A STUDY OF TWO METHODS OF INSTRUCTION EMPLOYED IN TEACHING SCIENCE AT THE ELEMENTARY LEVEL

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A STUDY OF TWO METHODS OF INSTRUCTION EMPLOYED IN TEACHING SCIENCE AT THE ELEMENTARY LEVEL

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PREFACE

The world of education is continually changing, as well as the individual areas of instruction which in their combined forms make up education. Industrial education is no exception to that statement. The change has been continual and far reaching in its movement from the apprenticeship program, through manual training, and finally to the field of industrial education. All too often we tend to think of industrial arts as construction activities only, rather than as a part of the general education program.

In this study I have attempted to direct the readers thoughts toward the beneficial results of integrating industrial arts education and the elementary school program.

Throughout the course of this study a number of people have been helpful in its successful completion. I would like at this time to express my appreciation to these individuals. Among these are Mr. Charles Standridge who aided me not only through teaching the units in his seventh grade science classes, but also in the

constructive criticism of the methods of presentation.

Doctor Harold Polk who served in the position of thesis advisor, and who was always available for conference and a helping hand.

Finally, my wife Pamela and our sons, John and Erik for without whose help, sacrifice and faith this study would not have been completed.

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CHAPTER I

INTRODUCTION

It has been said that today's technology is far greater and far more advanced than that of any other society in the history of the world. One result of this pace is a greater emphasis upon science in all levels of American schools.

In order for science to maintain the level required by the technology of today and that of the future changes will be required of this as well as other areas of the curriculum in an effort to improve instruction and increased student involvement. Nowhere is this more true than in the elementary school where the child must grasp the basic concept of science.[1]

One method of enriching the elementary science program could be the area of industrial arts. Hall states the concern of industrial arts at the elementary

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[1]Seymore Trieger, "New Forces Affecting Science in the Elementary School," Science and Children, October, 1963, pp. 1-22.

level is that of bringing about meaning and understanding.

> Industrial arts is concerned with bringing about increased meaning and understanding to units of instruction in the elementary school through the utilization of construction activities which may be integral parts of either individual or group projects. Another way of saying this might be that the purpose of industrial arts in the elementary school is to assist through construction activities in the introduction, presentation, and reinforcement of accepted subject matter fields.[2]

The elementary teacher of today does not need an increased amount in the number of subjects taught but rather a means through which the subject matter becomes something more than material to be read from a book. It is to this area of instruction that elementary industrial arts presents itself, through the utilization of its construction activities.

Purpose of the Problem

The object of this research was to determine the effectiveness of integrating industrial arts activities with the teaching of science in the seventh grade. A great deal of attention was placed upon student involvement

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[2]Ronald Hall, Industrial Arts For the Primary Grades, 1969, EDRS 035459, M.F. $0.25, H.C. $0.70.

in two areas of science, that of simple machines and electricity.

The study was developed through a comparison of conventional methods of instruction as compared to an experimental method of teaching. The conventional method consisted of such techniques as discussion, lectures, and other non-laboratory methods. In the experimental situation the methods were characterized by manipulative construction exercises, which involved the use of tools and materials.

In addition to the comparison of the two methods of instruction, a study was conducted to determine the attitudes of students involved in the program.

Throughout the course of the study answers were sought to the following questions:

1. To what extent can industrial art activities aid in the understanding of science concepts by seventh grade students?
2. What is the reaction of students to the integration of industrial arts activities with science?

During the course of the study the following plan was followed to reach a solution to the questions sought:

1. Develop a course of study in the areas of simple machines and electricity. This course of study can be subdivided into the following parts:
    - A. Assignment Sheets
    - B. Job Sheets
2. With industrial arts activities serving as the experimental factor, classroom activities would be conducted.
3. Report data assembled following a comparison between the experimental and control group, as shown through the utilization of scores of the pre-test and post-test.
4. Summarize and report the reaction of students to the two programs of instruction. This data to be developed through questionnaires.

Significance of the Problem

A study conducted by the Oklahoma State Department of Education during the school year 1966-1967 indicated that a total of 263 students terminated their formal education before completion of the seventh grade.[3] A similar study conducted by the Oklahoma State Department of Education during the school year of 1967-1968 indicated that a comparative number withdrew from school prior to entering the eighth grade.[4] Barclay and Cervantes summarized their study with the statement, "The academic dropout is uniquely a product of his social mileau that he is made, and not born an underachiever." It further pointed out in this study that identification of the factors of withdrawal from school are evident as early as the elementary period of the child's school life.[5] What percentage of these students lost interest in

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[3]Oklahoma State Department of Education Report of Dropouts By Counties and By Grades, 1966-1967.

[4]Oklahoma State Department of Education Report of Dropouts By Counties and By Grades, 1967-1968.

[5]A. Barclay and F. C. Cervantes, "Thematic Apperception Test As Indext of Personality Attributes, Characterizing the Adolescent Academic Dropout," Adolescent, Winter, 1969.

school because of the conventional method of instruction is unknown, as is the number that would have remained to graduate if industrial arts activities had been available. This study was an attempt to determine the potentiality and usefulness of industrial arts activities when employed as a means of enriching units of study in the elementary science program.

Hypotheses

During the course of the study the two following hypotheses were tested:

1. The achievement of pupil success will show no significant difference at the .05 level as a result of combining industrial arts activities with specific science units.
2. The attitudes of students will show no significant difference as a result of combining industrial arts activities with specific science units.

CHAPTER II

REVIEW OF LITERATURE

In order for man to understand and plan for the future, it is necessary to study the past, for without a firm foundation the structure would be greatly weakened. This is true of a study in elementary industrial arts as well. If a program is to be developed which will affect the educational lives of children then a study of the available literature must be conducted.

The program of construction activities which we now refer to as industrial arts had its origin in the thinking of Johonn Heinrich Pestalozzi and Frederick William Frobel in the 18th century.[1]

Pestalozzi who had become concerned about the education of children in Switzerland had the opportunity to put his concept into practice. Even though most of his early attempts resulted in failure, he was able to demonstrate

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[1]W. R. Miller and Gardner Boyd, Teaching Elementary Industrial Arts, (South Holland, Illinois, 1970), p. 7.

this natural process of learning. Probably the major contribution to education by Pestalozzi was the successful use of objects and manual activity, as a means of teaching the traditional school subjects. The use of "well made models" can provide the sense impressions to break down word symbols. This theory advanced by Pestalozzi has lasted through two centuries of successful use.[2]

Frobel's educational practices can be traced as a direct heir to the Pestalozzi educational ideas. He established schools for small children called kindergartens. The important effect of Frobel upon elementary industrial arts was his construction activities with small children. This activity is exemplified in such experiences as braiding straw mats, and preparation of geometric forms.[3]

Carl Gerbracht and Robert Babcock have outlined the growth of elementary industrial arts activities by the use of six divisions of time.

I. Early and Middle 19th Century
   A. Develop tool skill basic to manual trades and occupations (homemaking and industrial).
   B. Provide for constructive use of leisure time.

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[2]*Ibid*., p. 20.

[3]*Ibid*.

II. Late 19th Century
   A. To develop vocational skills
   B. Promote an appreciation of the dignity of labor through a broad knowledge of mechanical principles.
   C. To assist in clarifying academic studies.

III. Turn of the Century
   A. Develop an appreciation of good design
   B. Provide knowledge related to industrial production, primarily for better orientation to one's chosen vocation
   C. To provide concrete experiences to facilitate the teaching of the common branches of study.

IV. Early 20th Century
   A. To serve as "care" experiences on which to build the curriculum in lower elementary grades.
   B. Develop an understanding and appreciation of industry as the concern of everyone in an increasingly industrialized society.
   C. To assist in the intelligent selection and use of industry's products.

V. Somewhat Later
   A. Provide experiences relative to the practical constructive activities of men which are necessary to the common education of everyone and through these experiences to develop understandings and appreciations of our cultural heritage.

VI. Mid-Twentieth Century
   A. To provide an indispensable means for the more complete achievement of universally accepted goals of elementary education.[4]

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[4]Carl Gerbracht and Robert J. Babcock, Industrial Arts for Grades K-6, (Milwaukee, Wisconsin, 1959), pp. 1-2.

In the earlier attempts of elementary industrial arts efforts were made to include practical manipulative type work. This work was designed to serve two main purposes. First, the development of certain tool skills. These skills were thought to be basic to many occupations and trades. The idea that prevailed through this period was the acclaim of manual dexterity and hand-eye coordination.[5]

Gerbracht has described the objectives sought by this method of instruction as:

> (1) To lay a foundation for the sort of work many of its people were destined.
> (2) Manipulative experiences would help to provide for the constructive use of leisure time.[6]

Throughout this period of early experimentation with elementary industrial arts several men stand out as leaders in the movement. Among these are Frederick G. Bonser and Louis C. Mossman of Teacher's College, Columbia University. Bonser and Mossman attempted to apply the philosophy advocated by John Dewey in a publication known as _School and Society_. During the course of this a book was prepared known as _Industrial Arts For Elementary Schools_, which

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[5] _Ibid_., p. 3.

[6] _Ibid_.

was an attempt to apply Dewey's theory through both content and instructional methods. It was thought that industrial arts would help the child develop an appreciation and understanding of industry in our culture. This would also be related to social problems and to industrial product decision making. The method of this instruction would place industrial arts as the core of the academic process around which would revolve such areas as arithmetic, geography, history, science and reading.[7]

Dr. Felix Adler established a kindergarten patterned after that Frobel's school. Adler was instrumental in establishing the Workingman's School in New York and in the formulation of the New York Society for Ethical Culture.[8] The main contribution of Adler was the belief that constructional activity should be an organic part of other school studies. He felt that mathematical and physical principles would be much better taught through working with material things.[9]

Traditionally industrial arts has been a

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[7]Miller and Boyd, <u>Teaching Elementary Industrial Arts</u>, p. 7.

[8]Gerbracht and Babcock, <u>Op</u>. <u>Cit</u>., p. 3.

[9]Miller and Boyd, <u>Op</u>. <u>Cit</u>., p. 21.

disciplinary subject. A subject which attempted to lead a student through a series of prescribed exercises which in turn lead to the understanding of a tool or process.[10]

Delmar W. Olson in an attempt to define industrial arts has suggested a program to advocate the involvement of the student with industry and the world of work.

> ......It seems to me that it is time for us to reconsider what the mastering of materials, energies, tools, machines and products by man has done for him; to reflect on the control he has created out of his mastery, and to study all of this matter. In my opinion all of this stands as a challenge; it is the challenge of technology and the great mission of industrial arts. With this kind of industrial arts man can learn about this materials mastery as he discovers and develops his own native aptitudes for having better ideas with materials. He can find value in his technology beyond that of tool and skill and can gain even greater control of what happens to him in his time.[11]

Dr. Mary Margaret Scobey, Professor of Education at San Francisco State College, describes the objectives of industrial arts as:

> ......A field of study with unique and specific content that embraces those

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[10]Mary Margaret Scobey, <u>Teaching Children About Technology</u>, (Bloomington, Illinois, 1968), p. 5.

[11]<u>Ibid</u>.

> activities and insights dealing with industry. A phase of general education, it provides opportunities for children to observe, study, experiment and work with processes, materials, tools, and machines through which man has adopted his physical world to serve his needs. It is the study of the ways and means by which materials and products of daily life are obtained, prepared and used, and their influence upon society. Industrial arts is the study of man's relationship to his environment, to the world of work, and to human reaction and leisure. Industrial arts is the study of the total technology of man.[12]

However, she presents a different objective when referring to industrial arts at the elementary level.

> The unique contribution of industrial arts as this level is providing first-hand experiences with the processes and products of constructive endeavor with material things....There is no standard content, as such, which must be covered. Industrial arts justifies its existence on the basis of the help it gives the school.[13]

Gerbracht and Babcock agreed with Scobey's objective of elementary industrial arts when they made the statement, "it helps the school to do things better which the school is already trying to do."[14]

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[12] Ibid., p. 6.

[13] Ibid.

[14] Gerbracht and Babcock, Industrial Arts for Grades K-6, p. 1.

William R. Hoots expresses the theory that industrial arts at the elementary school level is not another subject to be added to an already crowded curriculum; rather it should be an integral part of that curriculum. This integral part would serve as an enrichment to that which they now have.[15]

Dr. Carl Gerbracht and Dr. Harold Gilbert suggest that the aim of industrial arts at the elementary level is ". . . to assist in the achievement of the generally accepted goals of elementary education."[16]

Gerbracht, while working in connection with Babcock, states that the most important contribution of industrial arts activities is the establishment of more adequate meanings through curriculum enrichment.[17]

E. F. Mitchell, Departmental Chairman of the Industrial and Occupational Education Department at Mississippi State University proposes that industrial

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[15]William R. Hoots, The Development of a Course of Study For Industrial Arts Education at the Elementary School Level, Research Report, 1968, EDRS 024822, M.F. $0.50, H.C. $5.65.

[16]Ibid.

[17]Gerbracht and Babcock, Industrial Arts For Grades K-6, p. 2.

arts is capable of developing the following fourteen points of values to aid the elementary student:

1. Reduces the level of abstraction
2. Involves more of the senses in the learning processes
3. Provides more fully for individual differences
4. Motivates learning
5. Provides outlets for inate desires to create
6. Helps establish learning readiness
7. Makes school a more pleasant experience
8. Introduces pupil to the world of work
9. Acquaints pupils with the care and use of common industrial tools and materials
10. Produces an environment which is conducive to the development of desirable social habits and personality characteristics
11. Produces tangible results from pupil effort
12. Provides opportunity for all levels of pupil success in accord with individual differences
13. Gives the child an objective median for expressing his ideas
14. Provides the child with a manipulative form of creative leisure-time expression.[18]

Scobey advocated that when children work with tools they will develop skill in the use of tools, materials, and processes. As skill develops concern for safety and

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[18]E. F. Mitchell, Industrial Arts and Vocational Education in Grades K-12, Final Report, 1968, EDRS 033195, M.S. $0.50, H.C. $5.05.

appreciation of craftsmanship should also increase. In addition to skill, safety and appreciation of workmanship the child should also learn:

1. To share tools and materials
2. To keep things in their proper places and be conservative in the use of them
3. To plan a project and follow through to a successful conclusion. To proceed from beginning to end, from simple to complex.
4. To maintain constant on going evaluation which develops critical thinking and reasoning on a cooperative basis and to accept and profit by the suggestions of others.
5. To discover procedures and processes and to use many resources for research.
6. To choose wisely among materials.
7. To use ingenuity in the procurement of tools and materials.
8. To show initiative in attacking and solving problems.
9. To value producing a thing for the good of the group rather than for individual purposes.[19]

Gerbracht and Babcock suggested a number of methods through which industrial arts can help both teachers and the school.

1. Teachers should do all in their power to insure that adequate learning takes place.
2. Teachers should recognize and make allowances for variations among students in learning capacities.

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[19] Scobey, Teaching Children About Technology, p. 24.

3. Socializing experiences should be provided
4. Personality characteristics are a concern of the school
5. The teacher must be concerned with motivation
6. Readiness to learn must be taken into account by the teacher
7. The school program should make children like learning.
8. The school program should acquaint children with their cultural heritage
9. The school must teach fundamental skills.[20]

Construction activities conducted in a program of industrial arts must be justified in terms of certain behavioral changes which result from the child's involvement.[21] Miller and Boyd further propose that some of the changes industrial arts is capable of bringing to the elementary child are:

1. Satisfy evidenced needs to build, to construct, and to express themselves creatively.
2. Clarify, enrich, and broaden the understanding of concepts through first hand experiences.
3. Apply knowledge in a natural and realistic setting.
4. Develop an increased desire or drive to learn
5. Utilize his developing problem-solving skills

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[20]Gerbracht and Babcock, Op. Cit., pp. 7-9.

[21]Miller and Boyd, Teaching Elementary Industrial Arts, pp. 7-9.

6. Produce objects representative of those being studied both for observation and for use in dramatic play.
7. Increase his understanding of the ways in which industry and technology affect the production of consumer goods.
8. Develop certain behaviors, attitudes, and appreciations that have no direct relationship to the object produced.[22]

Dr. Olson has described the benefits of industrial arts education in terms of functions. He feels the following are six areas of living in which this educational practice can meet the needs of youth.

1. Social
2. Cultural
3. Consumer
4. Recreational
5. Occupational
6. Technical[23]

The development of self-expression and personal competency are the direct result of the social phase of Olson's benefits. Through self-expression and personal competency the child will be aided in the discovery of himself through personal development. The cultural benefit is concerned with an understanding of the culture heritage of the world. A heritage that has been

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[22] Ibid.

[23] Hoots, The Development of a Course of Study For Industrial Arts Education at the Elementary School Level, Research Report.

influenced by man's control and mastery of materials and environment. A heritage that is the result of technological control and mastery of materials. The consumer function provides for an enlightened utilization of the products and services of industry. Through the advance of technology man has been provided with more leisure time. The result of this leisure time is the need for wholesome activities with which to occupy this time, help him understand this phenomenon and to better cope with the problems related to it. Industrial arts can provide skills appropriate for leisure time activities. The occupational function of industrial arts provides a child with information and experiences relative to the ways by which man earns his livelihood in occupations involving technology. Through this experience and information a child should be able to make an intelligent choice regarding the occupation or profession of his choice. Involvement of the child in the technical function acquaints pupils with the tools, machines and processes by which man has improved his welfare in his attempts to master his material environment.[24]

Dr. Donald F. Hackett's statement regarding the

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[24] Ibid.

relationship of industrial arts and the elementary school program presents the assumption that instruction in the work of work could add meaning and purpose to all of the curriculum.[25] Carl Gerbracht again presents this objective when referring to industrial arts at the kindergarten level. He feels the unique contribution of elementary industrial arts is that it provides first hand experiences with the processes and products of construction activity.[26]

Dr. Donald G. Lux's statement lends support to the theory that industry should be reflected in the elementary curriculum when he said:

> ......there is evidence that the apparently aimless search for suitable elementary school activities has been given direction and purpose by changes in our economy, our society and professional education which indicates that some of these activities should be industrially oriented, provided in every elementary classroom, and related to the total elementary program. Professional direction is still lacking, but the growing need will doubtless force activity on many fronts. Perhaps the work by Comenus, Locke, Rousseau, Pestalozzi, Bonsen, and Russel will culminate to the needs of modern

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[25]Donald F. Hackett, "Industrial Element For The Elementary School," School Shop, March, 1966.
See also
Hoots, Op. Cit.

[26]Gerbracht and Babcock, Industrial Arts For Grades K-6, p. 2.

> youth. Perhaps we are finally approaching the time when the nature, scope, and purpose of elementary school activities will be concisely defined and generally accepted.[27]

Dr. Walter R. Williams III in an article entitled "Studying Industry In The Grades" reflects a similar opinion as to the relationship of industrial arts and the elementary school.[28]

Edwin Kurth explains the function of elementary industrial arts as seen in terms of subject area and a method of teaching in this way.

> It is a subject area when the emphasis on the activities and materials result in children learning how people throughout the world have used the tools and materials of their environment to raise their level of living. As a subject, it satisfies children's need for constructive activity and encourages them to use a variety of media for creative expression. As a method or way of teaching, the learnings in industrial arts comes from children's natural interests in activity and in manipulative materials and devices as a means of expressing themselves. Activities help children relate in a functional way the information taught in all areas.[29]

Harold G. Gilbert in an address to the American

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[27]Hoots, Op. Cit.

[28]Ibid.

[29]Edwin Kurt, "Industrial Arts In The Elementary School," The Industrial Arts Teacher, XVIII, November-December, 1958, pp. 8-13.

Industrial Arts Association described the need for a balance between industrial arts and classroom activities.

> Industrial arts activities in the elementary school classroom needs to strike a balance between correlating with classroom work and making a unique contribution. If there is no attempt to correlate with other classroom subjects it is more difficult to justify the time devoted to industrial arts activities. In the other extreme, if the only value is to provide a medium of expression, a unique contribution may be lost. A balance between correlation and the unique contribution seems to be most effective for the general education of children.[30]

The principal schools of thought for elementary industrial arts can be divided into two groups. One group consists of those who would establish the program as a subject matter field. This program would be accountable for its own content, designed primarily to develop manipulative skills, and the presentation of information related to industry. The second group favors the use of industrial arts as a means of teaching standard subject areas. The manipulative processes would serve as illustrative or motivational techniques to be placed at the disposal of the classroom teacher.

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[30]Harold G. Gilbert, "Introducing Elementary School Children to Industrial Processes," Developing Human Potential Through Industrial Arts, Addresses and Proceedings of the 27th Annual Convention of the American Industrial Arts Association, Tulsa, Oklahoma, 1965, pp. 226-27.

The question of who should teach the elementary industrial arts program correlates very closely with the kind of program desired. Often the areas of industrial arts is considered a responsibility of the general classroom teacher. This person must be aware of the ways and means by which industry can be presented to supplement and reinforce other fields of study. The classroom teacher is the person who can most easily and most effectively integrate the industrial arts program into the content of other subjects and can more clearly demonstrate the relationship of industrial development to the life of the child. When industrial arts is taught by a specialist in a laboratory setting, the program may be an extension of the classroom subject fields, or may be organized to center around a special theme that becomes a laboratory unit. A possible loss of relationship between industrial arts and other subject matter areas exist with the central laboratory method.[31]

Once the type of program is selected the content or organization of that program should be considered. The elementary program in industrial arts differs from the

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[31]Scobey, Teaching Children About Technology, p. 7.

general secondary industrial arts program in that it is not limited to any certain material, although the activity generally produces a constructed object. Generally the laboratory method is centered around the world of work, rather than a single trade.[32]

Hackett recommends that the "industrial element" in the elementary school program should develop the following concepts:

1. Man is a tool-making, tool-using animal
2. Man has civilized himself through technology
3. We live in an industrial-technological culture
4. Technology improves man's standard of living
5. Technology produces change
6. Man works to be happy, useful, and successful
7. All work has dignity[33]

The term "industrial element" as used by Hackett should be understood to include such areas of work as:

1. Agriculture
2. Mining
3. Construction

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[32]Miller and Boyd, Teaching Elementary Industrial Arts, p. 7.

[33]Donald F. Hackett, "Introducing Elementary Children to Industrial Processes," Developing Human Potential Through Industrial Arts, Addresses and Proceedings of the 27th Annual Convention of The American Industrial Arts Association, Tulsa, Oklahoma, 1965, pp. 228-32.

4. Transportation
5. Communications
6. Trade
7. Service trades
8. Manufacturing industries

Simply the areas of "work" through which man earns a living.[34]

William E. Warner suggested a slightly different classification that includes:

1. Construction
2. Manufacturing
3. Power
4. Transportation
5. Communication
6. Personal Management[35]

Harold G. Gilbert divides industry into five groups for the elementary grades:

1. Manufacturing
2. Construction
3. Communications
4. Transportation
5. Power[36]

All too often the elementary child is introduced to only a few of the occupations of the world. Generally the child becomes acquainted with the policeman, fireman, and

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[34]Hackett, "Industrial Element For The Elementary School."

[35]Scobey, _Teaching Children About Technology_, p. 4.

[36]_Ibid_.

doctor, however, he is seldom made aware of the life of the bridge builder who constructed the Golden Gate Bridge, or the carpenter who built the house in which he lives. Through the programs outlined by Hackett, Warner, and Gilbert he is aided in the awareness of the world of work.

Although a specialist is often used to teach elementary industrial arts in the laboratory method, the classroom teacher can utilize construction activities to aid in the development of interest, and motivation of the area being taught. The unit plan is an ideal method of transition from the abstract to reality.

Donald Hackett has developed the illustration of a grade school teacher who would like to integrate the various subjects taught with a unit on communications. The first step would be to identify the understanding, values, skills, and attitudes to be developed in the class. Very briefly this plan might look like this:

Understanding - The pupil understands

1. how radio and television programs are broadcast
2. how newspapers are published
3. how the telephone and telegraph function
4. how designers communicate with builders
5. how sound travels
6. the impact of communications on economic and social progress
7. the interdependence of workers
8. the relationship between communications and other industries

9. social and economic problems created by technology in communications

Values - The pupil will
1. appreciate the people who provide communications
2. appreciate the technological developments in communications
3. believe in the democratic process as a way of life as a technique for solving a problem.

Skills and Attitudes - The pupil will
1. Work effectively with committees in solving problems
2. use resource materials and persons to aid in problem solving
3. communicate the results of his research in an effective manner
4. use democratic processes[37]

W. R. Miller and Gardner Boyd have compiled a list of eight points which they feel are essential to the unit plan:

1. A descriptive title that is capable of conveying the purpose of the unit to the children. The title should be stated in such a manner as to arouse interest and imagination as well.
2. The background of the group should be considered when planning activities. Learning is more effective when previous skill and knowledge can be drawn upon, but the student motivation is higher when a connection can be made between the subject and the students background.
3. Objectives or purposes should be prepared for the guidance of the activity. The statements not only guide the selection

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[37]Hackett, "Industrial Element For The Elementary School."

of activities, but also act as criteria of evaluation.

4. The introduction of a unit is extremely important. Success in the introduction of the unit is measured by the degree to which the children perceive the unit of work as important and their willingness to participate in the planning and in the execution of those plans.
5. The content and resource materials developed by the teacher provide that individual with an outline of the content to be covered. In addition it shows the competencies to be developed, the aids to be used, references, and other material the teacher will draw upon in attempting to relate the topic to the child.
6. Attention prior to teaching the unit should be given to the experiences and activities to be used. Those activities which are vital for the child to experience should be planned well in advance.
7. Special attention must be given to the experiences and activities selected in order to draw together the various parts of the unit for the summarization or culmination.
8. The evaluation of the effectiveness of the unit must be considered prior to the starting of the work. The evaluation should be a continuous process. Through such a continuing method weakness can be detected and corrective measures taken. It is possible that through this continual evaluation material can be gathered to enrich the unit.[38]

Planning and organization are the keys to effective integration of industrial arts activities at the elementary level. A number of factors determine the success of

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[38]Miller and Boyd, Teaching Elementary Industrial Arts, pp. 27-28.

such an attempt. Time spent in preparation will pay dividends in the efficiency of the program and in the interest and motivation of the students. A guide for such planning as exemplified below will add much to the success of the activity.

1. Clarify the purpose of the activity
2. Plan the activity-essentials
   (1) The teacher may have the procedure well in mind
   (2) Materials and tools will be on hand
   (3) Efficient room arrangement can be decided upon
   (4) Groups and individuals can be tentatively scheduled for certain parts of the activity
3. Establish standards for group work
   Plans for:
   (1) Distribution of tools
   (2) Material storage
   (3) Preparing the construction area
   (4) Clean up
4. Allow sufficient time
5. Provide for daily evaluation.[39]

The areas in which the teacher can utilize construction activities are only as limited as the individuals' imagination. The New York Public School System has developed teaching guides for construction activities in many fields relating to the elementary curriculum. Among these areas are puppets, modeling clay, posters, cloth and

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[39]*Ibid.*, pp. 29-31.

trimmings, paper construction, and wood construction.[40] Through these areas of construction the teacher is able to motivate, and develop interest through the lively imagination of the student. Through these activities the child can be transported from the world of abstract into the world needed for the lesson taught. Industrial arts can not insure that learning takes place, however it can make learning much more likely. Most children,

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[40]Art Teaching Guides: Puppets and Puppetry, Grades 2-6, Curriculum Bulletin No. 8L, 1968-69 Series, 1969, EDRS 034795, M.F. $0.25, H.C. Not Available from EDRS.
See also
Art Teaching Guides: Modeling With Clay, Kindergarten-Grade 6, Curriculum Bulletin, No. 7C, 1968-69 Series, 1969, EDRS 034793, M.F. $0.25, H.C. Not Available from EDRS.
See also
Art Teaching Guides: Making Posters, Grades 2-6, Curriculum Bulletin, No. 8A, 1968-69 Series, 1969, EDRS 034790, M.F. $0.25, H.C. Not Available from EDRS.
See also
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whether a gifted or a less than gifted child, whether handicapped or not handicapped can be provided with an experience that is satisfying and rewarding for him through elementary industrial arts. For most children, a tangible project brings a sense of achievement through which self-confidence is generally obtained and through which more healthful personality is developed.

The natural desire in children to make things can be used to stimulate efforts in other areas which may not seem so interesting. Listed below are a few suggestions through industrial arts construction activities can lend interest to other subject matter areas.

Science

1. Panorama - showing relationship between the sun, earth and moon.
2. A bird house or feeding station
3. Weather instruments
   Windvane
   Annemometer
   Rain gauge
4. Simple machines
   lever
   wheel and axle
   inclined plane
   wedge
   pulley
   screw
5. Electromagnetic crane
6. Diorama showing different kinds of clouds.

Social Studies

1. Transportation
2. T.V. and radio (field trips)
3. Models of frontier facts
4. Models of homes in other lands
5. Card board frames of post offices
6. Card board frames of grocery stores
7. Card board forms of banks

Art

1. Puppets
2. Simple stages
3. 3-D pictures
4. Clay using various methods of construction
   pinch
   coil
   slab
5. Mobiles
6. Wooden shapes

Mathematics

1. Large size dominoes to help the child learn numbers in groups
2. Large clock face with movable hands
3. Abacus
4. Construction of bean bag toss makes adding much more fun
5. Design and use play money
6. Record daily temperatures
7. Make height measuring devices
8. Make devices to show squares, circle, triangle, rectangle, and cubes.
9. Make scale drawings of homes and models

Language Arts

1. Movies or television box makes story telling much more interesting
2. A child size shadow frame for pantomine
3. Construct reading chart stand
4. Construct felt boards or flannel boards
5. Make book holders

6. Make lettered blocks
7. Bind books
8. Make book rest
9. Make book markers
10. Make scenery and props for play
11. Compile school newspaper.[41]

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[41]Robert R. Bailey, Integrating Industrial Arts and the Elementary School Curriculum, The Reason and Method of Elementary Industrial Arts, EDRS 017611, M.F. $0.25, H.C. $1.68.

CHAPTER III

EXPERIMENTAL METHODS AND PROCEDURES

In order to conduct an experiment in educational research steps must be taken to insure validity and control. This validity and control must be of the highest quality obtainable in order to insure true and unbiased results.

Environmental Setting

The research experiment was conducted in Sapulpa Junior High, Sapulpa, Oklahoma. This location was necessary because the industrial arts coordinator taught in the school, and could better aid the classroom teacher in the experiment.

Permission to conduct the study was requested of and received from Dr. John Martin, Superintendent of Schools, and Mr. Charles Dodson, Principal of Sapulpa Junior High School.

In this study, five seventh grade science classes were tested. A total of 103 students were involved in the experiment. The mean intelligence quotient of the students in the experimental and control groups was 98.48 with a range of 64, and a mode of 94. The mean intelligence quotient per individual was measured by the _Stanford Binet_ or the _Slosson Intelligence Test_ which have a high correlation.[1] In the Sapulpa School System the intelligent quotient is measured in the first grade, third, fifth and the seventh grade. The study was conducted prior to the testing of seventh grade students, therefore a mean of the first three scores was used to determine the intelligent quotient of the student having attended the Sapulpa schools throughout the first seven years. For those students transferring into the Sapulpa system either a mean of scores available was used or the Slosson Intelligence Test was administered in a special setting. The t scores of Group A, B, C, D and E are shown in Appendix I and M.

The teacher asked to participate had little industrial arts experience prior to the experiment. Orientation of methods and applications was conducted before the presentation of each unit.

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[1]Robert L. Thorndike and Elizabeth Hagen, _Measurement and Evaluation In Psychology and Education_, (New York: New York, John Wiley and Sons, Inc., 1969), p. 298.

The experimenter served in the position of Industrial Arts Consultant. It was the task of this individual to develop the course of study used in both the unit of simple machines and the unit of electricity. The course of study was directly related to the textbook at this grade level. The purpose was to develop a common relationship between the control and experimental groups. The textbook used by the Sapulpa School System at the seventh grade level was Principles of Science, by Heimler and Neal.[2] The experimenter did not instruct either the experimental nor the control group.

In an effort to develop true and unbiased results from the experiment a revolvement of the control group was followed. This practice resulted in Groups A, B and C serving as the control group for the unit of simple machines and Groups D and E serving as the experimental groups. For the unit of electricity Groups A, B and C became the experimental group, while Groups D and E served as the control group. It was believed that this rotation technique would help eliminate some of the

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[2]Charles H. Heimler and Charles D. Neal, Principles of Science, (Columbus: Ohio, Charles E. Merrill Publishing Company, 1966), pp. 129-275.

independent variables, which are difficult to remove from educational research.

Prior to the development of the course of study a thorough investigation was conducted of the two selected units in the textbook. Construction activities or "job sheets" were prepared in a manner which would attempt to develop interest through manipulative activities as related to the textbook. The procedures followed in this task were outlined in Dr. Fryklund's book, Analysis Technique For Instructors.[3]

A number of factors were considered in the selection of industrial arts related activities. These factors are essential to the successful integration of a subject matter field with manipulative activities in a classroom designed for lecture instruction.

1. The correlation of the industrial arts activities and the subject matter of the unit presented. Unless the construction activities employed can increase the student's understanding

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[3]Verne C. Fryklund, Analysis Techniques For Instructors, (Milwaukee: Wisconsin, The Bruce Publishing Company, 1965), pp. 70-121.

of that field of study through a working example or through creating interest in that field.

2. The physical environment of the classroom in which the industrial arts activities would be conducted. The time required in completion of the construction activity must be considered. Either the task should be completed within that working period, or storage facilities should be provided. The typical classroom is equipped with relatively small working desk which are not easily adaptable to larger projects.

3. The quantity of tools and materials required in excess of those available in a classroom designed for traditional methods of instruction.

One of the major purposes of industrial arts activities at the elementary level is that enrichment of a formal subject matter. Therefore, the project would not necessarily need to be a finished object, but rather could be reduced to the simplest level to require only a minimum of tools, space and time in its completion.

For the purpose of this study it was not the intent to have the student merely make a project. Therefore, material was pre-cut to be assembled by the student.

Test of the Hypothesis

In this study the hypothesis was tested by a pre-test and post-test which was administered to the experimental and control group. For the purpose of this experiment teacher constructed tests were selected in order to obtain a higher degree of correlation between the pre-test, post-test and the units of study. The administration of the pre-test was conducted several days prior to the presentation of the course of study for either machines or electricity.

The constructed test for electricity and simple machines consisted of multiple choice items as described in Thorndike and Hagen's work, _Measurement and Evaluation In Psychology and Education_.[4] The length of the simple machine test was sixty-nine items, while that of the electricity test was sixty-one items. The decision to use the split-half reliability procedure was based on

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[4]Thorndike and Hagen, _Op. Cit._, pp. 102-116.

several factors among which were:

1. Age level of the student being tested. The younger the child the less developed will be his skills of reading and writing.
2. The time factor was very important in this study. It was not a timed test but the environmental setting of the school system allowed a maximum of fifty-five minutes per class period. Therefore, allowance must be made for such daily teacher responsibilities as calling roll, announcements, passing out test booklets, and other time consuming tasks. The remaining time was then devoted to the test.

Split-half reliability has been described by Thorndike and Hagen as:

> Reliability estimated by dividing a test into two half-length tests, scoring these and getting the correlation between them, and then estimating correlation for full-length test......[5]

The split-half test arrangement for the unit of simple machines yielded a pre-test of thirty-five items

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[5] *Ibid*., p. 653.

as compared to a post-test of thirty-four items. The selection of the items for either the pre-test or post-test was through alternating the items per test. Even consecutive numbers were used to compose the pre-test while odd consecutive numbers were used for the post-test.

The reliability coefficients for the two units were established by classes. Each class was given idential pre-test and post-test. The only difference was in the methods of classroom presentation. Therefore, three coefficients were established for the control group and two for the experimental group in the unit of simple machines. In the unit of electricity two coefficients were established for control group and three for the experimental group. The coefficient and values used in computing them are presented in Table I. The data used in determining these values is shown in Appendix H and L, pages 345 and 378.

Student Questionnaire

The questionnaire was developed by the experimenter to summarize the attitude of seventh grade students toward construction activities. The classroom teacher was instructed to distribute the questionnaires to all students involved in the experiment. Each student was given preliminary instructions regarding the questionnaire among which were:

1. In order to obtain a more honest response of the student regarding the method of instruction it was asked that names be omitted from the questionnaire.
2. To prevent misunderstanding the classroom teacher read and explained the meaning of the questionnaire.

Both closed and open end questions were used. It was hoped that the student would respond honestly and frankly to the open end questions. However, in order to obtain direct information pertinent to the study, two closed end questions and two open end questions were used. A copy of the student questionnaire and a summary of statements made by students are presented in Chapter V.

Student Questionnaire

1. Which did you enjoy more, the lecture or the building and using of the projects related to the subjects?

   Lecture method ( )

   Use of objects ( )

2. In which course of study do you feel you learned more, the lecture method or the use of the objects related to the subject?

   Lecture method ( )

   Use of objects ( )

3. Do you feel that construction activities would help you develop a better understanding of material in areas of science other than electricity and simple machines? Why?

4. Do you feel that construction activities would help you develop a better understanding of material in subject matter areas other than science? Why?

Test Reliability

When comparing methods of educational instruction it is often necessary to make decisions based on the results of one or more tests. The statement can be made with a greater amount of accuracy if the test is reliable. In order to determine the reliability of the two unit test the Spearman-Brown Prophecy Formulas were used.[6] In order to compute the correlation coefficient between the two half test, the calculation was determined by the Pearson product-moment formula.[7]

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[6] *Ibid.*, p. 183.

[7] *Ibid.*, p. 660.

TABLE I

SUMMARY OF DATA COMPILED SHOWING RELIABILITY COEFFICIENTS AND THE CORRELATION COEFFICIENT OF THE TWO UNITS TESTED IN THE STUDY

SIMPLE MACHINES

ELECTRICITY

Groups Tested	Number of Students Tested	Items Pre-Test	Items Post	r11	r
Simple Machines					
Control A	19	35	34	0.43	0.27
Control B	20	35	34	0.58	0.41
Control C	20	35	34	0.24	0.14
Simple Machines					
Experimental D	23	35	34	0.21	.12
Experimental E	21	35	34	0.33	0.20
Electricity					
Experimental A	19	31	30	.54	.37
Experimental B	19	31	30	.23	.13
Experimental C	19	31	30	.06	.29
Electricity					
Control D	19	31	30	.11	.06
Control E	19	31	30	.40	.25

CHAPTER IV

INTERPRETATION OF DATA

Throughout the course of this study the major question asked was, can construction activities related to industrial arts aid the classroom teacher in the elementary grades significantly? It was hoped that a study of the traditional method of instruction as compared to the industrial arts activities would result in a greater understanding of material taught through construction activities. To measure the differences from the pre-test in this experiment teacher constructed tests were used. Following the completion of both units of study to all students a questionnaire was completed and the data summarized.

Analysis of Data Developed Following the Pre-Test of the Unit of Simple Machines

The control group for the study of simple machines was composed of Classes A, B and C, while Classes D and E served as the experimental group. The class size of each group was comparatively equal with Class A being the smallest and Class D being the largest. The mental level of the five groups was also homogeneously equal with Class A having the highest mean intelligent quotion and Class E having the lowest mean intelligent quotion. The number of students per class as well as the mean I.Q. of each class is shown in Table II. A summary of I.Q. scores by classes and for each student is shown in Appendix E.

The pre-test consisted of thirty-five items of which the highest score was eighteen with a frequency of three. The lowest score was five with a frequency of three. A summary of the pre-test scores as shown by classes and per student is shown in Appendix F and J.

The mean deviation was determined for all five groups in which Class A scored the highest with a mean of 13.16 while Class C scored the lowest with a mean of 10.75. Means for all five classes are presented in Table III.

The standard deviation was plotted for all classes.

Analysis of Data Developed Following Post-Test of the Unit of Simple Machines

The post-test consisted of thirty-four items of which the highest score made was thirty-three as compared to a score of eleven as the lowest. Only one person obtained a score of thirty-three while the score of eleven had a frequency of two. A summary of the post-test scores as shown by classes and per student is found in Appendix F and J.

The mean deviation was determined for all five groups in which Class A had the highest mean of 22.05 as compared to Class C with a mean of 19.20. A summary of the mean of all five groups is shown in Table II.

The standard deviation was plotted for all five classes through the same procedure as outlined in the pre-test analysis. A summary of the standard deviation for the post-test is shown in Table II.

TABLE II

The number of students, mean intelligent quotion, the pre-test mean, and the standard deviation of Classes A, B, C, D and E.

Simple Machines

	Number of Students	Mean I.Q.	Mean Pre-Test	Standard Deviation
Class A	19	102.11	13.16	3.47
Class B	20	95.32	11.65	4.26
Class C	20	100.55	10.75	4.33
Class D	23	100.17	12.08	3.95
Class E	21	92.60	11.53	4.45

Comparative Analysis of Data Developed Following the Pre-Test Post-Test of the Unit of Simple Machines

In order to determine the relative standing of a student from the pre-test to the post-test the standardized score was computed. The formula used for the standardized score was:

$$Z = \frac{X - \bar{X}}{S}$$

Z = standardized score

X = score of the student

$\bar{X}$ = mean score

S = standard deviation

The movement of the students when charting the standardized score of the pre-test as compared to the standardized score of the post-test indicated that nine of Class A obtained a higher standardized score in the post-test than in the pre-test. This can be compared to Class B which had eleven students gain in the post-test. Class C had eleven students obtain higher post-test than pre-test scores. Thus, the control group of fifty-nine students had thirty develop a score higher than each scored in the pre-test.

The experimental group composed of Classes D and E had a student improvement rate of eight and ten respectfully or a total of eighteen students as compared to forty-four students, at the .001 level.

A comparison of standardized scores of each student as compared to the pre-test - post-test is shown in Appendix G and K.

The difference between the pre-test and the post-test was computed and plotted on a bar graph. Class B had the greatest amount of difference between the pre-test score and the post-test score, followed by Class A, D, E and C.

To determine the significance of the post-test scores of simple machines Gosset's Student's t distribution was used as described by Spiegel.

$\bar{X}_1$ = mean score of the control group

$\bar{X}_2$ = mean score of the experimental group

N_1 = number of students in control group

N_2 = number of students in experimental group

$\bar{O}$ =

The computation of the level of significance as shown in the comparison of the control group post-test means as compared to the experimental post-test means is shown in Appendix G and K. The computation of significance shown when comparing the two post-test means of the unit of simple machines revealed that the level was insignificant.

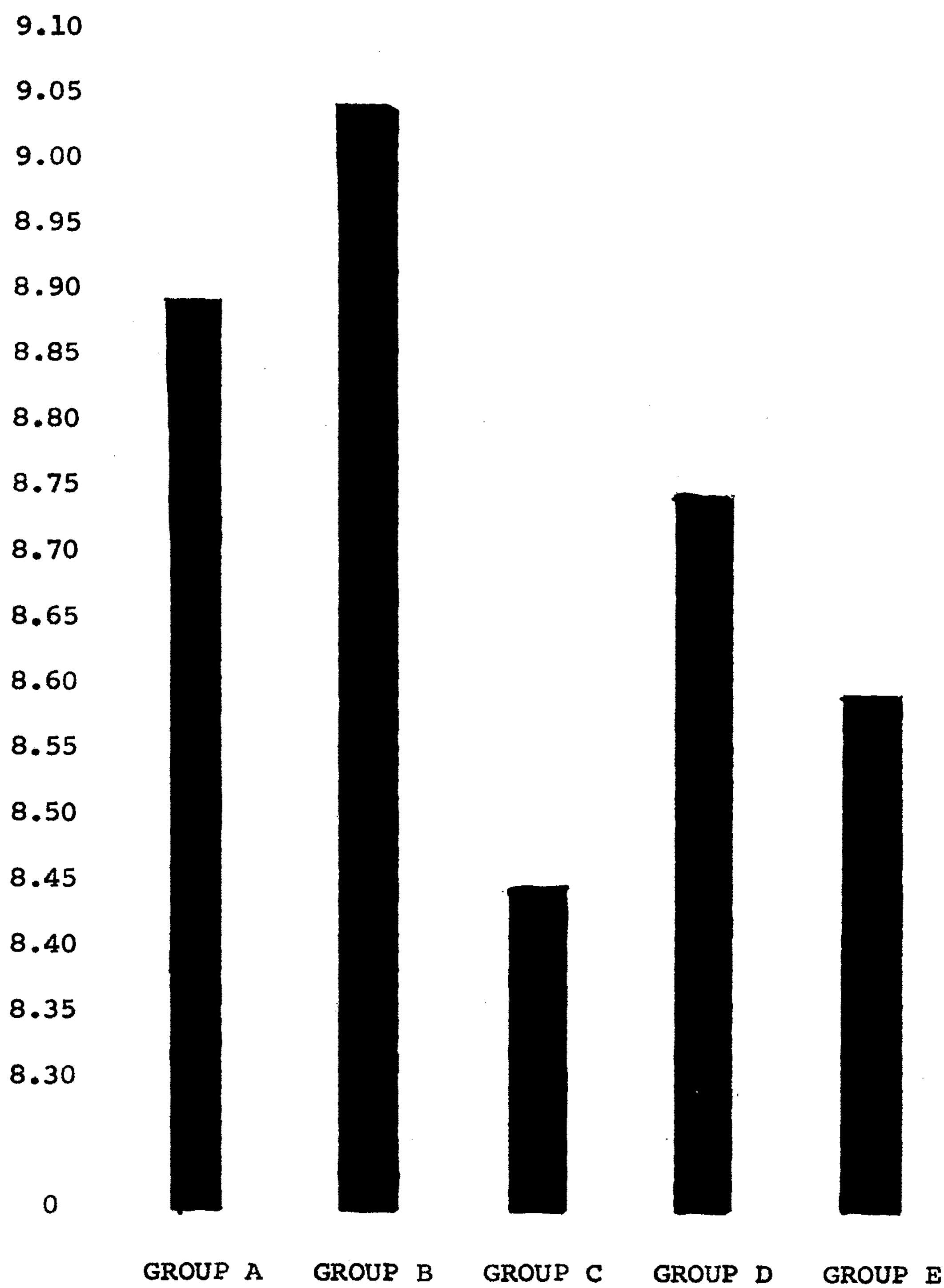

Figure 1. Comparison of Student Achievement as Shown in the Computation of the Difference Between the Pre-Test and Post-Test of Simple Machines of Classes A, B, C, D and E.

Analysis of Data Developed Following the Pre-Test of the Unit of Electricity

The experimental group for the study of electricity was composed of Classes A, B and C, while Classes D and E served as the experimental group. The size of each group remained the same as that shown in the unit of simple machines.

The pre-test consisted of thirty-one items of which the highest score was twenty-one with a frequency of one. The lowest score was five with a frequency of one. A summary of the pre-test scores as shown by classes and for each student is shown in Appendix J.

The mean deviation was determined for all five groups in which Class D scored the highest with a mean of 13.21 while Class E scored the lowest with a mean of 11.23. Means for all five classes are presented in Table III.

The post-test consisted of thirty items of which the highest score made was twenty-eight with a frequency of one as compared to a score of five which had a frequency of one. A summary of the post-test scores shown by classes and per student is found in Appendix J.

Analysis of Data Developed Following Post-Test

of the Unit of Electricity

TABLE III

The number of students, the pre-test mean and the standard deviation of Class A, B, C, D and E.

Electricity

	Number of Students	Mean Pre-Test	Standard Deviation
Class A	19	12.57	3.49
Class B	20	11.65	2.85
Class C	20	12.25	3.86
Class D	23	13.21	3.60
Class E	21	11.23	3.30

The mean deviation was determined for all five groups of which Class A had the highest mean of 20.40 as compared to Class E with a mean of 17.47. A summary of the mean of all five groups is shown in Table III.

The standard deviation was plotted for all five classes through the same procedure as outlined in the pre-test analysis. A summary of the standard deviation for the post-test is shown in Appendix K.

Comparative Analysis of Data Developed Following the Pre-Test Post-Test of the Unit of Electricity

In order to determine the relative standing of a student from the pre-test to the post-test the standardized score was computed. The process followed in the computation of the standardized score of the unit of simple machines was used to compute the standardized score of the unit of electricity.

The movement of the students when charging the standardized score of the pre-test as compared to the standardized score of the post-test indicated that twelve of Class A obtained a higher standardized score in the post-test than in the pre-test. This can be compared to Class B which had ten students gain in the post-test. Class C had nine students obtain higher scores in the post-test than in the pre-test. The experimental group which had a total of fifty-nine students had thirty-one improve his Z score more than .001 on this post-test as compared to the Z score of the pre-test.

The control group was composed of Classes D and E and had a student improvement rate of twelve and nine respectfully or a total of twenty-one students of the forty-four students in the combined groups, as the .001 level.

A comparison of the standardized scores of each student as compared to the pre-test, post-test as shown in Appendix K.

The difference between the pre-test mean and the post-test mean was computed and plotted on a bar graph as shown in Figure 2. Class A had the greatest amount of difference between the pre-test score and the post-test score, followed by Classes B, C, E and D.

To determine the significance of the scores of the electrical post-test, Gosset's Student's t distribution was used as described in the analysis of simple machines post-test.

The computation of the level of significance as shown in the comparison of the control group post-test means as compared to the experimental post-test means is shown in Appendix M. The level of significance shown when comparing the two post-test means was .29. Therefore, it would be significant at the .01 level.

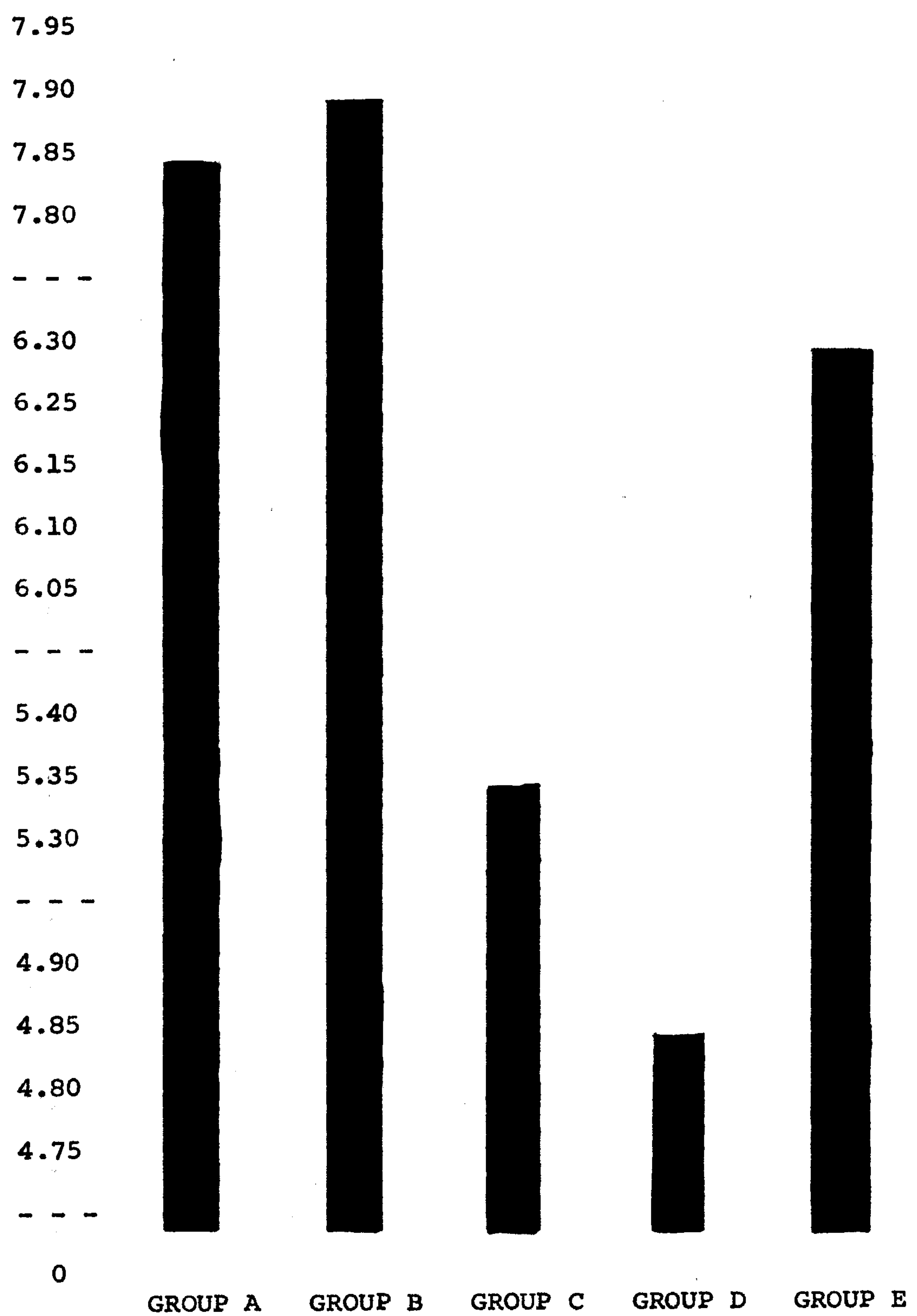

Figure 2. Comparison of Student Achievement as Shown in the Computation of the Difference Between the Pre-Test and Post-Test of Electricity of Classes A, B, C, D and E.

Summarization of Student Questionnaire

Following the instructional units of both simple machines and electricity, a survey sheet was completed by the students to gain an indication of how they felt the manipulative activities either benefited or hindered their ability to comprehend the subject matter presented. In addition to questions relating directly to the two units taught the students were also asked if they felt construction activities would help them to understand other areas in science and if those activities would aid in the development of a better understanding of material in subject matter other than science.

The results of the survey were as follows:

Question 1.	97	Yes	6	No
Question 2.	96	Yes	7	No
Question 3.	102	Yes	1	No
Question 4.	92	Yes	11	No

Listed below are a few of the statements made by the students regarding the use of either the traditional method of instruction or the industrial arts activities.

"I didn't like either, I thought it was boring, but the building of things could be more fun."

"I liked the experiments because I learned it faster and could understand it."

"I liked the one that we got to work and see experiments. The other one I didn't."

"In both chapters the material was interesting but the one on machines was more interesting because of the experiments."

"The unit on machines was best because of the experiments. They helped me learn the names of the parts and all about how they work."

"I liked machines because we made machines."

"I liked having the experiments."

"I liked the activities because I did improve my grade and it is more interesting."

"I did not become bored with the experiments like I do with talking."

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study was conducted to determine the effect of industrial arts activities upon the elementary science program. Throughout the study two primary areas of study were investigated. The two areas were simple machines and electricity. The methods of teaching the science program were composed of a traditional method and an experimental method. The traditional method was composed of lecture, discussion, reading, recitation and other non-laboratory activities. While the experimental method consisted of manipulative activities.

Individual unit tests were administered prior to teaching the unit and again after the units were completed. The mean score gain was used to indicate the effectiveness of the programs. Following the completion of the units taught a student questionnaire was completed to gain the attitude of the student in relationship to the units taught and the methods used.

The population of this experiment was 103 students at the seventh grade level, in the Sapulpa School System, Sapulpa, Oklahoma. The classroom teacher assigned to the seventh grade science class taught the two units to all five class groups. The experimenter served in the capacity of coordinator. It was the task of this individual to develop lesson plans and to develop related industrial arts activities which could be integrated with the science units.

The selection of the groups to serve as either a control group or experimental group was determined by the environmental setting of the school. In the first unit the Classes D and E served as the experimental group, while Classes A, B and C served as the control groups. In the unit of instruction on electricity the classes were rotated in order for the Classes A, B and C to serve as the experimental groups, and Classes D and E to serve as the control groups.

Conclusions

From the data assembled in this study the following conclusions are presented:

1. All groups made achievement gains as a result of either the experimental or

traditional methods of instruction.

2. The experimental group for the unit of instruction in electricity made significant gains in achievement at the .05 level.

3. The level of significance shown when comparing the two post-test means of the unit of simple machines was .0001. Therefore, no significant difference in student gain was ascertained between the groups in simple machines as a result of the construction activities.

4. The level of significance shown when comparing the two post-test means of the unit of electricity was .29. Therefore, a significant difference in student gain was ascertained between the groups at the .01 level of significance as a result of construction activities.

Recommendations

The relationship between industrial arts activities and the curriculum of the elementary school system offers vast possibilities that should be studied in depth in the future. If a child enjoys what he is studying he is more likely to learn, thus industrial arts activities cannot always teach the unit but can be of immeasurable help as a motivating technique.

On the basis of the findings of this research the following recommendations are made:

1. This study should be repeated using different units of study in the elementary curriculum.
2. Standardized measuring instruments should be developed to more accurately measure the intergradation of industrial arts activities and the relationship to the subject being studied.
3. It is recommended that further study be conducted in the field of elementary industrial arts.

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APPENDIX A

LABORATORY MANUAL FOR THE UNIT OF SIMPLE MACHINES COMPOSED OF ASSIGNMENT SHEETS AND JOB SHEETS

BLOCK I:

JOB I: **Construction of Simple Machines**

Lever

Pulley

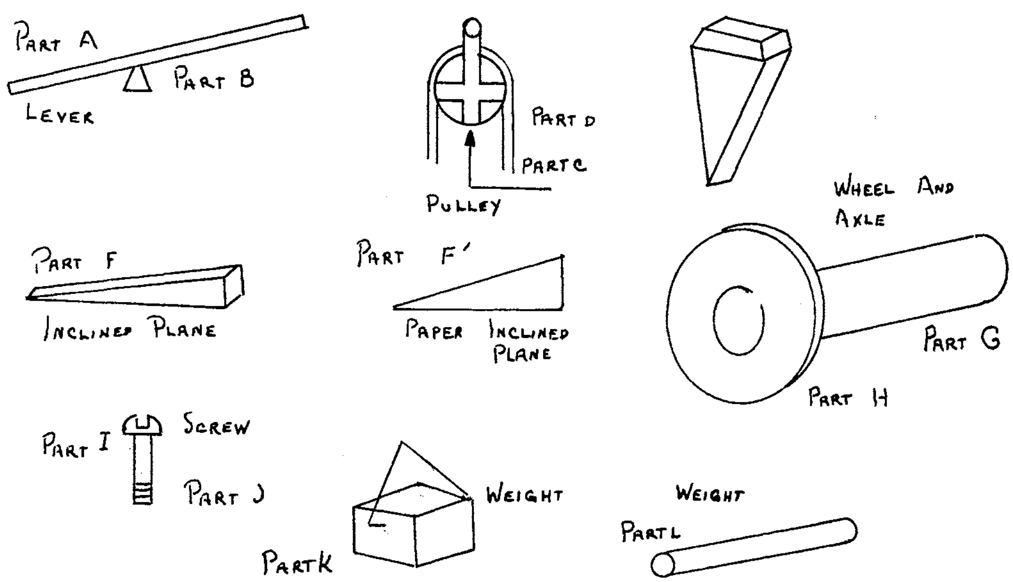
Wedge

Inclined Plane

Wheel and Axle

Screw

OBJECTIVE: Reinforcement of Identification of Simple Machines, Gained Through Construction and Manipulation of Stock.



GENERAL INSTRUCTIONS:

This job will consist of a series of exercises in which you will construct examples of various kinds of simple machines.

PROCEDURE:

Construction of a Lever

Step 1: Select "Part A", "Part B", and "Part K" from your box of supplies.

Step 2: Locate the center of the bar (Part A).

Step 3: Place the center of the bar on the fulcrum (Part B).

Step 4: Place the resistance force (Part K) on the end of the lever.

Step 5: Your hand now becomes the effort force which is placed at the opposite end of the resistance force. As you press down on the lever the weight will move.

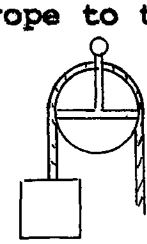
Construction of a Pulley

Step 1: Select "Part C", "Part D", and "Part K" from your box of supplies.

Step 2: Secure the wheel (Part C) to a frame provided by your instructor.

Step 3: Over the top of the wheel place the rope (Part D).

Step 4: Attach the rope to the resistance force (Part K).



Step 5: Your hand now becomes the effort force, exert pressure on the opposite side of the resistance force to operate the machine. This pulley will not multiply the effort force, rather it will change the direction of the machine.

Use of the Inclined Plane

Step 1: Select the inclined plane (Part F) and the weight (Part L) from your box of supplies.

Step 2: Place the resistance force (Part L) at narrowest point of your inclined plane.

Step 3: Your hand now becomes the effort force as you move the resistance force up the inclined plane. The result is that less effort is required to move a weight than would be needed to lift the same amount of weight.

Construction of Wheel and Axle

Step 1: Select "Part G" and "Part H" from your box of supplies.

Step 2: Place the axle (Part G) into the opening of the wheel (Part H).

Step 3: Turn the axle in your hand and notice the direction of rotation of the wheel. The advantage of this machine is that the distance of rotation of the axle is multiplied in the distance of rotation in the wheel.

Construction of the Screw

Step 1: Select "Part F" and "Part L" from your box of supplies.

Step 2: Place the tallest part of the inclined plane (Part F) beside the rod (Part L) and twist the rod in a clockwise direction.

Step 3: Continue winding the paper inclined plane until it has formed a spiral around the rod. You have now formed a screw because in reality a screw is only a circular inclined plane.

ASSIGNMENT SHEET I:

BLOCK I: Simple Machines

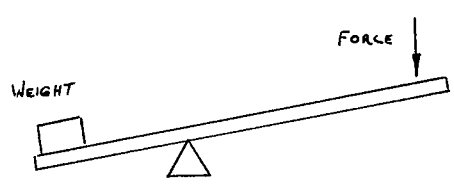
SUBJECT: Identification of Simple Machines and Their Functions

OBJECTIVE: To Identify Simple Machines Both In Their Natural State and As Parts of Complex Machines.

REFERENCES: Charles H. Heimler and Charles D. Neal, <u>Principles of Science</u>, (Columbus, Ohio, 1966), pp. 128-144.

MULTIPLE CHOICE PART I:

1. Pictured below is a simple machine. Select the correct name of that machine from the choices given.



A. Lever

B. Pulley

C. Inclined Plane

D. Wedge

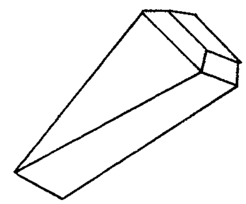
2. Pictured below is a simple machine. Select the correct name of that machine from the choices given.

A. Lever

B. Pulley

C. Inclined Plane

D. Wedge



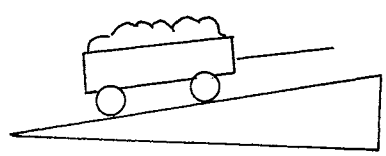
3. Pictured below is a simple machine. Select the correct name of that machine from the choices given.

A. Lever

B. Pulley

C. Inclined Plane

D. Wedge



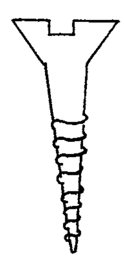
4. Pictured below is a simple machine. Select the correct name of that machine from the choices given.

A. Lever

B. Pulley

C. Inclined Plane

D. Wedge



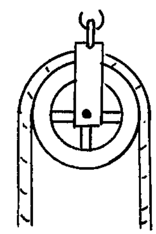
5. Pictured below is a simple machine. Select the correct name of that machine from the choices given.

A. Wheel and Axle

B. Pulley

C. Screw

D. Lever



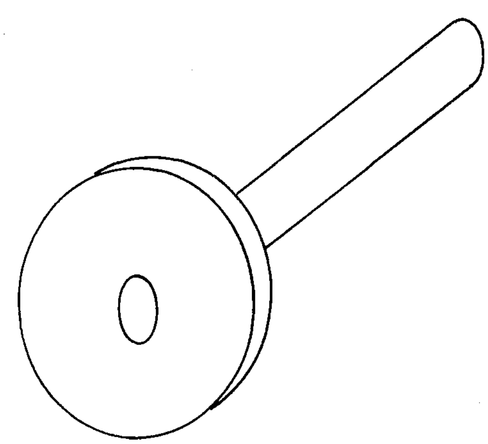
6. Pictured below is a simple machine. Select the correct name of that machine from the choices given.

A. Wheel and Axle

B. Pulley

C. Screw

D. Lever



MATCHING PART I:

Study the hand drill shown at the right. This is composed of a number of simple machines. Match the letter with the name of the machine. You may wish to use one answer more than once.

1._____ A. Lever

2._____ B. Wheel

3._____ C. Wedge

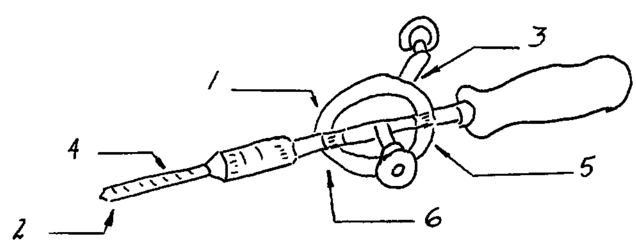
4._____ D. Inclined Plane

5._____ E. Pulley

6._____ F. Screw

G. Wheel and Axle

H. Axle



MATCHING PART II:

Study the brace and bit shown at the right. This machine is composed of a number of simple machines. Match the letter with the name of the machine. You may wish to use one answer more than once.

1.____ A. Lever

2.____ B. Wheel

3.____ C. Wedge

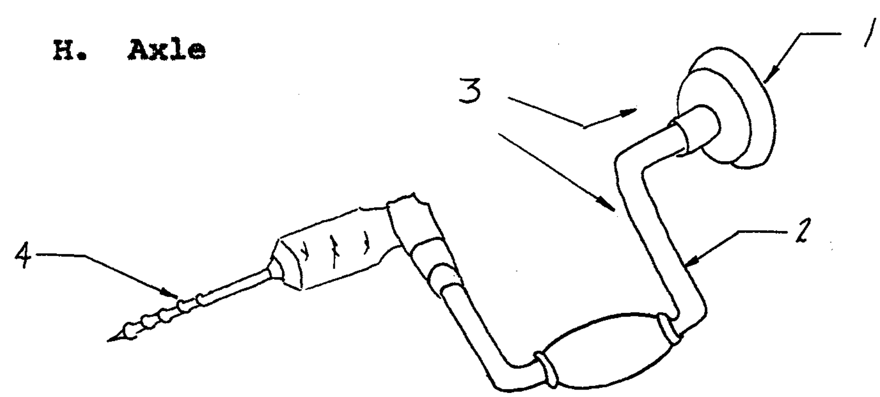
4.____ D. Inclined Plane

E. Pulley

F. Screw

G. Wheel and Axle

H. Axle



ASSIGNMENT SHEET I:

BLOCK I:

MATCHING PART I

1. B
2. C
3. A
4. D or F
5. B
6. G

MATCHING PART II

1. B
2. A
3. G
4. D or F

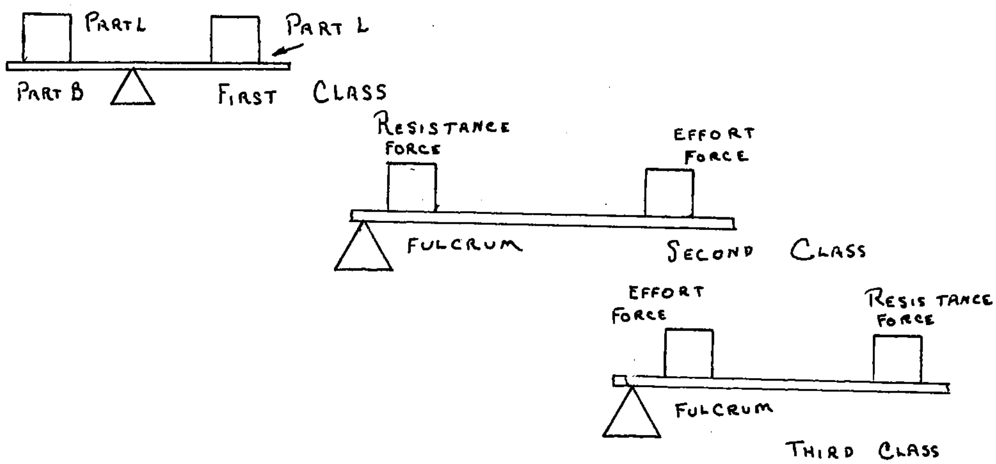
MULTIPLE CHOICE PART I

1. A
2. D
3. C
4. C
5. B
6. A

BLOCK II: Levers

JOB I: Levers, Classification of

OBJECTIVE: To Develop Understanding of Various Kinds of Levers Through the Construction of Simple Machines.



GENERAL INSTRUCTIONS:

This job will consist of the construction of the three classes of levers.

PROCEDURES:

Construction of First Class Lever

Step 1: Select "Part A", "Part B", and "Part L" from your box of supplies.

Step 2: Locate the center of the bar (Part A).

Step 3: Place the center of the bar over the center point of the fulcrum (Part B).

Step 4: The resistance force (Part L) is now located on the resistance arm of the arm.

Step 5: Your hand now becomes the effort force which is placed on the effort arm. When you exert effort with your hand the resistance force will be lifted. You have constructed a first class lever.

Construction of a Second Class Lever

Step 1: Select "Part A", "Part B" and "Part L" from your box of supplies.

Step 2: Place the fulcrum (Part B) near the end of the bar (Part A).

Step 3: Measure approximately 1-1/2 inches from the end of the bar and place the resistance force (Part L).

Step 4: Your hand will become the effort force as you lift on the end of the effort arm. You have now constructed a second class lever.

Construction of a Third Class Lever

Step 1: Select "Part A", "Part B", and "Part L" from your box of supplies.

Step 2: Place the fulcrum near the end of the bar.

Step 3: Place the resistance force at the end of the bar.

Step 4: Your hand becomes the effort force which is placed approximately 1-1/2 inches from the fulcrum. Force is exerted in an upward direction. You have now constructed a third class lever.

BLOCK II:

JOB II: Construction of Levers and Computation of Problems Involving Moment

OBJECTIVE: To Provide Experience in Determining Moment of Levers.

GENERAL INSTRUCTIONS:

This job will have two types of task. The first will be the construction of the lever, while the second will require solving the mathematical problem involved.

PROCEDURE:

Step 1: Construct a first class lever with materials available in your box of supplies.

Step 2: While using your lever as a working example, assume that a force of 100 pounds is exerted upon the effort end at a point 6 feet from the fulcrum.

Determine the moment of this arm.

Step 3: The formula used to determine the moment of a lever arm is as follows:

MOMENT = FORCE X DISTANCE

M = F X D

Step 4: Multiply the force or effort exerted by the distance the weight or force is removed from the fulcrum. In this case the force is 100 pounds and the distance is 6 feet.

MOMENT = FORCE X DISTANCE

M = 100 lb. X 6 Ft.

M = 600 Ft. Lb.

Step 5: Construct a first class lever from materials available in your box of supplies.

Step 6: Assume the effort exerted is 90 pounds on the effort arm, while the distance is five feet. Determine the moment of this arm.

A.______________________ Answer

Step 7: Construct a second class lever with material available in your box of supplies.

Step 8: Assume the resistance force is 50 lbs. and the distance from the fulcrum is three feet. What is the moment of the resistance arm.

B.______________________ Answer

Step 9: Construct a third class lever from material available in your box of supplies.

Step 10: Assume the effort force exerted is 75 lbs. at a distance of four feet from the fulcrum, while the resistance force of 100 lbs. is located eight feet from the fulcrum, determine the moment of both arms.

C.______________________ Answer (Effort Arm)

______________________ Answer (Resistance Arm)

JOB II

BLOCK II

A. 400 Ft. Lbs.

B. 150 Ft. Lbs.

C. 300 Ft. Lbs. (Effort Force)

800 Ft. Lbs. (Resistance Force)

BLOCK II:

JOB III: Construction of Levers and Computation of Problems Involving Ideal Mechanical Advantage.

OBJECTIVE: To Provide Experience in Calculating the Ideal Mechanical Advantage of Levers.

GENERAL INSTRUCTIONS:

This job will consist of two areas of work. The first will include construction of various classes of levers, while the second will consist of problems involving the ideal mechanical advantage.

PROCEDURE:

Step 1: Construct a first class lever with materials available in your box of supplies.

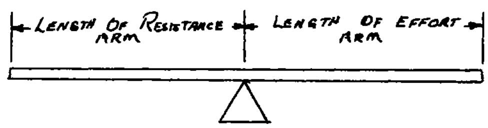
Step 2: While using your lever as a working example, assume the resistance force is placed at a length of 2 feet from the fulcrum and that the effort force is located 4 feet from the fulcrum, what is the ideal mechanical advantage of this lever?

Step 3: The formula used to determine the ideal mechanical advantage of a lever is as follows:

$$\text{MECHANICAL ADVANTAGE} = \frac{\text{EFFORT ARM}}{\text{RESISTANCE ARM}}$$

$$\text{M.E.} = \frac{\text{EA}}{\text{RA}}$$

Divide the length of the resistance arm into the length of the effort arm.



In the case of the previous example the length of the effort arm is 4 feet, while the length of the resistance arm is 2 feet. The process one should follow would be to divide 2 feet into 4 feet to obtain an ideal mechanical advantage of 2.

Step 4: Construct a first class lever from material available in your box of supplies.

Step 5: Assume that the distance from the resistance force to the fulcrum is 24 inches and the distance from the fulcrum to the point at which the effort is exerted is 3 feet. What is the ideal mechanical advantage of this machine?

A.______________________ Answer

Step 6: Construct a second class lever with materials available in your box of supplies.

Step 7: Assume the effort force is placed 6 foot away from the fulcrum and that the resistance force is placed 2 foot away from the fulcrum. Determine the ideal mechanical advantage of this lever.

B.______________________ Answer

Step 8: Construct a third class lever from materials available in your box of supplies.

Step 9: Assume that the distance between the fulcrum and the effort force is 12 feet, while the distance between the fulcrum and the resistance force is 24 feet. What is the mechanical advantage of this machine?

C.______________________ Answer

BLOCK II

JOB III

A. 1.5

B. 3

C. .5

BLOCK II

JOB IV: Construction of Levers and Computation of Problems Involving the Actual Mechanical Advantage of the Machine.

OBJECTIVE: To Provide Experience in the Calculation of the Actual Mechanical Advantage of Levers.

GENERAL INSTRUCTIONS:

This job will consist of two areas of work. The first involves the construction of various classes of levers, while the second is engaged in the determination of the actual mechanical advantage of levers.

PROCEDURE:

Step 1: From the materials available in your box of supplies construct a first class lever.

Step 2: Assume that the resistance force is 300 pounds while the effort force is 50 pounds. What is the actual mechanical advantage of this machine?

Step 3: The following formula will be useful in calculation of the actual mechanical advantage of a lever.

$$\text{ACTUAL MECHANICAL ADVANTAGE} = \frac{\text{RESISTANCE FORCE}}{\text{EFFORT FORCE}}$$

Therefore in the previous example, the effort force of 50 pounds would be divided into the resistance force of 300 pounds to determine an actual mechanical advantage of 6.

Step 4: Construct a first class lever from material available in your box of supplies.

Step 5: Assume that the lever is being used to move an object weighing 250 pounds while an effort force of 75 pounds is needed to move the weight. What is the actual mechanical advantage of this machine?

A.____________________ Answer

Step 6: Construct a second class lever from material available in your box of supplies.

Step 7: Determine the actual mechanical advantage of the following lever:

A man has a load of rocks weighing 100 pounds in a wheel barrow and must exert 50 pounds of pressure to dump the load.

B.____________________ Answer

Step 8: Construct a third class lever from material available in your box of supplies.

Step 9: The effort force is 100 pounds, while the resistance force is 150 pounds, what is the actual mechanical advantage of this lever?

C.____________________ Answer

BLOCK II

JOB IV

A. 3.3

B. 2

C. 1.5

ASSIGNMENT SHEET I

BLOCK II: Levers

OBJECTIVE: To Identify Levers Both as Simple Machines And as Parts of Complex Machines.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 129-135.

MULTIPLE CHOICE PART I:

1. The lever is a bar which rotates around a point known as the:

A. Center Point

B. Fulcrum

C. Axle

D. Force

2. The lever is a bar which consists of two arms, the one is the effort arm while the second is the:

A. Resistance Arm

B. Exertion Arm

C. Pressure Arm

D. Resistor Arm

3. We have three classes of levers in use today, these machines may be classified as:

A. Simple, complex and compound

B. Class A, Class B and Class C

C. Class 1A, Class 2B and Class 3C

D. First Class, Second Class and Third Class

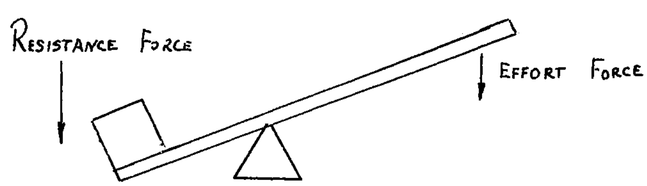
4. The lever pictured below should be described as which of the following classes:

A. Simple

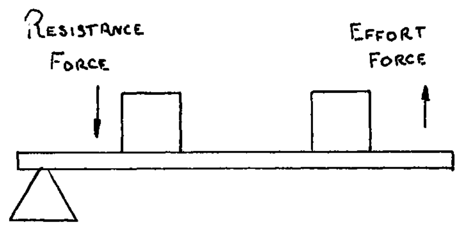
B. Class A

C. Class 1A

D. First Class



5. The lever pictured below should be described as which of the following classes:



A. Complex

B. Class B

C. Class 2B

D. Second Class

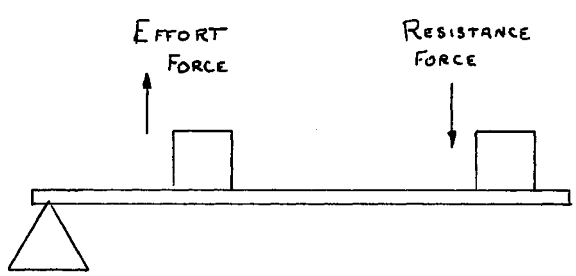
6. The lever pictured below should be described as which of the following classes:

A. Compound Lever

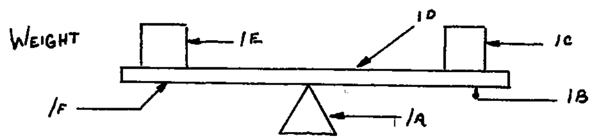
B. Class C Lever

C. Class 3C Lever

D. Third Class Lever



Study the drawing below before attempting to answer the following questions:



7. Which of the following would best describe the figure labeled 1A:

A. Fulcrum

B. Balance Point

C. Swivel

D. Counter Point

8. The resistance arm is indicated by which of the following designations:

A. 1B

B. 1C

C. 1E

D. 1F

9. The lever bar is best described as which of the following symbols:

A. 1A

B. 1C

C. 1D

D. 1E

10. The symbol which represents the effort force is which of the following:

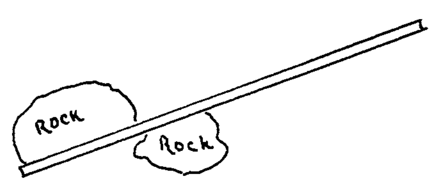
A. 1B

B. 1C

C. 1E

D. 1F

11. Study the following drawing and determine the class of lever used in the machine.



A. First Class Lever

B. Second Class Lever

C. Third Class Lever

D. None of these

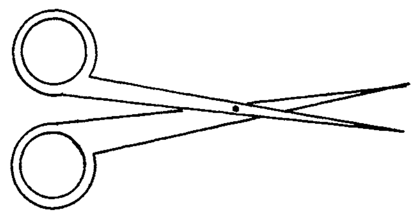
12. Study the following drawings and determine the class of lever used in the machine:

A. First Class Lever

B. Second Class Lever

C. Third Class Lever

D. None of these



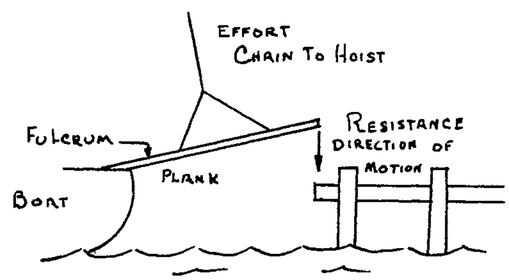
13. Study the following drawing and determine the class of lever used in the drawing:

A. First Class Lever

B. Second Class Lever

C. Third Class Lever

D. None of these



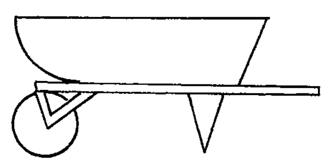
14. Study the following drawing and determine the class of lever used in the drawing:

A. First Class Lever

B. Second Class Lever

C. Third Class Lever

D. None of these



ASSIGNMENT SHEET I

BLOCK I

MULTIPLE CHOICE I

1. B
2. A
3. D
4. D
5. D
6. D
7. A
8. D
9. C
10. B
11. A
12. A
13. C
14. B

ASSIGNMENT SHEET II

BLOCK II: Levers

OBJECTIVE: To Reinforce the Processes of Compulation Required in Determining the Movement, Ideal Mechanical Advantage and Actual Mechanical Advantage of Various Classes of Levers.

REFERENCES: Charles H. Heimler and Charles D. Neal, _Principles of Science_, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 129-135.

MULTIPLE CHOICE PART I:

Read each of the statements below and select the correct answer from the choices given.

1. A child's seesaw would be an example of which of the following classes of levers:

A. First Class Lever

B. Second Class Lever

C. Third Class Lever

D. None of these

2. A lever is a simple machine that effects a force in which of the following methods:

A. Divides the force

B. Multiplies the force

C. Adds to the force

D. Takes away from the force.

3. Which of the following two things alone affect the action of a lever.

A. The effort force and the resistance force

B. The length of the lever bar and the placement of the fulcrum

C. The effort force and the placement of the fulcrum

D. The amount of force at each end of the lever and the length of the lever arm.

4. That force which is applied to the lever multiplied by the length of the lever arm is known as the:

A. Multiplication of forces

B. Reduction of forces

C. Moment

D. Movement of forces

5. Each lever contains an equal number of moments, that number is which of the following:

A. 1

B. 2

C. 3

D. 4

6. The unit of measurement of the moment is determined by the length of the bar multiplied by the force, therefore it is which of the following:

A. Pound foot

B. Foot

C. Pound

D. Horsepower

7. A balanced lever can be defined as:

A. A lever which is not in motion

B. A lever which cannot be moved

C. A lever which moves only through the effort arm

D. A lever which moves only through the resistance arm

8. When the ideal mechanical advantage is calculated for a lever the one determining this force is:

A. Allowing for the effect of friction and weight of the lever

B. Not allowing for the effect of friction and weight of the lever

C. Allowing for the effect of friction

D. Allowing for the effect of weight only

MATCHING PART I:

In the following questions you should study the drawing at the right, then match the indicated letter with the correct name at the left.

___1. Second Class Lever

___2. Lever Bar

___3. First Class Lever

___4. Third Class Lever

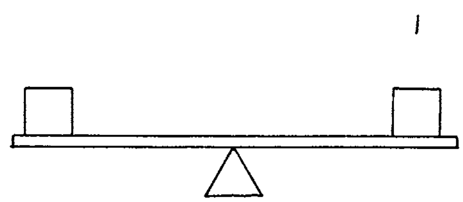
___5. Resistance Arm

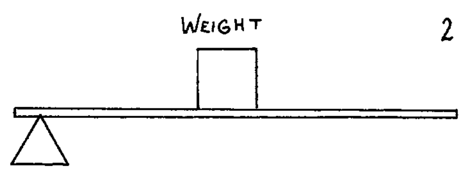
___6. Effort Force

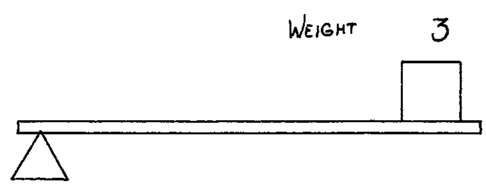
___7. Fulcrum

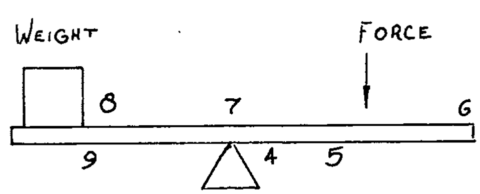
___8. Resistance Force

___9. Effort Arm









ASSIGNMENT SHEET II

BLOCK II

MULTIPLE CHOICE PART I

1. A
2. B
3. D
4. C
5. B
6. A
7. A
8. B

MATCHING PART I

1. B
2. G
3. A
4. C
5. J
6. F
7. D
8. H
9. E

BLOCK III: Pulleys

JOB I: Construction of Pulleys and Calculation of Problems Involving Mechanical Advantage.

OBJECTIVE: To Provide Experience in Computation of Mechanical Advantage of Pulleys Gained Through the Construction Process.

GENERAL INSTRUCTIONS:

This job will consist of two parts. The first will involve construction of the pulley, while the second will require solving the mathematical problem involved.

PROCEDURE:

Step 1: Select from your box of material the following parts:

Part D - Cord

Part C - Wheel and frame

Part K - Weight

Step 2: While using your lever as a working model, assume that the resistance force is 40 pounds and the effort force required to move the weight is 40 pounds, what then is the mechanical advantage of the pulley?

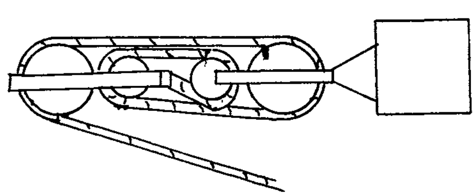
Step 3: The formula used to determine the ideal mechanical advantage of a pulley is as follows:

IDEAL MECHANICAL ADVANTAGE = TOTAL NUMBER OF SUPPORT ROPES

M. A. = S. R.

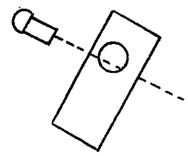
In the previous example the number of support ropes is equal to one, therefore the mechanical advantage of the pulley is one.

Step 4: Construct the pulley shown in the drawing below. Select from your box of materials the required items.

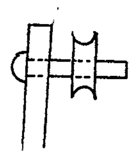


Step 5: Construction of the pulley is accomplished by the following steps:

A. Insert 1 bolt through the side of frame 1 in the hole located second from the top.



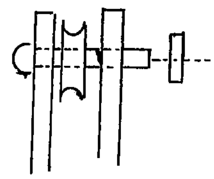
B. Part C should now be placed on the bolt, in such a way as to form a shaft with the bolt.



C. Insert a second bolt through the third hole from the top and place Part C on the bolt, through the same operations as followed in Step 5 A and B.

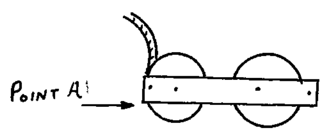
D. Insert a third bolt in the first hole and a fourth bolt through the last hole. Neither of these bolts will have a wheel upon them.

E. Frame #2 should now be placed over the ends of the four bolts and secured in place by four nuts.

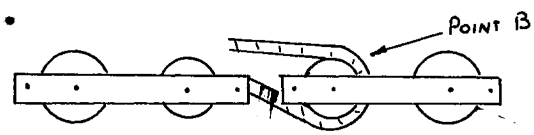


F. In the construction of the second part of the pulley follow Step 5 A, B, C, D and F.

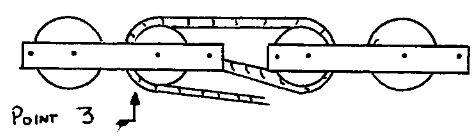
Step 6: The cord, Part D of the pulley should properly string around the pulley as directed in the following steps:



A. Secure the end of the cord at point 1 of the pulley.

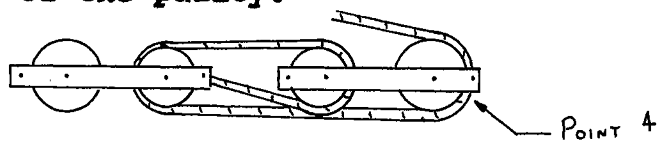


B. The loose end of the cord should pass under point 2 of the pulley.

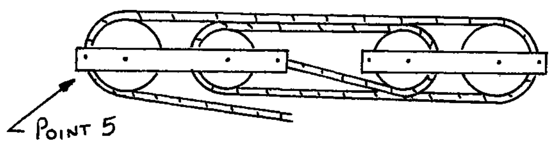


C. The loose end now passes over point 3 of the pulley.

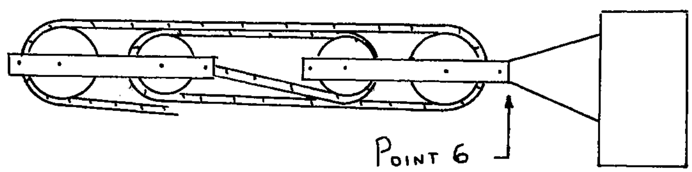
D. The loose end of the cord now passes under point 4 of the pulley.



E. The loose end of the cord now passes over point 5 of the pulley.



Step 7: The weight or resistance force labeled Part K should be attached to point 6.



Step 8: Assume the resistance force or the weight exerts a force of 75 pounds and the effort force required to move the weight one foot. What is the mechanical advantage of the pulley?

A.________________________ Answer

Step 9: Construct the pulley shown below by following items outlined in Steps 5 through Step 7.

Step 10: Assume the required effort force needed to move a 150 pound resistance force one foot is 50 pounds. What is the mechanical advantage of this machine?

B.________________________ Answer

Step 11: Construct the pulley shown below from materials available in your box of supplies:

Step 12: Determine the mechanical advantage of the machine shown above:

C.________________________ Answer

KEY

BLOCK III

JOB I

A. 4

B. 3

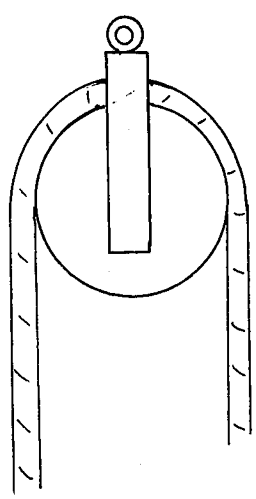
C. 2

ASSIGNMENT SHEET I

BLOCK III: Pulleys

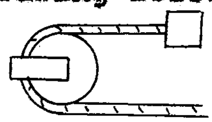
OBJECTIVE: To Reinforce the Processes of Computation Required in Determining the Mechanical Advantage of Various Pulleys.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 136-137.



MULTIPLE CHOICE:

1. What is the practical value of a single fixed pulley as shown in the drawing below?



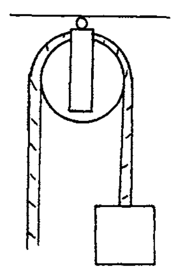
A. Requires less effort to lift a given weight

B. Changes the direction of a force

C. Increases the speed by which the machine moves a force

D. Requires less effort to lift a given weight and increases the speed by which the machine moves the force

2. Determine the mechanical advantage of the following machine:



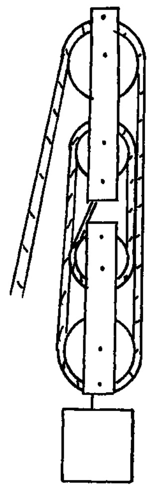
A. 1

B. 2

C. 4

D. 8

3. What amount of effort force is required to move the weight in the drawing below:



A. 4 lbs.

B. 125 lbs.

C. 500 lbs.

D. 2000 lbs.

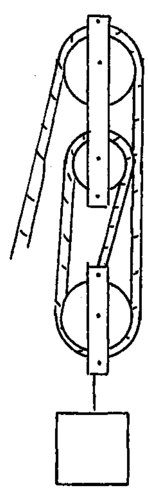
4. In the following drawing determine the distance of travel of the effort force:

A. 1 ft.

B. 3 ft.

C. 9 ft.

D. 12 ft.



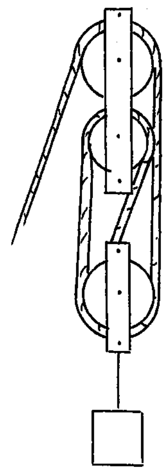
5. Determine the mechanical advantage of the following machine:

A. 1

B. 2

C. 3

D. 4



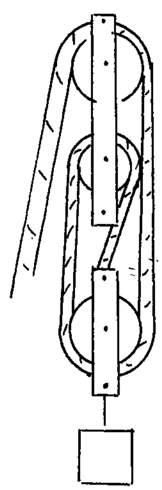
6. What amount of effort force is required to move the weight in the following drawing:

A. 3 lbs.

B. 200 lbs.

C. 600 lbs.

D. 1800 lbs.



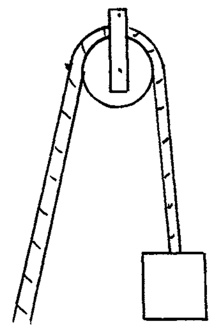
7. Determine the distance the effort force will travel in the following drawing:

A. 1 ft.

B. 3 ft.

C. 9 ft.

D. 12 ft.



KEY

ASSIGNMENT SHEET I

BLOCK III: Pulleys

1. C
2. A
3. B
4. B
5. C
6. B
7. A

BLOCK IV: Wheel and Axle

JOB I: Construction of the Wheel and Axle and Calculation of Problems Involving Mechanical Advantage.

OBJECTIVE: To Gain Experience in Computation of the Mechanical Advantage of the Wheel and Axle as Gained Through the Construction Process.

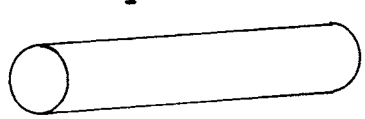
GENERAL INSTRUCTIONS:

This job will consist of two parts. The first will involve construction of the wheel and axle, while the second will require solving the mathematical problems involved.

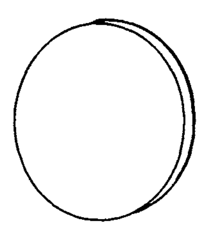
PROCEDURE:

Step 1: Select from your box of supplies the following parts:

Part G

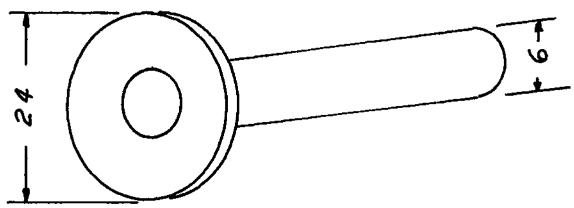


Part H



Step 2: Insert the axle into the center hole of the wheel to form a working model of the wheel and axle.

Step 3: Assume the diameter of the wheel is 24 inches and the diameter of the axle is six inches. What is the mechanical advantage of this machine?



Step 4: The following formula will be useful in calculation of the mechanical advantage of wheel and axle:

$$\text{MECHANICAL ADVANTAGE} = \frac{\text{DIAMETER OF THE WHEEL}}{\text{DIAMETER OF THE AXLE}}$$

$$\text{M. A.} = \frac{\text{D. W.}}{\text{D. A.}}$$

In the previous problem the diameter of the wheel which is 24 inches is divided by the diameter of the axle which is 6 inches. The result is that the mechanical advantage is 4.

Step 5: Construct a working model of the wheel and axle from your box of supplies. Follow steps 1 and 2 for the construction of the machine.

Step 6: Assume that a certain saw mill has a saw blade 5 foot in diameter attached to an axle 8 inches in diameter. What then is the mechanical advantage of this machine?

A.______________________ Answer

Step 7: Determine the mechanical advantage of the wheel and axle in the following problem. A cabinet maker wishes to place a "V" pulley on a lathe. The diameter of the pulley is 6 inches, the shaft upon which it turns is 3/4 of an inch in diameter. What is the mechanical advantage of this machine?

B.______________________ Answer

Step 8: A wheel and axle is found at the top of a large power shovel. The wheel is 10 feet in diameter, and the axle is 24 inches in diameter. The shovel is capable of lifting over 100 yards of dirt and rock. What is the mechanical advantage of this wheel and axle?

C.______________________ Answer

KEY

BLOCK IV

JOB I

A. 8.7

B. 4.5

C. 5.0

ASSIGNMENT SHEET I

BLOCK IV: Wheel and Axle

OBJECTIVE: To Reinvigorate the Procedure of Calculation Required in Determination of the Mechanical Advantage of the Wheel and Axle.

REFERENCES: Charles H. Heimler and Charles D. Neal, _Principles of Science_, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 136-137.

MULTIPLE CHOICE:

1. The wheel and axle operates on the same principle as which of the following combinations of machines?

A. Lever and Wedge

B. Lever and Pulley

C. Lever and Inclined Plane

D. Lever and Screw

2. To determine the mechanical advantage of a wheel and axle you would select which of the following formulas:

A. $\dfrac{\text{DIAMETER OF WHEEL}}{\text{DIAMETER OF AXLE}}$

B. DIAMETER OF WHEEL X DIAMETER OF AXLE

C. DIAMETER OF WHEEL + DIAMETER OF AXLE

D. DIAMETER OF WHEEL - DIAMETER OF AXLE

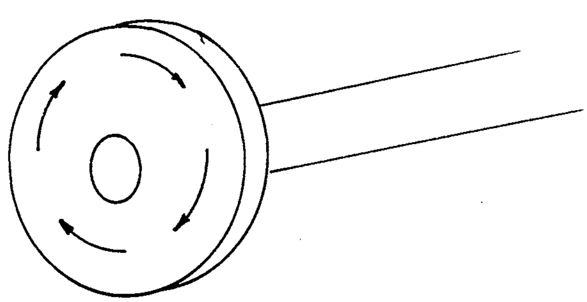
3. Study the drawing of the wheel and axle below. Assume the rotation of the axle is in a clockwise direction, in which direction would the wheel rotate?

A. Counter clockwise

B. Clockwise

C. Would not be effected by the rotation of the axle.

D. Possible to turn in either direction.



4. The drawing of the gear is an example of which of the following machines?

A. Pulley and lever

B. Wheel and axle

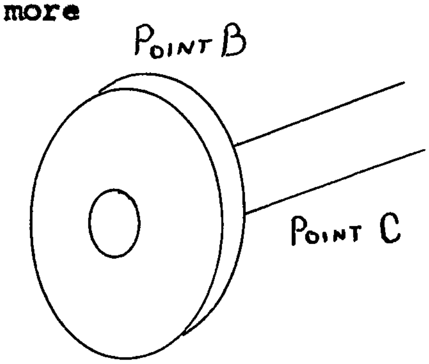
C. Pulley and wheel

D. Screw and axle

5. Study the drawing of the wheel and belt shown below. Assume the belt is attached to a motor of a single speed (point A). Compare the speed of the axle which will result by first placing the belt at point B and then placing the same belt at point C.

A. Point B will produce more speed on the axle than that of point C.

B. Point C will produce more speed than point B.



C. The speed of the axle will not be affected by placing the belt at either point B or point C.

D. The effect of either point B or point C will not be as great as will result if placed closer to the opposite end of the axle.

KEY

BLOCK IV

ASSIGNMENT SHEET I

1. B

2. A

3. B

4. B

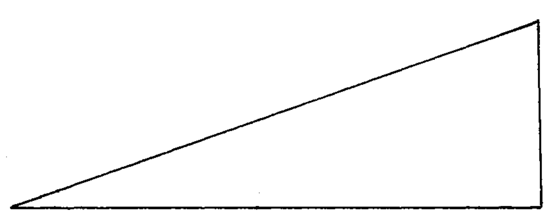
5. B

ASSIGNMENT SHEET I

BLOCK V: Inclined Plane

OBJECTIVE: To Reinforce the Procedure of Computation Required in Determining the Mechanical Advantage of the Inclined Plane.

REFERENCES: Charles H. Heimler and Charles D. Neal, *Principles of Science*, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 137-138.



MULTIPLE CHOICE:

1. An inclined plane can be described as:

A. A curved surface which is used for raising objects to higher elevations.

B. A convex surface which is used for raising objects to higher elevations.

C. A slanted surface which is used for raising objects to higher elevations.

D. A concave surface which is used for raising objects to higher elevations.

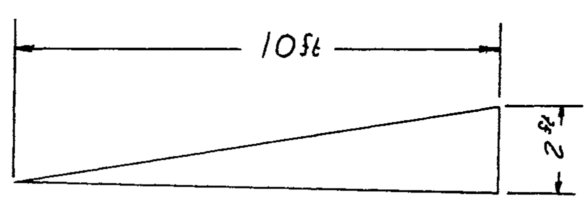
2. Determine the mechanical advantage of the inclined plane in the following example:

A. 1.0

B. 1.5

C. 2.0

D. 2.5



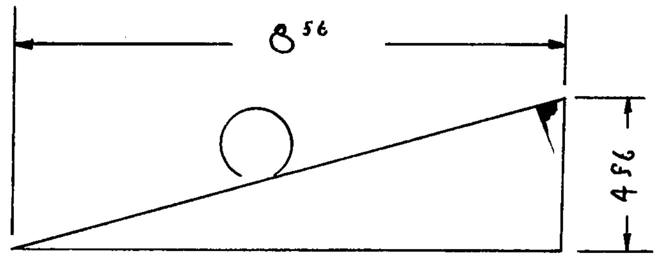
3. Determine the effort required to move the following object:

A. 9.5

B. 10.0

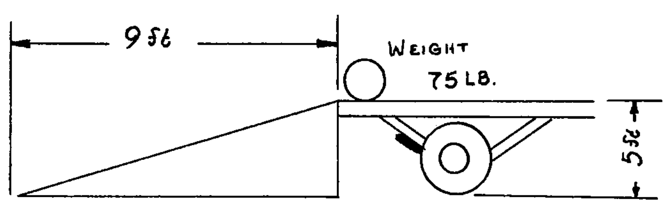
C. 10.5

D. 11.0



Study the following drawing and problem. Then determine both the mechanical advantage and the effort force required to move the object.

A workman would like to place 10 rolls of roofing paper on the bed of a truck. The height of the truck bed is 5 feet from the ground. The weight of a single roll of paper is 75 pounds. The length of the ramp selected is nine feet.



4. Mechanical Advantage

A. 1.0

B. 1.4

C. 1.8

D. 2.2

5. Effort

A. 4.1 lbs.

B. 4.3 lbs.

C. 4.5 lbs.

D. 4.7 lbs.

6. A certain inclined plane has a mechanical advantage of 2.0, what effort force would be required to move 50 pounds of weight?

A. 23.5 lbs.

B. 24.0 lbs.

C. 24.5 lbs.

D. 25.0 lbs.

A railroad ore car is moved up an inclined plane to a distance of 20 feet from the ground. The length of the ramp is 100 feet. The weight of the car with ore is 5 tons.

Calculate both the mechanical advantage and the effort required to move this car to the end of the ramp.

*NOTE: 1 ton = 2,000 lbs.

7. Mechanical Advantage

A. 4.0

B. 4.5

C. 5.0

D. 5.5

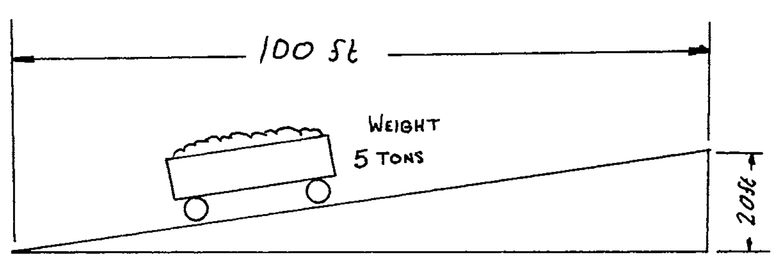
8. Effort

A. 1500 lbs.

B. 1700 lbs.

C. 1900 lbs.

D. 2000 lbs.



KEY

BLOCK V

ASSIGNMENT SHEET 1

1. C
2. B
3. B
4. C
5. A
6. D
7. C
8. D

BLOCK VI: Wedge

ASSIGNMENT SHEET 1: Computation of Problems Involving Mechanical Advantage as Related to the Wedge.

OBJECTIVE: To Reinforce the Processes of Calculation Involved in the Determination of Mechanical Advantage Found in Correlation to the Wedge.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 138.

MULTIPLE CHOICE:

1. A wedge may be described as:

A. A machine to produce leverage

B. A double inclined plane

C. A machine which changes the direction of a force

D. A slanted surface used for raising objects to higher elevations.

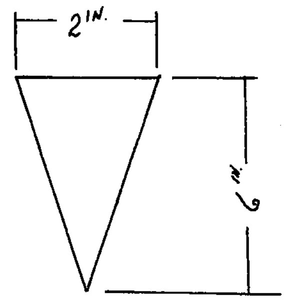
2. Determine the mechanical advantage of the wedge shown in the drawing below?

A. 2.0

B. 2.5

C. 3.0

D. 3.5



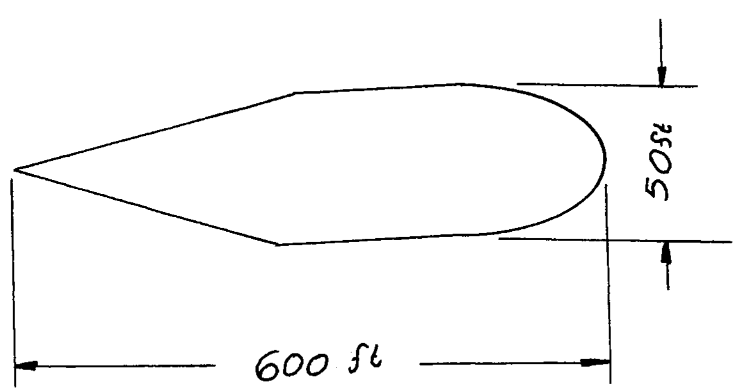
3. A certain ship has a width of 50 feet and a length from the fantail to the point of the prow is 600 feet long. Determine the mechanical advantage produced when the vessel moves through the water.

A. 10.5

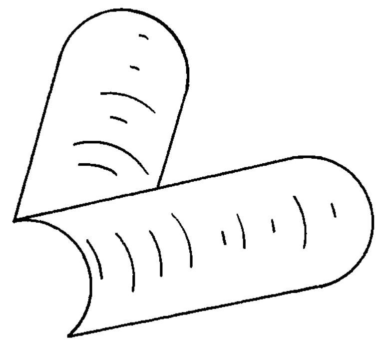
B. 11.0

C. 11.5

D. 12.0



4. A certain snow plow has a width of 12 feet and a length of 5 feet. Determine the mechanical advantage of the machine.



A. .41

B. .45

C. .51

D. .55

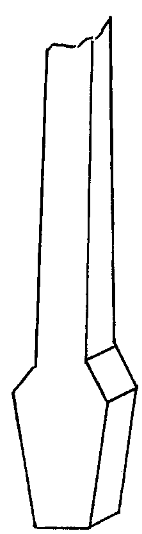
5. Determine the mechanical advantage of the tool in the following drawing. Width of blade is 0.25, length of blade is 0.75.

A. 3.0

B. 3.5

C. 4.0

D. 4.5



KEY

BLOCK VI

ASSIGNMENT SHEET 1

1. B
2. C
3. D
4. A
5. A

BLOCK VII: The Screw

JOB I: Construction of the Screw and Calculation of Problems Involving Mechanical Advantage.

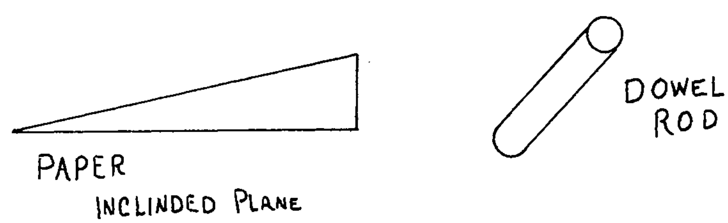
OBJECTIVE: To Reinforce the Processes Involved in Calculation of Problems Involving the Mechanical Advantage of the Screw.

GENERAL INSTRUCTIONS:

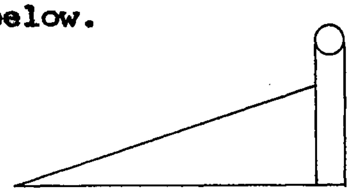
This job will consist of two parts. The first will involve construction of the screw, while the second will require solving the mathematical problems involved.

PROCEDURE:

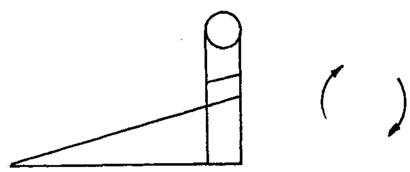
Step 1: Select from your box of supplies the following parts:



Step 2: Place the rod (Part) in a vertical position, with the paper inclined plane (Part) placed in the position shown below.



Step 3: Turn the dowel rod in a clockwise direction, while the inclined plane is twisted around it in a spiral.



Step 4: Continue turning the rod in a clockwise direction until the inclined plane has formed a spiral to the base of the dowel, as shown in the following drawing:

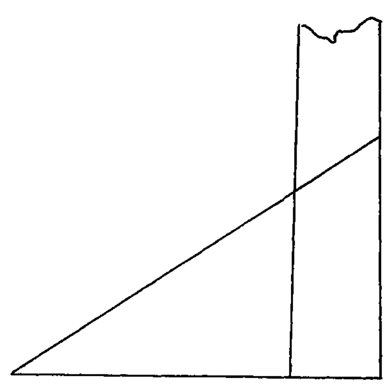
Step 5: While using the screw you have just built as a working model, assume the length of the thread is two inches, while the height of the thread is one inch. What is the mechanical advantage of this screw?

Step 6: The following formula will be useful in determining the mechanical advantage of the screw.

$$\text{MECHANICAL ADVANTAGE} = \frac{\text{LENGTH OF THE THREAD}}{\text{HEIGHT OF THE THREAD}}$$

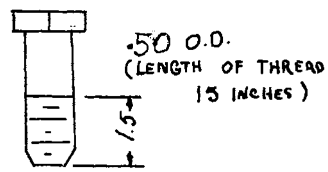
$$\text{M. A.} = \frac{\text{L. T.}}{\text{H. T.}}$$

Step 7: In the example of the screw on the preceding page the length of the thread is two inches which would be divided by the height of the thread which is one inch. Therefore, the mechanical advantage of the screw would be one.



Step 8: Follow procedure shown in Step 1 through Step 4 to form a working model of the screw. Determine the mechanical advantage of the following screw. A certain machine has a machine screw of .50 inches in diameter with thirty threads per inch. The length of the thread is 15 inches while the height of the thread is 1.5 inches.

A.______________________ Answer



Step 9: Determine the mechanical advantage of the following screw. A farmer would like to drill holes for fence posts with a large arbor. The height of the tool is 4 feet, while the outside diameter is 18 inches. If the thread of the arbor was placed in a straight line it would extend for 72 inches.

B.______________________ Answer

Step 10: Determine the mechanical advantage of the following screw. A drill bit has an outside diameter of .750 and a length of 6 inches from the point of the cutting tip to the top. The height of the cutting edge is 4 inches. If the cutting edge were placed in a straight line the length would extend for a distance of 9 inches.

C.______________________ Answer

KEY

BLOCK VII

JOB I

A. 10.0

B. 1.5

C. 2.25

BLOCK VIII: Efficiency

ASSIGNMENT SHEET 1: Calculation of Problems Involving Efficiency of Machines.

OBJECTIVES: To Reinforce the Process of Computation Involving Both Work Input and Work Output of Machines.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 139-141.

MULTIPLE CHOICE:

1. When a machine is classified as an ideal machine the work output should be:

A. Greater than the work input,

B. Lesser than the work input,

C. Equal to the work input, or

D. The relationship of work output is not effected by the work input.

The following formulas will be helpful in determining the amount of work input and work output of a machine.

WORK INPUT = EFFORT DISTANCE X EFFORT FORCE

Wi = De X Fe

WORK OUTPUT = RESISTANCE DISTANCE X RESISTANCE FORCE

Wo = Dr X Fr

Determine both the work input and work output of the following machine. The effort force used with a lever is 75 pounds. When the effort force is moved a distance of 6 feet, 150 pounds of resistance is moved 3 feet.

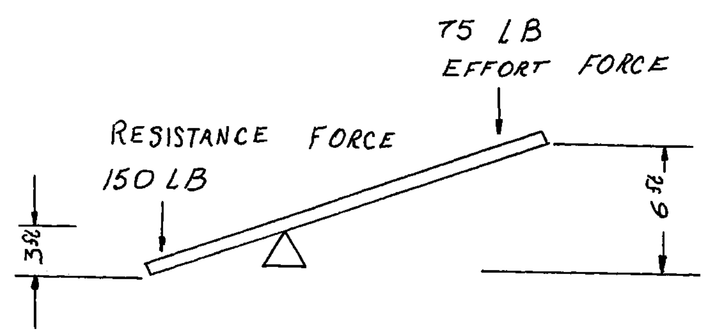
2. (Work Input)

A. 450 ft. lb.

B. 455 ft. lb.

C. 460 ft. lb.

D. 465 ft. lb.



3. (Work Output)

A. 450 ft. lb.

B. 455 ft. lb.

C. 460 ft. lb.

D. 465 ft. lb.

Determine both the work input and the work output of the following machine.

A set of pulleys requires an effort force of 35 pounds to move a distance of 4 feet. When the effort force moves this distance the resistance force which weighs 100 pounds is moved 2 feet.

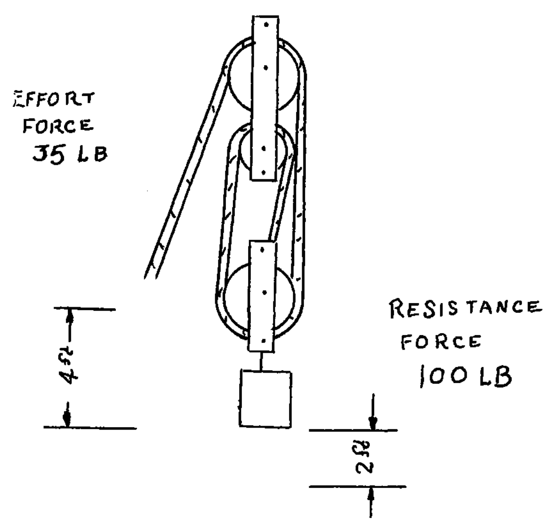
4. (Work Input)

A. 139 ft. lbs.

B. 139.5 ft. lbs.

C. 140 ft. lbs.

D. 140.5 ft. lbs.



5. (Work Output)

A. 199 ft. lbs.

B. 200 ft. lbs.

C. 201 ft. lbs.

D. 202 ft. lbs.

To determine the percent of efficiency of a machine the following formula should be used.

$$\text{PERCENT EFFICIENCY} = \frac{\text{WORK OUTPUT}}{\text{WORK INPUT}} \times 100\%$$

$$E\% = \frac{Wo}{Wi} \times 100\%$$

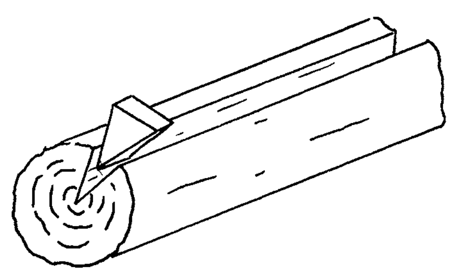
6. Find the efficiency of the wedge whose work input is 75 ft. lbs. and whose work output is 70 ft. lbs.

A. 91.5%

B. 92%

C. 92.5%

D. 93%



7. Find the percent of efficiency for the following machine.

Work input = 150 ft. lbs.

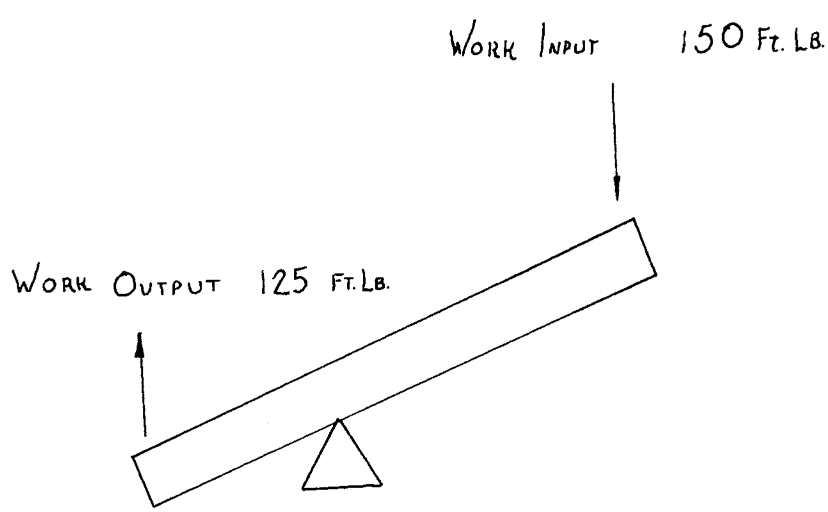
Work output = 125 ft. lbs.

A. 82.5%

B. 83.0%

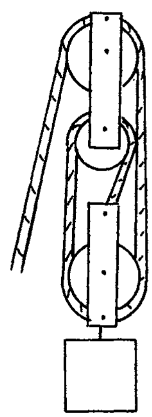
C. 83.5%

D. 84.0%



Study the following problem and drawing then determine the work input, work output and efficiency of the machine.

A certain set of pulleys require an effort force of 150 lbs. to move 5 feet, at the same time the effort force is moving the resistance force of 125 lbs. is moving a distance of 4 feet.



8. Work Input

A. 747 ft. lbs.

B. 748 ft. lbs.

C. 749 ft. lbs.

D. 750 ft. lbs.

9. Work Output

A. 498 ft. lbs.

B. 499 ft. lbs.

C. 500 ft. lbs.

D. 501 ft. lbs.

10. Efficiency

A. 66%

B. 66.5%

C. 67%

D. 67.5%

KEY

BLOCK VIII

ASSIGNMENT SHEET 1

1. C
2. A
3. A
4. C
5. B
6. D
7. B
8. D
9. C
10.

BLOCK IX: Power

ASSIGNMENT SHEET 1: Computation of Problems Involving Power of Machines.

OBJECTIVE: To Reinforce the Process of Calculation Involving Both Power and Horsepower.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 142-144.

The following formulas will be helpful in determining both the power and the horsepower of machines.

$$\text{POWER} = \frac{\text{WORK}}{\text{TIME}}$$

$$P = \frac{W}{T}$$

$$\text{HORSEPOWER} = \frac{\text{WORK} \div \text{TIME (Sec.)}}{550}$$

$$hp = \frac{\frac{w}{t}}{550}$$

1. Determine the power used in the following example. A machine lifted a 500 pound weight a distance of 15 feet in 5 seconds.

A. 1490 foot pound per second

B. 1500 foot pound per second

C. 1510 foot pound per second

D. 1520 foot pound per second

Determine the power of the following two cars. Both cars will travel a distance of one quarter mile. The first car which weighs 2,000 lbs. will travel this distance in 1.5 minutes. The second car weighs 2,000 lbs. and will travel the same distance in 2 minutes.

*NOTE: 1 mile = 5,280 feet

2. First Car

A. 29,322 foot pound per second

B. 29,325 foot pound per second

C. 29,328 foot pound per second

D. 29,331 foot pound per second

3. Second Car

A. 22,094 foot pound per second

B. 22,097 foot pound per second

C. 22,000 foot pound per second

D. 22,003 foot pound per second

4. Determine the horsepower of the following machine.

A bucket of tar weighing 100 pounds is lifted to a roof which is 20 feet from the ground. The time required to travel this distance is 30 seconds.

A. .6 horsepower

B. .8 horsepower

C. .10 horsepower

D. .12 horsepower

A large crane is used to move material to the top of a ten story building. The crane must lift a piece of steel which weighs 1,000 pounds. The length of time required for this machine to lift the metal is thirty seconds. What is the power exerted, and the horsepower of this machine?

*NOTE: Average height between floors is 8 feet.

5. Power

A. 256.6 foot pounds per second

B. 266.6 foot pounds per second

C. 276.6 foot pounds per second

D. 286.6 foot pounds per second

6. Horsepower

A. .50 horsepower

B. .51 horsepower

C. .52 horsepower

D. .53 horsepower

KEY

BLOCK IX

ASSIGNMENT SHEET 1

1. B
2. A
3. C
4. D
5. B
6. C

APPENDIX B

PRE-TEST AND POST-TEST

FOR THE UNIT OF

SIMPLE MACHINES

PRE-TEST

EXAMPLE A

The capitol of the United States is located in which of the following cities:

A. Washington, D.C.

B. Kansas City, Kansas

C. Dallas, Texas

D. Los Angeles, California

EXAMPLE B

In which of the following states do we live?

A. Arkansas

B. Oklahoma

C. New York

D. Missouri

1. A device that may be used to change the speed, direction, or the amount of force is known as a:

A. Tool

B. Machine

C. Fulcrum

D. Wrench

2. A device which produces work with one movement is called a:

A. Simple Machine

B. Compound Machine

C. Complex Machine

D. Single Machine

3. The lever consists of a bar that is free to move about a point called the:

A. Hinge

B. Center piece

C. Fulcrum

D. Point of force

4. The distance from the effort force to the fulcrum is referred to as:

A. An arm

B. A leg

C. A lever

D. A bar

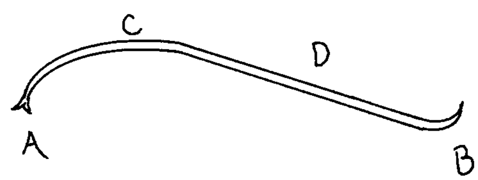
5. In the drawing below you are to select the point or fulcrum about which the nail bar rotates.

A.

B.

C.

D.



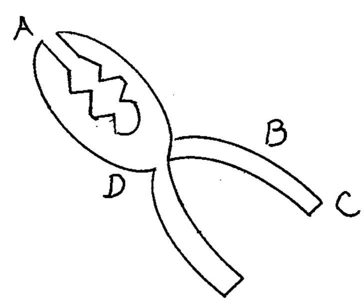
6. In the drawing below you are to select the point or fulcrum about which the lever will rotate:

A.

B.

C.

D.



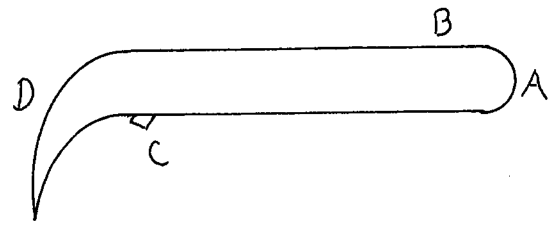
7. In the drawing below you are to select the point or fulcrum about which the beverage opener will rotate:

A.

B.

C.

D.

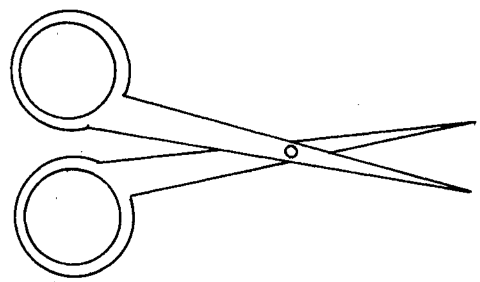


8. Study the drawing of a pair of scissors, then select the class of lever described.

A. First class

B. Second class

C. Third class



9. The function of a lever is to use small forces to overcome large forces, therefore we can say that a lever is a machine that works by one of the following processes:

A. Divides the effort force

B. Multiplies the effort force

C. Adds to the resistance force

D. Subtracts from the effort force

Two children are playing with a seesaw. Erick weighs 65 pounds and John weighs 55 pounds. The length of the seesaw is 12 feet. Both boys are on the ends of the board, the fulcrum is in the center. What moment will each boy create?

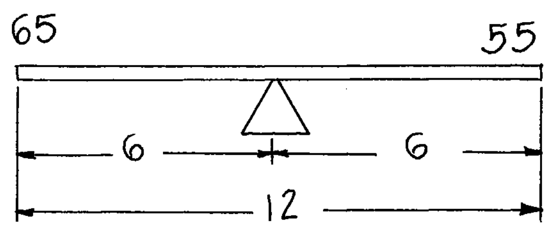
10. Erick

A. 388 pound foot

B. 389 pound foot

C. 390 pound foot

D. 391 pound foot



11. John

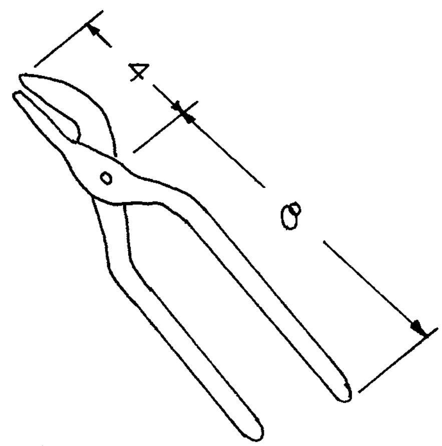
A. 326 pound foot

B. 328 pound foot

C. 330 pound foot

D. 332 pound foot

12. A pair of pliers has an overall length of twelve inches. The length of the effort arm is eight inches, while the length of the resistance arm is four inches. Thus the ideal mechanical advantage of this pair of pliers would be:



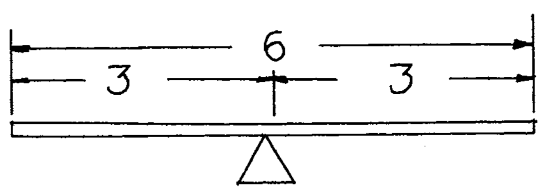
A. 2

B. 4

C. 6

D. 8

13. An acrobat wishes to turn two somersaults in mid-air. He will select a seesaw 6 foot in length with an effort arm of 3 feet and a resistance arm of 3 feet. What will be the ideal mechanical advantage of the seesaw?



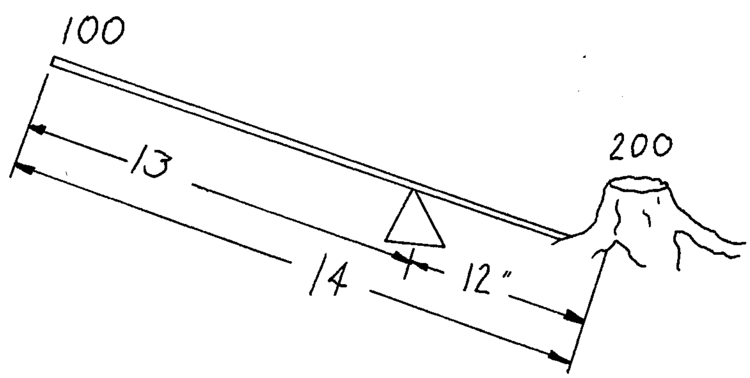
A. 1

B. 3

C. 6

D. 9

14. A farmer wishes to remove a tree stump with a lever. The bar is 14 feet long with the fulcrum placed 12 inches from the stump. The farmer will exert 100 pounds pressure on the effort arm, while the stump will exert 200 pounds of force on the resistance arm. What is the actual mechanical advantage of this lever?



A. 2

B. 3

C. 4

D. 5

15. The machine described as a wheel that turns an axle is known as:

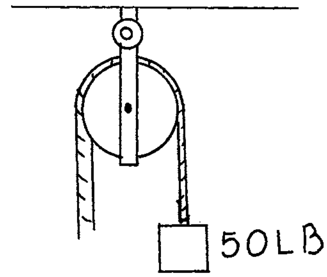
A. A lever

B. A pulley

C. An inclined plane

D. A wedge

16. The pulley in the following drawing is known as:



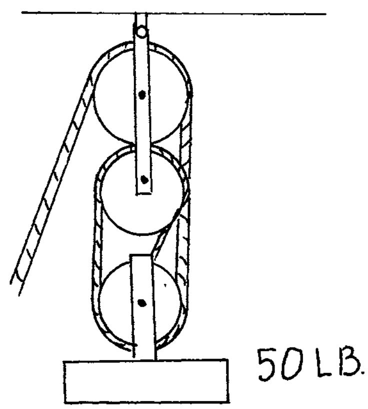
A. Block and tackle

B. Movable pulley

C. Traveling block

D. Fixed pulley

17. What effort force is required to raise the 50 lbs. weight six feet from the floor by using the pulley in the following drawing. The ideal mechanical advantage is 3.



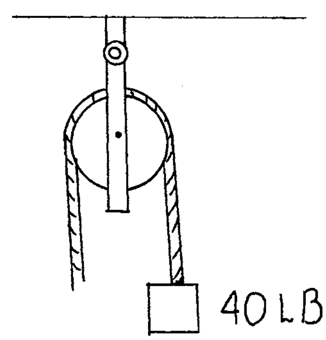
A. 10.0 pounds

B. 16.6

C. 20.0

D. 26.6

18. What is the ideal mechanical advantage of the pulley in the following drawing:



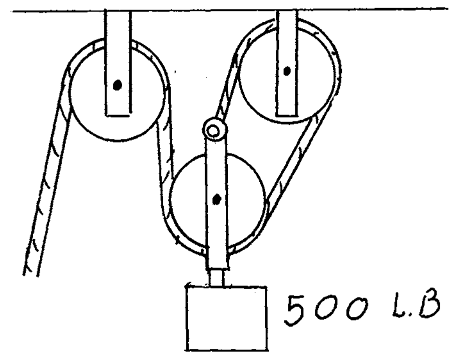
A. 0.5

B. 1

C. 1.5

D. 2.0

19. What is the ideal mechanical advantage of the pulley in the following drawing?



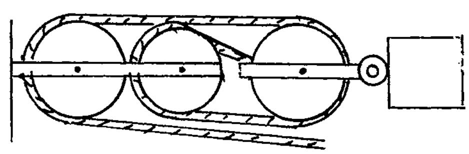
A. 2

B. 2.5

C. 2.75

D. 3

20. Study the drawing of the following pulley, then decide upon the ratio of movement of the resistance force as compared to the effort force. We want to lift the weight one foot.



A. 1 foot on the effort force is required to be one foot on the resistance force.

B. 2 feet on the effort force is required to lift one foot on the resistance force.

C. 3 feet on the effort force is required to lift the resistance one foot.

D. 4 feet on the effort force is required to lift the resistance force one foot.

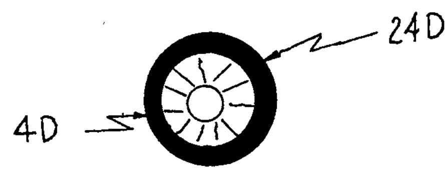
21. The rear wheel of a motorcycle has a diameter of twenty-four inches, while the sprocket or axle has a diameter of four inches. What is the mechanical advantage of this wheel?

A. 4

B. 6

C. 8

D. 10



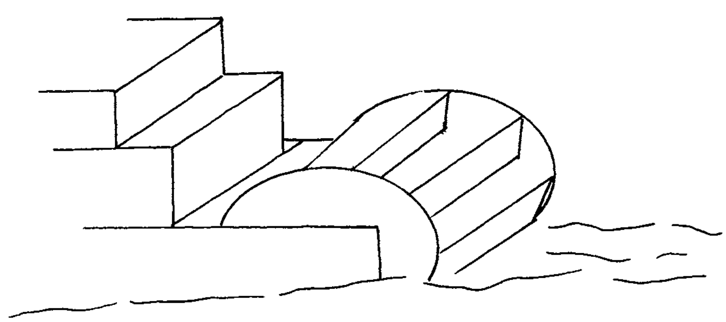
22. The paddle wheel of a steamboat is 14 feet in diameter, contains an axle of 24 inches in diameter, the length of the paddles are 30 feet. What is the mechanical advantage of the paddle wheel?

A. 7

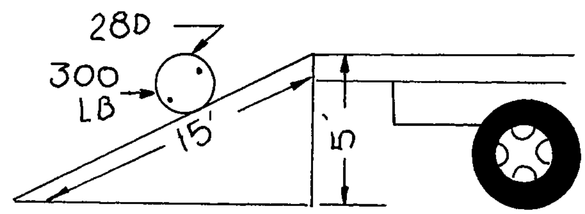
B. 8

C. 9

D. 10



23. An oil drum with a diameter of 28 inches, with a length of four feet and having a weight of 300 pounds must be loaded into the back of a truck which has a height of five feet. An inclined ramp of fifteen feet length and five feet high is selected. How much effort must the workman exert to place the barrel in the truck?



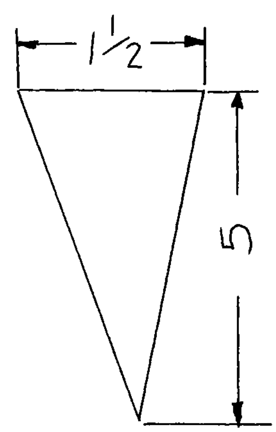
A. 98 pounds effort

B. 99 pounds effort

C. 100 pounds effort

D. 101 pounds effort

24. The mechanical advantage of the wedge in the following problem is:



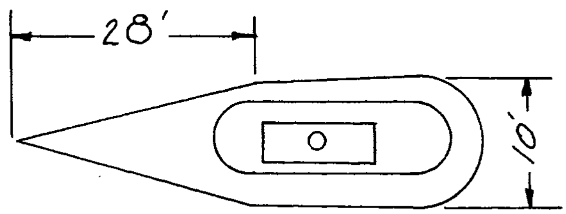
A. 2.5

B. 3.0

C. 3.5

D. 4.0

25. A man is building a small sail boat, the prow of which will be wedge shaped. If the width of the boat is fourteen feet at the widest point, and the distance to that point is twenty-eight feet, the vessel would have a mechanical advantage of:



A. 1

B. 2

C. 3

D. 4

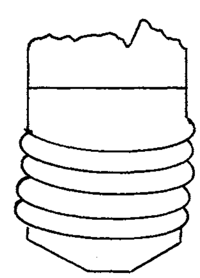
26. The base of a light bulb is a good example of which machine?

A. A circular lever

B. A circular pulley

C. A circular wedge

D. A circular inclined plane



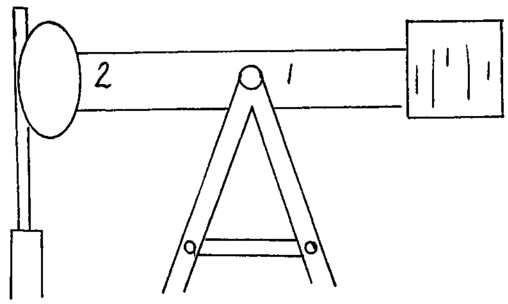
27. Number two in the drawing would be referred to which of the following simple machines?

A. Lever

B. Fulcrum

C. Pulley

D. Wedge



In the following question you will be asked to solve problems which involve both work input and work output. The formula for which are as follows:

WORK INPUT = EFFORT DISTANCE X EFFORT FORCE

W.I. = De X Fe

WORK OUTPUT = RESISTANCE DISTANCE X RESISTANCE FORCE

W.O. = Dr X Fr

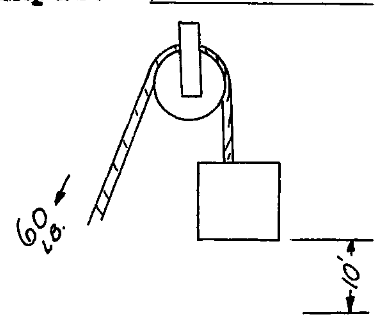
28. The effort force used with a curtain set of pulleys is 60 pounds. When this effort force is moved 10 feet what is the amount of work input? ____________

A. 558

B. 559

C. 600

D. 601



29. A certain machine moves 150 pounds of resistance a distance of five feet. What is the amount of work output of this machine?

A. 747

B. 748

C. 749

D. 750

30. A man once moved a weight which weighed 300 pounds with a lever. He placed a force of seventy-five pounds on the effort arm. This moved the arm a distance of three feet, the resistance arm in turn was moved twelve inches. What are the work output and work input of this machine?

A. Work input 75 pounds
   Work output 300 pounds

B. Work input 300 pounds
   Work output 225 pounds

C. Work input 225 pounds
   Work output 300 pounds

D. Work input 300 pounds
   Work output 75 pounds

31. The machine that is not efficient is not economical to operate. One method of improving the efficiency is to reduce the friction. Which of the following would be applied to the movable parts to reduce friction?

A. Increased pressure on the parts

B. Lubricant

C. Reduced pressure on the parts

D. Acid.

In the following problems the formula shown below will be helpful in obtaining the solution.

$$\text{POWER} = \frac{\text{WORK}}{\text{TIME}} \qquad \text{HORSEPOWER} = \frac{\text{WORK} \div \text{TIME (Sec)}}{550}$$

$$D = \frac{W}{T} \qquad Lp = \frac{W}{T} \qquad \text{WORK} = \text{DISTANCE X FORCE}$$

$$W = D \text{ X } F$$

32. Determine the amount of power used in the following problem?

WORK = 800 feet-pound

TIME = 5 seconds

A. 157 feet-pound

B. 158 feet-pound

C. 159 feet-pound

D. 160 feet-pound

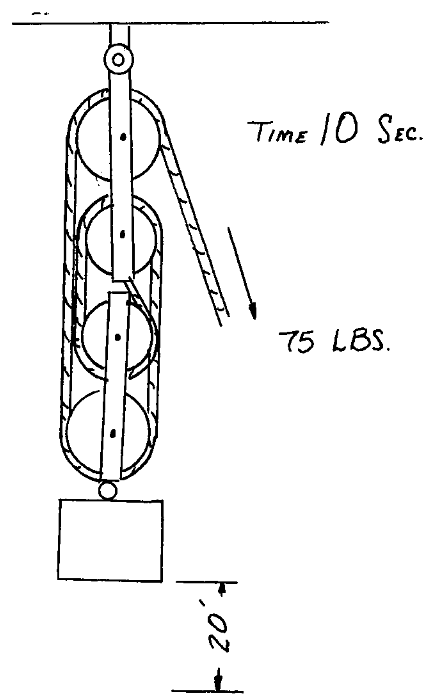
33. A force of 75 pounds placed on a pulley will lift a weight of 150 pounds, 20 feet in 10 seconds. What is the power of this machine?

A. 275 feet-pound

B. 300 feet-pound

C. 325 feet-pound

D. 350 feet-pound



34. Determine the horsepower of this machine in the following problem.

FORCE = 2000 pounds

DISTANCE = 30 feet

TIME = 20 seconds

A. 2.0 hp.

B. 3.0 hp.

C. 4.0 hp.

D. 5.0 hp.

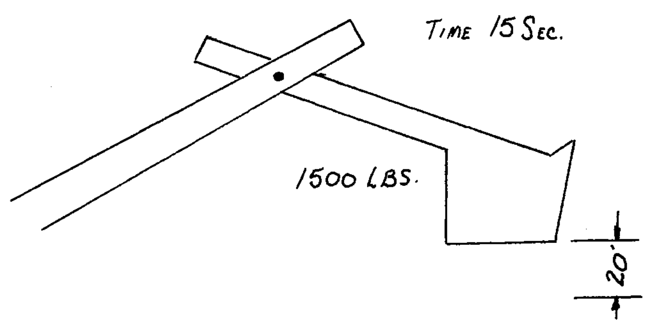
35. A power shovel was being used on a construction job. The shovel raised 1500 pounds of dirt to a height of 20 feet in 15 seconds. What horsepower was developed by the machine?

A. 1.5 hp.

B. 3.0 hp.

C. 4.5 hp.

D. 6.0 hp.



ANSWER SHEET

MULTIPLE CHOICE

Below you will find a series of numbers which correspond with the numbers of the questions on your test. Each one of the numbers has four letters, A, B, C and D. You are to select the correct choice from your test and color the block on your answer sheet which is the same as the letter you have selected.

EXAMPLE A

A. ( )

B. ( )

C. ( )

D. ( )

EXAMPLE B

A. ( )

B. ( )

C. ( )

D. ( )

1.

A. ( )

B. ( )

C. ( )

D. ( )

2.

A. ( )

B. ( )

C. ( )

D. ( )

3.

A. ( )

B. ( )

C. ( )

D. ( )

4.

A. ( )

B. ( )

C. ( )

D. ( )

5.

A. ( )

B. ( )

C. ( )

D. ( )

6.

A. ( )

B. ( )

C. ( )

D. ( )

7.

A. ( )

B. ( )

C. ( )

D. ( )

8.

A. ( )

B. ( )

C. ( )

D. ( )

9.

A. ( )

B. ( )

C. ( )

D. ( )

10.

A. ( )

B. ( )

C. ( )

D. ( )

11.

A. ( )

B. ( )

C. ( )

D. ( )

12.

A. ( )

B. ( )

C. ( )

D. ( )

13.

A. ( )

B. ( )

C. ( )

D. ( )

14.

A. ( )

B. ( )

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B. ( )

C. ( )

D. ( )

POST-TEST

EXAMPLE A

The capitol of the United States is located in which of the following cities:

A. Washington, D.C.

B. Kansas City, Kansas

C. Dallas, Texas

D. Los Angeles, California

EXAMPLE B

In which of the following states do we live?

A. Arkansas

B. Oklahoma

C. New York

D. Missouri

1. All machines can be classified as:

A. Compound-Complex

B. Simple-Single

C. Simple-Compound

D. Single-Complex

2. Machines composed of two or more simple machines are known as:

A. Simple Machines

B. Compound Machines

C. Complex Machines

D. Single Machines

3. The ends of a lever are referred to as a force. The names of these forces are:

A. The effort force - The lifting force

B. The effort force - The pushing force

C. The resistance force - The lifting force

D. The effort force - The resistance force

4. The distance from the resistance force to the fulcrum is referred to as:

A. An arm

B. A leg

C. A lever

D. A bar

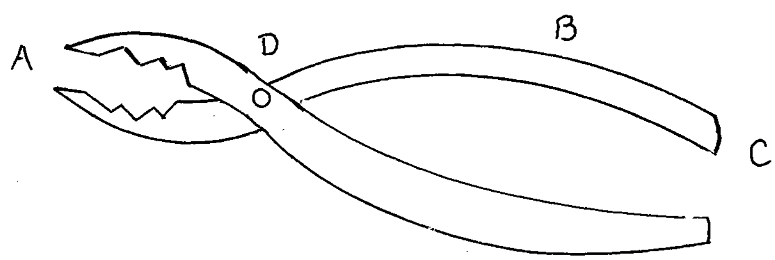
5. In the drawing below you are to select the point or fulcrum about which the handle of the pliers rotate.

A.

B.

C.

D.



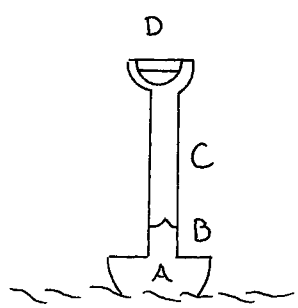
6. In the drawing below you are to select the point or fulcrum about which the spade will rotate.

A.

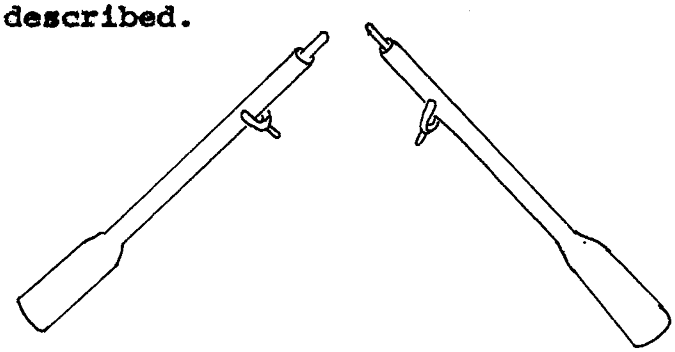
B.

C.

D.



7. Study the drawing of a pair of oars, then select the class of lever described.



A. First Class

B. Second Class

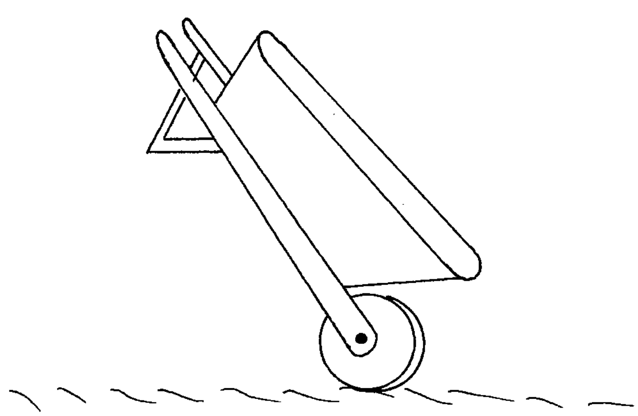
C. Third Class

8. Study the drawing of the wheelbarrow that is dumping dirt, then select the class of lever described.

A. First Class

B. Second Class

C. Third Class



In the following questions you are to solve the pound-foot solutions. The formula is:

MOMENT = FORCE X DISTANCE

M = F X D

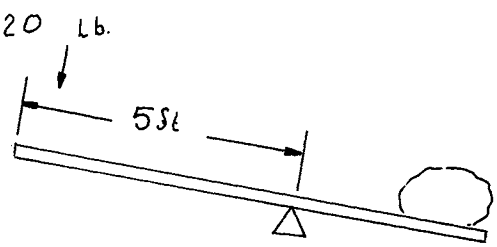
9. A man wishes to move a large rock with a lever, the fulcrum is placed 5 feet from the effort force of the bar, the man will place 20 pounds of force on the bar. What moment will he create?

A. 90 pound-foot

B. 95 pound-foot

C. 100 pound-foot

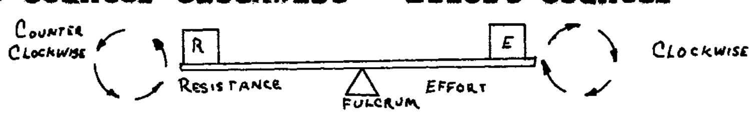
D. 105 pound-foot



10. All levers have two moments. Study the example below; select the direction of the movement of the moments.

A. Resistance Clockwise - Effort Clockwise

B. Resistance Counter Clockwise - Effort Counter Clockwise



C. Resistance Clockwise - Effort Counter Clockwise

D. Resistance Counter Clockwise - Effort Clockwise

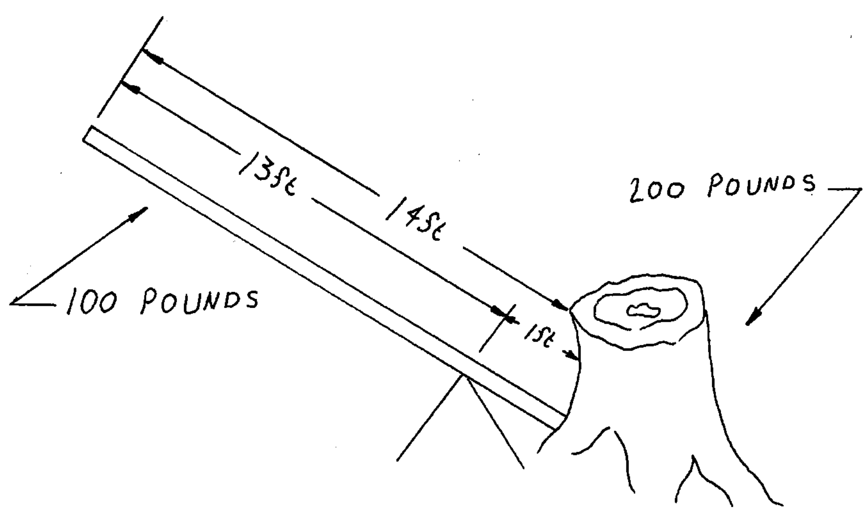
11. A farmer wishes to remove a tree stump with a lever. The bar is 14 feet long with the fulcrum placed 12 inches from the stump. The farmer will exert 100 pounds pressure on the effort, while the stump will exert 200 pounds of force on the resistance arm. What is the ideal mechanical advantage of this lever?

A. 12

B. 14

C. 25

D. 100



In the following questions you will be asked to solve for the actual mechanical advantage. The formula is:

$$\text{A.M.A.} = \frac{\text{RESISTANCE FORCE}}{\text{EFFORT FORCE}}$$

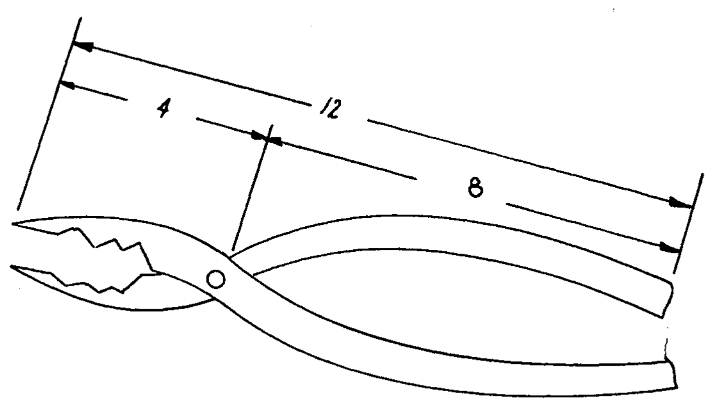
12. A pair of pliers has an overall length of twelve inches. The length of the effort arm is eight inches, while the length of the resistance arm is four inches. Thus the actual mechanical advantage of this pair of pliers would be:

A. 1

B. 2

C. 5

D. 12



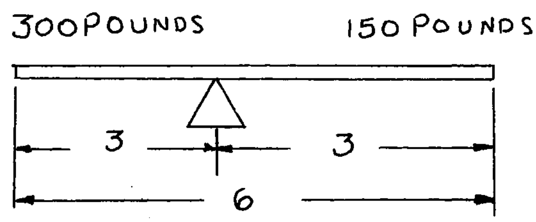
13. An acrobat wishes to turn two somersaults in mid-air. He will select a seesaw 6 feet in length with an effort arm of 3 feet and a resistance arm of 3 feet. The acrobat weighs 150 pounds and stands on the resistance arm. A weight of 300 pounds will be the actual mechanical advantage.

A. .15

B. .5

C. 3

D. 6



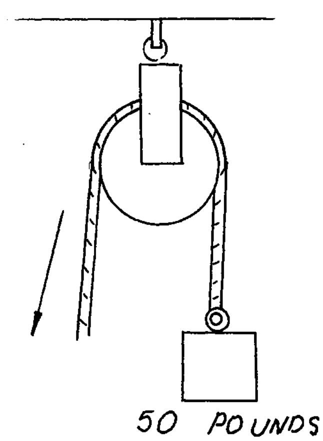
14. The pulley in the following drawing is known as:

A. Block and Tackle

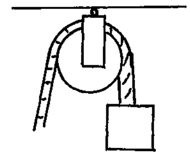
B. Movable Pulley

C. Traveling Block

D. Fixed Pulley



15. What is the practical value of the pulley shown in the following drawing?



A. Small amount of effort required to lift larger amount of weight.

B. Increases the speed by which an object may be lifted.

C. Changes the direction of the effort and resistance force.

D. There is no practical value of this pulley.

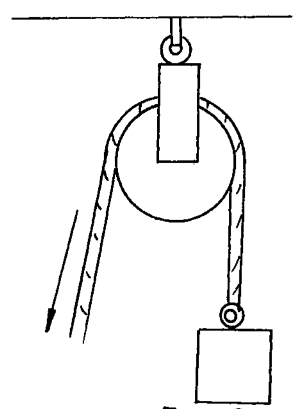
16. What is the ideal mechanical advantage of the pulley in the following drawing?

A. 1.0

B. 1.5

C. 2.0

D. 2.5



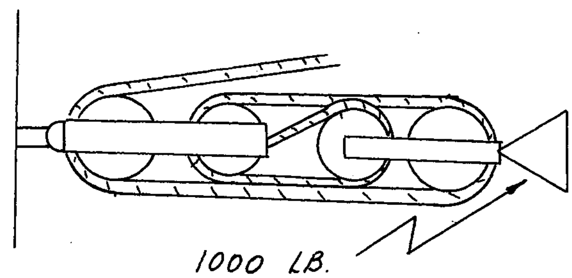
17. What amount of effort force would be required to raise a thousand pound weight the height of a two story building with the following block and tackle? The ideal mechanical advantage is 5.

A. 198 pounds

B. 199 pounds

C. 200 pounds

D. 201 pounds



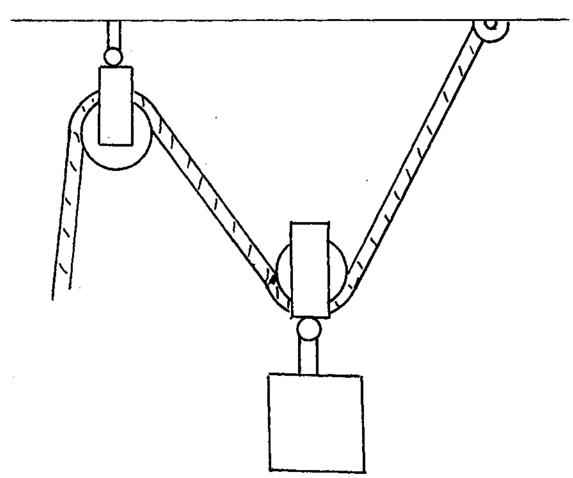
18. What is the ideal mechanical advantage of the pulley in the following drawing?

A. 2

B. 5

C. 15

D. 20



In the following problems the formula for determining the mechanical advantage of the wheel and axle is:

$$\text{M.A.} = \frac{\text{Diameter of Wheel}}{\text{Diameter of Axle}}$$

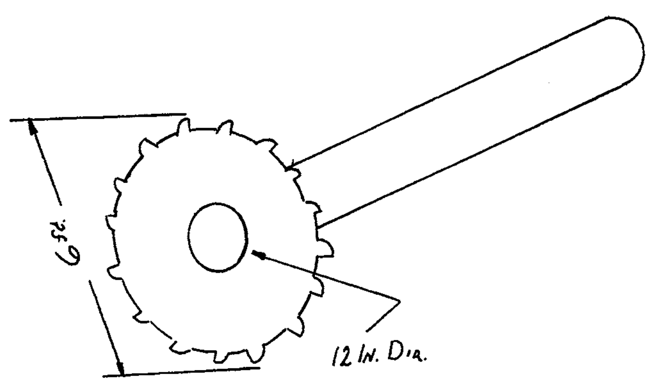
19. In a certain sawmill is a circular saw with a diameter of six feet, the arbor or axle of the saw has a diameter of twelve inches. What is the mechanical advantage of this wheel and axle?

A. 6

B. 12

C. 18

D. 72



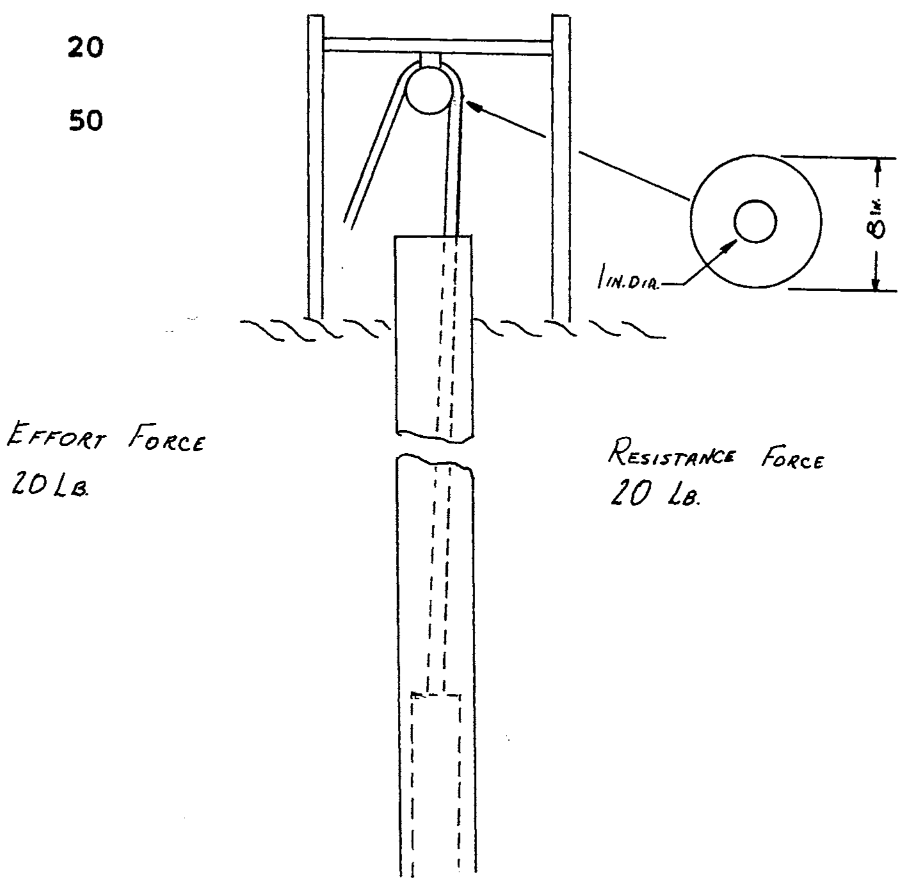
20. A single pulley wheel will be placed over an open well to draw a water bucket weighing twenty pounds. The depth of the well is fifty foot, which will require an effort force of twenty pounds. The diameter of the pulley wheel is eight inches and contains an axle with a diameter of one inch. What is the mechanical advantage of the pulley wheel?

A. 1

B. 8

C. 20

D. 50



In the following problems you will be asked to compute either the mechanical advantage or the effort force of an inclined plane. Therefore, the following formulas should be used:

$$(1) \quad \text{Mechanical Advantage} = \frac{\text{Length of Inclined Plane}}{\text{Height of Inclined Plane}}$$

$$(2) \quad \text{Effort Force} = \frac{\text{Weight of Object}}{\text{Mechanical Advantage}}$$

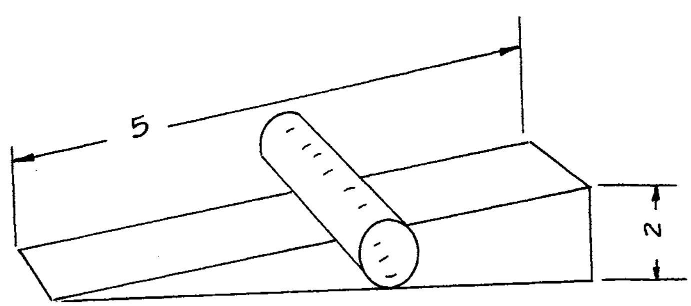
21. A man would like to move a pipe up a length of inclined plane of five feet. The height of the inclined plane is two feet. What is the mechanical advantage of this machine?

A. 2.0

B. 2.5

C. 5.0

D. 5.5



In the following problems you will be asked to determine the mechanical advantage of a wedge. The formula is:

$$\text{M.A.} = \frac{\text{Length of Wedge}}{\text{Thickness of Wedge}}$$

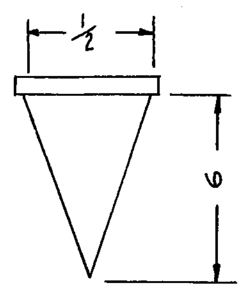
22. The mechanical advantage of the wedge in the following problem is:

A. 1

B. 3

C. 5

D. 7



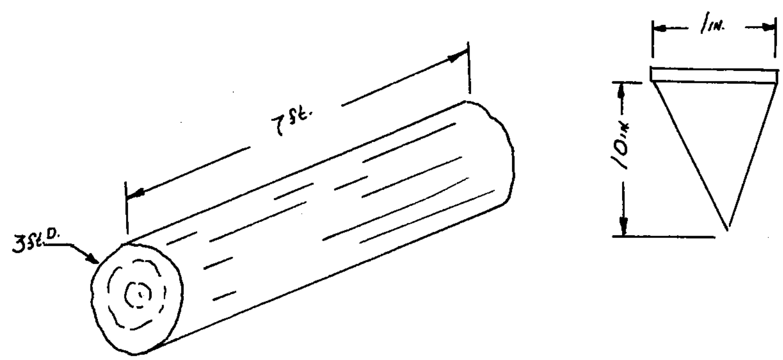
23. A farmer wishes to split fence posts from a log. The wedge he selects is one inch thick and ten inches in length. What is the mechanical advantage of this wedge?

A. 6.5

B. 7

C. 10

D. 10.5



24. The wood screw is a good example of which machine?

A. A circular lever

B. A circular pulley

C. A circular wedge

D. A circular inclined plane

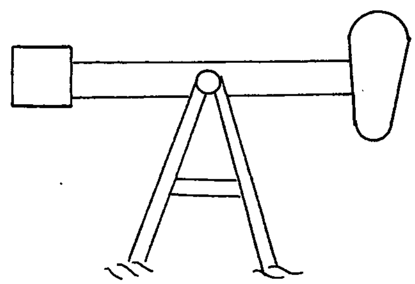
25. Study the following drawing of an oil field pump. Number one in the drawing would be referred to as which of the following simple machines:

A. Lever

B. Fulcrum

C. Pulley

D. Wedge



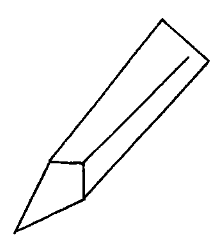
26. Study the following drawing of a cold chisel. Which of the following simple machines are illustrated:

A. Lever

B. Inclined Plane

C. Wedge

D. Circular Inclined Plane



In the following questions you will be asked to solve problems which involve both work input and work output. The formulas for which are as follows:

Work Input = Effort Distance X Effort Force

$$Wi = De \times Fe$$

Work Output = Resistance Distance X Resistance Force

$$Wo = Dr \times Fr$$

27. The effort force used with a certain set of pulleys is thirty pounds. When this effort force is moved three feet, what is the amount of work input?

A. 3

B. 30

C. 90

D. 900

28. A lever is capable of lifting a weight of 200 pounds a distance of 24 inches. What is the work output of this machine?

A. 2

B. 24

C. 200

D. 400

29. A man with a block and tackle moved 400 pounds of bricks a height of six feet by placing an effort force of 50 pounds to obtain an effort distance of 15 feet. What are the work input and work output for this machine?

A. Work input 50 ft. lb.
Work output 100 ft. lb.

B. Work input 750 ft. lb.
Work output 600 ft. lb.

C. Work input 600 ft. lb.
Work output 750 ft. lb.

D. Work input 100 ft. lb.
Work output 50 ft. lb.

30. Today we measure the power of a machine or the rate at which work is done by a term known as horsepower. Horsepower is defined as:

A. 550 ft. lb. of work in 1 second of time

B. 550 ft. lb. of work in 1 minute of time

C. 550 ft. lb. of work in 1 hour of time

D. 550 ft. lb. of work in 1 day of time

31. Determine the amount of power used in the following problem?

Force = 90 lb.

Distance = 20 feet

Time = 5 seconds

A. 5 ft. lb.

B. 20 ft. lb.

C. 36 ft. lb.

D. 180 ft. lb.

32. A lever can move a force of 220 pounds a distance of one yard in one minute. How much power does the machine use to move the weight?

A. 11 ft. lb.

B. 22 ft. lb.

C. 220 ft. lb.

D. 110 ft. lb.

33. Determine the horsepower of the machine in the following problems:

Force = 2500 pounds

Distance = 3 yards

Time = 1 minute

A. .3 hp.

B. .9 hp.

C. 1.3 hp.

D. 1.9 hp.

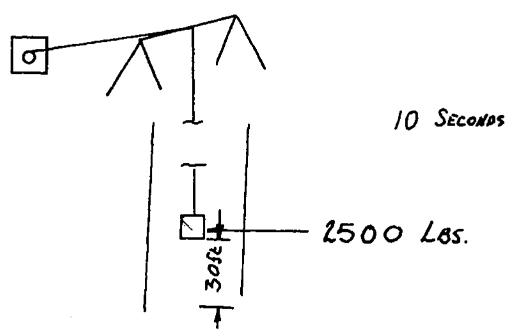
34. A winch is attached to an elevator in a mine shaft by a rope and pulley. The winch can lift 25,000 pounds a distance of 30 feet in 10 seconds. What is the horsepower of this machine?

A. 5.0 hp.

B. 9.7 hp.

C. 10.0 hp.

D. 13.6 hp.



ANSWER SHEET

MULTIPLE CHOICE

Below you will find a series of numbers which correspond with the numbers of the questions on your test. Each one of the numbers has four letters, A, B, C and D. You are to select the correct choice from your test and color the block on your answer sheet which is the same as the letter you have selected.

EXAMPLE A

A. ( )

B. ( )

C. ( )

D. ( )

EXAMPLE B

A. ( )

B. ( )

C. ( )

D. ( )

1.

A. ( )

B. ( )

C. ( )

D. ( )

2.

A. ( )

B. ( )

C. ( )

D. ( )

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C. ( )

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C. ( )

D. ( )

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C. ( )

D. ( )

10.

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C. ( )

D. ( )

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C. ( )

D. ( )

12.

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C. ( )

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34.

A. ( )

B. ( )

C. ( )

D. ( )

APPENDIX C

LABORATORY MANUAL FOR THE UNIT OF ELECTRICITY COMPOSED OF ASSIGNMENT SHEETS AND JOB SHEETS

BLOCK I: Magnetism

JOB I: Construction of a Compass

OBJECTIVE: To Provide Experience in the Use of the Magnet, To Develop Understanding of Attraction of Poles.

MATERIALS REQUIRED:

Small Magnet

Small Piece of Wood

Glass Container of Water

PROCEDURE:

Step 1: Fill glass container with water.

Step 2: Place piece of wood in water with the magnet on top in such a manner that the wood supports the magnet.

Step 3: Allow wood and magnet to come to rest. The north pole of the magnet will point toward the magnetic north pole.

BLOCK I: Magnetism

JOB II: Experimentation With Magnetic Forces

OBJECTIVE: To Reinforce Knowledge That Forces Will Attract Only Certain Kinds of Materials, But Will Pass Through Most Materials.

MATERIALS REQUIRED:

Various Types of Magnets

Glass

Wood

Rubber

Iron

Coins

Copper

Brass

Plastic

Paper

PROCEDURE:

Step 1: Complete the check list attached to this page while using the magnet.

Step 2: Move your magnet to a point that the magnetic force will have sufficient strength to be felt. It is possible that the force will not be present. If the latter is the case, mark your check list as non-magnetic. However, if you can feel the pull or repulsion of the force field indicate that the substance is magnetic.

Step 3: Place one at a time a sheet of glass, paper, plastic, and rubber between the magnet and material to be tested. Then indicate if the current flows through that material.

	Magnetic	Non-Magnetic	Magnetic Force Flows Through	Magnetic Force Does Not Flow Through
Glass				
Thread				
Rubber				
Iron				
Coins				
Copper				
Brass				
Plastic				
Paper				
Aluminum				
Tin				
Zinc				
Cloth				
Ceramic				
Steel				

BLOCK I: Magnetism

JOB III: Development of the Earth's Magnetic Poles

OBJECTIVE: To Develop Understanding of the Magnetic Forces of the Earth, Obtained Through Construction Processes.

MATERIALS REQUIRED:

Tape

Bar Magnet

Rubber Ball 4-8 inches in diameter

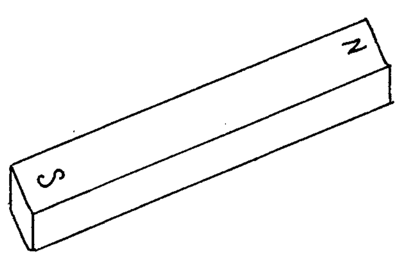
Piece of Wood 6-10 inches long by 1/2 inch wide

Compass

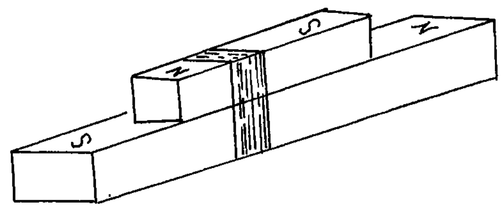
Small Flag

PROCEDURE:

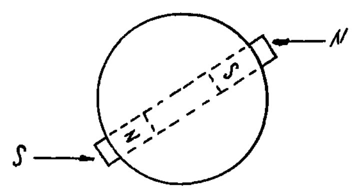
Step 1: Indicate both a north and south pole on the piece of wood.



Step 2: Tape the bar magnet to the piece of wood with its north end at the end of the wood marked south.



Step 3: Cut slots into the ball at opposite points, through which the assembled part may be inserted.



Step 4: Draw a sketch of the Americas on the ball and locate the geographical north and south poles.

Step 5: Hold a compass near the globe at different points. Explain any change in the compass reading.

ASSIGNMENT SHEET I

BLOCK I: Magnetism

SUBJECT: Identification of Magnets and Their Functions

OBJECTIVE: To Identify Magnets in Both Their Natural and Synthetic States

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 254-258.

MULTIPLE CHOICE:

1. The most common material from which magnets are made would be which of the following:

A. Lead and Steel

B. Lead and Iron

C. Brass and Steel

D. Steel and Iron

2. That natural magnetic substance known as "leading stone" to earlier sailors is known as:

A. Lodestone

B. Magnet Stone

C. Compass Stone

D. North Stone

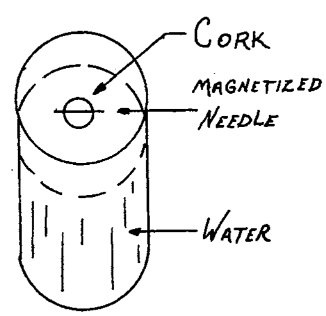
3. In this problem study the drawing below of the floating needle. Such a needle can be used as a compass. In which direction would the needle point?

A. Geographic North

B. Geographic South

C. Magnetic North

D. Magnetic South



4. That factor which determines the magnetic properties of an object is its:

A. Atomic Structure

B. Cell Structure

C. Electronic Structure

D. Electronic Charge

5. The geographic north pole is located at the exact top of the earth. However, the magnetic north pole is located at a distance of 1,000 miles from true north pole. The magnetic north pole is located on an island known as:

A. Banks Island, Canada

B. Prince of Wales Island, Canada

C. Devan Island, Canada

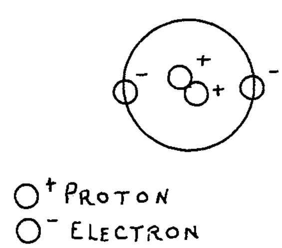
D. Prince Charles Island, Canada

6. Study the drawing of the atomic particle of a chemical substance below. Then decide if the object is magnetized or not.

A. Magnetized

B. Non-Magnetic

C. Can not answer the question with the information available.

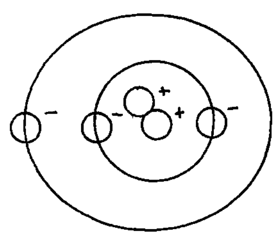


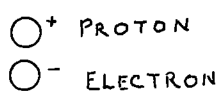
7. Study the following drawing of the atomic particle of the chemical substance then decide if the object is magnetic or not.

A. Magnetized

B. Non-Magnetic

C. Can not answer the question with the information available





KEY

ASSIGNMENT SHEET I

BLOCK I: Magnetism

1. D

2. A

3. C

4. A

5. B

6. B

7. A

BLOCK II: Static Electricity

JOB I: Production of Static Electricity With a Pencil

OBJECTIVE: To Give Student Firsthand Knowledge of Static Electricity and Attraction to Other Objects.

MATERIALS REQUIRED:

Pencil

Notebook Paper

PROCEDURE:

Step 1: Place a sheet of notebook paper on a flat surface.

Step 2: Rub the paper vigorously with the flat side of the pencil for several seconds.

Step 3: Place the sheet of paper against the chalkboard or wall.

BLOCK II: Static Electricity

JOB II: Production of Static Electricity With a Hair Comb

OBJECTIVE: To Reinforce Knowledge of Static Electricity Production Through Friction.

MATERIALS REQUIRED:

Hair Comb

Notebook Paper

PROCEDURE:

Step 1: Tear some paper into small pieces and place them on a desk.

Step 2: Take a comb and comb your hair for several seconds.

Step 3: Hold the comb above the bits of paper.

BLOCK II: Static Electricity

JOB III: Production of Electricity With a Glass Rod and Carpet Remnants.

OBJECTIVE: To Reinforce Knowledge That Static Electricity Is Produced Through Friction.

MATERIALS REQUIRED:

Glass Rod

Carpet Remnants

PROCEDURE:

Step 1: Tear some paper into small pieces and place them on a desk.

Step 2: Place carpet remnant on a flat surface.

Step 3: Rub briskly with flat side of glass rod for several seconds.

Step 4: Hold glass rod above the bits of paper.

BLOCK II: Static Electricity

JOB IV: Introduction of Third Force in the Production of Static Electricity.

OBJECTIVE: To Demonstrate the Effect of a Glass Plate and Static Electricity.

MATERIALS REQUIRED:

Hair Comb

Notebook Paper

Sheet of Glass

Blocks of Wood

PROCEDURE:

Step 1: Tear some paper into small pieces and place them on a desk.

Step 2: Take a comb and comb your hair for several seconds.

Step 3: Hold the comb above the bits of paper.

Step 4: Rearrange the bits of paper.

Step 5: Place the blocks of wood in such a position as to hold the sheet of paper above the pieces of paper.

Step 6: Again stroke your hair for several seconds with the comb and bring it near the paper underneath the glass.

ASSIGNMENT SHEET I

BLOCK II: Static Electricity

SUBJECT: Static Electricity, Its Origin and Control

OBJECTIVE: To Aid in the Development of Understanding of Static Electricity.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 258-261.

MULTIPLE CHOICE:

1. In the drawing below you will find two balls that have been attracted to each other. The result of this attraction will be a movement of electrons. This movement of electrons is known as:

A. Electrical Grounding

B. Electrical Attraction

C. Electrical Discharge

D. Electrical Intake

2. All substances are made of atoms. In turn atoms are made of protons, neutrons and electrons. Each of the three latter parts have an electrical charge. From the choices given below select the correct electrical charge for each part.

A. Protons - Positive Charge
Electrons - Negative Charge
Neutrons - Neither a Positive nor a Negative Charge

B. Protons - Negative Charge
Electrons - Positive Charge
Neutrons - Neither a Positive nor a Negative Charge

C. Protons - Neither a Positive nor a Negative Charge
Electrons - Positive Charge
Neutrons - Negative Charge

D. Protons - Negative Charge
Electrons - Neither a Positive nor a Negative Charge
Neutrons - Positive Charge

3. When a neutral object gains or loses electrons, the neutral electrical balance is upset. Study the following combinations and select the correct result of the change in electrons.

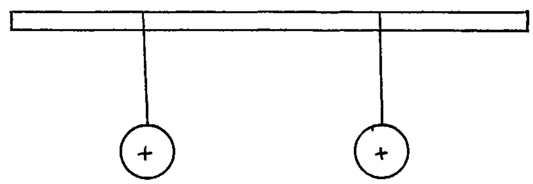
A. Gain of electrons produces positive static electricity - Loss of electrons produces negative electricity.

B. Gain of electrons produces negative static electricity - Loss of electrons produces positive static electricity.

C. Gain of electrons produces negative static electricity - Loss of electrons produces negative static electricity.

D. Gain of electrons produces positive static electricity - Loss of electrons produces positive static electricity.

4. In the drawing below you will find two balls with positive charges. What would be the reaction if the balls were allowed to swing freely.

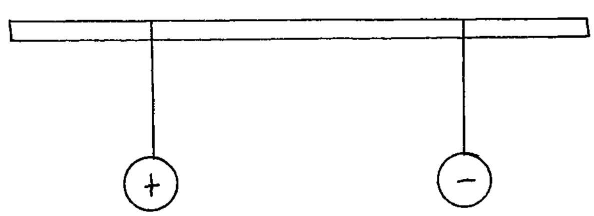


A. The two charges would repel each other

B. The two charges would attract each other

C. There would be no reaction.

5. In the drawing below you will find two balls, one contains a positive charge, while the other has a negative charge. What would be the reaction if the balls were allowed to swing freely.



A. The two charges would repeal each other

B. The two charges would attract each other

C. There would be no reaction.

KEY

ASSIGNMENT SHEET I

BLOCK II

1. C
2. A
3. B
4. A
5. B

BLOCK III: Current Electricity

JOB I: Producing Electricity With the Wet Cell Battery

OBJECTIVE: To Reinforce Knowledge of Electrical Production Through Chemical Action.

MATERIALS REQUIRED:

Zinc Strip

Copper Strip

Wooden Stick

Insulated Wire

Dilute Solution of Sulfuric Acid

Glass Jar

Water

Flashlight Bulb (1/2 Volt)

Miniature Light Socket

PROCEDURE:

Step 1: Fill the jar about 3/4 full of water.

Step 2: To the jar of water add 1/4 cup of diluted sulfuric acid.

Step 3: Cut two pieces of wire 15 inches long.

Step 4: Remove the insulation from one end of both pieces of wire.

Step 5: Attach the end with insulation removed, of one piece of wire, to the copper strip.

Step 6: Do the same with another piece of wire and attach it to the zinc strip.

Step 7: Place the two pieces of metal into the jar of diluted acid and place the wood piece between them.

Step 8: Complete the current by connecting the light bulb to the circuit.

ASSIGNMENT SHEET I

BLOCK III: Current Electricity

SUBJECT: The Study of the Movement of an Electrical Field of Force

OBJECTIVE: To Assist in the Process of Understanding the Movement of Electrical Energy.

REFERENCES: Charles H. Heimler and Charles D. Neal, *Principles of Science*, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 261-262.

MULTIPLE CHOICE:

1. A moving stream of electrons can best be described as:

A. Static Electricity

B. Current Electricity

C. Force Field

D. Grounded Force

2. Materials through which electrical current can be easily produced are known as:

A. Conductors

B. Insulators

C. Grounds

D. Terminals

3. From the list below select the material which would be the best conductor.

A. Wood

B. Plastic

C. Metals

D. Gases

4. Materials through which electrical currents have difficulty flowing are known as:

A. Conductors

B. Insulators

C. Grounds

D. Terminals

5. From the list of materials below select the substances which would not allow electrical current to pass through itself.

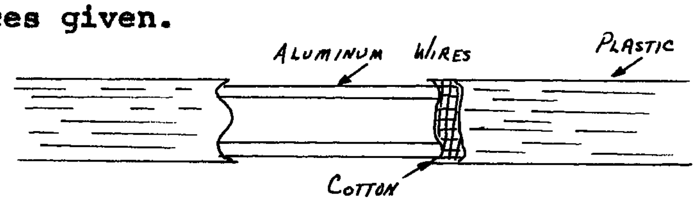
A. Copper

B. Rubber

C. Water

D. Silver

6. Study the drawing below of the section of electrical wiring. Then select the appropriate safety precaution from the choices given.



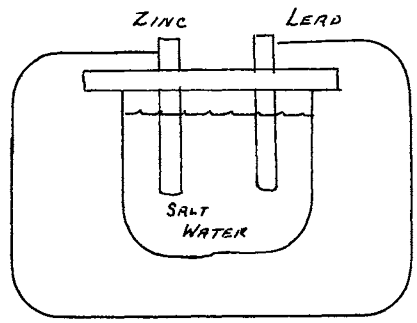
A. You may safely touch this wiring if your hands are dry.

B. Because the wire is made of aluminum you are in no danger of electrical shock.

C. The exposed distance is so small that even if you should receive an electrical shock it would be extremely mild.

D. Never touch a wire that is not insulated unless the current is turned off.

7. Study the drawing below and select the correct name from the choices given.



A. Wet Cell

B. Dry Cell

C. Storage Cell

D. Chemical Cell

8. In the drawing shown in question number seven the cell functions for which of the following reasons:

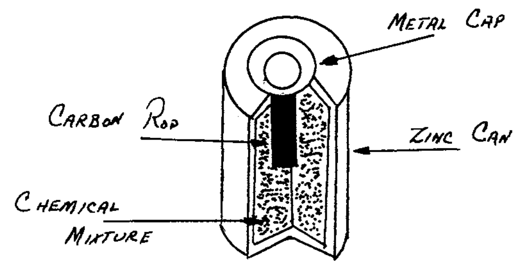
A. The salt water serves as an insulation.

B. The copper wire prevents the flow of electrons, therefore that flow must take place through the salt water.

C. The electrons flow from the zinc to the lead because the zinc loses electrons more easily than does the lead.

D. The electrons flow from the lead to the zinc because of the reaction between lead and salt water.

9. Study the drawing below and select the correct name from the choices given.



A. Wet Cell

B. Dry Cell

C. Storage Cell

D. Chemical Cell

10. The point through which electricity flows into or out of a cell is known as:

A. Electrical Point

B. Electrical End

C. Terminal

D. Post

11. The path through which current flows from terminal to terminal is which of the following:

A. Through both the positive and the negative terminal

B. Through the positive to the negative terminal

C. Through the negative to the positive terminal

D. Current does not flow through the terminals.

12. That instrument which is used to detect electric currents is known as:

A. A Galvanometer

B. A Generator

C. The Piezo Pressure Meter

D. The Thermocouple

13. When two or more cells are combined to produce a single current the resulting object is produced:

A. A Multicell

B. A Storage Unit

C. A Cell

D. A Battery

KEY

ASSIGNMENT SHEET 1

BLOCK III

1. B
2. A
3. C
4. B
5. B
6. D
7. A
8. C
9. B
10. C
11. C
12. A
13. D

BLOCK IV: Series and Parallel Circuits

JOB I: Construction of a Fuse

OBJECTIVE: To Provide Experience in Use of Fuse to Prevent Overheating of Short Circuits.

MATERIALS REQUIRED:

Battery

Insulated Wire

Tin Foil

Two Paper Clips

Block of Wood

PROCEDURE:

Step 1: Select a piece of wire approximately 15 inches long.

Step 2: Cut the wire in the middle and remove the insulation from the ends of both pieces of wire.

Step 3: Connect one piece of wire to the positive terminal and the other end to a paper clip.

Step 4: Connect the second piece of wire to the negative terminal and to the second paper clip.

Step 5: The paper clips should now be placed into grooves cut in the board. The result is that the paper clips will stand erect. Place these clips at a distance apart of approximately one inch.

Step 6: Cut a single layer of tin foil of a little over an inch in length and approximately one-half inch in width. The tin foil should be cut at a taper from both ends toward the middle with the center being the most narrow area.

Step 7: Place one end of the tin foil in one of the paper clips and the opposite end in the second clip.

Step 8: Allow time for current to flow and produce heat.

BLOCK IV: Series and Parallel Circuits

JOB II: Making a Series Circuit

OBJECTIVE: To Aid Students in Recognization of a Series Circuit.

MATERIALS REQUIRED:

Battery

Light Bulbs

Miniature Sockets

Insulated Bell Wire

PROCEDURE:

Step 1: Have students develop a circuit using only one path through which the current can flow.

Step 2: Each item in the circuit must be connected so that the current will pass directly through the item.

Step 3: Use as many load items as desired in the circuit.

BLOCK IV: Series and Parallel Circuits

JOB III: Making a Parallel Circuit

OBJECTIVE: To Aid Students in Recognization of a Paralle Circuit.

MATERIALS REQUIRED:

Battery

Light Bulbs

Miniature Sockets

Insulated Bell Wire

PROCEDURE:

Step 1: Have students develop a circuit through which the current will flow through each socket separately.

Step 2: Use as many load items as desired in the circuit.

ASSIGNMENT SHEET I

BLOCK IV: Series and Parallel Circuits

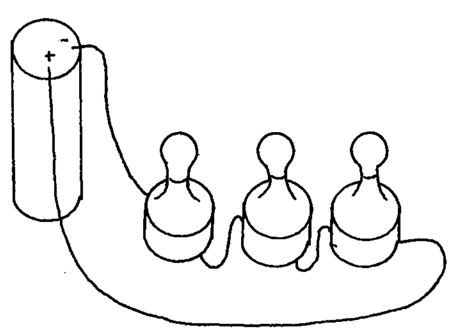
SUBJECT: The Fundamentals of an Electrical Circuit.

OBJECTIVE: To Assist the Student in Discovering That Electricity Can Flow Only in a Closed Circuit.

REFERENCES: Charles H. Heimler and Charles D. Neal, <u>Principles of Science</u>, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 262-263.

MULTIPLE CHOICE:

1. Study the drawing below of a wired circuit then identify the name of that circuit.



A. Single Wire

B. Single Pole

C. Series

D. Positive

2. A circuit through which electricity is flowing is said to be:

A. Closed

B. Opened

C. Channeled

D. Apertured

3. A circuit which is not connected either by turning off a switch, removing a fuse, pulling out a plug or disconnecting or cutting the wires is said to be:

A. Closed

B. Opened

C. Channeled

D. Apertured

4. From the choices given below select the two methods of wiring a circuit:

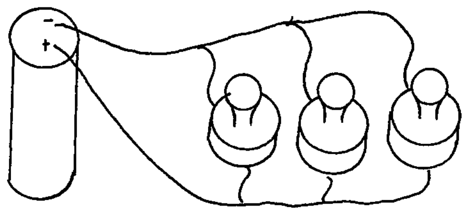
A. Single Wire - Double Wire

B. Single Pole - Double Pole

C. Series - Parallel

D. Positive - Negative

5. Study the drawing below of a wired circuit then identify the name of that circuit.



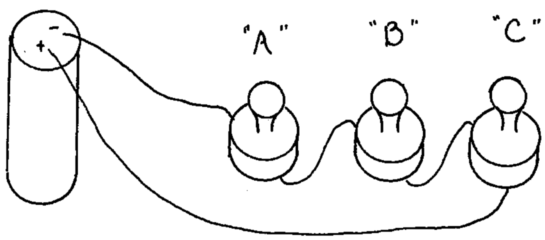
A. Double Wire

B. Double Pole

C. Parallel

D. Negative.

6. Study the drawing below of a wired circuit. What would be the result if light bulb "A" failed to function?



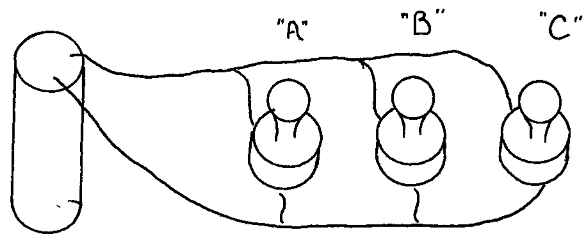
A. Only light "A" would cease to function

B. All lights would cease to function

C. Light "A" and "B" would not burn; light "C" would continue to operate.

D. Light "A" and "C" would not burn; light "B" would continue to operate.

7. Study the drawing below of a wired circuit. What would be the result if light bulb "A" failed to function?



A. Only light "A" would cease to function.

B. All lights would cease to function.

C. Light "A" and "B" would not burn; light "C" would continue to operate.

D. Light "A" and "C" would not burn; light "B" would continue to operate.

KEY

ASSIGNMENT SHEET I

BLOCK IV

1. C
2. A
3. B
4. C
5. C
6. B
7. A

BLOCK V: Direct and Alternating Current

JOB I: Construction of an Electric Motor

OBJECTIVE: To Provide Experience and Opportunities For Understanding of Alternating and Direct Current.

MATERIALS REQUIRED:

Wood 1" X 5" X 6"

Wood 3/8" X 1-1/8" X 2"

Six Wire Brads

Nineteen Feet of #22 D.C.C. Copper Wire

Two Small Staples

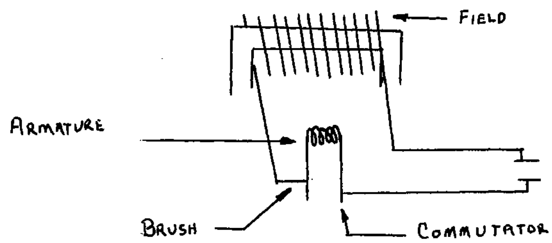
Twenty-One Pieces of Metal "L" Shaped
3/4" X 2-3/4" X 3-1/2"

Forty Spacers 3/4" X 2"

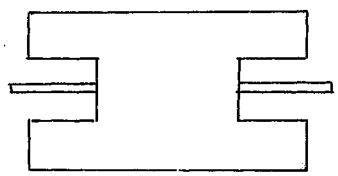
Two Stove Bolts and Four Nuts

PROCEDURE:

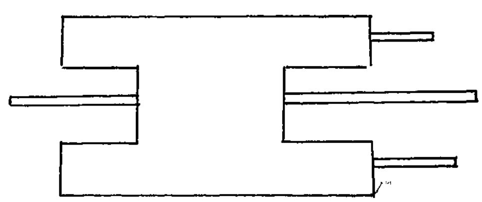
Step 1: Study the following electrical diagram.



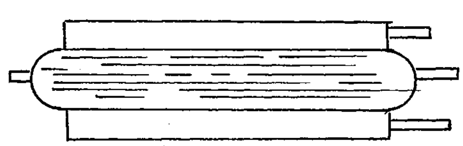
Step 2: Insert two brads into the armature as shown below.



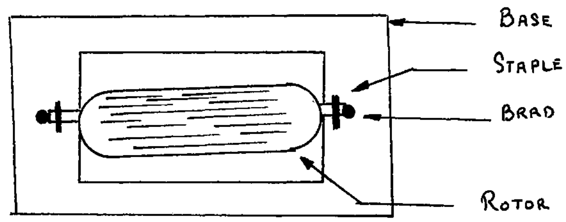
Step 3: Insert two smaller brads into the end of the armature to form the commutator.



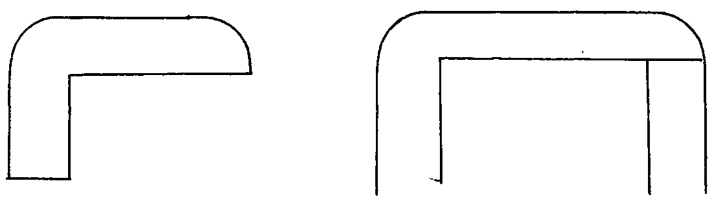
Step 4: Wrap fifty turns of #22 D.C.C. copper wire around the armature and then bind with tape.



Step 5: The rotor is now attached to the base with two small staples. The end play is adjusted by driving a small brad at each end of the commutator shaft.



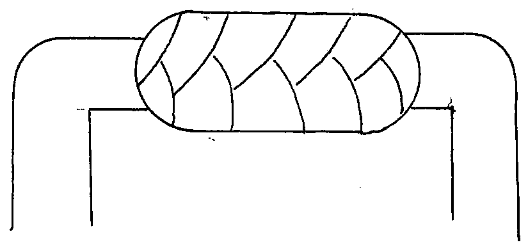
Step 6: Assemble the core by placing the twenty-one laminated pieces together to form the object below.



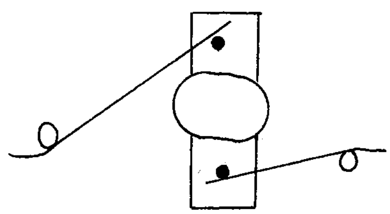
Place ten on one side and eleven on the opposite side. Between each of the laminated sections insert a spacer.

The four laminated pieces which are made longer are used for mounting the field to the base.

Step 7: The core is wound with 150 turns of #22 D.C.C. copper wire and taped.



Step 8: Connect brushes as shown below.



Step 9: Current is supplied by dry cell batteries.

ASSIGNMENT SHEET I

BLOCK V: Direct and Alternating Current

SUBJECT: Identification of Direct and Alternating Current and the Characteristics of Each Type of Current.

OBJECTIVE: To Develop Insights and Understandings of How Electricity is Produced.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 263-266.

MULTIPLE CHOICE:

1. The electrons which produce the current in a 60 cycle current move back and forth through the wire at the rate of which of the following:

A. 60 times per second or 3,600 times per minute

B. 60 times per minute or 3,600 times per hour

C. 60 times per hour or 1,440 times per day

D. 60 times per hour on the half hour or 1,440 times per day.

2. That current produced by a dry cell or a storage battery is known as:

A. Direct Current

B. Directional Current

C. Alternating Current

D. Artificial Current

3. That current which flows for a short time in one direction then stops, reverses and flows in the opposite direction is known as:

A. Direct Current

B. Directional Current

C. Alternating Current

D. Artificial Current

4. That current in which the movement of the electrons is continuous and in one direction is known as:

A. Direct Current

B. Directional Current

C. Alternating Current

D. Artificial Current

5. The most common type of current in the home is which of the following:

A. Direct Current

B. Directional Current

C. Alternating Current

D. Artificial Current

6. The electricity for your home is produced by what means?

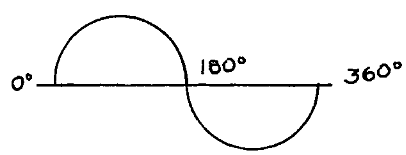
A. Dry Cell Batteries

B. Wet Cell Batteries

C. Storage Batteries

D. Generators

7. What type of current which if measured in a wave diagram would look like the drawing below is known as:



A. Direct Current

B. Directional Current

C. Alternating Current

D. Artificial Current

KEY

ASSIGNMENT SHEET I

BLOCK V

1. A
2. A
3. C
4. A
5. C
6. D
7. C

ASSIGNMENT SHEET I

BLOCK VI: Measurement of Current Electricity

SUBJECT: The Measurement of Electrical Current Through The Use of Coulombs, Amperes, Volts and Ohms.

OBJECTIVE: To Reinforce the Understanding of Computation Of Problems Dealing With Electrical Measurement.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 266-268.

MULTIPLE CHOICE:

1. The rate of flow of electricity for a period of time is which of the following units?

A. Coulomb

B. Ampere

C. Volt

D. Ohm

2. When you measure a quantity of water flowing through a pipe, you use a unit such as the gallon, cubic foot or pound. However, when you measure a quantity of electricity you need a different unit of measurement. Which of the following units would be used for the quantity of electricity?

A. Coulomb

B. Ampere

C. Volt

D. Ohm

3. All materials through which electricity flows offers some form of resistance. Electrical resistance is measured in which of the units listed below?

A. Coulomb

B. Amperes

C. Volts

D. Ohms

4. Electricity flows from one point to another because of an electrical force. This force is measured in:

A. Coulomb

B. Amperes

C. Volts

D. Ohms

KEY

ASSIGNMENT SHEET I

BLOCK VI

1. B

2. A

3. D

4. C

ASSIGNMENT SHEET I

BLOCK VII: Ohm's Law

SUBJECT: Methods of Determining Current, Volts and Ohms Mathematically Through Ohm's Law

OBJECTIVE: To Develop Understanding of Methods of Computation Used in Calculating Current, Volts and Ohms.

REFERENCES: Charles H. Heimler and Charles D. Neal, Principles of Science, Charles E. Merrill Publishing Co., (Columbus, Ohio, 1966), pp. 268-270.

MULTIPLE CHOICE:

1. According to Ohm's Law when the voltage in a circuit doubles what is the reaction of the amperes?

A. The amperes are reduced as the volts are increased

B. The amperes are not effected by the action of the volts.

C. The amperes increase proportionately with the increase in volts.

D. The term ampere and volt refer to the same phase of electricity, therefore amperes and volts are exactly the same thing.

2. According to Ohm's Law when the number of ohms is increased what is the reaction of the amperes?

A. The amperes are reduced

B. The amperes are not effected by the number of ohms

C. The amperes increase proportionately with the increase in ohms

D. The term amperes and ohms refer to the same phase of electricity, therefore amperes and ohms are exactly the same thing.

In the following problems the formula for Ohm's Law should be used in the process of solving the mathematical problems.

$$\text{Current} = \frac{\text{Electric Energy Per Charge}}{\text{Electrical Resistance}}$$

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$$

$$I = \frac{E}{R}$$

3. The generator of a car produces 12.0 volts of electrical energy per charge in a circuit. The resistance is 4.0 ohms. What quantity of current flows through the wires in this circuit?

A. 2.5 amperes

B. 3.0 amperes

C. 3.5 amperes

D. 4.0 amperes

4. The current passing through the tail light of an automobile is 6.0 amp. The resistance is 2.0 ohms. What is the voltage in this circuit?

A. 12.0 volts

B. 12.5 volts

C. 13.0 volts

D. 13.5 volts

5. A circuit has a current of 4.5 amp flowing through it. If the voltage is 24.3 volts, what is the resistance of the wire in the circuit?

A. 5.1 ohms

B. 5.2 ohms

C. 5.3 ohms

D. 5.4 ohms

6. In an effort to determine the number of amperes in a circuit one would apply Ohm's Law in the following manner:

A. Divide the number of volts into the number of ohms

B. Divide the number of ohms into the number of volts

C. Multiply the number of volts by the number of ohms

D. Add the number of volts to the number of ohms.

7. In an effort to determine the volts in a circuit according to Ohm's Law one would:

A. Divide the number of amperes into the number of ohms

B. Divide the number of ohms into the number of amperes

C. Multiply the number of ampere by the number of ohms

D. Add the number of amperes to the number of ohms.

8. When a person would like to know the amount of resistance in a circuit, he would use Ohm's Law in the following manner:

A. Divide the number of amperes by the number of volts

B. Divide the number of volts by the number of amperes

C. Multiply the number of volts by the number of amperes

D. Add the number of volts to the number of amperes.

KEY

ASSIGNMENT SHEET I

BLOCK VII

1. C
2. A
3. B
4. A
5. D
6. A
7. C
8. A

APPENDIX D

PRE-TEST AND POST-TEST

FOR THE UNIT OF

ELECTRICITY

PRE-TEST

EXAMPLE A

The first president of the United States was which of the following:

A. Abraham Lincoln

B. Andrew Jackson

C. John Adams

D. George Washington

EXAMPLE B

From the choices given below select the correct sum of the following numbers, 50 + 49:

A. 96

B. 99

C. 102

D. 105

1. That civilization which first used the term electricity was:

A. The Greek

B. The Roman

C. The Hebrew

D. The Egyptian

2. During the early 19th Century a man by the name of Hans Christian Oersted discovered the relationship between:

A. Magnetism and Lodestones

B. Magnetism and Amber

C. Electricity and Magnetism

D. Electricity and Lightning

3. That natural magnetic substance which was earlier called a "leading stone" is today known as which of the following:

A. The Geographic North Pole

B. Magnets

C. The North Magnetic Pole

D. Lodestone

4. All compasses have a needle which points in one direction. This needle has two ends or poles which are known as the:

A. East Pole - West Pole

B. East Pole - South Pole

C. North Pole - West Pole

D. North Pole - South Pole

5. The magnetic north pole can be described as:

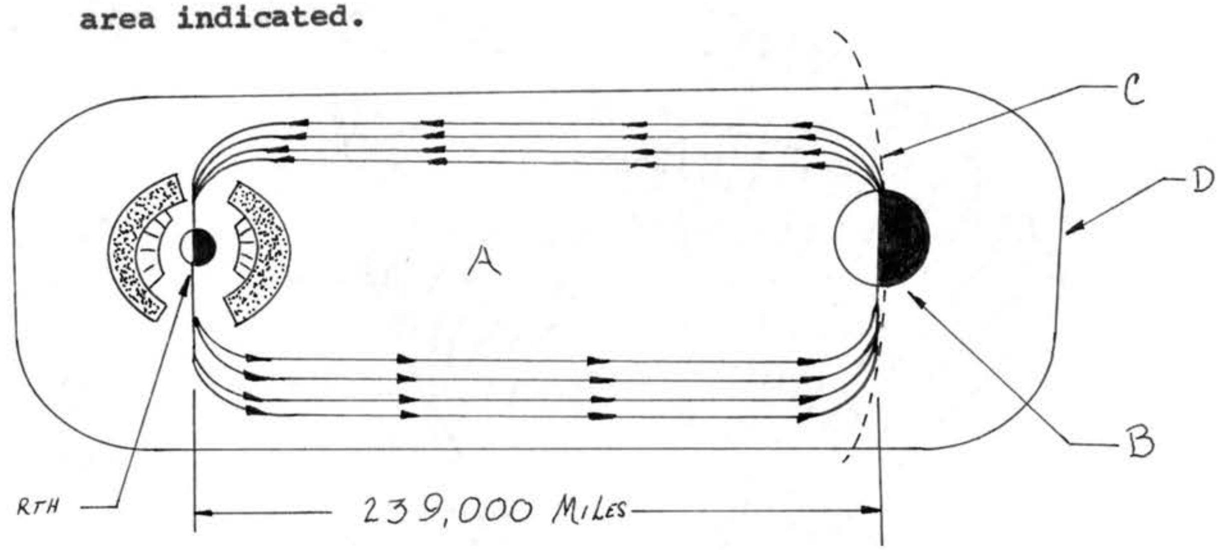
A. Stationary (always in the same exact position)

B. Not stationary (rather moves in a straight line from east to west

C. Not stationary (rather moves in a circle - a curve in which all points are an equal distance from the center of the circle)

D. Not stationary (rather moves in an ellipse - a curve in which all points are not an equal distance from the center of the circle)

Study the drawing below of the earth's magnetic force lines. Then select the correct name for the area indicated.



6. In the drawing above the letter B stands for which of the following:

A. Sun

B. Moon

C. North Star

D. Mars

7. In the preceding drawing the letter D stands for which of the following:

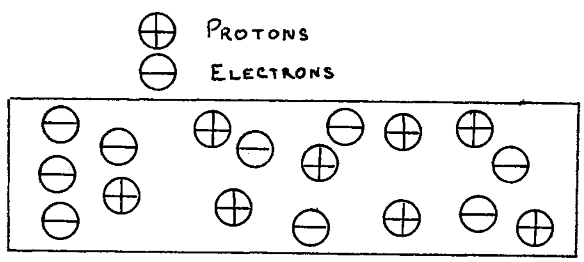
A. Earth's radiation belts

B. Merrill radiation belts

C. Heimler radiation belts

D. Van Allen radiation belts

8. Study the drawing of the object below and then determine what is the nature of the charge of static electricity.



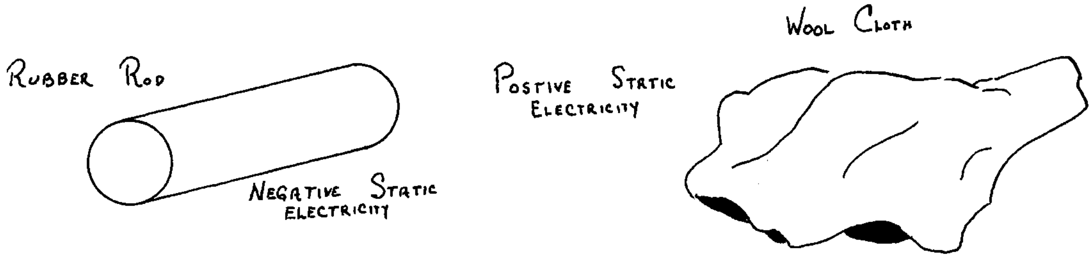
A. A neutral object

B. A positive charged object

C. A negative charged object

D. None of these

9. Study the drawing of the rubber rod and wool cloth shown below. Assume that the rubber rod has been rubbed with the cloth. The result is a flow of electrons. Determine which of the two objects gained electrons and which lost electrons.



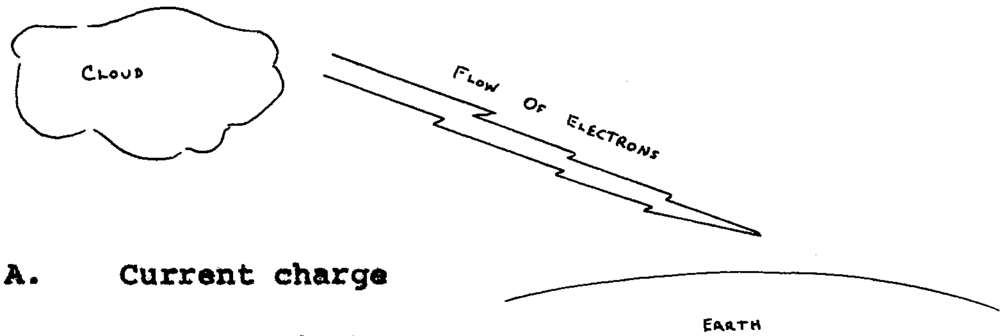
A. Rubber rod gained electrons - wool cloth gained electrons

B. Rubber rod lost electrons - wool cloth lost electrons

C. Rubber rod gained electrons - wool cloth lost electrons

D. Rubber rod lost electrons - wool cloth gained electrons

10. In the drawing of the clouds below the lightning is an example of which of the following terms:



A. Current charge

B. Current discharge

C. Electrical charge

D. Electrical discharge

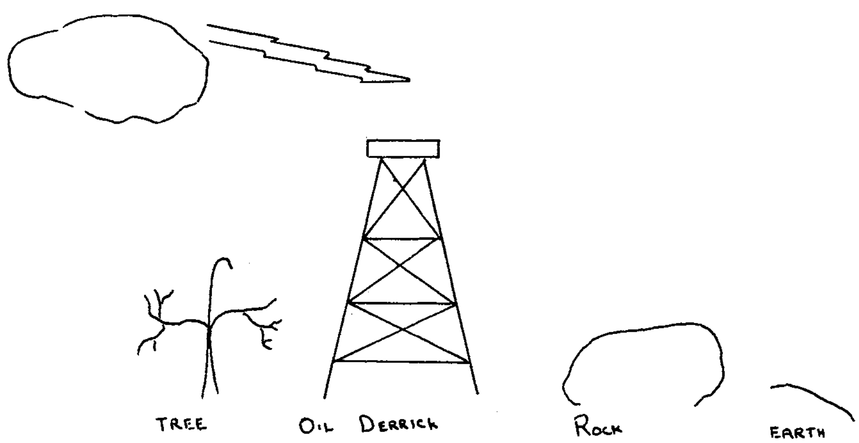
11. Study the drawing below of the cloud, lightning and objects on the ground. Which of the four objects would the lightning most likely strike?

A. 1

B. 2

C. 3

D. 4



12. That electrical current which consists of a moving stream of electrons is known as which of the following?

A. Static electricity

B. Electric current

C. Grounded current

D. Resistance current

13. Substances through which electrical current cannot be easily produced are known as:

A. An open switch

B. An insulator

C. A conductor

D. A terminal

14. The pathway through which an electrical current flows is known as:

A. An insulator

B. A ground

C. A closed circuit

D. An electrical circuit

15. That instrument which is used to measure and detect electrical current is known as:

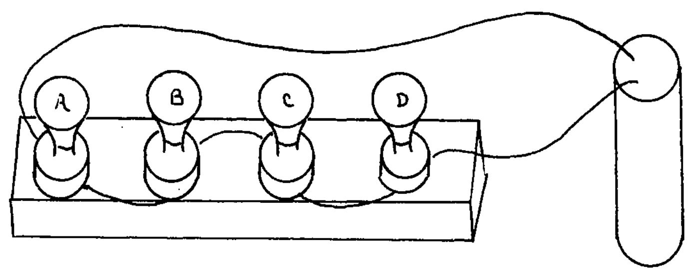
A. A switch

B. A terminal

C. A galvanometer

D. A cell

16. Study the drawing of the lights connected in a series circuit. What would be the result if light bulb "A" should be removed from its base?



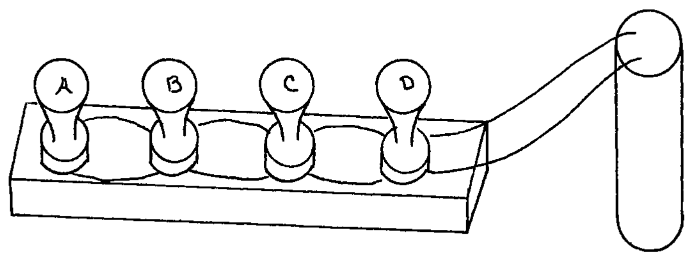
A. All of the lights would cease to function.

B. Lights "A" and "B" would cease to function; the remaining lights would burn.

C. Lights "B" and "D" would function while lights "A" and "C" would not burn.

D. All lights except "A" would function properly.

17. Study the drawing of the lights which are connected in a parallel circuit. What would be the result if light bulb "A" should fail to function.



A. All of the light bulbs would cease to function.

B. All of the light bulbs except "A" would function properly.

C. Light bulbs "A" and "D" would not function, while light bulbs "B" and "C" would continue to burn.

D. Lights "A" and "B" would fail to function while light bulbs "C" and "D" would continue to burn.

18. The current produced by a dry cell and storage battery is known as which of the following?

A. Alternating current

B. Auxiliary current

C. Direct current

D. Directional current

19. The electrons that produce current in your home will change directions many times per second. Select the number of times this change in direction will take place from the choices given below:

A. 40 times per second

B. 45 times per second

C. 50 times per second

D. 60 times per second

20. As the electrical current flows through a material it encounters various amounts of difficulty. The difficulty confronted in some conductors is very small, while in other such as rubber it is very great. This difficulty is known as:

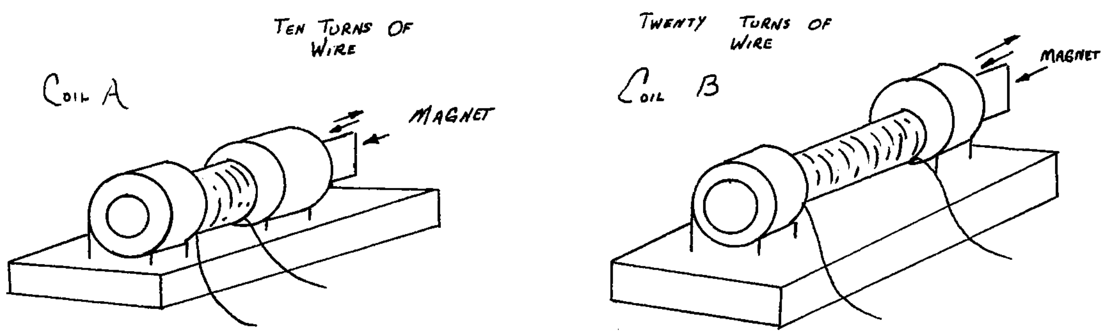
A. Electrical obstruction

B. Electrical repulsion

C. Electrical resistance

D. Electrical stoppage

21. Study the drawings of the two coils of wire shown below. Electrical current will be produced if a magnet is moved through the center of the coils. You will notice that coil "A" has ten turns of wire while coil "B" has twenty turns of wire. Given below are four possible results when current is produced from the coils. Select the correct one.



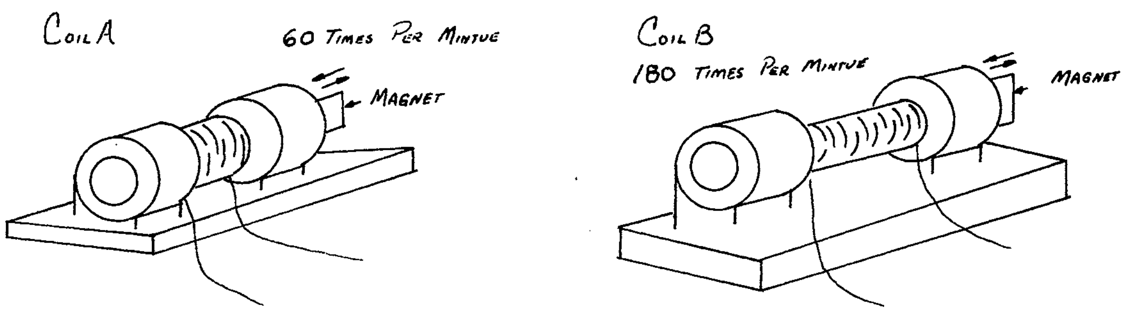
A. The current will be the same for both coil "A" and coil "B".

B. Coil "A" will produce a greater amount of current than coil "B".

C. Coil "B" will produce a greater amount of current than coil "A".

D. Neither coil "A" nor coil "B" are capable of producing an electrical current.

22. Study the drawings of the two coils of wire below. Electrical current will be produced if a magnet is moved through the center of the coils. You will notice that both coils have the same number of turns of wire and the same strength of magnets, however they differ in speed at which the magnet passes through the coil.



A. The current will be the same for both coil "A" and coil "B".

B. Coil "A" will produce a greater amount of current than coil "B".

C. Coil "B" will produce a greater amount of current than coil "A".

D. Neither coil "A" nor coil "B" are capable of producing an electrical current.

23. Select the power source of A.C. (Alternating Current) electricity which is known as household electricity from the choices given below:

A. Wet cell battery

B. Dry cell battery

C. Storage battery

D. Water or steam turbines

24. The rate of flow of electricity measured in time is known as an ampere. From the choices given below select the correct amount of electricity and time required for one ampere.

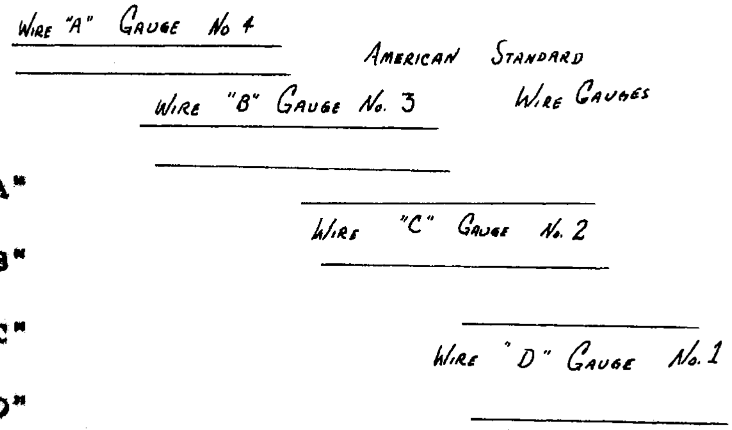
A. One coulomb of electrical charge per second

B. Ten coulomb of electrical charge per second

C. One coulomb of electrical charge per minute

D. Ten coulomb of electrical charge per minute

25. Below you will find several thicknesses of wire. Select the wire which would maintain the least amount of ohms.



A. Wire "A"

B. Wire "B"

C. Wire "C"

D. Wire "D"

26. According to Ohm's Law when the number of ohms of resistance is increased, what will be the result of the amperes?

A. The increase in ohms will not effect the amperes.

B. The increase in ohms will result in the number of amperes doubling.

C. The increase in ohms will result in the amperes increasing by one-half of their number.

D. The increase in ohms will result in a reduction of the amperes.

27. In the 1800's a German physicist developed a mathematical relationship between current, voltage and resistance. From the list of names below identify this man:

A. Frank D. Graham

B. George Simon Ohm

C. C. O. Mawson

D. Erik S. Broune

In the following problems use Ohm's Law as expressed in the equations below:

$$\text{Current} = \frac{\text{Electric energy per charge}}{\text{Electric resistance}}$$

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$$

$$I = \frac{E}{R}$$

28. The amount of electricy entering a house is 110 volts. However, the resistance encountered in the wiring is 6 ohms. What is the correct amount of current or amperes flowing through the wires?

A. 18.33

B. 18.66

C. 18.99

D. 19.32

29. A car generator produces 12 volts of electricity. However, the resistance encountered by the wiring is 1.5 ohms. How many amperes will be conducted through the wires?

A. 0.6 amperes

B. 0.7 amperes

C. 0.8 amperes

D. 0.9 amperes

30. A circuit has a current of 10 amps flowing through it. If the resistance is measured at 11 ohms what is the voltage of the circuit?

A. 109.5 volts

B. 110.0 volts

C. 110.5 volts

D. 111.0 volts

31. A circuit has a current of 15 amps flowing through it. If the voltage is 110 volts, what is the resistance of the wire in the circuit?

A. 6.66 ohms

B. 6.99 ohms

C. 7.00 ohms

D. 7.33 ohms

KEY

PRE-TEST

1.	A	19.	D
2.	C	20.	C
3.	D	21.	C
4.	D	22.	C
5.	D	23.	D
6.	B	24.	A
7.	D	25.	D
8.	A	26.	D
9.	C	27.	B
10.	D	28.	A
11.	B	29.	C
12.	B	30.	B
13.	B	31.	D
14.	D		
15.	C		
16.	A		
17.	B		
18.	C		

POST-TEST

EXAMPLE A

The first president of the United States was which of the following:

A. Abraham Lincoln

B. Andrew Jackson

C. John Adams

D. George Washington

EXAMPLE B

From the choices given below select the correct sum of the following numbers, 50 + 49:

A. 96

B. 99

C. 102

D. 105

1. That civilization which used the word electricity to describe the substance amber was which of the following:

A. The Greek

B. The Roman

C. The Hebrew

D. The Egyptian

2. Those substances from which magnets are commonly made are:

A. Lead and steel

B. Iron and steel

C. Iron and lead

D. Copper and lead

3. Free-floating magnets always point in the direction of the earth's

A. Magnetic north pole

B. Magnetic south pole

C. Magnetic east pole

D. Magnetic west pole

4. The magnetic north pole is separated from the geographic north pole by a distance of approximately:

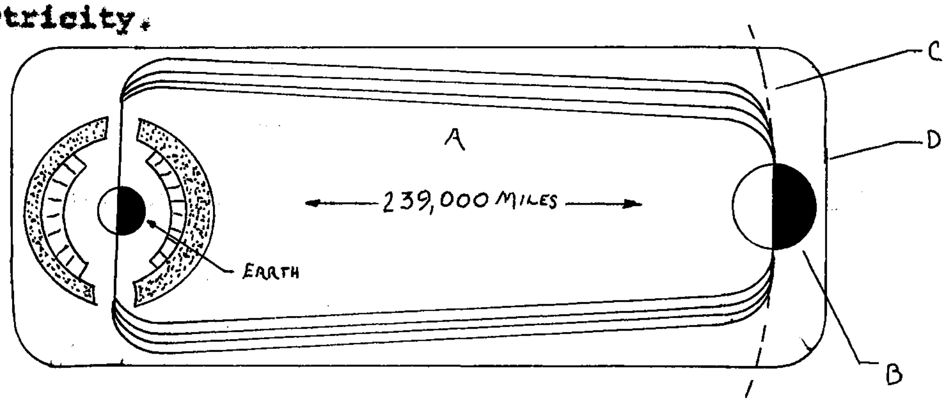
A. 990 miles south

B. 990 miles north

C. 1000 miles south

D. 1000 miles north

5. Study the drawing of the object below and then decide what is the nature of the charge of the static electricity.



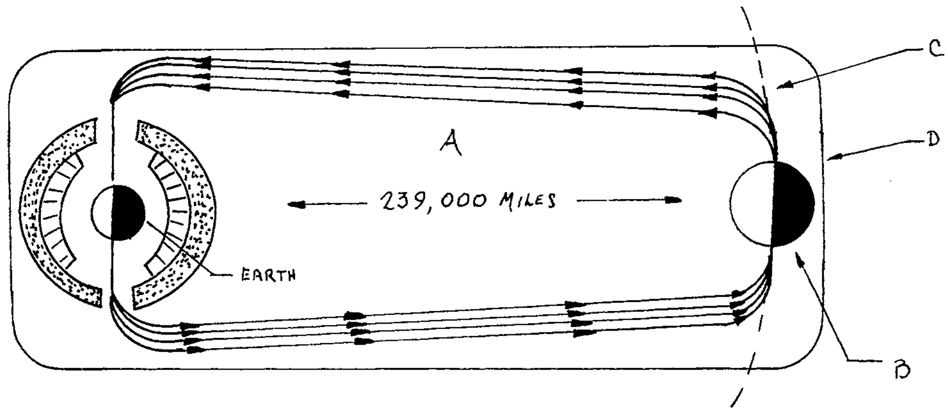
A. A neutral object

B. A positive charged object

C. A negative charged object

D. None of these

Study the drawing below of the earth's magnetic force lines. Then select the correct name for the area indicated.



6. In the drawing above the letter A stands for which of the following:

A. Positive sheet

B. Neutral sheet

C. Negative sheet

D. Permanent magnetic sheet

7. In the drawing above the letter C stands for which of the following:

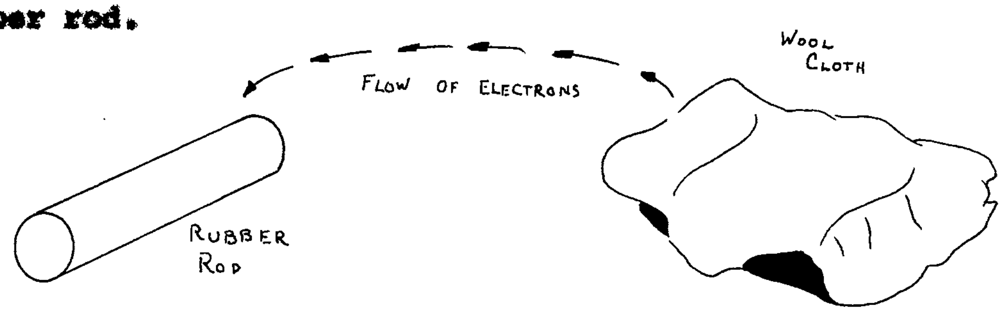
A. Magnetosphere

B. Stratosphere

C. Atmosphere

D. Radiosphere

8. Study the drawing of the rubber rod and wool cloth shown below. Assume that the rubber rod has been rubbed with the cloth. The result is a flow of electrons. Determine the charge static electricity produced on the rubber rod.



A. Neutral static electricity

B. Positive static electricity

C. Negative static electricity

D. None of these

9. The movement of electrons from one object to another object is known as which of the following?

A. Current charge

B. Current discharge

C. Electrical charge

D. Electrical discharge

10. When a lightning rod is connected to the earth it is said to be:

A. Resistant

B. Wired

C. Grounded

D. Shorted

11. That electrical current which consists of a non-moving electrical discharge is known as which of the following:

A. Static electricity

B. Electric current

C. Grounded current

D. Resistance current

12. Substances through which electrical current can be easily produced is known as:

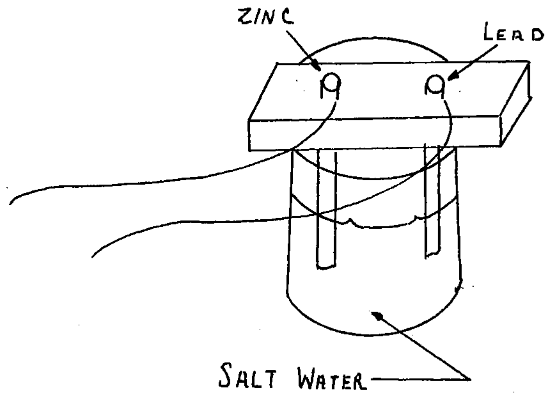
A. Closed switch

B. Insulators

C. Conductors

D. Terminal

13. Study the drawing below and determine the instrument used to produce electrical current.



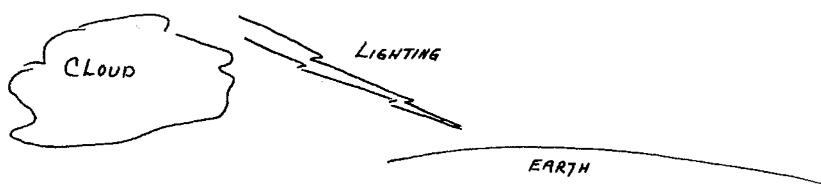
A. Wet cell

B. Dry cell

C. Galvanometer

D. Storage battery

14. Study the drawing of the cloud, lightning and earth, then determine which is the positive and negative terminal.



A. Cloud - negative terminal; earth - positive terminal

B. Earth - negative terminal; cloud - positive terminal

C. Cloud - negative terminal; earth - negative terminal

D. Earth - positive terminal; cloud - positive terminal

15. The object constructed when two or more cells are connected to increase the amount of electrical current is known as a:

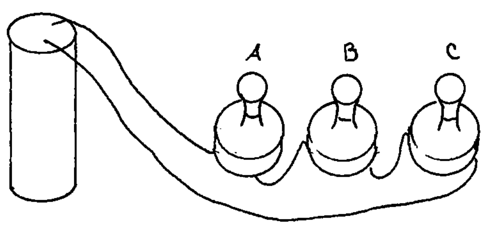
A. A battery

B. A storage unit

C. A galvanometer

D. A circuit

16. Study the drawing shown below of the lights which are connected in a series circuit. What would be the result if light bulb "C" failed to function?



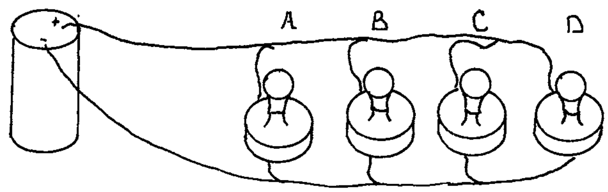
A. All lights except "C" would function properly

B. Lights "A" and "B" would function while lights "C" and "D" would fail to burn

C. Lights "C" and "B" would fail to function while lights "A" and "D" would continue to burn.

D. All lights would cease to function.

17. Study the drawing below of the lights which are arranged in a parallel circuit. What would be the result if light bulb "B" failed to function?



A. All of the light bulbs would cease to function.

B. All of the light bulbs except "B" would continue to burn.

C. Lights "A" and "B" would not function, while light bulbs "C" and "D" would continue to burn.

D. Lights "B" and "C" would not function while light bulbs "A" and "D" would continue to burn.

18. Select the power source of D.C. (Direct Current) electricity from the choices given below:

A. Hydroelectric generators

B. Storage battery

C. Thermonuclear generators

D. Local electric company

19. How many times per second does the current alternate in 60 cycle current?

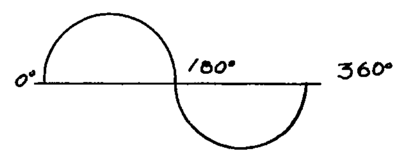
A. 60.00

B. 60.25

C. 60.50

D. 60.75

20. The wave diagram would be more correctly associated with which type of current?



A. Alternating current

B. Auxiliary current

C. Direct current

D. Directional current

21. The unit of measure used to determine electric change is a coulomb. One coulomb is equal to how many electrons?

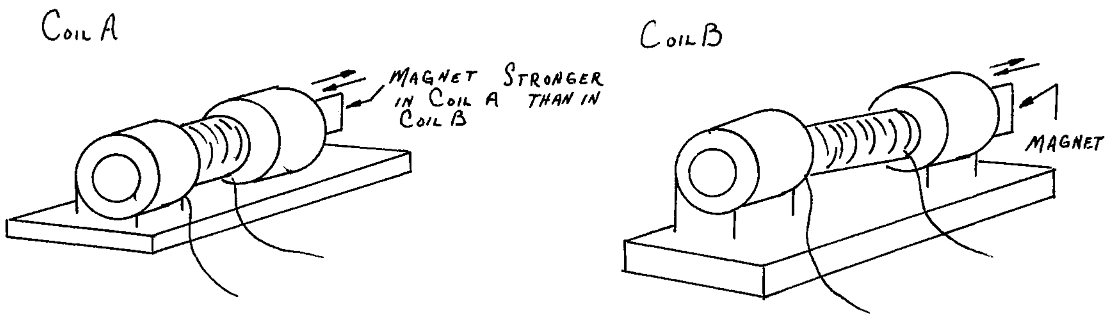
A. 6.0 million billion electrons

B. 6.3 million billion electrons

C. 6.6 million billion electrons

D. 6.9 million billion electrons

22. Study the drawings of the two coils of wire below. Electrical current will be produced if a magnet is moved through the center of the coils. You will notice that both coils have the same number of turns of wire, however they differ in the strength of the magnet. Given below are four possible results when current is produced from the coils. Select the correct one.



A. The current will be the same for both coil "A" and coil "B"

B. Coil "A" will produce a greater amount of current than coil "B"

C. Coil "B" will produce a greater amount of current than coil "A"

D. Neither coil "A" nor coil "B" are capable of producing an electrical current.

23. Electricity can be compared to water pumped from a well. The pressure forces the water through the pipe. From the choices below select the correct term of measurement referring to the force which forces electricity through wires.

A. Coulomb

B. Ampere

C. Resistance

D. Volts

24. Electrical resistance is measured in units known as:

A. Volt

B. Coulomb

C. Ohms

D. Ampere

25. A circuit has a current of 4 amps flowing through it. If the voltage is 28 volts, what is the resistance of the wire in the circuit?

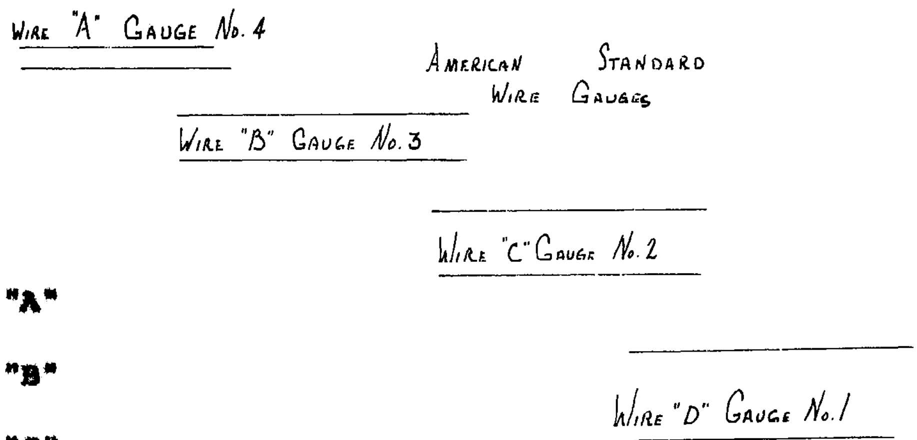
A. 6.0 ohms

B. 6.5 ohms

C. 7.0 ohms

D. 7.5 ohms

26. Below you will find several thicknesses of wire. Select that wire which would produce the greatest amount of electrical resistance.



A. Wire "A"

B. Wire "B"

C. Wire "C"

D. Wire "D"

27. According to Ohm's Law when the voltage in a circuit increases, what will be the result of the amperes?

A. The increase in voltage will not effect the amperes.

B. The increase in voltage will produce an increase in amperes.

C. The increase in voltage will produce a total reduction in the amount of amperes.

D. The increase in voltage will reduce the ampere by one-half.

28. In the following problems use Ohm's Law as expressed in the equations below:

$$\text{Current} = \frac{\text{Electric energy per charge}}{\text{Electric Resistance}}$$

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$$

$$I = \frac{E}{R}$$

A car battery supplies the electrical system with 12 volts of electricity. The resistance is 2 ohms, how many amperes will flow through the wires?

A. 5.5 amp

B. 6.0 amp

C. 6.5 amp

D. 7.0 amp

29. A large generator in an oil field plant produces 500 volts. However, the resistance created by the wiring is 9 ohms of resistance. What is the amperes available for use in the plant?

A. 55.5 amperes

B. 60.0 amperes

C. 60.5 amperes

D. 61.0 amperes

30. The current passing through a home's electrical wiring is found to be 19 amps. The resistance is measured at 11.6 ohms. Select the correct voltage of the circuit.

A. 220.0 volts

B. 220.4 volts

C. 220.8 volts

D. 221.2 volts

KEY

POST-TEST

1.	A	19.	A
2.	B	20.	A
3.	A	21.	B
4.	C	22.	B
5.	B	23.	D
6.	B	24.	C
7.	A	25.	C
8.	C	26.	A
9.	D	27.	B
10.	C	28.	B
11.	A	29.	A
12.	C	30.	B
13.	A		
14.	A		
15.	A		
16.	D		
17.	C		
18.	B		

APPENDIX E

SUMMARY OF DATA USED TO COMPUTE THE

MEAN INTELLIGENCE QUOTION FOR

GROUPS A, B, C, D AND E

SUMMARY OF DATA USED TO COMPUTE THE
MEAN INTELLIGENCE QUOTION
FOR GROUP A

Student	Intelligence Quotion	Mean Intelligence Quotion
A1	112	102.11
A2	110	
A3	108	
A4	107	
A5	106	
A6	106	
A7	105	
A8	104	
A9	103	
A10	103	
A11	101	
A12	101	
A13	100	
A14	100	
A15	99	
A16	96	
A17	94	
A18	93	
A19	93	

SUMMARY OF DATA USED TO COMPUTE THE
MEAN INTELLIGENCE QUOTION
FOR GROUP B

Student	Intelligence Quotion	Mean Intelligence Quotion
B1	130	95.32
B2	119	
B3	114	
B4	112	
B5	103	
B6	106	
B7	100	
B8	97	
B9	94	
B10	94	
B11	93	
B12	93	
B13	90	
B14	88	
B15	87	
B16	86	
B17	86	

Student	Intelligence Quotion	Mean Intelligence Quotion
B18	85	95.32
B19	84	
B20	83	

SUMMARY OF DATA USED TO COMPUTE
THE MEAN INTELLIGENCE
QUOTION FOR GROUP C

Student	Intelligence Quotion	Mean Intelligence Quotion
C1	125	100.55
C2	119	
C3	115	
C4	113	
C5	113	
C6	109	
C7	106	
C8	104	
C9	104	
C10	102	
C11	101	
C12	97	
C13	96	
C14	96	
C15	95	
C16	94	
C17	88	

Student	Intelligence Quotion	Mean Intelligence Quotion
C18	83	100.55
C19	80	
C20	71	

SUMMARY OF DATA USED TO COMPUTE
THE MEAN INTELLIGENCE
QUOTION FOR GROUP D

Student	Intelligence Quotion	Mean Intelligence Quotion
D1	119	100.17
D2	117	
D3	115	
D4	113	
D5	112	
D6	112	
D7	109	
D8	109	
D9	105	
D10	104	
D11	103	
D12	101	
D13	101	
D14	100	
D15	94	
D16	92	
D17	92	

Student	Intelligence Quotion	Mean Intelligence Quotion
D18	89	100.17
D19	88	
D20	87	
D21	87	
D22	83	
D23	72	

SUMMARY OF DATA USED TO COMPUTE
THE MEAN INTELLIGENCE
QUOTION FOR GROUP E

Student	Intelligence Quotion	Mean Intelligence Quotion
E1	122	92.60
E2	115	
E3	106	
E4	104	
E5	102	
E6	99	
E7	98	
E8	95	
E9	94	
E10	94	
E11	92	
E12	92	
E13	90	
E14	90	
E15	88	
E16	84	
E17	83	

Student	Intelligence Quotion	Mean Intelligence Quotion
E18	78	92.60
E19	78	
E20	74	
E21	66	

APPENDIX F

DISTRIBUTION OF SCORES AS SHOWN
FOLLOWING THE PRE-TEST AND
POST-TEST OF THE UNIT OF
SIMPLE MACHINES FOR
GROUPS A, B, C,
D AND E

DISTRIBUTION OF SCORES AS SHOWN
FOLLOWING THE PRE-TEST AND
POST-TEST OF THE UNIT OF
SIMPLE MACHINES FOR
GROUP A

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
A1	15	18
A2	13	25
A3	11	23
A4	11	25
A5	11	24
A6	12	22
A7	18	25
A8	11	21
A9	16	23
A10	14	25
A11	18	27
A12	10	16
A13	12	18
A14	13	20
A15	17	29
A16	14	30

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
A17	12	15
A18	14	18
A19	8	15

DISTRIBUTION OF SCORES AS SHOWN
FOLLOWING THE PRE-TEST AND
POST-TEST OF THE UNIT
OF SIMPLE MACHINES
FOR GROUP B

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
B1	12	22
B2	9	18
B3	17	24
B4	13	22
B5	13	25
B6	16	28
B7	10	16
B8	11	23
B9	17	33
B10	9	24
B11	14	26
B12	13	16
B13	9	13
B14	15	23
B15	12	18
B16	9	18

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
B17	7	17
B18	10	11
B19	5	17
B20	12	20

DISTRIBUTION OF SCORES AS SHOWN
FOLLOWING THE PRE-TEST AND
POST-TEST OF THE UNIT OF
SIMPLE MACHINES FOR
GROUP C

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
C1	15	30
C2	14	22
C3	11	16
C4	12	16
C5	12	19
C6	10	23
C7	13	18
C8	11	22
C9	6	20
C10	5	16
C11	16	27
C12	11	17
C13	11	26
C14	15	16
C15	6	15
C16	8	19

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
C17	7	16
C18	7	16
C19	12	18
C20	13	12

DISTRIBUTION OF SCORES AS SHOWN
FOLLOWING THE PRE-TEST AND
POST-TEST OF THE UNIT OF
SIMPLE MACHINES FOR
GROUP D

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
D1	15	30
D2	17	26
D3	16	22
D4	12	23
D5	12	15
D6	18	26
D7	14	22
D8	10	21
D9	10	12
D10	12	22
D11	9	26
D12	14	24
D13	16	23
D14	11	22
D15	11	20
D16	5	26

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
D17	15	23
D18	13	21
D19	11	25
D20	8	12
D21	12	19
D22	8	20
D23	9	23

DISTRIBUTION OF SCORES AS SHOWN FOLLOWING THE PRE-TEST AND POST-TEST OF THE UNIT OF SIMPLE MACHINES FOR GROUP E

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
E1	15	30
E2	10	26
E3	12	22
E4	14	28
E5	8	24
E6	17	24
E7	14	14
E8	12	14
E9	8	22
E10	11	18
E11	12	23
E12	11	20
E13	12	15
E14	13	27
E15	14	14
E16	14	22

Student	Pre-Test (Total Possible 35)	Post-Test (Total Possible 33)
E17	14	17
E18	9	20
E19	8	11
E20	6	14
E21	8	17

APPENDIX G

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUPS A, B, C, D, AND E AS SHOWN IN THE PRE-TEST POST-TEST STANDARDIZED VARIABLE OF THE SIMPLE MACHINES UNIT

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP A AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE SIMPLE MACHINES UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 13.16 = $\bar{X}$) (Standard Deviation = 3.42 = S)	Z Score Post-Test (Mean = 22.05 = $\bar{X}$) (Standard Deviation = 5.07 = S)
A11	1.39 Standard Deviations Above the Mean	0.97 Standard Deviations Above the Mean
A7	1.39 Standard Deviations Above the Mean	0.58 Standard Deviations Above the Mean
A15	1.16 Standard Deviations Above the Mean	1.51 Standard Deviations Above the Mean
A9	0.81 Standard Deviations Above the Mean	0.16 Standard Deviations Above the Mean
A1	0.68 Standard Deviations Above the Mean	0.79 Standard Deviations Above the Mean
A16	0.24 Standard Deviations Above the Mean	1.56 Standard Deviations Above the Mean
A10	0.24 Standard Deviations Above the Mean	0.58 Standard Deviations Above the Mean
A18	0.24 Standard Deviations Above the Mean	0.79 Standard Deviations Below the Mean

Student	Z Score Pre-Test (Mean = 13.16 = $\bar{X}$) (Standard Deviation = 3.42 = S)	Z Score Post-Test (Mean = 22.05 = $\bar{X}$) (Standard Deviation = 5.07 = S)
A2	0.05 Standard Deviations Below the Mean	0.58 Standard Deviations Above the Mean
A14	0.05 Standard Deviations Below the Mean	0.38 Standard Deviations Below the Mean
A17	0.33 Standard Deviations Below the Mean	1.39 Standard Deviations Below the Mean
A13	0.33 Standard Deviations Below the Mean	0.79 Standard Deviations Below the Mean
A6	0.33 Standard Deviations Below the Mean	0.009 Standard Deviations Below the Mean
A3	0.75 Standard Deviations Below the Mean	0.16 Standard Deviations Above the Mean
A8	0.75 Standard Deviations Below the Mean	0.20 Standard Deviations Below the Mean
A5	0.75 Standard Deviations Below the Mean	0.38 Standard Deviations Above the Mean
A4	0.75 Standard Deviations Below the Mean	0.58 Standard Deviations Above the Mean
A12	0.91 Standard Deviations Below the Mean	1.11 Standard Deviations Below the Mean
A19	1.58 Standard Deviations Below the Mean	1.39 Standard Deviations Below the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP B AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE SIMPLE MACHINE UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 11.65 = $\bar{X}$) (Standard Deviation = 4.26 = S)	Z Score Post-Test (Mean = 20.70 = $\bar{X}$) (Standard Deviation = 5.98 = S)
B3	1.25 Standard Deviations Above the Mean	0.55 Standard Deviations Above the Mean
B9	1.25 Standard Deviations Above the Mean	2.03 Standard Deviations Above the Mean
B6	1.02 Standard Deviations Above the Mean	1.22 Standard Deviations Above the Mean
B14	0.80 Standard Deviations Above the Mean	0.38 Standard Deviations Above the Mean
B11	0.55 Standard Deviations Above the Mean	0.31 Standard Deviations Above the Mean
B4	0.31 Standard Deviations Above the Mean	0.21 Standard Deviations Above the Mean
B5	0.31 Standard Deviations Above the Mean	0.72 Standard Deviations Above the Mean
B12	0.31 Standard Deviations Above the Mean	0.79 Standard Deviations Below the Mean
B1	0.08 Standard Deviations Above the Mean	0.21 Standard Deviations Above the Mean

Student	Z Score Pre-Test (Mean = 11.65 = $\bar{X}$) (Standard Deviation = 4.26 = S)	Z Score Post-Test (Mean = 20.70 = $\bar{X}$) (Standard Deviation = 5.98 = S)
B15	0.08 Standard Deviations Above the Mean	0.45 Standard Deviations Below the Mean
B20	0.08 Standard Deviations Above the Mean	0.11 Standard Deviations Below the Mean
B8	0.15 Standard Deviations Below the Mean	0.13 Standard Deviations Above the Mean
B7	0.37 Standard Deviations Below the Mean	0.95 Standard Deviations Below the Mean
B18	0.37 Standard Deviations Below the Mean	1.22 Standard Deviations Below the Mean
B16	0.63 Standard Deviations Below the Mean	0.45 Standard Deviations Below the Mean
B13	0.63 Standard Deviations Below the Mean	0.28 Standard Deviations Below the Mean
B10	0.63 Standard Deviations Below the Mean	0.55 Standard Deviations Above the Mean
B2	0.63 Standard Deviations Below the Mean	0.45 Standard Deviations Below the Mean
B17	1.08 Standard Deviations Below the Mean	0.62 Standard Deviations Below the Mean
B19	1.56 Standard Deviations Below the Mean	0.62 Standard Deviations Below the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP C AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE SIMPLE MACHINE UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 10.75 = $\bar{X}$) (Standard Deviation = 4.33 = S)	Z Score Post-Test (Mean = 19.20 = $\bar{X}$) (Standard Deviation = 5.85 = S)
C11	1.21 Standard Deviations Above the Mean	1.37 Standard Deviations Above the Mean
C1	0.98 Standard Deviations Above the Mean	1.84 Standard Deviations Above the Mean
C14	0.98 Standard Deviations Above the Mean	0.72 Standard Deviations Below the Mean
C13	0.98 Standard Deviations Above the Mean	1.16 Standard Deviations Above the Mean
C2	0.75 Standard Deviations Above the Mean	0.48 Standard Deviations Above the Mean
C7	0.52 Standard Deviations Above the Mean	0.20 Standard Deviations Below the Mean
C20	0.52 Standard Deviations Above the Mean	1.23 Standard Deviations Below the Mean
C4	0.28 Standard Deviations Above the Mean	1.23 Standard Deviations Below the Mean
C5	0.28 Standard Deviations Above the Mean	0.03 Standard Deviations Below the Mean

Student	Z Score Pre-Test (Mean = 10.75 = X) (Standard Deviation = 4.33 = S)	Z Score Post-Test (Mean = 19.20 = X) (Standard Deviation = 5.85 = S)
C19	0.28 Standard Deviations Above the Mean	0.20 Standard Deviations Below the Mean
C3	0.05 Standard Deviations Above the Mean	0.54 Standard Deviations Below the Mean
C8	0.05 Standard Deviations Above the Mean	0.48 Standard Deviations Above the Mean
C12	0.05 Standard Deviations Above the Mean	0.37 Standard Deviations Below the Mean
C13	0.05 Standard Deviations Above the Mean	1.16 Standard Deviations Above the Mean
C6	0.17 Standard Deviations Below the Mean	0.65 Standard Deviations Above the Mean
C16	0.63 Standard Deviations Below the Mean	0.03 Standard Deviations Below the Mean
C17	0.86 Standard Deviations Below the Mean	0.72 Standard Deviations Below the Mean
C18	0.86 Standard Deviations Below the Mean	0.72 Standard Deviations Below the Mean
C9	1.12 Standard Deviations Below the Mean	0.13 Standard Deviations Below the Mean
C10	1.33 Standard Deviations Below the Mean	0.72 Standard Deviations Below the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP D AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE SIMPLE MACHINE UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 12.08 = $\bar{X}$) (Standard Deviation = 3.95 = S)	Z Score Post-Test (Mean = 21.80 = $\bar{X}$) (Standard Deviation = 6.46 = S)
D6	1.50 Standard Deviations Above the Mean	0.65 Standard Deviations Above the Mean
D2	1.24 Standard Deviations Above the Mean	0.65 Standard Deviations Above the Mean
D3	0.99 Standard Deviations Above the Mean	0.03 Standard Deviations Above the Mean
D13	0.99 Standard Deviations Above the Mean	0.18 Standard Deviations Above the Mean
D17	0.74 Standard Deviations Above the Mean	0.18 Standard Deviations Above the Mean
D1	0.74 Standard Deviations Above the Mean	1.27 Standard Deviations Above the Mean
D12	0.48 Standard Deviations Above the Mean	0.34 Standard Deviations Above the Mean
D7	0.48 Standard Deviations Above the Mean	0.03 Standard Deviations Above the Mean
D18	0.23 Standard Deviations Above the Mean	0.12 Standard Deviations Below the Mean

Student	Z Score Pre-Test (Mean = 12.08 = X) (Standard Deviation = 3.95 = S)	Z Score Post-Test (Mean = 21.80 = X) (Standard Deviation = 6.46 = S)
D21	0.02 Standard Deviations Below the Mean	0.44 Standard Deviations Below the Mean
D10	0.02 Standard Deviations Below the Mean	0.03 Standard Deviations Above the Mean
D5	0.02 Standard Deviations Below the Mean	1.25 Standard Deviations Below the Mean
D4	0.02 Standard Deviations Below the Mean	0.18 Standard Deviations Above the Mean
D15	0.27 Standard Deviations Below the Mean	0.28 Standard Deviations Below the Mean
D19	0.27 Standard Deviations Below the Mean	0.51 Standard Deviations Above the Mean
D14	0.27 Standard Deviations Below the Mean	0.03 Standard Deviations Above the Mean
D9	0.52 Standard Deviations Below the Mean	1.57 Standard Deviations Below the Mean
D23	0.52 Standard Deviations Below the Mean	0.18 Standard Deviations Above the Mean
D22	1.03 Standard Deviations Below the Mean	0.27 Standard Deviations Below the Mean
D20	1.03 Standard Deviations Below the Mean	1.57 Standard Deviations Below the Mean
D16	1.79 Standard Deviations Below the Mean	0.65 Standard Deviations Above the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP E AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE SIMPLE MACHINE UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 11.53 = $\bar{X}$) (Standard Deviation = 4.45 = S)	Z Score Post-Test (Mean = 20.10 = $\bar{X}$) (Standard Deviation = 7.18 = S)
E6	1.23 Standard Deviations Above the Mean	0.54 Standard Deviations Above the Mean
E1	0.78 Standard Deviations Above the Mean	1.38 Standard Deviations Above the Mean
E16	0.55 Standard Deviations Above the Mean	0.26 Standard Deviations Above the Mean
E7	0.55 Standard Deviations Above the Mean	0.85 Standard Deviations Below the Mean
E4	0.55 Standard Deviations Above the Mean	0.99 Standard Deviations Above the Mean
E17	0.55 Standard Deviations Above the Mean	0.43 Standard Deviations Below the Mean
E15	0.55 Standard Deviations Above the Mean	0.85 Standard Deviations Below the Mean
E14	0.33 Standard Deviations Above the Mean	0.96 Standard Deviations Above the Mean
E11	0.01 Standard Deviations Above the Mean	0.39 Standard Deviations Above the Mean

Student	Z Score Pre-Test (Mean = 11.53 = X̄) (Standard Deviation = 4.45 = S)	Z Score Post-Test (Mean = 20.10 = X̄) (Standard Deviation = 7.18 = S)
E8	0.01 Standard Deviations Above the Mean	0.85 Standard Deviations Below the Mean
E3	0.01 Standard Deviations Above the Mean	0.26 Standard Deviations Above the Mean
E13	0.01 Standard Deviations Above the Mean	0.71 Standard Deviations Below the Mean
E12	0.01 Standard Deviations Below the Mean	0.01 Standard Deviations Below the Mean
E10	0.01 Standard Deviations Below the Mean	0.29 Standard Deviations Below the Mean
E2	0.34 Standard Deviations Below the Mean	0.82 Standard Deviations Above the Mean
E18	0.56 Standard Deviations Below the Mean	0.01 Standard Deviations Below the Mean
E5	0.79 Standard Deviations Below the Mean	0.54 Standard Deviations Above the Mean
E21	0.79 Standard Deviations Below the Mean	0.43 Standard Deviations Below the Mean
E19	0.79 Standard Deviations Below the Mean	1.27 Standard Deviations Below the Mean
E9	0.79 Standard Deviations Below the Mean	0.85 Standard Deviations Below the Mean
E20	1.24 Standard Deviations Below the Mean	0.85 Standard Deviations Below the Mean

APPENDIX H

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUPS A, B, C, D AND E OF SIMPLE MACHINES

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP A - SIMPLE MACHINES

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{90}{19} - \left(\frac{-18}{19}\right)\left(\frac{22}{19}\right)}{\left\{\sqrt{\frac{710}{19} - \left(\frac{-18}{19}\right)^2} \times \sqrt{\frac{270}{19} - \left(\frac{22}{19}\right)^2}\right\}}$$

$$r = \frac{4.74 - (-.948)(1.16)}{\left\{\sqrt{3.74 - (-.948)^2} \times \sqrt{1.42 - (1.16)}\right\}}$$

$$r = \frac{4.74 - (-11.016)}{\left\{\sqrt{3.74 - 8.99} \times \sqrt{1.42 - (1.34)}\right\}}$$

$$r = \frac{4.74 + 1.016}{\left\{\sqrt{5.25} \times \sqrt{.06}\right\}}$$

$$r = \frac{15.75}{2.29 \times .025}$$

$$r = \frac{15.75}{.056}$$

$$r = .278$$

GROUP A - SIMPLE MACHINES

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2\, r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$$

$$r_{11} = \frac{2(.278)}{1 + .278}$$

$$r_{11} = \frac{.556}{1.278}$$

$$r_{11} - 0.43$$

GROUP B - SIMPLE MACHINES

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP B - SIMPLE MACHINES

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{204}{20} - \left(\frac{14}{20}\right)\left(\frac{-7}{20}\right)}{\left\{\sqrt{\frac{676}{20} - \left(\frac{14}{20}\right)^2} \times \sqrt{\frac{375}{20} - \left(\frac{-7}{20}\right)^2}\right\}}$$

$$r = \frac{10.2 - (.70)(-.35)}{\left\{\sqrt{33.80 - (.70)^2} \times \sqrt{18.75 - (-.35)^2}\right\}}$$

$$r = \frac{10.2 - (-.2450)}{\left\{\sqrt{33.80 - .4900} \times \sqrt{18.75 - (-.35)^2}\right\}}$$

$$r = \frac{10.44}{\left\{\sqrt{33.31} \times \sqrt{18.63}\right\}}$$

$$r = \frac{10.44}{5.77 \times 4.31}$$

$$r = \frac{10.44}{24.86}$$

$$r = .41$$

GROUP B - SIMPLE MACHINES

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2\, r_{\frac{1}{2}\,\frac{1}{2}}}{1 + r_{\frac{1}{2}\,\frac{1}{2}}}$$

$$r_{11} = \frac{2(.41)}{1 + .41}$$

$$r_{11} = \frac{.82}{1.41}$$

$$r_{11} = .58$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP C - SIMPLE MACHINES

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{57}{20} - \left(\frac{24}{20}\right)\left(\frac{-5}{20}\right)}{\left\{\sqrt{\frac{576}{20} - \left(\frac{24}{20}\right)^2} \times \sqrt{\frac{333}{20} - \left(\frac{-5}{20}\right)^2}\right\}}$$

$$r = \frac{2.85 - (1.20)(-.25)}{\left\{\sqrt{28.8 - (1.2)^2} \times \sqrt{16.65 - (-.25)^2}\right\}}$$

$$r = \frac{2.85 - (-.30)}{\left\{\sqrt{28.8 - 1.44} \times \sqrt{16.65 - .06}\right\}}$$

$$r = \frac{2.85 + .30}{\left\{\sqrt{27.36} \times \sqrt{16.59}\right\}}$$

$$r = \frac{3.15}{(5.26)(4.07)}$$

$$r = \frac{3.15}{21.40}$$

$$r = .14$$

GROUP C - SIMPLE MACHINES

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$$

$$r_{11} = \frac{2(.14)}{1 + .14}$$

$$r_{11} = \frac{.28}{1.14}$$

$$r_{11} = .24$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP D - SIMPLE MACHINES

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{68}{23} - \left(\frac{-3}{23}\right)\left(\frac{25}{23}\right)}{\left\{\sqrt{\frac{827}{23} - \left(\frac{-3}{23}\right)^2} \times \sqrt{\frac{397}{23} - \left(\frac{25}{23}\right)^2}\right\}}$$

$$r = \frac{2.95 - (-.13)(1.08)}{\left\{\sqrt{35.90 - (-.13)^2} \times \sqrt{17.25 - (1.08)^2}\right\}}$$

$$r = \frac{3.09}{\left\{\sqrt{35.88} \times \sqrt{16.09}\right\}}$$

$$r = \frac{3.09}{(5.99)(4.10)}$$

$$r = \frac{3.09}{24.55}$$

$$r = .12$$

GROUP D - SIMPLE MACHINES

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$$

$$r_{11} = \frac{2(.12)}{1 + .12}$$

$$r_{11} = \frac{.24}{1.12}$$

$$r_{11} = .21$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP E - SIMPLE MACHINES

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{146}{21} - \left(\frac{2}{21}\right)\left(\frac{11}{21}\right)}{\left\{\sqrt{\frac{1080}{21} - \left(\frac{2}{21}\right)^2} \times \sqrt{\frac{471}{21} - \left(\frac{11}{21}\right)^2}\right\}}$$

$$r = \frac{6.95 - (.09)(.52)}{\left\{\sqrt{51.42 - (.09)^2} \times \sqrt{22.42 - (.52)^2}\right\}}$$

$$r = \frac{6.91}{\left\{\sqrt{51.42 - .0081} \times \sqrt{22.42 - .27}\right\}}$$

$$r = \frac{691}{\left\{\sqrt{51.41} \times \sqrt{22.15}\right\}}$$

$$r = \frac{6.91}{7.16 \times 4.70}$$

$$r = \frac{6.91}{33.64}$$

$$r = .20$$

GROUP E - SIMPLE MACHINES

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} \quad \frac{2r\,\tfrac{1}{2}\tfrac{1}{2}}{1 + r\,\tfrac{1}{2}\tfrac{1}{2}}$$

$$r_{11} = \frac{2(.20)}{1+ 20}$$

$$r_{11} = \frac{.40}{1.20}$$

$$r_{11} = .33$$

APPENDIX I

"STUDENT'S T" DISTRIBUTION
SIMPLE MACHINES

"STUDENT'S T" DISTRIBUTION
SIMPLE MACHINES

Control Group	Mean Score
Group A = 19	17.83
Group B = 20	16.17
Group C = 20	14.97
Total = 59 = N_1	Mean 16.32 = $\bar{X}_1$

Experimental Group	
Group D = 23	16.94
Group E = 21	15.81
Total = 44 = N_2	Mean 16.37 = $\bar{X}_2$

$$\frac{\bar{X}_1 - \bar{X}_2}{\sigma \sqrt{1/N_1 + 1/N_2}}$$

$$\sigma = \sqrt{\frac{N_1 S_1^2 + N_2 S_2^2}{N_1 + N_2 - 2}}$$

$$\sigma = \sqrt{\frac{59\,(266.3424) + 44\,(275.9769)}{59 + 44 - 2}}$$

$$\sigma = \sqrt{\frac{59(266.3424) + 44(275.9769)}{103 - 2}}$$

"STUDENT'S T" DISTRIBUTION
SIMPLE MACHINES

$$\sigma = \sqrt{\frac{17857.1742}{101}}$$

$$\sigma = \sqrt{176.8037}$$

$$\theta = 13.3$$

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sigma\sqrt{1/N_1 + 1/N_2}}$$

$$t = \frac{16.32 - 16.37}{13.3\sqrt{1/59 + 1/44}}$$

$$t = \frac{.05}{13.3\sqrt{.017 + .025}}$$

$$t = \frac{.05}{13.3\sqrt{.042}}$$

$$t = \frac{.05}{13.3\ (.0041)}$$

$$t = \frac{.05}{.04453}$$

$$t = .0001$$

APPENDIX J

DISTRIBUTION OF SCORES AS SHOWN FOLLOWING THE

PRE-TEST AND POST-TEST OF THE UNIT

OF ELECTRICITY FOR GROUPS

A, B, C, D AND E

DISTRIBUTION OF SCORES AS SHOWN FOLLOWING THE PRE-TEST AND POST-TEST OF THE UNIT OF ELECTRICITY FOR GROUP A

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
A1	14	22
A2	15	20
A3	16	22
A4	9	13
A5	17	21
A6	10	20
A7	18	24
A8	15	28
A9	15	22
A10	17	25
A11	14	23
A12	9	25
A13	7	17
A14	10	16
A15	19	26
A16	7	21

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
A17	11	15
A18	5	14
A19	10	13

DISTRIBUTION OF SCORES AS SHOWN FOLLOWING THE PRE-TEST AND POST-TEST OF THE UNIT OF ELECTRICITY FOR GROUP B

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
B1	14	13
B2	15	18
B3	16	18
B4	14	22
B5	9	23
B6	14	25
B7	15	22
B8	6	24
B9	9	21
B10	16	20
B11	10	21
B12	6	23
B13	10	22
B14	14	19
B15	11	21
B16	9	10
B17	11	18

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
B18	11	15
B19	11	18
B20	14	15

DISTRIBUTION OF SCORES AS SHOWN FOLLOWING
THE PRE-TEST AND POST-TEST OF THE
UNIT OF ELECTRICITY FOR GROUP C

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
C1	19	26
C2	8	20
C3	15	17
C4	18	22
C5	15	21
C6	13	23
C7	10	13
C8	16	23
C9	14	18
C10	11	20
C11	18	22
C12	8	11
C13	8	17
C14	14	10
C15	10	16
C16	14	15
C17	11	10

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
C18	6	14
C19	11	22
C20	6	12

DISTRIBUTION OF SCORES AS SHOWN FOLLOWING
THE PRE-TEST AND POST-TEST OF THE
UNIT OF ELECTRICITY FOR GROUP D

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
D1	11	22
D2	13	26
D3	16	22
D4	18	26
D5	21	20
D6	14	21
D7	11	19
D8	18	20
D9	18	21
D10	6	19
D11	15	18
D12	16	15
D13	12	24
D14	14	20
D15	13	8
D16	12	18
D17	14	21

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
D18	13	19
D19	14	15
D20	9	15
D21	9	12
D22	14	14
D23	13	14

DISTRIBUTION OF SCORES AS SHOWN FOLLOWING
THE PRE-TEST AND POST-TEST OF THE
UNIT OF ELECTRICITY FOR GROUP E

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
E1	21	24
E2	13	20
E3	9	27
E4	5	16
E5	16	27
E6	18	24
E7	11	19
E8	11	14
E9	10	16
E10	7	22
E11	13	15
E12	13	19
E13	10	14
E14	11	20
E15	9	13
E16	8	23
E17	7	5
E18	14	11

Student	Pre-Test (Total Possible 31)	Post-Test (Total Possible 30)
E19	14	12
E20	6	10
E21	10	16

APPENDIX K

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUPS A, B, C, D AND E AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE ELECTRICAL UNIT

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP A AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE ELECTRICAL UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 12.57 = $\bar{X}$) (Standard Deviation = 3.49 = S)	Z Score Post-Test (Mean = 20.40 = $\bar{X}$) (Standard Deviation = 4.96 = S)
A15	1.84 Standard Deviations Above the Mean	1.13 Standard Deviations Above the Mean
A7	1.55 Standard Deviations Above the Mean	0.72 Standard Deviations Above the Mean
A10	1.24 Standard Deviations Above the Mean	0.92 Standard Deviations Above the Mean
A5	1.24 Standard Deviations Above the Mean	0.12 Standard Deviations Above the Mean
A3	0.09 Standard Deviations Above the Mean	0.32 Standard Deviations Above the Mean
A9	0.07 Standard Deviations Above the Mean	0.32 Standard Deviations Above the Mean
A8	0.07 Standard Deviations Above the Mean	1.53 Standard Deviations Above the Mean
A2	0.07 Standard Deviations Above the Mean	0.08 Standard Deviations Above the Mean

Student	Z Score Pre-Test (Mean = 12.57 = X) (Standard Deviation = 3.49 = S)	Z Score Post-Test (Mean = 20.40 = X) (Standard Deviation = 4.96 = S)
A1	0.04 Standard Deviations Above the Mean	0.32 Standard Deviations Above the Mean
A11	0.04 Standard Deviations Above the Mean	0.52 Standard Deviations Above the Mean
A17	0.04 Standard Deviations Below the Mean	1.09 Standard Deviations Below the Mean
A6	0.07 Standard Deviations Below the Mean	0.08 Standard Deviations Above the Mean
A19	0.07 Standard Deviations Below the Mean	1.49 Standard Deviations Above the Mean
A14	0.07 Standard Deviations Below the Mean	0.88 Standard Deviations Below the Mean
A12	1.02 Standard Deviations Below the Mean	0.92 Standard Deviations Above the Mean
A4	1.02 Standard Deviations Below the Mean	1.49 Standard Deviations Below the Mean
A13	1.05 Standard Deviations Below the Mean	0.68 Standard Deviations Below the Mean
A16	1.05 Standard Deviations Below the Mean	0.12 Standard Deviations Above the Mean
A18	2.17 Standard Deviations Below the Mean	1.29 Standard Deviations Below the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP B AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE ELECTRICAL UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 11.65 = $\bar{X}$) (Standard Deviation = 2.85 = S)	Z Score Post-Test (Mean = 19.40 = $\bar{X}$) (Standard Deviation = 4.67 = S)
B10	1.52 Standard Deviations Above the Mean	0.12 Standard Deviations Above the Mean
B3	1.52 Standard Deviations Above the Mean	0.30 Standard Deviations Below the Mean
B7	1.17 Standard Deviations Above the Mean	0.55 Standard Deviations Above the Mean
B2	1.17 Standard Deviations Above the Mean	0.30 Standard Deviations Below the Mean
B6	0.82 Standard Deviations Above the Mean	1.20 Standard Deviations Above the Mean
B4	0.82 Standard Deviations Above the Mean	0.55 Standard Deviations Above the Mean
B1	0.82 Standard Deviations Above the Mean	1.37 Standard Deviations Above the Mean
B14	0.82 Standard Deviations Above the Mean	0.22 Standard Deviations Below the Mean
B20	0.82 Standard Deviations Above the Mean	0.93 Standard Deviations Below the Mean

Student	Z Score Pre-Test (Mean = 11.65 = X) (Standard Deviation = 2.85 = S)	Z Score Post-Test (Mean = 19.40 = X) (Standard Deviation = 4.67 = S)
B17	0.02 Standard Deviations Below the Mean	0.30 Standard Deviations Below the Mean
B18	0.02 Standard Deviations Below the Mean	0.93 Standard Deviations Below the Mean
B19	0.02 Standard Deviations Below the Mean	0.30 Standard Deviations Below the Mean
B15	0.02 Standard Deviations Below the Mean	0.34 Standard Deviations Above the Mean
B11	0.58 Standard Deviations Below the Mean	0.34 Standard Deviations Above the Mean
B13	0.58 Standard Deviations Below the Mean	0.55 Standard Deviations Above the Mean
B5	0.92 Standard Deviations Below the Mean	0.77 Standard Deviations Above the Mean
B16	0.92 Standard Deviations Below the Mean	2.00 Standard Deviations Below the Mean
B9	1.63 Standard Deviations Below the Mean	0.34 Standard Deviations Above the Mean
B8	1.98 Standard Deviations Below the Mean	0.98 Standard Deviations Above the Mean
B12	1.98 Standard Deviations Below the Mean	0.77 Standard Deviations Above the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP C AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE ELECTRICAL UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 12.25 = $\bar{X}$) (Standard Deviation = 3.86 = S)	Z Score Post-Test (Mean = 17.60 = $\bar{X}$) (Standard Deviation = 6.26 = S)
C1	1.75 Standard Deviations Above the Mean	1.34 Standard Deviations Above the Mean
C4	1.49 Standard Deviations Above the Mean	0.70 Standard Deviations Above the Mean
C11	1.49 Standard Deviations Above the Mean	0.70 Standard Deviations Above the Mean
C8	0.94 Standard Deviations Above the Mean	0.54 Standard Deviations Above the Mean
C5	0.71 Standard Deviations Above the Mean	0.54 Standard Deviations Above the Mean
C3	0.71 Standard Deviations Above the Mean	0.09 Standard Deviations Below the Mean
C14	0.45 Standard Deviations Above the Mean	1.22 Standard Deviations Below the Mean
C16	0.45 Standard Deviations Above the Mean	0.41 Standard Deviations Below the Mean
C9	0.45 Standard Deviations Above the Mean	0.06 Standard Deviations Above the Mean

Student	Z Score Pre-Test (Mean = 12.25 = $\bar{X}$) (Standard Deviation = 3.86 = S)	Z Score Post-Test (Mean = 17.60 = $\bar{X}$) (Standard Deviation = 6.26 = S)
C6	0.28 Standard Deviations Above the Mean	0.86 Standard Deviations Above the Mean
C17	0.32 Standard Deviations Below the Mean	1.22 Standard Deviations Below the Mean
C10	0.32 Standard Deviations Below the Mean	0.38 Standard Deviations Above the Mean
C19	0.32 Standard Deviations Below the Mean	0.70 Standard Deviations Above the Mean
C15	0.52 Standard Deviations Below the Mean	0.25 Standard Deviations Below the Mean
C7	0.52 Standard Deviations Below the Mean	0.73 Standard Deviations Below the Mean
C13	1.10 Standard Deviations Below the Mean	0.09 Standard Deviations Below the Mean
C2	1.10 Standard Deviations Below the Mean	0.38 Standard Deviations Above the Mean
C12	1.10 Standard Deviations Below the Mean	1.05 Standard Deviations Below the Mean
C18	1.62 Standard Deviations Below the Mean	0.57 Standard Deviations Below the Mean
C20	1.62 Standard Deviations Below the Mean	0.89 Standard Deviations Below the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP D AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE ELECTRICAL UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 13.21 = $\bar{X}$) (Standard Deviation = 3.60 = S)	Z Score Post-Test (Mean = 18.06 = $\bar{X}$) (Standard Deviation = 5.38 = S)
D5	2.16 Standard Deviations Above the Mean	0.36 Standard Deviations Above the Mean
D9	1.33 Standard Deviations Above the Mean	0.54 Standard Deviations Above the Mean
D8	1.33 Standard Deviations Above the Mean	0.36 Standard Deviations Above the Mean
D4	1.33 Standard Deviations Above the Mean	1.47 Standard Deviations Above the Mean
D12	0.77 Standard Deviations Above the Mean	0.57 Standard Deviations Below the Mean
D3	0.77 Standard Deviations Above the Mean	0.73 Standard Deviations Above the Mean
D11	0.49 Standard Deviations Above the Mean	0.02 Standard Deviations Below the Mean
D14	0.30 Standard Deviations Above the Mean	0.36 Standard Deviations Above the Mean

Student	Z Score Pre-Test (Mean = 13.21 = X) (Standard Deviation = 3.60 = S)	Z Score Post-Test (Mean = 18.06 = X) (Standard Deviation = 5.38 = S)
D17	0.30 Standard Deviations Above the Mean	0.54 Standard Deviations Below the Mean
D19	0.30 Standard Deviations Above the Mean	0.57 Standard Deviations Below the Mean
D6	0.30 Standard Deviations Above the Mean	0.54 Standard Deviations Above the Mean
D22	0.30 Standard Deviations Above the Mean	0.75 Standard Deviations Below the Mean
D18	0.28 Standard Deviations Below the Mean	0.17 Standard Deviations Above the Mean
D15	0.28 Standard Deviations Below the Mean	1.87 Standard Deviations Below the Mean
D23	0.28 Standard Deviations Below the Mean	0.75 Standard Deviations Below the Mean
D2	0.28 Standard Deviations Below the Mean	1.47 Standard Deviations Above the Mean
D13	0.33 Standard Deviations Below the Mean	1.00 Standard Deviations Above the Mean
D16	0.33 Standard Deviations Below the Mean	0.02 Standard Deviations Below the Mean
D1	0.61 Standard Deviations Below the Mean	0.73 Standard Deviations Above the Mean
D7	0.61 Standard Deviations Below the Mean	0.17 Standard Deviations Above the Mean
D20	1.17 Standard Deviations Below the Mean	0.57 Standard Deviations Below the Mean

Student	Z Score Pre-Test (Mean = 13.21 = $\bar{X}$) (Standard Deviation = 3.60 = S)	Z Score Post-Test (Mean = 18.06 = $\bar{X}$) (Standard Deviation = 5.38 = S)
D21	1.17 Standard Deviations Below the Mean	1.12 Standard Deviations Below the Mean
D10	2.00 Standard Deviations Below the Mean	0.17 Standard Deviations Above the Mean

SUMMARY OF DATA DEVELOPED FOLLOWING COMPUTATION OF Z SCORES FOR GROUP E AS SHOWN IN THE PRE-TEST - POST-TEST STANDARDIZED VARIABLE OF THE ELECTRICAL UNIT

$$Z = \frac{X - \bar{X}}{S}$$

Student	Z Score Pre-Test (Mean = 11.23 = $\bar{X}$) (Standard Deviation = 3.30 = S)	Z Score Post-Test (Mean = 17.47 = $\bar{X}$) (Standard Deviation = 6.90 = S)
E1	2.96 Standard Deviations Above the Mean	0.94 Standard Deviations Above the Mean
E6	2.05 Standard Deviations Above the Mean	0.94 Standard Deviations Above the Mean
E5	1.44 Standard Deviations Above the Mean	1.38 Standard Deviations Above the Mean
E19	0.84 Standard Deviations Above the Mean	0.80 Standard Deviations Below the Mean
E18	0.84 Standard Deviations Above the Mean	0.93 Standard Deviations Below the Mean
E2	0.53 Standard Deviations Above the Mean	0.36 Standard Deviations Above the Mean
E11	0.53 Standard Deviations Above the Mean	0.35 Standard Deviations Below the Mean
E12	0.53 Standard Deviations Above the Mean	0.22 Standard Deviations Above the Mean
E7	0.06 Standard Deviations Below the Mean	0.22 Standard Deviations Above the Mean

Student	Z Score Pre-Test (Mean = 11.23 = X) (Standard Deviation = 3.30 = S)	Z Score Post-Test (Mean = 17.47 = X) (Standard Deviation = 6.90 = S)
E8	0.06 Standard Deviations Below the Mean	0.50 Standard Deviations Below the Mean
E14	0.06 Standard Deviations Below the Mean	0.36 Standard Deviations Above the Mean
E9	0.37 Standard Deviations Below the Mean	0.21 Standard Deviations Below the Mean
E21	0.37 Standard Deviations Below the Mean	0.21 Standard Deviations Below the Mean
E13	0.37 Standard Deviations Below the Mean	0.50 Standard Deviations Below the Mean
E15	0.67 Standard Deviations Below the Mean	0.64 Standard Deviations Below the Mean
E3	0.67 Standard Deviations Below the Mean	1.38 Standard Deviations Above the Mean
E16	0.98 Standard Deviations Below the Mean	0.80 Standard Deviations Above the Mean
E10	1.28 Standard Deviations Below the Mean	0.65 Standard Deviations Above the Mean
E17	1.28 Standard Deviations Below the Mean	1.80 Standard Deviations Below the Mean
E20	1.58 Standard Deviations Below the Mean	1.08 Standard Deviations Below the Mean
E4	1.89 Standard Deviations Below the Mean	0.21 Standard Deviations Below the Mean

APPENDIX L

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUPS A, B, C D AND E - ELECTRICITY

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON PRODUCT MOMENT FORMULA FOR GROUP A - ELECTRICITY

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{102}{19} - \left(\frac{-12}{19}\right)\left(\frac{29}{19}\right)}{\left\{\sqrt{\frac{540}{19} - \left(\frac{-12}{19}\right)^2} \times \sqrt{\frac{587}{19} - \left(\frac{29}{19}\right)^2}\right\}}$$

$$r = \frac{10.10 - (-0.63)(1.52)}{\left\{\sqrt{28.4 - (-0.63)^2} \times \sqrt{30.9 - (1.52)^2}\right\}}$$

$$r = \frac{10.10 - (-.9976)}{\left\{\sqrt{28.4 - .3968} \times \sqrt{30.9 - 2.410}\right\}}$$

$$r = \frac{10.10 + .9976}{\left\{\sqrt{28.0031} \times \sqrt{28.49}\right\}}$$

$$r = \frac{11.0976}{28.2486}$$

$$r = .37$$

GROUP A - ELECTRICITY

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$$

$$r_{11} = \frac{2(.37)}{1 + .37}$$

$$r_{11} = \frac{.74}{1.37}$$

$$r_{11} = .54$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP B - ELECTRICITY

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{-71}{20} - \left(\frac{-12}{20}\right)\left(\frac{13}{20}\right)}{\left\{\sqrt{\frac{436}{20} - \left(\frac{-12}{20}\right)^2} \times \sqrt{\frac{525}{20} - \left(\frac{13}{20}\right)^2}\right\}}$$

$$r = \frac{3.55 - (-.60)(.65)}{\left\{\sqrt{21.80 - (-.60)^2} \times \sqrt{26.25 - (.65)^2}\right\}}$$

$$r = \frac{3.55 - (.39)}{\left\{\sqrt{21.80 - .3600} \times \sqrt{26.25 - .4225}\right\}}$$

$$r = \frac{3.55 - .39}{\left\{\sqrt{21.44} \times \sqrt{25.72}\right\}}$$

$$r = \frac{3.16}{4.66 \times 5.07}$$

$$r = \frac{3.16}{23.62}$$

$$r = .133$$

GROUP B - ELECTRICITY

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$$

$$r_{11} = \frac{2(.133)}{1 + .133}$$

$$r_{11} = \frac{.266}{1.133}$$

$$r_{11} = .23$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP C - ELECTRICITY

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{191}{20} - \left(\frac{12}{20}\right)\left(\frac{-15}{20}\right)}{\left\{\sqrt{\frac{790}{20} - \left(\frac{12}{20}\right)^2} \times \sqrt{\frac{663}{20} - \left(\frac{-15}{20}\right)^2}\right\}}$$

$$r = \frac{9.55 - (.60)(-.75)}{\left\{\sqrt{39.50 - (.60)^2} \times \sqrt{33.15 - (-.75)^2}\right\}}$$

$$r = \frac{9.55 - (-.45)}{\left\{\sqrt{39.50 - (.36)} \times \sqrt{33.15 - (.56)}\right\}}$$

$$r = \frac{9.55 + .45}{\left\{\sqrt{39.50 - .36} \times \sqrt{33.1 - .56}\right\}}$$

$$r = \frac{10.00}{\left\{\sqrt{39.14} \times \sqrt{32.59}\right\}}$$

$$r = \frac{10.00}{6.25 \times 5.70}$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP C - ELECTRICITY

$$r = \frac{10.00}{34.92}$$

$$r = .29$$

GROUP C - ELECTRICITY

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2r\frac{1}{2}\frac{1}{2}}{1 + r\frac{1}{2}\frac{1}{2}}$$

$$r_{11} = \frac{2\ (.29)}{1 + .29}$$

$$r_{11} = \frac{.0841}{1.29}$$

$$r_{11} = .06$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP D - ELECTRICITY

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{58}{23} - \left(\frac{15}{23}\right)\left(\frac{15}{23}\right)}{\left\{\sqrt{\frac{744}{23} - \left(\frac{15}{23}\right)^2} \times \sqrt{\frac{763}{23} - \left(\frac{15}{23}\right)^2}\right\}}$$

$$r = \frac{2.52 - (.65)(.65)}{\left\{\sqrt{32.20 - (.65)^2} \times \sqrt{33.20 - (.65)^2}\right\}}$$

$$r = \frac{2.52 - (.43)}{\left\{\sqrt{32.20 - .43} \times \sqrt{33.20 - .43}\right\}}$$

$$r = \frac{2.52 - .43}{\left\{\sqrt{31.77} \times \sqrt{32.77}\right\}}$$

$$r = \frac{2.09}{5.63 \times 5.72}$$

$$r = \frac{2.09}{32.20}$$

$$r = .06$$

GROUP D - ELECTRICITY

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r = \frac{2r\frac{1}{2}\frac{1}{2}}{1 + r\frac{1}{2}\frac{1}{2}}$$

$$r_{11} = \frac{2(.06)}{1 + .06}$$

$$r_{11} = \frac{.12}{1.06}$$

$$r_{11} = .11$$

COMPUTATION OF THE CORRELATION COEFFICIENT AS SHOWN THROUGH THE PEARSON-PRODUCT MOMENT FORMULA FOR GROUP E - ELECTRICITY

$$r = \frac{\frac{\Sigma f x'y'}{N} - \left(\frac{\Sigma f x'}{N}\right)\left(\frac{\Sigma f y'}{N}\right)}{\left\{\sqrt{\frac{\Sigma f (x')^2}{N} - \left(\frac{\Sigma f x'}{N}\right)^2} \times \sqrt{\frac{\Sigma f (y')^2}{N} - \left(\frac{\Sigma f y'}{N}\right)^2}\right\}}$$

$$r = \frac{\frac{189}{21} - \left(\frac{8}{21}\right)\left(\frac{31}{21}\right)}{\left\{\sqrt{\frac{405}{21} - \left(\frac{8}{21}\right)^2} \times \sqrt{\frac{1138}{21} - \left(\frac{31}{21}\right)^2}\right\}}$$

$$r = \frac{9.00 - (.38)(1.47)}{\left\{\sqrt{19.28 - (.38)^2} \times \sqrt{54.19 - (1.47)^2}\right\}}$$

$$r = \frac{9.00 - (.5586)}{\left\{\sqrt{19.28 - .1444} \times \sqrt{54.19 - 2.1609}\right\}}$$

$$r = \frac{9.00 - .5586}{\left\{\sqrt{19.1356} \times \sqrt{52.0291}\right\}}$$

$$r = \frac{8.4414}{4.37 \times 7.21}$$

COMPUTATION OF THE CORRELATION COEFFICIENT
AS SHOWN THROUGH THE PEARSON-PRODUCT
MOMENT FORMULA FOR GROUP E - ELECTRICITY

$$r = \frac{8.4414}{32.5077}$$

$$r = .25$$

GROUP E - ELECTRICITY

COMPUTATION OF THE LEVEL OF RELIABILITY AS SHOWN THROUGH THE SPEARMAN-BROWN PROPHECY FORMULA

$$r_{11} = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$$

$$r_{11} = \frac{2\ (.25)}{1 + .25}$$

$$r_{11} = \frac{.50}{1.25}$$

$$r_{11} = .40$$

APPENDIX M

"STUDENT'S T" DISTRIBUTION

ELECTRICITY

"STUDENT'S T" DISTRIBUTION
ELECTRICITY

Experimental Group	Mean Score
Group A = 19	16.49
Group B = 20	15.50
Group C = 20	14.95
Total = 59 = N_1	Mean 16.29 = $\bar{X}_1$

Control Group	Mean Score
Group D = 23	15.67
Group E = 21	14.35
Total = 44 = N_2	Mean 15.01 = $\bar{X}_2$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sigma\sqrt{1/N_1 + 1/N_2}}$$

$$\sigma = \sqrt{\frac{N_1 S_1^2 + N_2 S_2^2}{N_1 + N_2 - 2}}$$

$$\sigma = \sqrt{\frac{59(16.29)^2 + 44(15.01)^2}{59 + 44 - 2}}$$

"STUDENT'S T" DISTRIBUTION
ELECTRICITY

$$\sigma = \sqrt{\frac{59\ (265.46) + 44\ (225.30)}{103 \quad -2}}$$

$$\sigma = \sqrt{\frac{15662.14 \quad + \quad 9913.20}{101}}$$

$$\sigma = \sqrt{\frac{25575.34}{101}}$$

$$\sigma = \sqrt{253.22}$$

$$\sigma = 25.3$$

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sigma\sqrt{1/N_1 + 1/N_2}}$$

$$t = \frac{16.29 - 15.01}{25.3\sqrt{1/59 + 1/44}}$$

$$t = \frac{1.28}{25.3\sqrt{.01 \quad + .02}}$$

$$t = \frac{1.28}{25.3\sqrt{.03}}$$

$$t = \frac{1.28}{25.3\ (.173)}$$

"STUDENT'S T" DISTRIBUTION
ELECTRICITY

$$t = \frac{1.28}{4.37}$$

$$t = .29$$

VITA

Thomas Wyatt Brown

Candidate for the Degree of

Master of Science

Thesis: A STUDY OF TWO METHODS OF INSTRUCTION EMPLOYED IN TEACHING SCIENCE AT THE ELEMENTARY LEVEL

Major Field: Industrial Arts Education

Biographical:

Personal Data: Born in Seminole, Oklahoma, December 20, 1941, the son of Wyatt C. Brown.

Education: Graduated from Wewoka High School in 1959; received the degree of Associate of Arts in 1962 from Connors State College at Warner, Oklahoma; attended Oklahoma Baptist University, Shawnee, Oklahoma and Panhandle A&M, Goodwell, Oklahoma; received Bachelor of Arts in Education in 1965 from Northeastern State College, Tahlequah, Oklahoma.

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