the blue rays from the sun's light. *d.* _____ ( )
   (*e*) will look black in artificial light which contains all of the colors of the solar spectrum. *e.* _____ ( )

3. Light which reaches:
   (*a*) our eyes from a fish under water has been refracted. *a.* _____ ( )
   (*b*) the film of a camera in taking a picture has been refracted. *b.* _____ ( )
   (*c*) our eyes from a piece of coal has been absorbed. *c.* _____ ( )
   (*d*) the earth from the sun on a cloudy day is diffused. *d.* _____ ( )
   (*e*) our eyes from a piece of black cloth has been reflected. *e.* _____ ( )

Answers Score

4. Reflected light:

(a) travels about 186,000 miles per second in air. a. _____ ( )

(b) enables us to see a piano in a lighted room. b. _____ ( )

(c) enables us to see the pictures in a book. c. _____ ( )

(d) explains the images which can be seen in the surface of a quiet lake. d. _____ ( )

(e) enables us to see a burning match in an otherwise dark room. e. _____ ( )

5. Modern homes commonly use a diffused method of electric lighting because:

(a) it is the most economical method. a. _____ ( )

(b) there is little glare from this system of lighting. b. _____ ( )

(c) opal or frosted glass shades are more attractive than other kinds. c. _____ ( )

(d) less electrical energy will be used for the same amount of light at any one place in the room. d. _____ ( )

(e) diffused light prevents astigmatism. e. _____ ( )

6. In order to take pictures with a camera:

(a) the light must pass through a concave lens. a. _____ ( )

(b) the film must be covered with a chemical which will make a chemical change when light strikes it. b. _____ ( )

(c) an unreal image must be formed on the film. c. _____ ( )

(d) light must be striking the object to be photographed. d. _____ ( )

(e) the shutter must always be left open more than $\frac{1}{16}$ of a second. e. _____ ( )

NAME CLASS DATE RATING

UNIT VII SET X TEST IV

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You are to pick out from the list at the right a particular phrase which matches a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Sc
1. Huyghens believed that man received the sensation of light because	A. they are poorer conductors.		
2. It is often possible to see images in the surface of a lake because	B. ether vibrations started by luminous bodies reach the eye.	1. _____ (	
3. A blue serge suit appears black in ordinary artificial light because	C. the film can only be affected by an unreal image.	2. _____ (	
4. A tungsten light is more efficient than a carbon light because	D. of regular reflections.	3. _____ (	
5. A convex lens is always used in a camera because	E. it may be heated to a higher temperature.	4. _____ (	
6. Black clothes are warmer in bright sunlight than white clothes because	F. a blue color changes to black at night.	5. _____ (	
	G. they transform more light into heat.	6. _____ (	
	H. it is necessary that a real image be formed.		
	I. its light is better diffused.		
	J. of the unthinkable speed of light.		
	K. light is refracted when it passes through water.		
	L. it receives no blue light from such a source.		

NAME CLASS DATE RATING

UNIT VII SET X TEST V

DIRECTIONS. Read the problem over carefully, then in the blank spaces at the right fill in the words which complete the sentences below.

Three men, Mr. A, Mr. B, and Mr. C, are planning the illumination of their new homes. Mr. A uses indirect lighting, and puts in bulbs of a candle power which seem to him to make his home well lighted in all parts of the various rooms. Mr. B uses lamp shades which give diffused lighting. He fills all of the sockets with 150 candle power lamps because that was the kind of lamp which a lamp expert recommended to a neighbor when he had planned the illumination of his home. Mr. C uses direct lighting. He uses frosted bulbs. By means of a foot candle meter he chose bulbs of a candle power which gave the proper supply of light at the various places where light was used.

Mr. (1) ____ used the most scientific procedure in planning the illumination of his home. The bad effects of (2) ____ which often come from direct lighting were offset in Mr. C's home by the use of frosted bulbs. The least economical method of lighting was used by Mr. (3) _____. In illuminating a home it is more important to have the proper amount of light at the place where it is (4) ____ than at the (5) _____. All factors considered, it is probable that the home of Mr. (6) ____ is the most properly illuminated.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )

Results of Test VIII

(Personal Health and Our Environment)

In Table X the per cent made by each pupil is shown for Test VIII. Figure 8 shows the ranking of each pair of pupils in Test VIII with each other and with the other pairs. It also shows the medians of each class in the test.

In this test the highest per cent was ninety-six, which was made by a pupil in the lecture class. The highest score in the experimental class was ninety-two. The lowest score was also made in the lecture class; it was fifty-seven, while the lowest in the experimental was sixty.

The per cents of eleven pupils in the experimental class exceeded the per cents of the eleven pupils with whom they were paired in the experimental class, and in the other nine pairs the per cents of the pupils in the lecture class were higher than those with whom they were paired in the experimental class.

In pair number nine the pupil in the experimental class exceeded the other by a margin of five per cent; and in pair number eighteen a margin of twenty-seven per cent separated the two, in favor of the experimental class.

In this unit the lecture class exceeded the experimental class by three per cent. This difference is slight and not significant. The type of material that was covered in this unit is not of an experimental nature; there were few experiments to be worked by actual experimentation. The experimental class had more time to spend on textbook material and were doing nearly the same kind of work as the lecture group on this unit.

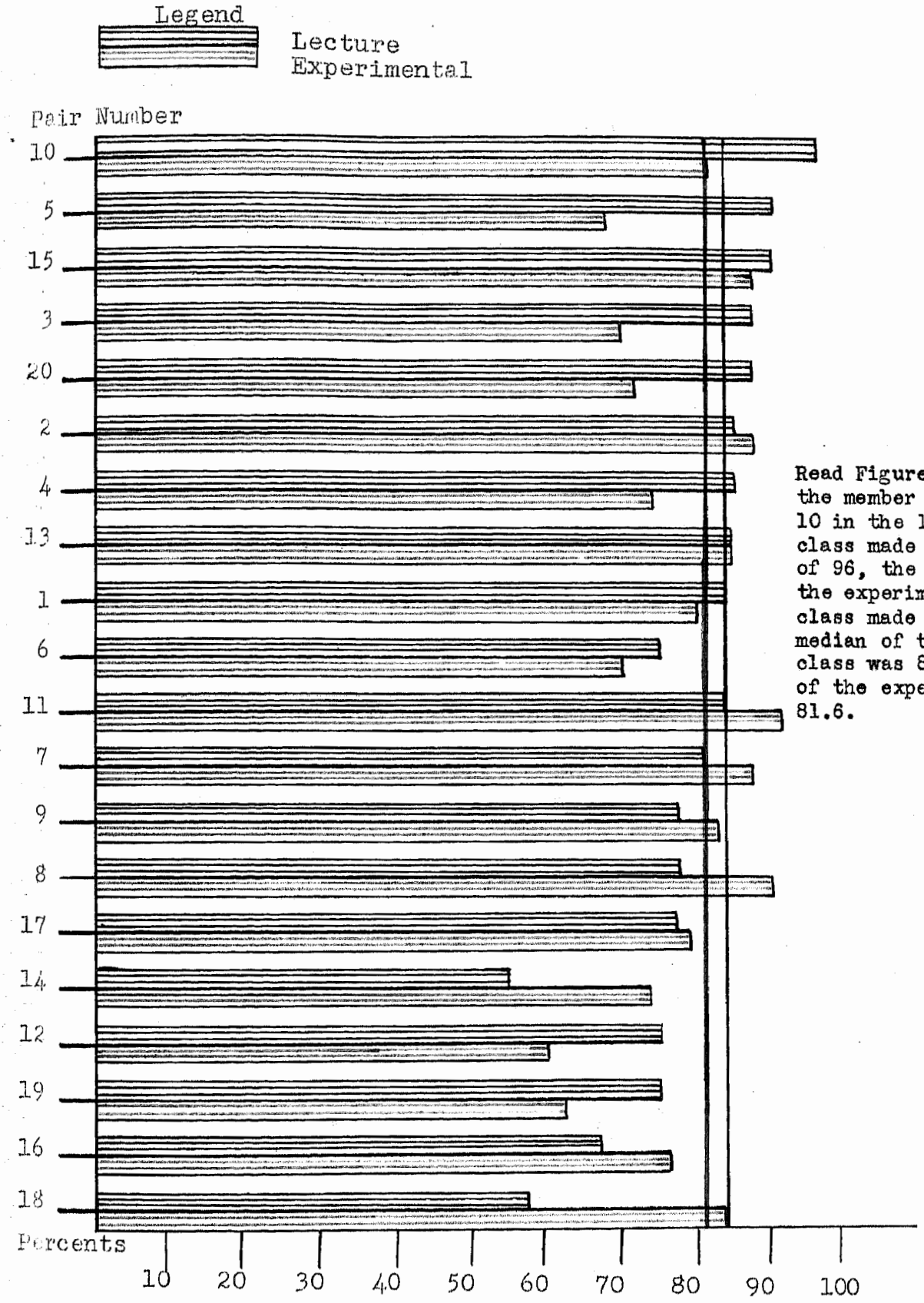
In considering the nature of the material in this unit one would expect nearly the same results from both groups.

TABLE X

SCORES MADE BY PUPILS IN TEST VIII
(PERSONAL HEALTH AND OUR ENVIRONMENT)

LECTURE			EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	84.04	T.F.	81.03
2	E.N.	86.38	D.M.	87.59
3	K.B.	87.93	A.E.	70.60
4	S.N.	86.20	V.H.	74.14
5	R.G.	89.66	R.W.	68.86
6	B.S.	84.48	A.W.	68.97
7	D.S.	82.76	M.B.	87.96
8	W.H.	77.41	E.S.	89.66
9	B.W.	79.31	M.W.	84.48
10	W.O.	96.55	D.S.	82.21
11	C.S.	84.52	D.C.	92.10
12	B.S.	75.80	D.D.	60.71
13	B.H.	86.20	D.V.	86.33
14	I.P.	76.90	E.S.	82.21
15	D.C.	89.65	R.W.	87.93
16	F.K.	67.24	F.K.	76.20
17	K.S.	77.59	R.T.	79.22
18	W.H.	57.11	J.S.	64.48
19	H.K.	74.45	G.K.	63.78
20	R.C.	87.93	J.W.	72.41
	Median	84.04		81.06
	Mean	81.57		79.94
	Range	57-96		60-92
	Q.D.	4.96		7.07

Read table thus: In Pair 1, pupil "M.T." made a score of 84.04%; pupil "T.F." the other member of the pair made 81.03. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 10 in the lecture class made a score of 96, the pupil in the experimental class made 82. The median of the lecture class was 84.4, and of the experimental, 81.6.

Figure 8

Ranking of Pupils in Test VIII (Personal Health and Our Environment)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

PERSONAL HEALTH AND OUR ENVIRONMENT

UNIT VIII SET X TEST I

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

A. Petri dishes
B. Headache
C. Hygeia
D. Saccharin
E. Cottonseed oil
F. Glucose
G. Chloroform
H. Alcohol
I. Iodine
J. Strychnine
K. Apoplexy
L. Appendicitis
M. Chicory
N. Adulterant
O. Cancer
P. Palmolive soap
Q. Kaffee Hag
R. Fly traps

	Answers	Score
1. Traps in which we collect and study bacteria.	1. _____	( )
2. The basis of many patent medicines used as home remedies.	2. _____	( )
3. A drug which may be used in patent medicine, and yet need not be disclosed on the label under the present law.	3. _____	( )
4. A disease sometimes resulting from excessive use of alcohol.	4. _____	( )
5. A chemical into which saccharin will dissolve and sugar will not.	5. _____	( )
6. A disease which has never been cured by the use of drugs.	6. _____	( )
7. An adulterant or substitute sometimes used for olive oil.	7. _____	( )
8. An adulterant commonly used in coffee.	8. _____	( )
9. An impurity put into foods or other materials to reduce the cost of manufacture.	9. _____	( )

NAME CLASS DATE RATING

UNIT VIII SET X TEST II

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. Habits which would increase one's health, efficiency, and happiness are:
   (*a*) To discuss the unpleasant happenings of the day at the evening meal. *a.* ------- ( )
   (*b*) To take a 15-minute rest before and after each meal. *b.* ------- ( )
   (*c*) To take a four-mile hike each evening just before dinner. *c.* ------- ( )
   (*d*) To eat large quantities of meat and eggs every day. *d.* ------- ( )
   (*e*) To have a regular time each day for bowel movement. *e.* ------- ( )

2. A city should tax her citizens to raise money:
   (*a*) for public parks. *a.* ------- ( )
   (*b*) for the inspection of all refrigerators used in the private homes of the city. *b.* ------- ( )
   (*c*) for the disposal of ashes and garbage. *c.* ------- ( )
   (*d*) for the inspection of all grocery stores. *d.* ------- ( )
   (*e*) for furnishing each child with playground equipment at his home. *e.* ------- ( )

3. Tobacco:
   (*a*) contains a deadly poison called nicotine. *a.* ------- ( )
   (*b*) has an opiate effect. *b.* ------- ( )
   (*c*) used in cigarettes has been proved to be a benefit to college students. *c.* ------- ( )
   (*d*) smoking easily becomes a habit which is difficult to break. *d.* ------- ( )
   (*e*) has been proved to contain a narcotic drug. *e.* ------- ( )

Answers Score

4. Some patent medicines advertised in magazines and sold in drug stores:
   (*a*) may legally contain as much as $\frac{1}{8}$ alcohol. *a.* _____ ( )
   (*b*) may legally contain the poison, arsenic, without disclosing it on the label. *b.* _____ ( )
   (*c*) claim to be a cure for any and every kind of disease. *c.* _____ ( )
   (*d*) might cause those habitually using them to become drug addicts. *d.* _____ ( )
   (*e*) contain nothing of any medicinal value. *e.* _____ ( )

5. Lasting habits of clean, straight, unselfish thinking:
   (*a*) provide the best insurance for a happy, useful life. *a.* _____ ( )
   (*b*) may be developed by having plenty of work and play of a worthwhile nature to occupy all of our time. *b.* _____ ( )
   (*c*) are necessary factors in the making of a good citizen. *c.* _____ ( )
   (*d*) are formed by never allowing ourselves to think any but clean, straight, unselfish thoughts. *d.* _____ ( )
   (*e*) will prevent us from entering certain types of work. *e.* _____ ( )

6. Individual paper towels are used in our public schools:
   (*a*) because they cost less than roller towels. *a.* _____ ( )
   (*b*) because they do not have to be laundered. *b.* _____ ( )
   (*c*) to prevent the transfer of germs from one individual to another. *c.* _____ ( )
   (*d*) to destroy the germs which may be on the hands of those using the towels. *d.* _____ ( )
   (*e*) because they dry the hands better than other kinds of towels. *e.* _____ ( )

NAME CLASS DATE RATING

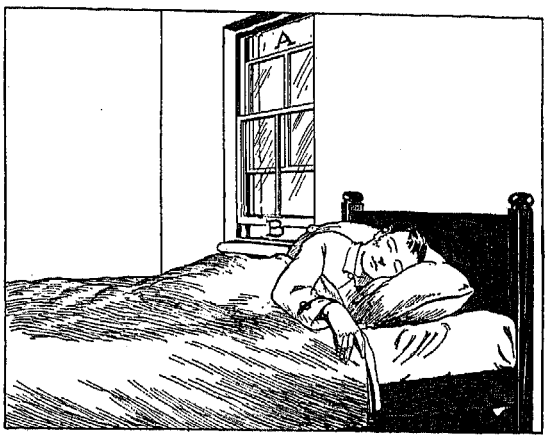
UNIT VIII SET X TEST III

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You are to pick from the list of phrases a particular phrase which matches a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. A moist cloth should always be used for dusting because	A. of the vitamins which they contain.	1. _____ ( )	
2. Excessive use of alcohol is dangerous because	B. they contain drugs which depress the heart action and deaden the sensation of pain.	2. _____ ( )	
3. Most headache cures are harmful because	C. it gives protection from dust and bacteria.	3. _____ ( )	
4. School lunches should be wrapped in waxed paper because	D. they are inexpensive.	4. _____ ( )	
5. The Pure Food and Drugs Act does not always prevent the sale of adulterated foods because	E. of the limited power given the Federal government.	5. _____ ( )	
6. Public city parks are healthful places because	F. it collects bacteria without scattering them.	6. _____ ( )	
7. Many people buy and use food containing harmful adulterants because	G. it lowers the resistance of the body to disease.	7. _____ ( )	
8. Every bedroom should be flooded with sunlight because	H. it is often used in patent medicine.	8. _____ ( )	
9. Plenty of green vegetables should be eaten because	I. it is one of the best germ killers known.	9. _____ ( )	
10. We should always use a handkerchief when coughing because	J. they do not read and understand the labels on the food which tells of the adulterant or preservative used.	10. _____ ( )	
	K. it gives the woodwork a nice gloss.		
	L. the headache is a sign that the body is ailing.		
	M. it is the best way to keep the foods from spoiling.		
	N. the air is nearly free from dust and bacteria there.		
	O. of the danger of spreading bacteria to other people.		
	P. it is one of the best germ killers known.		

UNIT VIII SET X TEST IV

DIRECTIONS. Study the diagram carefully. Think back on any experiment or demonstration that you might apply to the solution of this problem.



I know that air passes into my bedroom window at (1) ____ and passes out through (2) ____ because in the experiment with the ventilation box air passed in through the (3) ____ holes and out through the (4) ____ holes. This was because an equal volume of hot air weighs (5) ____ than an equal volume of cold air. Therefore the cold air comes in through the (6) ____ opening and (7) ____ the heated air out through the (8) ____ opening. This makes the circulation of air we call (9) _____.

Answers	Score
1. ----------	( )
2. ----------	( )
3. ----------	( )
4. ----------	( )
5. ----------	( )
6. ----------	( )
7. ----------	( )
8. ----------	( )
9. ----------	( )

Results of Test IX

(Diseases and How We Fight Them)

Table XI shows the per cent score made by each pupil in Test IX, and Figure 9 shows the ranking of each pair of pupils with each other and with the other pairs. It shows also the medians of each class.

The highest per cent, ninety, was made by a pupil in the experimental class. The highest score in the lecture class was eighty-two, eight per cent less than the highest score in the experimental class. The lowest per cent was thirty-one and was made in the lecture group; the lowest per cent in the experimental class was fifty per cent, nineteen per cent more than the lowest score in the lecture class.

The per cents of sixteen pupils in the experimental class exceeded the per cents of the sixteen pupils with whom they were paired in the lecture class. In the other four pairs the pupils in the lecture class exceeded the pupils in the experimental class.

In pair number nine the pupil in the experimental class exceeded the pupil in the lecture class by eleven per cent, while in pair eighteen a margin of twenty-two per cent separated the two, the score being in favor of the experimental pupil.

In unit nine, "Diseases and How We Fight Them," there was a significant difference in the medians of the two classes, in favor of the experimental class. The median of the experimental class was seventy-eight and that of the lecture, sixty-two.

In this unit much time was spent with the experimental group in studying bacteria under the microscope to determine the difference in those that cause the various diseases. This study seemed to create a desire on the part of the pupil to learn more about vaccination, antitoxin, immunity, and the

causes and results of the more common diseases. The fact that bacteria could be seen made the study of this unit most interesting to the experimental class.

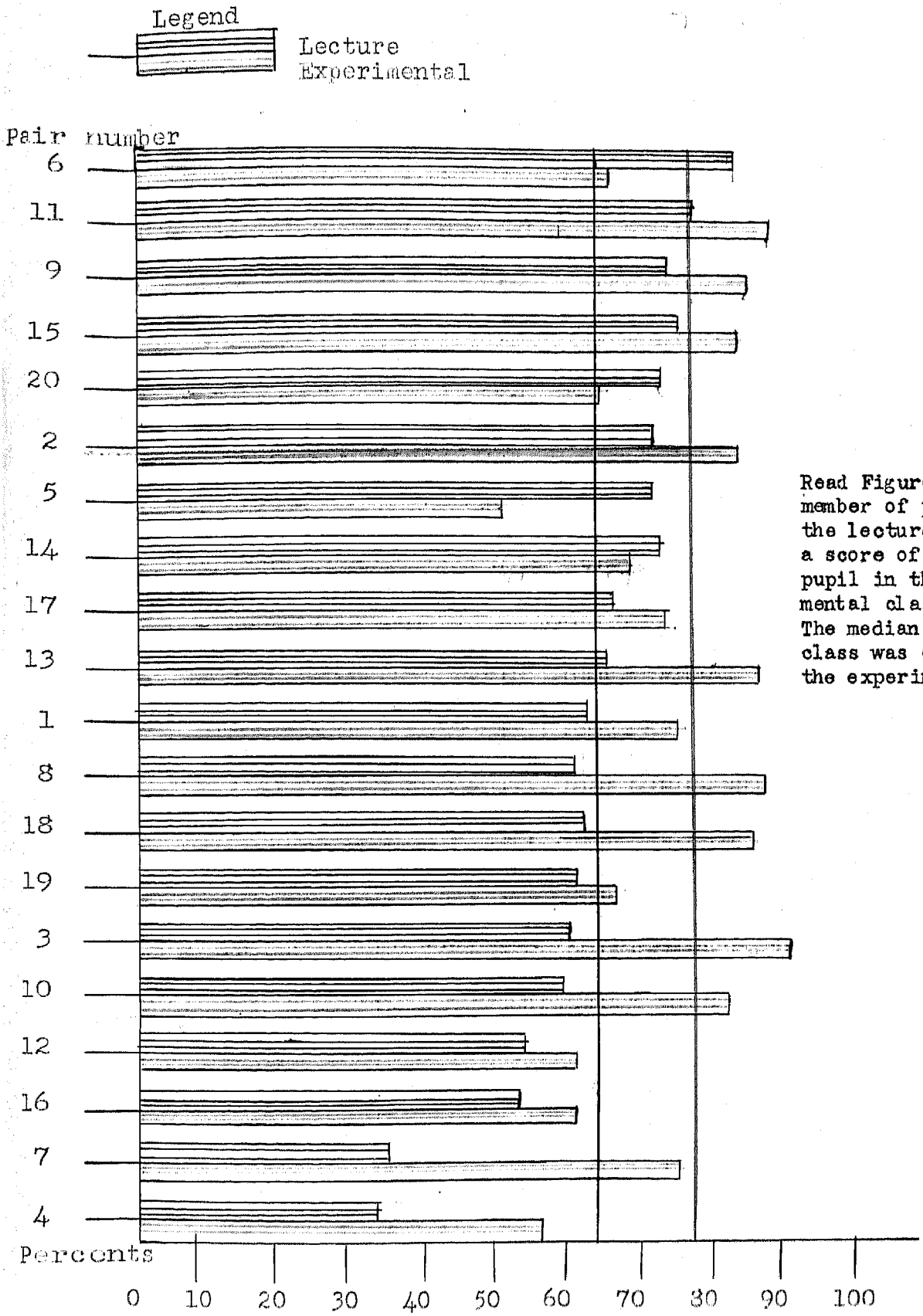
As far as this study goes, the interest that can be created by the experimental method of teaching would clearly indicate that it is the better method of teaching this kind of material.

TABLE XI

SCORES MADE BY PUPILS IN TEST IX
(DISEASES AND HOW WE FIGHT THEM)

	LECTURE		EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	62.08	T.F.	81.43
2	E.N.	70.00	D.M.	81.43
3	K.B.	60.57	A.E.	90.00
4	S.N.	31.43	V.H.	55.86
5	R.G.	70.00	R.W.	50.00
6	B.S.	82.86	A.W.	65.71
7	D.S.	33.33	M.B.	75.71
8	N.H.	62.86	E.S.	87.14
9	B.W.	74.29	M.W.	85.71
10	W.O.	58.57	D.S.	84.29
11	C.S.	77.14	D.C.	88.57
12	B.S.	53.12	D.D.	64.29
13	B.H.	64.29	D.W.	85.72
14	I.P.	68.57	E.S.	67.95
15	D.C.	74.28	R.W.	82.85
16	F.K.	52.81	F.K.	60.00
17	K.S.	65.71	R.T.	71.43
18	W.H.	62.85	J.S.	84.29
19	H.K.	61.43	G.K.	64.28
20	R.C.	72.86	J.W.	62.86
	Median	62.05		78.05
	Mean	62.33		74.47
	Range	31-82		50-90
	Q. D.	5.43		10.36

Read table thus: In Pair 1, pupil "M.T." made a score of 62.08%; pupil "T.F." the other member of the pair made 81.43. Read in like manner for succeeding pairs.



Read Figure thus: th
member of pair 6 in
the lecture class mad
a score of 82, the
pupil in the experi-
mental class made 65.
The median of the lec
class was 63.5, and o
the experimental, 78.

Figure 9

Ranking of Pupils in Test IX (Diseases and How We Fight Them)
(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

DISEASES AND HOW WE FIGHT THEM

UNIT IX SET X TEST I

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

A. Terminal	I. Toxins	P. Spinthariscope	W. Dick test
B. Smallpox	J. Hands	Q. Schick test	X. Typhoid fever
C. Yellow fever	K. Metcorite	R. A head cold	Y. Concurrent
D. Tuberculosis	L. Trichina	S. Antibodies	Z. Rheumatism
E. Cancer	M. Diarrhea	T. Microörganisms	AA. Deficiency
F. Sunlight	N. Jenner test	U. Mosquitoes	BB. Elephantiasis
G. Degenerative	O. X-ray machine	V. Diphtheria	CC. Measles
H. Hookworm			

	Answers	Score
1. A disease of unknown origin.	1. _____	( )
2. The kind of diseases caused by the breakdown of various parts of the body.	2. _____	( )
3. One of the greatest natural enemies of germs.	3. _____	( )
4. The final disinfection after the disease is over.	4. _____	( )
5. A common infective disease of the lungs.	5. _____	( )
6. The first disease ever to be prevented by the use of vaccination.	6. _____	( )
7. A parasite of the southern states which causes shiftlessness and ill health among the people infected with it.	7. _____	( )
8. A disease caused by organisms which are carried by mosquitoes.	8. _____	( )
9. The cause of all infectious diseases.	9. _____	( )
10. An instrument used in detecting infected teeth.	10. _____	( )
11. The common ailment which the first symptoms of almost all child's diseases is like.	11. _____	( )
12. The protective substances manufactured by the body to protect itself against the poisons made by disease germs.	12. _____	( )
13. The test given to determine whether children would take scarlet fever if exposed to it.	13. _____	( )
14. A small parasitic worm which may get into our bodies through the pork we eat.	14. _____	( )

NAME CLASS DATE RATING

UNIT IX SET X TEST II

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. The body protects itself against disease germs:
   (*a*) by a covering of skin. *a.* _____ ( )
   (*b*) by having corpuscles in the blood which are able to destroy germs. *b.* _____ ( )
   (*c*) by cells which secrete substances capable of making harmless the poisons which the germs give off. *c.* _____ ( )
   (*d*) by cells which secrete substances capable of destroying the germs. *d.* _____ ( )
   (*e*) by the production of antibodies. *e.* _____ ( )

2. Measles:
   (*a*) is a disease with beginning symptoms much like a head cold. *a.* _____ ( )
   (*b*) is not in the contagious stage until after the body is covered with a rash. *b.* _____ ( )
   (*c*) have been made less dangerous by the use of an antitoxin. *c.* _____ ( )
   (*d*) is a disease in which concurrent disinfection is of little value. *d.* _____ ( )
   (*e*) may leave the patient with defective eyes. *e.* _____ ( )

3. Rheumatism:
   (*a*) may be caused by infections. *a.* _____ ( )
   (*b*) might be caused by poisons coming from infected tonsils. *b.* _____ ( )
   (*c*) is a disease which afflicts only elderly people. *c.* _____ ( )
   (*d*) is a deficiency disease. *d.* _____ ( )
   (*e*) might be remedied by extracting infected teeth. *e.* _____ ( )

4. Yellow fever:

	Answers	Score
(*a*) might be contracted by sleeping in contaminated bed linens.	*a.* _____	( )
(*b*) might be contracted by being bit by the malaria mosquito.	*b.* _____	( )
(*c*) might be contracted by being in the same room with a person having the disease.	*c.* _____	( )
(*d*) is commonly carried from place to place by flies.	*d.* _____	( )
(*e*) might be prevented by the destruction of all kinds of mosquitoes.	*e.* _____	( )

5. The bubonic plague:

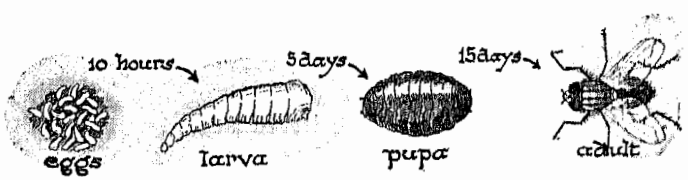
(*a*) is often carried directly to man by rats.	*a.* _____	( )
(*b*) has never been known to afflict people in North America.	*b.* _____	( )
(*c*) is a disease common among rats.	*c.* _____	( )
(*d*) is a germ disease.	*d.* _____	( )
(*e*) is often carried directly to man by fleas.	*e.* _____	( )

6. The common house fly:

(*a*) often carries typhoid germs on his feet.	*a.* _____	( )
(*b*) comes from the maggots commonly seen in horse manure and other filth.	*b.* _____	( )
(*c*) is the cause of the trichina worm in pork.	*c.* _____	( )
(*d*) cannot breed and grow in the presence of borax.	*d.* _____	( )
(*e*) is a one-celled animal parasite.	*e.* _____	( )

UNIT IX SET X TEST III

DIRECTIONS. Name the insect in the first space at the right and then label the stages in the life history of this insect.

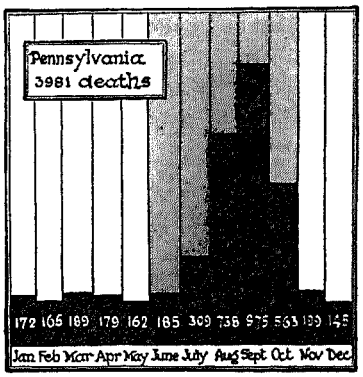


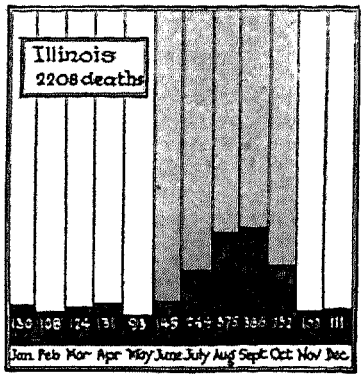
	Answers	Score
1.	_____	( )
2.	_____	( )
3.	_____	( )
4.	_____	( )
5.	_____	( )

NAME CLASS DATE RATING

UNIT IX SET X TEST IV

DIRECTIONS. Study the graphs carefully before you attempt to fill in the blanks in the numbered spaces to the right of the sentences.





The two graphs show similar conditions in two widely separated states. In both states the climatic conditions give a (1) ____ (2) ____ when flies cannot breed and a (3) ____ (4) ____ when flies breed rapidly. Since the (5) ____ (6) ____ of the fly takes only (7) ____ weeks in warm weather and since each female fly may lay (8) ____ eggs, it is evident that the rise of deaths to their highest point in (9) ____ coincides with the (10) ____ number of (11) ____ during that month. These graphs clearly show the relation between (12)____ (13) ____ that may be spread by (14) ____ and the actual occurrence of (15) ____.

Answers	Score
1. ----------	( )
2. ----------	( )
3. ----------	( )
4. ----------	( )
5. ----------	( )
6. ----------	( )
7. ----------	( )
8. ----------	( )
9. ----------	( )
10. ----------	( )
11. ----------	( )
12. ----------	( )
13. ----------	( )
14. ----------	( )
15. ----------	( )

NAME CLASS DATE RATING

UNIT IX SET X TEST V

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You are to pick out from the list at the right a particular phrase which matches a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. It is dangerous to go near a person having an infectious disease because	A. doctors recommend it for this purpose.		
2. Teeth may become a source of danger because	B. droplets are scattered by mouth spray to a distance of 3 or 4 feet.	1. _____	( )
3. The incubation period of a disease is most important from a public health standpoint because	C. if you touch them you will get the disease.	2. _____	( )
4. The antitoxin treatment if given in time will cure diphtheria because	D. a part of the life cycle of the parasite is carried on in its own body.	3. _____	( )
5. Vaccination against typhoid will be a preventive of that disease because	E. specific antibodies are thus formed in the blood which protects us against this disease.	4. _____	( )
6. The Anopheles mosquito is proven to carry malaria because	F. at that time a person may spread the disease to others most readily.	5. _____	( )
	G. the antitoxin is most carefully prepared and is sterile.	6. _____	( )
	H. we do not brush them night and morning.		
	I. malaria is always found in swampy places where these mosquitoes live.		
	J. basal pus pockets are often centers of infection.		
	K. it will neutralize or destroy the toxin caused by that specific germ.		

Results of Test X

(Homes and How They are Made)

Table XII shows the per cent score made by each pupil in Test X. Figure 10 shows the ranking of each pair of pupils in the same test with each other and with the other pairs. The medians of the two classes are also shown.

Two pupils in the experimental class made the highest percent, ninety-one. The highest score in the lecture class was eighty-seven. The lowest per cent, forty-two, was made in the lecture class and was three per cent less than the lowest score in the experimental class.

The median of the lecture class exceeded that of the experimental by six per cent. This difference is not significant, but does have eighty-four chances out of a hundred of being significant.

The results of this test would indicate that the lecture method of teaching proved most successful in teaching this unit. Most of the material is a general discussion type with few demonstrations. These demonstrations were discussed and illustrated in the text. In the lecture class these demonstrations were explained and discussed in class by the instructor, and this seemed to be more effective than actually performing the experiment as was done by the experimental class. This study shows that there is a tendency for the experimental group to neglect much of the textbook material that is called for in the tests.

The per cents made by fourteen "lecture" pupils exceeded those made by the fourteen "experimental" pupils with whom they were paired. One pair made the same score, and in the other five pairs the "experimental" pupils exceeded the "lecture."

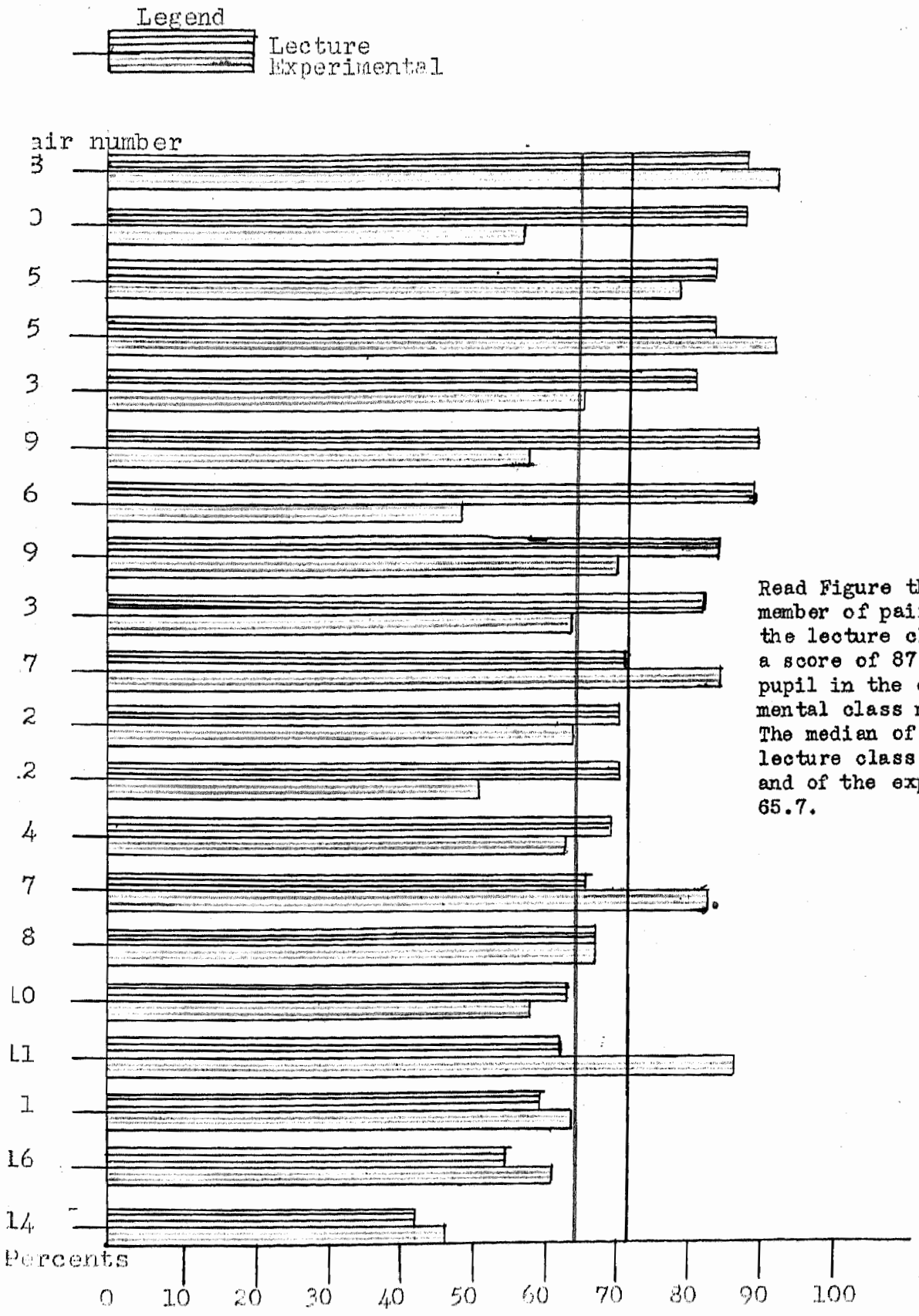
In pair nine the pupil in the lecture class exceeded the pupil in the experimental class seven per cent; in pair eighteen the pupil in the experimental class exceeded the pupil in the lecture class four per cent.

TABLE XII

SCORES MADE BY PUPILS IN TEST X
(HOMES AND HOW THEY ARE MADE)

	LECTURE		EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	58.03	T.F.	64.58
2	E.N.	70.83	D.M.	64.83
3	K.B.	81.25	A.E.	66.66
4	S.N.	68.75	V.H.	62.50
5	R.G.	83.33	R.W.	79.17
6	B.S.	79.16	A.W.	48.83
7	D.S.	66.67	M.B.	81.05
8	N.H.	66.67	E.S.	66.67
9	B.W.	77.29	M.W.	70.83
10	W.O.	62.50	D.S.	58.33
11	C.S.	61.71	D.C.	85.85
12	B.S.	70.83	D.D.	50.00
13	B.H.	77.08	D.V.	83.75
14	I.P.	42.25	E.S.	45.89
15	D.C.	83.33	R.W.	91.67
16	F.K.	54.01	F.K.	60.42
17	K.S.	72.09	R.T.	71.08
18	W.H.	87.50	J.S.	91.67
19	H.K.	81.25	G.K.	58.33
20	R.C.	87.50	J.W.	54.17
	Median	71.04		65.07
	Mean	71.61		66.83
	Range	42-87		45-91
	Q. D.	8.33		11.00

Read table thus: In Pair 1, pupil "M.T." made a score of 58.03%; pupil "T.F." the other member of the pair made 64.58%. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 18 in the lecture class made a score of 87, the pupil in the experimental class made 91. The median of the lecture class was 71.4, and of the experimental, 65.7.

Figure 10

Ranking of Pupils in Test X (Homes and How They Are Made)

(Scores of pupils in lecture class in descending order)

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HOMES AND HOW THEY ARE MADE

UNIT X SET X TEST I

DIRECTIONS. Indicate which of the following statements are *true* or *false* by *marking out* the reply you do *not* want. T equals True. F equals False.

	Answers		Score
1. The first homes were probably in caves.	1. T	F	( )
2. Most public buildings of the Greeks or Romans were built of wood.	2. T	F	( )
3. The safest type of earthquake-proof building is one built of bricks.	3. T	F	( )
4. A kitchen should be large and roomy with plenty of distance between the sink and the cupboard.	4. T	F	( )
5. Trees are of little value for the home grounds because they take so much good out of the soil.	5. T	F	( )
6. The vent pipe in the bathroom brings in fresh air.	6. T	F	( )
7. In the septic tank there are two types of bacteria at work.	7. T	F	( )
8. Oak, hickory, birch, and beech are examples of hardwoods.	8. T	F	( )
9. Wood treated with creosote resists boring insects.	9. T	F	( )
10. Sandstone is much used in building because of its durability.	10. T	F	( )
11. Concrete was used in ancient Roman times.	11. T	F	( )
12. Limestone is a necessary raw material for making cement.	12. T	F	( )
13. Varnish and shellac are made of the same materials.	13. T	F	( )
14. A bright tin surface, if exposed to water, will not rust.	14. T	F	( )
15. Close-grained woods, such as birch and maple, do not need a filler.	15. T	F	( )

NAME CLASS DATE RATING

UNIT X SET X TEST II

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You are to choose a particular phrase to fit a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. Plain walls are better than figured walls because	A. they are easier to cut.		
2. The hygienic reason why a kitchen should have all surfaces enameled or tiled is because	B. there are so many wastes to be disposed of	1. _____	( )
3. Sewers are necessary because	C. they are more restful to the eye.		
4. A septic tank is a hygienic method of sewage disposal because	D. it looks better.	2. _____	( )
5. Hardwoods are more useful for trim than softwoods because	E. it can be more easily kept clean.		
6. Stucco is much used as a covering for small houses because	F. they do not cost much.	3. _____	( )
7. Paint is used in building because	G. the bacteria in it decompose all the organic matter.	4. _____	( )
	H. it has a baffle plate which strains out the solid wastes.	5. _____	( )
	I. they are more durable.		
	J. it is waterproof, durable, and cheap.	6. _____	( )
	K. it protects materials from oxidation.	7. _____	( )

UNIT X SET X TEST III

DIRECTIONS. Read the problem through carefully before you attempt to fill in the numbered blanks.

You are planning to build a house in Southern California and will use wood in the construction. In the numbered spaces below place opposite the kind of wood mentioned the part of the house in which that wood is used.

Wood Used	Answers	Score
1. Hemlock or yellow pine	1. _____	( )
2. Oak or yellow pine	2. _____	( )
3. Redwood or oak	3. _____	( )
4. Spruce or pine	4. _____	( )
5. Redwood	5. _____	( )
6. Mahogany	6. _____	( )

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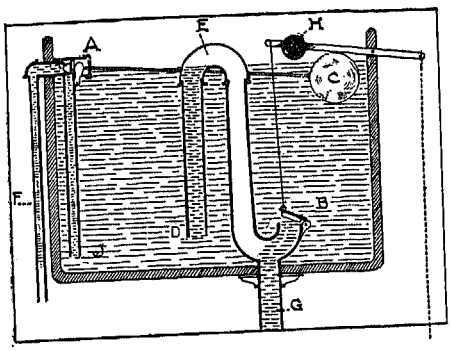
UNIT X SET X TEST IV

DIRECTIONS. Study the pictures carefully before you attempt to fill in the numbered blanks at the right.

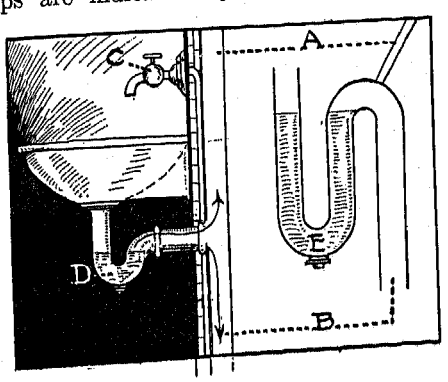
Answers Score

This diagram is to help understand the action of the ordinary toilet flush tank. If the flush tank is filled with water and one wishes to flush the toilet, he will open valve lettered (1) ---- by means of lever lettered (2) -----. This allows the water to flow downward through pipe (3) -----. When the valve closes again the water still continues to flow until its level is lowered to the point (4) ----, at which time the (5) ---- tube indicated by letter (6) ---- becomes filled with (7) ---- and the action stops. As the water level lowers, valve (8) ---- is opened by the lowering of the ball float at (9) -----. This allows the city water supply to enter the flush tank at (10) ---- through the pipe indicated by letter (11) -----. As the water level rises, the part indicated by letter (12) ---- is raised and valve (13) ---- is closed at the time that the tank is filled.



1. ------- ( )
2. ------- ( )
3. ------- ( )
4. ------- ( )
5. ------- ( )
6. ------- ( )
7. ------- ( )
8. ------- ( )
9. ------- ( )
10. ------- ( )
11. ------- ( )
12. ------- ( )
13. ------- ( )

In these two diagrams the traps are indicated by letters (14) ---- and (15) -----. These traps use (16) ---- as a seal to prevent (17) ---- from getting into the house from the (18) -----. The pipe lettered *A* is known as a (19) ---- pipe and furnishes an outlet for (20) ---- gases.



14. ------- ( )
15. ------- ( )
16. ------- ( )
17. ------- ( )
18. ------- ( )
19. ------- ( )
20. ------- ( )

Medians of All First Semester Tests

Table XIII shows the median for each pupil of each pair in the first ten tests that cover the first semester's work.

Figure 11 shows the ranking of each pair of pupils with each other and with the other pairs on their medians for the ten tests that cover the first semester's work.

Figures 12 and 13 show a comparison of the per cent scores of pair eight and pair eighteen in the first ten tests.

The highest median was eighty-one and was made by a pupil in the experimental class; the highest median in the lecture class was eighty. The lowest per cent in the experimental class was fifty-two; the lowest per cent in the lecture class was also fifty-two.

The medians of eleven pupils in the experimental class exceeded the medians of the eleven pupils with whom they were paired in the lecture class. In nine pairs the pupils of the lecture group exceeded the pupils in the experimental class.

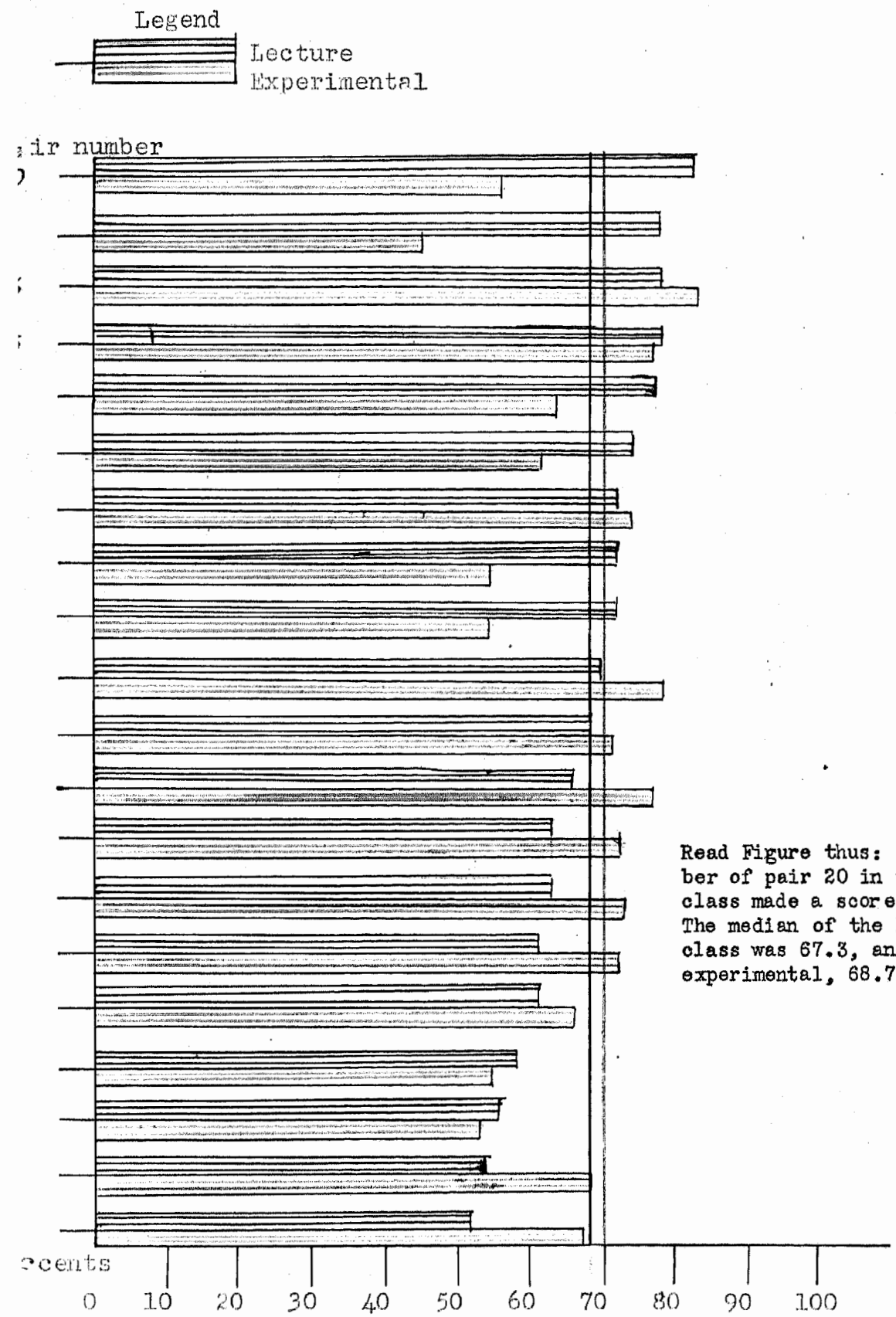
In the ten tests considered here the medians in the experimental class exceeded those in the lecture class in five cases; they were the same in one test, and the lecture class exceeded the experimental in four tests.

TABLE XIII

MEDIANS OF PER CENTS MADE BY PUPILS IN TESTS
FIRST SEMESTER

	LECTURE		EXPERIMENTAL	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	60.5	T.F.	65.9
2	E.N.	75.4	D.M.	62.8
3	K.B.	71.7	A.E.	72.4
4	S.N.	56.6	V.H.	54.1
5	R.G.	73.1	R.W.	60.3
6	B.S.	69.2	A.W.	53.7
7	D.S.	66.67	M.B.	81.05
8	N.H.	65.3	E.S.	66.67
9	B.W.	76.47	M.W.	73.8
10	W.O.	66.0	D.S.	68.7
11	C.S.	68.6	D.C.	76.0
12	B.S.	55.5	D.D.	52.5
13	B.H.	60.6	D.V.	63.75
14	I.P.	52.7	E.S.	66.2
15	D.C.	76.5	R.W.	81.9
16	F.K.	54.1	F.K.	68.8
17	K.S.	63.8	R.T.	71.6
18	W.H.	76.1	J.S.	75.1
19	H.K.	70.8	G.K.	54.4
20	R.C.	80.6	J.W.	54.8
	Median	67.3		68.7
	Mean	66.8		66.56
	Range	52-80		52-81
	Q. D.	6.82		9.12

Read table thus: In Pair 1, pupil "M.T." made a score of 60.5%; pupil "T.F.," the other member of the pair, made 65.9%. Read in like manner for succeeding pairs.



Read Figure thus: the member of pair 20 in the lecture class made a score of 54. The median of the lecture class was 67.3, and of the experimental, 68.7.

Figure 11

Ranking of Pupils in Medians of All Tests
First Semester

(Scores of pupils in lecture class in descending order)

Figure 12 shows a comparison of the two pupils who had the greatest variation in the control. The variation was in favor of the experimental pupil.

It is interesting to note that the pupil in the lecture class exceeded the pupil in the experimental class in four of the ten tests and was exceeded by the same pupil in the other six tests.

There were only two tests in which there was a great difference in the scores of the two pupils. This difference was found in tests eight and nine. In considering the entire class in these two tests, there was a slight difference in favor of the experimental class in test nine. Since there was a significant difference in favor of the experimental class in test nine, one would expect the experimental pupil to exceed the lecture pupil in that test. In test eight the only explanation that can be given for the results is the fact that the pupil in the lecture class was absent two days when this unit was being studied.

Legend:

Pair Eighteen Pupil X —— Lecture

Pupil Y —— Experimental

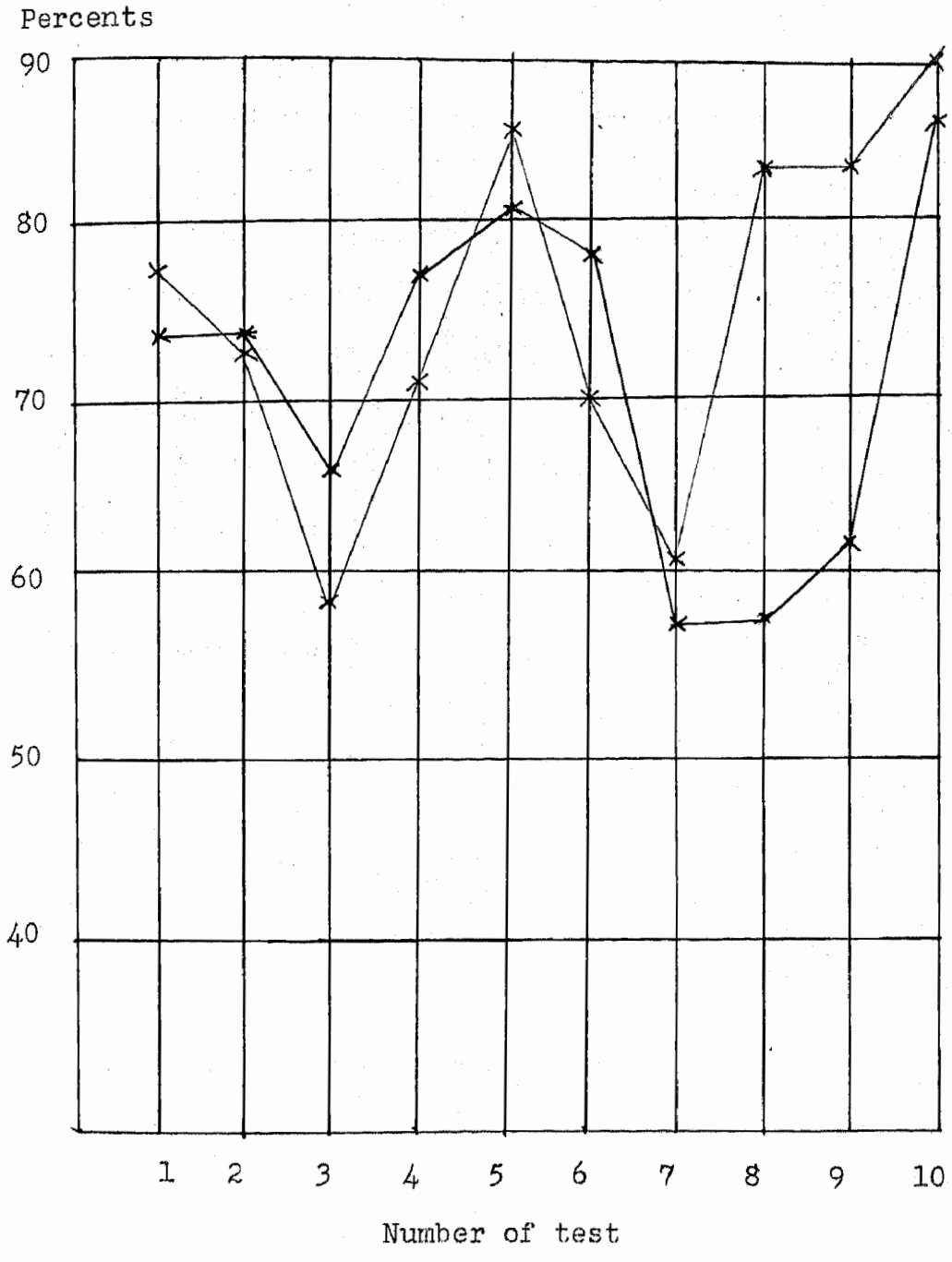


Figure 12

Ranking of Pupils in Pair Eighteen in the First Ten Tests

Read Figure thus: the pupil in the lecture class made a score of 74%, and the pupil in the experimental made 77% in test one. Read scores on succeeding tests in like manner.

Figure 13 shows a comparison of pair nine, the two pupils who had the least variation in the control. This pair was made up of identical twin girls.

It is interesting to note that the experimental pupil exceeded the lecture pupil in four tests; the results were the same in one test, and the lecture pupil exceeded the lecture pupil in tests eight and nine as was the case in the results of pair eighteen. This might be an indication that nature of material has something to do with the results obtained from the two methods of teaching.

The median for the lecture pupil in the ten tests was sixty-nine, and for the pupil in the experimental class it was sixty-four. This shows that as far as this pair goes the lecture method would be slightly favored over the experimental.

Legend:

Pair Nine Pupil X —— Lecture

Pupil Y —— Experimental

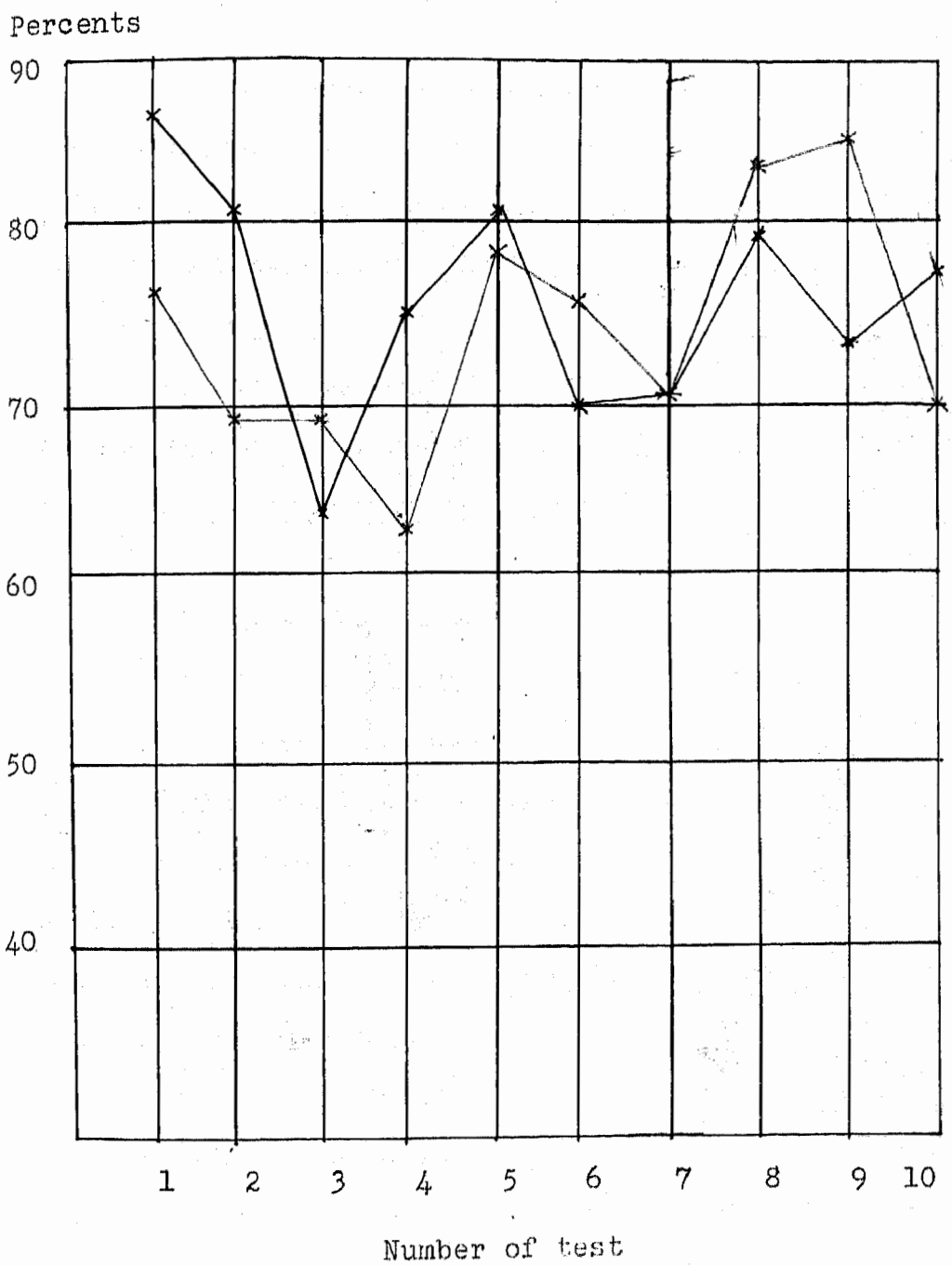


Figure 13

Ranking of Pupils in Pair Nine in First Ten Tests

Read Figure thus: the pupil in the lecture class made a score of 87%, and the pupil in the experimental made 77% in test one. Read scores on succeeding tests in like manner.

In each test the medians, quartile one, quartile three, and quartile deviation were considered in figuring the significance of the differences in per cents in the medians of each class. Statistically, there must be a variation of approximately ten per cent in the medians in order to have a significant difference. In only one of the ten tests that were given the first semester were the variations great enough to be statistically significant, and that was in favor of the experimental class. In tests five, seven, and ten the lecture class exceeded the experimental class in median per cents. In these tests the chances were ninety-seven, eighty-eight, and eighty-four out of one hundred, respectively, that the differences were significant, while in the other three cases, where the experimental class medians exceeded the lecture class medians, they were sixty-two, sixty-seven, and seventy-six per cent significant. This, of course, is little better than chance.

Any statistical difference between the two classes is an appreciable amount and not significant.

Test nine covered the unit "Diseases and How We Fight Them." In this test the experimental class exceeded the lecture class by thirteen per cent on the medians. Since this is a significant difference, it would indicate that the laboratory and experimental method of teaching is superior to the lecture method in teaching this kind of material, while in teaching the unit "How Water Serves Man," which is unit five, the lecture method of teaching seems to be the better method.

The study of this first semester would indicate there is no significant difference in two methods of teaching when the entire semester of work is considered, but that there are advantages in either method in teaching

different kinds of material. Material such as that covered by unit one, "How to Control Our Environment," unit six, "Our Clothing," and unit nine, "Diseases and How We Fight Them," is definitely experimental material, according to this study. In these three units there was a material difference in favor of the experimental method. It seems that the nature of the material in these units is such that the experimental method of teaching created more interest. These three units contained experimental material that was not explained by the text and was worked out in the experimental class.

In the five units where the lecture class exceeded the experimental class most of the experimental material was well illustrated by diagrams and figures in the text.

In the other two units where there was not a material difference in the results of the tests, the material covered by the units was mostly a general discussion of the subject.

As far as this study goes, experiments that are well illustrated by diagrams and figures and explained by the author of the text can be taught by the lecture method to an advantage; but material that is not illustrated as was shown in the three units mentioned above can be best taught by the experimental method.

CHAPTER III

RESULTS OF TESTS FOR SECOND SEMESTER

The same procedure was followed during the second semester as in the first except that the two classes were reversed. The "lecture class" of the first semester was taught by the experimental method the second semester; and the "experimental class" of the first semester was taught by the lecture method the second semester. By reversing the classes, if there is a tendency for any pupil to excel the pupil with whom he is paired regardless of method used, it should show up in the results of the tests for this semester. This also gives the observer a chance to see the reaction of the pupils to each method. There may be a possibility that some pupils react favorably toward one method or the other, or to material of a different nature.

Results of Test XI

(Electricity and Its Uses)

Test XI covered "Electricity and Its Uses," the first unit in the second semester's work. Table XIV shows the per cent made by each pupil in this test, while Figure 14 shows the ranking of each pair of pupils with one another and also with the other pairs. The median of each class is also shown.

The highest score was ninety and was made by a pupil in the experimental class. This exceeded the highest score in the lecture class by ten

per cent. The lowest score in the lecture class was thirteen, while the lowest score in the experimental was twenty-three.

The per cents of eight pupils in the experimental class exceeded the per cents of the eight pupils with whom they were paired in the lecture class, and in the other ten pairs the per cents made by the pupils of the lecture class exceeded those of the experimental class. The median of the experimental class was fifty-seven, and that of the lecture class fifty-nine. The difference is not significant. There are fifty-eight chances out of a hundred that the difference is significant. There is not a material difference in the scores of the two classes.

In pair number nine (twins), the pupil in the experimental class exceeded the pupil in the lecture class by three per cent. In pair eighteen the pupil in the lecture class exceeded the pupil in the experimental class fourteen per cent. (This is the pair with the greatest variation in the control, and this semester in favor of the lecture pupil.)

Since there is not a material difference in the results of the tests, one method of teaching would not be favored over another. It is interesting to note, however, that the highest score was made in the experimental class and the lowest in the lecture; but the median of the lecture class exceeded that of the experimental class two per cent. This would indicate that as a whole more pupils did a little better in the lecture class.

The material in this unit contained many experiments that were worked by the experimental class. These experiments were illustrated by diagrams and figures in the text and were studied in that manner by the lecture group.

The results of the test would indicate that the lecture class had a slight but statistically insignificant advantage, as far as this study goes.

TABLE XIV

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST ELEVEN
(ELECTRICITY AND ITS USES)

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	58.5	T.F.	50.70
2	E.N.	74.80	D.M.	52.11
3	K.B.	76.05	A.E.	60.58
4	S.N.	42.25	V.H.	49.16
5	R.G.	76.06	R.W.	50.70
6	B.S.	71.83	A.W.	50.70
7	D.S.	40.85	M.B.	57.74
8	N.H.	53.52	E.S.	70.42
9	B.W.	76.61	M.W.	73.24
10	W.O.	56.56	D.S.	67.67
11	C.S.	49.30	D.C.	71.83
12	B.S.	62.67	D.D.	39.43
13	B.H.	49.29	D.V.	63.38
14	I.P.	29.58	E.S.	63.38
15	D.C.	73.23	R.W.	81.69
16	F.K.	39.55	F.K.	47.89
17	K.S.	35.25	R.T.	80.28
18	W.H.	66.20	J.S.	80.29
19	H.K.	40.87	G.K.	49.29
20	R.C.	90.14	J.W.	13.66
	Median	57.5		59.1
	Mean	58.15		58.70
	Range	29-90		13-81
	Q. D.	10.56		16.23

In Pair 1, pupil "M.T." made a score of 58.5; pupil "T.F.," the other member of the pair, made 65.9%. Read in like manner for succeeding pairs.

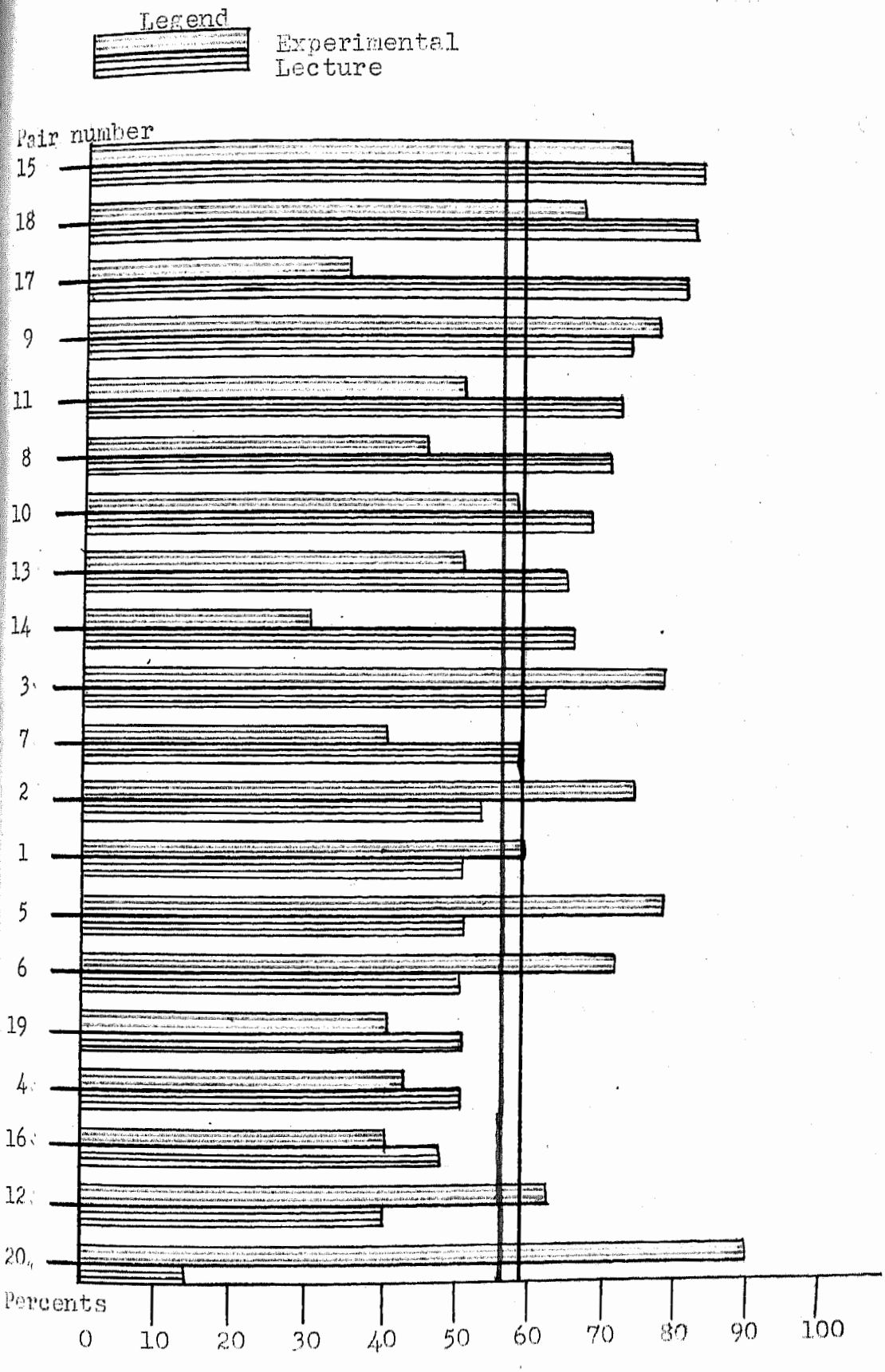


Figure 14

Ranking of Pupils in Test XI (Electricity and Its Uses)

NAME CLASS DATE RATING

ELECTRICITY AND ITS USES

UNIT XI SET X TEST I

DIRECTIONS. Indicate which of the following statements are *true* or *false* by *marking out* the reply you do *not* want. T equals True. F equals False.

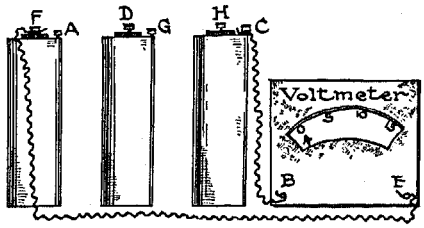
	Answers	Score
1. All matter contains magnetism.	1. T F	( )
2. If a copper bar is stroked by a magnet, it will become magnetized.	2. T F	( )
3. Magnetism and electricity are the same thing.	3. T F	( )
4. If a body contains as many electrons as protons, it is said to have no electric charge.	4. T F	( )
5. A proton is negative electricity.	5. T F	( )
6. If a body does not have enough electrons upon it, it is said to be positively charged.	6. T F	( )
7. If a ping-pong ball is given too many electrons, it will be repelled by a hard-rubber rod after being rubbed with wool.	7. T F	( )
8. If zinc and copper were put into a solution of acid and water, it would cause too many electrons to be on the zinc and too few on the copper.	8. T F	( )
9. A dry cell contains some liquid.	9. T F	( )
10. An insulator is material over which electrons will not flow.	10. T F	( )
11. Too much electricity flowing in a wire may cause it to melt.	11. T F	( )
12. We buy our electricity in kilowatt hours.	12. T F	( )
13. All houses are wired for the control of electricity by having all lights and electric devices connected in series.	13. T F	( )
14. If one kilowatt hour of electrical energy costs 10¢, then 1000 watts used for one hour would cost $10.00.	14. T F	( )
15. A copper wire in which there is a steady stream of electrons flowing will be surrounded by a magnetic field.	15. T F	( )

NAME CLASS DATE RATING

UNIT XI SET X TEST II

DIRECTIONS. Study the diagrams carefully before you attempt to fill out the blanks at the right.

(A)



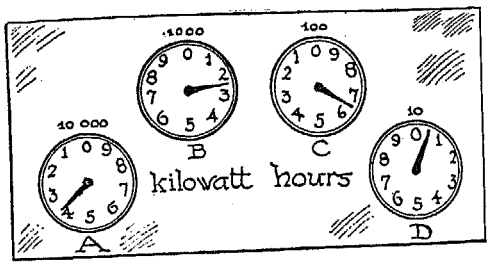
If the above group of cells were to be connected so that they would be in series across the voltmeter, the connections would be from *A* to (1) ____, and from (2) ____ to (3) _____. If they were to be connected in parallel, the connections would be from *A* to (4) ____ to (5) ____, and from *F* to (6) ____ to (7) _____. If the voltage of one cell is $1\frac{1}{2}$ volts, then the voltmeter reading across the parallel connection would be (8) ____ volts, and the voltmeter reading across the series reading would be (9) ____ volts. If the voltmeter were removed from the circuit, and a small light bulb put in its place between *B* and *E*, the most amperes of current would flow through the bulb when the cells were connected in (10) _____. The most heat would be produced in the filament of the light bulb when the cells were connected in (11) _____. The most light would be given when the cells were connected in (12) _____. The cells would last longer if connected in (13) _____. To connect dry cells in series is analogous to connecting together water tanks when they are on different (14) _____. Through a certain water pipe, the amount of water which will flow is proportional to the water (15) _____. To connect dry cells in parallel does not increase the (16) ____, but it does increase the (17) ____ which may be drawn from the group of cells.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )
11.	----------	( )
12.	----------	( )
13.	----------	( )
14.	----------	( )
15.	----------	( )
16.	----------	( )
17.	----------	( )

Answers Score

(B)

The reading of this kilowatt hour meter is (1) _____. The reading one month ago was 3134 kilowatt hours, thus (2) ____ hours of energy were used during the month. At the rate of 9¢ per kilowatt hour, the bill for this month will be (3) _____. If in the coming



month 58 kilowatt hours of energy are used, the pointer on dial *A* will be between (4) ____ and (5) _____. The pointer hand on dial *B* will be between (6) ____ and (7) _____. The hand on dial *C* will be between (8) ____ and (9) ____, and on dial *D* the hand will be between (10) ____ and (11) _____. In this meter the hand of dial (12) ____ moves the most rapidly. The hand of dial *C* turns (13) ____ times to one turn of the hand on dial *B*.

1. _____ ( )
2. _____ ( )
3. _____ ( )
4. _____ ( )
5. _____ ( )
6. _____ ( )
7. _____ ( )
8. _____ ( )
9. _____ ( )
10. _____ ( )
11. _____ ( )
12. _____ ( )
13. _____ ( )

NAME CLASS DATE RATING

UNIT XI SET X TEST III

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. When a negatively charged rubber balloon hangs by a silk thread:
   (*a*) it will be attracted to silk which has been rubbed upon a glass rod. *a.* _____ ( )
   (*b*) it will be attracted to hard rubber which has been rubbed by fur. *b.* _____ ( )
   (*c*) it will be repelled by any body which has an excess of electrons. *c.* _____ ( )
   (*d*) it will be attracted to an iron bar held in the hand. *d.* _____ ( )
   (*e*) it will be repelled by an insulated gold bar which contains more electrons than protons. *e.* _____ ( )

2. When an electric current flows through a wire:
   (*a*) the wire is always warmed by the current. *a.* _____ ( )
   (*b*) visible light is always given off. *b.* _____ ( )
   (*c*) a chemical change is made in the material of the wire. *c.* _____ ( )
   (*d*) there is a magnetic field about the wire. *d.* _____ ( )
   (*e*) there is a stream of electrons flowing through the wire. *e.* _____ ( )

3. A person is perfectly safe from being killed by electricity:
   (*a*) if he lets the current from a car storage battery flow through his body. *a.* _____ ( )
   (*b*) if he climbs the pole of a high tension electric line, but is careful that he does not touch the wire. *b.* _____ ( )
   (*c*) if he touches his fingers across the two poles of a powerful horseshoe magnet. *c.* _____ ( )
   (*d*) if he touches his two hands across the terminals of a group of dry cells connected so that they give 2000 volts. *d.* _____ ( )
   (*e*) if he stands upon the damp ground and touches one wire of the electric line leading into the house. *e.* _____ ( )

4. A storage battery:
   (*a*) may be tested by a hygrometer. *a.* _____ ( )
   (*b*) should be refilled with water every two weeks. *b.* _____ ( )
   (*c*) does not store up electric energy. *c.* _____ ( )
   (*d*) might be made of enough cells, properly connected, to furnish 2000 volts. *d.* _____ ( )
   (*e*) changes chemical energy to electrical energy when being discharged. *e.* _____ ( )

NAME CLASS DATE RATING

UNIT XI SET X TEST IV

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain *lettered* phrases. You are to choose a particular phrase to fit a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. If a magnet is suspended so that it swings freely in a horizontal plane, it takes a north-south position because	A. a dry cell is not a storage battery. B. of the earth's magnetism. C. electricity must be in motion to do work. D. the right hand rule has ceased to work. E. a positively charged body is a non-conductor. F. water offers no opposition to the flow of electricity. G. of the material out of which the magnet is made. H. electrical energy cannot be stored up. I. the magnetic field is set up by the current. J. it contains no electrons. K. the electrons are so small. L. of the excess of electrons on one body and the unsatisfied protons on the other.	1. ------- ( )	
2. An electromagnet will not attract pieces of iron and steel after the electric current has been shut off because		2. ------- ( )	
3. We can never hope to see an electric current because		3. ------- ( )	
4. A negatively charged body attracts a positively charged body because		4. ------- ( )	
5. Static electricity is of no value for running electric motors because		5. ------- ( )	
6. The name storage battery is misleading because		6. ------- ( )	

Results of Test XII

(Power, Machines, and the Work of the World)

Table XV shows the per cents made by each pupil in Test XII, and Figure 15 shows the ranking of each pair of pupils in Test XII with each other and with each other pair. The median of the class is also shown.

Eighty per cent, the highest score, was made by a pupil in the lecture class. This score exceeded the highest score in the experimental class by seven per cent. The lowest score, also made by a pupil in the lecture class, was twenty-nine, while the lowest score in the experimental class was thirty-nine.

The median of the lecture class exceeded that of the experimental class less than one per cent. The difference is not a material difference and not enough to be considered.

The per cents of twelve pupils in the lecture class exceeded the per cents of the twelve pupils with whom they were paired in the experimental class. In the other eight pairs the per cents made by the experimental class exceeded those of the lecture class.

In pair nine (identical twin girls) the pupil in the experimental class exceeded the pupil in the lecture class by two per cent. In pair eighteen the pupil in the lecture class exceeded the pupil in the experimental class by twenty per cent. This can be accounted for in part by the fact that the pupil in the experimental class was absent from school several days during the study of this unit.

Since there is a slight difference in the results of the test, the study would indicate that the method of teaching the material in this unit has little effect on the learning by the pupil; and that material which appears to be experimental may be learned by the pupil just as efficiently from well-illustrated diagrams and figures.

TABLE XV

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST TWELVE
(POWER, MACHINES, AND THE WORK OF THE WORLD)

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	51.5	T.F.	60.94
2	E.N.	60.92	D.M.	56.27
3	K.B.	70.31	A.E.	56.25
4	S.N.	51.56	V.H.	56.25
5	R.G.	59.37	E.W.	45.31
6	B.S.	68.75	A.W.	51.88
7	D.S.	39.63	M.B.	54.84
8	N.H.	54.69	E.S.	56.25
9	B.W.	56.25	M.W.	54.29
10	W.O.	62.50	D.S.	89.70
11	C.S.	71.88	D.C.	57.81
12	B.S.	53.12	D.D.	29.38
13	B.H.	56.25	D.V.	62.65
14	I.P.	46.25	E.S.	51.68
15	D.C.	73.43	R.W.	75.00
16	F.K.	54.69	F.K.	57.82
17	K.S.	48.44	R.T.	64.06
18	W.H.	50.00	J.S.	70.31
19	H.K.	45.31	G.K.	46.87
20	R.C.	73.44	J.W.	43.75
	Median	55.4		56.2
	Mean	57.41		56.61
	Range	39-73		29-80
	Q. D.	5.		7.42

In Pair 1, pupil "M.T." made a score of 51.5; pupil "T.F." the other member of the pair made 60.94%. Read in like manner for succeeding pairs.

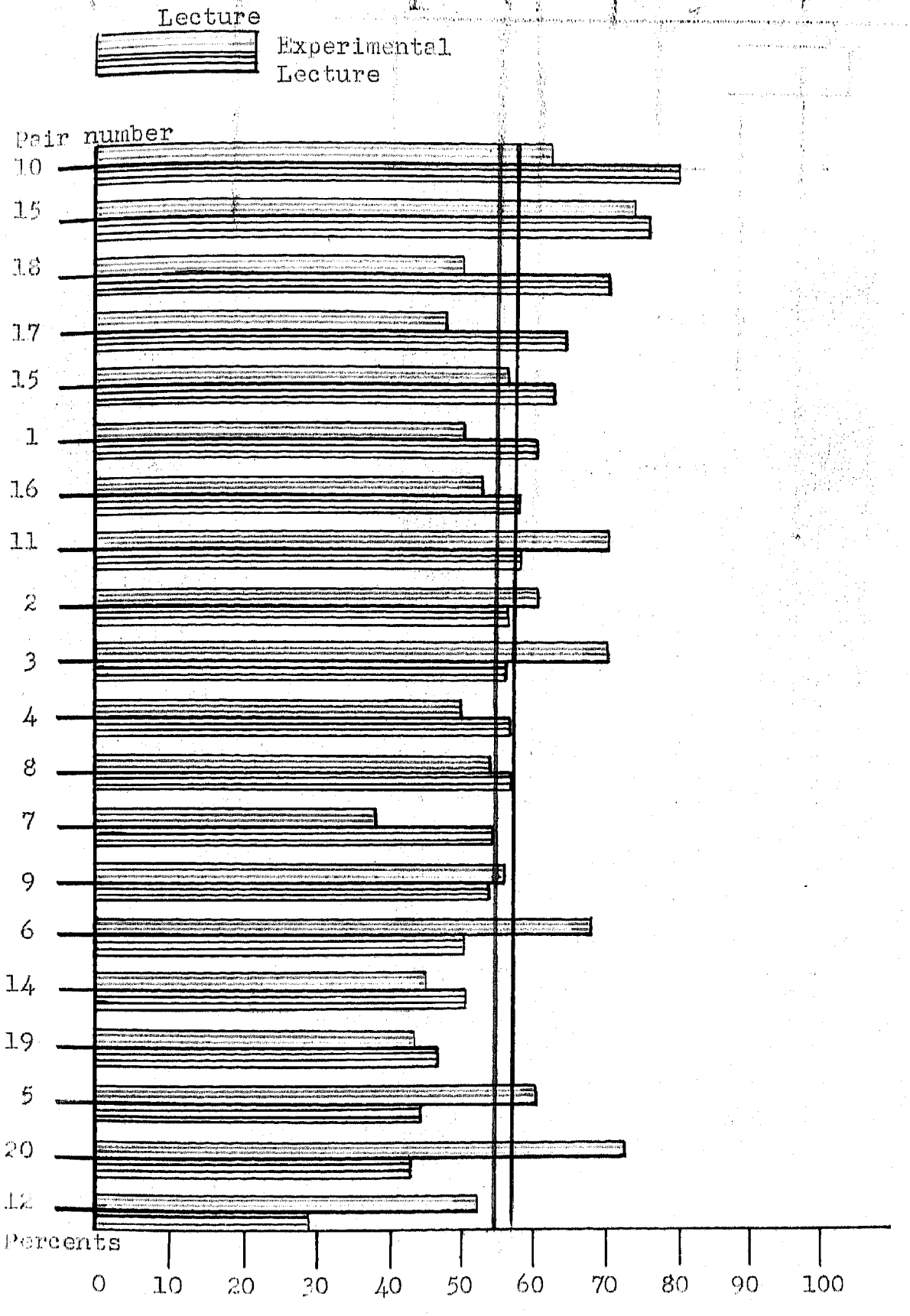


Figure 15

Ranking of Pupils in Test XII
(Power, Machines, and the Work of the World. Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

POWER, MACHINES, AND THE WORK OF THE WORLD

UNIT XII SET X TEST I

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

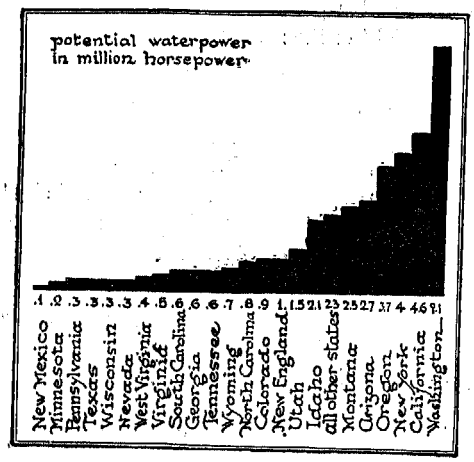
A. Inertia	H. Blast furnace	O. Transformer	V. Motor
B. Cylinder	I. Nine	P. Energy	W. Gram
C. Generator	J. Huyghens	Q. Newcomen	X. Newton
D. Weight	K. Friction	R. Resistance	Y. One hundred eighty
E. Penstock	L. Pendulum	S. Watt	Z. Bessemer converter
F. Gravity	M. Foot-pound	T. Five	AA. Power
G. Work	N. Two hundred seventy	U. Eccentric	

	Answers	Score
1. The term used which means the measure of gravity on the earth.	1. _____	( )
2. The type of resistance which must be overcome in lifting a stone.	2. _____	( )
3. The property of matter which causes a rapidly moving car to skid when it turns a corner rapidly.	3. _____	( )
4. The mechanical advantage of a machine which will lift 225 pounds by applying a force of 45 pounds.	4. _____	( )
5. The man who first stated the laws of gravitation.	5. _____	( )
6. The rate at which mechanical work is performed.	6. _____	( )
7. The closed pipe which brings water to a water turbine.	7. _____	( )
8. The chamber in which the piston on an engine moves to and fro.	8. _____	( )
9. The name of the device used for transforming mechanical energy into electrical energy.	9. _____	( )
10. The name of the device used for making steel from pig iron.	10. _____	( )

NAME CLASS DATE RATING

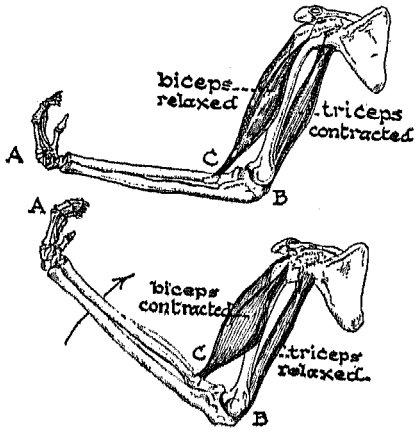
UNIT XII SET X TEST II

DIRECTIONS. Study the diagrams carefully before you attempt to fill in the blanks at the right.



If all of the potential water power in Virginia were developed, there would be about (1) ____ thousand horsepower. The only eastern state in the United States which has more potential water power than Montana is (2) _____. The state of Washington has about (3) ____ times as much potential water power as all the New England states put together. (4) ____ has more potential water power than any other state with (5) ____ second, and (6) ____ third. If all of the potential water power in California were developed, there would be about (7) ____ million horsepower.

The action of the arm is in reality the same action as the (8) ____ class lever. The fulcrum is indicated by letter (9) ____, the resistance by letter (10) ____, and the place where the force is applied by letter (11) _____. A pair of shears is a good example of a (12) ____ class lever, and a pair of sugar tongs furnish an example of a (13) ____ class lever. The (14) ____ class lever is the only one where the force to be overcome must be less than the force applied.



	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )
11.	----------	( )
12.	----------	( )
13.	----------	( )
14.	----------	( )

NAME CLASS DATE RATING

UNIT XII SET X TEST III

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers **Score**

1. As defined by science, work is done when:
   (*a*) a baby crawls up a flight of stairs. *a.* ------- ( )
   (*b*) a sack of sand falls to the earth from a balloon. *b.* ------- ( )
   (*c*) a lady labors for hours in an unsuccessful attempt to move a heavy stove. *c.* ------- ( )
   (*d*) an automobile coasts down hill. *d.* ------- ( )
   (*e*) a football player punts the ball between the goal posts. *e.* ------- ( )

2. A machine may be used for the following purposes:
   (*a*) to make energy. *a.* ------- ( )
   (*b*) to transfer energy from one place to another. *b.* ------- ( )
   (*c*) to decrease the amount of work necessary to move any object over a certain distance. *c.* ------- ( )
   (*d*) to give man a mechanical advantage in accomplishing work. *d.* ------- ( )
   (*e*) to enable a low-powered engine to move a very heavy object. *e.* ------- ( )

3. The amount of power used in doing work is a measure of:
   (*a*) the foot-pounds of work done per second. *a.* ------- ( )
   (*b*) the actual work accomplished. *b.* ------- ( )
   (*c*) the number of horses used in doing the work. *c.* ------- ( )
   (*d*) the amount of work that is done per minute. *d.* ------- ( )
   (*e*) the weight of the object moved. *e.* ------- ( )

	Answers	Score
4. In a steam engine:		
(*a*) heat energy is changed into mechanical energy.	*a.* _____	( )
(*b*) the cylinder is used for the compression of steam.	*b.* _____	( )
(*c*) motion is caused by steam being directed against rotating blades.	*c.* _____	( )
(*d*) the amount of steam entering the cylinder is regulated by a governor.	*d.* _____	( )
(*e*) the to and fro motion of the piston pumps the steam to the turbine.	*e.* _____	( )
5. Modern hydroelectric plants:		
(*a*) are driven by electrical energy.	*a.* _____	( )
(*b*) change mechanical energy into electrical energy.	*b.* _____	( )
(*c*) are driven by steam turbines.	*c.* _____	( )
(*d*) use the overshot type of water wheel.	*d.* _____	( )
(*e*) are driven by water turbines.	*e.* _____	( )
6. In the production of pig iron:		
(*a*) carbon is heated with the iron ore in a Bessemer converter.	*a.* _____	( )
(*b*) limestone is heated with the iron ore in order to remove the earth impurities.	*b.* _____	( )
(*c*) coke is used to furnish both heat and carbon.	*c.* _____	( )
(*d*) oxygen is removed from the iron ore in a blast furnace.	*d.* _____	( )
(*e*) limestone, coke, and iron ore are all heated together in a blast furnace.	*e.* _____	( )

NAME CLASS DATE RATING

UNIT XII SET X TEST IV

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You must pick out from the list at the right some particular phrase that will fit a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. Steel is used in the construction of bridges because	A. it gives a mechanical advantage in doing work.	1. -------	( )
2. The electric motor has revolutionized the methods used in many industries because	B. the fuel used in such an engine need not be mixed with air.		
3. Electric lighting circuits generally use alternating current because	C. it does not use a piston.	2. -------	( )
	D. direct current cannot be used with incandescent lamps.		
4. Fuel is valuable because	E. it is found in coal mines.	3. -------	( )
5. The momentum of a fly wheel is needed on a gasoline engine because	F. it decreases friction.		
6. Ignition is not needed on a Diesel engine because	G. it can do work without the use of energy.	4. -------	( )
7. A steam turbine is used in large electric light plants because	H. it is the best way to prevent jerky motion.	5. -------	( )
8. The moving parts of a machine need lubrication because	I. it eliminates unnecessary inertia in the operation of the engine.	6. -------	( )
9. One reason why the Watt engine was better than the Newcomen engine was because	J. it has chemical energy stored up in it.	7. -------	( )
10. A machine is of value to man because	K. the heat of compressed air causes combustion of oil.	8. -------	( )
	L. it costs less than cast iron.		
	M. a direct current cannot be changed by the use of a transformer to a different voltage.	9. -------	( )
	N. it kept the cylinder hot all of the time.	10. -------	( )
	O. it is especially suited for use when high speed and continuous running are desired.		
	P. it stands great strain without breaking.		
	Q. it has made possible the elimination of shafts and belts in transferring energy.		

Results of Test XIII

(Development of Transportation)

Table XVI shows the per cents made by each pupil in Test XIII. Figure 16 shows the ranking of each pair of pupils with each other and also with each other pair. The median of the class is also shown.

The highest score, ninety-two, and made by a pupil in the experimental class, exceeded the highest score in the lecture class by seven per cent. In both classes fifty-two was the lowest score.

The median of the lecture class exceeded that of the experimental class by seven points. This difference is a significant difference. A margin of seven means that it has ninety-five chances out of a hundred of being significant. This unit included a study of friction, effect of different grades, rolling and sliding friction, buoyancy, specific gravity, density, lighter than air machines, and airplanes. The experimental group performed all of the demonstrations that were listed in the text during the course of their study. These demonstrations were shown by diagrams in the text. They were explained by the instructor to the lecture class from these diagrams and to the experimental class by the actual demonstration.

As far as this study goes, the lecture method of teaching transportation proved to be most satisfactory. It is again another case where the material seemed to be of an experimental nature, yet the lecture method was more effective. The explanation to this may be the fact that most of the demonstrations were well illustrated in the text and needed only a good explanation to give to the pupil what he should get from the experiment. Again, present-day pupils are visually trained. The fact that in the experi-

mental class pupils worked in groups of three or four may be a reason for a greater number of the experimental pupils falling below the median of the lecture class. There is a tendency for one or two members of an experimental group of three or four to do the work and understand the experiment, while the rest of the group copy the results and know very little about the experiment.

In pair nine (twins), the pupil in the lecture class exceeded the pupil in the experimental class by twelve per cent. In pair eighteen the pupil in the lecture class exceeded the experimental pupil three per cent. This would indicate, as far as these two pairs go, that the lecture method of teaching is more effective in teaching this unit.

TABLE XVI

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST THIRTEEN
(DEVELOPMENT OF TRANSPORTATION)

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	56.1	T.F.	52.63
2	E.N.	68.42	D.M.	75.44
3	K.B.	75.44	A.E.	64.91
4	S.N.	66.66	V.H.	59.65
5	R.G.	82.48	R.W.	64.91
6	B.S.	80.71	A.W.	64.91
7	D.S.	56.14	M.B.	73.68
8	N.H.	52.63	[illegible].S.	75.44
9	B.W.	66.67	M.W.	78.95
10	W.O.	66.67	E.S.	80.70
11	C.S.	77.19	D.C.	73.68
12	B.S.	54.39	D.D.	71.93
13	B.H.	79.12	D.V.	85.56
14	I.P.	59.66	E.S.	68.44
15	D.C.	82.11	R.W.	85.96
16	F.K.	59.64	F.K.	70.81
17	K.S.	69.11	R.T.	84.21
18	W.H.	77.19	J.S.	80.70
19	H.K.	68.45	G.K.	76.67
20	R.C.	92.98	J.W.	77.19
	Median	67.5		74.5
	Mean	69.05		73.3
	Range	52-92		52-85
	Q. D.	7.45		7.45

In Pair 1, pupil "M.T." made a score of 56.1; pupil "T.F." the other member of the pair made 52.63%. Read in like manner for succeeding pairs.

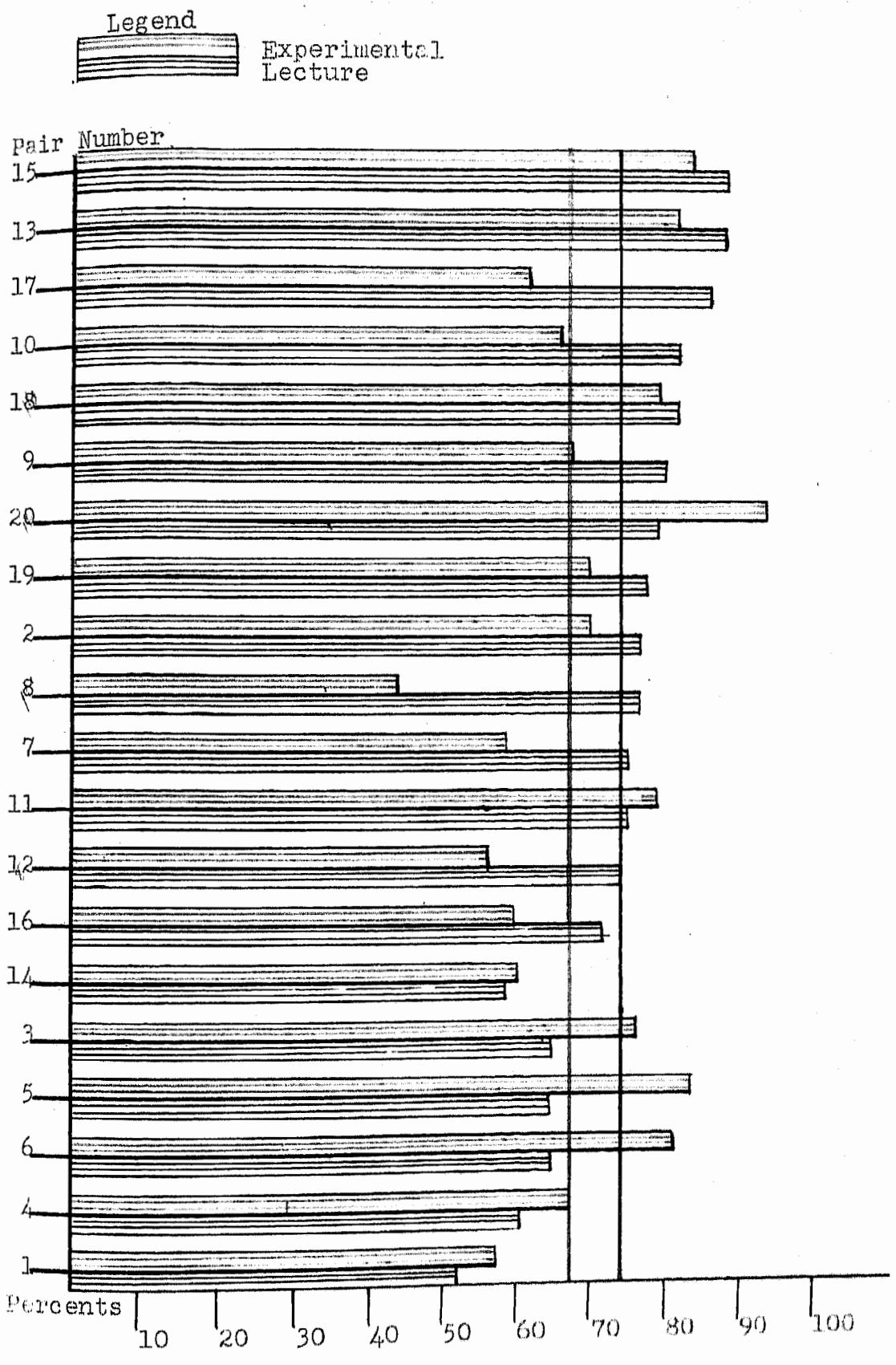


Figure 16

Ranking of Pupils in Test XIII
(Development of Transportation)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

DEVELOPMENT OF TRANSPORTATION

UNIT XIII SET X TEST I

DIRECTIONS. Place the *letter* of the word which completes the sentence in the space at the right.

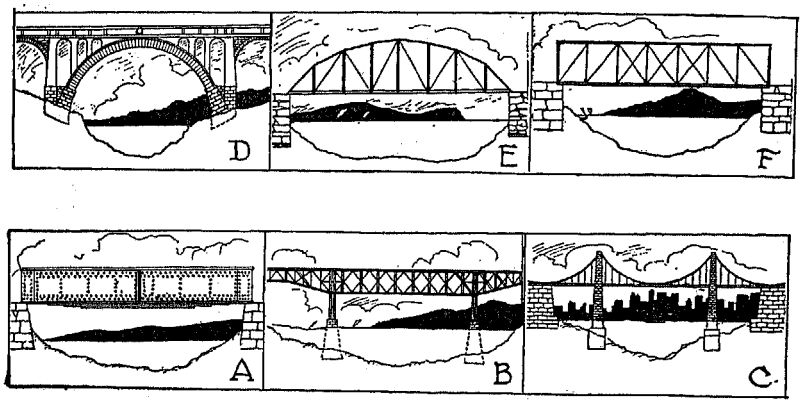
	Answers	Score
1. It requires more force to start a loaded wagon than to keep it going after it is started because of the (*a.* MOMENTUM, *b.* ENERGY, *c.* GRAVITY, *d.* INERTIA, *e.* SUCTION) of the wagon.	1. _____	( )
2. More work must be done to draw a load up hill than to draw it on the level because (*a.* INERTIA, *b.* MAGNETISM, *c.* GRAVITY, *d.* MOMENTUM, *e.* ENERGY) must be overcome.	2. _____	( )
3. The frame work and wheel controls of an automobile is called the (*a.* CHASSIS, *b.* TRACTOR, *c.* TRANSMISSION, *d.* HOUSING, *e.* CHASSEUR).	3. _____	( )
4. The carburetor on a gasoline engine is used (*a.* TO MIX THE GASOLINE AND AIR, *b.* TO MAKE THE SPARK, *c.* TO CONTROL THE VACUUM TANK, *d.* TO CHARGE THE STORAGE BATTERY, *e.* TO CONTROL THE INTAKE VALVES).	4. _____	( )
5. The first railroad was built in the United States about (*a.* 360, *b.* 235, *c.* 175, *d.* 110, *e.* 68, *f.* 35) years ago.	5. _____	( )
6. When a substance is lighter than the same bulk of water, it will float and we say that it is (*a.* STABLE, *b.* BUOYANT, *c.* DENSE, *d.* ELASTIC, *e.* IMMERSED).	6. _____	( )
7. A little boat which displaced 100 cubic feet of water weighs (*a.* 6250, *b.* 625, *c.* 62.5, *d.* 100, *e.* 172,800) pounds.	7. _____	( )
8. The density of lead is less than (*a.* IRON, *b.* ALUMINUM, *c.* GLASS, *d.* GOLD, *e.* OAK).	8. _____	( )
9. Of the following gases (*a.* HYDROGEN, *b.* CARBON DIOXIDE, *c.* OXYGEN, *d.* HELIUM, *e.* NITROGEN) is the lightest gas which is not inflammable.	9. _____	( )
10. The first trip made by a dirigible across the Atlantic was made in (*a.* 1907, *b.* 1914, *c.* 1919, *d.* 1924, *e.* 1928, *f.* 1932).	10. _____	( )

NAME CLASS DATE RATING

UNIT XIII SET X TEST II

DIRECTIONS. Study the diagrams carefully before you attempt to fill out the blanks at the right.

(A)



The cantilever bridge is indicated by letter (1) ____, the triangular truss bridge by letter (2) ____, the arch bridge by letter (3) ____, the suspension bridge by letter (4) ____, the girder bridge by letter (5) ____, and the modified truss bridge by (6) _____. The Brooklyn Bridge is a good example of a (7) ____ bridge. The most simple bridge used for crossing a short span is the (8) ____ bridge. For slightly greater spans, or where heavier loads must be supported, the next most simple bridge is the (9) ____ bridge. Where very great distances must be connected the principle of the (10) ____ is used.

(B)

This demonstration was to show how the (1) ____ may rise and sink in water. Bottle *B* is filled with just enough water so that its (2) ____ is slightly less than the weight of its own (3) ____ of water. The space *X* in the small bottle is filled with (4) _____. When pressure is placed upon the diaphragm at *A*, more water is forced into the space *X*, because the (5) ____ is the only compressible substance in the large container *C*. This makes the (6) ____ of bottle *B* slightly more than the weight of its own (7) ____ of water and thus it will (8) _____. When the pressure is released at diaphragm *A*, the (9) ____ at space *X* (10) ____ and forces the water out, thus making it lighter and allowing it to float to the surface.

Answers	Score
1. _____	( )
2. _____	( )
3. _____	( )
4. _____	( )
5. _____	( )
6. _____	( )
7. _____	( )
8. _____	( )
9. _____	( )
10. _____	( )
1. _____	( )
2. _____	( )
3. _____	( )
4. _____	( )
5. _____	( )
6. _____	( )
7. _____	( )
8. _____	( )
9. _____	( )
10. _____	( )

NAME CLASS DATE RATING

UNIT XIII SET X TEST III

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You are to choose a particular phrase to fit a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. Cars with wheels of large diameter do less damage to pavement than cars with wheels of small diameter because	A. it costs less. B. it stops the action of the induction coil. C. the material out of which it is made is lighter than air.	1. ------- ( )	
2. The gyro-compass has displaced the magnetic compass in most ocean-going vessels because	D. it is inflammable. E. the center of gravity is raised.	2. ------- ( )	
3. Carbon dioxide gas is undesirable for filling balloons because	F. it is more easily constructed. G. they do not have such large tires.	3. ------- ( )	
4. In stopping an automobile the driver releases the clutch because	H. they revolve more slowly and pick up less material.	4. ------- ( )	
5. Helium gas is rapidly displacing hydrogen gas for filling dirigibles because	I. it indicates the geographic north pole.	5. ------- ( )	
6. A balloon properly filled with hydrogen gas will rise because	J. it is too heavy. K. it cannot catch fire.	6. ------- ( )	
7. A canoe is more easily upset when people stand in it than if they remain seated because	L. of the buoyancy of the air. M. a canoe is easily upset. N. it disconnects the motor from the transmission.	7. ------- ( )	

NAME CLASS DATE RATING

UNIT XIII SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. Land transportation is being improved:
   (*a*) by the development of better fuels. *a.* _____ ( )
   (*b*) by the discovery of methods to neutralize gravity. *b.* _____ ( )
   (*c*) by the discovery of new ways to increase the friction in machines. *c.* _____ ( )
   (*d*) by the development of stronger and tougher steel alloys. *d.* _____ ( )
   (*e*) by the building of more hard-surfaced roads. *e.* _____ ( )

2. A submarine:
   (*a*) is made of material which is lighter than water. *a.* _____ ( )
   (*b*) contains air-tight tanks which contain a gas heavier than water. *b.* _____ ( )
   (*c*) is propelled by a Diesel oil engine while submerged under water. *c.* _____ ( )
   (*d*) can use electric lights while fully submerged. *d.* _____ ( )
   (*e*) theoretically can submerge to any desired depth and remain quietly at that level. *e.* _____ ( )

3. The storage battery in a car:
   (*a*) furnishes electrical energy for operating the carburetor. *a.* _____ ( )
   (*b*) furnishes electrical energy to drive the motor which starts the engine. *b.* _____ ( )
   (*c*) is kept charged by a generator which is run by the engine. *c.* _____ ( )
   (*d*) is directly connected to the engine spark plugs. *d.* _____ ( )
   (*e*) furnishes electrical energy to operate the flywheel. *e.* _____ ( )

4. The lifting power of an aëroplane is dependent upon:
   (*a*) the weight of the load carried. *a.* _____ ( )
   (*b*) the area of the wing surface. *b.* _____ ( )
   (*c*) the air pressure. *c.* _____ ( )
   (*d*) the density of the material used in the fuselage. *d.* _____ ( )
   (*e*) the speed with which it is flying. *e.* _____ ( )

Results of Test XIV

(Communication)

Table XVII shows the per cents made by each pupil in Test XIV, and Figure 17 shows the ranking of each pair of pupils with each other and also with each other pair. The median of each class is also shown.

The highest score was seventy-seven and was made by a pupil in the experimental class. The highest score in the lecture class was seventy-five. The lowest score in the experimental class was forty-seven, and that of the lecture class forty-seven.

The median of the lecture class exceeded that of the experimental four and seven-tenths per cent. This difference states statistically that out of a hundred chances it has ninety-five chances of being significant. This unit included many demonstrations similar to those in unit thirteen. It included demonstrations on electromagnet, electric bell, telegraph systems, telephone transmitter and receiver, and radio. These demonstrations were performed by the experimental class in the laboratory, while the lecture group studied the diagrams in the text as they were explained by the instructor.

The results in this unit are practically the same as in unit thirteen. This might be expected as the two units contain material of a similar nature. The same explanation may be given for the lecture class exceeding the experimental class as was given in unit thirteen.

In pair nine the pupil in the experimental class exceeded the pupil in the lecture class by five per cent. In pair nineteen the pupil in the experimental class exceeded the pupil in the lecture class by one per cent.

The per cents of thirteen pupils in the lecture class exceeded those in experimental class, and in the other seven pairs the experimental class exceeded the lecture.

TABLE XVII

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST FOURTEEN
(Communication)

EXPERIMENTAL			LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	52.6	T.F.	63.16
2	E.N.	63.15	D.M.	52.63
3	K.B.	60.65	A.E.	64.91
4	S.N.	57.89	V.H.	52.84
5	R.G.	63.16	R.W.	59.65
6	B.S.	64.14	A.W.	61.40
7	D.S.	49.11	M.B.	61.44
8	N.H.	47.37	E.S.	75.44
9	B.W.	63.16	M.W.	57.89
10	W.O.	56.14	D.S.	63.28
11	C.S.	70.18	D.C.	73.68
12	B.S.	49.12	D.D.	59.65
13	B.H.	75.44	D.V.	66.66
14	I.P.	49.12	E.S.	66.66
15	D.C.	70.18	R.W.	73.68
16	F.K.	52.63	F.K.	56.32
17	K.S.	57.89	R.T.	71.93
18	W.H.	56.14	J.S.	66.67
19	H.K.	47.36	G.K.	46.39
20	R.C.	77.19	J.W.	52.63
	Median	57		62.3
	Mean	58.73		62.34
	Range	47-77		46-75
	Q. D.	4.7		6.14

In Pair 1, pupil "M.T." made a score of 52.6; pupil "T.F." the other member of the pair made 63.16%. Read in like manner for succeeding pairs.

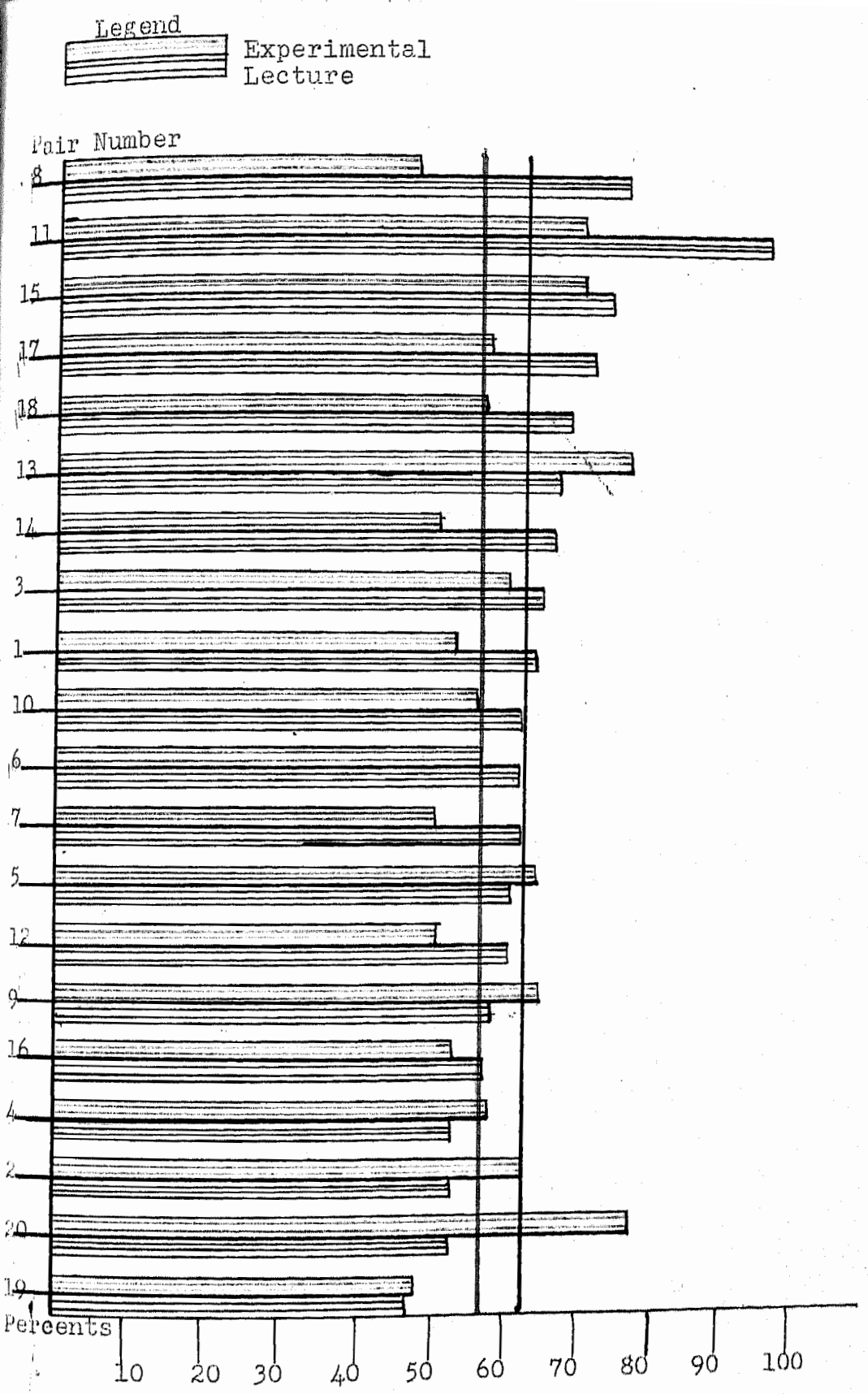


Figure 17

Ranking of Pupils in Test XIV
(Communication)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

COMMUNICATION

UNIT XIV SET X TEST I

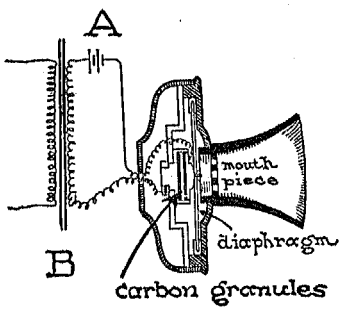
DIRECTIONS. Place the *letter* of the correct response in the space at the right.

	Answers	Score
1. The heliograph is an instrument which (*a.* RECORDS INCOMING TELEGRAPHIC MESSAGES, *b.* TRANSFORMS ELECTRIC VIBRATIONS INTO LIGHT, *c.* FLASHES MESSAGES BY REFLECTING THE SUN'S RAYS).	1. _____	( )
2. A wave of air with a frequency of (*a.* 10, *b.* 3,500, *c.* 72,000, *d.* 186,000) vibrations per second would affect the human organ of hearing.	2. _____	( )
3. The first message ever sent over a telegraph was sent about (*a.* 200, *b.* 900, *c.* 70, *d.* 50, *e.* 25) years ago.	3. _____	( )
4. In a telephone microphone the pressure on the carbon granules is varied by (*a.* AN ALTERNATING CURRENT, *b.* THE RESISTANCE OF THE CIRCUIT, *c.* THE VIBRATING DIAPHRAGM, *d.* AN ELECTROMAGNET).	4. _____	( )
5. The first successful Atlantic cable was laid by (*a.* EDISON, *b.* BELL, *c.* HENRY, *d.* MORSE, *e.* FIELD).	5. _____	( )
6. International radiophone communication was begun about (*a.* 75, *b.* 45, *c.* 25, *d.* 13, *e.* 9, *f.* 6, *g.* 2) years ago.	6. _____	( )
7. The sensitive and efficient telephone transmitter into which the person who broadcasts speaks is called a (*a.* HELIOPHONE, *b.* VACUUM TUBE, *c.* TELEPHONE, *d.* MULTIPLEX, *e.* MICROPHONE).	7. _____	( )
8. In radio broadcast transmission the device which produces the high frequency alternating current is called the (*a.* OSCILLATING TUBE, *b.* DETECTOR, *c.* CARRIER WAVE, *d.* AMPLIFIER, *e.* MODULATOR TUBE).	8. _____	( )
9. If you picked up a message at a frequency of 1000 kilocycles, it would be (*a.* BROADCAST, *b.* GOVERNMENT, *c.* AMATEUR TELEGRAPH, *d.* RADIO COMPASS, *e.* AMATEUR SHORT WAVE) message.	9. _____	( )
10. The man who invented the three element radio vacuum tube was (*a.* MAXWELL, *b.* HERTZ, *c.* MARCONI, *d.* EDISON, *e.* DEFOREST).	10. _____	( )
11. The device which is used for changing electrical energy into light energy is called (*a.* A VACUUM TUBE, *b.* A PHOTO-ELECTRIC CELL, *c.* A DRY CELL, *d.* NEON-TUBE, *e.* AN OSCILLATOR TUBE).	11. _____	( )

NAME CLASS DATE RATING

UNIT XIV SET X TEST II

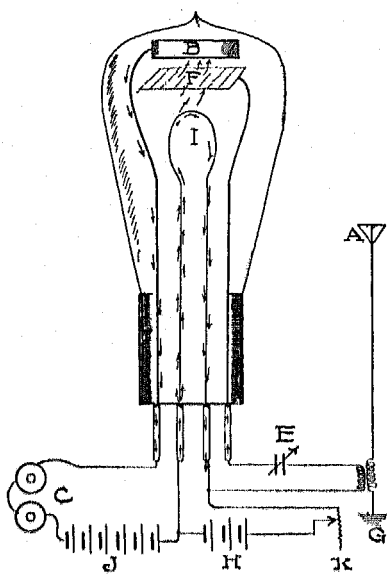
DIRECTIONS. Study the diagrams carefully before you attempt to fill in the blanks at the right.



This is a picture of a typical (1) ____ transmitter. The voice waves in the (2) ____ cause the (3) ____ to move to and fro. The resulting changes in (4) ____ on the carbon granules in the little box varies the (5) ____ of the circuit. When the carbon particles are compressed, (6) ____ current is allowed to flow in the circuit from the battery of dry cells at (7) ____, and when the carbon particles are allowed to separate due to decreased pressure, (8) ____ current will flow in the circuit. This varying current has to pass through the (9) ____ coil at *B*. In this coil the current is stepped up to a higher (10) ____ before going out on the main line.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )

This is a diagrammatic representation of a radio tube, and the wiring diagram of a simple radio receiving set. Opposite each of the parts place the letter found in the diagram which locates that part.



	Answers	Score
A battery	11. -------	( )
B battery	12. -------	( )
Phone receivers	13. -------	( )
Resistance	14. -------	( )
Aërial	15. -------	( )
Ground	16. -------	( )
Condenser	17. -------	( )
Plate	18. -------	( )
Filament	19. -------	( )
Grid	20. -------	( )

NAME CLASS DATE RATING

UNIT XIV SET X TEST III

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain *lettered* phrases. You are to choose a particular phrase to fit a particular statement. Place the *letter* of the proper phrase in the space at the right which makes the best sense. There are more phrases than statements.

Statements	Phrases	Answers	Score
1. When the circuit is closed, the hammer moves over and hits the gong in an electric bell because	A. it is difficult to receive distant stations when close to a powerful transmitter.	1. ------- ( )	
2. It is possible to communicate over long distances by means of dots and dashes because	B. sound waves travel in water.		
3. There is no need of a battery of dry cells to operate the receiver of a telephone because	C. it transforms changes in light energy into varying electric currents.	2. ------- ( )	
4. The transmitter of a high-powered radio station is generally located several miles from the studio because	D. of the magnetic force of the electromagnet.	3. ------- ( )	
5. It is possible to receive radio broadcast music when submerged in a submarine because	E. electromagnetic waves travel so rapidly.		
6. The photo-electric cell is a necessity in sending photographs by radio because	F. the electrical energy comes from the transmitter.	4. ------- ( )	
	G. it causes light waves to travel greater distances.		
	H. ether fills all the space between molecules of water.	5. ------- ( )	
	I. radio artists dislike the sound of the machinery in the transmitting station.	6. ------- ( )	
	J. electrical energy is not used in a telephone receiver.		
	K. a definite code has been worked out upon which the person sending and the person receiving have agreed.		
	L. the magnetism in the gong attracts the hammer.		

NAME _____ CLASS _____ DATE _____ RATING _____

UNIT XIV SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

	Answers	Score
1. An electromagnet:		
(*a*) is used in a common electric bell.	*a.* _____ ( )	
(*b*) is used in an electric telegraph sounder.	*b.* _____ ( )	
(*c*) is used in the telephone receiver.	*c.* _____ ( )	
(*d*) is used in a radio tube.	*d.* _____ ( )	
(*e*) is used in a radio telephone microphone.	*e.* _____ ( )	
2. When a telegraph message is being transmitted:		
(*a*) the electric circuit between sender and receiver is closed all of the time.	*a.* _____ ( )	
(*b*) the sounder armature is drawn down when the sender closes the key.	*b.* _____ ( )	
(*c*) the switch on the sending key is left open.	*c.* _____ ( )	
(*d*) the armature of the sounder is repelled upward by magnetism.	*d.* _____ ( )	
(*e*) there will be a dot and a dash at the sounder for every dot and dash made at the sending key.	*e.* _____ ( )	
3. A radio tube is useful:		
(*a*) for making weak signals strong in a long distance telephone line.	*a.* _____ ( )	
(*b*) for producing a high frequency alternating current.	*b.* _____ ( )	
(*c*) for changing alternating current into direct current.	*c.* _____ ( )	
(*d*) for amplifying radio signals.	*d.* _____ ( )	
(*e*) for impressing a voice wave upon a high frequency carrier wave.	*e.* _____ ( )	
4. The photo-electric cell:		
(*a*) will change light energy into electrical energy.	*a.* _____ ( )	
(*b*) will change sound energy into electrical energy.	*b.* _____ ( )	
(*c*) will change electrical energy into light energy.	*c.* _____ ( )	
(*d*) will change mechanical energy into electrical energy.	*d.* _____ ( )	
(*e*) will change electrical energy into sound energy.	*e.* _____ ( )	

Results of Test XV

(The Earth and Its Neighbors)

Table XVIII shows the per cents made by each pupil in Test XV, while Figure 18 shows the ranking of each pair of pupils with each other and also with each other pair. The median of each class is also shown.

The highest score was eighty and was made by a pupil in the lecture class. This exceeded the highest score in the experimental class by two per cent. The lowest score was twenty-five, made by a pupil in the lecture class. The lowest score in the experimental class was thirty-nine.

The median of the lecture class exceeded that of the experimental three per cent. This difference statistically means that out of one hundred it has eighty chances of being a significant difference.

In this unit there were a number of new terms that had to be learned, but there were few demonstrations to be performed as laboratory experiments. The fact that the experimental group worked from their manuals and less time was given to discussion in class may have been one reason for the experimental class ranking lower than the lecture. This study would indicate that on material of this nature where the laboratory manual is used, more time should be spent in classroom discussion than was spent in the experimental class.

In pair nine the pupil in the experimental class excelled the lecture pupil by two per cent. In pair eighteen the pupil in the lecture class exceeded the pupil in the experimental class thirty-four per cent, but this great difference may be due to the fact that the pupil in the experimental class was absent two days during the study of this unit.

The per cents made by thirteen pupils in the lecture class exceed the per cents made by the pupils with whom they were paired in the experimental class. In the other seven pairs the per cents made by the experimental pupils exceeded those made by the lecture.

TABLE XVIII

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST FIFTEEN
(THE EARTH AND ITS NEIGHBORS)

EXPERIMENTAL			LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	60.6	T.F.	64.64
2	E.N.	69,69	D.M.	25.76
3	K.B.	56.06	A.E.	60.60
4	S.N.	45.45	V.H.	45.50
5	R.G.	50.00	R.W.	66.67
6	B.S.	51.52	A.W.	59.09
7	D.S.	42.11	M.B.	59.24
8	N.H.	43.94	E.S.	57.58
9	B.W.	48.48	M.W.	46.81
10	W.O.	50.00	D.S.	51.52
11	C.S.	71.25	D.C.	77.25
12	B.S.	56.05	D.D.	42.42
13	B.H.	54.54	D.V.	54.67
14	I.P.	39.39	E.S.	43.97
15	D.C.	57.27	R.W.	69.69
16	F.K.	43.93	F.K.	38.03
17	K.S.	45.45	R.T.	50.00
18	W.H.	46.97	J.S.	80.30
19	H.K.	64.55	G.K.	51.52
20	R.C.	78.79	J.W.	53.03
	Median	50.7		53.7
	Mean	53.30		54.35
	Range	39-78		25-80
	Q. D.	6.38		5.60

In Pair 1, pupil "M.T." made a score of 60.6; pupil "T.F." the other member of the pair made 63.16%. Read in like manner for succeeding pairs.

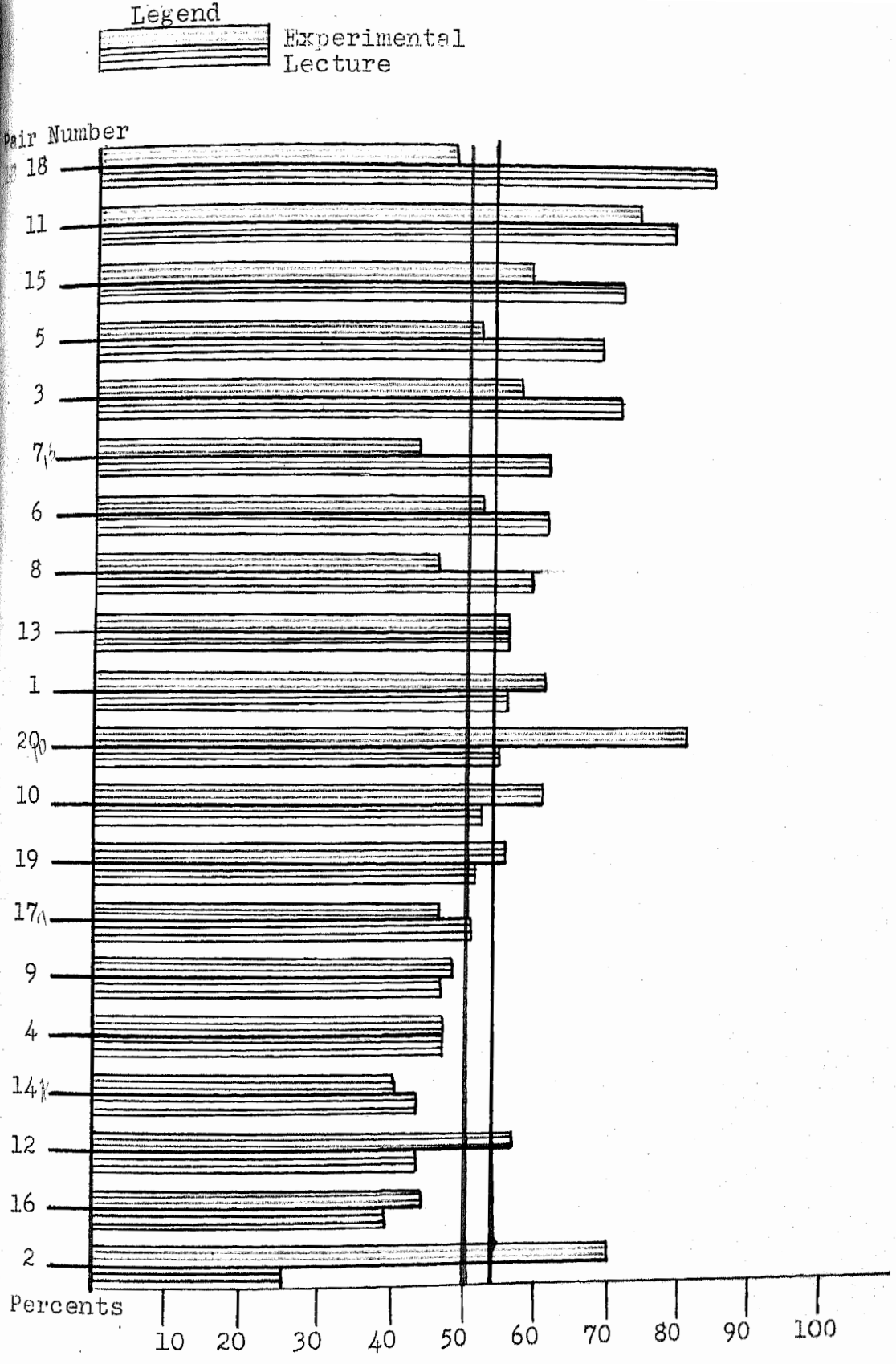


Figure 18

Ranking of Pupils in Test XV
(The Earth and Its Neighbors)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

THE EARTH AND ITS NEIGHBORS

UNIT XV SET X TEST I

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space at the right of the sentences.

A. The light second
B. Meteors
C. 12 hours
D. New moon
E. 186,000 miles per minute
F. First quarter
G. Nebular hypothesis
H. 186,000 miles per second
I. The moon
J. Last quarter
K. Asteroids
L. Neap tide
M. Comets
N. Ebb tide
O. Constellations
P. Stars
Q. Six hours
R. The light speed
S. 24 hours
T. Flood tide
U. The milky way
V. Spring tide
W. Galaxies
X. Full moon
Y. Satellites
Z. 186,000 miles per hour
AA. Planetesimal hypothesis
BB. The light year
CC. The sun

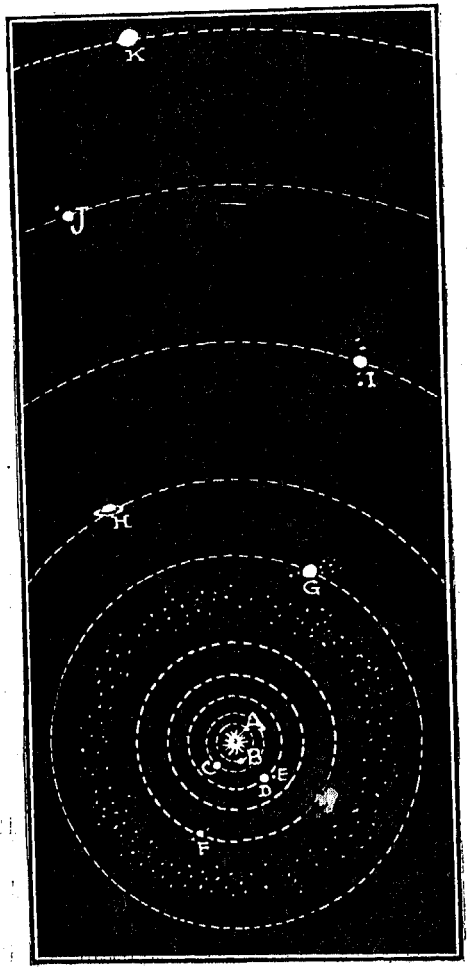
	Answers	Score
1. The source of energy which makes plants grow.	1. _____	( )
2. The name of the earth's satellite.	2. _____	( )
3. The approximate amount of time between two consecutive high tides at Boston.	3. _____	( )
4. What the hours of incoming tide water are called.	4. _____	( )
5. What the extra high high tide is called.	5. _____	( )
6. The phase of the moon at the time of an eclipse of the sun.	6. _____	( )
7. A discarded theory as to the possible origin of the earth and other planets of the solar system.	7. _____	( )
8. The numerous small bodies of the solar system with their orbits between Mars and Jupiter.	8. _____	( )
9. The kind of heavenly bodies which commonly visit our solar system and then leave again.	9. _____	( )
10. What star groups are called.	10. _____	( )
11. The speed of light.	11. _____	( )
12. The yardstick used by astronomers in measuring the distance to stars.	12. _____	( )

NAME

UNIT XV SET X TEST II

DIRECTIONS. Study the diagram carefully before you attempt to fill out the blanks at the right.

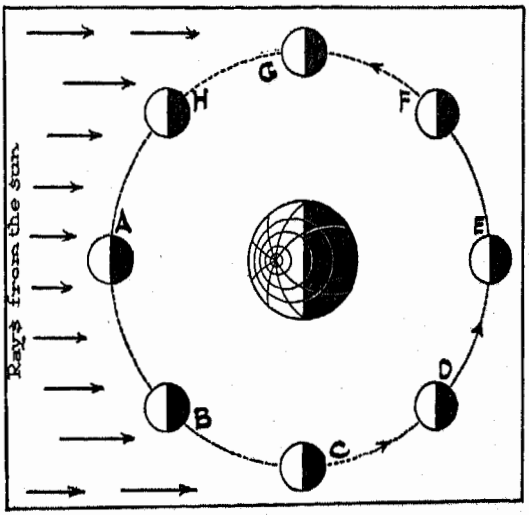
This is a diagram of the solar system. The sun is indicated by letter (1) ____, Saturn by letter (2) ____, Jupiter by letter (3) ____, the earth's moon by letter (4) ____, Mercury by letter (5) ____, Mars by letter (6) ____, Neptune by letter (7) ____, and Venus by letter (8) ____. The asteroids would be found in the space between the orbits indicated by letters (9) ____ and (10) ____.



Answers	Score
1. _____	( )
2. _____	( )
3. _____	( )
4. _____	( )
5. _____	( )
6. _____	( )
7. _____	( )
8. _____	( )
9. _____	( )
10. _____	( )

UNIT XV SET X TEST III

DIRECTIONS. Study the diagram carefully before you attempt to fill in the blanks at the right.



This diagram shows various relative positions of the moon, earth, and sun. These various positions affect tides upon the earth. An extra high high-tide upon the earth is called (1) ____ and would occur when the moon was in either position lettered (2) ____ or (3) _____. The lowest high-tide which is experienced upon the earth is called (4) ____ tide, and would occur when the moon was in either position lettered (5) ____ or (6) _____.

Answers	Score
1. _____	( )
2. _____	( )
3. _____	( )
4. _____	( )
5. _____	( )
6. _____	( )

NAME _____ CLASS _____ DATE _____ RATING _____

UNIT XV SET X TEST IV

DIRECTIONS. In this test you will find at the left certain statements and at the right certain phrases. You must pick out from the list at the right some particular phrase that will fit a particular statement. There will be more phrases than statements. Place in the space at the right of the phrases the *letter* of the phrase that makes sense.

Statements	Phrases	Answers Score
1. Man could not live on the moon because	A. the lighted side of the moon is away from the earth.	1. ------- ( )
2. We never see but one side of the moon because	B. it is in line with the axis of the earth.	2. ------- ( )
3. The moon is a greater factor than the sun in causing tides upon the earth because	C. the North Star does not appear to move.	3. ------- ( )
4. Different amounts of the lighted portion of the moon are visible on the earth at different times because	D. it is too close to the sun. E. it does not rotate on its axis. F. it is larger than the sun. G. it has more gravity concentrated in it.	4. ------- ( )
5. The Big Dipper appears to revolve about the North Star because	H. it casts a shadow on the earth. I. the moon changes its shape.	5. ------- ( )
6. When we have an eclipse of the moon, it is because	J. it rotates on its axis once for every complete revolution about the earth.	6. ------- ( )
7. Life as we know it could not exist upon Mercury because	K. it has no atmosphere.	7. ------- ( )
8. The North Star does not appear to move in the heavens because	L. of the rotation of the earth. M. of its change in relative position. N. it is too far away from the sun. O. it gets in the earth's shadow. P. it is closer to the earth.	8. ------- ( )

NAME _____ CLASS _____ DATE _____ RATING _____

UNIT XV SET X TEST V

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

1. All of the planets of the solar system:

	Answers	Score
(*a*) revolve about the sun in the same direction.	*a.*	( )
(*b*) have the same number of satellites.	*b.*	( )
(*c*) travel at the same speed about the sun.	*c.*	( )
(*d*) receive the same amount of energy from the sun.	*d.*	( )
(*e*) make one complete revolution about the sun every 365 days.	*e.*	( )

2. The solar system:

(*a*) is only a small part of our galaxy.	*a.*	( )
(*b*) contains more stars than planets.	*b.*	( )
(*c*) is merely another name for our galaxy.	*c.*	( )
(*d*) might reasonably be called the sun and its family.	*d.*	( )
(*e*) receives the most of its light and energy from the sun.	*e.*	( )

3. Our sun:

(*a*) is the only light-giving and energy-giving body in the solar system.	*a.*	( )
(*b*) is a star.	*b.*	( )
(*c*) is at the same distance from the earth at all seasons of the year.	*c.*	( )
(*d*) furnished the energy which is stored up in gasoline.	*d.*	( )
(*e*) is the center about which all stars in our galaxy revolve.	*e.*	( )

Answers Score

4. Our galaxy:
   (*a*) contains many stars which are invisible to the naked human eye. — *a.* _____ ( )
   (*b*) contains many stars larger than our sun. — *b.* _____ ( )
   (*c*) is the only one known to astronomers. — *c.* _____ ( )
   (*d*) is definitely known to contain many planets not in our solar system. — *d.* _____ ( )
   (*e*) is approximately ten times the size of our solar system. — *e.* _____ ( )

5. The distance from the earth to:
   (*a*) the sun is less than from the earth to Jupiter. — *a.* _____ ( )
   (*b*) Mars remains approximately constant from year to year. — *b.* _____ ( )
   (*c*) the North Star is approximately the same as the distance from the sun to Neptune. — *c.* _____ ( )
   (*d*) the moon is less than the distance from the earth to the nearest planet. — *d.* _____ ( )
   (*e*) the nearest star is less than the distance from the earth to the farthest planet in our solar system. — *e.* _____ ( )

6. An eclipse:
   (*a*) of the moon is more likely to occur than an eclipse of the sun. — *a.* _____ ( )
   (*b*) of the sun occurs when the earth is between the sun and the moon. — *b.* _____ ( )
   (*c*) of the moon could not happen while the moon is in the first quarter. — *c.* _____ ( )
   (*d*) of the sun is always at the time when the moon is full. — *d.* _____ ( )
   (*e*) of the moon would occur every month if the moon, sun, and earth were always in the same plane. — *e.* _____ ( )

Results of Test XVI

(Time and the Seasons)

Table XIX shows the per cents made by each pupil in Test XVI. Figure 19 shows the ranking of each pair of pupils with each other and also with each other pair. The median of each class is shown.

The highest score of eighty, which was made by a pupil in the lecture class, exceeded the highest score in the experimental class by a margin of six per cent. The lowest score of twenty-three was made by a pupil in the experimental class. The lowest score in the lecture class exceeded the score of twenty-three by nineteen per cent.

The median of the lecture class exceeded that of the experimental by four per cent. Statistically this difference has eighty-three chances out of one-hundred of being significant. This is a material difference, and the method of instruction must have had some effect on the results. The type of material that was presented in this chapter was of the nature that could not be performed in regular laboratory experiments. The laboratory work included work in the laboratory manual and textbook and several demonstrational experiments on light. The lecture class used only the textbook and spent much time studying the diagrams and explanations in the book.

As far as this study goes, the results of the test over this unit would indicate that material of a general discussion type illustrated by diagrams can best be taught by the lecture method. If material of an experimental nature is needed to clarify textbook material, the experimental method of teaching is very effective; otherwise it seems the lecture method is more effective.

In pair nine the pupil in the lecture class exceeded the pupil in the experimental class by a margin of nine per cent. The pupil in the lecture

class exceeded the pupil in the experimental class eight per cent, in pair eighteen.

In the twenty pairs, fourteen pupils in the lecture class exceeded the fourteen pupils with whom they were paired in the experimental class. In the other eight pairs the experimental pupils exceeded the lecture pupils.

TABLE XIX

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST SIXTEEN
(TIME AND THE SEASONS)

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	51.00	T.F.	61.70
2	E.N.	74.46	D.M.	72.34
3	K.B.	63.83	A.E.	68.13
4	S.N.	48.93	V.H.	51.06
5	R.G.	66.34	R.W.	53.19
6	B.S.	72.34	A.W.	57.45
7	D.S.	56.76	M.B.	61.72
8	N.H.	65.96	E.S.	76.60
9	B.W.	59.38	M.W.	66.00
10	W.O.	53.19	D.S.	70.21
11	C.S.	61.70	D.C.	63.80
12	B.S.	55.31	D.D.	42.55
13	B.H.	65.81	D.V.	74.47
14	I.P.	55.31	E.S.	57.45
15	D.C.	57.27	R.W.	74.46
16	F.K.	23.99	F.K.	55.33
17	K.S.	58.33	R.T.	76.59
18	W.H.	72.34	J.S.	80.29
19	H.K.	55.32	G.K.	44.00
20	R.C.	74.46	J.W.	53.03
	Median	58.8		62.7
	Mean	59.60		63.34
	Range	23-74		42-80
	Q. D.	8.5		5.4

In Pair 1, pupil "M.T." made a score of 51.00; pupil "T.F." the other member of the pair made 61.70%. Read in like manner for succeeding pairs.

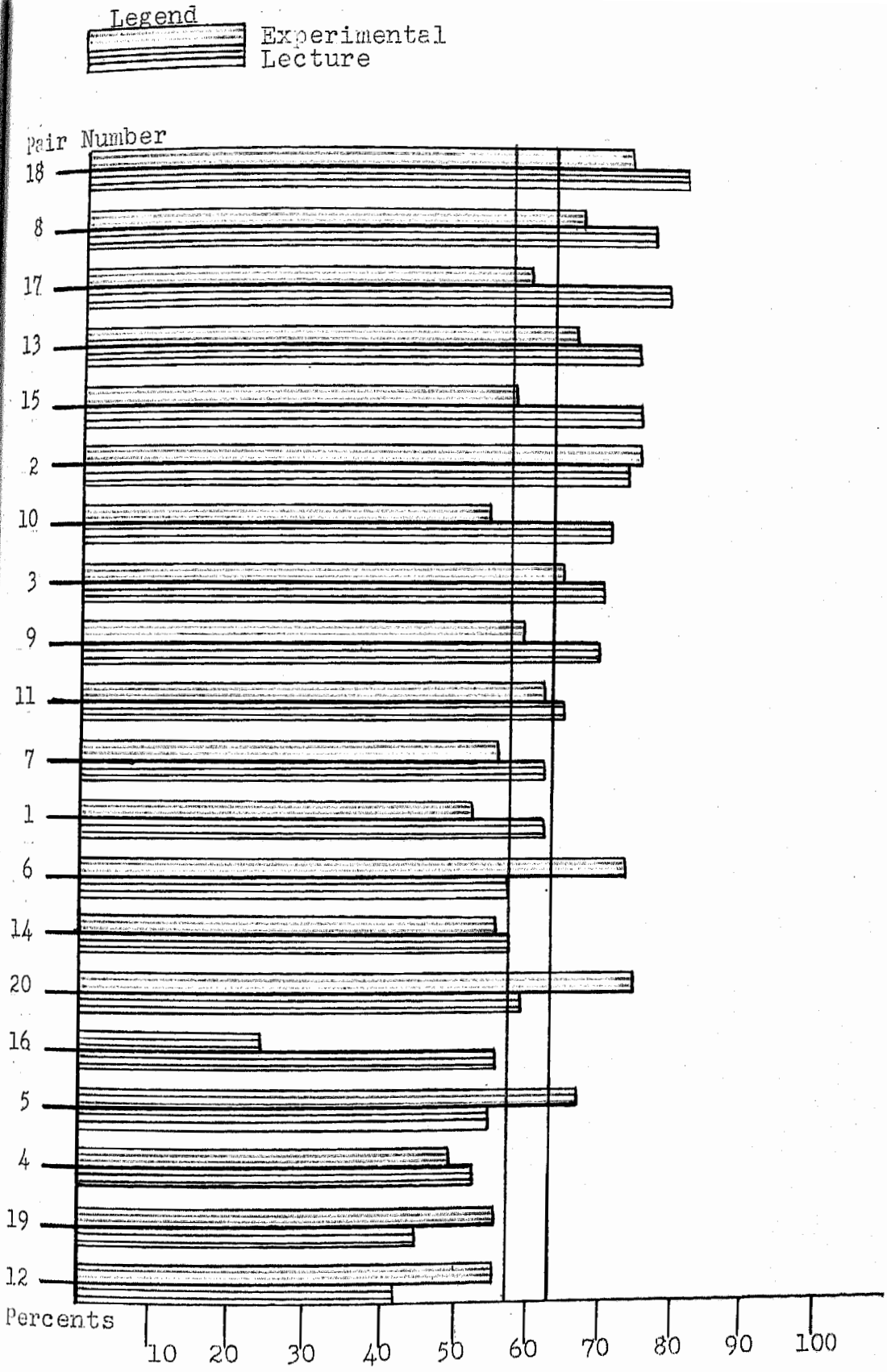


Figure 19

Ranking of Pupils in Test XVI
(Time and the Seasons)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

TIME AND THE SEASONS

UNIT XVI SET X TEST I

DIRECTIONS. Read the following sentences carefully before you attempt to fill out the blank spaces at the right.

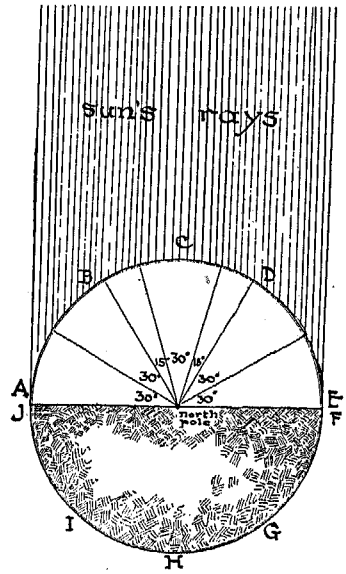
1. In revolving around the sun the earth's axis is inclined (1) ____ degrees to the plane of the earth's orbit on December 22 and June 21. On March 21 and September 22, the inclination is (2) ____ degrees.
2. The United States receives the largest number of rays of heat and light from the sun in the month of (3) _____.
3. South America receives the largest number of rays of heat and light from the sun in the month of (4) _____.
4. When it is 6 P.M. standard time in Los Angeles, it is (5) ____ standard time in Chicago.
5. When it is 5 A.M. daylight-saving time in New York City, it is (6) ____ standard time in Philadelphia.
6. The vertical rays of the sun will strike the equator on the dates (7) ____ and (8) _____.
7. In the seventeenth century, Christian Huyghens, a Dutch mathematician, applied the (9) ____ to regulate the movement of clocks.
8. In traveling from Japan to San Francisco by boat, suppose the passengers go to bed on Wednesday evening, and during the night the boat crosses the International Date Line. The passengers will wake up on (10) ____ morning.
9. In practically all modern clocks, which are not electrically driven, the power which drives the wheels is derived from the (11) _____.
10. At Huron, South Dakota, the days and nights are of equal length on the dates (12) ____ and (13) _____.

	Answers	Score
1.		( )
2.		( )
3.		( )
4.		( )
5.		( )
6.		( )
7.		( )
8.		( )
9.	pendulum	( )
10.	Wed	( )
11.		( )
12.		( )
13.		( )

NAME CLASS DATE RATING

UNIT XVI SET X TEST II

DIRECTIONS. Study the diagram carefully before you attempt to fill in the blanks at the right.



In this diagram the earth would be rotating in a direction from *J* to (1) _____. The portion of the earth's surface near letter (2) ____ would be early morning. The portion near letter (3) ____ would be evening twilight, and the portion near letter (4) ____ would be noon. The portion of the earth's surface receiving the greatest number of heat rays per square mile is near letter (5) _____. This is because the size of area covered by a beam striking the earth at an oblique angle is (6) ____ than when the beam meets the earth (7) ____ to the surface. A second reason for the greater intensity of heat from the (8) ____ is that the beam passes a (9) ____ distance through the atmosphere of the earth. A person standing at the north pole and looking directly overhead would see the (10) ____ star.

	Answers	Score
1.	_____	( )
2.	_____	( )
3.	_____	( )
4.	_____	( )
5.	_____	( )
6.	_____	( )
7.	_____	( )
8.	_____	( )
9.	_____	( )
10.	_____	( )

NAME CLASS DATE RATING

UNIT XVI SET X TEST III

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. A factor which helps cause the change of seasons on the earth is:
   (*a*) the rotation of the earth on its axis. *a.* _____ ( )
   (*b*) the revolution of the earth about the sun. *b.* _____ ( )
   (*c*) the distance of the earth from the sun. *c.* _____ ( )
   (*d*) the inclination of the earth's axis. *d.* _____ ( )

2. The summer weather in South Dakota is warmer than the winter weather because:
   (*a*) the earth is nearer the sun during the summer in South Dakota. *a.* _____ ( )
   (*b*) the sun gives off more heat rays during the summer. *b.* _____ ( )
   (*c*) the sun's rays strike that part of the earth's surface more directly in summer than in winter. *c.* _____ ( )
   (*d*) a square mile of that part of the earth's surface receives more heat rays from the sun in summer than in winter. *d.* _____ ( )

3. Standard time:
   (*a*) at Greenwich, England, is five hours ahead of standard time in an American city located on the 75th meridian west of Greenwich. *a.* _____ ( )
   (*b*) at San Francisco is four hours behind standard time at New York City. *b.* _____ ( )
   (*c*) at Cedar Rapids, Iowa, is identical with the solar time at that place. *c.* _____ ( )
   (*d*) in one time belt in the United States it is always one hour more or less than the standard time at the next adjoining time belt. *d.* _____ ( )

4. When it is 9 : 00 A.M. standard time at Santa Barbara, California, located on the 120th meridian west of Greenwich:
   (*a*) it is 12 : 00 noon at New York City. *a.* _____ ( )
   (*b*) it is 7 : 00 A.M. at Memphis, Tennessee, located on the 90th meridian west of Greenwich. *b.* _____ ( )
   (*c*) it is 5 : 00 P.M. at Greenwich, England. *c.* _____ ( )
   (*d*) it is 9 : 00 P.M. at Meshhed, Persia, located on the 60th meridian east of Greenwich, England. *d.* _____ ( )

NAME CLASS DATE RATING

UNIT XVI SET X TEST IV

DIRECTIONS. In the test below you will find at the right certain statements and at the left certain *lettered* phrases. You are to choose a particular phrase to fit a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. In the course of a year there is a variation in the number of hours of daylight at Dayton, Ohio, because	A. there is less air to bend and diffuse the light.		
2. A pendulum clock is of more value than a sundial because	B. it is needed far more in northern than in southern climates.	1. _____ ( )	
3. More heat is received from the sun at Nashville, Tenn., in July than in January because	C. it is more accurate than sidereal time.	2. _____ ( )	
4. The hours of twilight are longer in northern Canada than in Florida because	D. the sun's rays strike that part of the earth's surface more directly at that time of year.	3. _____ ( )	
5. The duration of twilight is short on a high mountain because	E. it is approximately 60 degrees across the United States.		
6. Standard time has been adopted throughout the world because	F. the sundial was invented so long ago.	4. _____ ( )	
7. The United States is divided up into four standard time belts because	G. the stars are older than the sun.	5. _____ ( )	
8. To locate positions on the earth with absolute certainty, the stars are used rather than the sun because	H. the earth's axis is inclined to the plane of the earth's orbit.	6. _____ ( )	
	I. the trees on high mountains absorb so much light.		
	J. of the great convenience to business and railroads.	7. _____ ( )	
	K. the United States has four natural geographical divisions.		
	L. of the relatively fixed positions of the stars.	8. _____ ( )	
	M. the earth rotates upon its axis.		
	N. it will work when the sun is not shining.		
	O. the earth is nearer to the sun at that time of year.		
	P. it takes longer for the sun to fall 18 degrees below the horizon at northern points than at southern points.		

Results of Test XVII

(Weather and Climate)

Table XX shows the per cents made by each pupil in Test XVII, and Figure 20 shows the ranking of each pair of pupils with each other and also with each other pair. The median of each class is also shown.

The highest score was seventy-nine, made by a pupil in the lecture class. This score is six per cent greater than the highest score in the experimental class. The lowest score was twenty-three and was made in the experimental class. The lowest score in the lecture class was forty-six.

The median in the experimental class exceeded the median in the lecture class by a margin of one per cent. This is not a material difference. Statistically it has sixty-one chances out of a hundred being significant. The experimental material in this chapter must have had some effect on the results of the test over the unit. It seems that the experimental material covered in this unit was a means of clarifying some of the textbook material. In the experimental class weather maps, barometers, barographs, rain gauges, and thermometers were studied in the laboratory. The uses of these instruments and the reading of them helped clarify much of the material in the text. If material is well illustrated and does not need experimentation to make it understandable, it seems that the experimental method of teaching is a waste of time and not as effective as the lecture method.

In pair nine the pupils in each class made the same score. In pair eighteen, the pupil in the experimental class exceeded the pupil in the lecture class five per cent.

Of the twenty pairs twelve pupils in the lecture class exceeded the pupils with whom they were paired in the experimental class, and in the other eight pairs the experimental pupils exceeded the lecture pupils.

TABLE XX

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST SEVENTEEN
(WEATHER AND CLIMATE)

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	46.6	T.F.	61.11
2	E.N.	66.66	D.M.	48.14
3	K.B.	66.66	A.E.	50.00
4	S.N.	50.00	V.H.	57.15
5	R.G.	60.00	R.W.	61.67
6	B.S.	58.33	A.W.	62.22
7	D.S.	46.67	M.B.	75.94
8	N.H.	65.00	E.S.	70.39
9	B.W.	53.33	M.W.	53.70
10	W.O.	73.33	D.S.	66.67
11	C.S.	73.33	D.C.	57.40
12	B.S.	56.66	D.D.	56.66
13	N.H.	56.66	D.V.	59.26
14	I.P.	41.66	E.S.	53.70
15	D.C.	73.33	R.W.	57.40
16	F.K.	23.99	F.K.	59.26
17	K.S.	56.33	R.T.	79.63
18	W.H.	60.00	J.S.	55.56
19	H.K.	55.00	G.K.	55.22
20	R.C.	73.33	J.W.	46.29
	Median	58.3		57.4
	Mean	57.94		59.36
	Range	23-73		46-79
	Q. D.	5.6		7.7

In Pair 1, pupil "M.T." made a score of 46.6; pupil "T.F." the other member of the pair made 61.11%. Read in like manner for succeeding pairs.

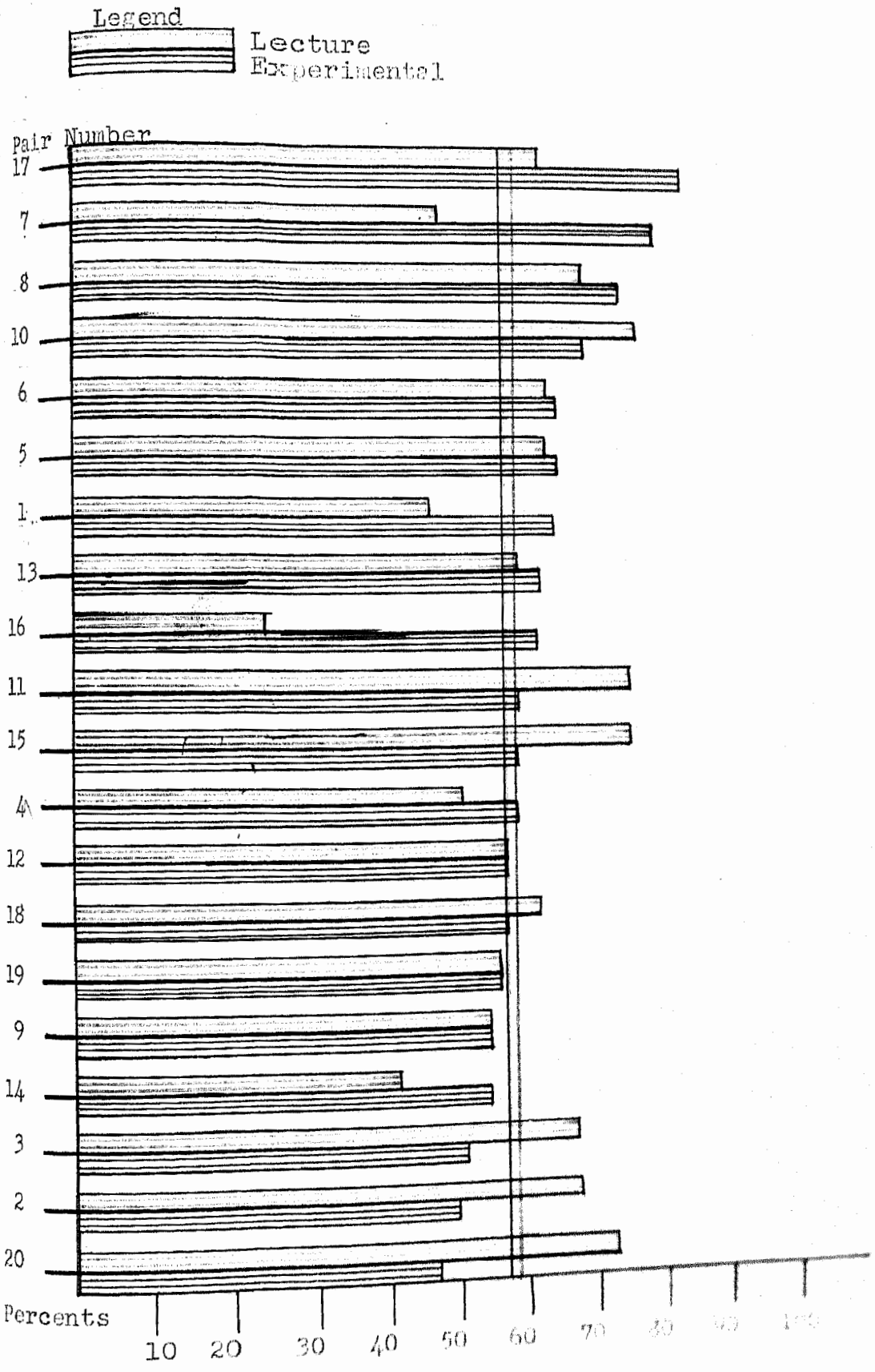


Figure 20

Ranking of Pupils in Test XVII
(Weather and Climate)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

WEATHER AND CLIMATE

UNIT XVII SET X TEST I

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out a particular word that will fit a particular statement. Place the *letter* of the word that matches in the space at the right of the sentences.

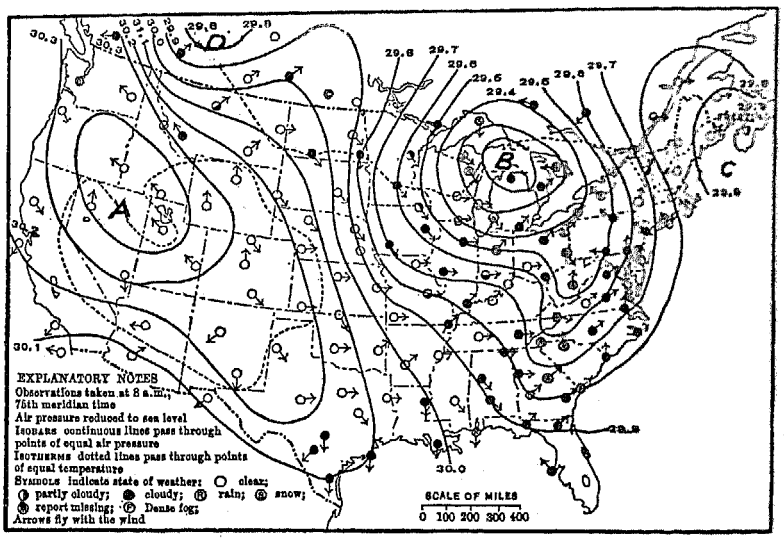
A. Anemometer
B. North to south
C. Tornado
D. $\frac{1}{5}$ of a mile
E. Stars
F. Dew point
G. Humidity
H. Hygrometer
I. West to east
J. Cyclonic
K. Sun
L. Seventy-five miles
M. Evaporation
N. Stratus
O. Barograph
P. Cirrus
Q. Condensation
R. Three miles
S. Moon
T. Anticyclonic
U. East to west
V. Hydrometer
W. Relative humidity
X. Freezing point
Y. Absolute humidity
Z. South to north
AA. Cumulus
BB. 15 miles

	Answers	Score
1. The source of the energy which causes changes in weather.	1. -------	( )
2. The process by which the water of a lake is changed into water vapor.	2. -------	( )
3. Another name commonly used which means the same as the saturation point of air.	3. -------	( )
4. The ratio between the amount of water a unit volume of air actually holds, and what it would hold if it were saturated.	4. -------	( )
5. The name of the instrument which *measures* the amount of water vapor in the air.	5. -------	( )
6. The type of storm area where the air is slowly moving inward and upward.	6. -------	( )
7. The approximate direction of motion of areas of high air pressure across the United States.	7. -------	( )
8. The approximate distance away of a lightning flash when 15 seconds elapsed before the thunder was heard.	8. -------	( )
9. The name of the instrument which *records* the changes in air pressure as they occur.	9. -------	( )
10. The type of cloud which is most likely to bring a local thunderstorm.	10. -------	( )

NAME CLASS DATE RATING

UNIT XVII SET X TEST II

DIRECTIONS. Study the map carefully before you attempt to fill in the blanks in the spaces at the right.



This is a diagram of a (1) ____ map. There is a cyclonic area at the points lettered (2) ____ and (3) _____. The anticyclonic areas are located at points lettered (4) ____ and (5) _____. The direction of the wind across the state of Wyoming is toward the (6) _____. In the city of Chicago they are having (7) ____ weather while in Alabama and South Carolina it is (8) _____. The barometric pressure in southern Texas is (9) ____ while in the city of Chicago it is (10) _____.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )

NAME CLASS DATE RATING

UNIT XVII SET X TEST III

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You are to pick out from the list at the right some particular phrase that will fit a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. The east side of the Rocky Mountains is a region of little rainfall because	A. the temperature does not fall low enough to reach the saturation point of the air.	1. ------- ( )	
2. During a summer afternoon, at almost any ocean resort, the breeze will blow in from the ocean because	B. it does so much damage.		
3. Cloudiness generally accompanies an area of low air pressure because	C. it is a desert.		
4. One reason why the people of the Middle Western States are active and resourceful is because	D. the perspiration on his body does not rapidly evaporate.	2. ------- ( )	
5. There are many nights when there is no dew formed upon the grass because	E. air is a poor conductor.		
6. A person feels uncomfortable on a warm day of high relative humidity because	F. the prevailing winds come from the west.	3. ------- ( )	
7. The wind always moves in a general direction from an anticyclonic area to a cyclonic area because	G. the air is rising in cyclonic areas.		
8. A tornado is known as a *local* storm because	H. the air is rising and being cooled below the saturation point.	4. ------- ( )	
9. There are many convection currents in the earth's atmosphere because	I. there is no moisture in the air.		
10. The relative humidity of a poorly ventilated room full of people increases because	J. the barometric pressure is always relatively low in a cyclonic area.	5. ------- ( )	
	K. it is helpful in making the beaches cool.		
	L. it rarely covers more than a small territory.	6. ------- ( )	
	M. the price of farm products have been too low.		
	N. the ocean is heated less rapidly than the land.	7. ------- ( )	
	O. it is always cloudy when it rains.	8. ------- ( )	
	P. the climate is temperate with moderate changes of temperature.		
	Q. of the unequal heating of the earth's surface.	9. ------- ( )	
	R. air from the lungs is laden with water vapor.	10. ------- ( )	
	S. it is lighter than cold, dry air.		

CLASS DATE RATING

UNIT XVII SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers **Score**

People having the greatest human energy are more generally found:

a) in climates like northern Canada. *a.* _____ ( )

b) in localities where the relative humidity is always high. *b.* _____ ( )

c) in the tropical and semi-tropical regions of the world. *c.* _____ ( )

d) in regions where changes in temperature are frequent. *d.* _____ ( )

e) in climates like that of Minnesota. *e.* _____ ( )

Climate:

(a) is approximately the same over a long period of time in any certain locality. *a.* _____ ( )

(b) is more greatly affected by the nearness of large bodies of water than by any other factor. *b.* _____ ( )

(c) is the result of several factors. *c.* _____ ( )

(d) is largely responsible for the kind of industry which is found in a certain locality. *d.* _____ ( )

(e) in any locality might be changed if the altitude of the place were changed. *e.* _____ ( )

Values which come from the work of the United States Weather Bureau are:

(a) the changing of poor climates in certain localities to good climates. *a.* _____ ( )

(b) the control of the weather for the good of industry. *b.* _____ ( )

(c) the irrigation of arid lands so that crops may be raised. *c.* _____ ( )

(d) the protection of mountain forests so that floods may be prevented. *d.* _____ ( )

(e) the prediction of weather changes so that industry may be prepared for the change. *e.* _____ ( )

Answers Score

4. As a basis for making weather forecasts, the United States Weather Bureau collects and records the following information:

(a) the changes which are taking place in the position of the moon. a. _____ ( )

(b) the anemometer reading. b. _____ ( )

(c) changes in the barometer reading. c. _____ ( )

(d) the dew point. d. _____ ( )

(e) the temperature. e. _____ ( )

5. The wet bulb thermometer of a hygrometer:

(a) has its temperature lowered by evaporation. a. _____ ( )

(b) shows a higher temperature than the dry bulb thermometer when in an anticyclonic area. b. _____ ( )

(c) would read the same as the dry bulb thermometer if the hygrometer were in atmosphere which was saturated. c. _____ ( )

(d) has its temperature increased by a raise in dew point, when the temperature of the dry bulb thermometer remains constant. d. _____ ( )

(e) would read the same temperature as the dry bulb thermometer if the wick should be allowed to become dry. e. _____ ( )

6. The earth's atmosphere:

(a) becomes heavier as it has more water evaporated into it. a. _____ ( )

(b) becomes lighter as it becomes warmer. b. _____ ( )

(c) increases in capacity to hold water vapor as it is cooled. c. _____ ( )

(d) may become cooled if allowed to suddenly expand. d. _____ ( )

(e) is caused to move over the earth's surface because of differences in air pressure. e. _____ ( )

Results of Test XVIII

(How the Earth Has Been Prepared for Life)

Table XXI shows the per cents made by each pupil in Test XVIII. Figure 21 shows the ranking of each pair of pupils with each other and also with each other pair. The median of each class is also shown.

The highest score was eighty-six, and it was made by a pupil in the experimental class. This score is six per cent greater than the highest score in the lecture class. The lowest score was forty-one, and it was also made by a pupil of the experimental class. The lowest score in the lecture class exceeded the lowest score in the experimental class by nine per cent.

The median in the lecture class exceeded that in the experimental class five per cent. This difference is a material difference. Statistically it has ninety-three chances in one hundred of being significant. The results of this test indicate that the material in this unit is lecture material. It is of a general nature and experiments are not necessary. There is evidence that material of this nature, that is explained fully in the text and does not suggest material for experimentation, is best taught by the lecture method.

In pair nine the experimental pupil exceeded the lecture pupil by a margin of eleven per cent. In pair eighteen the pupil in the lecture class exceeded the pupil in the experimental fourteen per cent. The pupil in the lecture class in pair nine was absent three days, and this may have been the reason for her score being below the median of the class and below that of the pupil with whom she was paired.

Of the twenty pairs in the study twelve of the pupils in the lecture class ranked higher than the twelve with whom they were paired in the experimental class. In the other eight pairs the experimental pupils exceeded those in the lecture class.

TABLE XXI

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST EIGHTEEN
(HOW THE EARTH HAS BEEN PREPARED FOR LIFE)

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	50.1	T.F.	63.08
2	E.N.	72.31	D.M.	69.23
3	K.B.	72.31	A.E.	69.23
4	S.N.	56.92	V.H.	66.16
5	R.G.	56.92	R.W.	63.08
6	B.S.	72.31	A.W.	64.91
7	D.S.	56.92	M.B.	80.00
8	N.H.	64.61	E.S.	72.31
9	B.W.	70.77	M.W.	58.92
10	W.O.	67.69	D.S.	75.40
11	C.S.	63.86	D.C.	61.51
12	B.S.	58.45	D.D.	52.31
13	B.H.	59.84	D.V.	72.30
14	I.P.	46.15	E.S.	61.54
15	D.C.	86.61	R.W.	72.30
16	F.K.	41.07	F.K.	58.85
17	K.S.	63.18	R.T.	78.46
18	W.H.	56.92	J.S.	70.77
19	H.K.	56.92	G.K.	67.77
20	R.C.	92.98	J.W.	77.19
	Median	61.4		66.9
	Mean	62.61		66.48
	Range	41-86		52-80
	Q. D.	5.3		7.3

In Pair 1, pupil "M.T." made a score of 50.1; pupil "T.F." the other member of the pair made 63.08%. Read in like manner for succeeding pairs.

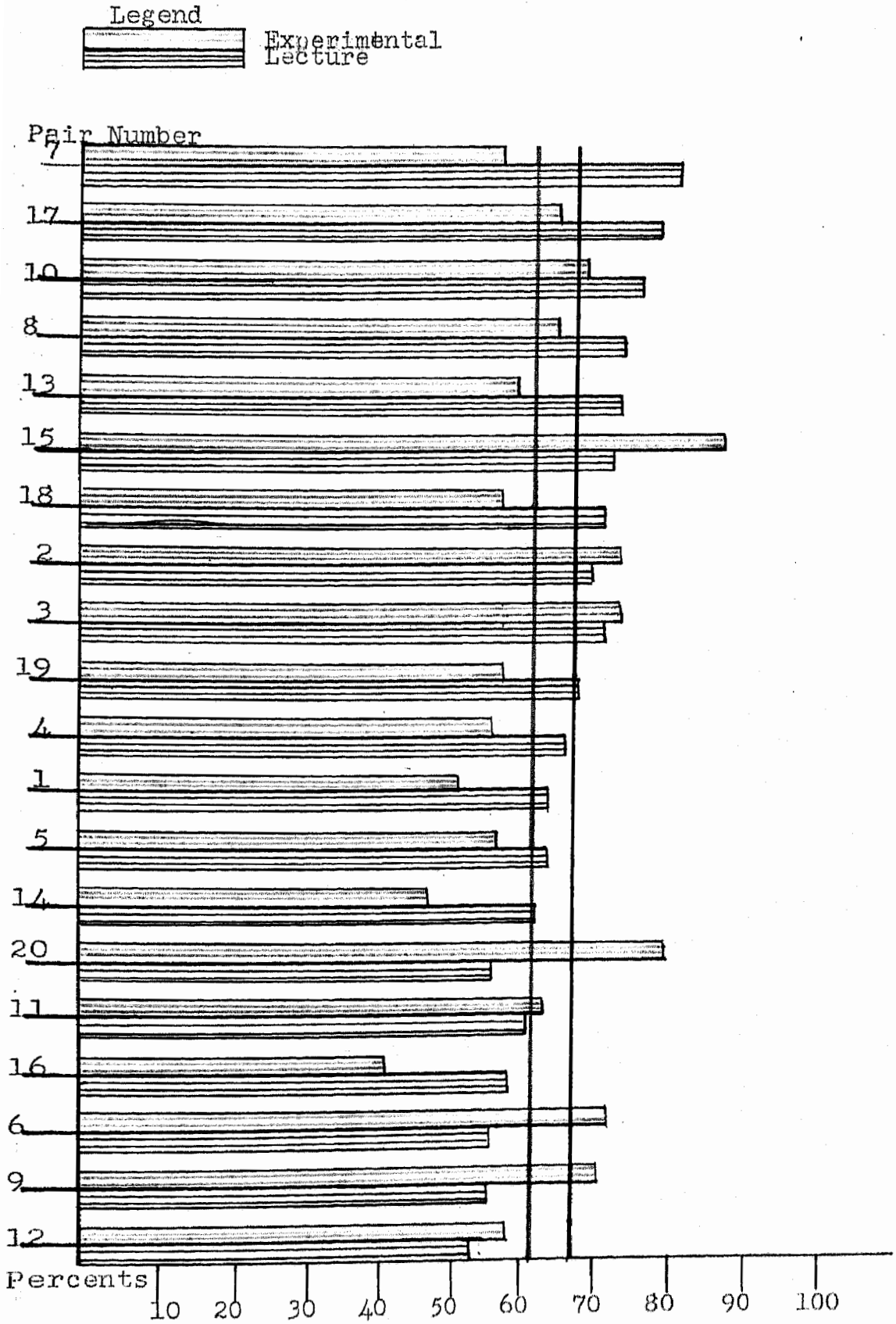


Figure 21

Ranking of Pupils in Test XVIII
(How the Earth has been Prepared for Life)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

HOW THE EARTH HAS BEEN PREPARED FOR LIFE

UNIT XVIII SET X TEST I

DIRECTIONS. Study the picture carefully before you attempt to fill out the blanks at the right.

This picture represents rocks which have been (1) ____ under (2) _____. Such rock shows layers or is said to be (3) _____. Such rocks are said to be sedimentary because they are formed from (4) _____. (5) ____, (6) ____, and (7) ____ are examples of sedimentary rocks. (8) ____ is formed from grains of sand (9) ____ together, while (10) ____ is hardened clay or mud.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )

NAME CLASS DATE RATING

UNIT XVIII SET X TEST II

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out from this list some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentence.

A. Lava
B. Solution
C. Iron
D. Sedimentary
E. Fertilizers
F. Gneiss
G. Layers
H. Glacier National Park
I. Fine clay
J. Local
K. Alfalfa
L. Humus
M. Sand
N. Rice
O. Glacial
P. Coarse humus loam
Q. Yellowstone National Park
R. Crystals
S. Marble
T. Nitrogen
U. Igneous
V. Potassium
W. Loam
X. Quartzite
Y. Gravel
Z. Corn
AA. Wind
BB. Yosemite National Park
CC. Barley

	Answers	Score
1. A farm crop which requires relatively little moisture.	1. _____	( )
2. The kind of liquid rock which is given out by a volcano.	2. _____	( )
3. The metamorphic rock formed from sandstone.	3. _____	( )
4. The type of soil in which water will rise highest by capillary action.	4. _____	( )
5. The oldest kind of rock upon the earth.	5. _____	( )
6. The raw food element which aids in making the leaves of growing plants green.	6. _____	( )
7. The kind of transported soil in the upper Mississippi Valley.	7. _____	( )
8. The type of erosion chiefly responsible for our natural limestone caves.	8. _____	( )
9. A general name given to all materials which farmers use to renew the productivity of their soil.	9. _____	( )
10. The National Park in the United States which is famed for its many geysers.	10. _____	( )
11. An identifying mark in all sedimentary rocks.	11. _____	( )
12. The kind of soil which is almost entirely composed of grains of quartz which came from disintegrated granite.	12. _____	( )

NAME CLASS DATE RATING

UNIT XVIII SET X TEST III

DIRECTIONS. In the test below you will find at the left certain statements and at the right certain phrases. You are to pick out from the list at the right a particular phrase which matches a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. Hard wheat is a favorite crop in the western plains of the United States because	A. it is there where the slipping and moving will be most pronounced.		
2. Water will not rise as high by capillary action in sand as in clay because	B. they usually appear in such places.	1. _____ ( )	
3. Earthquakes are likely to be more severe near a fault because	C. it contains much nitrogen, as well as other plant food elements.	2. _____ ( )	
4. Fertilizers must be added to farm lands because	D. it gives more bulk.	3. _____ ( )	
5. Cultivation of the surface of farm lands is desirable because	E. clay is heavier than sand.	4. _____ ( )	
6. Igneous rocks are crystalline in structure because	F. the loose soil on top hinders capillarity and thus conserves moisture.	5. _____ ( )	
7. Common barnyard manure is a good fertilizer because	G. it has become a custom to raise the crop there.	6. _____ ( )	
8. The ocean contains much salt and other minerals because	H. erosion by solution is constantly taking place.	7. _____ ( )	
	I. it requires relatively little moisture.	8. _____ ( )	
	J. of the difference in fineness of the material of which it is composed.		
	K. growing plants take the raw food materials from the soil.		
	L. of the great heat through which they have passed.		

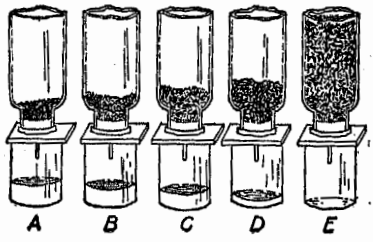
NAME CLASS DATE RATING

UNIT XVIII SET X TEST IV

DIRECTIONS. Read the following problem through very carefully before you attempt to fill in the numbered blanks. When you answer the problem questions, place the missing words in the space at the right having the corresponding number.

The five inverted bottles have had the bottoms removed and corks pierced with a small tube were inserted. They were then filled with equal amounts (by weight) of *A*, gravel; *B*, sand; *C*, clay soil; *D*, rich soil; *E*, leaf mold. They were then placed over empty beakers. Equal amounts of water were then poured over the contents of each jar. In jar *A* practically (1) ____ the water passed through; in jar *B* a (2) ____ amount was held back by the sand; in jar *C* still more was (3) ____ in the clay while the rich soil and leaf mold held the (4) ____ water. This shows that soil with (5) ____ matter in it holds water best.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )



NAME CLASS DATE RATING

UNIT XVIII SET X TEST V

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. The granite in a monument:
   (*a*) is a good example of an igneous rock. *a.* _____ ( )
   (*b*) was probably at one time so hot that it could flow like water. *b.* _____ ( )
   (*c*) is probably an older rock than the marble in a bank floor. *c.* _____ ( )
   (*d*) contains the ingredients for making sand. *d.* _____ ( )
   (*e*) may easily be identified by the layers in its structure. *e.* _____ ( )

2. A good example of weathering would be:
   (*a*) the splitting of a rock by water freezing in a crevice. *a.* _____ ( )
   (*b*) the wearing away of a rock by sand being blown against it. *b.* _____ ( )
   (*c*) the transportation of rock sediment to the ocean. *c.* _____ ( )
   (*d*) the breaking up of rock by the roots of trees forcing their way into the small cracks. *d.* _____ ( )
   (*e*) a raging blizzard on the mid-western plains. *e.* _____ ( )

3. The farmer has learned that a surface mulch is of value in helping prevent:
   (*a*) the growth of weeds. *a.* _____ ( )
   (*b*) the loss of moisture from the soil. *b.* _____ ( )
   (*c*) the ravaging of insects. *c.* _____ ( )
   (*d*) the need of fertilizer. *d.* _____ ( )
   (*e*) the evaporation of water. *e.* _____ ( )

Answers Score

4. If you were to make a search for fossils:
   (*a*) you would need to confine your search to the sea coast. *a.* ------- ( )
   (*b*) you could not expect to find any fossil sea life in the mountains. *b.* ------- ( )
   (*c*) you would probably find the greatest supply in beds of sedimentary rock. *c.* ------- ( )
   (*d*) you might find the remains of past animal life which was unlike the kind of animal life we know today. *d.* ------- ( )
   (*e*) you would probably be unable to find any specimens in beds of granite. *e.* ------- ( )

5. The soil of Minnesota and Iowa:
   (*a*) furnishes a good example of transported soil. *a.* ------- ( )
   (*b*) is classed as local soil. *b.* ------- ( )
   (*c*) is glacial soil. *c.* ------- ( )
   (*d*) was probably at one time much farther south than it is at present. *d.* ------- ( )
   (*e*) is the result of erosion. *e.* ------- ( )

6. A common method of supplying the soil with the missing raw food materials is:
   (*a*) by the provision of adequate irrigation. *a.* ------- ( )
   (*b*) by giving the soil adequate cultivation. *b.* ------- ( )
   (*c*) by spreading barnyard manure upon the soil. *c.* ------- ( )
   (*d*) by spreading common table salt upon the land. *d.* ------- ( )
   (*e*) by scattering iron filings over the land. *e.* ------- ( )

Results of Test XIX

(Life on the Earth)

Table XXII shows the ranking of each pupil in Test XIX, while Figure 22 shows the ranking of each pair of pupils with each other pair. The median of each class is also shown.

The highest score, eighty-four, was made by a pupil in the lecture class, and exceeded the greatest score in the experimental class by a margin of six per cent. The lowest score was twenty-nine and was made by a pupil in the experimental class. The lowest score made by a member of the lecture class was forty per cent.

The median of the experimental class was forty-nine, which is twelve per cent less than the median of the lecture class. This is a significant difference. Since this difference is significant, method must have some effect on the results of the test. There were many demonstrations and experiments that were performed by the experimental class. These experiments covered such material as study of cells, tissue, organs, osmosis, plant foods, the nitrogen cycle, and many others. In the lecture class this same material was studied from the diagrams and explanations in the text book. As far as this study goes, it indicates that nature of material, interest created, pupils depending on other pupils in the experimental method of teaching, and waste of time are all factors that must be considered in the two methods of teaching. There is a tendency for the experimental class to waste time and to depend upon only a few for most of the work, and also a possibility for the pupils to lose interest as well as gain interest in the laboratory. In the opinion of the researcher the material in this unit would be considered of an experimental nature by most science teachers, yet there was a signifi-

cant difference in favor of the lecture class in the results of the test. Waste of time, too much pupil help, loss of interest, and neglect of textbook material may be some of the factors that caused the experimental class to rank lower than the lecture class.

In pair nine the lecture pupil ranked seventeen per cent higher than the experimental pupil. The pupil in the lecture class ranked fourteen per cent higher than the pupil in the experimental class in pair eighteen.

Of the twenty pairs in the study sixteen pupils in the lecture class ranked higher than the sixteen with whom they were paired in the experimental class, one pair ranked the same, and in the other three pairs the experimental pupils ranked the highest.

TABLE XXII

MEDIANS OF PER CENTS MADE BY PUPILS IN TEST NINETEEN
(LIFE ON THE EARTH)

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	50.3	T.F.	73.85
2	E.N.	67.69	D.M.	64.62
3	K.B.	52.31	A.E.	60.00
4	S.N.	63.07	V.H.	43.08
5	R.G.	49.23	R.W.	53.85
6	B.S.	41.54	A.W.	52.31
7	D.S.	55.38	M.B.	67.85
8	N.E.	49.23	E.S.	78.46
9	B.W.	67.69	M.W.	84.61
10	W.O.	49.23	D.S.	63.09
11	C.S.	76.92	D.C.	81.51
12	B.S.	40.00	D.D.	40.00
13	B.H.	44.33	D.V.	70.77
14	I.P.	29.23	E.S.	61.54
15	D.C.	61.54	R.W.	60.00
16	F.K.	41.54	F.K.	53.85
17	K.S.	41.97	R.T.	73.86
18	W.H.	58.46	J.S.	72.62
19	H.K.	49.23	G.K.	61.54
20	R.C.	78.46	J.W.	61.54
	Median	49.7		62.3
	Mean	53.36		63.94
	Range	29-76		40-84
	Q. D.	8.11		9.57

In Pair 1, pupil "M.T." made a score of 50.3; pupil "T.F." the other member of the pair made 73.85%. Read in like manner for succeeding pairs.

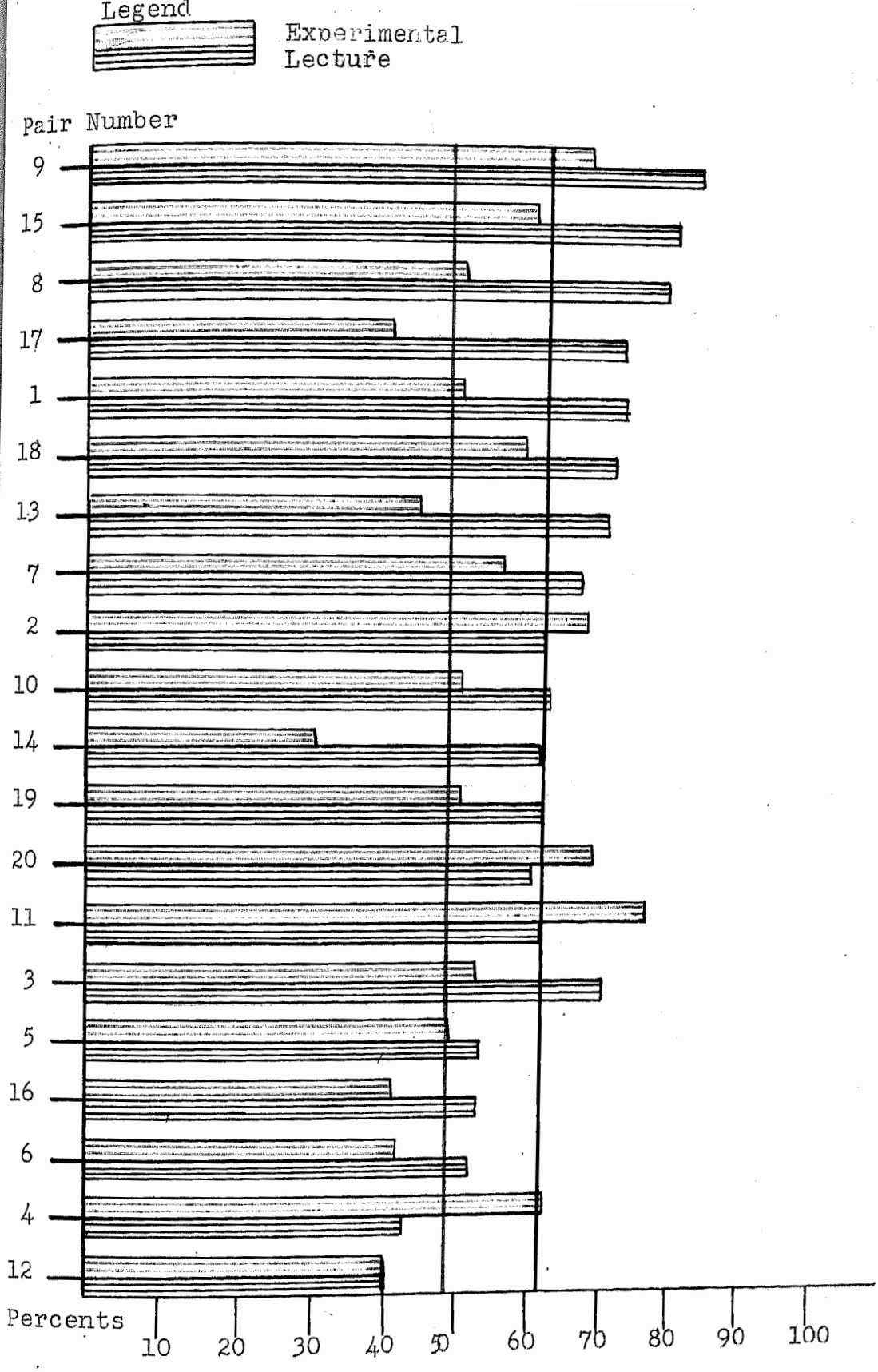


Figure 22

Ranking of Pupils in Test XIX
(Life on the Earth)

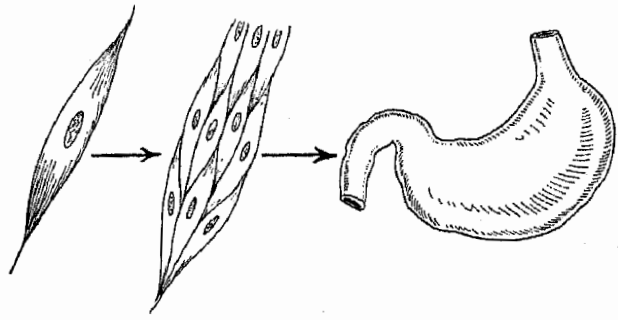
(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

LIFE ON THE EARTH

UNIT XIX SET X TEST I

DIRECTIONS. Fill in the missing words in the numbered spaces at the right.



Cells are (1) ____ of (2) ____ in plants and animals. They are formed of (3) ____ matter. When they are found alike in size and shape, they form (4) ____. Examples of (5) ____ are muscles, nerves of (6) ____ forming the outer surface of a leaf. When a number of (7) ____ are organized to do some (8) ____ work they form an organ. The root of a plant is an organ as is the arm of a man. Since (9) ____ things are made up of organs, they are called (10) ____.

	Answers	Score
1.	----------	( )
2.	----------	( )
3.	----------	( )
4.	----------	( )
5.	----------	( )
6.	----------	( )
7.	----------	( )
8.	----------	( )
9.	----------	( )
10.	----------	( )

NAME CLASS DATE RATING

UNIT XIX SET X TEST II

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space at the right of the sentences.

A. Root	H. Hypocotyl	O. Osmosis
B. Invertebrates	I. Birds	P. Oxygen
C. Organ	J. Embryo	Q. Frogs
D. Tissue	K. Air	R. Water
E. Cell	L. Weeds	S. Legumes
F. Vertebrates	M. Carbon dioxide	T. Parasites
G. Helium	N. Ozone	U. Lizards

	Answers	Score
1. A unit of structure in a living thing.	1. _____	( )
2. A structure having a definite work to do in the body.	2. _____	( )
3. Animals having a backbone.	3. _____	( )
4. The part of a seed that grows into a new plant.	4. _____	( )
5. A gas formed when seeds germinate.	5. _____	( )
6. The process by which water gets into the plant.	6. _____	( )
7. The substance that transpiration puts into the air.	7. _____	( )
8. Plants which feed on other living plants without giving anything in return.	8. _____	( )
9. Plants which hold useful bacteria in nodules on their roots.	9. _____	( )
10. Animals which help most in saving the crops of the nation.	10. _____	( )

NAME CLASS DATE RATING

UNIT XIX SET X TEST III

DIRECTIONS. In each group below is a partial statement followed by five phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

	Answer	Score
1. We know living things are composed of cells because:		
(*a*) they have a nucleus and cell wall.	*a.* _____	( )
(*b*) they are alive.	*b.* _____	( )
(*c*) we can see them under the compound microscope.	*c.* _____	( )
(*d*) we could not get movement unless we had small parts.	*d.* _____	( )
(*e*) people say they are.	*e.* _____	( )
2. Living things are classified:		
(*a*) by placing those most unlike in the same group.	*a.* _____	( )
(*b*) by looking for likeness in structure and development.	*b.* _____	( )
(*c*) by placing those having the same characteristics in the same group.	*c.* _____	( )
(*d*) into species, genus, and family.	*d.* _____	( )
(*e*) into organic and inorganic things.	*e.* _____	( )
3. Seeds germinate:		
(*a*) because they contain an embryo.	*a.* _____	( )
(*b*) because they contain food.	*b.* _____	( )
(*c*) only when air is present.	*c.* _____	( )
(*d*) quicker in light than in darkness.	*d.* _____	( )
(*e*) best when the germ or embryo is removed.	*e.* _____	( )
4. We know that root hairs absorb water from the soil:		
(*a*) because they are a part of the root.	*a.* _____	( )
(*b*) because they are only found when moisture is present.	*b.* _____	( )
(*c*) because soil particles which carry water cling to them.	*c.* _____	( )
(*d*) because there is a greater concentration of water outside the root hair than in its cell sap.	*d.* _____	( )
(*e*) because plants give off moisture and so they must take it in through the roots.	*e.* _____	( )

NAME CLASS DATE RATING

UNIT XIX SET X TEST IV

DIRECTIONS. In the test below you will find at the left certain statements, and at the right certain phrases. You are to pick from the list at the right some particular phrase which matches a particular statement. Place the *letter* of the proper phrase in the space at the right.

Statements	Phrases	Answers	Score
1. Animals and plants mutually help each other because	A. when the air in a closed jar where they are growing is tested, it is found to contain much carbon dioxide.	1. _____	( )
2. Living things are called organisms because	B. although they may die down in the winter they send up new shoots in the spring.	2. _____	( )
3. We know that seedlings use oxygen when they sprout because	C. such are sprayed on the surface of the food plants.	3. _____	( )
4. Osmosis will take place in an egg because	D. there is a greater concentration of water outside.	4. _____	( )
5. Weeds can grow where other plants cannot live because	E. they feed upon harmful insects.	5. _____	( )
6. Perennials are so called because	F. plants make food out of wastes that animals give off.	6. _____	( )
7. Insects with biting mouth parts can be killed with contact poisons because	G. they are made up of organs.	7. _____	( )
8. Plant lice can be killed with a kerosene emulsion spray because	H. they are adapted to live under unfavorable conditions.	8. _____	( )
9. Fungi do much harm to crops because	I. it clogs their breathing holes.	9. _____	( )
	J. they are so small.		
	K. birds should be encouraged to live near gardens.		
	L. they carry pollen on their wings.		
	M. we find them living together.		
	N. they are parasites.		
	O. there is oxygen in the air surrounding them.		

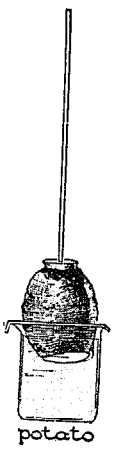
NAME _____ CLASS _____ DATE _____ RATING _____

UNIT XIX SET X TEST V

DIRECTIONS. Examine the diagrams carefully. Then fill in the blanks in the following sentences in the spaces to the right.

In each of three opaque dishes are placed blotting paper and an equal number of soaked seeds. In dish No. I the blotting paper is left dry, in dish No. II the paper is thoroughly moistened, while in dish No. III there is placed water sufficient to cover the blotting paper. The dishes are placed together in a moderately warm place and each is covered with an opaque cover. After five days examination shows that the seeds in dish No. I have not germinated, those in No. III started but then rotted, while those in No. II are growing. Since no dish has (1) ____ and since the (2) ____ has been the same in each dish, we may say the differences in (3) ____ are due to different amounts of (4) ____. The experiment proves that a moderate amount of (5) ____ is needed for germination of bean seeds.

A large potato is scooped out at one end so as to make a round depression about 2″ in depth. This depression is filled with sugar, and a rubber cork with a hollow tube is inserted tightly in the hole. The lower end of the potato is then removed and the potato is placed in a dish containing water. After a few minutes liquid is seen to rise in the tube. This is brought about by (6) ____ (7) ____. The concentration of water outside the potato is (8) ____ than the concentration of water in the (9) ____ of the potato. Likewise the concentration of water is less in the (10) ____ than it is in the (11) ____ of the potato. Therefore, since fluids or gases tend to move through a (12) ____ from a point of (13) ____ to a point of (14) ____ concentration of that fluid, we have a (15) ____ of liquid in the tube.



	Answers	Score
1.	_____	( )
2.	_____	( )
3.	_____	( )
4.	_____	( )
5.	_____	( )
6.	_____	( )
7.	_____	( )
8.	_____	( )
9.	_____	( )
10.	_____	( )
11.	_____	( )
12.	_____	( )
13.	_____	( )
14.	_____	( )
15.	_____	( )

Results of Test XX

(Improvement of Life on the Earth)

Table XXIII shows the ranking of each pupil in Test XX, and Figure 23 shows the ranking of each pair of pupils with each other and also with each other pair. The median of each class is shown.

The highest score was ninety-one and was made by a pupil in the lecture class. This score exceeded the highest score in the experimental class three per cent. The lowest score was forty-one and was also made in the lecture class. It was exceeded four per cent by the lowest score in the experimental class.

The median of the lecture class exceeded that of the experimental class five per cent. This difference is not definitely significant but has ninety chances in one hundred as being such. The material in this chapter is definitely lecture material as it is well illustrated by diagrams and figures. It does not suggest much laboratory work that is not offered in the text and that cannot be explained from the diagrams by the instructor.

In pair nine the pupil in the experimental class exceeded the pupil in the lecture class by a small margin of two per cent. In pair eighteen the pupil in the experimental class exceeded the pupil in the lecture class by a margin of six per cent.

Ten members of the experimental class exceeded those with whom they were paired in the lecture class, and ten members of the lecture class exceeded ten members of the experimental class.

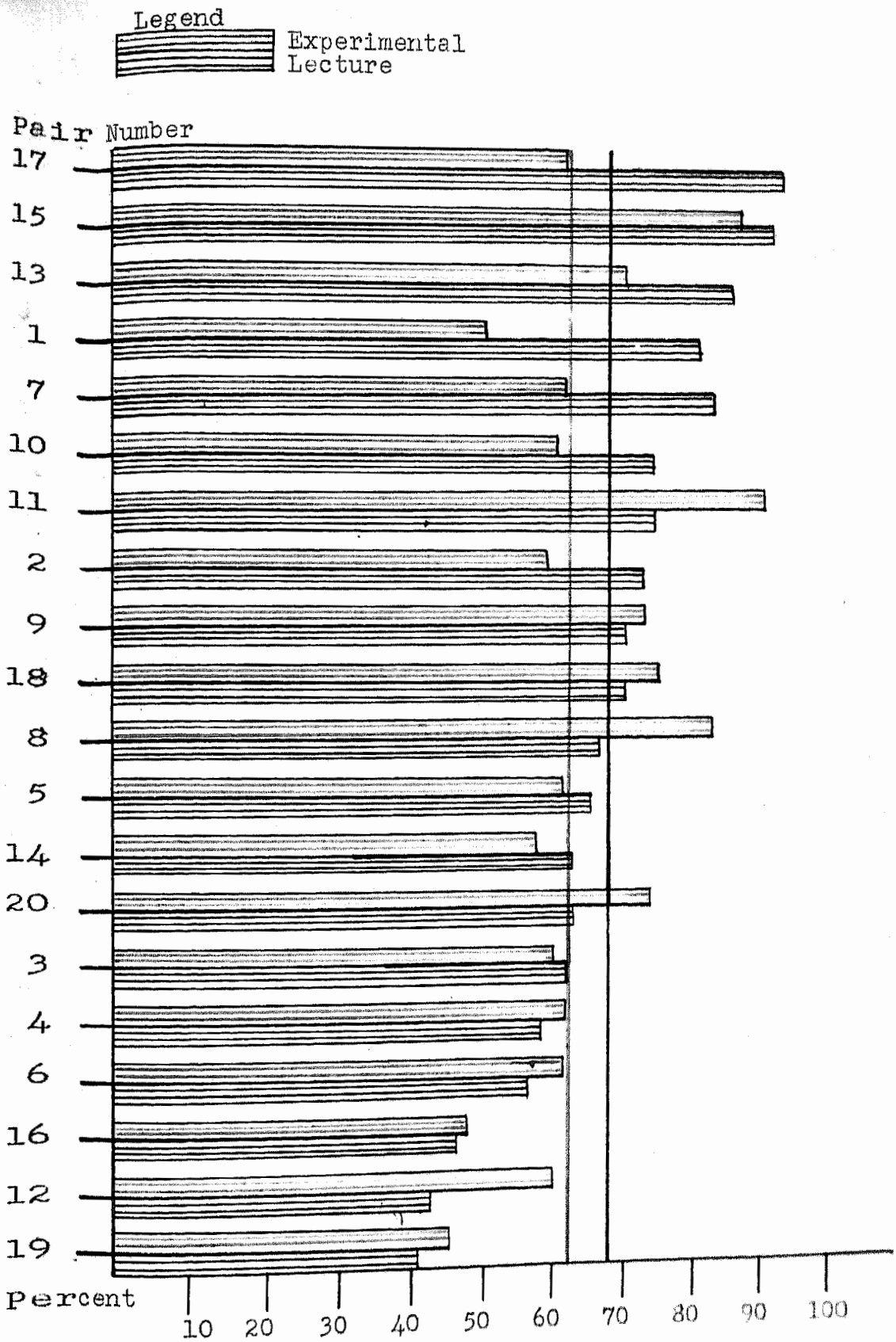


Figure 23

Ranking of Pupils in Test XX
(Improvement of Life on the Earth)

(Scores of pupils in lecture class in descending order)

NAME CLASS DATE RATING

IMPROVEMENT OF LIFE ON THE EARTH

UNIT XX SET X TEST I

DIRECTIONS. Indicate which of the following statements are *true* or *false* by *marking out* the reply you do *not* want. T equals True. F equals False.

	Answers	Score
1. The ovary of a flower holds and protects the seeds.	1. T F	( )
2. The sepals are the brightly colored parts of a flower.	2. T F	( )
3. Cross pollination is transfer of pollen from the anther of one flower of a given species to the pistil of another flower of the same species.	3. T F	( )
4. Pollen is produced in the pistil.	4. T F	( )
5. An embryo of an animal develops from a fertilized egg cell.	5. T F	( )
6. All variations produce new species of plants and animals.	6. T F	( )
7. All dogs came originally from a wolf-like ancestor.	7. T F	( )
8. Changes in environment may cause mutations.	8. T F	( )
9. Mendel discovered that peas hand down characteristics as unit characters.	9. T F	( )
10. Mendel's laws are not much used in plant breeding.	10. T F	( )
11. Burbank used selection and hybridizing but made little use of Mendel's laws to produce new plants.	11. T F	( )
12. By means of Mendel's law of segregation, it is possible to pick out seeds from plants that will hand down certain definite characters to their offspring.	12. T F	( )
13. Training and environment play a part with heredity in producing an efficient citizen.	13. T F	( )
14. The feebleminded in this country number over 300,000.	14. T F	( )
15. Improvement of the environment will likewise improve bad heredity.	15. T F	( )

NAME CLASS DATE RATING

UNIT XX SET X TEST II

DIRECTIONS. In this test you will find a list of words above a list of statements. You must pick out some particular word that will fit a particular statement. Place the *letter* of the word that matches in the space to the right of the sentences.

A. Body	F. Organs	K. Self pollination	P. Cells
B. Stamen	G. Petals	L. Tissues	Q. Variation
C. Sperm	H. Egg	M. Budding	R. Mutation
D. Chromosomes	I. Body	N. Wind	S. Characters
E. Germ	J. Cross pollination	O. Insects	

	Answers	Score
1. The cells which determine heredity.	1. _____	( )
2. The cell which causes fertilization.	2. _____	( )
3. The structure in a flower which holds sperm cells.	3. _____	( )
4. Structures within cells supposed to carry inheritable qualities.	4. _____	( )
5. Growth of pollen from anther of a flower on its own stigma.	5. _____	( )
6. Cross pollination of oranges is largely brought about by	6. _____	( )
7. Development in plants and animals is a process of division of	7. _____	( )
8. The hornless Hereford cattle arose as a	8. _____	( )
9. Hybrids crossed with one original parent tend to segregate unit	9. _____	( )
10. The seedless orange has been developed commercially by	10. _____	( )

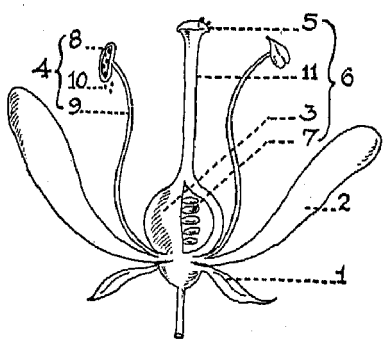
NAME CLASS DATE RATING

UNIT XX SET X TEST III

DIRECTIONS. Study the diagrams carefully before filling in the blank spaces at the right.

(A)

Fill out the numbers in the spaces at the right corresponding with the structures in the diagram.

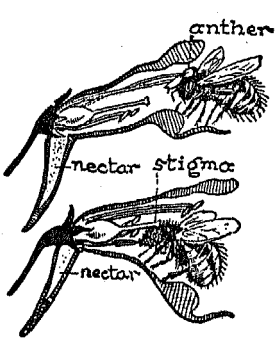


	Answers	Score
1.	_____	( )
2.	_____	( )
3.	_____	( )
4.	_____	( )
5.	_____	( )
6.	_____	( )
7.	_____	( )
8.	_____	( )
9.	_____	( )
10.	_____	( )
11.	_____	( )

(B)

The diagram shows how cross pollination might be effected in an irregular flower like a snapdragon. Fill out the statements below, placing your answers in the corresponding numbered spaces to the right.

The bee alights on the spur of the flower and forces its head into the tube of the flower in an attempt to get at the (1) ____ which is secreted in the bottom of the tube. In doing this its head and back rub against the (2) ____ and also against the (3) ____ surface of the (4) ____. If the bee then goes to another flower of the same kind, it carries (5) ____ from the first flower visited on the (6) ____ covering its head and back. It may transfer this (7) ____ to the pistil of second flower. Both (8) ____ and (9) ____ pollination may evidently take place in this flower.



	Answers	Score
1.	_____	( )
2.	_____	( )
3.	_____	( )
4.	_____	( )
5.	_____	( )
6.	_____	( )
7.	_____	( )
8.	_____	( )
9.	_____	( )

NAME CLASS DATE RATING

UNIT XX SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by four phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

	Answers	Score
1. Plants or animals reproduce sexually when:		
(*a*) pollen is produced in a flower.	*a.* _____	( )
(*b*) man makes buds or grafts.	*b.* _____	( )
(*c*) a plant springs up from last year's root.	*c.* _____	( )
(*d*) an egg cell is fertilized by a sperm cell.	*d.* _____	( )
2. Cross pollination takes place:		
(*a*) when a bee carries pollen from a rose to a pansy flower.	*a.* _____	( )
(*b*) when a bee carries pollen from the stamens of an apple blossom to the stigma of a cherry blossom.	*b.* _____	( )
(*c*) from the stamens of any flower to the stigma of any other flower.	*c.* _____	( )
(*d*) only between flowers of the same species of plant.	*d.* _____	( )
3. Cross pollination:		
(*a*) is brought about by insects, wind, man, or other agencies carrying pollen.	*a.* _____	( )
(*b*) occurs when pollen from one flower is deposited on the stigma of another flower of the same species.	*b.* _____	( )
(*c*) is only effective when the stigma is ripe enough to receive it.	*c.* _____	( )
(*d*) might be brought about by a man with a dry paint brush.	*d.* _____	( )
4. Variations:		
(*a*) are of two kinds, fluctuating and discontinuous.	*a.* _____	( )
(*b*) are always found in nature.	*b.* _____	( )
(*c*) may be due to a change of environment.	*c.* _____	( )
(*d*) which are discontinuous may result in mutants of new varieties of plants or animals which breed true.	*d.* _____	( )

NAME CLASS DATE RATING

UNIT XX SET X TEST IV

DIRECTIONS. In each group below is a partial statement followed by four phrases, any of which will complete the statement. Write *yes* after the statements which are true and *no* after the others. All, any, or none of the completions may be true statements.

Answers Score

1. Plants or animals reproduce sexually when:
   (*a*) pollen is produced in a flower. *a.* _____ ( )
   (*b*) man makes buds or grafts. *b.* _____ ( )
   (*c*) a plant springs up from last year's root. *c.* _____ ( )
   (*d*) an egg cell is fertilized by a sperm cell. *d.* _____ ( )

2. Cross pollination takes place:
   (*a*) when a bee carries pollen from a rose to a pansy flower. *a.* _____ ( )
   (*b*) when a bee carries pollen from the stamens of an apple blossom to the stigma of a cherry blossom. *b.* _____ ( )
   (*c*) from the stamens of any flower to the stigma of any other flower. *c.* _____ ( )
   (*d*) only between flowers of the same species of plant. *d.* _____ ( )

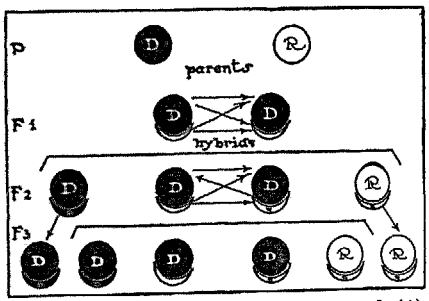
3. Cross pollination:
   (*a*) is brought about by insects, wind, man, or other agencies carrying pollen. *a.* _____ ( )
   (*b*) occurs when pollen from one flower is deposited on the stigma of another flower of the same species. *b.* _____ ( )
   (*c*) is only effective when the stigma is ripe enough to receive it. *c.* _____ ( )
   (*d*) might be brought about by a man with a dry paint brush. *d.* _____ ( )

4. Variations:
   (*a*) are of two kinds, fluctuating and discontinuous. *a.* _____ ( )
   (*b*) are always found in nature. *b.* _____ ( )
   (*c*) may be due to a change of environment. *c.* _____ ( )
   (*d*) which are discontinuous may result in mutants of new varieties of plants or animals which breed true. *d.* _____ ( )

UNIT XX SET X TEST V

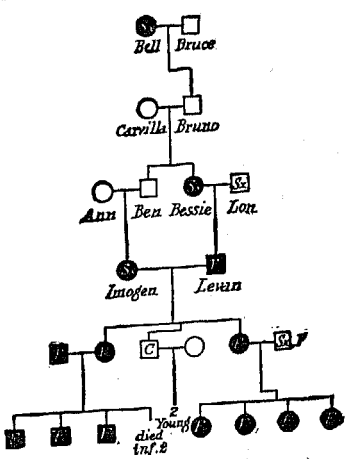
DIRECTIONS. Study the diagrams carefully before you fill out the blanks in the sentences below.

The diagram represents the cross breeding of yellow and green seeded peas. The former are marked *D*, the



latter *R*. In the first generation, lettered (1) ____, all the peas formed are (2) ____ in color. This shows the law of (3) ____, yellow being (4) ____ over green which is a (5) ____ character. Now if these hybrid peas are again cross bred in the (6) ____ generation, (7) ____ peas will appear in a ratio of (8) ____ yellow to (9) ____ green. The (10) ____ peas, if crossed in the (11) ____ generation or future generations will continue to produce (12) ____ (13) ____ peas to (14) ____ green pea. But if the green peas are crossed, they will always produce (15) ____ peas. This illustrates the law of (16) ____ because the recessive character of green-ness has been (17) ____ out.

This diagram seems to indicate that (18) ____ is a



(19) ____ characteristic and that (20) ____ in such families should be avoided.

	Answers	Score
1.	____	( )
2.	____	( )
3.	____	( )
4.	____	( )
5.	____	( )
6.	____	( )
7.	____	( )
8.	____	( )
9.	____	( )
10.	____	( )
11.	____	( )
12.	____	( )
13.	____	( )
14.	____	( )
15.	____	( )
16.	____	( )
17.	____	( )
18.	____	( )
19.	____	( )
20.	____	( )

Medians of All Second Semester Tests

Table XXIV shows the medians for each pupil of each pair in the ten tests that covered the second semester's work.

Figure 24 shows the ranking of each pair of pupils with each other and with the other pairs on their medians for the ten tests that cover the second semester's work.

Figure 25 and 26 show a comparison of the per cent scores of pair eight and pair eighteen in the last ten tests.

The highest median was seventy-four and was made by a member of the lecture class. This score exceeded the highest median in the experimental class by one per cent. The lowest median in the lecture class was forty-two, and that of the experimental was fifty-five.

The medians of twelve pupils in the lecture class exceeded the medians of the twelve pupils with whom they were paired in the experimental class. In eight pairs the pupils of the experimental group exceeded the pupils in the lecture class.

In the ten tests considered here the medians in the lecture class exceeded those in the experimental class in nine cases, and the experimental class exceeded the lecture in one case.

The median of the medians of the pupils in the lecture class in the ten tests was sixty-one and for the experimental class fifty-eight. This difference of four per cent is not a significant difference but has sixty-two chances in one hundred of being such.

TABLE XXIV

MEDIANS OF PER CENTS MADE BY PUPILS IN SECOND SEMESTER

	EXPERIMENTAL		LECTURE	
Pair Number	Name of Pupil	Per Cent	Name of Pupil	Per Cent
1	M.T.	51.2	T.F.	61.4
2	E.N.	67.5	D.M.	60.4
3	K.B.	65.2	A.E.	60.6
4	S.N.	54.2	V.H.	54.5
5	R.G.	61.4	R.W.	58.7
6	B.S.	65.6	A.W.	57.1
7	D.S.	52.5	M.B.	64.7
8	N.H.	54.1	E.S.	70.4
9	B.W.	64.9	M.W.	69.2
10	W.O.	68.5	D.S.	67.1
11	C.S.	71.5	D.C.	72.8
12	B.S.	55.6	D.D.	42.4
13	B.H.	58.2	D.V.	68.7
14	I.P.	46.2	E.S.	61.5
15	D.C.	73.2	R.W.	74.7
16	F.K.	42.7	F.K.	55.8
17	K.S.	56.6	R.T.	67.5
18	W.H.	59.2	J.S.	71.6
19	H.K.	51.8	G.K.	50.3
20	R.C.	77.8	J.W.	55.2
	Median	58.7		61.4
	Mean	59.39		62.28
	Range	46-77		42-74
	Q. D.	6.25		7.42

In Pair 1, pupil "M.T." made a score of 51.2; pupil "T.F.," the other member of the pair, made 61.4%. Read in like manner for succeeding pairs.

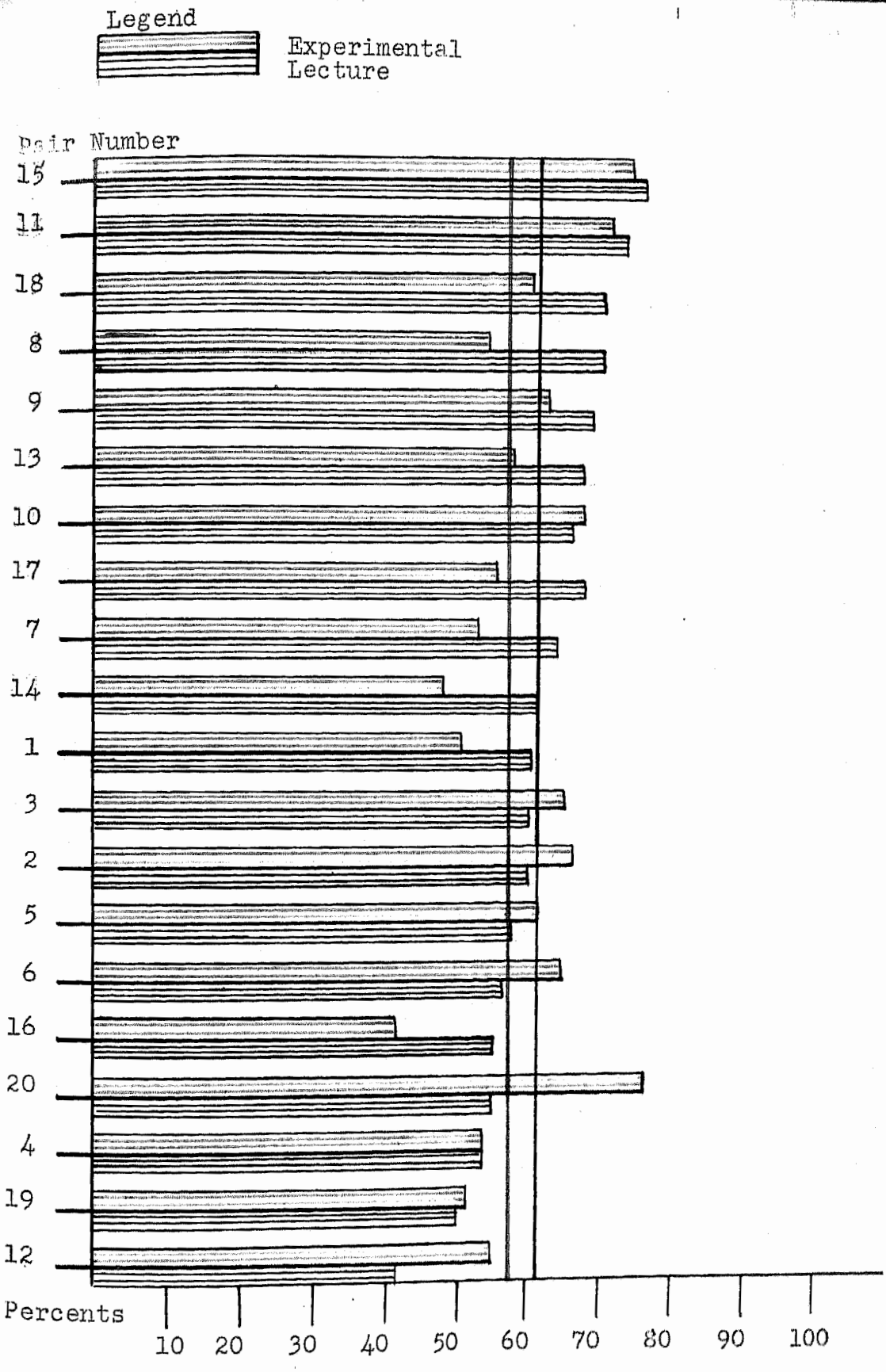


Figure 24

Ranking of Pupils in Medians of All Tests
Second Semester

(Scores of pupils of lecture class in descending order)

Legend:

Pair Nine Pupil X ——— Lecture

Pupil Y ——— Experimental

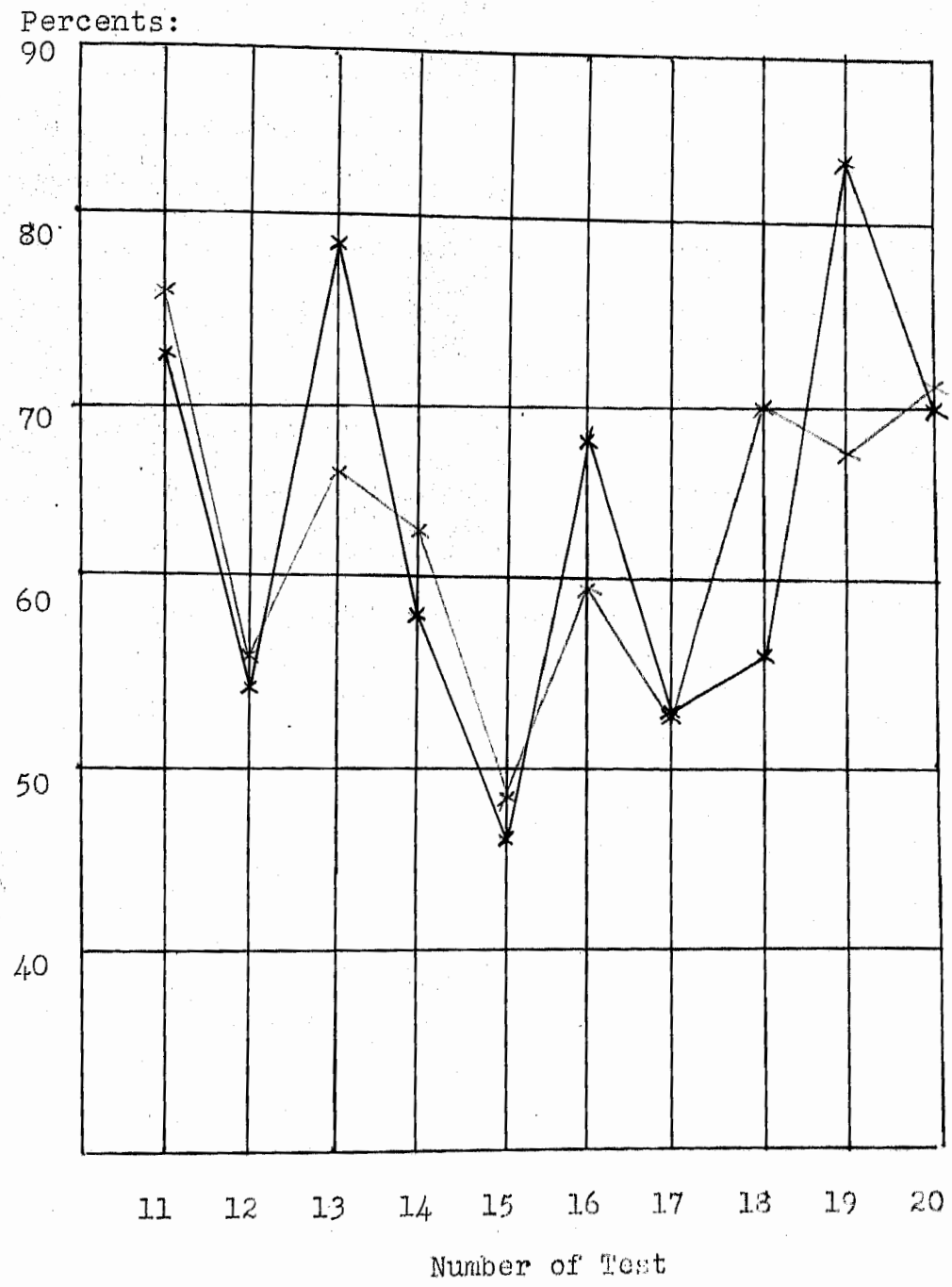


Figure 25

Ranking of Pupils in Pair Nine in the Ten Tests Given the Second Semester

Read Figure thus: The pupil in the lecture class made a score of 76%, and the pupil in the experimental made 75% in test eleven. Read scores on succeeding tests in like manner.

Figure 25 shows a comparison of the two pupils who had the least variation in the control. This pair was made up of identical twin girls. This figure shows the results of the tests taken the second semester.

It is interesting to note that the experimental pupil exceeded the lecture pupil in four cases; they ranked the same in one, and the lecture pupil exceeded the experimental in the other five. In test thirteen, test sixteen, and test nineteen the lecture pupil exceeded the experimental by a wide margin. This may indicate that method of teaching has something to do with the results.

The median for the lecture pupil in the ten tests was sixty-nine, and for the pupil in the experimental class it was sixty-four. This shows that as far as this pair goes the lecture method would be favored.

Legend:

Pair Nine

Pupil X ——— Lecture

Pupil Y ——— Experimental

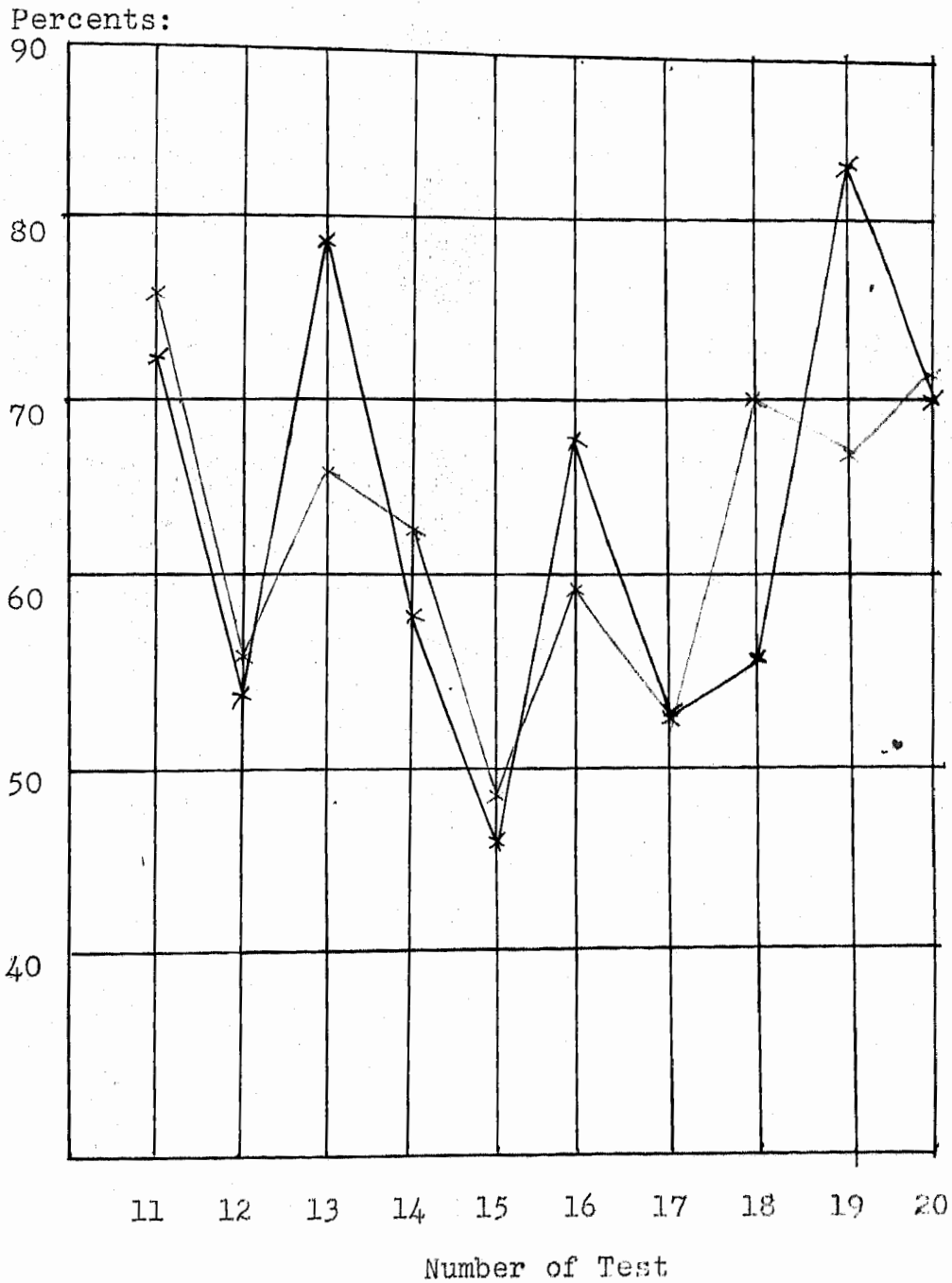


Figure 26

Ranking of Pupils in Pair Eighteen in the Ten Tests Given the Second Semester

Read Figure thus: The pupil in the lecture class made a score of 80%, and the pupil in the experimental made 65% in test eleven. Read scores on succeeding tests in like manner.

Figure 26 shows a comparison of pair eighteen, the two pupils who had the greatest variation in the control.

In this pair the lecture pupil exceeded the experimental pupil in eight of the ten tests. In the other two tests the experimental pupil exceeded the lecture pupil.

The median for the lecture pupil in the ten tests was seventy-one, and for the pupil in the experimental class it was fifty-nine. As far as this pair goes, the lecture method of teaching is more effective.

The variation in the two pupils was in favor of the lecture pupil the second semester and the experimental the first semester. In the first semester's work there was only a slight difference in the scores of the two pupils, while the second semester there was a great variation in the scores of the two pupils in favor of the lecture pupil.

SUMMARY AND CONCLUSIONS OF STUDY

SECOND SEMESTER

In the second semester study the experiment was worked out in the same manner as in the first semester except that the classes were reversed as has been described.

In test eleven, the first test in the second semester, the median of the lecture class exceeded that of the experimental class one and six-tenths per cent; in test twelve the lecture class exceeded the experimental class one and eight-tenths per cent; in test thirteen the lecture class exceeded the experimental class seven and five-tenths per cent; in test fourteen the lecture class exceeded the experimental class five and three-tenths per cent; in test fifteen the lecture class exceeded the experimental class three per cent; in test sixteen the lecture class exceeded the experimental class three and nine-tenths per cent; in test seventeen the experimental class exceeded the lecture class nine-tenths of one per cent; in test eighteen the lecture class exceeded the experimental class five and five-tenths per cent; in test nineteen the lecture class exceeded the experimental class twelve and six-tenths per cent; and in the final test, twenty, the lecture class exceeded the experimental class five and six-tenths per cent.

In the ten tests the medians of the lecture class exceeded the median of the experimental class in nine cases, and the experimental class exceeded the lecture class in only one.

Statistically, there must be a difference of approximately ten per cent in the medians in order to have a significant difference. In only one of the tests that were given the first semester was the variation great enough to be statistically significant, and that was in favor of the lecture

class on test nineteen. In tests eleven, twelve, thirteen, fourteen, fifteen, sixteen, eighteen, nineteen, and twenty the lecture class exceeded the experimental class in median per cents. In these tests the chances were fifty-eight, fifty-eight, ninety-five, ninety-five, eighty, eighty-three, ninety-three, one hundred, ninety, and seventy-five out of a hundred, respectively, that the differences were significant. In test seventeen, where the experimental class exceeded the lecture class, the difference was sixty-one per cent significant.

There is a statistically significant difference between the two classes in favor of the lecture class for the second semester. Statistics show, then, that the lecture method is more effective in teaching all units from eleven to twenty inclusive except unit seventeen, in which the experimental method was favored slightly.

As far as this study goes, if only one of the two methods is used in teaching, the lecture method should be used; but if it is possible for the experimental method to be used, it can be used in teaching certain kinds of material but not as effectively as is commonly believed.

It should be borne in mind that the instructor was thoroughly laboratory trained and had been a persistent user of laboratory (experimental) techniques.

CHAPTER IV

CONCLUSIONS OF ENTIRE STUDY

The purpose of this study has been an attempt to make a study of two methods of teaching general science under as carefully controlled conditions as it was possible to obtain, using normal class-room conditions. As a control situation sometimes leaves something to be desired, these results may not be conclusive. However, the evidence without exception points to a slight advantage in the lecture class for the first semester's work and a significant advantage for the lecture class over the last semester's work. This means then that the experimental class, which was exceeded slightly by the lecture class the first semester, when reversed and taught by the lecture method the second semester, showed a significant advantage over the experimental class the second semester. In the twenty tests given the medians of the experimental class exceeded those of the lecture class in five cases, four of these being the first semester. In the other fifteen tests the medians of the lecture class exceeded those of the experimental.

In this study it is clearly shown that as the two methods of teaching were used, the lecture method was more effective in teaching the entire course. When certain units are considered, the experimental method proved more effective. For material of a general nature, well illustrated and explained by the text, the lecture method proved more effective. Material that suggests outside experimental work that is essential in understanding the textbook needs the class demonstrations; but where the needed demonstra-

tions are illustrated by figures and diagrams in the text, they need not be demonstrated in class by the use of laboratory apparatus. This is not only a waste of time but an added expense with the purchase of equipment. This study shows that pupils in a lecture class tend to excel those in an experimental class where demonstrations that are illustrated by diagrams in the book are demonstrated in class by the use of apparatus in the experimental class. The results of the tests made by the lecture class and the experimental class show that there is a tendency for pupils in the experimental class to depend upon other pupils in the class for help and to neglect the study of the text. When pupils work in groups as they do in the experimental class, they tend to copy much of their work from their neighbors. If experimental work could be conducted by each pupil in place of group activity, there is no doubt that the results would be different. The teacher checked the results of each test and found that the leaders of the experimental group usually exceed the other pupils in the class. This may not be due to the fact that they were group leaders, for some pupils will react differently to experimental work, and the better pupils would naturally be the group leaders.

The two pairs that were considered throughout the study were pair eighteen, the pair that had the greatest variation in the control, and pair nine, which had the least variation in the control. In pair eighteen the margin was slightly in favor of the experimental pupil the first semester, and he had a slight advantage for the semester's work; but during the second semester he had a significant advantage over the other pupil when he was being taught by the lecture method and the other pupil by the experimental. This might indicate that there was a tendency in both pupils to do better

work in the lecture class and poorer work in the experimental class. In pair nine there was practically no difference in the test results of the two pupils during the first semester's work and a slight advantage in favor of the lecture pupil the second semester. This might indicate that the lecture method as a whole is more effective.

When consideration is given to the fact that laboratory equipment is very expensive, that it takes a great deal of time on the part of the instructor for the laboratory work, and that there is some evidence that in most of the units taught in a course in general science laboratory work does not give as good results as the lecture method, the conclusion seems justifiable that if more and better equipment were available so that it would be possible for each pupil to work individually on the few units in the course where experimentation seems necessary and the expense saved on equipment for the many units where there is some evidence that it is not needed, the course would be better taught with less expense.