The effectiveness of audio-visual aids in the teaching of science in the Lemon Street School Marietta, Georgia

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THE EFFECTIVENESS OF AUDIO-VISUAL AIDS IN THE TEACHING
OF SCIENCE IN THE LEMON STREET SCHOOL
MARIETTA, GEORGIA

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S. R. R., Jr.
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CHAPTER I

INTRODUCTION

Rationale.—Education is, ultimately, an institution by which societies maintain and reproduce themselves. Formal schooling, of course, is not the whole of education. But in every society in which the school exists at all, the primary function is to inculcate, in the young, the motives, attitudes and beliefs, the knowledges and skills, ways of thinking, of feeling and acting, that are desired by the society. At bottom, the educator is a mediator between the child and his culture. The teacher derives his authority to educate, in one way rather than another, from the basic moral and intellectual commitments of the people served by the school.

Scientific and technological changes have created a transitional era in our educational system. In this period of transitional change the American people must be able to overcome or cope with complex changes that are going on in their educational system. The direction and effectiveness of the changes which are occurring will be determined, in part, by how well school officials comprehend the social situation.

One of our principle goals in teaching is to develop in individual students the skills, attitudes, values, and knowledges necessary to deal thoughtfully with social problems. Effective science education demands that students sense a continued achievement and understanding of increasingly more difficult concepts as they progress from grade level to grade level.
Audio-visual materials can provide systematic, controlled sensory-motor experiences from which concepts can be formed and manipulated. It is no longer necessary for educators to rely on the haphazard experiences of a happenstance environment. Teachers can now bring into the lives of their pupils the sensory-motor experiences they consider essential for the development of certain concepts. One of the important means by which instruction can be improved, it is increasingly agreed, lies in the area of audio-visual materials and techniques. It is generally agreed that audio-visual materials have implications for more effective achievement of the goals of modern schools.

Master teachers realize that the most effective type of learning is gained by concrete, direct first hand experience which they are often unable to provide. Many teachers attempt to solve this problem, of lack of access to first hand experience, by the use of words both written and spoken. However the use of words alone will not provide vivid learning experiences. Recent studies show that, with careful selection and use of a wide variety of audio-visual materials, effective learning can take place and/or be enhanced.

Much has been written and said concerning audio-visual materials. Some may think of audio-visual education as being new, but the ideas

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are not new. From Aristotle\(^1\) to Dewey, the dangers of verbalism in teaching, use of words without meaning and of concepts acquired through memorization, rather than through understanding, have been repeatedly and forcefully emphasized.

**Statement of the Problem.**—The problem of this study was to test the hypothesis that there will be no statistically significant differences in the science learnings of two selected groups of science students when one group is taught with an extensive use of audio-visual materials.

**Purpose of the Study.**—The major purpose of this study was to attempt to teach two groups of science students when they were exposed to: (a) extensive use of audio-visual materials and (b) minimum use of audio-visual materials. The more specific purposes of the study were to attempt to ascertain the nature and extent to which the teaching of science is improved or enhanced when audio-visual materials are extensively used for the purpose of:

1. Motivation for learning science
2. Increasing interest in science
3. Enhancing understandings and meanings
4. Reducing the amount of verbal presentation
5. Providing abstract bases for first hand learning experiences
6. Increasing instrumental and manipulative skills
7. Fixing permanent learnings

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\(^1\) National Education Association, *The School Administrator and His Audio-Visual Program* (Washington, D. C., 1944), p. 97
8. Concept formation
9. Increasing ability to summarize, review and generalize

**Definition of Terms.**—"Audio-visual Aids" is defined as any device by means of which the learning process may be encouraged or carried on through the sense of hearing and the sense of sight.1

2. Minimum use of audio-visual aids in this study has reference to teaching by lectures and utilizing only textbooks and other materials traditionally associated with the "textbook method" of teaching.

3. Extensive use of audio-visual aids has reference to teaching based on extensive use of special kinds of devices and materials such as motion pictures, filmstrips, television, radio, recordings, graphic illustrations, school journeys, models and demonstrations.

**Method of Research.**—The Descriptive-Survey Method of research, utilizing the techniques of the questionnaire and standardized tests, was used to collect data for the study.

**Research Procedure.**—The following steps were taken:

1. Permission to conduct the study was secured from the proper authorities.

2. Literature related to the study was reviewed and summarized.

3. A questionnaire specifically designed to meet the needs of the research was constructed and approved by competent persons.

4. Four groups were selected and designated as groups A-1 and B-1 and A-2 and B-2. Groups A-1 and A-2, the experimental groups, were equated with group B-1 and B-2, the control groups. They were matched as to age, sex, general intelligence,

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Figure 1 - Method of Rotating Groups
Figure 2 - Diagram Method of Rotation
mental and achievements. The groups were rotated after the first six weeks.

5. The California Achievement Test, forms A and B were used at the beginning of the experiment and at the end to determine the science achievement of the students.

6. The data were tabulated, analyzed and interpreted.

7. Findings, conclusion, implication and recommendation were presented in the final thesis draft.

Related Literature.--A survey of the literature related to this study revealed that many studies have been made comparing the results of teaching with audio-visual aids with those not using such aids.

David R. Sumstine conducted an experimental study in 1918 for the purpose of determining the efficiency of the motion picture as a means of presentation. He used 475 subjects in four high school grades who were placed into three separate groups, namely, the film, film-lecture and lecture. The results were that:

After twenty-four hours those students who saw the film, made an average of 73.9, the lecture group had an average score of 67.0. After ten days had elapsed the film group had again reached first place in the effectiveness with an average score of 60.2 the lecture group had an average score of 51.5. After three months had elapsed the film group was first with an average score of 72.8, where as the film lecture group had an average score of 60.2, and the lecture an average score of 61.1. Thus, the comparative effectiveness of the film was demonstrated in different learning situations with a reasonably large group of high school pupils. Comparable groups of students were equated on the basis of mental ability, achievement test and chronological ages. They were taught units of work from geography, general science, handwork, plupies, health education, natural history, economic history, handwriting, and home economics. In most of the studies comparisons were made between various forms of visual education or between visual and non-visual methods. The results of the experiments showed:

1 Godfrey M. Elliot, Film and Education (New York: Philosophical Library, 1948), p. 58.
The effectiveness of the visual aids used depends upon its adaptation to the nature of the subject which is being taught and the quality of the visual aid which is being used. Many investigations have done much to add to the stabilization of visual aids as an effective means of instruction.  

H. E. Brown\(^2\) compared motion pictures and slides made from filmstrips in two studies with matched groups and concluded that the filmstrip is better, however, inspection of his data revealed that the average scores of his tests were about the same in the case of the two methods.

R. K. Watkins\(^3\) tested two groups, one in physics and one in general science, before and after showing the films and reports gains in the first group ranging from 28 per cent to 106 per cent and in the second from 33 per cent to 146 per cent.

E. B. Greedy\(^4\) reports an experiment with fourth grade geography classes using two methods. In one, the topic introduced by the use of lantern slides; in the other, stereographs were made available to the pupils to correspond with the slides. The lantern slides were shown only to introduce the topic, while the stereographs remained on the table until


\(^{3}\) *Ibid.*

the topic was finished. The results favored the use of slides.

The value of visual education rests on a number of psychological principles, but the U. S. Armed Forces demonstrated their value dramatically in their training program during the Second World War. Three important facts were discovered: (1) students learned more materials by the use of good visual aids in the hands of competent instructors than without these aids; (2) they learn more in a given period; and (3) they retain knowledge longer.¹

Preparation in audio-visual materials and techniques has been made mandatory in Pennsylvania for the Permanent Teacher's Certificate.² On October 10, 1934, the Pennsylvania State Council of Education passed the following resolution:

Resolved that all applicants for permanent teaching certificates on and after September 1, 1935 shall be required to present evidence of having completed and approved course in visual and sensory techniques.

New Jersey has also made audio-visual education a requirement in the four year teachers' college course. In 1945 the California State Board of Education adopted a regulation requiring all teacher-education institutions to provide a two-unit course, or its equivalent for students preparing to teach. The law became effective April 30, 1946. And although not a statutory requirement, such states as Florida, Virginia, California, Texas and Arkansas have regulations which have practically the force of law.


Current research is being carried out by educators, film producers, non-profit agencies, and various arms of military services. Indeed, the greatest understanding of these mass media of communications is currently springing from the research of the Army and Navy. Some of this stems from data gathered in World War II, which is only now being properly collated and interpreted, as well as the fact that the United States Navy has carried out elaborate researches in training methods and equipment since the war.

During World War II our armed services faced the urgent and perplexing problem of taking millions of young men and women (with all types of background, mentality, and ability) out of their peacetime pursuits and educating them rapidly and efficiently for the war. The program had to provide a maximum of training in a minimum. To a very considerable extent, the services organized their instructional program around their instructional program around audio-visual aids. In one way the designation was but natural, not only because of the very extensive use made of these aids, but also because many of the men and women who were taught through these devices had relatively little experience with them in their previous schooling.

Audio-visual materials must be understood in their relationship to teaching as a whole and to the learning process as a whole. Unless the

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teacher grasps this relationship, he can scarcely expect to make intelligent or fruitful use of these techniques that offer so much help in the daily tasks. Above all, it must be recognized that audio-visual methods are one group of methods and an enormously promising group, but not the only group. The teacher must understand that it is worth mastering the methods of audio-visual instruction because they can promote good teaching when used properly.

The time is right for a change in our high school science program.1 And change there certainly is today — more than that brought about by the two world wars or the various depressions. In the past, many educators and laymen looked askance at traditional general science, biology, chemistry, physics content and sequence. They are now aghast at the "Crash Programs" which have mushroomed overnight to replace them. It is important to know that a change is in order. It is important to decide what change.

In spite of the large number of "Crash Programs" many of the recent developments are the result of carefully considered youth-school-community studies. A recent study of these reveals certain emerging trends:

1. There is an increase in ability grouping.

2. School programs are being extended outside normal school hours through evening, Saturday and summer programs.

3. There is greater use of non-school personnel and facilities for teaching purpose.

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4. There is an academic strengthening and modernizing of high school science courses.¹

Research evidence, as reported by the National Society for the Study of Education supports the following claims for properly used audio-visual materials:²

1. They supply a concrete basis for conceptional thinking and hence reduce meaningless word responses of students.
2. They have high degree of interest for students.
3. They supply the necessary basis for developmental learning, and hence make learning more permanent.
4. They offer a reality of experience which stimulates self-activity on the part of pupils.
5. They develop a continuity of thoughts thus is especially true of motion pictures.
6. They contribute a growth of meaning and hence to vocabulary development.
7. They provide experiences not easily secured by other materials and contribute to the efficiency, depth and variety of learning.

In view of the evidence reviewed here it appears that: (1) visual aids make for higher achievement than no visual aids; (2) certain types of visual aids, particularly films, sound or silent promise to be most valuable.

Comparative studies have been made to determine the relative effectiveness of numerous methods of teaching science.³

² Ibid.
The studies have certain common features in their design and findings. One method, the so-called experimental method, is usually designed to incorporate technics which effects currently accepted theory regarding learning. The other method, the so-called control method, is usually designed in terms of the investigator's concept of conventional classroom technics. Two or more classes of students with assumed or demonstrated equivalent abilities are used as the subjects. Tests, designed to measure achievement in one or more the commonly accepted major objectives of science teaching, are usually administered to classes of students before and after the period of instruction by each of the methods. The effectiveness of the methods is judged in terms of gains from pretest to final test. In most comparisons the results are treated to determine the statistical significance of differences achieved by the methods.

The last 20 years, and especially the last 10 years, have seen remarkable improvement in all types of audio-visual materials. The pressure of the war program accelerated interest in the production of filmstrips and training films. Many classroom teachers from the public schools participated in these production programs and brought their teaching experience with them. As a result these projected materials and many other such training devices were carefully designed, tested, and often redesigned to follow the best learning principles. Training films often combined the efforts of professional educators, subject matter specialists, and production specialists.

Although during the war no time, money or effort could be spared to conduct a systematic and extensive research program to demonstrate the effectiveness of the improved quality of films and filmstrips, the testimony of hundreds of instructors and supervisors of education in the
Armed Services affirms that the more careful planning that went into films and filmstrips during the war produced materials that were more effective in the classroom. After the war the civilian producers of these audio-visual materials benefited from the experiences of Armed Services. Standards of photographic and sound quality are today appreciably higher than they were before the war. Production procedures have been simplified and improved so that better materials can be produced at less cost. But the most noticeable improvement is in the actual planning of films and filmstrips. Every scene of the picture and every word of the commentary are planned in advance. All these materials today must fit the curriculum. More and more each film and filmstrip is part of a series which is designed to help in the teaching of a large segment of a course of study. Educational collaborators have the responsibility of seeing that the subject-matter is presented in the optimum way to facilitate learning in the classroom.  

More and more today educational collaborators have some experience in the production of films and, there, are able to suggest scenes and sequences which not only will be effective in teaching but also are within the means and production facilities of the film producer. Thus the pattern developed during the war persists. Each film is designed to fit the curriculum, is presented to make learning easier and more effective, and is produced most efficiently.

It is to the advertising industry that we owe the high state of perfection which the graphic audio-visual materials have reached.

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Although the improvement here has not been as sudden as the improvement in films and filmstrips in the last 20 years, the growth of the advertising business in the United States has been matched by more experimentation and greater knowledge of the effectiveness of certain elements in graphs and charts. This can be demonstrated easily by any school which will undertake to send to a number of industrial firms for the free graphic materials which they provide schools. A display of free travel posters obtainable from travel agencies, such as airlines, steamships and tourist agencies of foreign governments, makes a striking show in a school auditorium or hallway. Here one can see also the technical advances in color reproduction which make modern posters so outstandingly interesting. They are not designed, of course for school curriculums, but alert teachers find many important uses of them.\footnote{Op. cit., p. 20.}
CHAPTER II

PRESENTATION AND ANALYSIS OF DATA

Introductory Statement.--The procedures for collection of the data for this study of the "tested differences" between the "traditional-method" and the "audio-visual aids methods" of teaching Science were: (1) the scores made by the one hundred and ten ninth and tenth grade students in the Lemon Street School, Marietta, Georgia, on the Intelligence and Achievements Tests were used to equate the two groups; and (2) administration of tests to the same one hundred and ten students at the Initial, Intermediate and Final periods of the experimentation. The series of tests used during this study were:

1. California Mental Short-Form Maturity Test
2. California Achievement Test
3. Cooperative Science Test
4. Cooperative Biology Test

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1Elizabeth T. Sullivan, Willis W. Clark, and Earnest W. Tiegs, California Short-Form Test of Mental Maturity (Los Angeles, California: California Test Bureau).

2Earnest W. Tiegs and Willis Clark, California Achievement Test (Los Angeles, California: California Test Bureau).


The data revealed by the scores on the above tests, as made by the two groups, are denoted as Experimental and Control. Further in the chapter data gathered from the tests results will be organized and presented in appropriate tables, which will be analyzed and interpreted. The scores obtained by each of the one hundred and ten students on each of the science Information Tests are given in Tables 8, 9, and 10, pages 34 to 39, Tables 13 and 14, pages 47 and 48, Tables 18 and 19, pages 56 and 59.

**Description of Students.**—The data which are descriptive of the one hundred and ten pupils concerned in this study are presented in Tables 1 and 2, pages 18 and 20 for the sixty pupils constituting the Experimental Groups A-1 and B-1, and in Tables 3 and 4, pages 22 and 23, for the fifty-five pupils constituting the Control Groups A-2 and B-2. Tables 1, 2, 3, and 4 present data about each student including the facts of sex, chronological age, intelligence quotient, mental age and achievement scores.

**Experimental Group A-1 and A-2—Ages.**—Table 1 reveals that in Experimental Group A-1 there were thirteen boys and seventeen girls whose chronological ages range from twelve years and nine months to sixteen years and three months. The mental ages of Experimental Group A-1 ranged from nine years and one month to five years and one month, with a mean mental age of seven years and zero months as shown in Chart 1, page 30.

Group A-1, with a chronological age mean score of 16.1, shows that most of the students are on their age level as compared with the national norm. Group A-1, with a mental mean score of 7.0, which shows
### TABLE 1
SEX, CHRONOLOGICAL AGES, INTELLIGENCE QUOTIENTS, MENTAL AGES AND ACHIEVEMENT SCORES OF GROUP A-1, EXPERIMENTAL GROUP

<table>
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<th>Pupil</th>
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most of the students are two grades below their level as compared with national norm.

Table 2 reveals that in Experimental Group A-2 there were eight boys and seventeen girls whose chronological ages range from twelve years and eleven months to fifteen years and nine months. The mental ages of Experimental Group A-2 ranged from eleven years and zero months to five years and three months, with a mean mental age of seven years and eight months as shown in Chart 2, page 31. Group A-2, with a chronological age mean score of 14.5, shows at the time the students were tested they were on their age level as compared with the national norm. Group A-2, with a mental mean score of 7.8, showed that students

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were one grade and two months below their grade level as compared with the national norm.

Control Group B-1 and B-2 Ages.—Table 3 reveals that in Control Group B-1 there were nineteen boys and eleven girls whose chronological ages range from thirteen years and three months to sixteen years and six months. The mental ages of Control Group B-1 ranged from ten years and zero months to four years and eight months, with a mean mental age of six years and eight months as shown in Chart 1, page 30.

Group B-1, with a chronological age mean score 15.4, shows that most of the students are slightly below their age level as compared with the national norm. Group B-1, with a mental mean score of 6.8, showed that the students were two grades and two months below their grade level as compared to the national norm.

Table 4 reveals that in Control Group B-2 there were sixteen boys and nine girls whose chronological ages ranged from thirteen years and three months to seventeen years and six months. The mental ages of
TABLE 3
SEX, CHRONOLOGICAL AGES, INTELLIGENCE QUOTIENTS, MENTAL AGES, AND ACHIEVEMENT SCORES OF GROUP B-1, CONTROL GROUP

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TABLE 4

SEX, CHRONOLOGICAL AGES, INTELLIGENCE QUOTIENTS, MENTAL AGES, AND ACHIEVEMENT SCORES OF GROUP B-2, CONTROL GROUP

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</tr>
<tr>
<td>14</td>
<td>M</td>
<td>13.3</td>
<td>88</td>
<td>6.2</td>
<td>6.4</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>17.2</td>
<td>88</td>
<td>6.2</td>
<td>6.4</td>
</tr>
<tr>
<td>16</td>
<td>M</td>
<td>14.0</td>
<td>82</td>
<td>6.2</td>
<td>7.1</td>
</tr>
<tr>
<td>17</td>
<td>F</td>
<td>14.2</td>
<td>82</td>
<td>6.4</td>
<td>6.2</td>
</tr>
<tr>
<td>18</td>
<td>F</td>
<td>14.3</td>
<td>81</td>
<td>6.3</td>
<td>7.4</td>
</tr>
<tr>
<td>19</td>
<td>F</td>
<td>14.2</td>
<td>80</td>
<td>6.0</td>
<td>6.6</td>
</tr>
<tr>
<td>20</td>
<td>M</td>
<td>14.10</td>
<td>80</td>
<td>6.5</td>
<td>6.8</td>
</tr>
<tr>
<td>21</td>
<td>M</td>
<td>15.6</td>
<td>77</td>
<td>6.6</td>
<td>6.7</td>
</tr>
<tr>
<td>22</td>
<td>M</td>
<td>15.3</td>
<td>75</td>
<td>6.3</td>
<td>5.8</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>17.1</td>
<td>75</td>
<td>6.3</td>
<td>7.0</td>
</tr>
<tr>
<td>24</td>
<td>F</td>
<td>15.7</td>
<td>72</td>
<td>6.0</td>
<td>6.5</td>
</tr>
<tr>
<td>25</td>
<td>F</td>
<td>17.6</td>
<td>59</td>
<td>5.3</td>
<td>6.6</td>
</tr>
</tbody>
</table>
Control Group B-2 ranged from ten years and three months, with a mean mental age of seven years and two months as shown in Chart 2, page 31.

Group B-2, with a chronological age mean score of 15.5, shows that most of the students are slightly below their age level as compared with the national norm. Group B-2, with a mental mean score of 7.2, showed that the students were one grade and eight months below their grade level as compared to national norm.

Results of the California Mental Maturity Test.—The one hundred and ten students in the four groups, two A's and two B's, Experimental and Control, respectively and alternately, were selected on the basis of intelligence quotients as determined from the data obtained through administration of the California Mental Maturity Test, and the data are revealed in Tables 1-6, pages 18, 20, 22, 23, 26, and 27.

Table 5 reveals that the intelligence quotients of Experimental Group A-1 ranged from 101 to 72 showing a spread of 29 points, with a mean intelligence quotient of 87.2, a median intelligence quotient of 89.0 and standard deviation 8.6.

Table 6 reveals that the intelligence quotients of Experimental Group A-2 ranged from 115 to 76 showing a spread of 39 points, with a mean intelligence quotient of 92.3, a median intelligence quotient of 89.8 and standard deviation 11.09.

Table 5 reveals that the intelligence quotients of Control Group B-1 ranged from 100 to 57 showing a spread of 43 points, with a mean intelligence quotient of 80.8, and a median intelligence quotient of 79.9.

Table 6 reveals that the intelligence quotients of Control Group B-2 ranged from 100 to 59 showing a spread of 41 points, with a mean
TABLE 5

FREQUENCY DISTRIBUTION OF THE INTELLIGENCE QUOTIENTS OF GROUPS A-1 AND B-1 ON THE CALIFORNIA MENTAL MATURITY TEST

<table>
<thead>
<tr>
<th>Intelligence Quotients</th>
<th>Group A-1</th>
<th>Intelligence Quotients</th>
<th>Group B-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-102</td>
<td>//</td>
<td>99-101</td>
<td>///</td>
</tr>
<tr>
<td>97-99</td>
<td>/</td>
<td>96-98</td>
<td>//</td>
</tr>
<tr>
<td>94-96</td>
<td>//</td>
<td>93-95</td>
<td>/</td>
</tr>
<tr>
<td>91-93</td>
<td>/////</td>
<td>90-92</td>
<td>0</td>
</tr>
<tr>
<td>88-90</td>
<td>/////</td>
<td>87-89</td>
<td>//</td>
</tr>
<tr>
<td>85-87</td>
<td>/////</td>
<td>84-86</td>
<td>///</td>
</tr>
<tr>
<td>82-84</td>
<td>/</td>
<td>81-83</td>
<td>///</td>
</tr>
<tr>
<td>79-81</td>
<td>//</td>
<td>78-80</td>
<td>/////</td>
</tr>
<tr>
<td>76-78</td>
<td>//</td>
<td>75-77</td>
<td>//</td>
</tr>
<tr>
<td>73-75</td>
<td>/////</td>
<td>72-74</td>
<td>///</td>
</tr>
<tr>
<td>70-72</td>
<td>/</td>
<td>69-71</td>
<td>///</td>
</tr>
<tr>
<td></td>
<td></td>
<td>66-68</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63-65</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60-62</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57-59</td>
<td>/</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>87.2</td>
<td><strong>Mean</strong></td>
<td>80.8</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>89.0</td>
<td><strong>Median</strong></td>
<td>79.9</td>
</tr>
<tr>
<td><strong>Sigma</strong></td>
<td>8.6</td>
<td><strong>Sigma</strong></td>
<td>11.2</td>
</tr>
</tbody>
</table>
TABLE 6

FREQUENCY DISTRIBUTION OF THE INTELLIGENCE QUOTIENTS OF GROUPS A-2 AND B-2 ON THE CALIFORNIA MENTAL MATURITY TEST

<table>
<thead>
<tr>
<th>Intelligence Quotients</th>
<th>Group A-2</th>
<th>Intelligence Quotients</th>
<th>Group B-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>115-117</td>
<td>/</td>
<td>98-100</td>
<td>///</td>
</tr>
<tr>
<td>112-114</td>
<td>0</td>
<td>95-97</td>
<td>//</td>
</tr>
<tr>
<td>109-111</td>
<td>/</td>
<td>92-94</td>
<td>///</td>
</tr>
<tr>
<td>106-108</td>
<td>//</td>
<td>89-91</td>
<td>/</td>
</tr>
<tr>
<td>103-105</td>
<td>/</td>
<td>86-88</td>
<td>///</td>
</tr>
<tr>
<td>100-102</td>
<td>//</td>
<td>83-85</td>
<td>0</td>
</tr>
<tr>
<td>97-99</td>
<td>//</td>
<td>80-82</td>
<td>///</td>
</tr>
<tr>
<td>94-96</td>
<td>//</td>
<td>77-79</td>
<td>/</td>
</tr>
<tr>
<td>91-93</td>
<td>//</td>
<td>74-76</td>
<td>//</td>
</tr>
<tr>
<td>88-90</td>
<td>//</td>
<td>71-73</td>
<td>/</td>
</tr>
<tr>
<td>85-87</td>
<td>/////</td>
<td>68-70</td>
<td>0</td>
</tr>
<tr>
<td>82-84</td>
<td>/</td>
<td>65-67</td>
<td>0</td>
</tr>
<tr>
<td>79-81</td>
<td>//</td>
<td>62-64</td>
<td>0</td>
</tr>
<tr>
<td>76-78</td>
<td>///</td>
<td>59-61</td>
<td>/</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>Total</td>
<td>25</td>
</tr>
<tr>
<td>Mean</td>
<td>92.3</td>
<td>Mean</td>
<td>85.8</td>
</tr>
<tr>
<td>Median</td>
<td>89.8</td>
<td>Median</td>
<td>86.7</td>
</tr>
<tr>
<td>Sigma</td>
<td>11.09</td>
<td>Sigma</td>
<td>9.5</td>
</tr>
</tbody>
</table>
intelligence quotient of 85.8, a median intelligence quotient of 86.7.

Comparative Data on Groups.—The data from Table 5 indicates that the sixty students are equally divided in the Experimental and Control groups of thirty students each, which are equated in terms of native ability as indicated by the differences of 5.8 points between the intelligence quotient means of Group A-1 and B-1, respectively in favor of the Experimental group; and in terms of the mental age which shows a difference of .2 points between the means of Group A-1 and B-1, respectively in favor of the Experimental Group A-1.

The data from Table 6 indicates that the fifty students are equally divided in the Experimental and Control Groups of twenty-five students each, which were equated in terms of native ability as indicated by the difference of 6.1 points between the intelligence quotient means of Groups A-2 and B-2, respectively in favor of the Experimental Group; and in terms of the mental age which shows a difference of .6 points between the means of Group A-2 and B-2 respectively in favor of the Experimental Group A-2.

From the comparison of the data of Tables 5 and 6 it would appear logical to assume that any difference in achievement to be found later in this study are caused by factors other than difference in native ability and that the differences in achievement may be attributed to relative effectiveness of either "traditional method" or the "audio-visual method" of instruction in teaching science as used in this experimentation.

The "T" Ratio of Groups.—The significant difference on the California Mental Maturity test between the two groups, Experimental A-1
and Control B-1 are shown in Chart 1, page 30. Chart 1 reveals for the intelligence quotients that the "t" ratio for Groups A-1 Experimental and B-1 Control was found to be 2.23, which indicates the differences as not being significant as it was less than 2.58 at the one percent level of confidence. The "t" ratio for the mental age was found to be .29, which indicates that the differences are not significant. The "t" ratio for the chronological age was found to be 1.25, which indicates the differences as being significant at the .05 per cent level.

The significant difference on the California Mental Maturity test between the two groups, Experimental A-2 and Control B-2 are shown in the Chart 2, page 31. Chart 2 reveals for the Intelligence quotients that the "t" ratio for groups A-2 Experimental and B-2 Control was found to be 2.05, which indicates the difference as not being significant as it was less than 2.58 at the one per cent level of confidence. The "t" ratio for the mental age was found to be 1.5, which indicates the differences as not being significant. The "t" ratio for the chronological age was found to be 2.12, which indicates the differences as not being significant as it was less than 2.58 at the one percent level of confidence.

To summarize, then the "t" ratio for the three factors identified in this order, chronological ages 1.25; intelligence quotients 2.23 and mental ages .29, which indicates that the chronological factor possessed the highest degree of differences in the intelligence of sixty students of the Experimental and Control groups A-1 and B-1. This would indicate that all the sixty students comprising the two groups had approximately equal abilities to profit from the instruc-
### CHART 1

**SIGNIFICANT DIFFERENCES FOR THE EXPERIMENTAL A-1 AND CONTROL B-1 GROUPS ON THE CALIFORNIA MENTAL MATURITY TEST**

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>No. of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Difference in Mean</th>
<th>Standard Error of Difference</th>
<th>&quot;t&quot; Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chronological</strong></td>
<td>Experimental A-1</td>
<td>30</td>
<td>14.1</td>
<td>.55</td>
<td>1.3</td>
<td>.31</td>
<td>4.25</td>
</tr>
<tr>
<td></td>
<td>Control B-1</td>
<td>30</td>
<td>15.4</td>
<td>1.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intelligence Quotients</strong></td>
<td>Experimental A-1</td>
<td>30</td>
<td>87.2</td>
<td>8.6</td>
<td>5.8</td>
<td>2.6</td>
<td>2.23</td>
</tr>
<tr>
<td></td>
<td>Control B-1</td>
<td>30</td>
<td>80.8</td>
<td>11.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mental Ages</strong></td>
<td>Experimental A-1</td>
<td>30</td>
<td>7.0</td>
<td>3.4</td>
<td></td>
<td>.2</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>Control B-1</td>
<td>30</td>
<td>6.8</td>
<td>1.54</td>
<td></td>
<td></td>
<td>.29</td>
</tr>
</tbody>
</table>

The "t" ratio for three factors identified in this order chronological 2.22; intelligence quotients 2.05; and mental ages 1.5; which indicates that the mental factor possessed the highest statistical analysis.
### Chart 2

**Significant Differences for the Experimental A-2 and Control B-2 Groups on the California Mental Maturity Test**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Cases</th>
<th>Chronological Intelligence Quotients</th>
<th>Mental Ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Experimental A-2</td>
<td>25</td>
<td>14.5</td>
<td>1.01</td>
</tr>
<tr>
<td>Control B-2</td>
<td>25</td>
<td>15.3</td>
<td>1.14</td>
</tr>
<tr>
<td>Experimental A-2</td>
<td>25</td>
<td>92.3</td>
<td>11.1</td>
</tr>
<tr>
<td>Control B-2</td>
<td>25</td>
<td>85.8</td>
<td>9.5</td>
</tr>
<tr>
<td>Experimental A-2</td>
<td>25</td>
<td>7.8</td>
<td>1.14</td>
</tr>
<tr>
<td>Control B-2</td>
<td>25</td>
<td>7.2</td>
<td>1.27</td>
</tr>
</tbody>
</table>

Degree of difference in the intelligence of the fifty students of the Experimental and Control groups A-2 and B-2. This would indicate that all of the fifty students comprising the two groups had approximately equal procedure of either the "traditional" or "audio-visual" method in this study.
Results on the California Achievement Test.—The one hundred and ten students in the four groups, Experimental and Control, were tested on the California Achievement Test, with the scores given in Tables 1, 2, 3, and 4.

Experimental Group A-1.—The data on the achievement range of the thirty students in the Experimental Group are shown in Table 7, page 33, which reveals a mean score of 8.0, a median score of 7.7, and with a standard deviation of 1.14.

Control Group B-1.—The data on the achievement range of the thirty students in the Control group are shown in Table 7, which reveals a mean score of 7.0, a median score of 7.3 and a standard deviation of 2.70.

Experimental Group A-2.—The data on the achievement range of the twenty-five students in the Experimental group are shown in Table 8, which reveals a mean score of 7.2, a median score of 6.7 and a standard deviation of 2.8.

Control Group B-2.—The data on the achievement range of the twenty-five students in the Control Group are shown in Table 8, which reveals a mean score of 7.0, a median score of 7.7 and a standard deviation of 2.6.

Comparative Data on Groups.—The data from Table 7 reveal that the achievement of students of the two groups have approximately the same mean score, with a difference of 1 point between the mean of 8.0 for the Experimental A-1 in contrast to a mean score of 7.0 for the Control group B-1. The same approximate equality is shown for the range of median scores for the two groups, with a difference of .4
TABLE 7
FREQUENCY DISTRIBUTION OF SCORES OF GROUP A-1 AND GROUP B-1 ON THE CALIFORNIA ACHIEVEMENT TEST

<table>
<thead>
<tr>
<th>Achievement Scores</th>
<th>Group A-1 Experimental</th>
<th>Achievement Scores</th>
<th>Group B-1 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.9-10.1</td>
<td>2</td>
<td>10.1-10.5</td>
<td>1</td>
</tr>
<tr>
<td>9.6-9.8</td>
<td>0</td>
<td>9.6-10.0</td>
<td>0</td>
</tr>
<tr>
<td>9.3-9.5</td>
<td>2</td>
<td>9.1-9.5</td>
<td>0</td>
</tr>
<tr>
<td>9.0-9.2</td>
<td>0</td>
<td>8.6-9.0</td>
<td>0</td>
</tr>
<tr>
<td>8.7-8.9</td>
<td>4</td>
<td>8.1-8.5</td>
<td>4</td>
</tr>
<tr>
<td>8.4-8.6</td>
<td>0</td>
<td>7.6-8.0</td>
<td>2</td>
</tr>
<tr>
<td>8.1-8.3</td>
<td>1</td>
<td>7.1-7.5</td>
<td>9</td>
</tr>
<tr>
<td>7.8-8.0</td>
<td>5</td>
<td>6.6-7.0</td>
<td>5</td>
</tr>
<tr>
<td>7.5-7.7</td>
<td>5</td>
<td>6.1-6.5</td>
<td>4</td>
</tr>
<tr>
<td>7.2-7.4</td>
<td>6</td>
<td>5.6-6.0</td>
<td>2</td>
</tr>
<tr>
<td>6.9-7.1</td>
<td>2</td>
<td>5.1-5.5</td>
<td>2</td>
</tr>
<tr>
<td>6.6-6.8</td>
<td>3</td>
<td>4.6-5.0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>Total</td>
<td>30</td>
</tr>
<tr>
<td>Mean</td>
<td>8.0</td>
<td>Mean</td>
<td>7.0</td>
</tr>
<tr>
<td>Median</td>
<td>7.7</td>
<td>Median</td>
<td>7.3</td>
</tr>
<tr>
<td>Sigma</td>
<td>1.14</td>
<td>Sigma</td>
<td>2.70</td>
</tr>
</tbody>
</table>

point between the median of 7.7 for the Experimental A-1 in contrast to a median score of 7.3 for the Control Group B-1. Again there is shown an approximate equality of the two groups in terms of standard
TABLE 8

FREQUENCY DISTRIBUTION OF SCORES OF GROUP A-2 AND
GROUP B-2 ON THE CALIFORNIA ACHIEVEMENT TEST

<table>
<thead>
<tr>
<th>Achievement Scores</th>
<th>Group A-2 Experimental</th>
<th>Achievement Scores</th>
<th>Group B-2 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5-9.8</td>
<td>// 2</td>
<td>9.1-9.3</td>
<td>/ 1</td>
</tr>
<tr>
<td>9.1-9.4</td>
<td>0 0</td>
<td>8.8-9.0</td>
<td>0 0</td>
</tr>
<tr>
<td>8.8-9.0</td>
<td>// 2</td>
<td>8.5-8.7</td>
<td>// 2</td>
</tr>
<tr>
<td>8.4-8.7</td>
<td>/// 4</td>
<td>8.2-8.4</td>
<td>0 0</td>
</tr>
<tr>
<td>8.0-8.3</td>
<td>/// 4</td>
<td>7.9-8.1</td>
<td>0 0</td>
</tr>
<tr>
<td>7.6-7.9</td>
<td>// 2</td>
<td>7.6-7.8</td>
<td>/ 1</td>
</tr>
<tr>
<td>7.2-7.5</td>
<td>0 0</td>
<td>7.3-7.5</td>
<td>/ 1</td>
</tr>
<tr>
<td>6.8-7.1</td>
<td>/// 4</td>
<td>7.0-7.2</td>
<td>///// 5</td>
</tr>
<tr>
<td>6.4-6.7</td>
<td>// 2</td>
<td>6.7-6.9</td>
<td>///// 4</td>
</tr>
<tr>
<td>6.0-6.3</td>
<td>/// 4</td>
<td>6.4-6.6</td>
<td>///// 8</td>
</tr>
<tr>
<td>5.7-5.9</td>
<td>/ 1</td>
<td>6.1-6.3</td>
<td>/ 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.8-6.0</td>
<td>/ 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5-5.7</td>
<td>/ 1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td></td>
<td><strong>25</strong></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>7.2</strong></td>
<td><strong>Mean</strong></td>
<td><strong>7.0</strong></td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td><strong>6.7</strong></td>
<td><strong>Median</strong></td>
<td><strong>7.7</strong></td>
</tr>
<tr>
<td><strong>Sigma</strong></td>
<td><strong>2.8</strong></td>
<td><strong>Sigma</strong></td>
<td><strong>2.6</strong></td>
</tr>
</tbody>
</table>

deviation, with a difference of .29 point between the standard deviation with .86 for the Experimental Group A-1 in contrast to the standard
deviation of 1.14 for the Control B-1.

The data from Table 8, page 34, reveal that the achievement of students of the two groups have approximately the same mean score, with a difference of .2 point between the mean of 7.2 for the Experimental Group A-2 in contrast to a mean score of 7.0 for the Control Group B-2. The same approximate equality is shown for the range of median scores for the two groups, with a difference of 1 point between the median of 6.7 for the Experimental A-2 in contrast to a median 7.7 for the Control Group B-2. Again there is shown an approximate equality of the two groups in terms of standard deviation, with a difference of .2 point between the standard deviation, 2.8 for the Experimental Group A-2 in contrast to the standard deviation of 2.6 for the Control Group B-2.

From the comparison of the data in Table 7 it would appear logical to assume that there was little significant difference in the prior or background achievement between two groups of students Experimental A-1 and B-1. From the comparison of the data in Table 8, there was little or no significant difference in prior or background achievement between the two groups A-2 and B-2.

**The "T" Ratio of Groups.**—The significant differences on the California Achievement Test between two groups, Experimental A-1 and Control B-1 are shown in Chart 3, page 36. Chart 3 reveals for the achievement that the "t" ratio for Group A-1 Experimental and Group B-1 Control was found to be 3.84, which indicates the difference as being significant at the .05 level of confidence.

The significant differences on the California Achievement Test between groups, Experimental A-2 and Control B-2 are shown in Chart 4,
### Chart 3

**Significant Differences for the Experimental A-1 and Control B-1 Groups on the California Achievement Test**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Difference in Mean</th>
<th>Standard Error of Difference</th>
<th>&quot;t&quot; Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental A-1</td>
<td>30</td>
<td>8.0</td>
<td>1.14</td>
<td>1.0</td>
<td>.26</td>
<td>3.84</td>
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<tr>
<td>Control B-1</td>
<td>30</td>
<td>7.0</td>
<td>.86</td>
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</tr>
</tbody>
</table>

### Chart 4

**Significant Differences for the Experimental A-2 and Control B-2 Groups on the California Achievement Test**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Difference in Mean</th>
<th>Standard Error of Difference</th>
<th>&quot;t&quot; Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental A-2</td>
<td>25</td>
<td>7.2</td>
<td>2.8</td>
<td>.2</td>
<td>.247</td>
<td>.80</td>
</tr>
<tr>
<td>Control B-2</td>
<td>25</td>
<td>7.0</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Page 36. Chart 4 reveals for the achievement that the "t" ratio was found to be .80, which indicates the differences as being not significant.
THE INITIAL EXPERIMENTAL PERIOD

Description of The Science Information Tests.—The Cooperative Science Information Test, Form X for Grades 7, 8, and 9 is designed to measure science achievement. It is divided into three parts, Information Background, Terms and Concepts and Comprehension and Interpretation. The combine scores of the three parts yield a total science score which is used as the basis of comparison in the study. The scores for the Science Information Test are found in Table 9, page 38.

The Cooperative Biology Test, Form X for Grade 10 is designed to measure science achievement at the tenth grade level. It is divided into two parts, Information Background and Comprehension and Interpretation. The combine scores of the two parts yield a total science score which is used as the basis of comparison in the study. The scores for the Biology Information Test are found in Table 10, page 39.

Results on the Initial Science Information Tests.—The Cooperative Science Test was administered as a power test to Group A-1, the Experimental and Group B-1, the Control. The test used about one hour and twenty minutes of actual working time to complete the test.

The Cooperative Biology Test was administered as a power test to Group A-2, the Experimental and Group B-2, the Control. The test used about forty minutes of actual working time to complete the test.

The test papers for each group were scored, tabulated, and the necessary statistical measures, such as mean, median, standard deviation, standard error and "t" ratio were computed. These data are
### TABLE 9

COOPERATIVE SCIENCE TEST SCORES

Initial Test

<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-1 Experimental</th>
<th>Number</th>
<th>Group B-1 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
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<td>20</td>
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</tbody>
</table>
### TABLE 9—Continued

<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-1 Experimental</th>
<th>Number</th>
<th>Group B-1 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>16</td>
<td>21</td>
<td>39</td>
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<td>28</td>
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</tr>
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<td>29</td>
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<td>29</td>
<td>30</td>
</tr>
<tr>
<td>30</td>
<td>34</td>
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<td>32</td>
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</tbody>
</table>

### TABLE 10

**COOPERATIVE BIOLOGY TEST SCORES**

*Initial Test*

<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-2 Control</th>
<th>Number</th>
<th>Group B-2 Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54</td>
<td>1</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
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<td>49</td>
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<tr>
<td>Number</td>
<td>Group A-2 Control</td>
<td>Number</td>
<td>Group B-2 Experimental</td>
</tr>
<tr>
<td>--------</td>
<td>------------------</td>
<td>--------</td>
<td>------------------------</td>
</tr>
<tr>
<td>6</td>
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<td>6</td>
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</tr>
<tr>
<td>7</td>
<td>47</td>
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</tr>
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<tr>
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<td>9</td>
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<td>46</td>
<td>10</td>
<td>41</td>
</tr>
<tr>
<td>11</td>
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<td>11</td>
<td>41</td>
</tr>
<tr>
<td>12</td>
<td>45</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
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</tr>
<tr>
<td>14</td>
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<td>14</td>
<td>41</td>
</tr>
<tr>
<td>15</td>
<td>43</td>
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</tr>
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</tr>
<tr>
<td>18</td>
<td>42</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td>19</td>
<td>42</td>
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</tr>
<tr>
<td>20</td>
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<td>21</td>
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<td>22</td>
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</tr>
<tr>
<td>23</td>
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</tr>
<tr>
<td>25</td>
<td>36</td>
<td>25</td>
<td>36</td>
</tr>
</tbody>
</table>
revealed in Tables 11 and 12 and Charts 5 and 6 pages $h_2$, $h_3$, and $h_4$ respectively.

**Experimental Group A-1.**—Table 11, page $h_2$, reveals that on the Initial Science Test that the thirty students in Experimental Group A-1 obtained scores that showed a mean score of $h_8.4$, a median score of $h_8.8$, and a standard deviation of $6.50$. In terms of grade placement, the scores of the Experimental A-1 ranged from 6th grade 3 months to 10th grade 1 month.

**Control Group B-1.**—Table 11 reveals that on the Initial Science Test that the thirty students in Control Group B-1 obtained scores that showed a mean score of $h_7.2$, a median score of $h_2.5$ and a standard deviation of $9.8$. In terms of grade placement, the scores of the Control B-1 ranged from 4th grade 6 months to 10th grade 4 months.

**Experimental Group A-2.**—Table 12, page $h_3$, reveals that on the Initial Science Test that the twenty-five students in Experimental Group A-2 obtained scores that showed a mean score of $h_4.1$, a median score of $h_3.8$, and a standard deviation of $5.26$. In terms of grade placement, the scores of the Experimental A-2 group ranged from 6 years 8 months to 10 years 5 months. Chart 6 reveals the difference in means, the standard error of difference and "t" ratio.

**Control Group B-2.**—Table 12 reveals that on the Initial Science Test that the twenty-five students in Control Group B-2 obtained scores that showed a mean score of $h_1.5$, a median score of $h_3.8$, and a standard deviation of $5.09$. In terms of grade placement, the scores of the Control B-2 ranged from 6 years 8 months to 10 years 3 months. Chart 5, page $h_4$, reveals the difference in mean, standard error of
## Table 11

Frequency Distribution of Scores of Group A-1 and Group B-1 on the Initial Cooperative Science Test

<table>
<thead>
<tr>
<th>Science Scores</th>
<th>Group A-1 Experimental</th>
<th>Science Scores</th>
<th>Group B-1 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>69-71</td>
<td>/</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>66-68</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>63-65</td>
<td>/</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>60-62</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57-59</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>54-56</td>
<td>4</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>51-53</td>
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<td></td>
<td>2</td>
</tr>
<tr>
<td>48-50</td>
<td>7</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>45-47</td>
<td>7</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>42-44</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>39-41</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>36-38</td>
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<td>3</td>
<td></td>
</tr>
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<td>33-35</td>
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<td></td>
</tr>
<tr>
<td>30-32</td>
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<td>3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>48.4</td>
<td>Mean</td>
<td>44.2</td>
</tr>
<tr>
<td>Median</td>
<td>48.8</td>
<td>Median</td>
<td>42.5</td>
</tr>
<tr>
<td>Sigma</td>
<td>6.50</td>
<td>Sigma</td>
<td>9.8</td>
</tr>
</tbody>
</table>
## TABLE 12

FREQUENCY DISTRIBUTION OF GROUP A-2 AND GROUP B-2 ON THE INITIAL COOPERATIVE BIOLOGY TEST

<table>
<thead>
<tr>
<th>Biology Scores</th>
<th>Group A-2</th>
<th></th>
<th>Biology Scores</th>
<th>Group B-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-55</td>
<td>/</td>
<td>1</td>
<td>52-53</td>
<td>/</td>
</tr>
<tr>
<td>52-53</td>
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<td>50-51</td>
<td>/</td>
</tr>
<tr>
<td>50-51</td>
<td>//</td>
<td>2</td>
<td>48-49</td>
<td>///</td>
</tr>
<tr>
<td>46-47</td>
<td>///</td>
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<td>46-47</td>
<td>/</td>
</tr>
<tr>
<td>44-45</td>
<td>///</td>
<td>3</td>
<td>44-45</td>
<td>/</td>
</tr>
<tr>
<td>42-43</td>
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<td>6</td>
<td>42-43</td>
<td>/</td>
</tr>
<tr>
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<td>38-39</td>
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<td>38-39</td>
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</tr>
<tr>
<td>36-37</td>
<td>///</td>
<td>4</td>
<td>36-37</td>
<td>///</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

| Mean           | 44.1      | Mean           | 41.5          |
| Median         | 43.8      | Median         | 41.2          |
| Sigma          | 5.26      | Sigma          | 5.09          |

difference and "t" ratio.

During the first six weeks of the experimentation, Groups A-1 and A-2, the Experimental and groups B-1 and 2, the Control were both taught by the same teachers and exposed to identical units of subject matter but were instructed by different methods. The Experimental
<table>
<thead>
<tr>
<th>CHART 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SIGNIFICANT DIFFERENCES FOR THE EXPERIMENTAL A-1 AND CONTROL B-1 GROUPS ON THE INITIAL COOPERATIVE SCIENCE TEST</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td><strong>EXPERIMENTAL Group A-1</strong></td>
</tr>
<tr>
<td><strong>CONTROL Group B-1</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHART 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SIGNIFICANT DIFFERENCES FOR THE EXPERIMENTAL A-2 AND CONTROL B-2 GROUPS ON THE INITIAL COOPERATIVE BIOLOGY TEST</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td><strong>EXPERIMENTAL Group A-2</strong></td>
</tr>
<tr>
<td><strong>CONTROL Group B-2</strong></td>
</tr>
</tbody>
</table>

Groups were taught by the use of "audio-visual" aids as described under "procedure" in Chapter I, whereas, the Control Groups were taught by the "traditional" method of recitation and discussion. To ascertain the
the relative effectiveness of the two methods of instruction, the end of the first six weeks period of experimentation was marked by the administering of the intermediate test.

The "t" Ratio of Groups.--The significant differences in the Cooperative Science Test the Experimental and Control groups is shown in Chart 5, page 44. Chart 5 reveals that between the two groups that the "t" ratio was found to be 1.99 for groups A-1 and B-1, which indicates the differences as not being significant as it was less than 2.58 at the one percent level of confidence. The significant differences in the Cooperative Biology Test the Experimental and Control groups is shown in Chart 6, page 44. Chart 6 reveals that between the two groups that the "t" ratio was found to be 2.36 for groups A-2 and B-2, which indicates the differences as not being significant as it was less than 2.58 at the one percent level of confidence.

THE INTERMEDIATE EXPERIMENTATION PERIOD

Introductory Statement.--The Intermediate Experimentation period designates the second testing for science information achievement for the one hundred and ten students in this study in order to find out to what extent the students of the four groups had profited from the use of different instructional procedures. The second testing was also used to secure data that would show to what extent either method was superior to the other. The data secured from the administering of the Cooperative Science Tests, which was filled up with the computation of the statistical measures pertinent to the analysis and interpretation
of the data. The scores are shown in Tables 13 and 14, pages 17 and 18.

Comparative Data on Groups.---The data from Table 15, page 50, reveal that the prior or background knowledge of the students of the two groups have a mean score of 49.1 for the Group A-1 Experimental and 42.2 of Group B-1 Control, with a mean difference of 6.9 point approximate the same difference is shown between the median of the two groups, 49.0 for Group A-1 and 39.4 for Group B-1, with a difference of 8.6 points.

From comparison of the data from Table 15 it would be proper to assume that there was little significant difference in the prior or background knowledge of science information between the two groups of students under investigation.

The data from Table 16, page 51, reveal that the prior or background knowledge of the students of the two groups A-2 and B-2 have mean scores of 52.9 for Experimental A-2 and 46.8 for Control B-2, with a difference of 5.01 points. The same approximate median is found for the two groups 45.8 for Experimental A-2 and 39.7 for Control B-2, a standard deviation of 6.38 for Experimental A-2 and 5.32 for Control B-2.

From comparison of the data from Chart 7, page 52, it would be proper to assume that there was some small degree of significant difference in the prior or background knowledge of science information between the four groups.

The significant differences in the Cooperative Biology Test between the Experimental and Control Groups are shown in Chart 8, page 52. Chart 8 reveals that between the two groups that the "t" ratio
<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-1 Experimental</th>
<th>Number</th>
<th>Group B-1 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>71</td>
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<td>73</td>
</tr>
<tr>
<td>2</td>
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<td>8</td>
<td>53</td>
<td>8</td>
<td>47</td>
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### TABLE 13—Continued

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<th>Group A-1 Experimental</th>
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<th>Group B-1 Control</th>
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<tbody>
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</table>

### TABLE 14

COOPERATIVE BIOLOGY TEST SCORES

Intermediate Test

<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-2 Experimental</th>
<th>Number</th>
<th>Group B-2 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>1</td>
<td>55</td>
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<tr>
<td>2</td>
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<td>6</td>
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<td>6</td>
<td>42</td>
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</tbody>
</table>
was found to be 2.99 for Groups A-2 and B-2, which indicates the differences as being significant at the five percent level of confidence.
TABLE 15  
FREQUENCY DISTRIBUTION OF SCORES OF GROUP A-1 AND GROUP B-1 ON THE INTERMEDIATE COOPERATIVE SCIENCE TEST

<table>
<thead>
<tr>
<th>Science Scores</th>
<th>Group A-1 Experimental</th>
<th>Science Scores</th>
<th>Group B-1 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>69-71</td>
<td>/</td>
<td>71-73</td>
<td>/</td>
</tr>
<tr>
<td>66-68</td>
<td>0</td>
<td>68-70</td>
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<td>63-65</td>
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<td>60-62</td>
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</tr>
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<td>57-59</td>
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<tr>
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<td>48-50</td>
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<td>/</td>
</tr>
<tr>
<td>45-47</td>
<td>///</td>
<td>47-49</td>
<td>/</td>
</tr>
<tr>
<td>42-44</td>
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<td>41-43</td>
<td>/</td>
</tr>
<tr>
<td>39-41</td>
<td>/</td>
<td>38-40</td>
<td>///</td>
</tr>
<tr>
<td>36-38</td>
<td>/</td>
<td>35-37</td>
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</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

Total

<p>| Mean          | 49.1                   | Mean          | 42.3                   |
| Median        | 49.0                   | Median        | 39.4                   |
| Sigma         | 6.99                   | Sigma         | 9.6                    |</p>
<table>
<thead>
<tr>
<th>Biology Scores</th>
<th>Group A-2 Experimental</th>
<th>Biology Scores</th>
<th>Group B-2 Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-61</td>
<td>/</td>
<td>54-55</td>
<td>//</td>
</tr>
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<td>52-53</td>
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</tr>
<tr>
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<td>/</td>
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</tr>
<tr>
<td>50-51</td>
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</tr>
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</tr>
<tr>
<td>46-47</td>
<td>///</td>
<td>40-41</td>
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</tr>
<tr>
<td>44-45</td>
<td>///</td>
<td>38-39</td>
<td>///</td>
</tr>
<tr>
<td>42-43</td>
<td>//</td>
<td>36-37</td>
<td>///</td>
</tr>
<tr>
<td>40-41</td>
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<td>///</td>
</tr>
<tr>
<td>38-39</td>
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<td>36-37</td>
<td>///</td>
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<tr>
<td>36-37</td>
<td>///</td>
<td>36-37</td>
<td>///</td>
</tr>
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Total: 25 25

<table>
<thead>
<tr>
<th></th>
<th>Group A-2</th>
<th>Group B-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>45.9</td>
<td>40.8</td>
</tr>
<tr>
<td>Median</td>
<td>45.8</td>
<td>39.7</td>
</tr>
<tr>
<td>Sigma</td>
<td>6.23</td>
<td>5.32</td>
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</tbody>
</table>
### CHART 7

**SIGNIFICANT DIFFERENCES FOR THE EXPERIMENTAL A-1 AND CONTROL B-1 GROUPS ON THE INTERMEDIATE COOPERATIVE SCIENCE TEST**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Difference in Mean</th>
<th>Standard Error of Difference</th>
<th>&quot;T&quot; Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>30</td>
<td>49.1</td>
<td>6.99</td>
<td>6.90</td>
<td>2.19</td>
<td>3.15</td>
</tr>
<tr>
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<td>42.3</td>
<td>9.6</td>
<td></td>
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</table>

### CHART 8

**SIGNIFICANT DIFFERENCES FOR THE EXPERIMENTAL A-2 AND CONTROL B-2 GROUPS ON THE INTERMEDIATE COOPERATIVE BIOLOGY TEST**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Difference in Mean</th>
<th>Standard Error of Difference</th>
<th>&quot;T&quot; Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>25</td>
<td>45.9</td>
<td>6.38</td>
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<tr>
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<td>40.8</td>
<td>5.32</td>
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</tbody>
</table>

**The "T" Ratio of Groups**—The significant differences in the Cooperative Science Test, between the Experimental and Control groups
is shown in Chart 7, page 52. Chart 7 reveals that between the two groups that the "t" ratio was found to be 3.15 for Groups A-1 and B-1, which indicates the differences as being significant at the five percent level.

Results in the Intermediate Information Test.—The data at this level of science information of the one hundred and ten students in the four groups as derived from the administering of the test at the end of the first six weeks of the science information test, are presented in Tables 15 and 16, pages 50 and 51, and in Charts 7 and 8, page 52, accompanied by the approximate statistical measures basic to their analysis and interpretation.

Experimental Group A-1.—Table 15 reveals that on the Intermediate Science Test that the thirty students in Experimental Group A-1 obtained scores that showed a mean score of 49.1, a median score of 49.0 and a standard deviation of 6.99.

Control Group B-1.—Table 15 reveals that on the Intermediate Science Test that the thirty students in the Control Group B-1 obtained scores of 42.3, a median score of 39.4 and a standard deviation of 9.6.

Experimental Group A-2.—Table 16 reveals that on the Intermediate Biology Test that the twenty-five students in Experimental Group A-2 obtained scores that showed a mean score of 45.9, a median score of 45.8, and a standard deviation of 6.38.

Experimental Group B-2.—Table 16 reveals that on the Intermediate Biology Test that the twenty-five students in Control Group B-2 obtained scores that showed a mean score of 40.8, a median score of 39.7 and a standard deviation of 5.32.
FINAL EXPERIMENTAL PERIOD

Introductory Statement.--The rotation method of Experimentation designed for this study made it necessary during the second six weeks period of the study that the four groups would rotate the instructional methods, therefore, during the period of the seventh through the twelfth week of study the previous Experimental Groups A's were taught by the "traditional-recitation" method and the previous Control Groups B's were taught by the "audio-visual-aids" method.

During the second six weeks period, when the original Experimental Groups A-1 and A-2 became the Control Groups A-1 and A-2, and the original Control Groups B-1 and B-2 became Experimental Groups B-1 and B-2. Again, identical learning materials were taught to each group by the same teacher at the end of the second six weeks period, that is, the end of the twelfth week which marked the close of the entire twelve weeks period of the study, the final science tests were given and followed up with computations of the necessary statistical measures basic to the analysis and interpretation of the data gathered from tests.

The relative effectiveness of the two methods of instruction, the "audio-visual aids" versus "traditional-recitations" was sought in demonstrated differences in "gains" of science knowledge between the students of the Experimental and Control groups as revealed by the final testing. The scores are shown in Tables 17 and 18, pages 55 and 56.

Results in the Final Science Information Test.--The data on the "gains" or the level of science information of the one hundred and ten
### TABLE 17

**COOPERATIVE SCIENCE TEST SCORES**

*Final Test*

<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-I Control</th>
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<th>Group B-I Experimental</th>
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### TABLE 17—Continued

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<tbody>
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<td>21</td>
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### TABLE 18

**COOPERATIVE BIOLOGY TEST SCORES**

**Final Test**

<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-2</th>
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<th>Group B-2</th>
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<td>2</td>
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<td>6</td>
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<td>46</td>
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</table>
TABLE 18—Continued

<table>
<thead>
<tr>
<th>Number</th>
<th>Group A-2 Control</th>
<th>Number</th>
<th>Group B-2 Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>45</td>
<td>7</td>
<td>46</td>
</tr>
<tr>
<td>8</td>
<td>43</td>
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</tbody>
</table>

students in the four study groups as derived from the administering at the end of the second six weeks period of the Cooperative Science
Information Test are presented in Table 19, page 59, and in Chart 9, page 60, Cooperative Biology Test, Table 20 and in Chart 10, page 60, accompanied by the appropriate statistical measures basic to their analysis and interpretation.

**Experimental Group B-1.**—Table 19 reveals that Experimental Group B-1 on the Final Science Information Test obtained scores that showed a mean score of 4.3.5, a median score of 4.2.0 and a standard deviation of 12.3.

**Control Group A-1.**—Table 19 reveals that on the Final Science Information Test Control Group A-1 obtained scores that showed a mean score of 4.9.5, a median score of 50.0 and a standard deviation of 5.6.

**Experimental Group B-2.**—Table 20, page 61, reveals that on the Final Biology Information Test, Experimental Group B-2 obtained scores that showed a mean score of 4.5.0, a median score of 4.4.7 and a standard deviation of 4.4.

**Control Group A-2.**—Table 20 reveals that on the Biology Information Test Group A-2 obtained scores that showed a mean score of 4.2.3, a median score of 4.1.3 and a standard deviation of 6.10.

**The "t" Ratio of Groups.**—The significant differences in the Cooperative Science Test the Experimental and Control groups is shown in Chart 9, page 60. Chart 9 reveals that between the two groups that the "t" ratio was found to be 2.40 for groups A-1 and B-1, which indicates the differences as not being significant as it was less than 2.58 at the one percent level of confidence. The significant difference in the Cooperative Biology Test, between the Experimental and Control Groups is shown in Chart 10, reveals that between the two groups that
TABLE 19
FREQUENCY DISTRIBUTION OF SCORES OF GROUPS A-1 AND B-1
ON THE FINAL COOPERATIVE SCIENCE TEST

<table>
<thead>
<tr>
<th>Science Scores</th>
<th>Group A-1 Control</th>
<th>Science Scores</th>
<th>Group B-1 Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>59-60</td>
<td>//</td>
<td>73-77</td>
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<tr>
<td>57-58</td>
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<td>68-72</td>
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</tr>
<tr>
<td>55-56</td>
<td>//</td>
<td>63-67</td>
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<tr>
<td>53-54</td>
<td>///</td>
<td>58-62</td>
<td>///</td>
</tr>
<tr>
<td>51-52</td>
<td>//    ///</td>
<td>53-57</td>
<td>/</td>
</tr>
<tr>
<td>49-50</td>
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<tr>
<td>47-48</td>
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<td>43-47</td>
<td>//    ///</td>
</tr>
<tr>
<td>45-46</td>
<td>///</td>
<td>38-42</td>
<td>//    ///</td>
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<td>43-44</td>
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<td>41-42</td>
<td>//</td>
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</tr>
<tr>
<td>39-40</td>
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</tr>
<tr>
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</tr>
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<td>Total</td>
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<td>30</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>49.8</td>
<td>Mean</td>
<td>43.5</td>
</tr>
<tr>
<td>Median</td>
<td>50.0</td>
<td>Median</td>
<td>42.0</td>
</tr>
<tr>
<td>Sigma</td>
<td>5.55</td>
<td>Sigma</td>
<td>12.3</td>
</tr>
</tbody>
</table>

The "t" ratio was found to be 1.76 for groups A-2 and B-2, which indicated the differences as not being significant as it was less than 2.58 at the one percent level of confidence.
### Chart 9

**Significant Differences for the Control A-1 and Experimental B-1 Groups on the Final Cooperative Science Test**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Difference in Mean</th>
<th>Standard Error of Difference</th>
<th>T Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A-1</td>
<td>30</td>
<td>49.8</td>
<td>5.55</td>
<td></td>
<td>6.0</td>
<td>2.50</td>
</tr>
<tr>
<td>Group B-1</td>
<td>30</td>
<td>43.5</td>
<td>12.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Chart 10

**Significant Differences for the Experimental B-2 and Control A-2 on the Final Cooperative Biology Test**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Difference in Mean</th>
<th>Standard Error of Difference</th>
<th>T Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A-2</td>
<td>25</td>
<td>42.3</td>
<td>6.10</td>
<td>-2.70</td>
<td>1.53</td>
<td>1.76</td>
</tr>
<tr>
<td>Group B-2</td>
<td>25</td>
<td>45.0</td>
<td>4.40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 20

FREQUENCY DISTRIBUTION OF GROUPS A-2 AND GROUP B-2 ON THE FINAL COOPERATIVE BIOLOGY TEST

<table>
<thead>
<tr>
<th>Biology Scores</th>
<th>Group A-2 Control</th>
<th>Biology Scores</th>
<th>Group B-2 Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-61</td>
<td>/</td>
<td></td>
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<tr>
<td>58-59</td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
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</tr>
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<td>48-49</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>46-47</td>
<td>///</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44-45</td>
<td>/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42-43</td>
<td>/////</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-41</td>
<td>/////</td>
<td></td>
<td></td>
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<tr>
<td>38-39</td>
<td>/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36-37</td>
<td>/////</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total          | 25               |                |                        |

| Mean           | 42.3             | Mean           | 45.0                   |
| Median         | 41.3             | Median         | 44.7                   |
| Sigma          | 6.10             | Sigma          | 4.0                    |
Recapitulation of Results on Tests.—At this point, a recapitulation in outline of results of the testing done during the period of this study is presented in order to give an overall view of the findings. Table 21, page 63, shows the total pertinent data of the analysis and the interpretations covering the entire period of the expectation.

Table 21 reveals that on the initial Test the Experimental Groups A-1 which was to use the "audio-visual" methods had a slight advantage of 4.2 points in mean score over the Control Group, which was to use the traditional-recitation method, that on the intermediate test given after the first six weeks of instruction - that the Experimental Group A-1 held the slight advantage 6.9 points in mean score over Group B-1. The final test, Group A-1, the former experimental group, which had been instructed with aids showed a slight advantage of 6.0 points in mean score over Group B, the former Control group, which had been instructed without aids.

Table 22, page 64, reveals that on the initial test the Experimental Group A-2 which was to use the "audio-visual" methods had a slight advantage of 2.8 points in mean score over the Control Group B-2, which was to use the "traditional-recitation" method, that on the intermediate test given after the first six weeks of instruction - that the Experimental Group A-2 held a slight advantage of 5.0 points in mean score over Group B-2. The final test Group A-2, the former Experimental Group, which had been instructed without aids showed
TABLE 21

THE MEAN SCORE, STANDARD DEVIATION, STANDARD ERRORS OF THE MEAN, DIFFERENCES BETWEEN THE STANDARD ERROR OF DIFFERENCES, MEAN AND "T" RATIO ON THE INITIAL, INTERMEDIATE AND FINAL TESTS

<table>
<thead>
<tr>
<th>TEST</th>
<th>INITIAL</th>
<th>INTERMEDIATE</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP</td>
<td>A-1</td>
<td>B-1</td>
<td>A-1</td>
</tr>
<tr>
<td>NUMBER</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>MEAN</td>
<td>48.4</td>
<td>44.2</td>
<td>49.1</td>
</tr>
<tr>
<td>STANDARD DEVIATION</td>
<td>6.04</td>
<td>9.8</td>
<td>6.99</td>
</tr>
<tr>
<td>STANDARD ERROR</td>
<td>1.12</td>
<td>1.81</td>
<td>1.29</td>
</tr>
<tr>
<td>DIFFERENCE BETWEEN MEANS</td>
<td>4.20</td>
<td>6.90</td>
<td>6.0</td>
</tr>
<tr>
<td>STANDARD ERROR OF DIFFERENCES</td>
<td>2.11</td>
<td>2.19</td>
<td>2.50</td>
</tr>
<tr>
<td>&quot;T&quot; RATIO</td>
<td>1.99</td>
<td>3.15</td>
<td>2.40</td>
</tr>
</tbody>
</table>

slightly a less advantage of 2.7 points in mean score under Group B-2, the former Control Group, which had been instructed without aids.

Therefore, the overall results on each and all three of the tests administered to ascertain the gain in science knowledge by the two methods of instruction used to test the null-hypothesis proposed for
the study.

There is no superiority in the acquisition of science knowledge when such knowledge is taught by means of audio-visual aids, rather than by traditional methods alone.

**TABLE 22**

THE MEAN SCORES, STANDARD DEVIATION, STANDARD ERRORS OF THE MEAN, DIFFERENCES BETWEEN THE MEANS, STANDARD ERROR OF DIFFERENCES AND "T" RATIO ON THE INITIAL, INTERMEDIATE AND FINAL TESTS

<table>
<thead>
<tr>
<th>TEST</th>
<th>INITIAL</th>
<th>INTERMEDIATE</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUMBER</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>MEAN</td>
<td>41.3</td>
<td>41.5</td>
<td>45.9</td>
</tr>
<tr>
<td>STANDARD DEVIATION</td>
<td>5.26</td>
<td>5.09</td>
<td>6.38</td>
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<tr>
<td>STANDARD ERROR</td>
<td>1.08</td>
<td>1.04</td>
<td>1.27</td>
</tr>
<tr>
<td>DIFFERENCE BETWEEN MEANS</td>
<td>2.8</td>
<td>5.01</td>
<td></td>
</tr>
<tr>
<td>STANDARD ERROR OF DIFFERENCES</td>
<td>1.10</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>&quot;T&quot; RATIO</td>
<td>2.36</td>
<td>2.99</td>
<td></td>
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</tbody>
</table>
CHAPTER III

SUMMARY AND CONCLUSION

Rationale.—Education is ultimately, an institution by which societies maintain and reproduce themselves. Formal schooling, of course is not the whole of education. But in every society in which the school exists at all, the primary function is to inculcate, in the young, the motives, attitudes and beliefs, the knowledges and skills, ways of thinking, of feeling and acting, that are desired by the society. At bottom, the educator is the mediator between the child and his culture. The teacher derives his authority to educate in one way rather than another from the basic moral and intellectual commitments of the people served by the school.

Scientific and technological changes have created a transitional era in our educational system. In this period of transitional change the American people must be able to overcome or cope with the complex changes that are going on in their educational system. The direction and effectiveness of the changes which are occurring will determine, in part, by how well school officials comprehend the social situation.

One of our principle goals in teaching is to develop in individual students the skills, attitudes, values, and knowledges necessary to deal
thoughtfully with social problems. Effective science education demands that students sense a continued achievement and understanding of increasingly more difficult concepts as they progress from grade level to grade level.

Audio-visual materials can provide systematic, controlled sensory-motor experiences from which concepts can be formed and manipulated.¹ It is no longer necessary for educators to rely on the haphazard experiences of a happenstance environment. Teachers can now bring into the lives of their pupils the sensory-motor experiences they consider essential for the development of certain concepts. One of the important means by which instruction can be improved, it is increasingly agreed, lies in the area of audio-visual materials and techniques. It is generally agreed that audio-visual materials have implications for more effective achievement of the goals of modern schools.²

Master teachers realize that the most effective type of learning is gained by concrete, direct first hand experience; which they are often unable to provide. Many teachers attempt to solve this problem of lack of access to first hand experience by the use of words both written and spoken. However the use of words alone will not provide vivid learning experiences. Recent studies show that, with careful


selection and use of a wide variety of audio-visual materials, effective learning can take place and/or be enhanced.

Much has been written and said concerning audio-visual materials. Some may think of audio-visual education as being new, but the ideas are not new. From Aristotle to Dewey, the dangers of verbalism in teaching, use of words without meaning and of concepts acquired through memorization rather than through understanding, have been repeatedly and forcefully emphasized.

Evolution of the Problem.—The problem involved in this proposed study evolved from the writer's experiences as a teacher of science. During this period, it was observed how difficult it was to motivate science students and get them to understand the facts and principles of science through use of only lecture and laboratory methods of teaching. As a result of this observation, the writer has a desire to develop a more adequate educational program in science at the Lemon Street Schools, Marietta, Georgia. It was decided to investigate the implications of audio-visual materials for improvement of the science courses.

Contribution to Educational Knowledge.—It is hoped that this study will reveal, to some degree, attributes and short-comings of science teaching when audio-visual materials are frequently used.

The results of a study of this type may be used to familiarize teachers and other personnel with useful methods and techniques of using audiovisual aids in improving science teaching.

**Statement of the Problem.**—The problem of this study was to test the hypothesis that there will be no statistically significant differences in the science learnings of two selected groups of science students when one group is taught by extensive use of audio-visual materials while the other group is taught with a minimum use of audio-visual materials.

**Purpose of the Study.**—The major purpose of this study was to attempt to teach two groups of science students where they were exposed to: (a) extensive use of audio-visual materials and (b) minimum use of audio-visual materials. The more specific purposes of the study was to attempt to ascertain the nature and extent to which the teaching of science is improved or enhanced when audio-visual materials are extensively used for the purpose of:

1. Motivation for learning science
2. Increasing interest in science
3. Enhancing understandings and meanings
4. Reducing the amount of verbal presentation
5. Providing abstract bases for first hand learning experiences

**Method of Research.**—The Descriptive-Survey Method of research, utilizing the techniques of the questionnaire and standardized test, was used to collect data for the study.

**Research Procedure.**—The following steps were taken:

1. Permission to conduct the study was secured from the proper authorities.
2. Literature related to the study was reviewed and summarized.
3. A questionnaire specifically designed to meet the needs of the research was constructed and approved by competent persons.

4. Four groups were selected and designated as groups A-1 and B-1 and A-2 and B-2. Groups A-1 and A-2, the experimental groups were equaled with group B-1 and B-2, the control groups. They were matched as to age, sex, general intelligence, mental age and achievements. The groups were rotated after the first six weeks.

5. The Science Achievement Test form was used at the beginning of the experiment and at the end to determine the science achievement of the students.

6. The data were tabulated, analyzed and interpreted.

7. Findings, conclusion, implication and recommendation were presented in the final thesis draft.

**Summary of Related Literature.**—The summary of the literature pertinent to the problem relative achievement in science for audio-visual aids and traditional classes identifies the significant theories, principles and practices as listed below:

1. The effectiveness of visual aids used depends upon its adaptation to the nature of the subject which is being taught and actual quality of visual aids which is being used. The following persons made studies of the comparative effectiveness of a variety of visual aids.  

2. Audio-visual materials must be understood in their relationship to teaching as a whole to the learning

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2. Ibid.

3. Ibid.

4. Ibid., p. 56.
process as a whole.\(^1\)

3. In spite of the large number of "crash" programs many of the recent developments are the result of careful considered youth-school-community studies. A recent study of these reveals certain emerging trends.\(^2\)

a) There is an increase in ability grouping.

b) School programs are being extended outside normal school hours through evening, Saturday and summer programs.

c) There is greater use of non-school personnel and facilities for teaching purposes.

d) There is an academic strengthening and modernizing of high school science courses.

4. Research evidence, as reported by the National Society for the Study of Education supports the following claims for properly used audio-visual materials:

a) They supply a concrete basis for conceptional thinking and hence reduce meaningless word responses of students.

b) They have high degree of interest for students.

c) They supply the necessary basis for developmental learning, and hence make learning more permanent.

d) They offer a reality of experiences which stimulates self-activity on part of pupils.

e) They develop a continuity of thoughts thus is especially true of motion pictures.

f) They contribute a growth of meaning and hence to vocabulary development.


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f) They contribute a growth of meaning and hence to vocabulary development.

g) They provide experiences not easily secured by other materials and contribute to the efficiency depth and variety of learning.

Findings.—The major objective of this experimentation was to determine the effectiveness of certain audio-visual aids in the teaching of science in the Lemon Street School, Marietta, Georgia. The study has been pursued in the gathering, analyzing, and interpreting of data on the two methods of instruction in the Lemon Street School of Marietta, Georgia. These data have been used to test the hypothesis that there is no superiority in the acquisition of science knowledge when such is taught by means of audio-visual aids rather than by traditional methods alone. The statistical treatment of the data has led to the assumption that the hypothesis is favored to be valid in the Teaching-Learning situation of the one hundred and ten students in the study. The situation and findings follow:

Situation

(a) The one hundred and ten students were divided into four groups, thirty each in two groups of ninth grade students and twenty-five each in two groups of tenth grade students.

(b) The four groups were designated as experimental groups A-1 and A-2, control groups B-1 and B-2. The experimental groups were to use the audio-visual method for the first six weeks and rotate the order for the second six weeks.

(c) The experimental Groups A-1 and A-2 and control Groups B-1 and B-2 were equated in terms of sex,
(f) Group A-2's statistical measures were: chronological age mean 11.5, with a standard deviation of 1.01; and intelligence quotient mean 92.3, a standard deviation 11.1, a mental age of 7.8, a standard deviation of 1.24.

(g) Group B-2's statistical measures were: chronological age mean 15.3, a standard deviation of 1.45; an intelligence quotient mean 85.8, a standard deviation of 9.5; a mental age of 7.2, a standard deviation of 1.27.

(h) Groups A-1 and B-1 showed a chronological age difference mean of 1.3, with a standard error of the means of .31, and a "t" ratio of 4.25; an intelligence quotient difference mean of 5.8, with a standard of means of 2.6, and a "t" ratio of 2.23; and a mental age difference mean of .2, with a standard error of the means of .68; and a "t" ratio of .29.

(i) Groups A-2 and B-2 showed a chronological age difference mean of .8, with a standard error of the means of .33, and a "t" ratio of 2.42, an intelligence quotient difference mean of 6.1, with a standard error of the means of 2.98, and a "t" ratio of 2.05; with a mental age difference mean of .6, with a standard error of the means of .39; and a "t" ratio 1.5.

Student Achievement. (California Test) Tables 5-6, Charts 1-2

(a) The level of scholastic achievement of the one hundred and ten students at the beginning of the study as determined by scores on the California achievement showed the following measures: Experimental Group A-1, a mean score of 8.0, with a standard deviation of .86 in contrast to a mean of 7.0, with a standard deviation of 1.14, for the central group B-1. The scores of the two groups showed a difference of the means of 1.0, with a standard error of the means of .26 and a "t" ratio of 3.84.

(b) Experimental Group A-2 and control Group B-2 showed the following measures: Experimental Group A-2, a mean score 7.2, with a standard deviation of 2.8 in contrast to a mean of 7.0 with a standard deviation of 2.6 for the control group B-2. The scores for the two groups showed a difference of the means of .2, with a standard error of the means of .277 and a "t" ratio of .80.

Initial Testing Tables 11-12, Charts 3-4

(a) The cooperative Science Test, Form X, was used to ascertain the "background" of science knowledge of the sixty ninth grade students of the two Groups A-1 and B-1. The following
statistical measures were found: Experimental A-1, a mean of 48.4, with a standard deviation of 6.04 in contrast to a mean of 44.2, and a standard deviation of 9.8 for the control B-1. The scores of the two groups showed a difference of means of 6.2, with a standard error of the means of 2.11, and a "t" ratio of 2.11.

(b) The Cooperative Biology Test, Form X, was used to ascertain the "background" of science knowledge of the fifty tenth grade students of the two groups A-2 and B-2. The following statistical measures were found: Experimental A-2, a mean of 44.3, with a standard deviation of 5.26 in contrast to a mean of 41.5 and a standard deviation of 5.09 for the control B-2. The scores of the two groups showed a difference of means of 2.8, with a standard error of the means of 1.10 and a "t" ratio of 2.36.

Intermediate Test

(a) The cooperative Science Information Test, Form X, was used to determine the relative effectiveness of two methods of instruction after six weeks period.

Experimental Group A-1. Using "audio-visual aids" method, showed the following statistical measures: A mean score of 45.9, a standard deviation of 6.99 as contrasts to Control Group B-1 using "traditional recitation" method with a mean score of 42.2 and a standard deviation of 9.6.

The two groups showed a difference of means of 6.9, with a standard error of the means of 2.19, and a "t" ratio of 3.5.

(b) The Cooperative Biology Information Test Form X, was used to determine the relative effectiveness of the two methods of instruction after a six weeks period.

Experimental Group A-2. Using "audio-visual aids" method, showed the following statistical measures: A mean score of 45.9, a standard deviation of 6.38 as contrast to Control B-2 using "traditional recitation" method with a score of 40.8, a standard deviation of 5.32.

The two groups showed a difference of means of 5.0, with a standard error of the means of 1.69 and a "t" ratio of 2.99.

Final Test

(a) The Cooperative Science Information Test, was used to determine the relative effectiveness of the two methods of instruction at the class of the second six weeks
period, which also marked the class of the experimentation.

**Experimental Group B-1.** The former control B-1, now using "audio-visual aids" in the rotation procedure, showed the following statistical measures: A mean score of 43.5 and a standard deviation of 12.3 as contrast to control A-1, now using the "traditional-recitation" method a mean score of 49.5, and a standard deviation of 5.55. The two groups showed difference of means of 6.0, with a standard error means of 2.5, and a "t" ratio of 2.40.

**Experimental Group B-2.** The former control B-2, now using "audio-visual aids" in the rotation procedure, showed the following statistical measures: a mean score of 44.7 and a standard deviation of 4.4 as contrast to control A-2, now using the "traditional-recitation" method a mean score of 42.3, a standard deviation of 6.1. The two groups showed differences of means of 2.7, with a standard error of the means of 1.53, and a "t" ratio of 1.76.

**Significant Differences**

<table>
<thead>
<tr>
<th></th>
<th>A-1</th>
<th>B-1</th>
<th>A-2</th>
<th>B-2</th>
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</thead>
<tbody>
<tr>
<td>Chronological age</td>
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<td>2.42</td>
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<tr>
<td>Intelligence quotient</td>
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<td>Mental age</td>
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<td>Achievement</td>
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<tr>
<td>Final</td>
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</tbody>
</table>

**Statistical Measures**

**Experimental A-1**

**California Mental Maturity Test**

<p>| | |</p>
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</tbody>
</table>

**Difference of means 5.8**

**Standard Error of mean 2.6**

**"t" Ratio 2.23**

**Control B-1**

**California Achievement Test**

<p>| | |</p>
<table>
<thead>
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<th></th>
</tr>
</thead>
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<tr>
<td>Sigma</td>
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</tbody>
</table>

**Difference of means 7.0**

**Standard Error of mean 1.14**

**"t" Ratio 1.76**
### Initial Science Test

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<th></th>
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<th>Sigma</th>
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<tbody>
<tr>
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<td>6.04</td>
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Difference of means 1.0  
Standard Error of means 2.6  
"t" Ratio 3.84

### Intermediate Science Test

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Difference of means 4.2  
Standard Error of means 2.6  
"t" Ratio 1.99

### Final Science Test

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Difference of means 6.0  
Standard Error of means 2.5  
"t" Ratio 2.40

### Statistical Measures

#### Experimental A-2

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Difference of means 6.1  
Standard Error of means 2.98  
"t" Ratio 2.05

#### Control B-2

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### California Mental Maturity Test

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Differences of means 2.6
Conclusions.—The major purpose of this experimentation was to validate the hypothesis that there is no superiority in the acquisition of science knowledge when such knowledge is taught by means of audio-visual aids, rather than by traditional methods alone. To state it another way, to ascertain whether or not the "audio-visual aids" method or the "traditional recitation" method possesses superiority as an instructional procedure in the teaching of high school science.

1. The findings derived from a careful analysis and interpretation of the data involved in this study would appear to warrant the conclusion that hypothesis set forth has been validated, namely: that there is no superiority in the acquisition of science knowledge when such knowledge is
taught by means of audio-visual aids rather than traditional methods.

2. Further, the data leads to the conclusion that the small but not statistically significant advantages derived from the use of "audio-visual aids" does not mark this method as superior over the traditional methods of instruction. However, observation during the experimentation, together with statistical evidence of a tendency toward superiority of the "audio-visual aids" method, leads to the belief unsupported by research evidence in this study but supported by evidences in other studies, that audio-visual aids do possess high merit as motivational devices for arousing and maintaining the interest of the learner in situations where-hin he or she would not otherwise merit interest in certain science activities.

Again, this conclusion is supported by the success with which this experimental study has been carried to completion as evidenced by the professional interest and cooperation of the Science Department and Guidance Department of the lemon Street School, the Superintendent of the Marietta Public Schools as well as the enthusiasm, interest, and cooperation of the one hundred and ten students who were subjects of the study.

3. The results of the findings of small non-statistically significant differences in favor of the use of "audio aids" in instruction as against their non-use should encourage believers in their efficiency to greater efforts to increase their fruitfulness as instructional techniques. At least the findings serve to re-emphasize that increased use of audio-visual aids does not minimize achievement in science, hence there is some indication that continuous research is needed to find out the demonstrable effectiveness of each of the methods of instruction now employed in this school.

4. Audio-visual methods are not inherently superior or inferior to other methods of teaching. However, they can, and this study indicates that they do, contribute equally as well as other methods to science learnings.

5. Teachers should not hesitate to use audio-visual aids extensively on the notion that such use will not result in attainment of the achievement goals of science teaching.

Implications.—The following implications are derived from the findings and conclusions:
1. Extensive use of audio-visual aids can result in acquisition and retention of science facts.

2. Audio-visual aids can impart science information as effectively as traditional methods.

3. Audio-visual aids can contribute to thinking and problem-solving as effectively as traditional methods.

4. The structure and sequence of extensive use of audio-visual aids appears to improve, but certainly does not decrease, science learnings, when audio-visual aid methods are followed by a rather lengthy unit presented along traditional lines.

5. Although unsupported by specific findings, it is important to indicate that experiences during this experiment indicates that when audio-visual aids are appropriately selected they facilitate the integration of science materials. This is a by-product implication of the accumulated data collected and dealt with in this study.

Recommendations.—In view of the fact that certain phenomena were observed which the research design did not permit dealing with during this experiment, and on the assumption that these phenomena are associated with this study:

1. It is recommended that other studies be conducted for periods similar or longer than those used in this study, and under similar conditions, to discover the extent to which use of audio-visual aids contributes to science learnings in the areas of:

   (a) The nature of the communication process is exemplified in dimensions of meaning and understanding of science principles and concepts.

   (b) Interest

   (c) Vocabulary development

   (d) Opinions and attitudes

   (e) Instrumental skills

   (f) Generalization and concept formation

   (g) Emotional growth and development
(h) Attainment of the non-achievement goals of science teaching.

2. It is recommended that science teachers have no hesitency to use audio-visual methods to attain their achievement objectives.

3. It is recommended that extensive use of Audio-visual aids be continued in the Lemon Street School and that supplementary and accessory researches be done in the areas identified in Recommendation one to discover whether there are superiorities in attaining the non-achievement goals of science education.
BIBLIOGRAPHY

Books


Elliott, Godfrey M. Film and Education. New York: Philosophical Library, 1948.


Articles


Unpublished Material


VITA

Ruff, Sullivan Reginald, Jr.

Education

Completed high school at the Sims High School, Union South Carolina. Received the B. S. Degree in Chemistry from Allen University 1948; M. S. Degree in Chemistry from Atlanta University 1956; Plan to complete requirements for the degree of Master of Arts in Education Atlanta University, August 1962: Thesis topic: The Effectiveness of Audio-Visual Aids in the Teaching of Science in the Lemon Street School, Marietta, Georgia.

Experience


Personal Data

Married, four children.
APPENDIXES
INSTRUCTIONS TO EXAMINEES:

This is a test of mental maturity. In taking it you will show how well you understand relationships and what you do when you face new problems. No one is expected to do the whole test correctly, but you should answer as many items as you can. Work as fast as you can without making mistakes.

DO NOT WRITE OR MARK ON THIS TEST BOOKLET UNLESS TOLD TO DO SO BY THE EXAMINER.
DIRECTIONS: Mark as you are told the letter, R, for each picture that shows a right; mark the letter, L, for each picture that shows a left.

Samples A and B

Correct Test Booklet Marks

Correct Answer Sheet Marks

A | B
R | L
R | L

A | B
R | L
R | L

R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L
R | L

STOP
NOW WAIT FOR FURTHER INSTRUCTIONS

Test 1 Score
(number right).................................
TEST 2

DIRECTIONS: In each row find the drawing that is a different view of the first drawing. Mark its number as you are told.

Stop now wait for further instructions.

Test 2 Score
(number right) ____________________________
DIRECTIONS: The first three pictures in each row are alike in some way. Decide how they are alike, and then find the one picture among the four to the right of the dotted line that is most like them and mark its number.

TEST 3

D 4 12 3 4 43
.36 .37 .45
38
.42 I 1 2 3 "f*'' 50
Page 4
SF-JH-57

STOP
Test 3 Score (number right) .........................
DIRECTIONS: Read each group of statements below and the conclusions which follow. Then mark as you are told the number of each answer you have decided is correct.

TEST 4

E. All four-footed creatures are animals.
   All horses are four-footed.
   Therefore
   1 Creatures other than horses can walk
   2 All horses can walk
   3 All horses are animals

51. Mr. X is an aviator.
    Mr. X is scoutmaster for his home town.
    Therefore
    1 Aviators make good scoutmasters
    2 One aviator is a scoutmaster
    3 Scoutmasters make good aviators

52. Three boys are on a mountain trail.
    Dick is farther up the trail than Dan.
    Frank is farther up than Dick.
    Which boy is in the middle position on the trail?
    1 Dick
    2 Dan
    3 Frank

53. No human beings are exempt from accidents.
    Automobile drivers are human beings.
    Therefore
    1 No human being is dependable
    2 No automobile drivers are exempt from accidents.
    3 Few human beings make safe automobile drivers

54. If he remains with his friend he will suffer loss, and if he leaves his friend he will suffer loss.
    But, he must remain with his friend or leave him.
    Therefore
    1 He should remain with his friend
    2 It takes courage to leave a friend
    3 He will suffer loss

55. All squares have four equal sides.
    This figure does not have four equal sides.
    Therefore
    1 It is a circle
    2 It is not a square
    3 It is either a triangle or a rectangle

56. He is either foreign-born or a native.
    But, he is not foreign-born.
    Therefore
    1 He is a voter
    2 He is a native
    3 He is a soldier

57. Pine Street is parallel to River Drive.
    River Drive is parallel to Cypress Street.
    Therefore
    1 Pine Street is east of River Drive
    2 Cypress Street crosses Pine Street
    3 Pine Street is parallel to Cypress Street
58. Either your sister is more intelligent than you, or as intelligent, or less intelligent. 
   But, your sister is not more intelligent, nor is she less intelligent. 
   Therefore  
   1 Your sister is less intelligent than you  
   2 Your sister is as intelligent as you  
   3 Your sister is more intelligent than you  

59. Jim has a better batting average than Ed. 
   Ed has a better batting average than Bill. 
   Who has the best batting average?  
   1 Jim  
   2 Bill  
   3 Ed  

60. A weighs less than B. 
   B weighs less than C. 
   Therefore  
   1 B weighs more than C  
   2 A's weight equals B's and C's  
   3 A weighs less than C  

61. The box contains either gold or silver or crystal. 
   It does not contain silver. 
   Therefore  
   1 It contains crystal  
   2 It contains either gold or crystal  
   3 The conclusion is uncertain  

62. If he is to keep his place on the team he must avoid disputes with the captain and the coach. 
   But, he will neither avoid disputes with the captain, nor will he avoid disputes with the coach. 
   Therefore  
   1 He will not remain on the team  
   2 He will lose in popularity with the school  
   3 He may have a reasonable complaint  

63. If the claim is unjust, refusal to permit its discussion before the Student Council is unwise. 
   If the claim is just, refusal is inexcusable. 
   But, the claim is either unjust or it is just. 
   Therefore  
   1 The refusal is justified  
   2 The refusal is being discussed freely  
   3 The refusal is either unwise or inexcusable  

64. A's house is situated northeast of B's. 
   B's house is situated northeast of C's. 
   Therefore  
   1 A's house is situated nearest to C's  
   2 C's house is nearer to A's house than to B's  
   3 A's house is situated to the northeast of C's  

65. W is between X and Y. 
   X is between Y and Z. 
   Therefore  
   1 W is not between Y and Z  
   2 W is between X and Z  
   3 W is nearer to X than to Z  

STOP NOW WAIT FOR FURTHER INSTRUCTIONS
DIRECTIONS: In each row of numbers below, there is one that does not belong. Find the number that should be omitted from each row among the answer numbers on the right, and mark its letter as you are told. When you have finished as many as you can from 66 to 75, read the Directions in the middle of the page and proceed with rows 76 to 80.

### TEST 5.

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| A. | 6  | 9  | 10 | 12 | 14 |    |
|----|----|----|----|----|----|
| (66). | 14 | 12 | 10 | 8  | 7  | 6  | 4  |    |
| (67). | 13 | 11 | 10 | 7  | 4  |    |
| (68). | 15 | 13 | 9  | 5  | 1  |    |
| (69). | 7  | 8  | 11 | 12 | 13 |    |
| (70). | 2  | 4  | 9  | 10 | 13 |    |
| (71). | 29 | 27 | 24 | 14 | 10 | 13 | 70 |
| (72). | 17 | 14 | 9  | 7  | 5  | 2  |
| (73). | 21 | 10 | 9  | 8  | 6  | 3  |
| (74). | 3  | 8  | 12 | 17 | 22 | 23 | 30 |
| (75). | 20 | 19 | 17 | 14 | 16 | 15 | 16 |

### DIRECTIONS: Go right on with the following until told to stop. In each row of numbers below, the numbers grow larger or smaller in a regular series of whole numbers. Decide what numbers are missing, find them among the answers on the right, and mark the letter of your choice for the correct answer.

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<td>b 53, 33, 23</td>
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STOP NOW WAIT FOR FURTHER INSTRUCTIONS

**Test 5 Score:** (number right)........................................
TEST 6.

G. If you earned $5.00 and spent $3.00, how many dollars would you have left?
   a $1.00
   b $2.00
   c $3.00
   d $5.00

81. If a freight train travels at the rate of 20 miles an hour, how many miles will it travel in 4 hours?
   a 5
   b 24
   c 80
   d 60

82. How many pieces of candy can you buy for 15 cents at the rate of 4 for 5 cents?
   a 9
   b 12
   c 15
   d 60

83. On a road map each one-half inch represents 20 miles. How many miles are represented by 5 inches?
   a 10
   b 20
   c 100
   d 200

84. Large envelopes that sell for 3 cents each can be had for 30 cents a dozen. How much is saved when bought by the dozen?
   a 10¢
   b 6¢
   c 2½¢
   d 9¢

85. How many one-inch cubes can be placed in a box 5 inches long, 4 inches wide, and 3 inches high?
   a 12
   b 23
   c 60
   d 100

86. If you had 20 words in spelling and were marked 90%, how many words did you spell correctly?
   a 1
   b 11
   c 18
   d 19

87. How many 1½ cent stamps would you give in even exchange for 30 one-half cent stamps?
   a 10
   b 15
   c 20
   d 45
88. A ball team played 25 games and won 7 games more than it lost. How many games did it win?
   a) 7  
   b) 9  
   c) 16  
   d) 18  

89. How many sheets of paper 7 inches by 10 inches can you cut from a sheet of paper 21 inches by 30 inches?
   a) 3  
   b) 6  
   c) 9  
   d) 34  

90. At 10 cents a foot, what is the cost of enough molding to go around the ceiling of a room 15 feet wide by 16 feet long?
   a) $3.10  
   b) $6.20  
   c) $31.00  
   d) $24.00  

91. 2½ times what number equals 40?
   a) 16  
   b) 8  
   c) 15  
   d) 17  

92. If a 5 inch cube of ice weighs 4⅓ pounds, how many pounds will a 10 inch cube weigh?
   a) 212½  
   b) 8½  
   c) 34  
   d) 50  

93. What is the number which if multiplied by 2 is 4 less than 3 times 6?
   a) 6  
   b) 7  
   c) 14  
   d) 8  

94. Jim says his age is ¼ of his uncle's, and that their ages together total 40 years. How many years difference is there between Jim's and his uncle's age?
   a) 10  
   b) 20  
   c) 24  
   d) 30  

95. A tank is fed by two pipes, one of which can fill it in 2 hours, and the other in 3 hours. A third pipe can empty it in 1 hour. If the tank is full and all three pipes are opened and operating to full capacity, how many hours will it take to empty the tank?
   a) 2  
   b) 4  
   c) 5  
   d) 6  

STOP NOW WAIT FOR FURTHER INSTRUCTIONS
TEST 7.

H. blossom 1 tree 2 vine 3 flower 4 garden — H
96. strange 1 real 2 tell 3 certain 4 unknown — 96
97. reply 1 news 2 answer 3 note 4 open — 97
98. liberty 1 benefit 2 seize 3 freedom 4 aid — 98
99. assist 1 consent 2 help 3 agree 4 overlook — 99
100. admire 1 defend 2 protect 3 approve 4 agree — 100
101. aim 1 offer 2 apply 3 haste 4 end — 101
102. esteem 1 reject 2 estimate 3 exceed 4 respect — 102
103. acquire 1 agree 2 conduct 3 obtain 4 conflict — 103
104. counsel 1 glory 2 advice 3 generous 4 satisfy — 104
105. ample 1 season 2 plentiful 3 alive 4 autumn — 105
106. amaze 1 agree 2 betray 3 surprise 4 contrary — 106
107. oppress 1 promise 2 imitate 3 crowd 4 burden — 107
108. liberal 1 lonely 2 generous 3 learned 4 real — 108
109. predatory 1 soft 2 stationary 3 plundering 4 lasting — 109
110. obstinate 1 saucy 2 headstrong 3 satisfactory 4 obedient — 110
111. eternal 1 worthy 2 brief 3 endless 4 native — 111
112. fugitive 1 fetter 2 accident 3 saddle 4 runaway — 112
113. legend 1 ancient 2 legion 3 story 4 leisure — 113
114. entreat 1 refuse 2 plead 3 repair 4 reform — 114
115. notable 1 terrible 2 brilliant 3 severe 4 famous — 115
116. diminish 1 obtain 2 repeat 3 reduce 4 plentiful — 116
117. envious 1 amiable 2 jealous 3 boisterous 4 enormous — 117
118. prophecy 1 suggestion 2 task 3 substance 4 prediction — 118
119. corrode 1 collect 2 disintegrate 3 applaud 4 blame — 119
120. invariably 1 probably 2 seldom 3 always 4 motionless — 120
121. detect 1 remove 2 discover 3 overtake 4 apply — 121
122. reluctantly 1 gladly 2 instantly 3 certainly 4 unwillingly — 122
123. inefficient 1 unprudent 2 prudent 3 incompetent 4 inevitable — 123
124. facetious 1 active 2 fragile 3 humorous 4 inventive — 124
125. ambiguous 1 hard 2 doubtful 3 responsible 4 confident — 125
126. utilize 1 harmonize 2 identify 3 use 4 invite — 126
127. dejected 1 slow 2 disheartened 3 weighty 4 destroyed — 127
128. dexterity 1 safety 2 advantage 3 affection 4 skill — 128
129. defer 1 affirm 2 delay 3 confer 4 ordain — 129
130. deride 1 advance 2 encourage 3 ennoble 4 ridicule — 130
131. concede 1 overrule 2 engage 3 allow 4 endeavor — 131
132. invoke 1 hover 2 imitate 3 ask 4 invest — 132
133. coerce 1 varnish 2 adverse 3 treasure 4 compel — 133
134. tarnish 1 frighten 2 blacken 3 lament 4 torment — 134
135. antecedent 1 actual 2 pretended 3 previous 4 genuine — 135
136. disparage 1 divert 2 discredit 3 deprive 4 divide — 136
137. impervious 1 empty 2 injurious 3 impenetrable 4 important — 137
138. deleterious 1 harmful 2 just 3 tardy 4 particular — 138
139. presage 1 wisdom 2 precedent 3 foretell 4 promote — 139
140. surfeit 1 excess 2 excel 3 survey 4 feature — 140
141. vertigo 1 greenish 2 truth 3 strength 4 giddiness — 141
142. quondam 1 quota 2 survivor 3 former 4 future — 142
143. mandible 1 handcuff 2 jaw 3 law 4 forceful — 143
144. odium 1 favor 2 blame 3 smell 4 poem — 144
145. chuff 1 peevish 2 churl 3 cliff 4 laugh — 145

Page 10

STOP
# California Short-Form Test of Mental Maturity

## Junior High Level

**GRADES 7-9, '57 S-Form**

**DEVIS ED BY E. T. SULLIVAN, W. W. CLARK, AND E. W. TIEGS**

See **MANUAL** for instructions.

## Examiner

**Teacher or Examiner** (Blank)

**Examinee's Age** (Blank)

**City** (Blank)

**Grade or Occupation** (Blank)

**SEX** (Circle one)

- M
- F

**Date of Birth** (Blank)

**Month** (Blank)

**Day** (Blank)

**Year** (Blank)

## Diagnostic Profile

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<tbody>
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<td>1. Sensing Right and Left</td>
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<td>15</td>
</tr>
<tr>
<td>2. Manipulation of Areas</td>
<td>144</td>
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<tr>
<td>3. Similarities</td>
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<td>15</td>
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<tr>
<td>4. Inference</td>
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<td>5. Number Series</td>
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<td><strong>LANGUAGE DATA</strong></td>
<td>144</td>
<td>80</td>
</tr>
<tr>
<td><strong>MENTAL AGE</strong></td>
<td>144</td>
<td>80</td>
</tr>
<tr>
<td><strong>NON-LANGUAGE DATA</strong></td>
<td>144</td>
<td>65</td>
</tr>
<tr>
<td><strong>CHRONOLOGICAL AGE</strong></td>
<td>144</td>
<td>108-288</td>
</tr>
</tbody>
</table>

**Average Grade Placement Equivalent (Intell. M.A.)**

<table>
<thead>
<tr>
<th>Yr.</th>
<th>Mental Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>120</td>
</tr>
<tr>
<td>132</td>
<td>144</td>
</tr>
<tr>
<td>156</td>
<td>168</td>
</tr>
<tr>
<td>180</td>
<td>192</td>
</tr>
<tr>
<td>204</td>
<td>216</td>
</tr>
<tr>
<td>240</td>
<td>288</td>
</tr>
</tbody>
</table>

**I.Q.**

- *Shift decimal two places to the right before recording.*

**Summary of Data**

<table>
<thead>
<tr>
<th>Score</th>
<th>L + NL</th>
<th>Language Data</th>
<th>Non-Language Data</th>
<th>Total Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Normal Population**

- 9th Grade I.Q.
- 10th Grade I.Q.
- 11th Grade I.Q.
- 12th Grade I.Q.

**College Freshmen**

- I.Q.

**College Sophomores**

- I.Q.

**College Graduates**

- I.Q.

**Other**

- I.Q.
INSTRUCTIONS TO STUDENTS:

This is a language test. In taking it you will show what you know about capitalization, punctuation, and words and sentences, and how well you can spell and write. No one can do the whole test correctly, but you should answer as many items as you can. Work as fast as you can without making mistakes.

DO NOT WRITE OR MARK ON THIS TEST BOOKLET UNLESS TOLD TO DO SO BY THE EXAMINER.
DIRECTIONS: In the sentences below the line, some of the letters with numbers above them should be capitals. Mark the number of each letter that should be a capital. Some lines may have more than one letter that should be a capital; others may have no such letter.

SAMPLE: A. His name is sam and he's my friend. 

In Sample A the number 3 letter, s, in sam, should be a capital. Notice how the 3 has been marked.

TEST 5 — SECTION A

1. we shall travel east to Bagdad.

2. Mary visited her aunt, they went to

3. a show the first evening.

4. The only correct abbreviation for september

5. always has four letters, sept.

6. Abraham lincoln's birthplace, kentucky, is very

7. far from where he lived later.

8. I read Black beauty and think it

9. is a very good book.

10. The last day of october is known to

11. all of our people as hallowe'en.

12. Beautiful france has a capital named paris.

13. On sunday I started for the rocky Mountains

14. to visit with my uncle Bill.

15. Jack asked, "may you play ball today?"
DIRECTIONS: In the story below the line, numbers 16, 17, 18, etc., indicate places where punctuation may or may not be needed. In the answer row which has the number used in the story, make a black mark within the pair of dotted lines under the punctuation needed. If none is needed, mark N. Use the same answer row to show all punctuation needed at any one number in the story.

SAMPLE: B. Is\textsubscript{1} John coming\textsubscript{2} home\textsubscript{3}

No punctuation is needed at 1 after the word, is, in Sample B, so a mark has been made under the N in answer row 1. A mark under N in answer row 2 shows that punctuation is not needed at 2 in the sample. A mark under the ? in answer row 3 shows the punctuation needed at 3 in the sample.

TEST 5 — SECTION B

Saturday,\textsubscript{16} on the way\textsubscript{17} back from a fishing trip\textsubscript{18} Jack\textsubscript{19} and Bill met Tom, who said\textsubscript{20} Where have you been\textsubscript{21} “We\textsubscript{22} have been fishing\textsubscript{23} up at the lake\textsubscript{24} answered Bill.\textsubscript{25} “We caught some bass\textsubscript{26} trout, and perch.”

Jack said\textsubscript{27} “Bill kept us\textsubscript{28} from drowning too. We were\textsubscript{30} out in a canoe and I stood up.\textsubscript{31} The canoe began tipping and Bill yelled,\textsubscript{32} ‘Sit down,\textsubscript{33} just as the canoe\textsubscript{34} was about\textsubscript{35} to tip over.’

STOP NOW WAIT FOR FURTHER INSTRUCTIONS
TEST 5 — SECTION C

36. (1 Has't 2 Haven't) the children come home yet?

37. (1 Doesn't 2 Don't) the boy know it is dangerous to go into deep water?

38. He (1 did 2 done) the work well.

39. We were at the theater last night where we (1 saw 2 seen) some trained animals.

40. He should (1 have gone 2 have went) home before six o'clock.

41. Put (1 them 2 those) books on the table.

42. The cake was given to (1 he 2 him) and Mary.

43. Miss Sparks gave the basket of flowers to her and (1 I 2 me.)

44. (1 Lay 2 Lie) still and rest until morning.

45. The ball game started when the mayor (1 throwed 2 threw) the baseball onto the field.

46. As these men worked hard the previous day. YES NO 46

47. When the problem is one of addition. YES NO 47

48. The lake was surrounded by snow-covered hills. YES NO 48

49. After talking with the natives in the camp. YES NO 49

50. Running as hard as we could. YES NO 50

51. Great caravan routes lead to Damascus. YES NO 51

52. With the first breath of autumn. YES NO 52

53. Which in turn rests on logic. YES NO 53

54. To hold in mind a single line of reasoning requires higher types of thought than those which are involved in mastering a single statement. YES NO 54

55. When the pupil does not understand what he is aiming to accomplish in algebra or geometry and is carried along for a time by the demands of the teacher. YES NO 55

STOP NOW WAIT FOR FURTHER INSTRUCTIONS
DIRECTIONS: Read the following sentence. Then consider how each individual word in that sentence is used in order that you may classify it as a part of speech. Mark the number which shows the classification of each word. If you do not know an answer, or if you think that none of the answers given is correct, mark the number, 5.

We walk in the park almost every afternoon and watch other small children feed doves which perch on their shoulders.

<table>
<thead>
<tr>
<th>WORDS</th>
<th>PARTS OF SPEECH</th>
</tr>
</thead>
<tbody>
<tr>
<td>56. we</td>
<td>1 noun</td>
</tr>
<tr>
<td>57. walk</td>
<td>1 noun</td>
</tr>
<tr>
<td>58. in</td>
<td>1 pronoun</td>
</tr>
<tr>
<td>59. the</td>
<td>1 verb</td>
</tr>
<tr>
<td>60. park</td>
<td>1 verb</td>
</tr>
<tr>
<td>61. almost</td>
<td>1 noun</td>
</tr>
<tr>
<td>62. every</td>
<td>1 noun</td>
</tr>
<tr>
<td>63. afternoon</td>
<td>1 noun</td>
</tr>
<tr>
<td>64. and</td>
<td>1 pronoun</td>
</tr>
<tr>
<td>65. watch</td>
<td>1 noun</td>
</tr>
<tr>
<td>66. other</td>
<td>1 noun</td>
</tr>
<tr>
<td>67. small</td>
<td>1 noun</td>
</tr>
<tr>
<td>68. children</td>
<td>1 noun</td>
</tr>
<tr>
<td>69. feed</td>
<td>1 noun</td>
</tr>
<tr>
<td>70. doves</td>
<td>1 noun</td>
</tr>
<tr>
<td>71. which</td>
<td>1 verb</td>
</tr>
<tr>
<td>72. perch</td>
<td>1 noun</td>
</tr>
<tr>
<td>73. on</td>
<td>1 pronoun</td>
</tr>
<tr>
<td>74. their</td>
<td>1 noun</td>
</tr>
<tr>
<td>75. shoulders</td>
<td>1 noun</td>
</tr>
</tbody>
</table>

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. D Score (number right)
DIRECTIONS: Each line in this test contains four spelling words and the word, None. These words are numbered 1, 2, 3, 4, and the None is numbered 5. In some of the lines, one word is misspelled. In others, no word is misspelled. If there is a misspelled word, mark its number. If no word is misspelled, mark the 5.

SAMPLE: C. 1 now 2 just 3 come 4 ron 5 None

SAMPLE: D. 1 go 2 see 3 do 4 may 5 None

<table>
<thead>
<tr>
<th>Correct Test Mark</th>
<th>Correct Answer Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>D</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

TEST 6

| 76. 1 score | 2 rathur | 3 lame | 4 bitter | 5 None |
| 77. 1 soak  | 2 really | 3 escape| 4 often  | 5 None |
| 78. 1 sipply| 2 nature | 3 loose | 4 promise| 5 None |
| 79. 1 split | 2 elephunt| 3 niece | 4 sixty  | 5 None |
| 80. 1 entire| 2 trout  | 3 losing| 4 lisened| 5 None |
| 81. 1 lantern| 2 faint  | 3 motion| 4 arrest | 5 None |
| 82. 1 moral | 2 sentury | 3 haste | 4 compel | 5 None |
| 83. 1 tried | 2 woolen | 3 peech | 4 shining| 5 None |
| 84. 1 safety| 2 dreamed| 3 careless| 4 unles | 5 None |
| 85. 1 assist | 2 special | 3 weight | 4 paddle | 5 None |
| 86. 1 funny | 2 takeing | 3 until  | 4 alone  | 5 None |
| 87. 1 obedient| 2 register| 3 target | 4 sesion | 5 None |
| 88. 1 suburb | 2 laboratory| 3 carear | 4 efficiency| 5 None |
| 89. 1 pantry | 2 whistle | 3 insect | 4 willow | 5 None |
| 90. 1 mortal | 2 salute  | 3 evidence| 4 estate | 5 None |
| 91. 1 moskuito| 2 singular| 3 hymn  | 4 drama  | 5 None |
| 92. 1 tangle | 2 presence | 3 intense | 4 prairy | 5 None |
| 93. 1 evil | 2 detail | 3 justise | 4 amuse  | 5 None |
| 94. 1 foreign| 2 examenation| 3 accent | 4 diamond | 5 None |
| 95. 1 horrid | 2 strain | 3 orphan | 4 investegate| 5 None |
| 96. 1 lease | 2 expand | 3 misterious| 4 cucumber| 5 None |
| 97. 1 swich| 2 paw | 3 sleeve  | 4 noisy  | 5 None |
| 98. 1 disposition| 2 brilliant| 3 magnificecent| 4 accord | 5 None |
| 99. 1 remit | 2 oxygan | 3 interfere | 4 delicious | 5 None |
| 100. 1 stubborn| 2 permanent| 3 campain | 4 indifferent| 5 None |
| 101. 1 silence | 2 vegetable| 3 patient | 4 mere  | 5 None |
| 102. 1 aerial | 2 individuel| 3 exquisite| 4 convict | 5 None |
| 103. 1 scaucer| 2 unable | 3 sow  | 4 prison  | 5 None |
| 104. 1 amiable| 2 seiges| 3 beneficial | 4 chaperon | 5 None |
| 105. 1 strenuous| 2 accrued| 3 infamy | 4 melencholy | 5 None |

Page 6

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Test 6 Score (number right)..........................
Write the words which are pronounced.

1. 

2. 

3. 

STOP NOW WAIT FOR FURTHER INSTRUCTIONS
California Language Test
intermediate  GRADES  7 - 8 - 9  form AA
DEvised BY ERNEST W. TIEGS AND WILLIS W. CLARK

Name: [Column], Last: [Column], First: [Column], Middle: [Column]
Occupation or Grade: [Column], Sex: [Column]
School or Organization: [Column], City: [Column]
Date of Test: Month Day Year
Date of Birth: Month Day Year

DIAGNOSTIC PROFILE
(Chart Student's Scores Here)

Grade Placement

DIAGNOSTIC ANALYSIS OF LEARNING DIFFICULTIES

5. Mechanics of English, and Grammar

A. Capitalization:

B. Punctuation:

C. Words and Sentences:

D. Parts of Speech:

TOTAL LANGUAGE 95

See MANUAL for instructions on preparation of Diagnostic Profile and Diagnostic Analysis of Learning Difficulties.
Intermediate \( \text{GRADES} \) 7 - 8 - 9 \( \text{form AA} \)

California Reading Test
(Formerly: Progressive Reading Test)

DEVISED BY ERNEST W. TIEGS AND WILLIS W. CLARK

INSTRUCTIONS TO STUDENTS:

This is a reading test. In taking it you will show how many words you know and how well you understand what you read. No one can do the whole test correctly, but you should answer as many items as you can. Work as fast as you can without making mistakes.

DO NOT WRITE OR MARK ON THIS TEST BOOKLET UNLESS TOLD TO DO SO BY THE EXAMINER.
**DIRECTIONS:** Mark as you are told the number of the word that means the opposite or about the opposite of the first word.

**SAMPLE:** A. large 1 rich 2 small 3 gone 4 away

<table>
<thead>
<tr>
<th>DIRECTIONS:</th>
<th>Mark as you are told the number of the word that means the opposite or about the opposite of the first word.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST 1 — SECTION A</td>
<td>Correct Test Booklet Mark</td>
</tr>
<tr>
<td>1. addition 1 victory 2 review 3 subtraction 4 hammer</td>
<td>2 A</td>
</tr>
<tr>
<td>2. unknown 1 neglect 2 property 3 known 4 drum</td>
<td></td>
</tr>
<tr>
<td>3. add 1 about 2 house 3 sometime 4 subtract</td>
<td></td>
</tr>
<tr>
<td>4. whole 1 item 2 part 3 sweet 4 lower</td>
<td></td>
</tr>
<tr>
<td>5. domestic 1 foreign 2 election 3 contrary 4 perish</td>
<td></td>
</tr>
<tr>
<td>6. advance 1 autumn 2 decrease 3 cottage 4 model</td>
<td></td>
</tr>
<tr>
<td>7. divisor 1 plunge 2 submit 3 multiplier 4 line</td>
<td></td>
</tr>
<tr>
<td>8. fraction 1 parrot 2 paddle 3 spacious 4 integer</td>
<td></td>
</tr>
<tr>
<td>9. purchase 1 sale 2 spoke 3 market 4 cloud</td>
<td></td>
</tr>
<tr>
<td>10. similar 1 publish 2 burden 3 reveal 4 unlike</td>
<td></td>
</tr>
<tr>
<td>11. total 1 carriage 2 fraction 3 native 4 treasure</td>
<td></td>
</tr>
<tr>
<td>12. even 1 rapid 2 odd 3 promise 4 regular</td>
<td></td>
</tr>
<tr>
<td>13. irregular 1 ashore 2 hymn 3 countenance 4 systematic</td>
<td></td>
</tr>
<tr>
<td>14. equality 1 inequality 2 scandal 3 rely 4 pare</td>
<td></td>
</tr>
<tr>
<td>15. annaex 1 casket 2 separate 3 balloon 4 adult</td>
<td></td>
</tr>
<tr>
<td>16. wholesale 1 coral 2 ascribe 3 fleecy 4 retail</td>
<td></td>
</tr>
<tr>
<td>17. concave 1 flaw 2 convex 3 discretion 4 caramel</td>
<td></td>
</tr>
<tr>
<td>18. creditor 1 meridian 2 expand 3 debtor 4 dough</td>
<td></td>
</tr>
<tr>
<td>19. base 1 surface 2 diagonal 3 altitude 4 contents</td>
<td></td>
</tr>
<tr>
<td>20. assets 1 expenses 2 liabilities 3 gain 4 statement</td>
<td></td>
</tr>
<tr>
<td>21. bisect 1 binomial 2 reduce 3 double 4 increase</td>
<td></td>
</tr>
<tr>
<td>22. assessment 1 reduction 2 effect 3 loom 4 dividend</td>
<td></td>
</tr>
</tbody>
</table>

**TEST 1 — SECTION B**

<table>
<thead>
<tr>
<th>TEST 1 — SECTION B</th>
<th>Correct Test Booklet Mark</th>
<th>Correct Answer Sheet Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. melt 1 permit 2 human 3 freeze 4 farther</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. spring 1 matter 2 autumn 3 rivulet 4 year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. invisible 1 visible 2 reasonable 3 monkey 4 stupid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. contract 1 package 2 couch 3 expand 4 glitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. natural 1 increase 2 accidental 3 spread 4 artificial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. bleach 1 badge 2 dye 3 dell 4 madman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. constant 1 attack 2 grade 3 variable 4 stuff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. decay 1 want 2 optical 3 punctual 4 growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. compound 1 sturdy 2 scramble 3 element 4 rave</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. consume 1 hillside 2 develop 3 fern 4 girdle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. repel 1 attract 2 poisonous 3 motto 4 staple</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. preserve 1 eccentric 2 diary 3 annihilate 4 soot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. molten 1 indigo 2 frozen 3 frenzy 4 rafter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. segregate 1 colonial 2 naught 3 ginger 4 cluster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. sterile 1 plush 2 fertile 3 huff 4 minor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38. transparent 1 shawl 2 opaque 3 studied 4 inclination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39. analysis 1 shorten 2 concrete 3 amalgamate 4 synthesis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40. conserve 1 patter 2 identify 3 janitor 4 expend</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41. terminal 1 origin 2 faucet 3 engraver 4 countess</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42. septic 1 germ 2 tank 3 sterile 4 separate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43. mutation 1 reduction 2 heredity 3 deaf 4 environmental</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44. agitaton 1 quiescent 2 agrarian 3 agnostic 4 cogitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45. abundant 1 recent 2 minute 3 process 4 summon</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DIRECTIONS: Mark as you are told the number of the word that means the opposite or about the opposite of the first word.

SAMPLE: B. large 1 rich 2 small 3 gone 4 away

TEST 1 — SECTION C

46. war 1 peace 2 certain 3 dark 4 number 46
47. boss 1 mortgage 2 employee 3 scan 4 quill 47
48. interior 1 rage 2 scorn 3 relate 4 exterior 48
49. enemy 1 ally 2 interest 3 storm 4 practice 49
50. citizen 1 slope 2 alien 3 operation 4 divine 50
51. government 1 spirit 2 increase 3 anarchy 4 wheel 51
52. lawful 1 naught 2 quote 3 illegal 4 reprove 52
53. publish 1 suppress 2 decay 3 most 4 wax 53
54. liberty 1 glory 2 captivity 3 manufacture 4 standard 54
55. honesty 1 strenuous 2 fraud 3 prior 4 indifferent 55
56. majority 1 beggar 2 equity 3 minority 4 forge 56
57. challenge 1 thimble 2 indulge 3 defend 4 harbinger 57
58. opponent 1 wallet 2 radical 3 tenant 4 assistant 58
59. conquest 1 defeat 2 strain 3 salary 4 process 59
60. assault 1 countenance 2 delivery 3 protect 4 festival 60
61. organization 1 spill 2 dissolution 3 ripple 4 theme 61
62. freedom 1 depart 2 fortune 3 example 4 subjection 62
63. descendant 1 scenery 2 ascent 3 ancestor 4 volunteer 63
64. prohibition 1 minion 2 toleration 3 reduction 4 phosphorous 64
65. corruption 1 integrity 2 lowly 3 cravat 4 racketeer 65
66. system 1 connect 2 agree 3 beam 4 chaos 66
67. neutrality 1 leaves 2 controversy 3 millinery 4 hereditary 67
68. truce 1 hobble 2 flier 3 campaign 4 economic 68

TEST 1 — SECTION D

69. present 1 absent 2 milk 3 number 4 front 69
70. direct 1 afraid 2 loud 3 indirect 4 health 70
71. perfect 1 stood 2 imperfect 3 equal 4 manner 71
72. pit 1 tumble 2 compel 3 reduce 4 peak 72
73. unusual 1 common 2 meadow 3 assure 4 drown 73
74. definite 1 indulge 2 gobbles 3 indefinite 4 escort 74
75. positive 1 peel 2 namely 3 lonesome 4 negative 75
76. progress 1 dizzy 2 decline 3 caravan 4 concrete 76
77. agreement 1 scripture 2 discord 3 stag 4 tinkle 77
78. convict 1 combine 2 moral 3 prejudice 4 free 78
79. cause 1 effect 2 against 3 certain 4 cold 79
80. final 1 original 2 caught 3 meal 4 establish 80
81. reverence 1 loaf 2 dishonor 3 philosopher 4 screen 81
82. oppose 1 standard 2 gobbles 3 serve 4 drove 82
83. criticism 1 infest 2 coupling 3 commendation 4 feud 83
84. hypocrisy 1 cooky 2 chide 3 blithe 4 fidelity 84
85. esteem 1 pitch 2 factory 3 guilty 4 blame 85
86. initial 1 hustle 2 terminal 3 fraught 4 eddy 86
87. worthless 1 add 2 instruct 3 merit 4 credit 87
88. revelation 1 filial 2 moulder 3 sorcery 4 disguise 88
89. falter 1 fern 2 unity 3 execute 4 girdle 89
90. intricate 1 efficiency 2 clay 3 simple 4 delicacy 90

Page 4
CIR-AA
DIRECTIONS: Read the following directions. Mark as you are told the number or letter of each correct answer.

TEST 2 — SECTION E

91. Read the following names:
Mary Louis Roger Elizabeth
Mark the number which shows the first letters of the boys’ names.
1 ML 2 RE 3 LR 4 ME — 91

92. Read these numbers:
5 1 0 6 7 4 5 9 8 0
Mark the letter of the third number after 6.
a7 b5 c9 d1 — 92

93. The area of a triangle is found by multiplying \( \frac{1}{2} \) the base by the altitude. Mark the letter of the number of square feet in a triangle which has a base of 4 feet and an altitude of 3 feet.
a6 b12 c4 d2 — 93

94. Latitude is the distance north or south from the equator. Mark the letter of the following ship’s reading which indicates latitude.
a West 8° 2’ 20”
b North 2° 48’ 10”
c East 10° 19’ 30” — 94

95. American is the proper adjective derived from the proper noun, America. Mark the number of the word which is the proper adjective of the proper noun, Arabia.
1 Arabia’s 2 Arabia 3 Arabian — 95

96. Regular adverbs are formed by adding \( ly \) to the adjectives, such as beautiful, beautifully. Mark the number of the word which is the adverb formed from the adjective, sweet.
1 sweetly 2 sweetest 3 sweeter — 96

97. The word, full, used as a suffix drops one \( l \); as cup, cupful. Mark the number of the word which has the word \( full \) added as a suffix to the word, mouth.
1 full 2 mouthful 3 mouth full — 97

98. Nouns ending in \( y \), when the \( y \) is preceded by a vowel, form the plural regularly by adding \( s \); as monkey, monkeys. Mark the number of the word which is the plural of donkey.
1 donkeys 2 donkey 3 donkey’s — 98

99. Read the following recipe:
2 cups flour
\( \frac{1}{2} \) cup lard
1 teaspoonful salt
milk
2 teaspoonfuls baking powder
Take the flour, salt, and baking powder and sift together; mix in the lard thoroughly; add the milk; roll the dough out about one-half inch thick and cut with a biscuit cutter. Bake in a hot oven about twelve minutes. Mark the number of the item which is the fourth thing to be used in mixing the above recipe.
1 milk 2 lard 3 salt 4 baking powder — 99

100. The length of the diagonal line in a rectangle is found by adding the square of the base to the square of the altitude and then extracting the square root of this sum. Mark the letter which indicates the length in inches of the diagonal of a rectangle whose base is 8 inches and whose altitude is 6 inches. (Eight squared is 64, 6 squared is 36, and 10 is the square root of 100.)
a 6 b 8 c 10 d 36 — 100

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. E Score (number right)..........................
DIRECTIONS: Mark as you have been told the number or letter of each correct answer.

TEST 2 — SECTION F

101. The introduction is found in what part of a book?
   1 beginning  2 middle  3 end — 101

102. The appendix is found in what part of a book?
   1 beginning  2 middle  3 end — 102

103. A glossary contains
   1 index  2 definitions  3 pictures — 103

104. The bibliography is found in what part of a book or chapter?
   1 beginning  2 middle  3 end — 104

105. A preface is found in what part of a book?
   1 beginning  2 middle  3 end — 105

106. On what page does “Methods of Handling” begin?
   a 1  b 25  c 40  d 55 — 106

107. Which of these stories is on page 75?
   1 Reindeer Meat  2 The Embargo  3 Imported Meat — 107

✓ Look at the following and answer questions 106 and 107.

Table of Contents

Chapter Page
1. The Vastness of the Industry 1
2. Methods of Handling 25
3. Land and Water Transport 40
4. Chicago’s Stockyards 55
5. The Embargo 60
6. Reindeer Meat 70
7. Imported Meat 77

108. Information concerning French Guiana will be found on what page?
   a 298-99  b 351  c 251  d 355 — 108

109. Information concerning manufacturing in France will be found on what page?
   a 298-99  b 301-2  c 300  d 299 — 109

110. Information concerning products of French Equatorial Africa will be found on what page?
   a 380  b 351  c 355  d 350 — 110

INDEX

France: Advantages of climate and surface of, 298-99; cities of, 301-2; foreign possessions of, 298, 349-51; industries and manufacturing, 300; location of, 298; people of, 300; problems of, 302-3; transportation in, 299.

French Africa, problems of, 351.
French Equatorial Africa: location of, 380; products of, 350.
French Guiana, 251.
French Indo-China: capital of, 393; industries of, 392; problems of its people, 393.
French Somaliland, 350, 355.

✓ Look at this index and find the answers to questions 108, 109, and 110.
 Decide which are the TWO best topics to look up in an encyclopedia or reference book for information on the following subjects. Mark the numbers of these two topics.

Sample C: Skating in Holland
1 Skating 2 Wrestling
3 Baseball 4 Football
5 Recreation in Holland

Answers to Sample C:

<table>
<thead>
<tr>
<th>Correct Test Booklet Mark</th>
<th>Correct Answer Sheet Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 c</td>
<td>1-2 1-3 1-4 1-5 2-3</td>
</tr>
</tbody>
</table>

111. Raising Sheep in Australia
1 Australia 2 Animals
3 Sheep 4 Farming 5 Meat

112. Rubber Plantations in Brazil
1 Automobile Tires
2 Plantations 3 Rubber
4 Brazil 5 South America

113. Communication by Radio
1 Telegraph 2 Radio 3 Cables
4 Inventors 5 Wireless

114. Destructive Insects in the Citrus Industry
1 Horticulture
2 Industry 3 Citrus Fruit
4 Destruction 5 Pests

115. The Baseball Game in America
1 Schools 2 Big League
3 Baseball 4 Games
5 America

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

TEST 2 — SECTION G

Read this story:

After the Revolutionary War, America was thrown upon her own economic and social resources. Some of the problems are particularly well illustrated by the textile industry.

In the early days it was difficult for America to make much progress or to compete with England in this field. England would not allow machinery or models of machines to be exported and discouraged their skilled mechanics from leaving their own country. However, in 1789, Samuel Slater, who had previously worked in an English factory, came to Rhode Island and built the first power cotton spinning mill in America. He has been called the "Father of American Manufacture."

Even with the aid of such men as Slater the textile industry developed very slowly. Fifteen years after the first cotton mill was built, there were only four cotton mills in America. The passing of the Embargo Act of 1807 and the War of 1812 stimulated manufacturing temporarily, but the close of the War of 1812 was followed by a slump in American industry which gave rise to additional protective tariff laws.

During the Civil War manufacturing of textiles was greatly hindered because of lack of raw materials. However, after 1865 a new industrial era began. Many mechanical improvements were made and "mass production" was instituted. Before long the United States had advanced to first rank among textile-producing nations. She has held this position until recent years when foreign competition appears to have become a very important factor.
TEST 2—SECTION G (Continued)

Mark as you have been told the number of each correct answer. You may look back to find the answers.

116. The best title for the story is
1 Textiles 2 Raw Materials 3 Communication

117. Samuel Slater built a
1 cotton gin 2 telegraph 3 spinning mill

118. In 1805, there was the following number of cotton mills
1 two 2 four 3 ten

119. The Embargo Act of 1807 was a
1 treaty 2 restriction 3 amendment

120. Mechanical improvements were responsible for
1 no production 2 limited production 3 mass production

121. The textile industry includes
1 mining 2 agriculture 3 manufacture of cloth

122. England affected the early development of the textile industry in the United States by
1 encouragement 2 hindrance 3 financing

Mark the number of each correct answer. You may look back to find the answers.

123. The best title for this story is
1 Origin of Fish 2 Commercial Fishing 3 Fish

124. The fish is a
1 variation 2 vertebrate 3 biped

The fish is the lowest of the five large classes of vertebrates. The principal characteristics of a fish are: it is cold-blooded, breathes by means of gills, lays eggs, and lives in the water. It has a bony skeleton and a wedge-shaped body which is covered with overlapping scales. There are, however, numerous variations from the typical fish. For example, the catfish has no scales, the climbing perch can climb trees, and the flying fish can rise out of the water for gliding flight.

At the present time there are about 13,000 known species of fish found in great abundance and variety in oceans, lakes, and rivers throughout the world. Records show that, in one year, the amount of fresh fish and shell fish caught in the five leading states and territories of the United States was as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>Weight in Pounds</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>851,388,000</td>
<td>27.4</td>
</tr>
<tr>
<td>Alaska</td>
<td>642,498,000</td>
<td>20.7</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>446,545,000</td>
<td>14.4</td>
</tr>
<tr>
<td>Maine</td>
<td>162,700,000</td>
<td>5.2</td>
</tr>
<tr>
<td>Washington</td>
<td>152,224,000</td>
<td>4.9</td>
</tr>
<tr>
<td>Others</td>
<td>842,397,000</td>
<td>27.4</td>
</tr>
<tr>
<td>Total</td>
<td>3,097,752,000</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Many varieties of fish are of great economic value. Such fish as salmon and tuna are very popular and are therefore more expensive, even though they do not have as high food value as cheaper fish, such as herring, cod, and mackerel. These cheaper fish compare favorably in food value with beef and mutton. Aside from food value, there are many by-products in commercial fishing, such as the various kinds of fish oils, glue, gelatine, isinglass, fertilizers, and leather.
TEST 2—SECTION G (Continued)

125. "Known species" means
1 money 2 samples 3 varieties —125

126. The third state or territory in amount of commercial fishing in one year was
1 California 2 Massachusetts 3 Maine —126

127. About 20 per cent of the fish were caught in
1 Alaska 2 California 3 Maine —127

128. The fish having the greatest food value is
1 Tuna 2 Salmon 3 Mackerel —128

129. One of the by-products of fish is
1 rubber 2 isinglass 3 wood —129

GO RIGHT ON TO THE NEXT STORY

✓ Mark the number of each correct answer. You may look back to find the answers.

130. The best title for this story is
1 Invention of Locomotives 2 Transportation Systems 3 Railroads —130

131. The locomotive was invented in
1 England 2 United States 3 France —131

132. The principal railroad lines had been constructed by
1 1868 2 1890 3 1885 —132

133. Railroad construction in the United States has been
1 steady 2 systematic 3 irregular —133

134. Transportation facilities in 1826 were
1 good 2 fair 3 poor —134

135. Better transportation facilities enabled merchants to conduct their business with
1 less capital 2 about the same capital 3 more capital —135

GO RIGHT ON TO THE NEXT PAGE
The Telegraph

For eleven years Samuel Morse had been trying to interest someone in his invention of the telegraph, and endured great poverty in attempting to carry out the experimentation. Finally, in 1843, Congress appropriated $30,000.00 for this purpose, and Morse was enabled to make rapid progress in the development of telegraphy.

In the spring of 1844 when the political parties were holding their conventions, the telegraph was ready for practical application. He was able to notify the candidates and the people in Washington of the results of the conventions before they were able to secure the information otherwise. This aroused the public interest, and there was a general realization of the remarkable accomplishment. From that time forward the telegraphic system grew with astounding rapidity, and covered the entire world within thirty years.

At first the telegraph was mechanically complicated, but with constant research the instruments became simpler. During recent times, however, with the complexities of modern life the system has become somewhat involved. Every city has an intricate system of telegraph wires underneath the surface of the streets, and even the continents are connected by cables in the oceans.

The development of the telegraph has brought the world closer together by providing a method whereby ideas and messages of the entire world may be brought within the reach of all in a minimum of time. This process has been greatly accelerated by recent improvements in wireless telegraphy.

Statements
1. Wider use of telegraphy
2. Communication of words
3. The inventor's struggle
4. Congress and elections
5. Effects of telegraphy
6. Ideas and messages
7. The practical demonstration
8. Necessity

138. The best title for the first paragraph is statement
1 2 3 4 5 ___138

139. The best title for the second paragraph is statement
4 5 6 7 8 ___139

140. The best title for the third paragraph is statement
1 2 3 4 5 ___140

141. The best title for the fourth paragraph is statement
4 5 6 7 8 ___141

The following things are mentioned in the story:
- Complex system
- Mechanically complicated instruments
- Wireless telegraphy
- Simpler instruments

The order in which the above things were mentioned in the story is as follows:

142. Complex system was
1st 2nd 3rd 4th ___142

143. Mechanically complicated instruments were
1st 2nd 3rd 4th ___143

144. Wireless telegraphy was
1st 2nd 3rd 4th ___144

145. Simpler instruments were
1st 2nd 3rd 4th ___145
California Reading Test
intermediate GRADES 7-8-9 form AA
DEVISED BY ERNEST W. TIEGS AND WILLIS W. CLARK

Name
Last First Middle
City
Occupation Sex
or Grade M-F
School or Organization
Date of Test
Month Day Year
Date of Birth
Month Day Year

DIAGNOSTIC PROFILE
(Chart Student's Scores Here)

<table>
<thead>
<tr>
<th>Grade Placement</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>7.0</th>
<th>8.0</th>
<th>9.0</th>
<th>10.0</th>
<th>11.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
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<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
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<td>18</td>
<td>19</td>
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<td>20</td>
<td>21</td>
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<td>23</td>
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<td>27</td>
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<tr>
<td></td>
<td>40</td>
<td>45</td>
<td>50</td>
<td>55</td>
<td>60</td>
<td>65</td>
<td>70</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DIAGNOSTIC ANALYSIS OF LEARNING DIFFICULTIES

1. Reading Vocabulary
   A. MATHEMATICS: 1-22 Basic vocabulary
   B. SCIENCE: 23-45 Basic vocabulary
   C. SOCIAL SCIENCE: 46-63 Basic vocabulary
   D. GENERAL: 69-90 Basic vocabulary

2. Reading Comprehension
   E. FOLLOWING SPECIFIC DIRECTIONS: 91, 92 Simple choice
   F. REFERENCE SKILLS: 93, 94, 95 Definitions and directions
   G. INTERPRETATION OF MEANINGS: 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135

See MANUAL for instructions on preparation of Diagnostic Profile and Diagnostic Analysis of Learning Difficulties
California Arithmetic Test

(Formerly: Progressive Arithmetic Test)

DEVISED BY ERNEST W. TIEGS AND WILLIS W. CLARK

INSTRUCTIONS TO STUDENTS:

This is an arithmetic test. In taking it you will show how well you can think and work problems. No one is expected to do the whole test correctly, but you should answer as many items as you can. Work as fast as you can without making mistakes.

DO NOT WRITE OR MARK ON THIS TEST BOOKLET UNLESS TOLD TO DO SO BY THE EXAMINER.
DIRECTIONS: Decide how each of the amounts below should be written as a number. Then mark as you are told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think that none of the answers given is correct, mark the letter, e. In doing this test you should finish the first column before doing the second. Look at the samples to the right and see how they are marked.

TEST 3 — SECTION A

1. Eight hundred forty-five
   a 80,045
   b 8045
   c 845
   d 458
   e None
   (1)

2. Five thousand twenty
   a 520
   b 5020
   c 500020
   d 50,020
   e None
   (2)

3. Ten thousand sixty-four
   a 10,000,64
   b 1064
   c 10,064
   d 10,640
   e None
   (3)

4. One million ten thousand eleven
   a 1,001,011
   b 1,000,000,10,000,11
   c 1,010,011
   d 1,100,011
   e None
   (4)

5. Three-eighths
   a .38
   b .888
   c .038
   d .3
   e None
   (5)

6. Ninety-nine dollars and five cents
   a $99.50
   b $99.5
   c $99.05
   d 99.05
   e None
   (6)

7. Fifty-five per cent
   a 55,000
   b $0.55
   c 55%
   d 55
   e None
   (7)

8. LXX means
   a 20
   b 30
   c 70
   d 90
   e None
   (8)

9. DCC means
   a 200
   b 400
   c 600
   d 700
   e None
   (9)

10. M means
    a 500
    b 1000
    c 4000
    d 6000
    e None
    (10)

11. Find the largest number, marked a, b, c, or d, in each of the following rows. Then mark its letter.
    11. a .45  b 200  c 156  d 80  (11)
    12. a 89%  b 66%  c 106%  d 55%  (12)
    13. a .025  b .099  c .75  d .015  (13)
    14. a %  b %  c %  d %  (14)
    15. a %  b (%)^2  c (%)^4  d (%)^8  (15)

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. A Score
(number right).............................................
DIRECTIONS: Mark the letter or number of each correct answer. If you do not know an answer, or you think that none of the answers given is correct, you should mark the letter, e (items 16-20), or the number, 5 (items 21-25). Finish the first column before doing the second. Remember to do your figuring on scratch paper if you are marking your answers on an answer sheet.

### TEST 3 — SECTION B

<table>
<thead>
<tr>
<th>16. ( \sqrt{64} ) is</th>
<th>21. ( \pi ) means</th>
<th>22. % means</th>
<th>23. ( \circ ) means</th>
<th>24. ( \sqrt{\text{means}} )</th>
<th>25. ( \Delta ) means</th>
</tr>
</thead>
<tbody>
<tr>
<td>a 10</td>
<td>( \text{\textasciitilde add} )</td>
<td>( \text{\textasciitilde per cent} )</td>
<td>( \text{\textasciitilde multiply} )</td>
<td>( \text{\textasciitilde square} )</td>
<td></td>
</tr>
<tr>
<td>b 8</td>
<td>( \text{\textasciitilde pi} )</td>
<td>( \text{\textasciitilde subtract} )</td>
<td>( \text{\textasciitilde degree} )</td>
<td>( \text{\textasciitilde pyramid} )</td>
<td></td>
</tr>
<tr>
<td>c 4096</td>
<td>( \text{\textasciitilde radius} )</td>
<td>( \text{\textasciitilde dram} )</td>
<td>( \text{\textasciitilde per cent} )</td>
<td>( \text{\textasciitilde circle} )</td>
<td></td>
</tr>
<tr>
<td>d 24</td>
<td>( \text{\textasciitilde degree} )</td>
<td>( \text{\textasciitilde dollar} )</td>
<td>( \text{\textasciitilde divide} )</td>
<td>( \text{\textasciitilde octagon} )</td>
<td></td>
</tr>
<tr>
<td>e None</td>
<td>( \text{\textasciitilde None} )</td>
<td>( \text{\textasciitilde None} )</td>
<td>( \text{\textasciitilde None} )</td>
<td>( \text{\textasciitilde None} )</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>17. 10% of 50 =</th>
<th>18. A right angle equals how many degrees?</th>
<th>19. Which two numbers are both factors of 15?</th>
<th>20. What is the greatest common divisor of 9, 18, and 27?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a 500</td>
<td>a 90°</td>
<td>a 10, 5</td>
<td>a 27</td>
</tr>
<tr>
<td>b 60</td>
<td>b 45°</td>
<td>b 3.5</td>
<td>b 6</td>
</tr>
<tr>
<td>c 5</td>
<td>c 180°</td>
<td>c 2.25</td>
<td>c 3</td>
</tr>
<tr>
<td>d ( \frac{1}{2} )</td>
<td>d 360°</td>
<td>d 2.30</td>
<td>d 9</td>
</tr>
<tr>
<td>e None</td>
<td>e None</td>
<td>e None</td>
<td>e None</td>
</tr>
</tbody>
</table>

DIRECTIONS: Some rules used in measurement, numbered 1, 2, 3, 4, and 5, are given to the right below. Some problems that can be worked with these rules are given on the left, numbered 26, 27, 28, 29, and 30. Mark the number of the rule on the right which is used to find the answer to each problem on the left.

### Problems

<table>
<thead>
<tr>
<th>Problems</th>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>26. Volume of a prism</td>
<td>( \text{\textasciitilde 26} )</td>
</tr>
<tr>
<td>27. Area of a rectangle</td>
<td>( \text{\textasciitilde 27} )</td>
</tr>
<tr>
<td>28. Length of a rectangle</td>
<td>( \text{\textasciitilde 28} )</td>
</tr>
<tr>
<td>29. Circumference of a circle</td>
<td>( \text{\textasciitilde 29} )</td>
</tr>
<tr>
<td>30. Area of a triangle</td>
<td>( \text{\textasciitilde 30} )</td>
</tr>
</tbody>
</table>

### Rules Used in Measurement

1. Multiply \( \frac{1}{2} \) base by altitude.
2. Multiply diameter by 3.1416 or 3\( \frac{1}{4} \).
3. Multiply width by length.
4. Divide area by width.
5. Multiply area of base by altitude.

STOP NOW WAIT FOR FURTHER INSTRUCTIONS Sec. B Score (number right)..........................
DIRECTIONS: Work these problems. Then mark as you have been told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think that none of the answers given is correct, you should mark the letter, e. Finish the first column before doing the second. Remember to do your figuring on scratch paper if you are marking your answers on an answer sheet.

### TEST 3 — SECTION C

<table>
<thead>
<tr>
<th>Problem</th>
<th>Options</th>
<th>Correct Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>31. Add:</strong> 72</td>
<td>a 131, b 13, c 69, d 75, e None</td>
<td>d 75 (31)</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td></td>
</tr>
<tr>
<td><strong>32. Subtract:</strong> 45 d</td>
<td>a 17, b 17 d, c 17 d², d —17 d, e None</td>
<td>a 17 (32)</td>
</tr>
<tr>
<td></td>
<td>28 d</td>
<td></td>
</tr>
<tr>
<td><strong>33. The minuend is 8; the subtrahend is 12; the difference is</strong></td>
<td>a —4, b 20, c 40, d ½, e None</td>
<td>c 40 (33)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>34. Multiply:</strong> 4 (—8)</td>
<td>a —4, b 32, c —32, d —12, e None</td>
<td>a —12 (34)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>35. Divide:</strong> —24</td>
<td>a —192, b 3, c 16, d —3, e None</td>
<td>a —192 (35)</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td><strong>36. Find the value of x in each of these equations. Then mark its letter.</strong></td>
<td>a 320, b 5, c ½, d 5x, e None</td>
<td>(36)</td>
</tr>
<tr>
<td></td>
<td>8 x = 40</td>
<td></td>
</tr>
<tr>
<td><strong>37. x + 5 = 8</strong></td>
<td>a 31, b 13, c 13x, d 12x, e None</td>
<td>a 31 (37)</td>
</tr>
<tr>
<td></td>
<td>x =</td>
<td></td>
</tr>
<tr>
<td><strong>38. x² = 81</strong></td>
<td>a x—9, b 81², c 9, d 81x, e None</td>
<td>a x—9 (38)</td>
</tr>
<tr>
<td></td>
<td>x =</td>
<td></td>
</tr>
<tr>
<td><strong>39. ( \frac{x}{2} = 8 )</strong></td>
<td>a 8x, b 16, c 4, d ½, e None</td>
<td>(39)</td>
</tr>
<tr>
<td></td>
<td>x = ( \frac{x}{2} )</td>
<td></td>
</tr>
<tr>
<td><strong>40. If a = 4, b = 6, and c = 2, find the value of x in the following equation:</strong></td>
<td>a 8, b 12, c 4, d 2, e None</td>
<td>e None (40)</td>
</tr>
<tr>
<td></td>
<td>x = a + b — c</td>
<td></td>
</tr>
</tbody>
</table>

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. C Score (number right)..................
### TEST 3 — SECTION D

41. In a classroom there were 6 rows of desks with 7 desks in each row. Four desks were removed from the room. How many desks were left?

- a 38
- b 13
- c 42
- d 9
- e None

42. Jack bought a used automobile for $75.00. He paid $15.00 down and is to pay the rest in twelve equal payments. How much will each payment be?

- a $15.00
- b $7.50
- c $5.00
- d $12.00
- e None

43. Mary weighs 95 pounds, Sally weighs 85 pounds, and Jane weighs 120 pounds. What is their average weight in pounds?

- a 100
- b 96\%\frac{1}{2}
- c 97\%\frac{1}{2}
- d 102\%\frac{1}{2}
- e None

44. How many square feet are there in a strip of paper which is 2 feet wide and 22 feet long?

- a 20
- b 26
- c 11
- d 52
- e None

45. A box is 10 inches long, 6 inches wide, and 4 inches deep. How many cubic inches does it contain?

- a 20
- b 120
- c 64
- d 240
- e None

46. Find the area of a parallelogram having a base of 20 in. and an altitude of 8 in.

- a 40 sq. in.
- b 28 sq. in.
- c 2\%\frac{1}{2} sq. in.
- d 160 sq. in.
- e None

47. Find the area of a triangle having a base of 20 in. and an altitude of 12 in.

- a 240 sq. in.
- b 120 sq. in.
- c 1\%\frac{1}{2} sq. in.
- d 3\% sq. in.
- e None
48. When the scale of a map is "1/4 in. = 20 mi.," how many miles apart are two cities that are represented on a map as 1 1/2 in. apart?
   a 30  b 60  c 40  d 120  e None

49. Dick, Harry, and James together received $50.00. Dick received $15.00, Harry received $25.00, and James received $10.00. What per cent of the $50.00 did Dick receive?
   a 15  b 20  c 30  d 50  e None

50. Frank earned $16.00 and saved $8.00 of it. What per cent did he save?
   a 1/2  b 50  c 33 1/3  d 24.00  e None

51. A man received seven per cent interest on a loan of $200.00 for one year. How much interest did he receive?
   a $20.00  b $14.00  c $7.00  d $9.00  e None

52. Helen missed 3 problems on a test but did 85% of them correctly. How many problems were there in the test?
   a 20  b 10  c 82  d 88  e None

53. John sold brushes at $1.50 each and received a commission of 30% on his sales. How much did he make on each brush sold?
   a $1.00  b 45¢  c 30¢  d 50¢  e None

54. A wooden building, valued at $12,500, was insured for 80% of its value. The rate of insurance was 24 cents per $100.00. What was the amount of the premium?
   a $24.00  b $12.50  c $8.00  d $31.00  e None

55. Mary's father has a furniture store. The list price of a chair is $50.00 and two discounts are given: one of 20% and another of 10%. What did the chair cost Mary's father?
   a $35.00  b $36.00  c $14.00  d $15.00  e None
DIRECTIONS: Do these problems in addition. Then mark as you have been told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think none of the answers given is correct, you should mark the letter, e. Finish each column before going on to the next. Be sure to reduce fractions to lowest terms. Remember to do your figuring on scratch paper if you are marking your answers on an answer sheet.

| (56)   |  1 3 4 + 4 5 3 | (57)   |  3 0 7 + 4 3 0 | (58)   |  2 7 + 2 5 | (59)   |  2 5 + 4 2 | 3 3 + 7 2 | (60)   |  3 2 7 1 + 9 4 6 8 + 1 3 4 5 + 7 0 1 | (61)   |  $ 5 6 3 5 + $ 3 6 8 + $ 1 2 7 5 + $ 8 1 5 | (62)   | $ 20.00 + $ .25 + $ 2 + $ 1.75 = |
|--------|---------------|--------|---------------|--------|-----------|--------|-----------|---------|-----------------------------|--------|-----------------------------|--------|-----------------------------|
|        | a 60702       |        | a 177         |        | a 32      |        | a 172     |         | a 13675         |        | a $60.94         |        | 5 3 1/2            |
|        | b —681        |        | b 132010      |        | b 52      |        | b 162     |         | b 14685         |        | b $79.73         |        | 3 5/6             |
|        | c 381/34      |        | c 737         |        | c 2       |        | c 182     |         | c 13775         |        | c $80.93         |        | +2 1/4            |
|        | d 687         |        | d 1 123/307   |        | d 1 1/2   |        | d 171     |         | d 14785         |        | d $69.88         |        | +2 1/4            |
|        | e None         |        | e None         |        | e None    |        | e None    |         | e None           |        | e None           |        | 5 3/4             |

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<th>(73)</th>
<th>33.4 + 6.21 + .0382 + 8 =</th>
<th>(74)</th>
<th>10% of 60 + 10% of 80 =</th>
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STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. E Score (number right) ________________
DIRECTIONS: Do these problems in subtraction. Then mark as you have been told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think none of the answers given is correct, you should mark the letter, e. Finish each column before going on to the next. Be sure to reduce fractions to lowest terms.

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STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. F Score (number right)
DIRECTIONS: Do these problems in multiplication. Then mark as you have been told the letter of each correct answer. Finish each column before going on to the next. Be sure to reduce fractions to lowest terms.

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<td>(109)</td>
<td>6 ¾ × 5 ½ =</td>
<td>a 1 1 ½</td>
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<td>b 3 0 ½</td>
<td>e 3 6</td>
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STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. G Score (number right) 

Page 9 
CIA-AA
DIRECTIONS: Do these problems in division. Then mark as you have been told the letter of each correct answer. Finish each column before going on to the next. Be sure to express remainders as fractions and reduce fractions to lowest terms.

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<th>Problem</th>
<th>Options</th>
<th>Correct Answer</th>
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<td>(117) (6 \div 6 = 0)</td>
<td>a 66, b 360, c 54, d 10, e None</td>
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<td>(118) (5 \div 5 = 5)</td>
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<td>(119) (4 \div 2 = 4)</td>
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<td>(120) (22 \div 8 = 3)</td>
<td>a 8910, b 46, c 406, d 8954, e None</td>
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<td>(121) (300 \div 0 = 0)</td>
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<td>(122) (46 \div 3 = 15)</td>
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<tr>
<td>(124) (\frac{1}{2} \div 2 =)</td>
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<td>c 1</td>
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<td>a 7(\frac{1}{6}), b 2(\frac{1}{2}), c 17(\frac{1}{6}), d 53(\frac{1}{3}), e None</td>
<td>a 7(\frac{1}{6})</td>
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<td>a (\frac{1}{2}), b 2(\frac{1}{2}), c 10(\frac{1}{2}), d 2(\frac{1}{2}), e None</td>
<td>c 10(\frac{1}{2})</td>
</tr>
</tbody>
</table>

STOP NOW WAIT FOR FURTHER INSTRUCTIONS
AMERICAN COUNCIL ON EDUCATION

COOPERATIVE SCIENCE TEST

FOR GRADES 7, 8, and 9

FORM X

by

PAUL KAMBLY, University of Oregon

with the editorial assistance of

PAUL J. BURKE, Cooperative Test Service, and AGATHA TOWNSEND, Educational Records Bureau

Please print:

Name .......................................................... Date

Last First Middle

Grade or Class .............................................. Age

Yrs. Mos.

School .......................................................... City

City.

Sex .......................................................... M. or F.

Title of the science course you are now taking (for example: General Science)

Teacher

General Directions: Do not turn this page until the examiner tells you to do so. This examination consists of three parts, and requires 80 minutes of working time. The directions for each part are printed at the beginning of the part. Read them carefully, and proceed at once to answer the questions. DO NOT SPEND TOO MUCH TIME ON ANY ONE ITEM. ANSWER THE EASIER QUESTIONS FIRST; then return to the harder ones, if you have time. There is a time limit for each part. You are not expected to answer all the questions in any part in the time limit; but if you should, go on to the next part. If you have not finished Part I when the time is up, stop work on that part and proceed at once to Part II. No questions may be asked after the examination has begun. If you finish Part III before time is up, you may go back and work on any part.

You may answer questions even when you are not perfectly sure that your answers are correct, but you should avoid wild guessing, since wrong answers will result in a subtraction from the number of your correct answers.

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<th>Part</th>
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<tr>
<td>II Terms and Concepts</td>
<td>15</td>
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<tr>
<td>III Comprehension and Interpretation</td>
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15 Amsterdam Avenue, New York 23, N. Y.
PART I
INFORMATIONAL BACKGROUND
(40 minutes)

Directions: Each of the questions or incomplete statements below is followed by five choices. Select the one that best completes the statement or answers the question, and put its number in the parentheses at the right.

1. What instrument enables us to see stars which are too dim to be seen with the naked eye?
   1-1 Dynamometer
   1-2 Electroscope
   1-3 Galvanoscope
   1-4 Telescope
   1-5 Microscope

2. The atmosphere consists of
   2-1 a mixture of gases.
   2-2 a transparent liquid.
   2-3 a single element.
   2-4 a single compound.
   2-5 empty space.

3. Which one of the following diseases is carried by mosquitoes?
   3-1 Cancer
   3-2 Malaria
   3-3 Heart disease
   3-4 Tuberculosis
   3-5 Pneumonia

4. Which one of the following is an example of an animal in the surroundings in which it is best fitted to live?
   4-1 A tiger in a jungle
   4-2 A brook-trout in the ocean
   4-3 A squirrel in a desert
   4-4 A penguin in a forest
   4-5 A monkey in an open field

5. If your clothing should catch fire what should you do first?
   5-1 Run for water
   5-2 Call the fire department
   5-3 Beat the fire with a newspaper
   5-4 Wrap a rug or blanket around you
   5-5 Stand perfectly still

6. Which one of the following was invented before the others?
   6-1 The telephone
   6-2 The telegraph
   6-3 Radio
   6-4 Television
   6-5 Radar

7. What does the Milky Way consist of?
   7-1 A huge accumulation of dust in the solar system
   7-2 The trail left by a comet
   7-3 A cloud of gas
   7-4 Stars so far away that they appear as a cloud
   7-5 Ice crystals in the atmosphere

8. Which one of the following animals can most easily change his environment to fit his needs?
   8-1 A whale
   8-2 A gorilla
   8-3 A man
   8-4 An elephant
   8-5 A horse

9. Why does one hear thunder some time after seeing the lightning flash?
   9-1 Light travels faster than sound
   9-2 The sound has farther to go
   9-3 Sound cannot penetrate clouds
   9-4 Sound cannot travel fast in rain
   9-5 Sound travels faster than light

10. Paint prevents the rusting of iron by
    10-1 preventing nitrogen from coming in contact with the iron.
    10-2 reacting chemically with iron.
    10-3 preventing oxygen and moisture from coming in contact with the iron.
    10-4 preventing carbon dioxide from coming in contact with the iron.
    10-5 changing the rate at which iron reacts chemically

11. Which one of the following is not one of the scientific attitudes?
    11-1 Tolerance
    11-2 Respect for another’s point of view
    11-3 Basing judgment on facts
    11-4 Withholding judgment
    11-5 Belief in superstitions

12. Bees help some species of plants by
    12-1 carrying nectar from one flower to another.
    12-2 destroying harmful insects.
    12-3 removing nectar.
    12-4 destroying pollen.
    12-5 carrying pollen from one flower to another.

13. The largest body in the solar system is
    13-1 the earth
    13-2 the sun
    13-3 Saturn
    13-4 Venus
    13-5 Mars

14. The poisonous gas present in automobile exhaust gases is
    14-1 carbon
    14-2 carbon monoxide
    14-3 carbon dioxide
    14-4 carbon tetrachloride
    14-5 chloroform

Go on to the next page.
15. Which diseases may spread because of an impure water supply?
15-1 Cholera and typhoid fever
15-2 Yellow fever and tuberculosis
15-3 Malaria fever and smallpox
15-4 Scarlet fever and pneumonia
15-5 Tuberculosis and smallpox
16. The best general health rule is to
16-1 use high quality medicines.
16-2 see your doctor twice a year.
16-3 take plenty of vitamin pills.
16-4 keep in good physical condition.
16-5 keep away from disease germs.
17. Some regions contain large boulders which are very different in composition from other rocks nearby. The agency probably responsible for their presence is
17-1 glaciers.
17-2 floods.
17-3 winter frosts.
17-4 erosion.
17-5 weathering.
18. Clouds of the type shown above are composed of
18-1 water particles.
18-2 dust particles.
18-3 smoke.
18-4 compressed air.
18-5 snow.
19. The stars appear to rise and set because
19-1 they revolve around the sun.
19-2 they revolve around the earth.
19-3 the earth is very far away from the stars.
19-4 the earth rotates on its axis.
19-5 the earth revolves around the sun.
20. The first step in solving a problem in a scientific way is to
20-1 perform a series of experiments.
20-2 find out what is already known about the problem.
20-3 make a list of possible procedures.
20-4 draw tentative conclusions.
20-5 get authorities to suggest possible answers.
21. What is usually the best reason for including fruits and leafy vegetables in the diet?
21-1 They furnish a great deal of water.
21-2 They are rich in proteins.
21-3 They are economical foods.
21-4 They are rich in minerals and vitamins.
21-5 They furnish fewer calories per unit of volume.
22. The attraction of a comb for small bits of paper is used to demonstrate
22-1 magnetic lines of force.
22-2 static electricity.
22-3 gravity.
22-4 inertia.
22-5 current electricity.
23. The moon affects the earth by
23-1 controlling weather conditions.
23-2 causing tides.
23-3 furnishing signs that indicate weather changes.
23-4 causing steady ocean currents.
23-5 causing prevailing winds.
24. The pitch of a tone produced by a vibrating wire is raised by
24-1 raising the temperature of the wire.
24-2 increasing the diameter of the wire.
24-3 increasing the length of the wire.
24-4 increasing the tightness of the wire.
24-5 increasing the amplitude of the vibrations.
25. Which one of the following men became famous because of his study of birds?
25-1 Mendel
25-2 Burbank
25-3 Faraday
25-4 Harvey
25-5 Audubon.
26. Some fire extinguishers contain a water solution of soda and a small bottle of sulfuric acid. The solution rushes from the nozzles when this type of fire extinguisher is turned upside-down because
26-1 heat is generated by the acid.
26-2 carbon dioxide is liberated from the soda.
26-3 steam is formed.
26-4 acid opens the nozzle.
26-5 hydrogen is released from the acid.
27. Breathing is often difficult on high mountains because
27-1 the breathing muscles do not work properly.
27-2 air pressure is lower.
27-3 air pressure is higher.
27-4 the proportion of carbon dioxide in the air is high.
27-5 the proportion of oxygen in the air is high.
28. It takes 10 lb. of force to overcome the friction in the pulleys. The total force required to raise the 200 lb. is:
   28-1 73 lb.
   28-2 146 lb.
   28-3 180 lb.
   28-4 200 lb.
   28-5 210 lb.
29. The report of a gun is shorter and sharper when it is fired in the open than when it is fired in a room because:
   29-1 the air is less dense.
   29-2 the air pressure is lower.
   29-3 the sound travels faster.
   29-4 there is less reflection of sound.
   29-5 there is more reflection of sound.
30. Helium is preferred over hydrogen for use in lighter-than-air craft because it:
   30-1 is lighter than hydrogen.
   30-2 does not burn.
   30-3 is cheaper.
   30-4 is more plentiful.
   30-5 is more easily prepared.
31. The difference in temperature between summer and winter in the United States is caused by the:
   31-1 prevailing winds coming from the south in summer and from the north in winter.
   31-2 nearness of the earth to the sun in summer compared to the further distance in winter.
   31-3 rotation of the earth on its axis.
   31-4 changes in the direction of ocean currents.
   31-5 difference in the angle at which the sun's rays strike the earth during the summer and winter.
32. The chief function of the oil in the crankcase of an automobile engine is to:
   32-1 remove heat from the cylinders.
   32-2 decrease the friction between moving parts.
   32-3 remove heat produced by friction around the bearing of the crankshaft.
   32-4 prevent oxidation in the cylinders.
   32-5 increase the force of explosions in the cylinders.
33. Which of the following diseases is not caused by parasites?
   33-1 Tuberculosis
   33-2 Typhoid fever
   33-3 Diabetes
   33-4 Diphtheria
   33-5 Yellow fever
34. Which of the following are carriers of Rocky Mountain Spotted Fever?
   34-1 Ticks
   34-2 Lice
   34-3 Mosquitoes
   34-4 Rats
   34-5 Fleas
35. Which of the following is an important function of the circulation of the blood in the body?
   35-1 Collection of excess protoplasm from the cells of the body
   35-2 Distribution of heat from the lungs to all parts of the body
   35-3 Oxidation of carbohydrates in the red corpuscles
   35-4 Distribution of lymph to lymph spaces in the body
   35-5 Distribution of oxygen and digested foods to all parts of the body
36. By making holes in cloth the larvae of certain moths:
   36-1 escape from sunlight.
   36-2 make a passageway for themselves.
   36-3 secure organic foods.
   36-4 get material for building homes.
   36-5 provide food for their young.
37. Which of the following is the most important basis for a truly scientific conclusion?
   37-1 Available facts
   37-2 What the experts say
   37-3 Textbook information
   37-4 Newspaper information
   37-5 What the majority says
38. An apple tree that bears two or more different kinds of apples has been successfully:
   38-1 cross fertilized.
   38-2 pruned.
   38-3 hybridized.
   38-4 inbred.
   38-5 budded or grafted.
39. Magnetic variations in the sound producing mechanism of a radio:
   39-1 drive a motor which operates the speaker.
   39-2 cause vibrations in the diaphragm of the speaker.
   39-3 produce heat, causing changes in the diaphragm of the speaker.
   39-4 produce radio waves in the speaker.
   39-5 increase the intensity of sound waves.

Go on to the next page.
40. The flywheel of a single-cylinder steam engine
40-1 increases the mechanical advantage of the piston.
40-2 compresses steam in the cylinder after the power stroke.
40-3 keeps the piston moving after the piston reaches one end of the cylinder.
40-4 compresses steam in the cylinder during the compression stroke.
40-5 increases the rate of piston movement.

41. Which of the following is not a cause of winds?
41-1 Differences in air pressure
41-2 Differences in air temperature between different latitudes
41-3 Differences in air temperature over the sea and over dry land
41-4 Differences in elevation on the earth's surface
41-5 Lines of force in the earth's magnetic field

42. Four of the following processes are carried on by all living things. The one that is not carried on by all living things is
42-1 photosynthesis.
42-2 nutrition.
42-3 respiration.
42-4 excretion.
42-5 circulation.

43. Which of the following is found in gasoline engines but is lacking in Diesels?
43-1 Pistons
43-2 Cooling systems
43-3 Connecting rods
43-4 Flywheels
43-5 Spark plugs

44. Who developed the treatment for hydrophobia?
44-1 Jenner
44-2 Harvey
44-3 Pasteur
44-4 Faraday
44-5 Koch

45. Which of the following involves only a physical change?
45-1 Milk becomes sour
45-2 Cider changes to vinegar
45-3 Cream is churned to butter
45-4 Fresh butter becomes rancid
45-5 Fruit juice changes to wine

46. Canned fruit is less likely to decay if jars are sealed while the fruit is still steaming hot because
46-1 atmospheric pressure helps to seal the jars.
46-2 the lids loosen as the fruit cools.
46-3 the lids expand as the fruit cools.
46-4 the fruit stays hot longer in sealed jars.
46-5 air that enters the cooling jars is filtered by the lids.

47. Whole milk provides a more nearly balanced diet than most other single foods because it contains
47-1 most of the important nutrients.
47-2 a high percentage of water.
47-3 an abundance of carbohydrates.
47-4 nutrients that are easily digested.
47-5 nutrients of high caloric value.

48. How many miles in a 24-hour period would one have to travel along the equator in order to keep the sun constantly overhead?
48-1 10,000 miles
48-2 15,000 miles
48-3 25,000 miles
48-4 32,000 miles
48-5 50,000 miles

49. The substance in storage batteries in addition to distilled water is
49-1 iron sulfate.
49-2 iron oxide.
49-3 copper sulfate.
49-4 sulfuric acid.
49-5 hydrochloric acid.

50. The sphere shown in A is immersed in the water as shown at B. Which of the following can be determined by weighing the water which overflows into beaker C without doing anything else?
50-1 Density of the sphere
50-2 Volume of the sphere
50-3 Weight of the sphere
50-4 Specific gravity of the water
50-5 Density of the water

51. How does the oxygen and carbon dioxide content of the air in an air-tight room change during the night if growing plants are in the room?
51-1 Oxygen decreases and carbon dioxide increases
51-2 Oxygen increases and carbon dioxide decreases
51-3 Both decrease
51-4 Both increase
51-5 Both stay the same

Go on to the next page.
52. The substance most often used in manufacturing lard substitutes is
   52-1 beeswax.
   52-2 tar.
   52-3 cottonseed oil.
   52-4 castor oil.
   52-5 tung oil.

53. A balloon drifting over Wyoming at altitudes above 40,000 feet travels
   53-1 east because the land slopes to the east.
   53-2 south because the air rises at the equator.
   53-3 north because the earth rotates toward the east.
   53-4 east because the winds at high altitudes move eastward.
   53-5 west because of forces set up by the earth's rotation.

54. A thick glass beaker breaks more easily when hot water is put into it than a thin glass beaker because it
   54-1 holds the heat better.
   54-2 is more brittle.
   54-3 expands to a lesser extent.
   54-4 absorbs more heat.
   54-5 expands unequally.

55. What position do the valves of a lift pump have during the downstroke of the piston?
   55-1 Both valves are fully open
   55-2 Both valves are closed
   55-3 The piston valve is open and the valve at the bottom of the cylinder is closed
   55-4 The piston valve is closed and the valve at the bottom of the cylinder is open
   55-5 Both valves are partly open

56. The low efficiency of steam engines is caused by the
   56-1 loss of heat in steam that leaves the cylinders.
   56-2 loss of energy during oxidation.
   56-3 loss of steam around the piston rod.
   56-4 external combustion of fuel.
   56-5 friction between moving parts.

57. Young shrubs and trees die if animals are allowed to eat their leaves because
   57-1 they cannot secure sufficient moisture.
   57-2 water evaporates too rapidly.
   57-3 they cannot manufacture sufficient food.
   57-4 the soil near their roots is no longer shaded.
   57-5 disease-causing bacteria enter the wounded leaves.

58. One advantage that is gained by connecting electric lights in parallel is that
   58-1 short circuits cannot occur.
   58-2 one light may be turned off without affecting other lights.
   58-3 all the lights use the same current.
   58-4 it takes fewer amperes of current to make each light glow.
   58-5 all lights can be regulated by one switch.

59. The function of the silks on a growing ear of corn is to
   59-1 regulate the formation of cobs.
   59-2 deliver the food that is stored in the kernels.
   59-3 produce pollen.
   59-4 manufacture the food stored in the kernels.
   59-5 receive pollen grains and furnish a pathway to the ovaries.

60. Diesel engines are often used in trucks because they
   60-1 operate without electrical ignition.
   60-2 are easier to start than gasoline engines.
   60-3 are usually lighter than gasoline engines of equal horsepower.
   60-4 have an efficiency less than that of gasoline engines.
   60-5 may be operated with a low-grade fuel.

61. Light travels from the sun to the earth in about
   61-1 one second.
   61-2 two minutes.
   61-3 five seconds.
   61-4 eight minutes.
   61-5 fifteen minutes.

62. Most tap water that is to be used in an aquarium should be
   62-1 boiled.
   62-2 treated with chemicals.
   62-3 aerated.
   62-4 sealed in jars for several days.
   62-5 filtered.

63. During the stroke that follows the exhaust stroke of a four-cycle gasoline engine
   63-1 both valves are open.
   63-2 both valves are closed.
   63-3 the intake valve is closed and the exhaust valve is open.
   63-4 the intake valve is open and the exhaust valve is closed.
   63-5 either valve may be open depending on the type of engine.
64. The best way to determine the amount of dissolved solid matter in water is to
64-1 freeze the water.
64-2 examine the water under a microscope.
64-3 let the water stand until the solid matter settles to the bottom.
64-4 filter the water.
64-5 distill the water. ................. 64( )

65. Which of the following must have happened in those regions of the Rocky Mountains where great deposits of marble are found?
65-1 Volcanoes were once active
65-2 Molten rock flowed to the surface
65-3 Limestone was once deposited
65-4 The climatic changes have been most pronounced
65-5 Glaciers have changed the surface 65( )

66. The amount of heat necessary to raise the temperature of one gram of water one degree centigrade is called a
66-1 watt.
66-2 gram degree.
66-3 calorie.
66-4 unit of energy.
66-5 British Thermal Unit. ............ 66( )

67. Soap in water helps to dissolve dirt by
67-1 bringing the dirt into contact with the air in the soap bubbles.
67-2 changing the chemical composition of the dirt particles.
67-3 acting as an acid.
67-4 surrounding the dirt particles.
67-5 liquefying the dirt. ................. 67( )

68. What is responsible for the knock which is sometimes heard when a water faucet is closed suddenly?
68-1 Expansion of the water in the pipes
68-2 Inertia of the water in the pipes
68-3 Expansion of the pipes
68-4 Friction between flowing water and the pipes
68-5 Contraction of water in the pipes 68( )

69. The determiners of hereditary characteristics that pass from generation to generation are called
69-1 cells.
69-2 chromosomes.
69-3 nuclei.
69-4 mutants.
69-5 genes. .................................. 69( )

70. Which of the following is not an important characteristic of the scientific method?
70-1 Exact quantitative measurement
70-2 Experimental tests and hypotheses
70-3 Gathering facts before conclusions are drawn
70-4 Using one experiment to test several assumptions at the same time
70-5 Drawing tentative conclusions on the basis of quantitative measurement 70( )

71. By pounding the end of a handle against a hard substance a loose axe head can be driven on tightly. The axe head is tightened because of
71-1 inertia.
71-2 centrifugal force.
71-3 reaction.
71-4 potential energy.
71-5 centripetal force. ................. 71( )

72. Bread dough rises because
72-1 yeast plants multiply rapidly increasing the bulk of the dough.
72-2 flour expands as it absorbs moisture.
72-3 moisture evaporates from the dough.
72-4 yeast plants produce carbon dioxide which inflates the bread.
72-5 heat expands the air spaces in the dough. ............... 72( )

73. The blue color of some objects is caused by the
73-1 absorption of all colors except blue.
73-2 reflection of all colors except blue.
73-3 transformation of white light into blue light.
73-4 absorption of all colors.
73-5 reflection of all colors. ............ 73( )

74. Why are walls usually given a rough finish rather than a polished one?
74-1 Paper adheres more firmly to a rough wall
74-2 A rough wall absorbs less light
74-3 A rough wall diffuses light that it reflects
74-4 a rough surface is a poorer radiator of heat
74-5 A rough surface is a better absorber of heat .................... 74( )

75. The belief that living things are produced only by other living things is best described as a
75-1 theory.
75-2 superstition.
75-3 fallacy.
75-4 folk-tale.
75-5 revelation. ............................ 75( )

Go on to the next part.

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Number right_______
Subtract_____
(See table at left)

Raw Score on Part I = Difference_______
PART II
TERMS AND CONCEPTS
(15 minutes)

Directions: Continue as in the preceding part.

1. At certain times the moon comes between the sun and the earth, and cuts off the sunlight. This effect is called
   1-1 transit.
   1-2 an eclipse.
   1-3 a penumbra.
   1-4 a sunspot.
   1-5 a solar prominence. 1

2. Putting a given quantity of air into a smaller space by applying pressure is called
   2-1 saturation.
   2-2 evaporation.
   2-3 compression.
   2-4 reaction.
   2-5 boiling. 2

3. When sugar is put into hot tea, the sugar
   3-1 dissolves.
   3-2 decomposes.
   3-3 crystallizes.
   3-4 evaporates.
   3-5 concentrates. 3

4. Some land which is too dry to be productive can be made fertile by supplying water to it. This process is called
   4-1 erosion.
   4-2 irrigation.
   4-3 fertilization.
   4-4 cultivation.
   4-5 flood control. 4

5. What does a botanist study?
   5-1 Stars
   5-2 Rocks
   5-3 Plants
   5-4 Insects
   5-5 Fishes. 5

6. In astronomy a constellation is
   6-1 a group of stars.
   6-2 a cloud of dust.
   6-3 a group of spiral nebulae.
   6-4 an island universe.
   6-5 a display of light in the sky. 6

7. Dinosaurs once were plentiful on the earth, but now none remain. That is to say, dinosaurs are now
   7-1 extinct.
   7-2 immune.
   7-3 adaptable.
   7-4 ascendent.
   7-5 retarded. 7

8. The process of heating milk for a while and then rapidly cooling it is known as
   8-1 distillation.
   8-2 certification.
   8-3 pasteurization.
   8-4 condensation.
   8-5 evaporation. 8

9. The caterpillar is an early stage in the life history of a
   9-1 fly.
   9-2 bee.
   9-3 grasshopper.
   9-4 butterfly.
   9-5 mosquito. 9

10. The sun and the planets revolving around it are called the
    10-1 galaxy.
    10-2 planetarium.
    10-3 universe.
    10-4 constellation of the sun.
    10-5 solar system. 10

11. The bones that make up the spinal column of man are called
    11-1 clavicles.
    11-2 vertebrae.
    11-3 tarsals.
    11-4 carpals.
    11-5 notochords. 11

12. The best type of soil for most crops is
    12-1 clay.
    12-2 sand.
    12-3 river bottom.
    12-4 loam.
    12-5 sandy clay. 12

13. Grape juice changes into wine when it is acted upon by
    13-1 yeasts.
    13-2 light rays.
    13-3 high temperatures.
    13-4 low temperatures.
    13-5 high pressures. 13

14. Airplanes are streamlined in order to
    14-1 decrease air resistance.
    14-2 increase air resistance.
    14-3 make it possible to replace water radiators with air coolers.
    14-4 lighten their weight.
    14-5 increase the strength of body frames. 14

15. People interested in wise use of natural resources are called
    15-1 fanatics.
    15-2 conservationists.
    15-3 fundamentalists.
    15-4 socialists.
    15-5 theorists. 15

16. Heat from a cup of hot chocolate reaches the handle of the spoon with which it is stirred by
    16-1 convection.
    16-2 diffusion.
    16-3 capillary action.
    16-4 conduction.
    16-5 radiation. 16

Go on to the next page.
17. The structure shown at A is the
17-1 anther.
17-2 stigma.
17-3 style.
17-4 ovary.
17-5 petal.  

18. The two structures essential for the formation of seeds are
18-1 A and B.
18-2 B and C.
18-3 C and D.
18-4 D and E.
18-5 B and D.  

19. The structure shown at C is the
19-1 pistil.
19-2 receptacle.
19-3 flower stalk
19-4 ovary.
19-5 sepal.  

20. Stalagmites are formed in caves by
20-1 slow erosion.
20-2 outcroppings of limestone.
20-3 currents of water flowing through caves.
20-4 deposition of limestone from seepage water.
20-5 chemical action of water on certain rocks.  

21. The carburetor of a gasoline engine
21-1 produces sparks in the cylinders.
21-2 is the combustion chamber.
21-3 helps to mix gasoline vapor and air.
21-4 purifies and heats the gasoline.
21-5 regulates the order in which sparks are produced in the cylinders.  

22. The smallest blood vessels in the body are
22-1 veins.
22-2 arteries.
22-3 ventricles.
22-4 tracheae.
22-5 capillaries.  

23. If a blue-black color is produced when iodine is placed on a sample of food, the food must contain
23-1 proteins.
23-2 minerals.
23-3 carbohydrates.
23-4 fats.
23-5 vitamins.  

24. The unit commonly used in computing the amount of electrical energy consumed is
24-1 an ampere.
24-2 a volt.
24-3 an ohm.
24-4 a kilowatt-hour.
24-5 a joule.  

25. A substance more commonly obtained by eating plant tissues than by eating animal tissues is
25-1 fat.
25-2 protein.
25-3 protoplasm.
25-4 glycogen.
25-5 starch.  

26. The front teeth of mammals are called
26-1 incisors.
26-2 canines.
26-3 pre-molars.
26-4 bicuspids.
26-5 molars.  

27. An electric transformer is used to change
27-1 one voltage level into another.
27-2 a direct current into an alternating current.
27-3 electrical energy into energy of motion.
27-4 electrical energy into heat energy.
27-5 magnetism into electricity.  

28. The red color of some soils is caused by
28-1 red clay particles.
28-2 oxides of iron.
28-3 elements deposited by green plants.
28-4 excessive quantities of mineral matter.
28-5 a red pigment released when plants decay.  

29. If the force arm and the resistance arm of a lever are equal in length
29-1 a small force will overcome a large resistance.
29-2 the mechanical advantage is two.
29-3 the force moves as far as the resistance.
29-4 the force moves in the same direction as the resistance.
29-5 the force must be much larger than the resistance.  

30. The part of a camera which focuses the picture on the film is called the
30-1 lens.
30-2 shutter.
30-3 diaphragm.
30-4 range finder.
30-5 timer.  

31. In regions where rolling land is cultivated, farmers may grow crops by planting the rows around the hill rather than up and down. This practice is called
31-1 rotating crops.
31-2 strip cropping.
31-3 listering.
31-4 terracing.
31-5 contour farming.  

Go on to the next page.
32. A single fixed pulley is usually used to
32-1 move large resistance with smaller
forces.
32-2 increase the distance a resistance is
moved.
32-3 make the output of work greater
than the work input.
32-4 develop mechanical advantages
greater than one.
32-5 apply forces from a convenient
position.

33. Which organ is a gland?
33-1 Lung
33-2 Kidney
33-3 Stomach
33-4 Pancreas
33-5 Gall bladder

34. Which of the following is an alloy?
34-1 Copper
34-2 Bronze
34-3 Rust
34-4 Aluminum
34-5 Zinc

35. By using simple machines
35-1 output work can be made greater
than input work.
35-2 energy can be created.
35-3 friction can be eliminated.
35-4 small forces can move short dis-
tances to move large resistances
further distances.
35-5 small forces may overcome large re-
sistances.

36. The vertebrate animals that are covered
with scales, and breathe only by means of
lungs are called
36-1 amphibians.
36-2 fish.
36-3 reptiles.
36-4 hemichordates.
36-5 mammals.

37. Which makes use of the magnetic lines of
force around an electric current?
37-1 A compass
37-2 A dry cell
37-3 A storage battery
37-4 An electric toaster
37-5 A telephone receiver

38. A substance which stimulates the produc-
tion of antibodies in the human body is
called
38-1 a vaccine.
38-2 a toxin.
38-3 an antitoxin.
38-4 an antiseptic.
38-5 a medicine.

39. Which of the following substances is a
chemical compound?
39-1 Oxygen
39-2 Carbon
39-3 Air
39-4 Sugar
39-5 Nitrogen

40. A boy buys a pedigreed dog. The pedigree
40-1 lists the dog's ancestors.
40-2 is a guarantee that the dog is healthy.
40-3 tells how to train the dog.
40-4 is a record of the amount of money
paid for the dog.
40-5 guarantees that the dog is good
breeding stock.

41. Electrical energy is changed to mechanical
energy by a
41-1 generator.
41-2 dynamo.
41-3 motor.
41-4 magneto.
41-5 condenser.

42. The process by which subsoil moisture
reaches the topsoil is called
42-1 osmosis.
42-2 capillarity.
42-3 evaporation.
42-4 weathering.
42-5 diffusion.

43. The negative electrode of a dry cell is
43-1 a paper cup.
43-2 a steel can.
43-3 a zinc can.
43-4 a strip of lead.
43-5 ammonium chloride.

44. In the operation of an automobile engine
a useful function of friction is to
44-1 warm the crankshaft bearings.
44-2 make the brakes hold.
44-3 develop electric currents in the gen-
erator.
44-4 hold the intake valve closed during
the power stroke.
44-5 hold the exhaust valve closed during
the power stroke.

45. The instrument used to measure the rate
of flow of electric current is
45-1 a barometer.
45-2 a transformer.
45-3 a condenser.
45-4 an ammeter.
45-5 an electroscope.

Go on to the next part.

Number wrong
0 3 7 11 15 19 23 27 31 35

Amount to be subtracted
0 1 2 3 4 5 6 7 8 9

Raw Score on Part II = Difference
To measure the volume, or size, of an irregular body that is heavier than water, such as a stone, the following method may be used. Pour water into a graduated cylinder until it is approximately half full, and read carefully the volume of the water in cubic centimeters. (See the figure at the left.) Lower the stone gently into the water, and again read the volume. The approximate volume of the stone may be calculated from these two readings. (Items 1 through 5 refer to this passage and diagram.)

### Directions

**1.** When the stone is placed in the water, the water level rises
- 1. 10 cubic centimeters.
- 2. 20 cubic centimeters.
- 3. 30 cubic centimeters.
- 4. 40 cubic centimeters.
- 5. 50 cubic centimeters. *(1) *

**2.** It is possible to calculate the volume of a body by this method because
- 1. the rise in water level is largely due to the volume of the stone.
- 2. the stone is lighter than water.
- 3. the volume of all bodies can be calculated by measuring their dimensions.
- 4. immersing a body in water increases its volume.
- 5. water is readily compressed. *(2) *

**3.** It would not be possible to measure in exactly this manner the volume of a piece of
- 1. coal.
- 2. lead.
- 3. wood.
- 4. glass.
- 5. iron. *(3) *

**4.** The volume of a body that is heavier than water is equal to
- 1. its weight.
- 2. the depth to which it sinks in water.
- 3. the volume of the water into which it is placed.
- 4. the volume of a graduated cylinder.
- 5. the volume of the water it displaces. *(4) *

**5.** The volume of the stone is about
- 1. 20 cubic centimeters.
- 2. 30 cubic centimeters.
- 3. 40 cubic centimeters.
- 4. 50 cubic centimeters.
- 5. 70 cubic centimeters. *(5) *

Go on to the next page.
Chemists need solvents in which to carry out chemical reactions. Dry chemicals in general react very slowly with one another. They must be dissolved in a liquid that will divide and scatter their molecules and give them freedom of motion so that they may choose new partners and form new compounds. Water, alcohol, ether, benzene, and many less well known liquids serve this purpose.

Chemists need many solvents for many different purposes. What the solvent does not dissolve is just as important as what it does dissolve. The universal solvent sought by alchemists, the solvent that was to dissolve everything, would have been utterly useless if found with nothing to keep it in. If you wish to remove a grease spot from your clothing, you want a solvent that will dissolve grease. If it dissolved the cloth as well, it would be effective but useless as a spot remover. (Items 6 through 9 refer to this passage.)

6. In general, two substances will react with each other more readily if they are both
6-1 dissolved in liquid.
6-2 in a dry state.
6-3 compounds.
6-4 free from water.
6-5 not dissolved.

7. The usefulness of any solvent depends upon
7-1 its ability to dissolve everything.
7-2 its ability to remove spots from clothing.
7-3 its ability to dissolve certain substances without affecting others.
7-4 the number of molecules it contains.
7-5 the number of new compounds it contains.

8. According to the passage, which of the following would be a useless material for removing spots from clothing?
8-1 A liquid
8-2 Ether
8-3 Any chemical
8-4 A solution
8-5 A universal solvent

9. A universal solvent placed in a container would
9-1 have no reaction.
9-2 be a practical solvent for all purposes.
9-3 be effective only if dissolved in another liquid.
9-4 contain no free-moving molecules.
9-5 dissolve the container.

The Alaska brown bear sometimes weighs over 1600 pounds and is the world's largest carnivore. In ferocity, however, it does not have the reputation of the grizzly. Its food is found in great abundance. Hoards of salmon run all summer, and the plentiful vegetable food of late spring and late fall is supplemented by mice, marmots, and carrion.

The Alaska brown bear goes into hibernation high on mountain slopes, sometimes as late as November, and emerges in April or May. The cubs, born during hibernation, remain with the mother for about two years and take six or seven years to reach full size. (Items 10 through 12 refer to this passage.)

10. One would be least likely to encounter the Alaska brown bear in the open during the month of
10-1 June.
10-2 October.
10-3 August.
10-4 January.
10-5 May.

11. The food eaten by the Alaska brown bear
11-1 is made up entirely of vegetables.
11-2 is made up entirely of fish and small animals.
11-3 is less in the summer than in the winter.
11-4 is obtained entirely from rivers and streams.
11-5 differs with the season of the year.

12. The age of a tiny cub seen wandering in the woods with its mother in October might be
12-1 1 month.
12-2 6 years.
12-3 3 months.
12-4 4 months.
12-5 10 months.
13. As the tube is filled with water, it is likely that
13-1 drops of water will fall from the jet onto the blades of the paddle wheel.
13-2 a vacuum will be formed in the can.
13-3 the blades of the paddle wheel will prevent air from escaping from the jet.
13-4 air will escape from the jet and turn the paddle wheel.
13-5 the pressure of the air in the can will break it. . . . . . . . . . . .13( )

14. The reason for the answer to item 13 is that
14-1 air dissolves in water.
14-2 two substances cannot occupy the same space at the same time.
14-3 steam exerts great pressure.
14-4 the force of friction is stronger than that of compressed air.
14-5 water evaporates rapidly when exposed to air. . . . . . . . . . . . .14( )

15. The operation of the paddle wheel is most similar to that of a
15-1 windmill.
15-2 dynamo.
15-3 reciprocating steam engine.
15-4 pulley.
15-5 flywheel. . . . . . . . . . . . .15( )

16. If the rubber stoppers were not airtight, it is likely that
16-1 water would immediately leak out of the can.
16-2 no more water could enter the can.
16-3 less air would escape from the jet.
16-4 water would be forced back up the glass tube.
16-5 water would be forced from the jet 16( )

Go on to the next page.
One of the best ways for man to fight the insects who rival him for the earth's bounty is to turn insect against insect. A group of Texas scientists has discovered that a certain wasp destroys the boll weevil, a beetle which in 1941 destroyed 12-14% of the South's cotton. An army of these stiletto-bearing flyers is being raised at the University of Texas. The wasp dashes among cotton rows, seeks out bolls full of weevil larvae, plunges her stiletto into each of these grubs, forces an egg through the hollow tube into each paralyzed victim, then flits on to another cotton boll. In two days the wasp egg hatches into a grub which lives off the juices of the weevil grub until it is fully grown in five more days. In another thirty days it matures, and then as an adult deposits 45 eggs which hatch to produce larvae that will kill a like number of weevils. About 400 female wasps per acre will clean up fields badly infested with weevils.

Wasps can be grown in honey-smeared cages and released in fields to work as effectively as the unpampered outdoor variety. Equipment is now being devised for mass production of the billions of wasps which cotton growers need. (Items 17 through 20 refer to this passage.)

17. These wasps may be produced in large quantities by
17-1 growing them in honey-smeared cages.
17-2 protecting them from the boll weevil.
17-3 destroying part of the cotton crop.
17-4 destroying the weevil grubs.
17-5 feeding honey to the weevil grubs. 17 ( )

18. The successful destruction of the boll weevils by this method depends on the
18-1 destruction of 12 to 14% of the cotton crop.
18-2 number of female wasps that can be grown and distributed.
18-3 training of aviators at the University of Texas.
18-4 discovery of new poisons to paralyze the weevil.
18-5 ability of the wasp to paralyze the adult beetle. 18 ( )

19. One food of the larvae of these wasps is
19-1 cotton.
19-2 honey.
19-3 weevil grubs.
19-4 eggs.
19-5 adult weevils. 19 ( )

20. One food of the adult wasps hinted at in the passage is
20-1 cotton bolls.
20-2 wasp eggs.
20-3 larvae.
20-4 honey.
20-5 weevil grubs. 20 ( )
One of the most useful methods in prying up underground secrets such as the presence of valuable minerals and oils is that of the artificial earthquake—called seismic exploration. The “earthquake” is produced by exploding a charge of dynamite in a hole 5 or 6 inches in diameter and 20 feet or more in depth. The seismic wave spreads out in all directions. Some of it travels directly along the ground, while some penetrates deeply and is reflected back wherever rock layers of sufficiently differing densities exist.

Some distance from the shot hole, a number of receptors or pickups are strung along the ground. These are small portable seismographs, similar to the large instruments that pick up real earthquakes. The vibrations of each one of these receptors are sent electrically to an instrument truck where they are recorded as wavy lines on a moving strip of photographic paper, one line to each receptor. The time of arrival of each impulse at the receptor is read to the thousandth of a second. From such a record, the depths of reflecting beds of rock can be calculated, and the presence of minerals and oils can be determined by trained geologists. (Items 21 through 25 refer to this passage.)

21. In the process described, dynamite is used to produce
   21-1 seismographs.
   21-2 minerals and oils.
   21-3 receptors.
   21-4 seismic waves.
   21-5 real earthquakes. ............... 21(  )

22. This method of exploration may result in discovering new sources of
   22-1 lumber.
   22-2 gasoline.
   22-3 sugar.
   22-4 water power.
   22-5 electricity. ............... 22(  )

23. This method is useful in
   23-1 discovering all underground secrets.
   23-2 accurately locating earthquakes.
   23-3 discovering dynamite.
   23-4 obtaining minerals from their ores.
   23-5 detecting the presence of certain minerals. ............... 23(  )

24. The depth of certain layers of rock is calculated by accurate measurement of the time required for a wave to go from the
   24-1 artificial earthquake to the rock layer and back to the receptors.
   24-2 receptors to the instrument truck.
   24-3 seismograph to the receptors.
   24-4 seismograph to the rock layers.
   24-5 instrument truck to the receptors. 24(  )

25. The actual record from which geologists can determine the probable presence of minerals is recorded in the
   25-1 receptors.
   25-2 ground.
   25-3 instrument truck.
   25-4 artificial earthquake.
   25-5 portable seismograph. ............... 25(  )

Go on to the next page.
The discovery of the planet Neptune illustrates the fact that astronomy is an exact mathematical science. Observers had noticed that Uranus, accidentally discovered in 1781, was being pulled out of its usual path. The position of the suspected, although then unseen, planet was calculated. When the new planet, later named Neptune, was first seen in 1846, it was exactly where the astronomers had predicted that it would be. Neptune has one moon, which is larger than the planet Mars. Because of its great distance from the sun, its surface temperature is very low.

For many years Neptune was thought to be the planet farthest away from the sun. In 1930 a new planet was discovered and was named Pluto after the god of darkness. This planet is so far from the sun and receives so little of its light that it was first seen as a small spot of light on a photograph taken of a part of the sky in which it happened to be. The existence of this planet had been suggested some twenty years before its discovery because of the fact that Neptune seemed to be pulled out of its accustomed orbit, and was discovered by a combination of mathematical calculations and photographs of the parts of the sky where it was believed to exist. (Items 26 through 30 refer to this passage.)

26. The planet Neptune was discovered as a result of its attraction for
   26-1 Mars.
   26-2 Pluto.
   26-3 Uranus.
   26-4 its moon.
   26-5 the sun. . . . . . . . . . . . . 26( )

27. It is likely that the lowest average surface temperature would be found on
   27-1 Uranus.
   27-2 Mars.
   27-3 Neptune.
   27-4 Neptune’s moon.
   27-5 Pluto. . . . . . . . . . . . . 27( )

28. The planets Pluto and Neptune were both discovered as a result of
   28-1 an accident.
   28-2 mathematical calculations.
   28-3 photographic methods.
   28-4 observing their effects upon the planet Uranus.
   28-5 observing their effects upon the sun. 28( )

29. In general the three steps in the finding of Neptune and Pluto occurred in the following order:
   29-1 calculation, discovery, observation.
   29-2 discovery, calculation, observation.
   29-3 discovery, observation, calculation.
   29-4 observation, calculation, discovery.
   29-5 observation, discovery, calculation. 29( )

30. The pulling of Neptune from its regular path had suggested the presence of a planet farther out in space as far back as
   30-1 1781.
   30-2 1826.
   30-3 1846.
   30-4 1910.
   30-5 1930. . . . . . . . . . . . . 30( )

If you finish this part before the time is up, you may go back and work on any part.
Please print:

Name..............................................Date..............................................

Last Name..................................First Name...........................................

Grade or Class..................................Age...........................................

Yrs. Mos........................................Date of Birth........................................

School........................................City.............................................Sex........................................

M. or F........................................

Number of years you have studied biology: (one semester = ½ year; one quarter = ¼ year).

General Directions: Do not turn this page until the examiner tells you to do so. This examination consists of two parts and requires 40 minutes of working time. The directions for each part are printed at the beginning of the part. Read them carefully and proceed at once to answer the questions. DO NOT SPEND TOO MUCH TIME ON ANY ONE ITEM. ANSWER THE EASIER QUESTIONS FIRST; then return to the harder ones if you have time. There is a time limit for each part. You are not expected to answer all the questions in any part in the time limit; but if you should, go on to the next part. If you have not finished Part I when the time is up, stop work on that part and proceed at once to Part II. If you finish Part II before the time is up, you may go back and work on either part. No questions may be asked after the examination has begun.

You may answer questions even when you are not perfectly sure that your answers are correct, but you should avoid wild guessing since wrong answers will result in a subtraction from the number of your correct answers.

<table>
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PART I
(20 minutes)

Directions: Each of the incomplete statements or questions below is followed by five possible answers. For each item, select the answer which best completes the statement or answers the question, and put its number in the parenthesis at the right.

1. Which is a common source of trichina worm infection for human beings?
   1-1 Beef
   1-2 Pork
   1-3 Fish
   1-4 Mutton
   1-5 Chicken

2. If an animal is covered with hair and bears its young alive, in which two groups does it belong?
   2-1 Mammal and bird
   2-2 Mammal and reptile
   2-3 Invertebrate and arthropod
   2-4 Vertebrate and reptile
   2-5 Vertebrate and mammal

3. Which of the following best defines the environment of an organism?
   3-1 The land on which it lives
   3-2 The organisms and conditions which make its life possible
   3-3 The climate of the locality in which it lives
   3-4 The plants and animals which surround it
   3-5 The surroundings and conditions in which it lives

4. Nurserymen commonly advertise trees that bear five different varieties of apples. What makes it possible to produce such trees?
   4-1 Mutations
   4-2 Cross pollination
   4-3 Special types of soil
   4-4 Selective breeding
   4-5 Budding or grafting

5. Which of the following characteristics is of greatest value in distinguishing a seed-eating bird from an insect-eating bird?
   5-1 Flight movements
   5-2 Shape of beak
   5-3 Shape of feet
   5-4 Size of crop
   5-5 Length of alimentary canal

6. What is the chief function of root hairs?
   6-1 The harboring of nitrogen-fixing bacteria
   6-2 The binding of soil particles
   6-3 Storage
   6-4 Anchorage
   6-5 Absorption

7. Which of the following changes would best balance a meal consisting of bread and butter, mashed potatoes, tapioca pudding, and candy?
   7-1 Adding beef, eggs, or cheese
   7-2 Omitting the candy and adding milk, squash, and carrots
   7-3 Omitting the candy and adding fresh vegetables, beef, and milk
   7-4 Omitting the tapioca pudding and candy, and adding pork, boiled rice, and pineapple
   7-5 Adding mince pie and hot chocolate

8. Which is a direct result of the oxidation of simple sugar in a cell?
   8-1 Increase in cell size
   8-2 Decrease in cell size
   8-3 Loss of energy
   8-4 Release of energy
   8-5 Storage of food

9. What factor that is essential for green plant growth is lacking at great depths in the ocean?
   9-1 Light
   9-2 Oxygen
   9-3 Carbon dioxide
   9-4 Minerals
   9-5 Nitrogen

10. Which of the following elements is found in carbohydrates, fats, and proteins?
    10-1 Carbon
    10-2 Nitrogen
    10-3 Phosphorus
    10-4 Sulfur
    10-5 Potassium

11. In an intestinal parasite, which of the following is usually most degenerate?
    11-1 Sensory system
    11-2 Circulatory system
    11-3 Reproductive system
    11-4 Respiratory system
    11-5 Digestive system

12. In the human body, excess carbohydrates are normally stored in the
    12-1 blood stream
    12-2 spleen
    12-3 liver
    12-4 kidney
    12-5 pancreas

Go on to the next page.
Leaves taken from green plants which have been kept in the dark for several days do not show any evidence of starch when tested with iodine because

13-1 plants grown in the dark do not use food.
13-2 iodine does not affect starch that has been kept in the dark.
13-3 plants do not manufacture food in the dark.
13-4 chlorophyll breaks down in the dark.
13-5 light changes starch molecules into sugar.

Which of the following is the best evidence of division of labor in a protozoan?
14-1 One-celled structure
14-2 Specialized tissues
14-3 Performance of different functions by certain cell parts
14-4 Absence of specialized tissues
14-5 Granular appearance of protoplasm

Which of the following biological principles is best illustrated by a balanced aquarium?
15-1 All living things respond to stimuli in their environment.
15-2 Plants and animals are dependent upon each other and upon their environment.
15-3 Food, oxygen, and certain optimal conditions of temperature, moisture, and light are essential to the life of most living things.
15-4 Protective adaptations aid survival.
15-5 All plants and animals are engaged in a constant struggle for energy.

Which statement is part of Darwin’s theory of evolution?
16-1 Individuals well adapted to their environment are more likely to live and reproduce.
16-2 The number of individuals in a species steadily increases.
16-3 Any organism quickly adapts itself to its environment.
16-4 Changes in organisms caused by environmental conditions are hereditary.
16-5 The production of a new organ results from a new need.

Some scientists believe that wavy hair in human beings is the result of incomplete dominance of curly over straight hair. If this is correct, which of the following is most likely to be true if a wavy-haired couple has several children?
17-1 All have wavy hair.
17-2 All have curly hair.
17-3 All have straight hair.
17-4 All three types may appear.
17-5 All have either curly or wavy hair.

18. Which man is usually given credit for the discovery and proof that blood circulates in a vascular system?
18-1 Galen
18-2 Darwin
18-3 Jenner
18-4 Harvey
18-5 Koch

19. A spike is driven into a thirty-foot tree at a height of five feet from the ground. The tree grows ten feet taller during the next fifteen years. How far above the ground is the same spike at the end of that period?
19-1 Five feet
19-2 Ten feet
19-3 Fifteen feet
19-4 Twenty feet
19-5 Thirty feet

20. Which of the following is an example of sexual reproduction?
20-1 Sprouting of tubers
20-2 Budding of yeast
20-3 Fission of paramecia
20-4 Formation of seeds
20-5 Grafting of fruit trees

21. Which of the following best explains the fact that the number of sperms produced by many animals is much larger than the number of eggs?
21-1 Eggs contain stored food.
21-2 Sperms contain nuclear material.
21-3 Sperms are small.
21-4 Sperms are exposed to many adverse conditions.
21-5 Several sperms fertilize each egg.

22. Fossils are found in two different rock strata which lie as they were originally formed. In which of the following characteristics are the fossils taken from the lower stratum always different from those taken from the upper?
22-1 Age
22-2 Size
22-3 Abundance
22-4 Structure
22-5 State of preservation

23. Two fundamental concerns of all organisms are (1) to obtain food, and (2) to keep from being destroyed. Which of the following is also a fundamental concern of all organisms?
23-1 Growing larger and larger
23-2 Obtaining oxygen from the air
23-3 Maintaining proper body temperature
23-4 Reproducing
23-5 Adapting to the changing environment

24. What is the basic reason for the high body temperature of birds?
24-1 Rapid movement
24-2 Feather covering
24-3 Rapid oxidation
24-4 Thick layer of fat next to skin
24-5 High protein consumption

Go on to the next page.
25. Which organ is responsible for the final digestion of most food?
   25-1 Stomach
   25-2 Small intestine
   25-3 Large intestine
   25-4 Liver
   25-5 Pancreas

26. Of what advantage is the slow movement of capillary blood?
   26-1 Pressure is decreased.
   26-2 Pressure is increased.
   26-3 There is more opportunity for exchange of materials.
   26-4 There is more opportunity for energy transformations.
   26-5 Less heart action is necessary.

27. What are the end-products of fermentation by yeast?
   27-1 Sugar and carbon dioxide
   27-2 Alcohol and carbon dioxide
   27-3 Starch and alcohol
   27-4 Water and carbon dioxide
   27-5 Alcohol and water

28. Which of the following is most often true of plants that have inconspicuous flowers?
   28-1 Few seeds will mature.
   28-2 Insects distribute the pollen.
   28-3 Few flowers grow on each plant.
   28-4 Large quantities of nectar are produced.
   28-5 Wind distributes the pollen.

29. Which of the following best explains the struggle for existence among all living things?
   29-1 Carnivorous species
   29-2 Natural antagonisms
   29-3 Instincts
   29-4 Evolution
   29-5 Over-production

30. Plants sometimes die when the soil is tamped too solidly around their roots. In such a case, which of the following is most responsible for the death of the plant?
   30-1 Rapid evaporation of soil water
   30-2 Insufficient mineral supply
   30-3 Insufficient air
   30-4 Crushed root hairs
   30-5 Inability of new roots to grow through hard soil

31. Which of the following is usually accepted as an explanation of sudden changes in lines of organic evolution?
   31-1 Mutations
   31-2 New needs
   31-3 New uses of organs
   31-4 Environmental changes
   31-5 Natural selection

32. With which of the following structures are root hairs most closely associated?
   32-1 Cortex
   32-2 Central cylinder
   32-3 Vascular bundles
   32-4 Root cap
   32-5 Epidermis

33. Why does washing the leaves of plants kept in the house often improve the health of the plant?
   33-1 Stomates are cleared.
   33-2 Water enters the stomates.
   33-3 Opaque materials are removed.
   33-4 Dust is removed from the upper surfaces of leaves.
   33-5 Impurities are removed.

34. Which of the following best accounts for the loss of weight by athletes during a hard game?
   34-1 Oxidation of food
   34-2 Excretion of water
   34-3 Liberation of energy
   34-4 Excretion of carbon dioxide
   34-5 Destruction of protoplasm

35. Which of the following is the best explanation for an ear of corn with many undeveloped kernels?
   35-1 Staminate flowers were not developed.
   35-2 A fungus disease attacked the ear.
   35-3 Essential minerals were lacking in the soil.
   35-4 Pistillate flowers were not developed.
   35-5 Pistillate flowers were not pollinated.

36. Some animals resemble objects in their environment. Which of the following statements concerning these animals is most nearly correct?
   36-1 They are benefited by the resemblance.
   36-2 They are insuring perpetuation of the species.
   36-3 They are all cold-blooded animals.
   36-4 They are not highly developed.
   36-5 They are inactive

37. Which of the following is the most effective method for securing a culture of protozoans?
   37-1 Allowing pure distilled water to become stagnant
   37-2 Boiling river water and covering the container
   37-3 Adding river water to an open jar containing dried grass
   37-4 Distilling river water and allowing the residue to become stagnant
   37-5 Exposing a Petri-dish of agar-agar to the air for a few minutes

38. Which of the following statements is true of living green plants?
   38-1 They carry on respiration all the time and photosynthesis part of the time.
   38-2 They carry on photosynthesis all the time and respiration part of the time.
   38-3 They use oxygen and give off carbon dioxide during photosynthesis.
   38-4 They use carbon dioxide and give off oxygen during respiration.
   38-5 They carry on photosynthesis in place of respiration.
What is the chief function of the cells of the most recent wood rings in the stems of trees and shrubs?
39-1 Manufacture of food
39-2 Digestion
39-3 Support
39-4 Conduction
39-5 Storage

Which of the following illustrates the principle of osmosis?
40-1 Passage of water into root hairs
40-2 Passage of water through stomates
40-3 Entrance of oxygen into lung capillaries
40-4 Hormone secretion
40-5 Absorption of food from the small intestine

Which of the following procedures would most quickly result in a "balance of nature" in a given region?
41-1 Introducing equal numbers of different species
41-2 Leaving the region unmolested
41-3 Allowing hunters to destroy predatory animals
41-4 Introducing natural enemies of insects
41-5 Reducing the number of herbivorous animals

Which tissue is lacking in a mature corn stem?
42-1 Xylem
42-2 Phloem
42-3 Cambium
42-4 Pith
42-5 Vascular tissue

What factor other than shade makes a forest relatively cool in hot weather?
43-1 Evaporation
43-2 Condensation of water vapor
43-3 Natural low temperature of trees
43-4 Absorption
43-5 High humidity

Information concerning the food habits of a mammal may be most readily obtained from the
44-1 teeth.
44-2 tongue.
44-3 large intestine.
44-4 stomach.
44-5 digestive glands.

What factor in the life of forest trees reduces the number of knots in the lumber cut from their trunks?
45-1 Competition for light
45-2 Competition for soil minerals
45-3 Protection from wind damage
45-4 Abundant moisture
45-5 Rich soil

46. Drawing A in the figure represents a plant root system in wet soil with a glass tube securely fastened to the cut stem at C. The tube contains water and mercury as shown. Drawing B represents the same apparatus after a few hours have passed. Which of the following statements best explains the difference in the mercury levels in drawing B?
46-1 Atmospheric pressure has increased.
46-2 Water has passed into the root from the soil.
46-3 The roots have manufactured food.
46-4 The roots have carried on transpiration.
46-5 The roots are using stored food.

47. Which of the following is usually associated with the ability of an animal to regenerate lost parts?
47-1 Small size
47-2 Large size
47-3 Little specialization
47-4 Great specialization
47-5 Presence of joints

48. Which of the following structures is similar in origin and structure to the wing of a bird?
48-1 Foreleg of a cat
48-2 Leg of a man
48-3 Wing of a grasshopper
48-4 Leg of a crayfish
48-5 Wing of a moth

49. What distinguishes most insects from all other animals?
49-1 Compound eyes
49-2 Segmented bodies
49-3 Number of appendages
49-4 Small size
49-5 Food habits

50. Which characteristic of an active snake is most responsible for the fact that food consumption per unit volume is typically much less than that of an active mammal such as a dog?
50-1 Long intestine
50-2 Efficient digestive system
50-3 Type of locomotion
50-4 Cold-blooded body
50-5 Hinged jaws which allow ingestion of whole animals as food

51. Which of the following best explains the large number of existing insects?
51-1 Freedom from competition
51-2 High degree of adaptation
51-3 Protective coloration
51-4 High degree of development
51-5 Unlimited food supply

Go on to the next page.
52. Which of the following benefits derived from forests is the most important reason for forest conservation?
52-1 Lumber
52-2 Recreation areas
52-3 Soil binding
52-4 Regulation of water supply
52-5 Homes for wildlife

53. Which of the following changes will usually result from changing the environment of a plant for several generations?
53-1 A change in the number of chromosomes
53-2 A non-heritable change in the vegetative parts
53-3 A heritable change in the species
53-4 A change in the sex cells
53-5 A permanent change in the life cycle

54. In which structure does most digestion take place in a young potato plant which is being propagated from a piece of tuber?
54-1 Leaf
54-2 Stem
54-3 Root
54-4 Tuber
54-5 Epidermis

55. What characteristic of fruits and vegetables makes it necessary for a person who lives chiefly on these substances to eat a larger volume of food than one who eats mainly animal products?
55-1 High vitamin content
55-2 Low vitamin content
55-3 High proportion of cellulose
55-4 Low proportion of cellulose
55-5 Low carbohydrate content

PART II
(20 minutes)

Directions: This part consists of diagrams and passages, followed by several items concerning the diagram or passage. For each item, decide on the basis of the diagram or passage which one of the choices given below the incomplete statement or question best completes the meaning of the statement or answers the question. Put the number of your choice in the parentheses at the right of each item.

The development of every kind of living organism is influenced by the activities of other living organisms. There are intimate interrelations not only between various species of plants, but also between plants and animals.

A common biotic relationship is that found in competition. Plants compete with each other for water, for mineral nutrients, for space, and for light. In a forest, the plants which grow more slowly are shaded by more rapidly growing individuals, and often die as a result of their inability to obtain sufficient light. As a result of competition for moisture in the soil, those plants which absorb water most rapidly usually survive, whereas those which take up moisture more slowly are likely to succumb in the competition. Morphological features, such as depth of root systems and development of water-storage tissues, and physiological characteristics, such as rate of transpiration and of water absorption, and photosynthetic efficiency, are factors which determine what species will survive under given environmental conditions and what species will lose out.

Parasitism is another biotic relationship which influences strikingly the development and distribution of plants. Infections by fugal parasites may interfere seriously with photosynthetic activity, and thus indirectly reduce the numbers and quality of seeds produced.

Akin to parasitic relationships are symbiotic relationships. The term symbiosis (meaning "living together") is used to refer to an intimate biotic association in which the organisms involved live together more commonly than they live apart, and in which the relationship is often mutually beneficial. Lichens are regarded as symbiotic associations of algae and fungi, and the nitrogen fixing bacteria which inhabit the nodules of leguminous roots live apparently in a symbiotic relationship of mutual benefit with their hosts.

Animals constitute an important biotic factor which influences the growth and distribution of plants, for animals are dependent directly or indirectly upon plants for food. Overgrazing of grasslands and forests by animals produces marked vegetational changes. When leaves are continually cropped, the food-making machinery of plants is destroyed, and plants starve and die.

Flower-pollinating insects are an important factor in the distribution of plants, for most species of angiosperms are insect pollinated and are therefore dependent upon pollinating insects for their production of seed. Fluctuations of insect populations thus markedly influence the degree to which such plants may propagate themselves.

Items 1–9 on page 7 refer to the passage above.

Go on to the next pa
Forest trees often grow taller than trees of the same species growing in the open. This may be accounted for by competition for
1-1 water.  
1-2 light.  
1-3 food.  
1-4 space.  
1-5 mineral nutrients.  

What effect of fungous parasites on green plants interferes most directly with photosynthetic activity?
2-1 Destruction of leaf tissue  
2-2 Reduction of water supply  
2-3 Depletion of storage products  
2-4 Reduction in the number of seeds  
2-5 Stimulation of abnormal growths  

What is the chief contribution to legumes of the nitrogen-fixing bacteria which inhabit the nodules of their roots?
3-1 Free nitrogen  
3-2 Nitrates  
3-3 Nitrites  
3-4 Minerals necessary for photosynthesis  
3-5 Food for the roots  

Which of the following is true of many symbiotic relationships, but is never true of parasite and host?
4-1 Two organisms live together in close association.  
4-2 One organism provides food for another organism.  
4-3 Each organism helps the other in one or more ways.  
4-4 Each organism belongs to a different species.  
4-5 One organism provides a place to live for another.  

5. What is the chief contribution to the fungus of the alga which helps make up a lichen?
5-1 Water  
5-2 Major portion of the plant body  
5-3 Absorption of mineral nutrients  
5-4 Protection  
5-5 Food  

6. What characteristic of bluegrass is most important in helping these plants survive the grazing of animals?
6-1 Succulent leaves  
6-2 Growing region at the tip of the leaves  
6-3 Growing region at the base of the leaves  
6-4 Spreading root system  
6-5 Vegetative reproduction  

7. Which of the following groups of plants is most dependent upon insects for pollination?
7-1 Mosses  
7-2 Ferns  
7-3 Gymnosperms  
7-4 Dicotyledons  
7-5 Fungi  

8. Which of the following insects has the greatest influence on the number of seeds produced by angiosperms?
8-1 Paper wasp  
8-2 Butterfly  
8-3 Lady bug  
8-4 Bumblebee  
8-5 Housefly  

9. Which one of the following factors that Darwin used to account for the development of new species is not stated or implied in the second paragraph of this passage?
9-1 Over-production of individuals  
9-2 Inheritance of favorable characteristics  
9-3 Variation among individuals  
9-4 Survival of the fittest  
9-5 Struggle for existence  

Go on to the next page.
The basic experiment which underlies our modern ideas about photosynthesis was performed by Van Helmont about three hundred years ago. His simple but conclusive experiment proved that very little of the total substance of a plant comes from the soil. He planted a willow shoot weighing five pounds in a pot containing exactly 200 pounds of thoroughly dried earth. Then for five years he carefully watered it with rain-water. The earth in the pot was covered to prevent dust from blowing in. At the end of the five years the willow weighed 169 pounds. At the same time the earth in the pot, when again thoroughly dried, proved to have lost but two ounces. He concluded that the new substance of the willow was made of water.

We now know that green plants use water and carbon dioxide as raw materials in the manufacture of food, and that the end products are a carbohydrate and oxygen. Chlorophyll is in some way essential, and the process takes place only in the presence of light energy. The process can be summarized by the chemical equation

\[ \text{6CO}_2 + \text{6H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{6O}_2. \]

The chief organs of food manufacture in higher plants are the leaves. They are well adapted for the effective discharge of this function. The thin broad shape of typical leaves presents a large area to sunlight and allows a ready exchange of gases with the surrounding atmosphere. The tissues within a leaf are shown in the accompanying diagram. The cells between the upper and lower epidermis constitute the mesophyll. All mesophyll cells are richly supplied with chloroplasts. The intercellular spaces of the spongy mesophyll are connected with the external atmosphere through the stomates. This affords a passageway for CO₂ to reach the cells and O₂ to leave, and, during respiration, for the reverse process. There is usually a great deal of water vapor passing through the intercellular spaces and evaporating out through the stomates. Ramifying through the mesophyll are the supporting and transporting veins made up of fibro-vascular bundles.

![Diagram of leaf structure]

Items 10-18 on page 9 refer to the passage and diagram above.
How much did the willow which Van Helmont planted gain in weight during the five year period?

10-1 200 lbs.
10-2 169 lbs.
10-3 164 lbs.
10-4 31 lbs.
10-5 5 lbs.

What did Van Helmont attempt to control by covering the pot of soil in which he planted the willow twig?

11-1 Water loss by evaporation
11-2 Transpiration
11-3 Removal of soil by the wind
11-4 Introduction of additional soil into the pot
11-5 Amount of water used

Why is oxygen considered a by-product of photosynthesis?

12-1 It is not part of the food manufactured.
12-2 It is present in carbon dioxide and water.
12-3 It is used by plants in respiration.
12-4 It is a useless gas.
12-5 It is released as a free gas.

The chemical equation for photosynthesis, as given in the passage, could be improved by

13-1 balancing it.
13-2 indicating that energy is required.
13-3 indicating that energy is released.
13-4 identifying the waste products.
13-5 including the word photosynthesis.

This discussion of photosynthesis provides the least information about

14-1 the steps in the process.
14-2 the raw materials.
14-3 the end products.
14-4 the source of energy.
14-5 the food manufactured.

What adaptation for food manufacture is shown in the diagram but is not mentioned in the passage?

15-1 Air spaces in spongy mesophyll
15-2 Large area for light reception
15-3 Fibro-vascular bundles
15-4 Concentration of chloroplasts in upper mesophyll cells
15-5 Openings in the lower epidermis.

What is the chief function of the two epidermal layers of a leaf?

16-1 Food manufacture
16-2 Conduction
16-3 Light reception
16-4 Protection
16-5 Support

During the daytime, what gas is present in the intercellular spaces of mesophyll cells in higher concentration than in the surrounding atmosphere?

17-1 Carbon dioxide
17-2 Nitrogen
17-3 Oxygen
17-4 Hydrogen
17-5 Carbon

What structures are mentioned in the passage but not shown in the diagram?

18-1 Veins
18-2 Stomates
18-3 Chloroplasts
18-4 Epidermal cells
18-5 Intercellular spaces

Go on to the next page.
When the left ventricle of the heart contracts, the blood it contains is forced out between valves into the largest blood vessel of the body, the aorta. This blood vessel branches, and blood is thus carried all over the body. By means of smaller divisions called capillaries, the blood is enabled to come close enough to cells to discharge food and oxygen to them, taking up wastes in return. It then flows into small veins leading back to the heart. During the systemic circulation, the blood passes through the kidneys, where it eliminates urea, and through the intestinal walls, where it gains a fresh supply of food.

The passage of venous blood from the stomach and the intestine through the liver requires special blood vessels comprised in the portal system. Passage of the blood through the liver keeps the carbohydrate content of the blood uniform.

When the venous blood reaches the heart it enters the right auricle, on the side opposite that from which it started out on the journey through the body. From the right auricle, it passes into the right ventricle. When this contracts, blood is forced through the pulmonary arteries to the lungs. It returns through the pulmonary veins to the left auricle and ventricle, from which it starts out again on a trip around the body.

The ventricles contract and expand together so that there are two waves of blood sent out at each beat, one to the lungs and one to the general circulation. While the ventricles are contracting and forcing out their blood, both auricles have been filling so there is no stop in the flow.

The general plan of circulation described above is summarized in the following diagram.

Items 19–26 refer to the passage and diagram above.

19. Which blood vessel shown on the diagram is the largest in the body?
   19-1 A
   19-2 B
   19-3 C
   19-4 D
   19-5 E

20. Which of the following best explains the greater thickness of the left ventricle walls as shown in the diagram?
   20-1 Contractions are more frequent.
   20-2 Volume of blood pumped is greater.
   20-3 Blood is pumped over greater distances.
   20-4 There are more blood vessels leaving the left side.
   20-5 There is a greater supply of "pure" blood.

21. The wastes of oxidation, picked up by the blood in the capillaries of all active tissues, consist of
   21-1 broken-down red corpuscles.
   21-2 glycogen and oxygen.
   21-3 amino acids and water.
   21-4 urea and fibrinogen.
   21-5 carbon dioxide and water.

22. When blood is leaving the right ventricle of the human heart, how is it moving in the other parts of the heart?
   22-1 It is entering the left ventricle and the two auricles.
   22-2 It is entering the two auricles, and leaving the left ventricle.
   22-3 It is neither entering nor leaving the auricles, and is leaving the left ventricle.
   22-4 It is leaving all other parts.
   22-5 It is leaving the left auricle, and entering the right auricle and ventricle.
Which of the following is the most accurate characterization of the blood carried by all arteries?

23-1 Moving toward the heart
23-2 Moving away from the heart
23-3 Pure
23-4 Impure
23-5 Oxygenated

Which of the following procedures is used to determine the blood pressure in human beings?

24-1 Counting the number of heart beats per minute
24-2 Weighing a unit volume of blood taken from an artery
24-3 Attaching a manometer to an artery
24-4 Measuring the pressure necessary to stop the flow of blood through an artery
24-5 Measuring the pressure in large veins

25. What is the chief advantage of a four-chambered-heart?

25-1 Oxygenated blood and deoxygenated blood are kept completely separated.
25-2 More blood is pumped per unit of time.
25-3 One part rests while the other parts contract.
25-4 Blood enters the heart at the same time it is pumped out.
25-5 Higher capillary pressure is maintained.

26. What other animals have a heart similar to that shown in the diagram?

26-1 Crayfish
26-2 Adult frogs
26-3 Fish
26-4 Reptiles
26-5 Birds

The figure above illustrates the life history of a mosquito. Items 29 and 30 refer to this figure.

29. What characteristic of the adult shown in the figure indicates that the drawing represents a member of the genus Culex rather than Anopheles?

29-1 Comparative size
29-2 Position
29-3 Number of legs
29-4 Length of abdomen
29-5 Length of wings

30. Which of the following life processes is directly benefited by the structure shown at E?

30-1 Circulation
30-2 Sensation
30-3 Excretion
30-4 Locomotion
30-5 Respiration

If you finish before the time is up, you may go back and work on either part.

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