THE DESIGN AND FIELD TEST
OF A SELF-INSTRUCTIONAL MEDIA
ASSISTED LEARNING UNIT

by

Harold Bellamy Kirchner
B.Ed., University of British Columbia, 1965

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE (EDUCATION)
in the Faculty
of
Education

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THE DESIGN AND FIELD TEST
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ASSISTED LEARNING UNIT

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THE DESIGN AND FIELD TEST OF A SELF-INSTRUCTIONAL MEDIA ASSISTED LEARNING UNIT

This study sought to determine whether cognitive and manipulative skills normally acquired through lecture and laboratory courses could be mastered by learners working independently in their homes utilizing instructional materials designed in accordance with appropriate criteria.

The study developed from a growing concern expressed in the professional and lay literature that it may not be possible to meet the growing needs for educational services with conventional campus-type learning space and procedures. More specifically, the study sought answers to the following three questions:

1. What are the criteria for the effective design and application of the software and,

2. Can students learn from a self-instructional media assisted learning unit?

3. What logistical problems must be solved in assisting students to make profitable use of self-instructional media assisted learning units?

The study proceeded through five major phases: development of criteria, design of the instructional unit, selection of the sample, field test of the instructional unit, and evaluation of the procedure.
A list of items relating to the design of a self-learning program and kit were compiled into a questionnaire and mailed to twenty-seven knowledgeable educators in British Columbia. The results of the questionnaire led to the development of a set of appropriate criteria for use in a system of self-instructional program and kit design.

A program designed to lead the learner to the mastery of a body of knowledge and the acquisition of manipulative skills was developed. Course material was presented to the student by means of printed matter, audio-taped material and various kinds of visual media. The subject matter was basic electricity. All hardware and software items in the program were housed in an appropriate container.

Twelve housewives living in North and West Vancouver were chosen as the sample study group. Each of the housewives was provided with a self-learning kit and the instructions needed to complete the course. The field test period was one month.

Data was gathered and analysed on two areas of student performance. The first dealt with component and symbol identification. Results of a pre- and post-experimental period test provided two findings: that the experimental group had limited prior knowledge of the subject matter to be studied; and that significantly increased test scores
resulted from undertaking the self-instructional program. The second area tested was knowledge and principles. Results were similar to those obtained from the recognition test.

The two tests were also administered to a group of students at the British Columbia Institute of Technology who were studying Electricity and Electronics. The purpose of the external administration was twofold: to provide the writer with informal evidence on the suitability of his testing instruments; and to provide a tentative means of assessing the performance of the experimental group relative to learners within a more conventional instructional program. It appeared that the tests used with the experimental group were not unsuitable for students taught by more conventional means and that the performance of the conventionally taught group was not widely divergent from the experimental group. However, these findings are not presented as conclusions because the groups could not be suitably equated on various necessary factors. On the other hand, the results provided an indication that the self-instructional program was not markedly divergent in effectiveness and content from conventional courses in Electricity and Electronics. Informal data gathered from the experimental subjects by means of questionnaire and interview yielded the following findings:

1. The learner was an active participant in the process and did much more than just listening and reading.
2. The material learned had application and meaning in real life.

3. The system permitted the student to start and stop at her own pace.

4. The system was capable of providing opportunities for adaptation to individual differences.

5. The system placed the responsibility for learning with the student.

Logistical problems in providing this type of instruction were reported. On the basis of the evidence the following conclusions were warranted:

1. It is possible to gain substantial guidance from experts in the field as to what criteria should be incorporated in the design of the necessary hardware and software of a self-instructional unit.

2. Students working independently at home with the assistance of a self-instructional media assisted learning unit can achieve reasonable mastery over conceptual and manipulative skills normally taught in a campus laboratory.

3. The reaction of the experimental group to this type of learning was positive.

4. The logistical problems encountered when this form of instruction is used are not insurmountable.

The results of this study indicate that a self-instructional approach may be one solution to the problem of increased numbers of students, the knowledge explosion, high cost of educational facilities, and the press for space in our learning institutions.
ACKNOWLEDGEMENTS

The writer wishes to express his sincerest appreciation to his senior supervisor Dr. John F. Ellis for his assistance, encouragement and patience in the development of this study and in the preparation of the thesis.

The writer is indebted to members of the examining committee: Dr. Selma Wasserman, and Dr. Norman Robinson for their counsel and encouragement. Appreciation is extended to Dr. Milton McClaren who rendered invaluable assistance to the writer in the development of this study.

Appreciation is also extended to many of the leading educators in this province whose cooperation in providing information to the writer made it possible to establish the guidelines and criteria for program and kit design used in this study.

Finally, but certainly not least of all, the writer wishes to express his deepest appreciation to Mrs. Leta Jones for her typing and to his wife Joy and daughter Shawn for their patience and understanding throughout the writing of this study.

H.B.K.
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CHAPTER I

THE PROBLEM

The central concern of this study was to determine whether certain cognitive and technical skills normally acquired through lecture type courses taught in classrooms and laboratories could be attained by the learner working independently, in his own home, with self-instructional materials.

I. BACKGROUND OF THE PROBLEM

The number of students who attend colleges, institutes of technology, and universities increases significantly each year. This expanding post-secondary school enrollment, coupled with the complex and diverse needs of business, industry, and government for graduates with high levels of competence, has created a need for new systems of learning. The latter is emphasized by Dymond:

.... with the growing complexity and varieties of skills and knowledge in our economy and the consequent lengthening of the learning period, we must find more efficient means of transmitting knowledge to speed up the learning period. In short we must pay more attention to improving the methodology of the education and training process (1).
A recent forecast suggests the order of magnitude of the problem. Between 1970 and 1980 university enrollments are expected to double (2, pp. 55-73). Similarly, enrollments in colleges and other post-secondary institutes will increase because of the high birth rates of the 1940's and 1950's. In addition, the development of post-secondary institutions through the support of Federal and Provincial Governments is making attendance at post-secondary institutions possible for many more citizens than in the past. Increasing numbers of students, particularly adults, are taking advantage of the improved accessibility of learning opportunities. Rising enrollments are obviously reflected in higher operating costs. Operating expenditures for higher education in Canada exceeded two billion dollars in 1970 (2, p. 59). Expenditures can be expected to increase at a rate of approximately 15 per cent per year. Even though these forecasts may prove to be excessive, the cost of post-secondary education could well be reaching levels that are unacceptable to many citizens.

The rapid increase in operating expenditures is paralleled by the cost of building new facilities. One of the most conspicuous activities in cities throughout Canada in the last decade has been the construction of new universities, colleges, and vocational schools. Construction
of Community Colleges has also increased in this period. Capital expenditures for post-secondary institutions in 1968-69 was approximately 200 million dollars and is expected to be five times as great by 1980.

Thus, if present trends continue there would seem to be only one logical result: it will be difficult if not impossible for local, provincial and federal governments to allocate a sufficiently large proportion of their revenues for education. After all, education is only one of a large number of social concerns that require financial support. Rising demands in health, welfare, urban renewal, housing, and pollution control together with increasing educational costs will place an intolerable burden on available sources of revenue.

It should therefore be obvious that current education practices will be subjected to increasing rigorous scrutiny. The effectiveness of teaching procedures, for example, will have to be examined and new methods that are more productive and less expensive will have to be developed. In this regard, the largely unrealized possibilities of flexible scheduling, television, radio, computer assisted programmed instruction and many other types of instructional teaching devices and
strategies should be exploited.

In other words, although teachers at all levels are currently using a variety of self-instructional approaches, they have not decreased their own direct physical involvement in the learning environment. The cost savings which may be possible through self-instruction will never be realized unless personal costs are reduced.

It is recognized that the purpose of public education, regardless of level, is to assist the learner to develop appropriate attitudes, knowledge and skills. This task has traditionally required the efforts of a competent teacher both to create a conducive learning environment and to be physically present within it at all times. However, it would seem to be feasible for a teacher to create an effective and efficient learning environment which, in its operation, would require less of his direct involvement. For example, a carefully devised self-instructional program could well provide students with a means of acquiring knowledge and skill normally acquired through direct contact with a teacher. Such a self-instructional program could not only reduce the direct involvement of the teacher and the commensurate instructional costs, but could also provide a means whereby learners outside of the conventional educational institutions could acquire knowledge and skill
in a wide variety of subject areas.

In addition, investigations have indicated that a person acquires knowledge and skill according to his own motivation, abilities and general readiness (3, pp. 63 - 83) and these are, of course, widely variable within groups of learners. Educators must therefore accept the implications for instruction of individual differences, particularly those relating to learner's motivation, his personal and economic circumstances, his learning ability, and his unique rate and style of learning. All this is particularly germane for high schools and post-secondary institutions whose programs have been based primarily upon campus oriented group-paced lecture and laboratory presentations.

II. STATEMENT OF THE PROBLEM

The general problem addressed in this study was the following: is it possible to devise a teaching-learning procedure which, when contrasted with existing procedures, places less reliance on the physical presence of the teacher, does not necessarily require the provision of institutional space, takes into account differential learning rates and personal circumstances of learners, and reaches acceptable levels of efficiency and effectiveness?

The specific purpose of this investigation has been
to determine whether certain cognitive and technical skills
normally acquired through lecture-laboratory type courses
can be acquired by the learner working independently at
home, utilizing self-instructional materials that have been
designed in accordance with the recommendation of experts.

III. QUESTIONS ADDRESSED IN THE STUDY

In the design and field test of a self-instructional
unit the writer has attempted to answer the following
questions:

1. What are the criteria for the effective
design and application of the software
and hardware components of the unit?

2. Can students learn from a self-instructional
media assisted learning unit?

3. What kinds of logistical problems must be
anticipated and met in assisting students
to make maximum use of a self-instructional
media assisted learning unit?

IV. DEFINITION OF TERMS

Self-Instructional Media Assisted Learning Unit (Simelu).

For the purpose of this study the self-instructional
media assisted learning unit was a kit constructed in
accordance with criteria validated by experts, containing
the necessary hardware and software that made it possible
for a learner in her own home to complete a course of instruction without the physical presence of a teacher. Specifically the unit contained audio tape, a laboratory manual, a text book, 35 mm. slides, slide projector, tape recorder, measuring instrument, and small electrical components.

Remote Location

A remote location was defined as a place other than a campus or laboratory classroom where the learning activity was conducted. In this study the remote location was the learner's home.

Hardware

Hardware was defined as the mechanical and electrical devices used by the learner throughout the program. These included the electrical power supply, electrical measuring instrument, slide projector, tape recorder, circuit terminals, electrical resistors, and jumper wires.

Software

Software was defined as that material used in the presentation of lesson material through the media of graphics, audio, and the written word. The items included were cassette tapes, coloured slides, laboratory manual, and text book.
Learning Unit

The learning unit was defined as a series of instructional experiences designed to lead the learner to mastery of a body of knowledge. In this study the learning unit consisted of nine lessons and twelve laboratory experiments concerned with the fundamentals of electricity and electronics. Each lesson was approximately fifteen minutes in length while each laboratory experiment was designed to be completed by the learner in thirty minutes.

Self Instruction

Self instruction meant that the course was self-operational. Much of the instruction was given by audio tape with a variety of visual media. The laboratory manual contained notes and diagrams which the student watched while listening to the taped comments of the instructor. At specified times in the program the student became actively involved by solving a problem, completing a derivation, or performing an experiment with materials in the kit. The learner worked through each learning activity on her own, reinforced with assigned readings, questions, solutions to problems, and activity units or experiments that provided the necessary verification of theory.
V. ORGANIZATION OF REMAINDER OF THESIS

In the process of completing this investigation the writer first reviewed the literature relating to self-instructional programs designed primarily for late secondary and post-secondary educational settings. This review is presented in Chapter II. Chapter III provides a description of the procedure used in conducting this study. Chapter IV provides a description of the Self-Instructional Media Assisted Learning Unit. Chapter V contains the analysis, results and general conclusions of this study. Chapter VI outlines the logistical problems encountered in the field test. The last chapter provides the reader with a discussion of the results and their implications and presents recommendations for further study.
REFERENCES FOR CHAPTER I


(3) Jones, J. C., Learning, (Harcourt, Bruce, and World Inc., 1967.)
CHAPTER II
REVIEW OF LITERATURE

During the past few years government leaders, educators, and members of the business community have emphasized the need for education to adopt newer and more effective means of coping with the escalating demand for post-secondary education. In a recent royal commission report on technological trends for the Province of Alberta it was stated:

Expanded communication capabilities in the home will make possible a variety of new approaches to education via computer-assisted instruction, remote problem solving and instructional television. Consequently, the technological opportunity to make education a home centred activity will dramatically alter our present institution bound concept of education (30, p. 18).

In a recent newspaper editorial devoted to the problems facing higher education in the province of British Columbia, Dr. John Ellis, Professor, Simon Fraser University had this to say:

A crisis in higher education is overtaking B. C. and revolutionary methods of teaching - including home study through electronic media in the place of obsolete university campuses - will be required to solve it. (4)
Since this study was concerned with a Self-Instructional Media Assisted Learning Unit for an adult population the following review deals with pertinent and related studies. The first part of the review deals with the British Open University concept which has provided a new and imaginative structure and format for mass home study instruction. The latter part of the review deals with various instructional methods and the techniques that are currently used in post-secondary education institutions.

THE OPEN UNIVERSITY

A unique experiment in university level teaching is now under way in Britain. If successful, the Open University will ultimately make higher education available to all who can profit from it regardless of age, occupation, or academic background.

The Royal Charter which established the Open University defined its objectives as:-

the advancement and dissemination of learning and knowledge by teaching and research by a diversity of means; such as, broadcasting and technological devices appropriate to higher education, by correspondence tuition, residential courses, and seminars; and to provide education of university and professional standards and promote the educational well-being of the community generally (27).
The Open University is intended to provide for three main areas of undergraduate studies: post-experience training, education, and research for higher degrees, (25, p. 5) thus giving people the opportunity of continuing education for formal qualifications at university level by studying in their own time.

We took it as axiomatic said the committee, that no formal academic qualifications would be required for registration as a student. Anyone could try his or her hand, and only failure to progress adequately would be a bar to continuation of studies, (26, p. 16).

Having been accepted for a degree program the student receives a correspondence package of materials to study and assignments to complete. The learning package is integrated with specially prepared weekly programmes on B.B.C. 2 television and B.B.C. Radio 3 and 4.

Anyone can view or listen to these programmes but only enrolled students receive the correspondence package, have access to the tutors, and can write the examinations. Students who register for a science course receive, on loan, an equivalent of $150.00 worth of experimental equipment in order to carry out practical experiments in the home.

In addition, there is a network of 300 study centres, equipped with television, radio receivers, and recorders. These have been established to provide students with study and seminar
space where they may discuss course material with tutors and general problems with counsellors. Radio and television sets are provided for use by those students who cannot see or hear all the programmes on their own sets.

All students are expected to attend a residential summer school of either one or two weeks duration, depending on the number of course credits being taken. In this connection the Open University cooperates with several other universities to make use of existing laboratories and libraries.

The student's final rating is based on an on-going assessment of the student's work during the year, summer school achievements, and a final examination. To ensure that standards are maintained and kept in line with other universities an external examiner is appointed.

Lewis (13, p. 5) reports that the planning and production of correspondence materials, home experimental kits, student activities, multiple choice tests, radio and television programmes have created heavy demands on the staff of the Open University. Stannard agrees with Lewis and describes a typical situation faced by his colleagues at the Open University.
Never before have a handful of academics occupied positions of influence over so many students. Each year we shall be directing the education of far more students than one would normally expect to come into contact with in a whole lifetime. This places upon us a heavy responsibility, and the awareness of this responsibility is continually with us. It shows up in various ways. For example, when piloting a course unit on twenty guinea pig students, we may be tempted to think that if only one of them experiences difficulty with a certain section, then we had not done too badly. However, if one student in twenty is in trouble, that means a total of three hundred and fifty students in trouble each year! (21, p. 27)

To illustrate how small decisions become magnified, Stannard describes a situation relating to a simple science experiment that was to be performed by the student in his own home using equipment provided in the home experimental kit.

I well remember reading of a simple experiment that could be performed in the home using a glass milk bottle. I decided to include it in one of my units. Although it was an obvious little experiment I thought it best to spend a quarter of an hour making absolutely sure that it did work. In fact, it did not work, and in the process I broke two bottles. Under normal circumstances this would be an event of no consequence. However, being at the Open University meant that had I not taken the trouble to check the experiment I would have been directly responsible for the systematic smashing of some tens of thousands of milk bottles! (21, p. 27)
From the very beginning the Science Faculty has subscribed to the view that practical work is an essential ingredient of all science courses. "Activities performed at a time when it is most relevant to the student brings subject matter alive and makes it more meaningful!" (21, p.20)

To achieve a component of practical application of the theory studied in the foundation science course, a basic experimental kit forms part of the correspondence materials. The kit is worth $250 and includes a microscope, a photo-electric colourmeter, a spectroscope, a balance and weights, a stop watch, tuning forks, a spirit burner, glassware and chemicals. All parts are housed in a plastic box.

The over-riding aim of the Open University is to provide access to education regardless of a person's previous educational attainment; to provide an alternative way for people who, for one reason or another do not wish to follow the traditional education ladder; and to make it easy for people to re-enter the education system - essentially to provide a second chance for an education for the working class.

An analysis of the occupational breakdown of those people who applied for first year courses indicates that the largest majority of applicants fall into the "white collar"
and professional worker category (See Table 1). The fact that teachers formed the largest group of applicants, doctors, accountants, musicians the second largest group, and housewives comprising the third largest group, illustrates that the Open University is not in fact registering large numbers of the "working class".

Stannard has offered a rationale for the low enrollment of applicants from the working class.

At present the vast majority of these people (working class) do not want a higher education. They have never thought of themselves as taking such a course of study and they do not in any way identify themselves with universities - universities exist for other people, not for them. Their spare time, and that of all their friends and acquaintances is given over to TV, football, bingo and visits to public houses - it is not spent in study. (21, p. 30)

The Open University has created a great deal of interest in highly developed countries with sophisticated educational systems. In addition, it has been of interest to rapidly developing countries with urgent needs to accelerate the pace of higher general and technological education. Stone (22) believes that the Open University will likely remain a unique institution.
### TABLE I

**OCCUPATIONS OF APPLICANTS TO THE OPEN UNIVERSITY FOR FIRST YEAR COURSES IN 1971**

<table>
<thead>
<tr>
<th>OCCUPATION</th>
<th>NUMBER OF APPLICATIONS</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housewives</td>
<td>3758</td>
<td>9.2</td>
</tr>
<tr>
<td>Armed Forces</td>
<td>699</td>
<td>1.7</td>
</tr>
<tr>
<td>Administrators</td>
<td>2830</td>
<td>6.9</td>
</tr>
<tr>
<td>Teachers</td>
<td>14642</td>
<td>35.9</td>
</tr>
<tr>
<td>Professional &amp; Arts (Doctors, Accountants, Musicians, etc.)</td>
<td>4869</td>
<td>11.9</td>
</tr>
<tr>
<td>Qualified Scientists, Engineers</td>
<td>3275</td>
<td>8.0</td>
</tr>
<tr>
<td>Technicians, Draughtsmen</td>
<td>3037</td>
<td>7.5</td>
</tr>
<tr>
<td>Electrical, machine trades</td>
<td>730</td>
<td>1.8</td>
</tr>
<tr>
<td>Manufacturing (including farming, transport, etc.)</td>
<td>1171</td>
<td>2.8</td>
</tr>
<tr>
<td>Clerical and Office Staff</td>
<td>3323</td>
<td>8.2</td>
</tr>
<tr>
<td>Sales Staff, police, fire brigade</td>
<td>1409</td>
<td>3.4</td>
</tr>
<tr>
<td>Others</td>
<td>1073</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>40816</strong></td>
<td><strong>99.9</strong></td>
</tr>
</tbody>
</table>
However by bringing higher education to adult students in their own homes by the most successful combination of well-tried and technologically advanced means that the University can devise will make it a pioneer institution. James (10, pp. 32 - 33) suggests that the University's major contribution to educational development may well be that, by making public the relationship between teacher and learner other institutions will be encouraged to use mass media for individualized instruction.

There are distinct differences existing between the traditional type of educational institution that exists in North America and the type of education made available under the concept of Britain's Open University. North American education reflects the life styles and learning matters that influenced university education 60-80 years ago at a time when higher education was monopolized by a small group of middle and upper class government and business people. It was a time when the prime teaching device was the human voice and although books were available, there were no devices such as tape recorders, films, television, cassettes and phonograph records available. It was a society in which long-distance travel was a real venture and a time when knowledge for the "educated man" was considered to be limited and fixed.
The surprising thing about higher education today is the fact that so many of the educational concepts of the 19th century still apply. Our universities and colleges are largely self contained and are viewed by many as islands of learning with faculty and students, library, classrooms, laboratory facilities, housing, recreation, and parking space all forming part of enclosed communities. An institution that provides adequately for the needs of the worker, housewife, socially disadvantaged or late bloomer is rarely to be found. Higher education still tends to be designed for the young full-time student who is able to motor or ride on public transportation and spend the major part of his day on a campus.

An educational system that is designed for full-time day students, who take traditional on-campus lectures and tutorials is not necessarily the only way or even the best way of providing educational opportunities for all. Face to face on-campus contact can be replaced in good measure by other instructional systems and without loss of quality. It is the process, not the setting that is important.

One might ask - what conditions made it possible for the Open University to function in Britain? The answer lies in the geography, population, and communications network of the country.
Britain is relatively small in size (area of Vancouver Island) with high population densities. These conditions alone make it possible for the Open University to draw from large audiences which are concentrated in defined land areas. The excellent radio and television broadcasting facilities of video and radio signals and the excellent co-operation and working relationship that exists between the B.B.C. and the academic staff of the Open University has also contributed much to the success of Britain's Open University. Furthermore, the Open University has developed a common curriculum of limited course offerings. Having a limited number of courses to prepare permits the hiring of a relatively small body of academic staff, but the courses offered reach a very large number of students.

Staff in all of the Open University faculties totals about 150 with some additional staff required in the media technology area. The total projected operating costs for 1973-74, including all production and dissemination costs for 40,000 students are less than 2 million pounds (22, p. 9). Furthermore, the co-operation of existing universities, polytechnic and technical colleges in providing study centres for students has increased the flexibility of the Open University and avoided the high costs of building additional new centres.
In order for the Open University concept to apply in British Columbia it will be necessary for the government to engage in extensive planning. This would have to include an examination of curriculum, instructional strategies, working arrangements between the major radio and television networks and educators in institutes of higher learning and many other related matters.

If British Columbia were to use television for the presentation of educational program material the cost would be very high and planning would require careful selection of program material in order to provide courses that would be of interest to a diverse group of people. The large number of courses currently offered in our post-secondary institutions and the variance in content that exists is an added problem that would have to be solved in order to make the courses offered viable.

Institutions such as the University of British Columbia, Simon Fraser and the University of Victoria already have authority within their existing power to offer courses via television. However, the government to date has made no definite decision on program funding or the allocation
of an educational television channel for the province. If a system of providing a more accessible education is made available in the province, there exists a large pool of students from the ranks of housewives, workers, the handicapped, and the general public.

SELF-PACED LEARNING SYSTEMS

There have been a considerable number of writers in the field of education and psychology who have emphasized the need for self-paced learning systems. Gagne (5); Allen (1, pp. 27-51); McKeegan (16, pp. 232-237); Glaser (7), are but a few who emphasize this new type of learning system. They have criticized the existing lock-step system of instruction as an inhibitor of the learning process and have called for the provision of instructional programs that will cater more to the individual differences and requirements of students.

Instructional programs which place the emphasis on the individual activity of the learner are now operating in a number of schools. Names such as LAP (Learning Activity Package); (11, pp. 178-183); UNIPAC (23, p. 231-236); and PLAN (Program for Learning in Accordance with Needs) (17, p. 19) are but a few now in operation.

Any discussion of learning packages soon leads to
semantic difficulties. Unruh (28, pp. 763-766) states that the pedagogical meaning of "package" has not been defined in an educational context and is a term used at times to refer to a "boxed" assortment of materials and at other times to a complicated learning system made up of sub-systems and encompassing a complex educational program.

Despite substantial differences among learning packages there are a number of commonalities. Typically each has a set of teaching-learning materials, and each focuses on a major learnable idea, skill or attitude. The objectives tend to be stated or implied in behavioural terms, with the emphasis on the performance of the learner. Packages tend to rely heavily on the use of learning resources which can be student operated. Finally, learning packages typically contain student evaluative devices such as pre-tests, self-tests and post-tests (27, pp. 31-33).

Embryonic programs have been developed that are designed to be used as self-paced learning packages. One example of such a learning package is the Milton Project introduced into the Milton Area School District located in Central Pennsylvania (28, p. 234). Individualized self-paced programs in language arts, mathematics, science, and social studies in the junior high level and programs in English and Mathematics at the high school level have been
developed. In all of the Milton programs there has been a heavy emphasis on the print mode in presenting the course material, however, the social studies program makes rather extensive use of teacher-prepared tapes and commercially adapted films. Comparative studies involving experimental and control groups were not undertaken in the Milton project.

Another program is the Project Plan teaching units, or TLU's developed by the American Institute for Research in Palo Alto, California (30, pp. 835-839). This project has focused on the four disciplines of science, language arts, mathematics and social studies for students in grades 1 and 2. Students pursue individual programs of study utilizing specially designed Teaching Learning Units (TLU's). Each TLU is approximately a two week module or increment of a particular subject domain. The student reports his progress by a data card; and when ready he is evaluated on the attainment of the learner objectives. Evaluation tests of the student are fed from the school via telephone lines to a computer where print-outs are made and sent back to the school the following day. The results of each test forms the basis for alternative TLU's that can be taken by the students.

Students in the PLAN project operate audio visual equipment themselves after a minimum amount of instruction.
Instruction in the use of tape recorders, filmstrip viewers, record players, and other equipment is part of the first few weeks of the program. Children who are more proficient often help others who have trouble with the equipment.

A third approach to self-paced instructional programs revolves around the concept of Learning Activity Packages, called LAP's, developed initially at the Nova Schools in Fort Lauderdale, Florida (11).

The LAP program is designed to guide the student through a highly structured program based on the use of learning materials. Individualization is provided by allowing the student optional learning modes, and by utilizing a variety of instructional media, subject content, and activities from which he may choose.

The first thing the student does after he receives a Learning Activity Package is to read the rationale or purpose for the unit. This is a short introduction which explains why the content is important to him. Following the rationale is a list of the behavioural objectives which are described in terms of what is expected of the learner. After reading the objectives the student takes the pre-test, he then has a conference with the teacher to determine a suitable program of instruction. The teacher
also assists the learner in selecting an appropriate text(s) audio visual materials, and other learning aids designed to reach the goals of the program.

Working independently or at times in a small group the learner may do any of the following activities: read, view films, solve problems, attend a lecture, go on a field trip, write a research report; study transparencies, listen to audio tapes, perform experiments or consult with his teacher. Once the student feels he has successfully completed the requirements of the course, he takes a post-test. On successful post-test results the student is awarded a grade.

With the expansion of technological and scientific knowledge a need to incorporate new information into training programs has occurred. A method of teaching these new skills and knowledge is currently being undertaken through self media assisted programs instead of the traditional lecture-demonstration technique.

After a thorough survey of the training required to teach dentists to effectively use chairside assistants, a self-instructional course "Introduction to Four Handed Dentistry" was developed under contract by Pipe and Associates, Los Altos, California. (15, pp. 18-21)
Broadly described, the course objectives were to enable students to acquire the cognitive and psychomotor skills necessary for them to position double-ended instruments correctly on a tray; transfer an instrument from the tray to the dentist's hand as requested; retrieve it from the dentist; manipulate the instrument for use of the other end or the same end, as needed; and return it to the tray, placed so that the end which the dentist will need next will be ready for future delivery.

The self media assisted course was designed to eliminate the need for an instructor. However, for the course to be relevant and meaningful it was necessary for two people to work together at certain stages if the student was to practice four handed instrument transfer. A decision was made to structure the course so that two students would take the course together. Four types of audio-visual media were employed to present course material: work book, audio tape, 35 mm. colour slides and silent 8 mm. single concept film loops.

Comments from students from field tests indicated that they were successful in meeting the course objectives. However, a formal evaluation of the performance data remains to be completed.
The Audio-tutorial approach as pioneered by Postlethwait may be classified as a comprehensive self-pacing system of learning. According to the developer:

It involves the teacher identifying as clearly as possible those responses, attitudes, concepts, ideas and manipulatory skills to be achieved by the student and then designing a multifaceted, multisensory approach which will enable the student to direct his own activity to attain these objectives. The program of learning is organized in such a way that students can proceed at their own pace, filling in gaps in their background information and omitting the portions of the program which they have covered at some previous time. It makes use of every educational device available and attempts to align the exposure to these learning experiences in a sequence which will be most effective and efficient. The kind, number and nature of the devices involved will be dependent on the subject matter under consideration. (18, p. 7).

Since the inception of the audio-tutorial approach, other institutions, including elementary, secondary schools, vocational and technical schools and numerous junior colleges have begun to use the system of instruction (6, 2, 8, 9). This increase in use not only indicates a diversity of age-level uses but, in addition, a variable application of this approach to other subject areas such as history (22) and earth science (31).

The use of video taped instructional programs is
another example of the application of modern technology to the field of education (24). Taylor indicates in his study that video instruction is as effective as live instruction. Further, Carre (3) suggested that television is a more efficient way of coping with large numbers of students than multiple deliveries of the same lecture. Lindenlaub, and Ogborn (14) experimented with teaching graduate level courses over closed circuit TV, along with the results of comparative tests, have indicated that closed circuit TV can be used effectively to unite a large geographical region for graduate instructional purposes.

The computer deserves mention because of its potential impact on independent study. In a recent report describing new and imaginative ways the media is being used in education, the potential of the computer as it relates to Computer Assisted Instruction was discussed:

Computer Assisted Instruction offers a flexibility which television teaching does not permit. It is true that the student sits before an individual receiving set, and sees pictures, and text and even hears voice recordings, but he may start and stop the machine at will, he may signal to have material repeated, he may put questions (in writing) and receive answers. The computer in turn, tests the student from time to time to see whether he is learning what he is supposed to be learning. If he is, the lesson proceeds, if he isn't, the
computer gives him additional explanation which has been stored in "branch lines" of the recorded course. In fact the computer does everything in individual teaching that a tutor could do, provided the professor and the production staff have anticipated all the possibilities and have fed all the relevant materials into the computer. (25)

Recognizing the potential of the Computer, industry has made an effort to apply computer assisted instruction to the problems of industrial training. (19, pp. 11-16) In cooperation with the manufacturing facility of a major electronics corporation, newly hired technicians received their required training in data processing fundamentals through either CAI or the programmed text currently in use at the time. Students' examination scores, course completion times, and attitudes compared with those of students who received the material through a self study text indicated that CAI students scored lower on the final examination which was based on computer technology, but completed the course in considerably less time than the self study students.

Although research is not conclusive nor nearly enough in depth regarding the application of media technology to the educational process, there are indications that schools and universities are beginning to develop formats, or processes using media as the vehicle of instruction. In addition, it would appear that a growing number of
projects are being developed with a reasonable amount of success and without great emphasis on expensive equipment.

Media technology provides no panacea of instruction but a careful assessment of its potential within a framework of appropriate learning strategies can provide effective learning programs. It seems likely that carefully designed combinations of media may be required to achieve the kind of instruction that caters to students' needs, and at the same time exploits the properties of media to fullest advantage.

Each of the self-paced learning systems described in this chapter all have several basic component functions in common:

1. Each system concentrated on specific learnable ideas, principles, or skills.
2. The objectives are made very clear to the learner and it is the learner who is to accept the initiative for learning.
3. Each system uses media resources which are operated by the student.
4. Some of the self-paced systems use a variety of media components so as to provide a variation in the instructional mode.
5. The systems are complete each with a set of teaching-learning materials.
6. The majority of systems have built into the package student evaluative devices including pre-tests, self tests, and pre-tests.

The materials forming part of the learning systems, referred to above, are systematically organized into learning units with each designed to take the student through a learning program of logical order.

On the basis of review of the literature there was no evidence of a standard format for the application of an individualized learning program at the post-secondary level. The review indicated a wide variety of uses on application of new forms of instructional strategies involving tape, television, computer assisted instruction, etc. However, the greatest need in the design and implementation of the study outlined in this investigation was to design a unit which would provide empirical evidence relating to the effectiveness of learning and efficacy of use of the included materials.

It is important to point out that this study not only involved different groups, but in addition required the writer to design and construct written, visual and other materials requisite for this study.
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CHAPTER III

PROCEDURE USED IN THE STUDY

I. INTRODUCTION

The original intention of this study was to develop a self-instructional learning package that would incorporate the use of written and audio visual materials that could be used by the learner in the absence of a teacher or instructor. Normally such an investigation could have utilized commercial materials, standard formats or program design, and establish procedures and criteria for evaluating the results. As indicated in chapter II, there are a wide variety of self-instructional programs and audio visual materials available. However, there is a dominant lack of qualified research in the development of self-instructional programs, design and layout of materials and a means of evaluating the results of their use and application. With respect to the latter, this implies both a measurement of knowledge and skills acquired through a self-instructional program and specifically with respect to the degree of involvement of the teacher or agency with the learner throughout his learning experience.

On the basis of the above, the writer approached this study in three main procedural steps. The remaining portion
of this chapter will describe step #1 which was the development of criteria that would be used as a basis for the design of the self-instructional program and kit. The next step followed was to develop a self-instructional program and kit that would include the essential characteristics developed out of step #1. The final step in this general procedure was to develop a field test which would provide evidence relating to the efficacy of use and the amount of knowledge and skill acquired through this self-instructional program. These steps will be described in the accompanying paragraphs with detailed descriptions of the various problems that were encountered within each respective step.
Initially the project set out to explore several questions. What are the criteria for the design of a good program? What criteria should be employed in the construction or the actual kit used to contain the learning materials? Can learners learn from a self-instructional unit? Finally, what kinds of logistical problems must be anticipated and met in order to assist the learner to make maximum use of self-instructional media assisted learning units?

In an effort to determine design criteria for this study, a list of items common to program and kit design were compiled into a questionnaire (Appendix H). Twenty-seven leading educators in British Columbia were each mailed a questionnaire to obtain from them an indication of the relevancy of the items chosen. The experts selected to receive the questionnaire met one or more of the following criteria:

1. The rater have training and experience in research design.
2. The rater have administration and or teaching experience in secondary schools, community colleges or university programs.
3. The rater be familiar with recent developments in self-learning instructional programs.
There was a 100% return of the questionnaires. They were analyzed and tabulated to determine item significance and the criteria to be used in the design of the program and kit.

III. DEVELOPMENT OF PROGRAM AND KIT

The material content for the program was developed once the design format was established. Content was determined through an analysis of the knowledge and manipulative skills which are considered pre-requisite to further study in electrical technology. First year college physics courses, trade manuals, and technical courses of study were scrutinized to uncover the basic principles common to beginning electrical courses. The program that was eventually developed was designed to achieve the following learning objectives:

1. Accurately read the scales of an electrical measuring instrument known as a multimeter.

2. Use a multimeter to measure the electrical units of current, voltage and resistance in series and parallel circuits.

3. Plan and assemble series and parallel circuits using small components, circuit board and power supply.

4. Calculate the values for current voltage and resistance in series and parallel circuits through the application of formula derived from the principles of Ohms Law.
5. Compile data and make sound conclusions regarding the functional characteristics of series and parallel circuits.

6. Construct a continuity and presence of voltage tester from schematic and pictorial diagrams.

The program was designed to teach cognitive and manipulative skills to the student, in his own home, using media as the vehicle of instruction.

The self learning kit used in the study was developed over a two year period and was based on the criteria obtained from the same group of experts used to obtain the criteria for program design. On the basis of the responses and comments made by the group of experts to statements in the questionnaire, a list of kit design criteria was established.

IV. FIELD TEST OF PROGRAM AND KIT DESIGN

Selection of Subjects

It was decided that twelve housewives would form the sample group. The decision to use housewives was based on the assumption that such a group would not normally have had any formal training in electricity or electronics or have worked in an area related to electricity or electronics.

Subjects were to be residents of North or West Vancouver.
This arrangement permitted the writer to reach the learner's home quickly should equipment in the kit malfunction or need replacing.

Each subject was to have a minimum of grade eight education and be over twenty-one years of age. Grade eight education was necessary to permit the student to successfully handle the mathematics in the course. The age criteria of twenty-one years or over permitted the study of a group of typical college age students.

In order that test scores and related data would not be unduly biased as a result of the subjects background or work experience in electricity, all those subjects who applied and who had work experience in the subject field were rejected.

**Obtaining Sample Group**

The potential sample group was canvassed through a newspaper advertisement placed in both of the local newspapers, the Lions Gate Times, and the Citizen (Appendix A). Those people who read the advertisement and who wished to participate in the project were directed to phone the writer at his home on or before June 11th, 1971.
The name, address, and phone number of each person who called was put on a list. Phone calls received after the June 11th deadline were also listed but respondents were told that they were too late to participate in this particular project. The fifty-one people who responded within the deadline were mailed a two page letter describing in detail the background and rationale for the project (Appendix B). Also enclosed with the letter was a Participant's Data Sheet (Appendix C). This form served to supply the writer with the person's education and background. A self addressed envelope was provided for return of the Participant's Data Sheet.

From the total of fifty-one responses twelve participants were selected by random process for the study. Those selected were contacted by phone to make arrangements for delivery of their kit. Respondents not selected for participation in the project were mailed a letter thanking them for their interest in the project (Appendix F).

A kit was delivered to each of the twelve participants who in turn were asked to sign a form stating that the complete kit would be returned at the completion of the project (Appendix M).
External Sample Group

A sample group of twenty-seven second year British Columbia Institute of Technology electricity/electronic students were given the same pre-test and knowledge post-test that was administered to the sample control group.

The external group was composed of those students (all male) who had completed their first year of studies in the electricity/electronics program and who were now at the beginning stages of their second and final year of studies at the institute. All students in this group had completed grade XII on the Academic Technical Program with Mathematics 12, Physics 11 and 12 and Chemistry 11 specialties.

Mr. Reg Ridsdale, Department Head, supervised the administration of both the pre-test and post-test.

The main purpose for selecting the British Columbia Institute of Technology group was to provide the writer with informal evidence on the suitability of his testing instruments and to provide a tentative means of assessing the performance of the experimental group relative to learners in a more conventional instructional system.
Symbol and Component Recognition Test

Before the student commenced the program she was given a pre-test designed to test her ability to recognize standard electrical components and symbols (Appendix 0). Because there were no standard tests available with proven validity and reliability, it became necessary for the writer to design his own test instrument for this purpose.

The same test was applied to the external British Columbia Institute of Technology group of students during the third week of their second year at the British Columbia Institute of Technology.

Knowledge and Skills Test

At the completion of the program each student was given a Knowledge and Skills Test. The test was divided into Part A: Principles and Knowledge (Appendix P) and Part B: Applied Skills (Appendix Q). Part A contained a series of twenty multiple choice questions designed to test the student's understanding of the basic electrical principles learned in the program. The number of test items used was determined after an analysis of the basic principles in the course. No standardized test with proven validity and reliability is available.
Part B: of the Post-test required the student to construct and assemble various types of electrical circuits and to take accurate measurements within each circuit. The number and type of test item was constructed by the writer as no standardized test battery was available.

All the manipulations and performance tasks in Part B were recorded on an Evaluation Check List (Appendix R). This list comprised a total of thirty-three separate tasks divided among the major headings of series and parallel circuits.

**Participant's Daily Log**

A daily log of activity was maintained by each participant and on the Friday of each week all log sheets were mailed to the writer (Appendix L).

The log sheet was used to inform the writer of the on-going developments in the course and where certain modification, refinements or deletions could be made in the program in the future.

**Field Test Procedure**

In keeping with the original intent - that of determining whether or not it would be feasible for a learner to acquire cognitive and manipulative skills,
working independently at home using self-instructional materials - the study was conducted in the home of the learner.

At the time the self-learning kit was delivered to the home of the learner a pre-test on component and symbol identification was written by the participant. After the test was completed the following verbal instructions were given to the participant:

1. Should any of the equipment in the cabinet not function properly phone me at 987-3727.

2. When you begin the course start by reading the first four pages of the blue covered manual.

3. Submit a Log Sheet(s) in the self addressed envelope provided on the Friday of each week.

4. Phone me once you have completed Step No. 16 described in the course procedure chart (Appendix J).

The student was then asked to sign a form stating that the kit would be returned intact at the completion of the course. The writer then left.

The phone call made by the participant after Step No. 16 provided the writer with information on the student's progress. At the time of the phone call the participant was instructed to again phone the writer when Step No. 28 of the course procedure was completed. Arrangements were made at the time
of this phone call to make the second visit to the learner's home to apply a post-test and to claim the self learning kit.
DESCRIPTION OF THE SELF-INSTRUCTIONAL MEDIA ASSISTED LEARNING UNIT

I. PROGRAM DESIGN

One of the basic assumptions that had to be made in the design of the program was that the learner would not have the guidance of a teacher during any part of the course. Consequently, the learning activities were designed for individual instruction with the initiative for learning the responsibility of the learner.

In developing the lesson material an attempt was made to answer the question, What theory is essential in order to permit the student to achieve the course objectives? It was not possible to answer this question by adopting published work books or laboratory manuals for use in the study because those available did not present topics in the sequence desired or provide the necessary content material. Consequently, a laboratory manual of experiments was developed by the writer for this purpose (Appendix T). To be included in the manual were all the activity units or experiments that would verify the principles under study plus additional content material, pictures, diagrams, problems, and answers to problems. It was the information provided in the laboratory manual that formed the basis for
the sequence aspect of the learning materials in the program.

An attempt was made to organize the course material in a logical sequence which proceeded from the simpler concepts to those which were more difficult. As advanced applications were discussed, the basic principles were reviewed so that a continuous process of building each new principle upon information previously mastered was the organizational approach adopted for the instructional material in the course. Each unit under study concluded with a summary of key points and a series of questions designed to review and apply the theory material of the unit.

The program commenced with a discussion of the parts and materials that made up the self-learning kit. The first lesson in the program was based on the use of a multimeter to measure electrical resistance. From this point the instructional material continued through a discussion of resistors and resistor colour codes, the measurement of resistance, voltage, and current, application of Ohms Law, and series and parallel circuits. The course material concluded with the student constructing a simple continuity and presence of voltage tester (Appendix T).
It has been this writer's teaching experience that students learn to understand and appreciate the theory and related information of topics under study if they are permitted to see how the theory is actually applied in concrete situations. Consequently, in developing the program material, emphasis was not on "How can I tell the student about this topic?" rather, "What learning activity can I design to verify the theory under study?"

To illustrate, one of the objectives in the program was to permit the student to understand the relationship of current, voltage, and resistance in a series electrical circuit. To achieve this objective the principles and theory related to current, voltage, and resistance was presented to the learner through audio taped lessons and assigned readings. Once the student had completed the principles and concepts portion of the lesson she was then directed to perform the related laboratory experiment for each of the respective units outlined in the laboratory manual. In performing the laboratory experiment the student would assemble a series circuit, apply circuit power and take measurements with an electrical measuring instrument for current, voltage, and resistance in the circuit. These measurements were recorded by the student, analyzed to determine relationships, and recorded as reference material. This process reinforced and verified the theory under study.
Program Format

In developing a format for the program an attempt was made to sequence the learning material in such a manner that the learner was actively involved with the course material throughout the entire course. A description of the learning activities that the student became involved in during the program is described in the following paragraphs.

The course material was presented to the learner by means of audio taped instruction. The audio portion of each lesson was augmented with text material, 35 mm. coloured slides of complete electrical circuits and systems, experiment procedure sheets, diagrams and drawings of systems and components, and references to specific readings in the prescribed text for the course.

In working through the actual program the student performed the following or some approximation of it:

1. Listened to a cassette taped lesson, studied a chart, diagram, or pictorial drawing of an electrical component or system.

2. Responded to course material by either connecting up components and devices to form an electrical circuit, project a slide or series of slides, play or replay a tape, compile data from an experiment, answer questions, read assigned text material, or take actual readings in an electrical circuit with a measuring instrument.
3. Examine the correct solution to problems to make a comparison to her own solution to the same problem.

The program was designed to be self-operational with no assistance required from a live teacher.

Each lesson was introduced with a brief statement outlining the objective and the importance of the topic under study. This introduction was then followed with a presentation of the lesson material in which key points and basic principles were described, and supported through references to material in the text, laboratory manual, or 35 mm. slides. Each cassette lesson concluded with a summary of the key points of the topic under study, assigned readings, and directions to follow in performing the next step in the program.

Laboratory Experiment

The purpose for the experiments in the program was to provide the learner with an opportunity to "verify" the various principles and theory under study. Each experiment was introduced with the stated topic, followed with a list of the materials required to perform the experiment, instructions, cautions, and procedures to follow while performing the experiment. A note to the student at the
beginning of each experiment emphasized the need to read the instructions carefully before commencing the actual experiment. At the end of each experiment the next step to take was stated in a boxed square titled: "YOUR NEXT STEP".

**Photographic Slides**

Coloured slides were employed to illustrate the correct set-up of equipment, parts of experiments, and procedures. A typical student response would involve the learner with laboratory equipment which she manipulated while viewing the correct use on one of the designated coloured slides. Additional directions and guidance were also provided on the cassette tape.

In summary, the programming or sequencing aspect of the course material was provided the learner through directions that appeared at the end of each taped lesson, a laboratory experiment, or on the coloured slide. At no time throughout the program was the student left to determine what was to be the next step to take in order to proceed through the course material.

**Laboratory Manual**

The laboratory manual provided the main focal point of
reference for the student. To begin the course the learner was asked to refer to the blue covered manual and read carefully the first four pages. The final instructions to the learner on page four was to "insert cassette No. 1 into the tape recorder." Reference information for lesson material, all the laboratory experiments, solutions to problems, and directions to the learner were described in the manual. An index provided a quick and easy method of locating material in the manual.

Text Book

The text book *Electricity and Electronics*, by Peter Buben, Marshall Schmitt, and Harold Kirchner was selected as the text book for the course. This book was chosen because the written material, diagrams, and assignments related very close to the topics under study. It also included basic information about tools, materials, and industrial processes common to electrical and electronic technology and was in this regard of particular assistance to the learner during the project construction phase of the program.

The text is divided into eleven sections containing a total of sixty-two learning units. The book makes extensive use of pictorial illustrations and diagrams to describe electrical and electronic principles and theory.
All participants in the program assembled an electrical project at the end of the course called a Presence of Voltage and Continuity Tester. The assembly and mounting of parts, correct use of tools, and the soldering procedures required to complete the project were provided the student through illustrations and explanations outlined in the textbook.

Participant's Daily Log

A daily log of activity was maintained by each participant and were mailed to the writer on the Friday of each week (Appendix L). The log provided the writer with related information on the learner's progress and the performance of the equipment provided in the self learning kit. Each log sheet had space provided for the learner to indicate the unit lesson currently under study, participant's name and the date. The learner was directed to comment on any or all of the lessons (cassette tape), lab experiments, the textbook, slide projector, multimeter, power supply, tape recorder, or small circuit parts that were used in each experiment.
II. KIT DESIGN

Any discussions related to learning kits soon reveal that there are a number of types on the market today. The type of kit may vary from the basic text and teachers manual to units containing curriculum guides, text, learning aids, audio and video electronic equipment and specially designed cabinets and portable carrying cases. Some kits are designed by management consulting firms to teach business personnel such topics as sales promotion (45), and personal leadership (46).

Other companies have concentrated on the health field to produce learning kits for the dental profession on such topics as correct use of dental instruments, preparation of dental materials, basic dental anatomy and genetics (47). Probably one of the most energetic of all industries in the development of learning kits has been the electronic industry. Through development of teaching programs (48), instructional materials (49), laboratory equipment (50), and components (51) these industries have developed the lion's share of the educational and training kits available today.

The self learning kit used in this study was developed over a two year period and was based on the criteria submitted by experts and the experience gained by the
writer in developing a previous kit to teach basic electronic principles to grade nine students.

In, an effort to determine the best design characteristics for the self learning kit, a list of items related to kit design was compiled into a questionnaire and mailed to thirty-one educational experts. This was the same group of experts who responded to the questionnaire on the criteria for program design. On the basis of the responses and comments made by these experts basic guidelines were established and incorporated into the construction of the self learning kit used in this study.

Learning Kit Cabinet

The cabinet was constructed so as to permit it to be used in an upright position. (See Plate No. 1) The upright design of the cabinet was chosen based on the following advantages:

1. Minimum working space would be required when the learning kit was in use.

2. All components in the kit could be easily viewed by the user.

3. The overall available storage space in the cabinet is better utilized if components in the kit were stored to be later used when the cabinet is placed in the upright position.

4. The upright position permitted ease of carrying.
5. Less work space area (table top) would be required if component parts of the kit could remain in place in the cabinet when the kit was in use.

The cabinet was constructed from \( \frac{3}{4} \)" plywood. The choice of wood permitted ease of construction as well as providing the added advantage of electrical current insulation. The heavier pieces of equipment were all stored in the lower section of the cabinet. This permitted greater stability of the cabinet and avoided the annoying situation of having test leads of the power supply and multimeter droop down the front of the cabinet when this equipment was in use. Lighter components in the kit such as the 35 mm. slides, tapes, small electronic parts, and test leads all occupied the upper portion of the cabinet and were labelled for easy identification.

The outside surface of the lid of the cabinet was constructed partly from plywood and partly from phenolic circuit board. The plywood portion provided a writing surface for the student while the phenolic circuit board served as the area designed for circuit construction. (See Plate No. 2) The textbook, projector screen, and lab manual were all stored on the underside of the cabinet lid and held in place with an elastic band. (See Plate No. 3) The lid was secured to the main cabinet with two spring type hinges. Ease in carrying the entire self-contained
kit was achieved by placing a suitcase type handle at the top of the main cabinet. The overall dimensions of the complete unit was $19\frac{1}{4}'' \times 16\frac{5}{8}'' \times 6''$.

The various electrical circuits which formed part of every laboratory experiment were all assembled and disassembled in a matter of minutes. This was achieved by the use of terminal clips which were inserted into the holes of the phenolic circuit board. (See Plates Nos. 4, 5, and 6). Once the terminal connectors were in place on the circuit board it was a process of connecting jumper wires or resistor lead ends to the terminals to complete the circuit wiring. No special tools or soldering of wires to terminals was required. Circuits could therefore be assembled in a very short period of time thus eliminating the time consuming process of having to solder and unsolder each electrical connection. Furthermore, the terminals, jumper wires, and resistors could be used over and over without damage to these parts normally caused by the soldering and unsoldering process.

**Hardware in the Kit**

The major equipment of the self-learning kit included the power supply, measuring instrument (multimeter), tape
recorder, and slide projector. These units were durable, inexpensive, and could be purchased locally. The cost of the purchase of a power supply for each kit was kept reasonable by first buying twelve 6-12 volt battery chargers at a cost of $16.00 each and then modifying each unit for use in the course. Modification to the twelve power supplies was done by the writer and consisted of installing a safety fuse, "on-off" power switch, electrical power receptacles, and power outlet receptacles. After all modifications were incorporated the total cost for each power supply was $22.00. This was a very modest cost because commercially sold units of the type needed for this study were priced between $45.00 and $55.00.

The twelve electrical measuring instruments required for the project were loaned to the writer by the Triplett Corporation, Bluf ton, Ohio. This saved the writer considerable costs as the individual instruments retail at $65.00 each.

The instrument model was the Triplett 630PLK. This particular instrument was chosen due to its excellent measuring qualities, rugged construction, safety overload protection system, and easy to read scale.
The tape recorder in each kit was a Phillips, Model EL3302 solid state cassette type. This unit was selected because of its playback capabilities, size, and the external plug in ear phone feature. Twelve units were borrowed from the Learning Resources Centre, Simon Fraser University for the period of the field tests. Single units sell at a price of $49.95 and can be purchased locally. Please see Plates No.'s. 7, 8, and 9 for method used to indicate to the participant the procedure for using the recorder and inserting cassette tape correctly into the recorder.

An electric slide projector manufactured in Japan under the trade name Bikoh was selected for use in each kit. Features such as excellent projection qualities, minimum projection distance requirements from unit to screen (12"-14"), and silent operation characteristics were reasons for selecting this unit as part of the kit. Twelve units were borrowed from the Learning Resources Centre, Simon Fraser University for the period of the field tests. (See Plates No's. 10 and 11 for the procedure employed to indicate correct method of using projector.)

A quantity of small electronic parts and components used to assemble each electrical circuit are common stock.
items that can be purchased from any local radio store. These parts were all stored in a small 4" x 3" x 2" plastic box. See plates 4, 5 and 6 for method of inserting terminal clips into circuit board.

At the termination of the program each participant was required to construct an electrical project which incorporated the knowledge and skills learned in the course. The project was a circuit tester designed to indicate the presence of household voltage and the electrical continuity of such things as lamp cords, toaster cords, Xmas tree lights, etc. All the necessary parts and pieces were supplied and stored in the cabinet. The directions for assembling were provided in the manual on pages 44, 45 and 46. Each participant was permitted to keep her tester.
PLATE 1

View Showing Cabinet in its Upright Position Ready For Use.
PLATE 3

View Showing the Storage of Text Book, Manual, and Projector Screen on the Underside of Cabinet Lid.
View Showing Method of Inserting Terminal Clips Into Phenolic Circuit Board.
PLATE 7

View Showing Surface Instructions for Using Tape Recorder (finger pointing to red strip)
View With Tape Recorder Cassette Lid Raised Showing Instructions For Method of Inserting Cassette Tape.
PLATE 9

View of Cassette Tape Correctly Positioned in Recorder With Finger Pointing to Red Dot on Cassette Tape.
PLATE 10

View Showing Instructions For Placement of Slide Carriage on Projector.
PLATE 11

View Showing Position of Slide Carriage For Correct Placement into Projector.
REFERENCES FOR CHAPTER IV


(2) Dr. Clemenz Electricity Trainer, A brochure prepared by National Teaching Aids (Vancouver, B. C. 1970).


(4) Loop and Learn, A brochure prepared by Milner-Fenwick Inc., (Baltimore, Maryland).


CHAPTER V

ANALYSIS AND CONCLUSIONS

I. INTRODUCTION

This chapter provides an analysis of accumulated data together with warranted conclusions. This is done under two headings. First, information derived from questionnaire results relating to program and kit design is analyzed and conclusions are drawn. Second, test results provided by the experimental subjects and the external comparisons are made and warranted conclusions drawn.

II. PROGRAM AND KIT DESIGN CRITERIA

The learning unit incorporated a number of characteristics which were judged important to the facilitation of learning. The criteria used for kit and program design in this study were derived from two questionnaires completed by leading educational experts in the Province of British Columbia. The same questionnaires were administered later to the experimental sample group as a means of determining user reaction.
Program Design Questionnaire

A list of items relevant to the design of a self-learning program and kit was derived from available sources, was compiled into a questionnaire and was mailed to twenty-seven British Columbia educators knowledgeable in self-learning problems (Appendix H). The questionnaire solicited the opinions of these experts regarding various aspects of the design of a program and kit that could be used by the learner, in her own home, to reach cognitive and manipulative objectives. The experts were asked to respond to the items by circling a choice ranging from "Very Important" to "Unimportant". The questionnaire sought to answer the questions "What are the characteristics of a good self-learning program?" and "What are the characteristics of good kit design for a self-learning program?"

The results of the responses concerning the program questionnaire is summarized in Table II. With the exception of a few items the sum of "Very Important" and "Important" had substantial agreement amongst the raters. The number of responses to both of these categories when grouped together was 387 out of a possible 459 or 84% of the total categories. Furthermore, with the exception of item #7 there was nothing approaching a negative concern.
# Responses Made by Educational Experts to Items in a Questionnaire Designed to Determine the Criteria to be Used for Program Design

## Part A: Program Design Characteristics
(27 Subjects—Educational Experts)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Very Important</th>
<th>Important</th>
<th>Uncertain</th>
<th>Probably Not Important</th>
<th>Unimportant</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Instructions to the learner should be clear, simple and meaningful.</td>
<td>24</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>2. The learning and instructional materials should be attractive in format.</td>
<td>3</td>
<td>19</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>3. The learner should have frequent opportunity to check his progress and to determine how well he is doing.</td>
<td>18</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>4. The materials should require the learner to respond in a variety of ways including written and/or manipulative tasks.</td>
<td>10</td>
<td>12</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>5. The materials should provide for varied activity (listening, reading, performing) on the part of the learner.</td>
<td>7</td>
<td>16</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Very Important</td>
<td>Important</td>
<td>Uncertain</td>
<td>Probably Not Important</td>
<td>Unimportant</td>
<td>Total</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>-----------</td>
<td>-----------</td>
<td>------------------------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>6. The various media (print, picture, diagram, sound, etc.) used by the learner should be of good quality.</td>
<td>9</td>
<td>16</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>7. The program should be broken down into a series of units that are relatively self-contained each of which may be completed in a single sitting or approximately one hour.</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>8. Units of study within the program should assist the learner to make generalizations, draw conclusion and make applications.</td>
<td>16</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>9. The content and activities of the program should be interesting to the learner.</td>
<td>13</td>
<td>11</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>10. The learner should be permitted to repeat an activity until mastery is achieved.</td>
<td>9</td>
<td>14</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>11. It should be possible for the learner to receive immediate reinforcement in the form of verification of adequacy of his performance.</td>
<td>12</td>
<td>12</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>12. It should be possible for the learner to bypass activities he has already mastered.</td>
<td>8</td>
<td>13</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Very Important</td>
<td>Important</td>
<td>Uncertain</td>
<td>Probably Important</td>
<td>Unimportant</td>
<td>Total</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-------------------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>13. The content and activities in the program should provide a basis for future learning in a given area.</td>
<td>7</td>
<td>13</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>14. Correct answers to required responses should be readily available to the learner.</td>
<td>12</td>
<td>13</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>15. The learner should have access to teacher assistance should any unforeseen difficulties arise.</td>
<td>13</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>16. The program should provide the learner with manipulative or &quot;hands on&quot; application of theory.</td>
<td>10</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>17. For efficiency of learning, the program should be appropriate to the basic skills level of the learner (reading, mathematics, etc.)</td>
<td>16</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Total by Categories</td>
<td>191</td>
<td>196</td>
<td>53</td>
<td>17</td>
<td>2</td>
<td>459</td>
</tr>
</tbody>
</table>
Final Criteria for Program Design

In order that a consensus of items be established for use in the development of the self-learning program, items which indicated the experts strongly agreed, or agreed with the questionnaire statement, was accepted as program criteria. Any items with a total of less than 75%, or 20 out of 27, responses in the category of "Very Important" and "Important" were eliminated from the final list of program and kit criteria. Item No. 7, which had 44% or 12 out of 27 of the total responses in the "Very Important" and "Important" categories, was eliminated as a criterion for inclusion in the design of the self-learning program. To summarize there was substantial consensus amongst the experts even with the preliminary criteria. The final criteria used in designing the self-learning program were as follows:

1. Instructions to the learner should be clear, simple and meaningful.

2. The learning and instructional materials should be attractive in format.

3. The learner should have frequent opportunity to check his progress and to determine how well he is doing.

4. The materials should require the learner to respond in a variety of ways including written and/or manipulative tasks.
5. The materials should provide for varied activity (listening, reading, performing) on the part of the learner.

6. The various media (print, picture, diagram, sound, etc.) used by the learner should be of good quality.

7. Units of study within the program should assist the learner to make generalizations, draw conclusions and make applications.

8. The content and activities of the program should be interesting to the learner.

9. The learner should be permitted to repeat an activity until mastery is achieved.

10. It should be possible for the learner to receive immediate reinforcement in the form of verification of adequacy of his performance.

11. It should be possible for the learner to by-pass activities he has already mastered.

12. The content and activities in the program should provide a basis for future learning in a given area.

13. Correct answers to required responses should be readily available to the learner.

14. The learner should have access to teacher assistance should unforeseen difficulties arise.

15. The program should provide the learner with manipulative or "hands on" application of theory.

16. For efficiency of learning, the program should be appropriate to the basic skills level of the learner (reading, mathematics, etc.).
Kit Design Questionnaire

The results of the responses made to the kit design questionnaire can be seen in Table III. The same format of statements as that used in the program questionnaire was also used for the questionnaire to establish the criteria to be incorporated in the design of the self-learning kit. With the exception of Items No.'s 2, 4, 5, 6, 7, 8, 10 and 11, the sum of "Very Important" and "Important" had the majority of agreement amongst the raters. The number of responses to both of these categories when grouped together was 242 out of a possible 378 or 64% of the total categories. To summarize, there was substantial consensus even with the preliminary criteria.

Final Criteria for Kit Design

The same procedure used to obtain a consensus with the statements in the program questionnaire was applied to the statements in the kit questionnaire. By eliminating those items that had a total of less than 75% of the responses in the "Very Important" and "Important" categories, the criteria used for the construction of the learning kit was established. The final criteria used in the design of the self-learning kit were as follows:
**RESPONSES MADE BY EDUCATIONAL EXPERTS TO ITEMS IN A QUESTIONNAIRE DESIGNED TO DETERMINE THE CRITERIA TO BE USED FOR KIT DESIGN**

**PART B: KIT DESIGN CHARACTERISTICS**
(27 Subjects—Educational Experts)

<table>
<thead>
<tr>
<th>STATEMENT</th>
<th>RESPONSES MADE TO CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>1. The learner should be able to gain easy access to components and materials in a self-learning kit.</td>
<td>12</td>
</tr>
<tr>
<td>2. The learner should be able to operate a self-learning kit in a working space no larger than a kitchen table top.</td>
<td>2</td>
</tr>
<tr>
<td>3. The learner should be able to easily identify all components in a self-learning kit.</td>
<td>10</td>
</tr>
<tr>
<td>4. The learner should be able to easily lift and carry the cabinet containing all parts of the self-learning kit.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
</tr>
<tr>
<td>5.</td>
<td>The component parts of a self-learning kit should be durable.</td>
</tr>
<tr>
<td>6.</td>
<td>The colour of the cabinet of the self-learning kit should be attractive.</td>
</tr>
<tr>
<td>7.</td>
<td>The learner should be able to make the kit ready for use and stored after use in a short period of time (say 5 minutes).</td>
</tr>
<tr>
<td>8.</td>
<td>The learner should be able to assemble and disassemble experiments quickly (say 5 minutes).</td>
</tr>
<tr>
<td>9.</td>
<td>The learner should be free of the possibility of any physical hazard in handling the equipment and the kit.</td>
</tr>
<tr>
<td>10.</td>
<td>The learner should not require tools, parts or components in addition to those supplied.</td>
</tr>
<tr>
<td>11.</td>
<td>So far as possible the learner should not have to remove equipment and components from the kit in order to use them.</td>
</tr>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
</tr>
<tr>
<td>12.</td>
<td>The use of the kit will not require resources not normally found in the average home (i.e. illumination, utilities, etc.).</td>
</tr>
<tr>
<td>13.</td>
<td>The use of the kit will not require specially prepared work surfaces (i.e. acid resistant, or mark proof table tops).</td>
</tr>
<tr>
<td>14.</td>
<td>The kit and its component parts will not offer any hazard to children.</td>
</tr>
<tr>
<td>Total by Categories</td>
<td>80</td>
</tr>
</tbody>
</table>
1. The learner should be able to gain easy access to components and materials in a self-learning kit.

2. The learner should be able to easily identify all components in a self-learning kit.

3. The learner should be free of the possibility of any physical hazard in handling the equipment and the kit.

4. The use of the kit will not require resources not normally found in the average home (i.e. illumination, utilities, etc.)

5. The use of the kit will not require specially prepared work surfaces (i.e. acid resistant, or mark proof table tops).

6. The kit and its component parts will not offer any hazard to children.
Participant's Response to Items in the Program Questionnaire

At the completion of the program all participants were mailed the same questionnaire that was sent to the educational experts. Participants were instructed to respond to all statements based on their experience with the self-instructional program. An analysis of the results of the responses made by the participants (See Table IV), indicated that there was a high measure of agreement among the participants both in the program and kit design criteria. In the case of responses made to the program statements the categories of "Very Important" and "Important", when grouped together, had a total of 147 out of a possible 187 or 78% of the total responses. Items No.'s 2, 7 and 12 showed the greatest number of negative responses with 36%, 45% and 27% respectively falling into the category of "Probably not Important" and "Unimportant" categories.

Comparing the responses made by the experts to those made by the participants there was close agreement on the majority of the statements in the program questionnaire. Both groups indicated that statement No. 7 was of low importance. However, the participants indicated that statements No.'s 2 and 12 were also of low importance. To summarize, both experts and participants were in close agreement.
### TABLE IV

RESPONSES MADE BY PARTICIPANTS TO ITEMS IN A QUESTIONNAIRE DESIGNED TO DETERMINE THE CRITERIA TO BE USED FOR PROGRAM DESIGN

**PART A: PROGRAM DESIGN CHARACTERISTICS**

(11 Participants)

<table>
<thead>
<tr>
<th>STATEMENT</th>
<th>RESPONSES MADE TO CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>1. Instructions to the learner should be clear, simple and meaningful.</td>
<td>10</td>
</tr>
<tr>
<td>2. The learning and instructional materials should be attractive in format.</td>
<td>0</td>
</tr>
<tr>
<td>3. The learner should have frequent opportunity to check his progress and to determine how well he is doing.</td>
<td>5</td>
</tr>
<tr>
<td>4. The materials should require the learner to respond in a variety of ways including written and/or manipulative tasks.</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
</tr>
<tr>
<td>5.</td>
<td>The materials should provide for varied variety (listening, reading, performing) on the part of the learner.</td>
</tr>
<tr>
<td>6.</td>
<td>The various media (print, picture, diagram, sound, etc.) used by the learner should be of good quality.</td>
</tr>
<tr>
<td>7.</td>
<td>The program should be broken down, into a series of units that are relatively self-contained each of which may be completed in a single sitting of approximately one hour.</td>
</tr>
<tr>
<td>8.</td>
<td>Units of study within the program should assist the learner to make generalizations, draw conclusions and make applications.</td>
</tr>
<tr>
<td>9.</td>
<td>The content and activities of the program should be interesting to the learner.</td>
</tr>
<tr>
<td>10.</td>
<td>The learner should be permitted to repeat an activity until mastery is achieved.</td>
</tr>
</tbody>
</table>
It should be possible for the learner to receive immediate reinforcement in the form of verification of adequacy of his performance.

It should be possible for the learner to bypass activities he has already mastered.

The content and activities in the program should provide a basis for future learning in a given area.

Correct answers to required responses should be readily available to the learner.

The learner should have access to teacher assistance should any unforeseen difficulties arise.

The program should provide the learner with manipulative or "hands on" application of theory.

For efficiency of learning, the program should be appropriate to the basic skills level of the learner, reading, mathematics, etc.)

<table>
<thead>
<tr>
<th></th>
<th>Very Important</th>
<th>Important</th>
<th>Uncertain</th>
<th>Important</th>
<th>Not Important</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>11</td>
</tr>
</tbody>
</table>

Total by Categories | 71 | 76 | 18 | 18 | 4 | 187
Participants Response to Items in the Kit Questionnaire

Results of the responses made by the participants to items in the questionnaire can be seen in Table V. In the case of responses made by the participants to the grouping of "Very Important" and "Important" a total of 96 out of a possible 154, or 62% of the total responses fell into this category. However, participants rated several of the individual items low in importance. For example, none of the items No.'s 6, 8, 11 and 14 had a total response of more than 45%. One item, No. 11, did not receive one response in the "Very Important" and "Important" category.

Comparing the response of the experts to those of the participants we find close agreement on the majority of statements. For example, both groups indicated close agreement on the importance of items No.'s 6, 8, 10, and 11. Whereas the experts rated item No. 9 very high (85% of total responses in the "Very Important" and "Important" category), the participants rated the same items relatively low (62% of total responses in the "Very Important" and "Important" category). To summarize, both experts and participants were in almost complete agreement.
### RESPONSES MADE BY PARTICIPANTS TO ITEMS IN A QUESTIONNAIRE DESIGNED TO DETERMINE THE CRITERIA TO BE USED FOR KIT DESIGN

**PART B: KIT DESIGN CHARACTERISTICS**

(*11 Participants*)

<table>
<thead>
<tr>
<th>STATEMENT</th>
<th>RESPONSES MADE TO CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>1. The learner should be able to gain easy access to components and materials in a self-learning kit.</td>
<td>7</td>
</tr>
<tr>
<td>2. The learner should be able to operate a self-learning kit in a working space no larger than a kitchen table top.</td>
<td>2</td>
</tr>
<tr>
<td>3. The learner should be able to easily identify all components in a self-learning kit.</td>
<td>3</td>
</tr>
<tr>
<td>4. The learner should be able to easily lift and carry the cabinet containing all parts of the self-learning kit.</td>
<td>2</td>
</tr>
<tr>
<td>5. The component parts of a self-learning kit should be durable.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
</tr>
<tr>
<td>6. The colour of the cabinet of the self-learning kit should be attractive.</td>
<td>1</td>
</tr>
<tr>
<td>7. The learner should be able to make the kit ready for use and stored after use in a short period of time (say 5 minutes).</td>
<td>3</td>
</tr>
<tr>
<td>8. The learner should be able to assemble and disassemble experiments quickly (say 5 minutes).</td>
<td>1</td>
</tr>
<tr>
<td>9. The learner should be free of the possibility of any physical hazard in handling the equipment and the kit.</td>
<td>2</td>
</tr>
<tr>
<td>10. The learner should not have to remove equipment and components from the kit in order to use them.</td>
<td>1</td>
</tr>
<tr>
<td>11. So far as possible the learner should not have to remove equipment and components from the kit in order to use them.</td>
<td>0</td>
</tr>
<tr>
<td>12. The use of the kit will not require resources not normally found in the average home (i.e. illumination, utilities, etc.)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Very Important</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
</tr>
<tr>
<td>13</td>
<td>The use of the kit will not require specially prepared work surfaces (i.e. acid resistant, or mark proof table tops).</td>
</tr>
<tr>
<td>14</td>
<td>The kit and its component parts will not offer any hazard to children.</td>
</tr>
</tbody>
</table>

Total by Categories: 36 60 15 26 17 154
III. TEST RESULTS

One of the purposes of the study was to determine whether the subjects could identify and name electrical symbols and components used throughout the course. A component and symbol identification test was administered to the twelve subjects prior to their beginning the course. A second administration of the same test was applied to all participants at the completion of the course. The same test was given to a group of students registered in the second year of the Electricity/Electronics program at the British Columbia Institute of Technology (external group). The purpose of the external administration was twofold: to provide the writer with evidence relating to the suitability of the testing instrument; and to provide a tentative means of assessing the performance of the experimental group relative to learners within a more conventional instructional program. An analysis of the test results of the two groups is presented in the accompanying section.

Results of the Pre-Test of Component and Symbol Identification Applied to the Experimental Group

In the pre-test, the twelve subjects were first asked to indicate whether they had seen the twenty electrical components and symbols. Their second task was to write the
correct name of each item. The results of the pre-test are summarized in Table VI. With respect to item recognition the subjects were able to recognize an average of 37.5% of the components and symbols with a range of items recognized from 3 to 11 out of a possible score of 20. Only 3 subjects out of 12 recognized 10 or more items and the highest score was 11 out of 20. On the average the subjects were able to correctly name only 15.4% of the items. The highest individual percentage of correctly named items was 30% with a range of from 0 to 6 items. The results of the test indicate that the subjects did not possess a minimum knowledge of the symbols and components used in the test and confirmed the appropriateness of the procedure for selecting subjects.

Results of the Post-Test of Component and Symbol Identification Applied to the Experimental Group

The test of Component and Symbol Identification was administered to each subject after completing the final assignment in the course. The results of the second administration are summarized in Table VII. It should be noted that one subject withdrew from the project thus leaving eleven completed test results.

On the average the subjects were able to recognize 75% of the components and symbols with a range of items.
TABLE VI
RESPONSES OF EXPERIMENTAL GROUP TO ITEMS ON PRE-TEST OF COMPONENT AND SYMBOL IDENTIFICATION

<table>
<thead>
<tr>
<th></th>
<th>ITEMS RECOGNIZED</th>
<th>ITEMS CORRECTLY NAMED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Possible Score Per Student</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Total Possible Correct Responses</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>Total Correct Responses</td>
<td>90</td>
<td>37</td>
</tr>
<tr>
<td>Mean</td>
<td>7.5</td>
<td>3.08</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2.6</td>
<td>1.8</td>
</tr>
<tr>
<td>Percentage of Correct to Possible</td>
<td>37.5%</td>
<td>15.4%</td>
</tr>
</tbody>
</table>
**TABLE VII**

RESPONSES OF EXPERIMENTAL GROUP TO ITEMS ON POST-TEST OF COMPONENT AND SYMBOL IDENTIFICATION

<table>
<thead>
<tr>
<th></th>
<th>ITEMS RECOGNIZED</th>
<th>ITEMS CORRECTLY NAMED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Highest Possible Score Per Student</strong></td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total Possible Correct Responses</strong></td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td><strong>Total Correct Responses</strong></td>
<td>172</td>
<td>156</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>15.6</td>
<td>14.1</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>3.7</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Percentage of Correct to Possible</strong></td>
<td>75.0%</td>
<td>67.7%</td>
</tr>
</tbody>
</table>
recognized from 9 to 20 out of a possible score of 20. There were 9 subjects out of 11 who recognized 75% or more of the items. On the average the subjects were able to correctly name 70%, or 14.1 of the 20 items. The highest individual percentage of correctly named items was 95% with a range from 35% to 95%. It was assumed that the practice effect between pre- and post-test was minimal or non-existent.

Comparison of Pre-Test and Post-Test of Component and Symbol Identification for Experimental Group

A comparison of the pre-and post-tests revealed a general increase in students ability to recognize electrical components and symbols. The range of scores shifted upwards from 3 to 11 on the initial test administration. The mean performance for the initial test was 7.5 and shifted to 15.6 on the second test administration. A comparison of mean performance on pre- and post-test was made using the T-Test. The difference was significant at the .01 level. Thus, it is possible to conclude that the self-instructional program led to a significantly improved performance in symbol recognition.

The second part of the test, naming components and symbols, revealed substantial difference between pre- and post-test results. The mean on the pre-test was 3.08 and on the post-test was 14.1. This increase was significant
at the .01 level of confidence. The application of the T-Test took into account the necessary statistical restrictions relating to sample groups of less than 30.

Test of Component and Symbol Identification with External Group

The test of component and symbol identification was administered to twenty-seven subjects enrolled in the Electricity/Electronics program at the British Columbia Institute of Technology. The results of this test are summarized in Table VIII. With respect to item recognition, on the average 87.4% (or 17.6 items out of 20) of the components and symbols were recognized. Results were similar when the subjects were asked to name each of the 20 items. In this regard on the average 78.3% (or 15.8 items out of 20) of the items were named correctly.

Comparison of the Experimental Group Post-Test Results with the External Group Results on the Same Test

The mean score of the experimental group on item recognition was 15.6 (Table VII), while the mean score of the external group (British Columbia Institute of Technology students) on the same part of the test was 17.6 (Table VIII).
TABLE VIII

RESPONSES OF THE EXTERNAL GROUP OF BRITISH COLUMBIA
INSTITUTE OF TECHNOLOGY STUDENTS TO ITEMS OF
THE COMPONENT AND SYMBOL IDENTIFICATION TEST

<table>
<thead>
<tr>
<th></th>
<th>ITEMS RECOGNIZED</th>
<th>ITEMS CORRECTLY NAMED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Possible Score Per Student</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Total Possible Correct Responses</td>
<td>540</td>
<td>540</td>
</tr>
<tr>
<td>Total Correct Responses</td>
<td>475</td>
<td>428</td>
</tr>
<tr>
<td>Mean</td>
<td>17.6</td>
<td>15.8</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>3.6</td>
<td>3.9</td>
</tr>
<tr>
<td>Percentage of Correct to Possible</td>
<td>87.4%</td>
<td>78.3%</td>
</tr>
</tbody>
</table>
The difference between these scores did not reach the .05 level of significance using the T-Test. In other words there was no statistically significant difference in the mean performance of these two groups. It should be noted however, that the post-test administered to the experimental group was designed to measure the amount of item recognition that each student had acquired in the course. When the same test was administered to the external group of British Columbia Institute of Technology students additional evidence was obtained. Since the latter group had previously acquired knowledge and skills similar to what was proposed in this self-instructional course, similar test results for both groups would lend support to the stated purpose of this self-instructional program. It is further recognized however, that the British Columbia Institute of Technology group had acquired extensive electrical knowledge and skill that was not measured by the post-test. Hence both groups can not be considered to possess equal knowledge and skill in electricity simply because there was no significance in the test results of the two groups. However, what is more important is that there was no significant difference between the mean performance of the experimental and external groups. This factor provides evidence to support the contention that the test was a reasonable measure of item recognition and that
the experimental group was similar to the external group in their ability to recognize the items on the test battery.

Similar results were also found on Item Identification. The experimental group produced a mean of 14.1 on the post-test while the external group registered a mean of 15.8. The difference of 1.7 points (15.8 - 14.1) did not reach a significant level at the .05 level of confidence. Hence the same conclusions stated previously for "item recognition" applies equally to this part of the test battery.

Test of Knowledge and Applied Skills with Experimental Group

A post-test was administered to the eleven subjects at the completion of their final lesson (Appendix P, Q). Part "A" of the test reflected the course objective and was designed to test the student's knowledge and understanding of electrical terminology and basic electrical principles. Because of its fidelity to course objectives it was assumed to possess face validity. Part "B" was concerned with the application of electrical knowledge through the assembly of electrical circuits in which measurements for resistance, current and voltage were made. The results of Part A are summarized in Table IX.
TABLE IX

RESPONSES OF THE EXPERIMENTAL GROUP
TO ITEMS ON THE POST-TEST

PART A: ELECTRICAL PRINCIPLES AND KNOWLEDGE

<table>
<thead>
<tr>
<th></th>
<th>ITEMS CORRECTLY ANSWERED</th>
<th>ITEMS INCORRECTLY ANSWERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Possible Score Per Student</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Total Possible Correct Responses</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>Total Correct Responses</td>
<td>174</td>
<td>46</td>
</tr>
<tr>
<td>Mean</td>
<td>15.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Percentage of Correct to Possible</td>
<td>79.1%</td>
<td>20.9%</td>
</tr>
</tbody>
</table>
In terms of correct responses provided, on the average the subjects correctly answered 79.1% of the items with a range from 9 to 20 out of a possible score of 20. Ten of the eleven subjects answered 50% or more correctly with one subject attaining a score of 100%; two with 90%; five with 80%; one with 75%; one with 52% and one with 42%. The mean score for those answering correctly was 15.9.

Part B of the post-test covered an assessment of the student's knowledge and manipulative ability in series circuit construction and a measure of knowledge and manipulative ability in parallel circuit construction. On this part of the test, 278 correct scores were registered out of a possible 363 for the group (See Table X). The mean score was 25.2 out of 33. Thus, on the average, 73.8% of the tasks were completed by the subjects with a range of successfully completed tasks ranging from 11 to 33 out of a possible 33. The scores of two subjects on questions 5 and 9 had a marked effect in depressing the overall group performance.

On the basis of the results of the tests applied to the subjects in this study it is reasonable to conclude that students were able to achieve the learning objectives prescribed for the study.
TABLE X

RESPONSES OF THE EXPERIMENTAL GROUP TO TASK ITEMS ON THE POST-TEST

PART B: CIRCUIT CONSTRUCTION

<table>
<thead>
<tr>
<th></th>
<th>Successfully Completed Tasks</th>
<th>Tasks Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Possible Score Per Student</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Total Possible Score</td>
<td>363</td>
<td></td>
</tr>
<tr>
<td>Total Correct Score</td>
<td>278</td>
<td>85</td>
</tr>
<tr>
<td>Mean</td>
<td>25.2</td>
<td>7.7</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>6.6</td>
<td>6.5</td>
</tr>
<tr>
<td>Percentage of Correct to Possible</td>
<td>73.8%</td>
<td>26.2%</td>
</tr>
</tbody>
</table>
Test of Knowledge with External Group of British Columbia Institute of Technology Students

At the completion of this study Part A of the post-test was administered to twenty-seven students registered in the Electricity/Electronics program at the British Columbia Institute of Technology. The results of this test are summarized in Table XI.

On the average 86.8% of the items were correctly answered with a range from 14 to 20 out of a possible score of 20. Three of the twenty-seven subjects obtained a perfect score; three obtained 95%; five 90%; nine 85%; five 80%; one 75%; and one 70%. Their mean of 17.3 indicated that this group had a good knowledge of the principles of electricity.

Comparison of the Post-Test (Part A) Results Between the Experimental Group and the External Group

The mean score for the experimental group was 15.9 and for the external group was 17.3. The difference between the mean performance of the two groups was 1.4 and did not prove to be significant at the .05 level of confidence as determined by the T-Test.

It was inferred in the previous section that the external group (British Columbia Institute of Technology) of students possessed greater knowledge and skill in the
<table>
<thead>
<tr>
<th></th>
<th>ITEMS CORRECTLY ANSWERED</th>
<th>ITEMS INCORRECTLY ANSWERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Possible Score Per Student</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Total Possible Correct Responses</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>Total Correct Responses</td>
<td>469</td>
<td>71</td>
</tr>
<tr>
<td>Mean</td>
<td>17.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Percentage of Correct to Possible</td>
<td>86.8%</td>
<td>13.2%</td>
</tr>
</tbody>
</table>
subject of electricity due to their previous educational background. Hence the background of the experimental group was not the same as that of the external group. In other words, it is reasonably safe to assume that the external group possessed a greater background and skill in the general field of electricity than the experimental group did. However, the experimental group was not significantly different to the external group in the knowledge and principles measured by this test battery. The percentages and mean performance for the experimental group indicated that the self-instructional course, was successful in aiding the learner to acquire a high level of knowledge of electrical principles.

Summary

1. Items relevant to program and kit design were derived from available sources. A group of educational experts responded to the collected items and a set of criteria for both program and kit design emerged from their consensus. The judgement of experimental subjects was remarkably similar to those of the experts.

2. Test results of the experimental subjects on symbol recognition and naming indicated that the course had been successful in increasing performance in these areas.
3. A comparison of these results with a non-equated external group failed to show a significant difference. These results do not demonstrate the superiority or inferiority of programmed or conventional instruction. However, they do provide encouraging evidence about the relative effectiveness of the experimental teaching method used.

4. Similarly, the scores of the experimental group on the knowledge test scores and a non-equated external group were not significantly different.

On the basis of the foregoing and of the more complete descriptions given in this chapter, it would appear to be safe to conclude that this Self-Instructional Media Assisted Learning Unit can assist learners to attain reasonable levels of knowledge and skill. Further, these levels may not be markedly different from levels attained under more traditional modes of instruction.
CHAPTER VI

LOGISTICAL PROBLEMS

I. INTRODUCTION

Several problems in logistics were encountered in the field test of the learning program. Some of these were anticipated and materialized. Other problems that were expected were not encountered. Still other problems were faced and met even though they had not been expected.

Sources of information on logistical problems were records of the phone calls made by participants to the writer and the participant's daily log sheets. This material is presented in the following section.

Phone Calls and House Visits During Period of Field Test

The final instruction given to each participant at the time she received the self learning kit was to phone the writer should any equipment in the kit not function properly. Participants were also requested to phone the writer once steps #16 and #28 in the sequence of program steps were completed. A record of all phone calls received, action taken and visits made by the writer can be seen in Table XII.
<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Date Kit Delivered</th>
<th>Date of Phone Call</th>
<th>Purpose of Participant's Phone Call</th>
<th>Action Taken</th>
<th>Date of House Call</th>
<th>Time Taken To Make House Visit Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>June 12</td>
<td>June 20</td>
<td>To report that Step #16 completed.</td>
<td>Instructed participant to continue. Sending in log sheets with comments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>June 28 To report that Step #28</td>
<td>Arranged date of house visit to test participant and pick up kit.</td>
<td>June 30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>completed.</td>
<td></td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>June 12</td>
<td>June 14</td>
<td>Report that two resistors missing.</td>
<td>Delivered missing resistors to participant.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>June 22 To report that Step #16</td>
<td>No action required.</td>
<td>June 14</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>completed.</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>June 30 Step #28 completed.</td>
<td>Arranged date of house visit to test participant and pick up kit.</td>
<td>July 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>Date 1</td>
<td>Date 2</td>
<td>Description</td>
<td>Date 3</td>
<td>Date 4</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------</td>
<td>---------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>June 12</td>
<td>June 22</td>
<td>To report that Step #16 completed.</td>
<td>No action required</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Evening call to report &quot;on-off&quot; power supply light not working.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 22</td>
<td></td>
<td>Delivered replacement power supply.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>July 2 Report Step #28 completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arranged date of house visit to test participant and pick up kit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>June 12</td>
<td>June 13</td>
<td>Two resistors missing.</td>
<td>Delivered missing resistors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>June 16 Multimeter not working.</td>
<td>House call made - replaced burnt out fuse.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>June 21 Report Step #16 completed.</td>
<td>No action required</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>July 1 Report Step #28 completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arranged date for house visit to test participant and pick up kit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>June 12</td>
<td>June 22</td>
<td>Report that Step #16 completed.</td>
<td>No action required</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>July 2 Report that Step #28 completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arranged date of house visit to test participant and pick up kit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>July 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step #</td>
<td>Date 1</td>
<td>Date 2</td>
<td>Description</td>
<td>Date 3</td>
<td>Action</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>June 12</td>
<td>June 22</td>
<td>To report that Step #16 completed.</td>
<td></td>
<td>No action required.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 23</td>
<td></td>
<td>Multimeter not working.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 5</td>
<td></td>
<td>To report that Step #28 completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>House call made to replace burnt out fuse.</td>
<td>June 23</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arranged date for house visit to test participant and pick up kit.</td>
<td>July 5</td>
<td>135</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>June 13</td>
<td>June 23</td>
<td>To report Step #16 completed.</td>
<td></td>
<td>No action required.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>June 23</td>
<td>To report Step #28 has been completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 30</td>
<td></td>
<td>Arranged date for house visit to test participant and pick up kit.</td>
<td>July 1st</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>June 12</td>
<td>June 17</td>
<td>Power supply light not working.</td>
<td></td>
<td>House visit made - bent pins on plug to make better contact.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>June 17</td>
<td>Report Step #16 completed.</td>
<td>June 17</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 20</td>
<td></td>
<td>No action required.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 30</td>
<td></td>
<td>Report Step #28 completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arranged date for house visit to test participant and pick up kit.</td>
<td>July 1</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>June 12</td>
<td>June 20</td>
<td>Report Step #16 completed.</td>
<td></td>
<td>No action required.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>June 20</td>
<td>Report Step #28 completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 5</td>
<td></td>
<td>Arranged date for house visit to test participant and pick up kit.</td>
<td>July 9</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Case</td>
<td>Date 1</td>
<td>Date 2</td>
<td>Description</td>
<td>Action</td>
<td>Date</td>
<td>Hours</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>June 22</td>
<td></td>
<td>House call made to replace burnt-out fuse.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 7</td>
<td></td>
<td>Arranged date for house visit to test participant and pick up kit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>June 13</td>
<td>June 14</td>
<td>Multimeter not working.</td>
<td>House visit made - repositioned safety pop-out fuse on meter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 24</td>
<td></td>
<td>No action required.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 8</td>
<td></td>
<td>Arranged date for house visit to test participant and pick up kit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>June 13</td>
<td>June 23</td>
<td>Participant reported to be quite ill.</td>
<td>Arranged to pick up kit from participant's house.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Participant dropped from program.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Hours 27:35
There was a total of thirty-one phone calls made during the time of the field study from June 12 to July 9 inclusive. Of the thirty-one calls received, twenty-one or 67% of the total number were to report, as requested by the investigator, that steps #16 and #28 had been completed. The remaining ten phone calls or 33% of the total, had to do with inoperative equipment and parts missing from the kit.

There was a total of twenty house calls made to the homes of participants. Eleven of twenty house visits, or 55% of the total number were for the express purpose of giving the participant her post-test and to reclaim the learning kit both of which were required by the planned field test procedure. Six of the twenty house calls, or 30% of the total number, were made to repair or replace equipment. The piece of equipment that required the most attention was the electrical measuring instrument called the multimeter. This device alone required four visits all of which were to replace burnt out fuses caused by improper application of the meter's circuit probes in powered circuits. The remaining two visits were to repair malfunctioning power supplies. In one case the power supply had to be replaced because it could not be repaired on the premises. The other unit was made serviceable by bending the male pins on the electrical power cord so that better electrical contact was achieved.
Two house visits were made to provide the participants with small circuit resistors that had been inadvertently left out of the kits during the time they were assembled. One house visit was made to pick up a kit from a participant who had to withdraw from the course due to illness.

There was a total of twenty-seven hours and thirty-five minutes of time used to make a total of twenty house calls during the field test period. This represents approximately two hours and thirty minutes of house visiting time for each person who participated in the study. Twenty-one hours, or 75% of the total visiting time was taken up with the administration of the post-test. The remaining time or seven hours, or thirty-five minutes per participant, was the house visiting time needed to make all the necessary equipment repairs and replacements. To put this another way, 75% of visitation time was devoted to the requirements of the field test procedure and were fully anticipated. The remainder, or on the average of thirty-five minutes per participant, was devoted to unplanned events.

An analysis of the number and nature of the phone calls made by each participant, the number and nature of repairs made to equipment, and the time taken to make all the house visits would indicate that the self learning kit and the
approach used in this study presented relatively few problems for a course of this nature. The actual servicing of the equipment was carried out in a minimal amount of time, resulting in little or no lost time for participants. Considering that the sample group had never used any of the equipment prior to enrolling in the course, and the limited breakdowns that occurred, it would appear that the selection of the equipment used in the self learning unit was of a type that was both reliable and simple.

However, the following two findings were of even greater importance. First, the fact that there were no calls for assistance with the content and operation of the program, suggests that the programming had been careful and effective. Second, the fact that only about twenty-eight hours of instructor's time was needed for direct contact during the field test period suggests that the operation of this type of program is not inordinately demanding of direct professional assistance.

Comments on Participant's Log Sheet

As has been previously mentioned in Chapter III, each participant was asked to complete a daily log sheet and mail it to the writer on the Friday of each week.
The log sheet contained space to comment on each item it used in the self-learning kit (Appendix L). Participants could submit more than one log sheet each week if they desired to do so. Participants were not required to make any specified number of comments on their log.

The main purpose for the log sheet was to provide information to the writer about the usefulness of each item in the kit. A summary of the ninety comments is provided in Table XIII.

Of all the items that could be commented upon the cassette lessons drew the greatest number of favorable comments from participants. Remarks such as "very clear", "easy to understand", "informative" and "helpful" were typical of the kinds of remarks made by participants. All comments submitted about the cassette tapes could only be classified as positive.

The laboratory experiments had the second largest group of comments. Two comments stated that a given experiment did not assist the learner. Seven comments were to the effect that a given laboratory experiment was difficult to follow. Seventeen comments, or 65% of the total comments submitted on this item stated that the laboratory experiments assisted the learner to understand the material under study.
<table>
<thead>
<tr>
<th>Item</th>
<th>Item Assisted Learner to Understand Course Material</th>
<th>Item Did Not Assist Learner To Understand Course Material</th>
<th>Item Difficult To Use</th>
<th>Item Difficult To Follow</th>
<th>Total Comment By Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassette Lesson</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Lab. Experiment</td>
<td>17</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>Text Book</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Slide Projector</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Slides</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Multimeter</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Power Supply</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tape Recorder</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Small Circuit Parts:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circuit Terminals</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Resistors</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Comments Submitted 90
The limited number of comments made to the remaining items on the log sheets makes it difficult to draw conclusions. However, the slide projector, multimeter, circuit terminals, and resistors appeared to be difficult for some to use. This conclusion was substantiated during the period of the post-test when the writer observed the difficulty, some participants were having with these items, particularly when using small parts to assemble electrical test circuits.

The laboratory experiments and text book were reported by some of the participants to be difficult to follow. However, these remarks were submitted very early in the course and did not appear on any of the log sheets of the learners after they had progressed further into the course material and obtained a background of knowledge to better cope with the material in the text and laboratory experiments.

On the basis of the frequency and nature of telephone calls, the number and duration of house visits and the comments of participants recorded in their log sheets it is possible to conclude that the logistical problems encountered in the field test were minimal in frequency and severity.
CHAPTER VII

DISCUSSION, IMPLICATIONS, SUGGESTIONS FOR FURTHER RESEARCH AND SUMMARY

I. DISCUSSION AND IMPLICATIONS

This study has taken a small but hopefully a significant step toward the improvement of home study courses through the integration of print and electronic media. It has produced some useful findings regarding the achievement of a group of learners who used a self-instructional media assisted learning package. More importantly, the study has demonstrated that students working independently at home with the assistance of a self-instructional, media assisted learning unit can achieve reasonable mastery of conceptual and manipulative skills normally taught in a campus laboratory. It seems possible, therefore, that one solution to the problem of increased numbers of students, the information explosion, high cost of educational facilities, and the press for space in our learning institutions lies in the introduction of home teaching programs.

The findings of this study have implications for the adult who wishes to develop marketable skills. The results suggest very strongly that learners can indeed acquire
knowledge and skills formerly available only to those who were able to use the laboratories of our teaching institutions.

It is unlikely that the increased availability of home learning packages or televised courses will replace the need for conventional two and four year post secondary campuses. There will continue to be a need for traditional on-campus type learning because a majority of learners seem to prefer the more typical kind of learning experience. Direct contact with class mates and instructors and the fringe benefits of campus sports, social activities and library facilities will no doubt continue to appeal to the majority of students.

Nevertheless, the point to be made is simply that for an increasing number of college-age students and many thousands of adults, home learning packages such as the one developed for this study offer a new alternative learning opportunity and for many the only workable alternative. Furthermore, the self-instructional home learning package makes possible a more accurate cost accounting of learning to the actual services rendered. In contrast, the precise costs of the myriad of on-campus services and activities are difficult to determine.

There are those that argue that no "mechanical" form of instruction can do the job better or equal to that done by a live teacher. Such people maintain that back-and-forth
interaction between one student and another and student with teacher is essential to ensure that the knowledge being passed on is correctly understood. There are those who have a general concern that the quality of learning is threatened by the use of mechanical or electronic devices. This criticism assures that the useful interactions between instructors and students may only occur with regularity on our existing campuses. It also assumes a definition of quality education that few have been careful to articulate and still fewer have met in their experience or practice. This investigator subscribes to the meaning of quality education as defined by Ernest L. Boyer, chancellor of the State University of New York.

First of all, quality does not depend on the number of credit hours that appear on a student's transcript. It does not depend upon the number of years he has been physically present on campus, nor on the regularity of lectures he has sat through. It is not guaranteed by forcing all students to jump through an identical and well-worn set of hoops. And it is certainly not guaranteed by pouring millions of dollars in bigger and better buildings. It seems to me that "quality" of an individual's education depends upon four fundamental conditions:

1. A student with a motivation to learn.
2. Teachers to channel that motivation toward clear educational objectives.
3. The availability of resources adequate to achieve these objectives.
4. Rigorous evaluation of both the students and the institution to determine how well these objectives are being achieved. (1)
Each of Boyer's criteria can be met in the design and development of self-instructional media assisted learning units. Furthermore, such units will likely enhance the learning experiences. In turn, they will challenge some of the deceptive crutches used by faculty and administration who zealously retain institutional practices and minutely regulate the students who must remain on campus for set periods in order to obtain certain qualifications.

The self-instructional media assisted learning unit described in this study provides a working model for teachers and administrators interested in self-instructional programs. The particular design permits the learner to move through his package at a pace appropriate to his ability and rate of learning independent of other learners. Both teacher and learner have a clear idea of objectives and expectations - a condition which is not always met by other instructional programs.

In addition, the learning program described in this study, even if applied to institutional learning, permits more efficient use of teacher time, economy in material costs through repeated use, and the likelihood of superior instruction. Furthermore, such a system frees the teacher
to perform the tasks which require his professional skill and judgement - those of materials preparation, diagnosis, prescription and evaluation.

The writer is fully cognizant of the limitations of this study. However, he feels reasonably confident in offering the following hypothesis: It is economically feasible and educationally defensible to produce self-instructional courses that can teach knowledge and skills without the physical presence of the instructor.

II. SUGGESTIONS FOR FURTHER STUDY

It is hoped that the framework and findings in the present study will stimulate other investigators to speculate and investigate further. Some major questions and some promising research possibilities that became apparent during the study will now be discussed.

As the study progressed it became evident that future research should investigate the psychological factors which lie behind an adult's decision to take a course by the self-instructional method instead of enrolling in a traditional course. Informal discussions with the
experimental subjects indicated very clearly that they viewed the program as less threatening than attendance at a conventional institution. Furthermore, several subjects stated that they felt more confident of their own abilities than they had previously and were seriously considering more formal study. It may well be that successful experiences with well-structured appealing home study procedures would encourage many people to regard their own learning capabilities more highly.

Other questions come to mind. What sorts of knowledge and skill can be best taught by the self-instructional method? What factors are related to failure or premature drop out? Perhaps lack of success may show that a relation exists with the inefficient performance of tasks and insufficient assistance with those tasks. At what point and by what means should the instructor intervene to maximize the possibilities of success?

Further research might also attempt to answer more precisely or comprehensively certain questions inadequately examined in the present study. For example, more accurate estimates of the time spent on each unit of study or laboratory experiment and more detailed descriptions of the difficulties encountered with equipment in the kit are needed. What is the best media mix? What are the most
reliable types of equipment? Further studies might also use larger samples, certain occupations, or students already enrolled in conventional courses. In addition, one might study the effect on learning of having a resource teacher available to the learner at designated periods in the program. Direct contact might be replaced by phone contact or by mail contact. Finally, one might experiment with teacher assistants, further use of non-human resources such as printed material, television, and combined classroom lectures and self-instructional material.

The ultimate question to be tackled by future research is how can professional educators improve the effectiveness of self-instructional media-assisted learning units. Furthermore, educators should study the ways in which self-instructional programs and conventional instructional programs might intertwine to present learners with a learning strategy that is most appropriate to his requirements.

The simple fact is that this study raises questions about virtually all the fundamental issues facing education. What do learners want to learn? What do they need to learn? Why do they want to learn? How can they be helped to learn effectively? And where should they learn?
III. SUMMARY

This study was undertaken by the writer because of his interest in the subject matter contained in the program - electricity and electronics - and his interest in ways of presenting material to the learner through the use of current technological media. The latter, however, became a central focus of this study.

A review of the relevant literature was enlightening with regard to the application of modern technology, such as television and a variety of other forms of audio visual materials to instructional programs. In the vast majority of cases, however, these new approaches were, supplements to, rather than replacements of courses taught in conventional institutions by traditional methods of instruction. There was scarce evidence regarding their effectiveness in the learning process. Controlled investigations were almost totally lacking.

Since there were no standard criteria that could have been used as a basis for the design of a self-instructional program, regardless of age level or subject matter, criteria were established by soliciting the views of leading educators. Opinions received from these experts all emphasized the
importance of adhering to the basic principles of learning. Although there were weaknesses in the type of instrument used to solicit opinions, the writer gleaned valuable ideas that directly affected the general program design and physical features of the instructional package.

The second task undertaken by the writer was to attempt to design a self-instructional program in the subject of electricity that was of a kind that could be undertaken by the learner in the absence of an instructor. It was to be a program that contained all lessons, materials and equipment required to complete the course. Further, the program had to be designed in order that the learner could progress through each lesson or stage in a non-traditional instructional setting, namely the person's own home. This task presented the greatest challenge to the investigator. Traditional correspondence type courses with written lessons and textbook references are useful for the non-manipulative type subject. Electricity, on the other hand, or at least certain fundamental aspects of it, require manipulation of instruments and materials to clarify and reinforce underlying principles. It was therefore necessary to incorporate the use of a variety of audio-visual modes or presentation such as slides, tapes, pictorial diagrams, and a variety of electrical experiments that would permit the learner to verify the topics under study.
Since the writer would not be physically present, he utilized the sound tape to present the lesson material. Auditory instructions, supplemented by visual instructions through slides, diagrams and printed material were blended in the presentation of each lesson.

Another closely related problem was the design of the instructional kit. The two most important criteria appeared to be compactness and ease of use. A number of prototype kits were constructed and progressively modified to reduce bulk and to streamline the accessibility of materials that became part of the program. The end product was a suitcase style of instructional kit containing all equipment, materials and references weighing less than thirty pounds.

If this study had concluded after the program and kit had been produced, the writer would already have gained a substantial measure of satisfaction. However, the final and perhaps, the most important task was to determine whether the self-instructional program could assist a learner in acquiring the knowledge, skills, and concepts by herself without any form of professional assistance and in the privacy of her own home. The results of this exercise are summarized in Chapter V. In fact, the learners acquired the knowledge, skills, and concepts as outlined for the course.
The only involvement on the part of this investigator during the experimental period was to make the initial delivery of the learning kit, administer a pre-test, replace or repair faulty equipment, and at the conclusion of the field trial, to administer a post-test.
REFERENCE FOR CHAPTER VII

(1) Boyer, E.L., "We Must Find New Forms of Higher Education." (an address given by Mr. Boyer at a conference sponsored by the California State Colleges 1972).
BIBLIOGRAPHY

A. BOOKS


B. ARTICLES


HOUSEWIVES INVITED TO PARTICIPATE IN A HOME LEARNING EXPERIMENT

An educational experiment designed to test the value of a SELF-LEARNING KIT requires the voluntary assistance of 12 housewives. The project will last approximately 3-4 weeks or 20-30 hours and will be done by each housewife in her own home using tapes, slides, instruments and written materials, all of which will be provided at no expense to the participant.

This is an educational experiment, not a commercial venture. It is a project designed to test the feasibility of offering college level courses in the home rather than at a campus.

Housewives wishing to participate in this study must meet the following requirements:

RESIDENCE: Live in North or West Vancouver
AGE: 20 years or over
EDUCATION: Completion of grade 8
TRAINING: No formal training in College level physics, electricity or electronics. No work experience in physics or electronics.

If you meet the above requirements and wish further information about your possible participation in this learning experiment at no cost to you please phone Harold Kirchner, Director, Self Learning Project any night after 7:00 p.m. at 987-3727.

Please reply on or before June 11th, 1971.
Dear Mrs.

We wish to acknowledge your generous offer to participate in our self-learning project. The response to the advertisement has been most gratifying, hence, we are now in the process of selecting twelve housewives from the district of North and West Vancouver.

May I take this opportunity to mention briefly something about myself and the project. I am a university graduate currently employed as a College Administrator. I have taught classes at the elementary, high school, college and university levels. My particular interest is the development of self learning units which are capable of being used by the learner independent of assistance from a teacher.

The number of students who attend colleges, institutes of technology, and universities increases significantly each year. This increase in numbers, coupled with the complex and diverse needs of business, industry, and government for graduates with high levels of competence, makes essential the need for improved methods and procedures for facilitating the learning process.

Changes in teaching and learning methods must be developed to reduce the high costs of education and put at the disposal of students more productive and inexpensive ways of learning. It is with these thoughts in mind that I have developed a self learning program which can be used by the learner in his own home independent of teacher assistance.

Before asking you to complete the accompanying questionnaire which will be used for selecting our "students", may I briefly describe the SELF-LEARNING KIT.

Self-Learning is, of course, not a new concept; it has been used extensively in high school correspondence courses and by a variety of commercial firms to teach everything from typing to home repairs. In the majority of these courses, however, the learner is normally mailed a series of lessons and one or more textbooks.

The basic purpose of this SELF-LEARNING KIT is to teach knowledge of technical skills in the absence of a teacher. The KIT however, contains taped instructions, slides, measuring instruments as well as written instructions. A Tape Recorder and Slide Projector is provided along with several other
instruments. All equipment is contained in a "Simple to Use" kit that can be stored in a single portable cabinet.

We have chosen electricity as our field of study and housewives as our subjects for very good reasons. In most cases, housewives have had no formal training or practical experience in electricity or related fields. This simply means your previous experience and knowledge will not unduly influence the results of the study. In addition, housewives were chosen because they have normally been away from a formal learning environment for a few years. Finally, since you are home a good part of the day, a self-learning kit appears to us to be the most feasible way of assisting you in many forms of continuous learning.

Although the subject of electricity may be a topic quite foreign to you, please be assured that it is not a difficult one to master. The particular course will centre around basic principles which I believe you will find interesting and useful.

At specific times throughout the project I will ask you to complete various questionnaires and perform certain prescribed tasks. The information you provide me will be tabulated to determine the overall value and effectiveness of the particular program. Obviously this type of self learning program is new and untried. Accordingly, we must have information upon which to judge its effectiveness. Consequently, each participant in the program must be willing to tell me in some detail how she reacted to the course materials and how much she learned from them. At the end of this study the kit must be returned as it is required for further experimental studies.

Because of cost we have been able to construct only twelve complete kits. I will therefore select by a random process 12 participants from the relatively large number of persons who have expressed interest in the program.

I would like to emphasize that this project is not a commercial venture but rather a study designed specifically to determine the feasibility of offering college level courses to people in their homes. I would like to assure you that should you be one of the people selected for the project your involvement will be at no financial cost to you.

If you are still interested in participating please complete the attached form and return to me so that it reaches me no later than [date]. Within a week from this date I shall inform all applicants of my choice of participants.

Thank you for your interest in this project.

Yours sincerely,

Harold Kirchner
Director
Self Learning Project.

HK:ch
PARTICIPANT'S DATA SHEET

1. NAME OF CANDIDATE: ____________________________________________

2. ADDRESS: _________________________________________________________

3. PHONE NUMBER: ___________________________________________________

4. CANDIDATE'S AGE
   Between 20 and 29 [ ]    Between 40 and 49 [ ]
   Between 30 and 39 [ ]    50 and over [ ]

5. EDUCATIONAL LEVEL:
   Secondary School: Highest grade completed _________________________
   College or University: Number of years completed _____________________
   Specialized Training: Specify _______________________________________
   Number of years Completed _________________________________________
   Degrees or Diplomas: Specify _______________________________________

6. HAVE YOU UNDERTAKEN STUDY IN ANY ONE OF THE FOLLOWING AREAS?
   College or University Physics: Yes [ ]   No [ ]
   College or University Electronics: Yes [ ]   No [ ]
   Other Specialized Training in Physics or Electronics: Specify

7. NUMBER OF SCHOOL CHILDREN IN THE FAMILY: Boys ______ Ages ______
   Girls ______ Ages ______

8. IS THERE A MEMBER OF YOUR HOUSEHOLD ACTIVELY ENGAGED IN THE STUDY OF
   PHYSICS OR ELECTRONICS ON A HIGHER LEVEL: Yes [ ]   No [ ]

9. ARE YOU PRESENTLY EMPLOYED? Yes [ ]   No [ ]
   BRIEFLY DESCRIBE YOUR JOB: _______________________________________
   Hours/Week ___________________
   Signature: ___________________
   Date: _______________________

Note: Information obtained from this questionnaire will be considered confidential. Its purpose is solely to obtain a representative sample for this study.

PLEASE RETURN TO - Harold Kirchner, Director, Self Learning Project,
622 Croydon Place, North Vancouver, B.C.
Dear Mrs. ________________

At the present time I am attempting to summarize the results of our study. Briefly, eleven of the twelve participants completed all aspects of the Self Learning Program and I can say at this point that each of you have successfully completed the project in a minimum of time and with a high level of success. Needless to say, I am not only proud of your accomplishments but in addition, more than ever convinced that this kind of self learning instructional kit can be developed in numerous other educational areas.

In a project such as this, additional questions constantly arise. May I again respectfully request your help in completing the following questionnaire. The enclosed questionnaire was given to a number of experts in the field of education to determine the important characteristics relating to program and kit design. I have a summary of the replies of these experts relating to this questionnaire. I now feel it is extremely important to this study to compare the opinions of these experts to those of housewives who have followed this program and who have in a very practical way used and judged each aspect of this self-learning kit.

May I, therefore, respectfully request that you complete this questionnaire and return to me as soon as convenient.

In closing I have tentatively scheduled a summary meeting of all participants in my home in early September (actual date to be announced). During this informal meeting I hope to provide you with a complete summary of the study. It is hoped that during this meeting other comments from you may be shared with your fellow students.

Yours truly,

Harold Kirchner

HK:b1
Enclosure (1)
PARTICIPANTS RESPONSE TO NEWSPAPER ADVERTISEMENT

Please mention below your reasons for wishing to participate in this project. Your particular reasons will help us to determine more clearly the needs of people who wish to learn at home.

Thank you.
Dear Mrs.,

The response to my advertisement in the local paper has been extremely gratifying. There were over fifty housewives who indicated an interest in the project.

Since the initial study required only 12 housewives it was necessary for me to draw "from a hat" in order to insure my selection was unbiased and fair to all who had volunteered. By "chance" you were not selected for this study.

May I, once again, express my sincere appreciation to you for volunteering your assistance. If it is necessary to undertake another similar study in the near future I will keep your name on my "active file" and hopefully seek your assistance.

Many thanks,

Sincerely,

Harold Kirchner.

HK:DS
Dear

Approximately two weeks ago I mailed you a questionnaire based on the design characteristics of a Self Learning Kit.

Because I have not yet received the questionnaire from you I am wondering if the material may have gone astray. On the other hand, due to your own commitments, it may not have been possible for you to answer the questionnaire.

I would be most grateful if you could complete the questionnaire and mail it to me as soon as possible. When all questionnaires are received the results will be analyzed and I will take the next major step in the development of a Self Learning Kit.

It is quite possible that the original questionnaire never reached you. I am therefore taking this opportunity of enclosing another copy with this letter.

Please disregard this letter if you have already mailed the questionnaire.

Thank you very much for your co-operation.

Yours truly,

Harold Kirchner.

HK:ds
SELF LEARNING KIT QUESTIONNAIRE

PROGRAM AND KIT DESIGN

RATER'S NAME: ___________________________________________

POSITION: ________________________________________________

The following statements may or may not be important characteristics of program design (software) in a Self Learning Kit. Please indicate how important you believe each characteristic is by circling your choice of "Very Important", "Important", "Uncertain", "Probably not Important", "Unimportant".

PART A: PROGRAM DESIGN CHARACTERISTICS

1. Instructions to the learner should be clear, simple, and meaningful.

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2. The learning and instructional materials should be attractive in format.

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3. The learner should have frequent opportunity to check his progress and to determine how well he is doing.

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4. The materials should require the learner to respond in a variety of ways including written and/or manipulative tasks.

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5. The materials should provide for varied activity (listening, reading, performing) on the part of the learner.

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6. The various media (print, picture, diagram, sound, etc.) used by the learner should be of good quality.

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7. The program should be broken down into a series of units that are relatively self contained each of which may be completed in a single sitting of approximately one hour.

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8. Units of study within the program should assist the learner to make generalizations, draw conclusions, and make applications.

9. The content and activities of the program should be interesting to the learner.

10. The learner should be permitted to repeat an activity until mastery is achieved.

11. It should be possible for the learner to receive immediate reinforcement in the form of verification of adequacy of his performance.

12. It should be possible for the learner to bypass activities he has already mastered.

13. The content and activities in the program should provide a base for future learning in a given area.

14. Correct answers to required responses should be readily available to the learner.

15. The learner should have access to teacher assistance should any unforeseen difficulties arise.

16. The program should provide the learner with manipulative or "hands on" application of theory.
17. For efficiency of learning, the program should be appropriate to the basic skills level of the Learner (reading, mathematics, etc.).

Very Important  Important  Uncertain  Probably not Important  Unimportant

COMMENTS: PLEASE LIST ANY ADDITIONAL COMMENTS YOU WISH TO MAKE REGARDING PROGRAM DESIGN CHARACTERISTICS
### PART B. KIT DESIGN CHARACTERISTICS

On this page and the one following there are a number of statements that may or may not be important characteristics of kit design (hardware) in a Self Learning Kit. Please indicate how important you believe each characteristic is by circling your choice.

1. The learner should be able to gain easy access to components and materials in a self learning kit.

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2. The learner should be able to operate a self learning kit in a working space no larger than a kitchen table top.

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3. The learner should be able to easily identify all components in a self learning kit.

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4. The learner should be able to easily lift and carry the cabinet containing all parts of the self learning kit.

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5. The component parts of a self learning kit should be durable.

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6. The colour of the cabinet of the self learning kit should be attractive.

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7. The learner should be able to make the kit ready for use and stored after use in a short period of time (say 5 minutes).

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8. The learner should be able to assemble and disassemble experiments quickly (say within 5 minutes).

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9. The learner should be free of the possibility of any physical hazard in handling the equipment and the kit.

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10. The learner should not require tools, parts or components in addition to those supplied.

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11. So far as possible the learner should not have to remove equipment and components from the kit in order to use them.

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12. The use of the kit will not require resources not normally found in the average home (i.e. illumination, utilities, etc.).

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13. The use of the kit will not require specially prepared work surfaces (i.e. acid resistant, or mark proof table tops).

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14. The kit and its component parts will not offer any hazard to children.

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**COMMENTS:** PLEASE LIST ANY ADDITIONAL COMMENTS YOU WISH TO MAKE REGARDING KIT DESIGN CHARACTERISTICS.
Lesson 1: Using the Multimeter to Measure Resistance
   (a) External parts
   (b) Reading the resistance scale
   (c) Selector Knob

Lesson 2: Resistors and the Resistor Colour Code
   (a) Purpose and use of resistors
   (b) Reading the colour code
   (c) Resistor sizes and ratings

Lesson 3: How to Measure Voltage with a Multimeter
   (a) Range setting
   (b) Voltage scale
   (c) Polarity
   (d) Circuit connections
   (e) Voltage drop

Lesson 4: The Power Supply
   (a) Function
   (b) External parts
   (c) Circuit connection

Section 5: How to Measure Current with a Multimeter
   (a) Range settings
   (b) Current scale
   (c) Method of connecting meter in circuit

Lesson 6: Application of Ohms Law to a Series Circuit
   (a) Basic formulas
   (b) Relationship of E, I, and R
   (c) Problems

Lesson 7: Characteristics of Parallel Circuits
   (a) Basic formulas
   (b) Relationship of E, I, and R in separate branches
   (c) Relationship of E_T, I_T, and R_T
   (d) Problems

Lesson 8: Constructing the Project
   (a) Application
   (b) Parts and components
   (c) Schematic diagram
   (d) Soldering techniques
PREFACE

This course consists of a number of sequential steps designed to assist you to understand the material under study. You are encouraged to complete each of the following steps in the order they appear below:

**STEP NO. 1**
READ THE FIRST FOUR PAGES OF THE MANUAL

Date Completed

**STEP NO. 2**
PLAY TAPE NO. 1: INTRODUCTION TO THE PARTS OF THE SELF LEARNING TAPE

Date Completed

**STEP NO. 3**
INSERT INTO TAPE RECORDER LESSON NO. 1: USING THE MULTIMETER TO MEASURE RESISTANCE

Date Completed

**STEP NO. 4**
PERFORM LAB EXPERIMENT NO. 1: USING THE MULTIMETER TO MEASURE RESISTANCE

Date Completed

**STEP NO. 5**
PERFORM LAB EXPERIMENT NO. 2: DETERMINING CORRECT METER READINGS FOR FOUR DIFFERENT POINTER POSITIONS WITH RANGE SELECTOR SWITCH AT X1; X10; X1K; X100K

Date Completed

**STEP NO. 6**
INSERT INTO TAPE RECORDER LESSON NO. 2 TITLED: RESISTORS AND THE RESISTOR COLOUR CODE

Date Completed

**STEP NO. 7**
PERFORM LAB EXPERIMENT NO. 3: MEASURING RESISTORS IN SERIES

Date Completed

**STEP NO. 8**
INSERT INTO TAPE RECORDER LESSON NO. 3 TITLED: HOW TO MEASURE VOLTAGE WITH A MULTIMETER

Date Completed

**STEP NO. 9**
PERFORM LAB EXPERIMENT NO. 4: DETERMINING THE CORRECT VOLTAGE FOR FOUR DIFFERENT POINTER INDICATIONS

Date Completed
1. PROJECT SLIDES 4, 5, and 6.
2. INSERT INTO TAPE RECORDER LESSON NO. 4: THE POWER SUPPLY
   Date Completed ______________________________

STEP NO. 11

PERFORM LAB EXPERIMENT NO. 5: MEASURING TERMINAL VOLTAGE AND VOLTAGE DROP ACROSS THREE INDIVIDUAL RESISTORS IN SERIES
   Date Completed ______________________________

STEP NO. 12

INSERT INTO TAPE RECORDER LESSON NO. 5 TITLED: HOW TO MEASURE CURRENT WITH A MULTIMETER
   Date Completed ______________________________

STEP NO. 13

PERFORM LAB EXPERIMENT NO. 6: DETERMINING THE CORRECT CONVERTED CURRENT UNITS FOR MILLIAMPERES AND AMPERES
   Date Completed ______________________________

STEP NO. 14

PROJECT SLIDE NO. 7
   Date Completed ______________________________

STEP NO. 15

PERFORM LAB EXPERIMENT NO. 7: MEASURING CURRENT FLOW IN A SERIES CIRCUIT
   Date Completed ______________________________

STEP NO. 16

CONTACT MR. KIRCHNER

STEP NO. 17

INSERT INTO TAPE RECORDER LESSON NO. 6: APPLICATION OF OHMS LAW TO A SERIES CIRCUIT
   Date Completed ______________________________

STEP NO. 18

PERFORM LAB EXPERIMENT NO. 8: APPLYING THE PRINCIPLE OF OHMS LAW TO DETERMINE THE UNKNOWN VALUE OF TOTAL CURRENT (I) IN A SERIES CIRCUIT
   Date Completed ______________________________

STEP NO. 19

PERFORM LAB EXPERIMENT NO. 9: OHMS LAW CALCULATIONS
   Date Completed ______________________________

STEP NO. 20

INSERT INTO RECORDER LESSON NO. 7: CHARACTERISTICS OF PARALLEL CIRCUITS
   Date Completed ______________________________
STEP NO. 21
PERFORM LAB EXPERIMENT NO. 10: MEASURING RESISTANCE IN A PARALLEL CIRCUIT

Date Completed

STEP NO. 22
PERFORM LAB EXPERIMENT NO. 11: MEASURING VOLTAGE IN A PARALLEL CIRCUIT

Date Completed

STEP NO. 23
PERFORM LAB EXPERIMENT NO. 12: MEASURING CURRENT IN A PARALLEL CIRCUIT

Date Completed

STEP NO. 24
1. READ SAMPLE OHMS LAW PROBLEMS - PARALLEL CIRCUITS IN YOUR MANUAL PAGES 38 AND 39
2. PERFORM LAB EXPERIMENT NO. 13: OHMS LAW CALCULATIONS FOR PARALLEL CIRCUITS

Date Completed

STEP NO. 25
INSERT INTO TAPE RECORDER LESSON NO. 8: CONSTRUCTING THE PROJECT

Date Completed

STEP NO. 26
PROJECT SLIDES 8, 9, 10 AND 11

Date Completed

STEP NO. 27
CONTACT MR. KIRCHNER

STEP NO. 28
CONSTRUCT THE PROJECT: PRESENCE OF VOLTAGE AND CONTINUITY TESTER

Date Completed

PROGRAM COMPLETED
LABORATORY EXPERIMENTS

LAB NO. 1: Using a multimeter to measure resistance.

LAB NO. 2: Determining correct meter readings for four different pointer positions with range selector switch at X1; X10; 1K; and 100K.

LAB NO. 3: Measuring resistors in series.

LAB NO. 4: Determining the correct voltage reading for four different pointer indication.

LAB NO. 5: Measuring terminal voltage and voltage drops across three individual resistors in series.

LAB NO. 6: Determining the correct converted current units for milliamperes and amperes.

LAB NO. 7: Measuring current flow in a series circuit.

LAB NO. 8: Applying the principle of Ohms Law to determine the unknown value of total current (I) in a series circuit.

LAB NO. 9: Ohms Law calculations.

LAB NO. 10: Measuring resistance in a parallel circuit.

LAB NO. 11: Measuring voltage in a parallel circuit.

LAB NO. 12: Measuring current in a parallel circuit.
Self Instructional Media Assisted Learning Unit

**Participants Daily Log**

Participant is requested to complete a log sheet each day the Self Learning Kit is used. All log sheets to be mailed to the Director, Self Learning Project the Friday of each week.

Unit Under Study: ______________________________________

Participant's Name: ___________________________________ Date: ____________________

Comment on any or all of the following sections:

A. Cassette Lesson:

B. Lab Experiment, Text Book:

C. Slide Projector, Multimeter, Power Supply, Tape Recorder:

D. Small Circuit Parts:

E. General Comment:
Self-Instructional Media Assisted Learning Unit

Participant's Acceptance of Kit

This is to acknowledge that I have received the complete kit of parts and components referred to as a Self-Instructional Media Assisted Learning Unit.

I shall return the complete kit to Mr. Harold Kirchner, Director, Self-Learning Project at the completion of the self-learning program.

Participant's signature

__________________________________________

Date: ____________________
LIST OF 35 MM. SLIDES USED IN KIT

NO. 1: Method of inserting electrical terminals into circuit board.

NO. 2: Method of removing resistor from electrical terminal.

NO. 3: Measuring resistance.

NO. 4: Parts of the Power Supply.

NO. 5: Power Supply to connections to electrical terminal.

NO. 6: Polarity of Power Supply and Meter.

NO. 7: Measuring Current.

NO. 8: Parts of the project tester.

NO. 9: Internal wiring of tester.

NO. 10: Tester and presence of voltage (outlet plug).

NO. 11: Tester and continuity test (extension cord).
Self Instructional Media Assisted Learning Unit

Component and Symbol Identification

Name: ____________________________  Date: ____________________________

Address: ____________________________

The various components and symbols illustrated on the following pages will be used throughout this self-learning program. It is recognized that each student participating in this program will only be able to identify a few of these items. Please do not feel inadequate if you have difficulty in answering each question; this is simply a method of determining your prior knowledge of components and symbols. As you progress through the course each item will be clearly identified along with its basic use.

Please attempt to answer all items, do not look up answers in reference materials, and do not seek assistance from any person. This is your first self-appraisal in this program. Others will be made to let you know how well you are doing as you progress through this self-learning program.

Good luck to you in your first exposure to the program!
Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans __________________________

Have you seen this symbol before?

YES ☐ NO ☐

What does it represent?

Ans __________________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans __________________________
Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?

YES ☐ NO ☐

What is it called?

Ans _______________________

Have you seen these objects before?

YES ☐ NO ☐

What are they called?

Ans _______________________

Have you seen this object before?
Have you seen this type of dial before?

YES □  NO □

What does it represent?

Ans ________________________________

Have you seen this object before?

YES □  NO □

What is it called?

Ans ________________________________

Have you seen this object before?

YES □  NO □

What is it called?

Ans ________________________________

Have you seen this symbol before?

YES □  NO □

What does it represent?

Ans ________________________________
Have you seen this object before?  
K  
YES [ ] NO [ ]  
What is it called?  
Ans__________________________

Have you seen this object before?  
L  
YES [ ] NO [ ]  
What is it called?  
Ans__________________________

Have you seen this object before?  
M  
YES [ ] NO [ ]  
What is it called?  
Ans__________________________
Have you seen this object before?  
YES[ ] NO[ ]
What does it represent?
Ans__________________________

Have you seen this object before?  
YES[ ] NO[ ]
What is it called?
Ans__________________________

Have you seen these objects before?  
P YES[ ] NO[ ]
What are they called?
Ans__________________________

Have you seen this symbol before?  
Q YES[ ] NO[ ]
What does it represent?
Ans__________________________
Have you seen these symbols before?

R

YES [ ] NO [ ]

What do they represent?

Ans

Have you seen this object before?

S

YES [ ] NO [ ]

What does it represent?

Ans

Have you seen this object before?

T

YES [ ] NO [ ]

What is it called?

Ans
SELF INSTRUCTIONAL MEDIA ASSISTED LEARNING UNIT

POST TEST

PART A

CANDIDATES NAME: ____________________________

DIRECTIONS

1. Read each question carefully.
2. Select the response (a, b, c, or d) which best answers the question.
3. Put the letter of that item selected in the space marked "Ans. (___)".

Example: The letters "T.V." stand for:
   (a) transistor radio
   (b) radio station
   (c) television set
   (d) tape recorder

   Ans. (___)

1. An atom is composed of:
   (a) protons and neutrons
   (b) electrons
   (c) electrons, protons, and neutrons
   (d) neutrons and electrons

   Ans. (___)

2. Electric current is the movement of:
   (a) protons
   (b) electrons
   (c) neutrons
   (d) electrons and neutrons

   Ans. (___)

3. A rule which may be applied to the action of an electric charge is:
   (a) Unlike charges repel; like charges attract
   (b) Like charges neither repel nor attract
   (c) Like charges repel; unlike charges attract
   (d) Unlike charges can neither repel nor attract, whereas like charges can both repel and attract

   Ans. (___)
4. Which of the following is the correct symbol for a resistor?
   (a) \[\text{symbol 1}\]
   (b) \[\text{symbol 2}\]
   (c) \[\text{symbol 3}\]
   (d) \[\text{symbol 4}\]
   
   Ans. (___)

5. The following diagram represents an/a.

   \[\text{Diagram with parallel circuit symbol}\]
   
   (a) parallel circuit
   (b) series circuit
   (c) series-parallel circuit
   (d) incomplete circuit
   
   Ans. (___)

6. The rate of flow of electrons is expressed in:
   (a) volts
   (b) ohms
   (c) amperes
   (d) none of these
   
   Ans. (___)

7. The ohm:
   (a) is a unit of electrical resistance
   (b) measures the amount of voltage
   (c) is a source of power
   (d) none of the above
   
   Ans. (___)
8. In the circuit diagram, the letter "a" indicates:

- (a) current
- (b) battery
- (c) electrons
- (d) wire connection

Ans. (___)

9. The symbol |||| represents a:

- (a) switch
- (b) parallel connection
- (c) resistor
- (d) battery

Ans. (___)

10. In the diagram below the components are arranged:

- (a) in parallel
- (b) in opposition to each other
- (c) in series
- (d) none of the above

Ans. (___)

11. Which is correct?

- (a) If voltage is increased and resistance is kept constant, current will decrease
- (b) If resistance is increased and voltage is kept constant, current will decrease
- (c) both (a) and (b)
- (d) current increases with increased amperage

Ans. (___)
12. Ohms law can be expressed:

(a) \( E = I \times R \)
(b) \( R = \frac{I}{E} \)
(c) \( I = \frac{R}{E} \)
(d) all of the above

Ans. (___)

13. Three resistors of 150, 100 and 75 ohms are connected in series. The total resistance of the circuit is:

(a) 65 ohms
(b) 150 ohms
(c) 250 ohms
(d) 325 ohms

Ans. (___)

14. What is the total voltage \( (E_T) \) of the circuit shown below?

\[ E_T? \]

\[ R_1 \quad 2 \text{ohm} \quad R_2 \quad 5 \text{ohm} \quad R_3 \quad 6 \text{ohm} \]

(a) 2 volts
(b) 3 volts
(c) 6 volts
(d) 33 volts

Ans. (___)

15. The correct formula for current in a parallel circuit is:

(a) \( I_T = I_1 \times I_2 \times I_3 \) etc.
(b) \( I_T = I_1 \times E_1 \)
(c) \( I_T = I_1 + I_2 + I_3 \) etc.
(d) \( I_T = I_1 = I_2 = I_3 \) etc.

Ans. (___)
16. The correct voltage equation for the circuit shown below is:

\[ E_T + E_1 + E_2 + E_3 = 0 \]  
\[ E_T = E_1 - E_2 - E_3 = 0 \]  
\[ E_T = E_1 - E_2 - E_3 \]  
\[ E_T = E_1 + E_2 + E_3 \]

Ans. (___)

17. In a parallel circuit containing a 4-ohm, 5-ohm, and 6-ohm resistor, the current flow is:

(a) highest through the 4-ohm resistor  
(b) lowest through the 4-ohm resistor  
(c) highest through the 6-ohm resistor  
(d) equal through all three resistors

Ans. (___)

18. If lamp L₂ in the circuit below should suddenly burn out, which of the below statements is correct?

(a) More current would flow through lamp L₁  
(b) Source voltage would decrease  
(c) The filament resistance of lamp L₁ would decrease  
(d) Lamp L₁ would still burn normal

Ans. (___)
19. In the circuit below, if an additional resistor were placed in parallel to \( R_3 \) the ammeter reading would:

(a) increase
(b) decrease
(c) remain the same
(d) drop to zero

Ans. (___)

20. What happens in a series circuit when the voltage remains constant and the resistance increases?

(a) current increases
(b) current decreases
(c) current remains the same
(d) current is reduced by half

Ans. (___)
DIRECTIONS:

Using the parts and components in your Self Learning Kit construct and perform the following:

**SERIES CIRCUIT**

PROBLEM #1: Construct a simple series circuit, without power, using any three resistors.

PROBLEM #2: Measure total circuit resistance \((R_T)\) in a simple series circuit which contains three resistors (use the circuit constructed in problem #1).

PROBLEM #3: Measure the total circuit voltage \((E_T)\) in a simple series circuit which contains three resistors (use the circuit constructed in problem #1).

PROBLEM #4: Measure the total circuit current in a simple series circuit which contains three resistors (use the circuit constructed in problem #1).

**PARALLEL CIRCUIT**

PROBLEM #5: Construct a parallel circuit, without power, using any three resistors.

PROBLEM #6: Measure the total circuit resistance \((R_T)\) of three resistors in parallel (use the circuit constructed in problem #1).

PROBLEM #7: Measure the resistance of three individual resistors connected in parallel (use the circuit constructed in problem #1).

PROBLEM #8: Measure the total circuit voltage \((E_T)\) of a parallel circuit which contains three resistors in parallel (use the circuit constructed in problem #1).

PROBLEM #9: Measure the voltage across three individual resistors connected in parallel (use the circuit constructed in problem #1).

PROBLEM #10: Measure the total current flowing in a circuit which contains three resistors in parallel (use the circuit constructed in problem #1).

PROBLEM #11: Measure the current flowing in each of the branch circuits containing three resistors in parallel (use the circuit constructed in problem #1).
EVALUATION CHECK LIST
FOR POST TEST: PART B

DATE: ___________________________ CANDIDATES NAME: ___________________________

CIRCUIT ONE

PROBLEM 1 - SERIES CIRCUIT
1. Student obtains the necessary components __________ YES No
2. Student correctly assembles circuit components __________ YES No
   Assistance required: ___________________________

PROBLEM 2 - RESISTANCE
1. Student makes appropriate meter setting __________ YES No
2. Student places meter correctly into circuit __________ YES No
3. Student correctly reads meter indication __________ YES No
   Assistance required: ___________________________

PROBLEM 3 - VOLTAGE
1. Student makes appropriate power supply settings __________ YES No
2. Student makes appropriate meter setting __________ YES No
3. Student places meter correctly into circuit __________ YES No
4. Student correctly reads meter indication __________ YES No
   Assistance required: ___________________________

PROBLEM 4 - CURRENT
1. Student makes appropriate meter setting __________ YES No
2. Student places meter correctly into circuit __________ YES No
3. Student correctly reads meter indication __________ YES No
   Assistance required: ___________________________
CIRCUIT TWO

PROBLEM #1 - PARALLEL CIRCUIT

1. Student obtains the necessary components
   [ ] YES [ ] NO
2. Student correctly assembles circuit components
   [ ] YES [ ] NO
   Assistance required: ________________________________

PROBLEM #2 - RESISTANCE

1. Student makes appropriate meter setting
   [ ] YES [ ] NO
2. Student places meter correctly into circuit
   [ ] YES [ ] NO
3. Student correctly reads meter indication
   [ ] YES [ ] NO
   Assistance required: ________________________________

PROBLEM #3 - INDIVIDUAL RESISTORS

1. Student makes appropriate meter setting
   [ ] YES [ ] NO
2. Student places meter correctly into circuit
   [ ] YES [ ] NO
3. Student correctly reads meter indication
   [ ] YES [ ] NO
   Assistance required: ________________________________

PROBLEM #4 - VOLTAGE

1. Student makes appropriate power supply setting
   [ ] YES [ ] NO
2. Student makes appropriate meter setting
   [ ] YES [ ] NO
3. Student places meter correctly into circuit
   [ ] YES [ ] NO
4. Student correctly reads meter indication
   [ ] YES [ ] NO
   Assistance required: ________________________________

PROBLEM #5 - VOLTAGE, INDIVIDUAL RESISTORS

1. Student makes appropriate meter setting
   [ ] YES [ ] NO
2. Student places meter correctly into circuit
   [ ] YES [ ] NO
3. Student correctly reads meter indication
   [ ] YES [ ] NO
   Assistance required: ________________________________
PROBLEM #6 - CURRENT

1. Student makes appropriate meter setting
2. Student places meter correctly into circuit
3. Student correctly reads meter indication

Assistance required: ______________________________

PROBLEM #7 - CURRENT, INDIVIDUAL BRANCHES

1. Student makes appropriate meter setting
2. Student places meter correctly into circuit
3. Student correctly reads meter indication

Assistance required: ______________________________
The following list of parts and supplies are required for each Independent Study Unit.

<table>
<thead>
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<th>Quantity</th>
<th>Description</th>
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<tr>
<td>1 only</td>
<td>Kit Cabinet</td>
</tr>
<tr>
<td>11 only</td>
<td>33 mm. Coloured Slides</td>
</tr>
<tr>
<td>8 only</td>
<td>Cassette Lesson Tapes</td>
</tr>
<tr>
<td>1 only</td>
<td>6-10 Volt Power Supply</td>
</tr>
<tr>
<td>1 only</td>
<td>Slide Projector (Bikon Model)</td>
</tr>
<tr>
<td>1 only</td>
<td>Tape Recorder (Philips Model)</td>
</tr>
<tr>
<td>1 only</td>
<td>Multimeter (Triplett Model)</td>
</tr>
<tr>
<td>2 only</td>
<td>Power Leads</td>
</tr>
<tr>
<td>2 only</td>
<td>Circuit Leads</td>
</tr>
<tr>
<td>2 only</td>
<td>Multimeter Leads</td>
</tr>
<tr>
<td>1 only</td>
<td>Plastic Storage Box for Small Parts</td>
</tr>
<tr>
<td>1 only</td>
<td>Plastic Box for Construction of Project and Accompany Small Parts</td>
</tr>
<tr>
<td>1 only</td>
<td>Laboratory Manual</td>
</tr>
<tr>
<td>1 only</td>
<td>Projector Screen</td>
</tr>
<tr>
<td>1 only</td>
<td>Text Book</td>
</tr>
<tr>
<td>3 only</td>
<td>10 ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>3 only</td>
<td>100 ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>3 only</td>
<td>150 ohm 1/2 watt resistors</td>
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<tr>
<td>3 only</td>
<td>330 ohm 1/2 watt resistors</td>
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<tr>
<td>3 only</td>
<td>470 ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>3 only</td>
<td>1,000 ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>3 only</td>
<td>2,200 ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>3 only</td>
<td>3,300 ohm 1/2 watt resistors</td>
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<td>4 only</td>
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<td>4 only</td>
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<tr>
<td>4 only</td>
<td>100,000 ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>4 only</td>
<td>150,000 ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>4 only</td>
<td>3.3 meg. ohm 1/2 watt resistors</td>
</tr>
<tr>
<td>4 only</td>
<td>10 meg. ohm 1/2 watt resistors</td>
</tr>
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introduction

TO THE SELF LEARNING KIT

important BEFORE STARTING TO USE THE MATERIALS IN THIS KIT READ THE FOLLOWING 4 PAGES carefully
this is your self learning kit

IT CONTAINS EVERYTHING YOU WILL NEED TO DO THIS COURSE
these are the parts of the kit

MULTIMETER

CIRCUIT BOARD ON LID

35mm PROJECTOR

TAPE RECORDER

TEST LEADS

TAKE HOME PROJECT

LAB MANUAL

TEXT BOOK

ELECTRIC PARTS

TAPE CASSETTES

POWER PACK

35mm SLIDES

PROJECTOR SCREEN
you will learn how to:

- Read the scale of an electrical measuring instrument known as a multimeter
- Use a multimeter to measure the electrical units of current, voltage, and resistance
- Plan and assemble electrical circuits
- Design and construct an electrical project of your own
- Compile data and make conclusions
1 REMOVE THE TAPE RECORDER FROM CABINET AND PLACE FLAT ON THE CIRCUIT BOARD

2 REFER TO RECORDER OPERATING INSTRUCTIONS IN THE LAB MANUAL

3 INSERT CASSETTE NO. 1 INTO TAPE RECORDER

note: IF VOICE ON RECORDER IS PLAYED TOO LOUD IT WILL DISTURB OTHERS IN THE ROOM KEEP VOLUME LOW OR USE EARPHONES
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* LAB 9: OHMS LAW CALCULATIONS

* INFORMATION SHEET NO. 6: CURRENT FLOW IN PARALLEL CIRCUITS

* INFORMATION SHEET NO. 7: CURRENT DIVISION IN A PARALLEL CIRCUIT

* INFORMATION SHEET NO. 8: RESISTANCES IN PARALLEL

* LAB 10: MEASURING RESISTANCE IN A PARALLEL CIRCUIT

* LAB 11: MEASURING VOLTAGE IN A PARALLEL CIRCUIT

* LAB 12: MEASURING CURRENT IN A PARALLEL CIRCUIT

* SAMPLE OHMS LAW PROBLEMS - PARALLEL CIRCUIT

* LAB 13: OHMS LAW CALCULATIONS FOR PARALLEL CIRCUITS

* INFORMATION SHEET NO. 9: METHOD OF USING CIRCUIT TERMINALS

* PRESENCE OF VOLTAGE AND CONTINUITY TESTER

* DIAGRAM OF PRESENCE OF VOLTAGE AND CONTINUITY TESTER

* APPENDIX "A"
  LIST OF 35 mm SLIDES
  LIST OF LAB EXPERIMENTS
  LIST OF TAPE LESSONS
TRIPLETT METER

VOLT RANGE | ADD DB
-----------|-------
3          | 0     
10         | 10    
50         | 24    
250        | 38    

OHMS PER VOLT
20,000 DC 5,000 AC

*"0" DB AT 1 MW ON 600 OHM LINE*

PUSH BUTTON TO RESET OVERLOAD PROTECTOR

DC+

5000 DCV

1000 OFF 5000

50 DCV

250

10

2.5

x1

5000 ACV

x10

x1K

x100K

100 \mu A

1000 DC MA

V:Ω:A

OUT PUT

DC−
LAB EXPERIMENT NO. 1

TOPIC: Using a Multimeter to measure resistance

MATERIALS REQUIRED:
- Multimeter
- Multimeter test leads
- Four resistors with the following colour bands:
  - No. 1 - Brown - Black - Black - Silver
  - No. 2 - Brown - Green - Brown - Silver
  - No. 3 - Brown - Black - Orange - Silver
  - No. 4 - Brown - Green - Yellow - Silver
- Eight terminal clips

INSTRUCTIONS:
1. This experiment will not involve the use of a power supply.
2. Read and follow each step carefully.
3. Before proceeding further project slides 1 and 2 which show how to make circuit terminal connections.
4. Refer to Information Sheet No. 5 for method of inserting terminals into circuit board.

PROCEDURE:
1. Place 4 sets of terminals and resistors 3" apart on circuit board as shown.

NOTE: REFER TO INFORMATION SHEET NO. 9: 'METHOD OF USING CIRCUIT TERMINALS'.
PROCEDURE CON'T.

2. Place Multimeter Range Selector Switch to the "XI" position.

3. Place small end of black test lead into outlet jack marked "COM" - place the red lead into outlet marked "V - A".

4. Zero pointer by placing one test lead flat on circuit board. Place second lead on top of the metal end of first lead and adjust "ADJ" switch until meter pointer reads "0" on resistance scale.

5. Place meter leads across resistor Number 1 and note pointer indicator.

6. Rotate Multimeter Range Selector to the "X10" position.


8. Place meter leads across resistor Number 1 and note pointer indication.

9. Rotate Multimeter Range Selector to the "X1K" position.


11. Place meter leads across resistor Number 1 and note pointer indication.

12. Rotate Range Selector to the "X100K" position.


14. Place meter leads across resistor Number 1 and note pointer indication.

15. Determine the resistance value of resistor No. 1. Record value.

16. Repeat procedure steps 2 to 15 for resistors 2, 3 and 4.

Resistor Values

<table>
<thead>
<tr>
<th>Number 1 Resistor</th>
<th>Ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number 2 Resistor</td>
<td>Ohms</td>
</tr>
<tr>
<td>Number 3 Resistor</td>
<td>Ohms</td>
</tr>
<tr>
<td>Number 4 Resistor</td>
<td>Ohms</td>
</tr>
</tbody>
</table>

NOTE: THE ACTUAL VALUE FOR NUMBER 1, 2, 3, and 4 RESISTORS CAN BE FOUND AT THE END OF LAB EXPERIMENT NO. 2

YOUR NEXT STEP

DO LAB EXPERIMENT NO. 2 TITLED: 'DETERMINING CORRECT METER READINGS FOR FOUR DIFFERENT POINTER POSITIONS WITH RANGE SELECTOR SWITCH AT X1; X10; X1K; and X100K.
LAB EXPERIMENT NO 2

TOPIC: Determining correct meter readings for four different pointer positions with Range Selector Switch at X1; X10; X1k; and X100K.

MATERIALS

REQUIRED: Nil

INSTRUCTIONS: No special instructions required.

PROCEDURE: Indicate the value for pointers A, B, C, and D for each Range Selector Switch position shown below.

![Voltmeter Scale Diagram]

<table>
<thead>
<tr>
<th>Pointer A</th>
<th>Pointer B</th>
<th>Pointer C</th>
<th>Pointer D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range Switch on:</td>
<td>Range Switch on:</td>
<td>Range Switch on:</td>
<td>Range Switch on:</td>
</tr>
<tr>
<td>X1</td>
<td>X1</td>
<td>X1</td>
<td>X1</td>
</tr>
<tr>
<td>X10</td>
<td>X10</td>
<td>X10</td>
<td>X10</td>
</tr>
<tr>
<td>X1k</td>
<td>X1k</td>
<td>X1k</td>
<td>X1k</td>
</tr>
<tr>
<td>X100K</td>
<td>X100K</td>
<td>X100K</td>
<td>X100K</td>
</tr>
</tbody>
</table>

Solutions to Lab Experiment No 2 can be found at the end of Lab No 3.

LAB EXPERIMENT NO. 1 SOLUTIONS

No 1 Resistor 10 ohms No 3 Resistor 10,000 ohms
No 2 Resistor 150 ohms No 4 Resistor 150,000 ohms

YOUR NEXT STEP:
INSERT INTO TAPE RECORDER CASSETTE TITLED: 'RESISTORS AND THE RESISTOR COLOUR CODE'.
**INFORMATION SHEET NO. I**

**SUBJECT:** How to use the Colour Code for resistors

<table>
<thead>
<tr>
<th>COLOUR</th>
<th>1ST BAND</th>
<th>2ND BAND</th>
<th>3RD BAND</th>
<th>4TH BAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>2</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
<td>3</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
<td>4</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
<td>5</td>
<td>100,000</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>6</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
<td>7</td>
<td>10,000,000</td>
<td></td>
</tr>
<tr>
<td>Gray</td>
<td>8</td>
<td>8</td>
<td>100,000,000</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>9</td>
<td>9</td>
<td>1,000,000,000</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td></td>
<td></td>
<td>0.1</td>
<td>5%</td>
</tr>
<tr>
<td>Silver</td>
<td></td>
<td></td>
<td>0.01</td>
<td>10%</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
</tr>
</tbody>
</table>

Put down its number value
If the band colour is **red** then the number will be **2**. Put this number down.

Put down its number value
If the band colour is **green** then the number will be **5**. Put this number down.

This band colour is the multiplier and if the colour is **red** the number will be **100**. Put this number down.

\[ 2 \times 5 \times 100 = 2500 \text{ ohms} \]

If the 4th band happened to be gold then the resistor could have a value of either 2,625 or 2,375 ohms or + or -5% of 2,500.
LAB EXPERIMENT NO 3

TOPIC: Measuring resistors in series

MATERIALS REQUIRED: Multimeter
Test heads
Any three resistors from resistor box

INSTRUCTIONS:
1. Read and follow each step carefully.
2. Project slide No. 3

PROCEDURE:
1. Connect resistors $R_1$, $R_2$, and $R_3$ as shown on circuit board.

2. With the test lead probes take readings and record resistance values across each of the following:
   (i) Across $R_1$ at terminal points 1 and 2
   (ii) Across $R_2$ at terminal points 2 and 3
   (iii) Across $R_3$ at terminal points 3 and 4
   (iv) Across $R_1$, $R_2$ and $R_3$ at terminal points 1 and 4

3. Compare meter readings to colour code value of resistors.
   Note: All measured readings should be within 10% of the calculated resistance if the resistances you are using have silver 4th bands and 5% if the 4th band is gold.

4. Remove resistors and terminals from circuit board.

CONCLUSION:
1. A series circuit is one in which each resistor (or device to be operated) is connected by a single wire, so that the current must pass through each device to power the next.

2. In a series circuit the total resistance is equal to the sum of the individual resistors. This can be stated in the following way:
   $$ R_T = R_1 + R_2 + R_3 \text{ etc.} $$

YOUR NEXT STEP:
INSERT INTO THE RECORDER CASSETTE NO. 3 TITLED: HOW TO MEASURE VOLTAGE WITH A MULTIMETER.
LAB EXPERIMENT NO. 4

TOPIC: Determining the correct voltage reading for four different pointer indications.

MATERIALS REQUIRED: Nil

INSTRUCTIONS: No special instructions.

PROCEDURE: Indicate the values for pointers A, B, C and D for each Range Selector Switch shown below.

<table>
<thead>
<tr>
<th>Pointer A</th>
<th>Pointer B</th>
<th>Pointer C</th>
<th>Pointer D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range Switch On</td>
<td>Range Switch On</td>
<td>Range Switch On</td>
<td>Range Switch On</td>
</tr>
<tr>
<td>2.5 DCV</td>
<td>2.5 DCV</td>
<td>2.5 DCV</td>
<td>2.5 DCV</td>
</tr>
<tr>
<td>10 DCV</td>
<td>10. DCV</td>
<td>10. DCV</td>
<td>10. DCV</td>
</tr>
<tr>
<td>50 DCV</td>
<td>50 DCV</td>
<td>50 DCV</td>
<td>50 DCV</td>
</tr>
<tr>
<td>250 DCV</td>
<td>250 DCV</td>
<td>250 DCV</td>
<td>250 DCV</td>
</tr>
<tr>
<td>5000 DCV</td>
<td>5000 DCV</td>
<td>5000 DCV</td>
<td>5000 DCV</td>
</tr>
<tr>
<td>1000 DCV</td>
<td>1000 DCV</td>
<td>1000 DCV</td>
<td>1000 DCV</td>
</tr>
</tbody>
</table>

NOTE: SOLUTIONS FOR POINTER INDICATIONS MAY BE FOUND AT THE END OF LAB #5.

NEXT STEP: SET UP PROJECTOR AND SCREEN. PROJECT SLIDES 4, 5, and 6. INSERT CASSETTE NO. 4: THE POWER SUPPLY.
TRIPLETT METER

VOLTAGE RANGES:
- DCV: 5000, 1000, OFF, 5000
- ACV: 50, 10, 2.5, 1, 0.1
- Ω: 5000, 1000, 250, 50, 10, 2.5

OHMS PER VOLT:
- DC: 20,000
- AC: 5000

DEADBAND:
- DC: 1 MW, ON 600 OHM LINE

OVERLOAD PROTECTOR:
PUSH BUTTON TO RESET

ADJUSTMENTS:
- Ω ADJ
- DC+ Ω ACV
- DC−
LAB EXPERIMENT NO. 5

TOPIC: Measuring terminal voltage and voltage drops across three individual resistors in series.

MATERIALS REQUIRED:
- Multimeter
- Multimeter test leads
- Battery Charger Power Supply
- Three resistors: 10,000 ohm
- 15,000 ohm
- 2,200 ohm
- Four terminal clips

INSTRUCTIONS:
1. Read and follow each step carefully.
2. The Battery Charger should be at 12 volts.
3. The last step is to plug Battery Charger into the wall outlet.
4. When dismantling your circuit the first thing you do is remove the Battery Charger plug from the wall outlet.

PROCEDURE:
1. Connect circuit as shown below:
   - Note: Attach Power Supply Leads to Terminals 1 and 4 before plugging Charger into wall outlet.
   - BLACK
   - RED
   - TO WALL OUTLET
   - $R_1 = 10k$
   - $R_2 = 15k$
   - $R_3 = 2.2k$

2. Set Range Selector Switch to 50 VDC.
3. Touch Black Probe to terminal 4 and Red Probe to terminal 1, making sure that black meter Probe touches black lead of power supply and red meter lead touches red lead of power supply. Record terminal voltage value.

VALUE: _____
PROCEDURE:

4. Touch Red Probe to terminal 1 and Black Probe to Terminal 2. Record voltage drop across $R_1$.  
   VALUE: __________

5. Touch Red Probe to terminal 2 and Black Probe to terminal 3. Record voltage drop across $R_2$.  
   VALUE: __________

6. Touch Red Probe to terminal 3 and Black Probe to terminal 4. Record voltage drop across $R_3$.  
   VALUE: __________

7. After completing meter readings remove charger power supply plug from wall outlet.

8. Total voltage values of $R_1$; $R_2$; and $R_3$.  
   VALUE: __________

9. Compare value obtained in step 8 with voltage value in step 3. (terminal voltage)

10. Read in your textbook the section titled "The Series Circuit", pgs. 146, 147.

CONCLUSIONS:

1. The voltage measured across each register is called "voltage drop" because it is the amount of pressure used to force the electricity (electrons) through the particular resistor.

2. The larger the resistance the larger the voltage drop. The smaller the resistance the smaller the voltage drop.

NOTE: Voltage drop does not mean lost voltage. It simply means that each resistor is using some of the force of the applied voltage. If you measure the applied voltage it will still read the full amount.

3. The individual voltage drops add up to equal the terminal voltage. This can be stated in the following way:
   $$E_T = E_1 + E_2 + E_3 \text{ etc.}$$

LAB EXPERIMENT NO. 4 SOLUTIONS:

<table>
<thead>
<tr>
<th>POINTER A</th>
<th>POINTER B</th>
<th>POINTER C</th>
<th>POINTER D</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 VDC</td>
<td>.50 volts</td>
<td>.75 volts</td>
<td>1.1 volts</td>
</tr>
<tr>
<td>10 VDC</td>
<td>2 volts</td>
<td>3 volts</td>
<td>4.4 volts</td>
</tr>
<tr>
<td>50 VDC</td>
<td>10 volts</td>
<td>15 volts</td>
<td>22 volts</td>
</tr>
<tr>
<td>250 VDC</td>
<td>50 volts</td>
<td>75 volts</td>
<td>110 volts</td>
</tr>
<tr>
<td>5000 VDC</td>
<td>1000 volts</td>
<td>1500 volts</td>
<td>2200 volts</td>
</tr>
<tr>
<td>1000VDC</td>
<td>100 volts</td>
<td>300 volts</td>
<td>440 volts</td>
</tr>
</tbody>
</table>

YOUR NEXT STEP: INSERT INTO TAPE RECORDER CASSETTE NUMBER 5 TITLED: 'HOW TO MEASURE CURRENT WITH A MULTIPLIER'
SUBJECT: Converting units of current flow from (a) milliamperes to amperes and (b) amperes to milliamperes.

A MILLIAMPERE = \frac{1}{1000} OF AN AMPERE

OR

1000 MILLIAMPERES = 1 AMPERE

CONVERTING MILLIAMPERES TO AMPERES

RULE:

TO CHANGE MILLIAMPERES TO AMPERES MOVE THE
DECIMAL POINT THREE PLACES TO THE LEFT.

EXAMPLE 1:

1000 MILLIAMPERES = 1.000 AMPERE

REFERENCE POINT

EXAMPLE 2:

20 MILLIAMPERES = 0.020 AMPERE

CONVERTING AMPERES TO MILLIAMPERES

RULE:

TO CHANGE AMPERES TO MILLIAMPERES MOVE THE
DECIMAL POINT THREE PLACES TO THE RIGHT.

EXAMPLE 1:

0.250 AMPERE = 250 MILLIAMPERE

EXAMPLE 2:

5 AMPERE = 5000 MILLIAMPERE
INFORMATION SHEET NO. 3

SUBJECT: Methods of connecting a meter in a series circuit to measure (a) resistance, (b) voltage, and (c) current.

**MEASURING RESISTANCE**

**MEASURING VOLTAGE**

"IMPORTANT" OBSERVE POLARITY OF CHARGER AND METER

**MEASURING CURRENT**

CURRENT MUST PASS DIRECTLY THROUGH METER
**LAB EXPERIMENT NO. 6**

**TOPIC:** Determining the correct converted current units for milliamperes and amperes.

**MATERIALS REQUIRED:** Nil

**INSTRUCTIONS:** No special instructions

**PROCEDURE:** Put the correct readings in the space provided.

### MILLIAMPERES (ma) to AMPERES

1. 400 ma _______ ampere  
2. 10 ma _______ ampere  
3. .3 ma _______ ampere  
4. 1500 ma _______ ampere  
5. 1 ma _______ ampere  
6. 70 ma _______ ampere  
7. .28 ma _______ ampere  
8. 900 ma _______ ampere  
9. 57 ma _______ ampere  
10. .4 ma _______ ampere

### AMPERES to MILLIAMPERES

1. .4 ampere _______ ma  
2. .07 ampere _______ ma  
3. .005 ampere _______ ma  
4. .0003 ampere _______ ma  
5. .65 ampere _______ ma  
6. .18 ampere _______ ma  
7. .060 ampere _______ ma  
8. .16 ampere _______ ma  
9. .125 ampere _______ ma  
10. .030 ampere _______ ma

**SOLUTIONS TO LAB EXPERIMENT NO.6 CAN BE FOUND AT THE END OF LAB EXPERIMENT NO.7.**

**YOUR NEXT STEP:**

PROJECT SLIDE 7
TRIPLETT METER

VOLT
 RANGE | ADD DB
 3     | 0
10    | 10
50    | 24
250   | 38

OHMS PER VOLT
20,000 DC  5,000 AC

"O" DB AT 1 MW
ON 600 OHM LINE

PUSH BUTTON TO RESET
OVERLOAD PROTECTOR

Ω ADJ

5000 DCV

×1

DCV50

×10

10

2.5

5000 OFF

1000

250

5000 OFF

1000

250

50 ACV

×10

10

3

10 A

DC+

Ω ACV

DC−

5000 ACV

×1K

×100K

100 μA

100

1000

DC MA

V: Ω: A

OUT ○ PUT
LAB EXPERIMENT NO. 7


MATERIALS REQUIRED: Multimeter and test leads, Battery Charger Power Supply, six terminal clips, three resistors; 10 Ohms, 150 Ohms, 1000 Ohms, 2 jumper wires.

INSTRUCTIONS:
1. Read and follow each step carefully
2. The battery charger should be at 12 volts.
3. Your last step in the following procedure will be to plug the battery charger power cord into the wall outlet.

PROCEDURE:
1. Important - Before you begin this experiment read and study Information Sheet No. 3.
2. Connect circuit as shown below:

   ![Circuit Diagram]

3. Set Range Selector Switch of Multimeter to 10A.
4. Set Battery Charger lead to terminal #1 and black end to terminal #6.
5. Plug Battery Charger power cord into wall outlet. Turn Battery Charger to "ON".
6. Touch Red Probe of Multimeter to terminal #1 and Black Probe to terminal #2. Move Range Selector Switch down from 10A until pointer indicates the amperage flowing in circuit. Record Amperage

NOTE It is important to observe that Multimeter has been connected in the circuit in such a manner that the electricity must pass through the meter. To remove any one of the two meter probes would open the circuit.

7. Turn Battery Charger off. Set Range Selector of Multimeter back to 10A.
8. Connect a Jumper Wire between terminals #1 and #2.
9. Disconnect the end of Resistor R2 from terminal #2.
10. Turn Battery Charger on.
11. Touch Red Probe of Multimeter to terminal #2 and Black Probe to terminal #3. Move Range Selector Switch down from 10A until pointer indicates the amperage flowing in circuit. Record Amperage
12. Turn Battery Charger off. Set Range Selector of Multimeter back to 10A.
13. Re-connect the lead of resistor R1 back to Terminal #2.

14. Record the amount of amperage flowing at the following remaining parts of the circuit:

**IMPORTANT**
The meter must be inserted directly into the circuit. In order do this one end of resistor R2 and resistor R3 must be disconnected first.
(a) Between terminal #4 and #5
Record Amperage
(b) Between terminals #5 and #6
Record Amperage

Make certain that you observe Charger and Meter polarity.

15. After completing experiment remove Charger power cord from wall outlet.

**CONCLUSIONS**

1. The current flowing in a series circuit is the same value at any point in the circuit.
2. The formula for representing current flow in a series circuit can be stated in the following way:
   \[ I_1 = I_2 = I_3 \]
   when \( I_1, I_2 \) and \( I_3 \) represents the current flowing at resistors \( R_1, R_2 \) and \( R_3 \).

**LAB EXPERIMENT NO.6 SOLUTIONS:**

<table>
<thead>
<tr>
<th>Milliamperes to Amperes</th>
<th>Ampere to Milliamperes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. .4 ampere</td>
<td>6. 180 ma</td>
</tr>
<tr>
<td>2. .01 ampere</td>
<td>7. 60 ma</td>
</tr>
<tr>
<td>3. .0003 ampere</td>
<td>8. 160 ma</td>
</tr>
<tr>
<td>4. 1.5 ampere</td>
<td>9. 125 ma</td>
</tr>
<tr>
<td>5. .001 ampere</td>
<td>10. 30 ma</td>
</tr>
</tbody>
</table>

YOUR NEXT STEP

INSERT CASSETTE NO.6 "APPLICATION OF OHMS LAW" TO A SERIES CIRCUIT
SUBJECT: Relationship of Current and Voltage

Current in a circuit increases when the voltage is increased for the same resistance.

Current in a circuit decrease when the resistance is increased for the same voltage.
SUBJECT: Method of determining the three formulas for Ohm's Law.

\[ E = I \times R \]

Volts = Ampere \times Ohms

\[ I = \frac{E}{R} \]

\[ R = \frac{E}{I} \]

Ampere = Volts \div Resistance

Ohms = Volts \div Ampere
SAMPLE OHMS LAW PROBLEMS

Suppose the problem asks you to find what current will flow through a series circuit in which there are resistances of 10 ohms, 5 ohms, and 15 ohms, when the voltage is supplied by a 6-volt battery. Take the following steps:

1. Draw a wiring diagram and place the information at the proper points, as shown below.

```
  E = 6 volts  I = ?
       A
R_1 = 10 ohms  R_2 = 5 ohms  R_3 = 15 ohms
```

2. To solve a problem with the formulas of Ohm's Law, you must know two of the three values, so write down the symbols: \( E, I, R \).

Then read the problem over again to see which values are given. Write them down, putting a question mark after the unknown value. In the problem above, you have 6 volts.

Write this after \( E \). You have three resistances \(-R_1, R_2, R_3\). You know the total resistance is the sum of these three.

Write the formula down and substitute numbers for the three resistances. Put a question mark after \( I \). Now you have:

\[
E = 6 \text{ volts}  \quad I = ?
\]

\[
R = 30 \text{ ohms}  \quad (R_1 + R_2 + R_3 = 10 + 5 + 15)
\]

3. Now select the formula you must use. You learned that Ohm's Law can be stated in three ways:

\[
I = \frac{E}{R} \quad E = IR \quad R = \frac{E}{I}
\]

The formula to use is the one that can be solved most easily for the value you want; in this case it is \( I = \frac{E}{R} \).

Write down the formula and substitute the values, thus:

\[
I = \frac{E}{R} \quad \text{or} \quad I = \frac{6}{30} = 0.2 \text{ amperes}
\]
There are several kinds of problems relating to series circuits. These types and the methods of solving them are:

1. **To find the current in a series circuit.** First find the total resistance. Use the formula 
   \[ R = R_1 + R_2 + R_3, \text{ etc.} \]
   Then use the formula \( I = \frac{E}{R} \).

2. **To find the voltage required in a series circuit.**
   When the various resistance values and the current are known. First find the total resistance. Then use the formula \( E = IR \).

3. **To find the voltage drop through a resistance when the current and the resistance are known.** This is the reading of the voltmeter when its terminals are attached to the terminals of the resistance. The reading shows the voltage used in driving the current through the resistance. The voltage drop is calculated from the current and the resistance by using the formula \( E = IR \).

4. **To find the total voltage when the voltage drops through the circuit are known.** The total voltage in a circuit is always equal to the sum of the individual voltage drops. This is expressed in the formula:
   \[ E = E_1 + E_2 + E_3, \text{ etc.} \]
LAB EXPERIMENT NO. 8

TOPIC: Applying the principle of Ohms Law to determine the unknown value of total current \( I \) in a series circuit.

MATERIALS REQUIRED:
Multimeter and Test leads, Battery Charger Power Supply, Six Terminal Clips, Four Resistors: 2-10 ohm, 1000 ohm, and 150 ohm.

INSTRUCTIONS:
1. Read and follow each step carefully.
2. The last step is to plug Battery Charger into wall outlet.
3. When dismantling your circuit the first thing you do is remove the Battery Charger plug from wall outlet.

PROCEDURE:
1. Connect circuit as shown below

   ![Diagram of circuit](image)

2. Measure total circuit resistance \( R_T \) by measuring the circuit resistance at terminals #1 and #6. Record \( R_T \) value in Table provided.
3. Apply power supply leads to terminals #1 and #6. Set Charger switch to 12 volt.

   IMPORTANT: Observe polarity on Multimeter and Charger.

4. Plug power lead of power supply into wall outlet.
   - Set multimeter Range Switch for Direct Voltage.
   - Turn Battery Charger on. Measure total circuit Voltage \( E_T \) by touching probes to terminals #1 and #6. Record value of \( E_T \) in Table provided.
5. Set Power Supply Charger to 6 volts and measure for \( E_T \). Record Value in Table provided.
6. Turn Battery Charger Power Supply off. Apply Ohms Law Formula to determine total circuit current \( I_T \) for both 12 and 6 volt power supply settings. Record values in Table provided.
7. Set Multimeter Range Switch for highest amperage Value. Disconnect jumper wire between #3 and #4 terminals.
8. Set Power Supply Charger to 12 volts.
9. Turn Battery Charger Power Supply on. Touch meter probes to terminals #3 and #4 to measure for I. Reduce Range Selector Switch until suitable amperage reading is obtained on Multimeter. **IMPORTANT**

Observe polarity on Meter and Charger. Record Value in Table provided.

10. Repeat steps 8, 9, and 10 for 6 volts. Record value in table provided.

11. Turn Battery Charger Power Supply off and remove plug from wall outlet.

<table>
<thead>
<tr>
<th>12 VOLT SUPPLY</th>
<th>6 VOLT SUPPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEASURED</strong></td>
<td><strong>CALCULATED</strong></td>
</tr>
<tr>
<td>( R_T )</td>
<td>( E_T )</td>
</tr>
</tbody>
</table>

CONCLUSIONS
1. In a series circuit the current will decrease if the voltage decreases with the resistance held constant.
2. When any two values in a circuit are known, the third or unknown value may be calculated by using the Ohms Law for the unknown.

YOUR NEXT STEP:

PERFORM LAB EXPERIMENT NO. 9: OHMS LAW CALCULATIONS
LAB EXPERIMENT NO. 9

TOPIC: Ohms Law Calculations

PROCEDURE: Do the following Problems.

Read Unit 20: Ohm's Law in your text. pgs. 144-145.

1. FIND I

\[ R_1 = 5 \text{ ohms} \quad R_2 = 9 \text{ ohms} \]

\[ E = 6 \text{ volts} \quad I = ? \]

2. FIND I

\[ R_1 = 4 \text{ ohms} \quad R_2 = 3 \text{ ohms} \quad R_3 = 8 \text{ ohms} \]

\[ E = 9 \text{ volts} \quad I = ? \]

3. FIND E

\[ R_1 = 5 \text{ ohms} \quad R_2 = 4 \text{ ohms} \quad R_3 = 6 \text{ ohms} \]

\[ E = ? \quad I = 2 \text{ amperes} \]

4. FIND E

\[ R_1 \quad R_2 \quad R_3 \]

\[ E_1 = 5 \text{ volts} \quad E_2 = 4 \text{ volts} \quad E_3 = 9 \text{ volts} \]

\[ E = ? \]

5. FIND \[ E_1, E_2 \text{ and } E_3 \]

\[ R_1 = 5 \text{ ohms} \quad R_2 = 8 \text{ ohms} \quad R_3 = 9 \text{ ohms} \]

\[ E_1 = ? \quad E_2 = ? \quad E_3 = ? \]

\[ E = ? \quad I = 3 \text{ amperes} \]

6. FIND \[ E_1, R_1, R_2, \text{ and } R_3 \]

\[ R_1 \quad R_2 \quad R_3 \]

\[ E_1 = 6 \text{ volts} \quad E_2 = 10 \text{ volts} \quad E_3 = 4 \text{ volts} \]

\[ E = ? \quad I = 2 \text{ amperes} \]

NOTE: The values for problems 1 - 6 can be found at the end of lab experiment No. 10.

YOUR NEXT STEP:

INSERT THE CASSETTE: CHARACTERISTICS OF PARALLEL CIRCUITS INTO THE TAPE RECORDER.
SUBJECT: CURRENT FLOW IN PARALLEL CIRCUITS.

DIFFERENT TYPES OF ELECTRICAL EQUIPMENT IN PARALLEL DIVIDE ........
INFORMATION SHEET NO. 7

SUBJECT: CURRENT DIVISION IN A PARALLEL CIRCUIT.

MORE CURRENT FLOWS THROUGH THE BRANCH HAVING LESS RESISTANCE.
SUBJECT: RESISTANCES IN PARALLEL

Resistances in parallel can be compared with water pipes in parallel. In each case, if the total cross-section is increased the opposition to current flow--resistance--is decreased. Two water pipes of the same size placed side by side carry twice as much water as a single pipe; and equal resistances connected side by side--parallel connection--pass twice as much current as a single resistance. This greater current flow indicates that the total resistance of the parallel-connected resistances is less than that of a single resistance.

To find the resistance of equal resistances connected in parallel, you need only to divide the value of one resistance by the number of resistances. Suppose that your circuit consists of four 200-ohm resistances in parallel. The total resistance of the parallel connection is one-fourth that of a single 200-ohm resistance, or 50 ohms. This parallel connection will act in the circuit as though it were a single 50-ohm resistance.
LAB EXPERIMENT NO. 10

TOPIC: MEASURING RESISTANCE IN A PARALLEL CIRCUIT

MATERIALS REQUIRED:
- Multimeter and Test Leads
- 8 circuit terminals
- 3 resistors: 2 - 1000
- 1 - 100
- 6 jumper wires

INSTRUCTIONS: Read instructions carefully.

PROCEDURE:

1. Construct the circuit shown below. Place jumper wires between terminals

```
            +------------------+
            |                 |
            |                 |
            |   R1 1000       |
            |                 |
            |   R2 1000       |
            |                 |
            |   R3 1000       |
            |                 |
            |                 |
            |   JUMPER WIRE   |
            |                 |
            |                 |
            +------------------+
```

2. Set Range Selector Switch of Multimeter to the "R X 10" setting. Zero pointer.

3. Disconnect one end of resistor $R_1$. Place meter lead probes across $R_1$. Adjust Range Selector to give best reading. Enter Resistance value in the table provided.

4. Connect $R_1$ back into the circuit.

5. Disconnect one end of resistor $R_2$. Place meter lead probes across $R_2$. Enter resistance value in the table provided.

6. Disconnect one end of resistor $R_3$. Place meter lead probes across $R_3$. Enter resistance value in the table provided.

7. Connect $R_3$ back into the circuit.

8. Measure the total circuit resistance by placing meter lead probes at terminals 1 and 8. Enter resistance value in the table.


CONCLUSIONS:

1. In a parallel circuit the total resistance is always less than the smallest resistance value in the circuit.

2. Resistances in a parallel circuit may be calculated by using the following formula:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots \ldots \text{etc.}$$
LAB EXPERIMENT NO. 9 SOLUTIONS:

1. $I = 0.43$ amperes
2. $I = 0.6$ amperes
3. $E = 30$ volts
4. $E = 18$ volts
5. $E = 66$ volts
   $E_1 = 15$ volts
   $E_2 = 24$ volts
   $E_3 = 27$ volts
6. $E = 20$ volts
   $R_1 = 3$ ohms
   $R_2 = 5$ ohms
   $R_3 = 2$ ohms

YOUR NEXT STEP:

DO LAB EXPERIMENT NO. 11 MEASURING VOLTAGE IN A PARALLEL CIRCUIT.
LAB EXPERIMENT NO. 11

TOPIC: MEASURING VOLTAGE IN A PARALLEL CIRCUIT.

MATERIALS REQUIRED:
- Multimeter and Test Leads
- 3 - Resistors: 2 - 1000 ohm
  1 - 100 Ohm
- 8 - Circuit Terminals
- 6 jumper wires

INSTRUCTIONS:

You are about to apply 12 volts to the circuit to observe how voltage reacts at each resistor in parallel. The voltage at each resistor is measured by connecting the meter leads on each side of the resistor. DO NOT DISCONNECT any resistor to measure the voltage across them.

PROCEDURE:

Note: THE LAST THING YOU WILL DO IS PLUG THE LEAD OF THE POWER SUPPLY INTO THE WALL OUTLET.

1. Construct the circuit shown below

2. Connect the output leads of the Power Supply to terminals 1 and 8. The Red (+) to terminal No. 1 and the Black (-) to terminal No. 8.

3. Set the "6 - 12 volt" Slide Switch on Power Supply to 12 volts.

4. Insert the two Output Leads for the Power Supply into the "Output Plugs" on the Power Supply.

5. Connect the red Output Lead to terminal No. 1 and the black Output Lead to terminal No. 8.

6. Set the Range Selector Switch on the Multimeter to 50 volts DCV.

7. Place the Red Lead (+) Probe of the Multimeter to circuit terminal No. 1 and the Black Lead Probe to terminal No. 8.

8. Place the "On-Off" switch on the Power Supply to the "On" position. Enter the terminal voltage in the table provided. Turn the Power Supply off.
9. Disconnect Multimeter leads but leave Power Supply leads connected.

10. Connect the meter leads across $R_1$ (points 2 and 7) - black meter lead to point 7.

11. Turn on power supply and record the voltage across $R_1$ in table provided. Turn off the power Supply.

12. Disconnect the meter leads from points 2 and 7 and connect them to 3 and 6 (observe polarity).

13. Turn on the power supply and record voltage in table provided.

14. Repeat for terminals 4 and 5 (observe polarity).

15. Study the values in your table.

16. Leave circuit set up for Experiment No. 12: Measuring Current in a Parallel Circuit

CONCLUSIONS:

1. In a parallel circuit the voltage is the same in all parts of the circuit.

2. The voltage in a parallel circuit can be stated in the following way:

$$E_T = E_{R_1} = E_{R_2} = E_{R_3} \text{ etc. ...}$$

TABLE FOR VOLTAGES

<table>
<thead>
<tr>
<th>$E_{R_1}$</th>
<th>$E_{R_2}$</th>
<th>$E_{R_3}$</th>
<th>$E_T$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

YOUR NEXT STEP:
DO LAB EXPERIMENT NO. 12: MEASURING CURRENT IN A PARALLEL CIRCUIT.
LAB EXPERIMENT NO. 12

TOPIC: MEASURING CURRENT IN A PARALLEL CIRCUIT.

MATERIALS REQUIRED:
- Multimeter and Test Leads
- 3 Resistors: 2 - 1000 ohm
- 8 Circuit Terminals
- 1 - 100 ohm
- 6 Jumper Wires

INSTRUCTIONS:

Now you may measure d-c current in the same circuit. REMEMBER YOU MUST BREAK THE CIRCUIT AND INSERT THE METER. You must calculate the current before measuring it so that you can set the meter current range to handle the current safely (without damaging the meter).

As you know, to calculate current you must use Ohms Law. \( I = \frac{E}{R} \)

Assuming you still have the circuit set up from your previous experiment, and 12 volts available at the Power Supply, set the Range Selector Switch to [10A]

PROCEDURE:

1. Connect the circuit as shown below.

2. Disconnect \( R_1 \) at either end and connect the meter as shown.

![Diagram of the circuit with a meter connected to measure current.]

Note: You can connect the meter on either side of the resistor to measure current as long as you observe polarity (+ to + and - to -).

3. Turn on the Power Supply and move Range Selector Switch from [10A] down the settings until meter indicates current flow. Enter current flow in the table provided. Turn off the Power Supply.
4. Disconnect the meter leads from the circuit; re-connect resistor \( R_1 \).

5. Disconnect \( R_2 \) at either end; then connect the meter in the circuit. Set Range Selector to 10A. Be sure to observe polarity.

6. Turn on the Power Supply and move Range Selector Switch from 10A down the settings until meter indicates current flow. Enter current flow in the table provided. Turn off the Power Supply.

7. Repeat for resistor \( R_3 \).

8. Measure for total Current flow \( (I_T) \) by disconnecting the jumper wire between terminals 1 and 2. The red meter lead will connect to point 1 and the black meter lead to point 2.

   Note: Set Range Selector Switch at 10A and work down the settings until current flow is indicated. Enter value in table.

9. Disconnect the Power Supply and dismantle the circuit.

10. Study the figures in your table. You will see that the sum of the currents through each resistor equals the total current.

CONCLUSIONS:

1. The total current in a parallel circuit is equal to the sum of the various currents in the various branches of the circuit. This rule can be stated as:

   \[ I_T = I_{R_1} + I_{R_2} + I_{R_3} + \text{etc.} \]

   You have just learned how volts, current, and resistance function in a simple d-c parallel circuit.

Now that you have had some practice in measuring resistance, voltage drop, and current in a parallel circuit, you need some practice calculating them.

<table>
<thead>
<tr>
<th>( I_{R_1} )</th>
<th>( I_{R_2} )</th>
<th>( I_{R_3} )</th>
<th>( I_T )</th>
</tr>
</thead>
</table>

YOUR NEXT STEP

1. READ SAMPLE OHMS LAW PROBLEMS - PARALLEL CIRCUITS IN YOUR MANUAL.
2. DO LAB EXPERIMENT NO. 13 OHMS LAW CALCULATIONS FOR PARALLEL CIRCUITS.
SAMPLE OHMS LAW PROBLEMS.

PARALLEL CIRCUITS

There are several kinds of problems to be solved in connection with parallel circuits. The commonest types and the methods of solving them follow:

1. To find the resistance of a parallel circuit when the values of the individual resistances are known. For example, two resistances of 6 and 3 ohms, respectively, are connected across a 6-volt battery. What is the resistance of the circuit? Use the formula \( \frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} \)

   \[ \frac{1}{R_t} = \frac{1}{6} + \frac{1}{3} \]
   \[ R_t = \frac{2}{3} \text{ ohms} \]

2. To find the joint resistance as shown in 1. Apply the formula \( \frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} \)

3. To find the voltage required to force a certain current through a parallel circuit containing two resistances. For example, what voltage is required to force 2 amperes through a parallel combination consisting of 2 ohms and 5 ohms? First find the resistance as shown in 1. Then apply the formula \( E = I R \)

   \[ E = 2 \times 1.43 = 2.86 \text{ volts} \]

4. To find the current flowing through one resistance in a parallel circuit when the current through the other resistance is known. For example, a circuit has a branch of 6 ohms resistance and a branch of 4 ohms resistance. A current of 3 amperes flows through the resistance of 6 ohms. What current flows through the resistance of 4 ohms?
The current through any branch can be found if the resistance and voltage are known. Since the voltage is the same at each resistance in a parallel circuit, if we find the voltage at one resistance, we will know the voltage at the other. The voltage at the 6-ohm resistance can be found by using the formula

\[ E = I R = 3 \times 6 = 18 \text{ volts} \]

The current through the 4-ohm resistance can now be found by using the formula

\[ I = \frac{E}{R} = \frac{18}{4} = 4.5 \text{ amperes} \]

These results can easily be checked. The total current is 4.5 + 3, or 7.5 amperes. The resistance is

\[ R = \frac{E}{I} = \frac{18}{7.5} = 2.4 \text{ ohms} \]

Using the formula

\[ \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = 2.4 \text{ ohms} \]

Thus you prove the result.
LAB EXPERIMENT NO. 13

TOPIC: OHMS LAW CALCULATIONS FOR PARALLEL CIRCUITS

PROCEDURE: Do the following problems.

Read Unit 20: Series and Parallel Circuits in your Text. pgs. 146 - 153

1. FIND $R_T$, $I_T$, $I_1$, and $I_2$

$$E = \text{6 volts}$$

2. FIND $R_T$, $I_T$, $R_1$, and $R_2$

$$E = \text{60 volts}$$

3. FIND $I_2$, $R_1$, $R_2$, $E_T$, and $R_T$

$$I_1 = 2 \text{ amps}$$

$$E_1 = \text{60 volts}$$

$$I = 10 \text{ amps}$$

4. FIND $I_T$, $R_1$, $R_2$, and $R_T$

$$I_1 = 12 \text{ amps}$$

$$I_2 = 4 \text{ amps}$$

NOTE: The values for problems 1-4 can be found on the next page.

YOUR NEXT STEP:
INSERT THE CASSETTE: CONSTRUCTING THE PROJECT.
SOLUTIONS FOR LAB EXPERIMENT NO. 13

1. \( R_T = 2 \text{ ohms} \)
   \( I_T = 3 \text{ amps} \)
   \( I_1 = 2 \text{ amps} \)
   \( I_2 = 1 \text{ amps} \)

2. \( R_T = 10 \text{ ohms} \)
   \( I_T = 6 \text{ amps} \)
   \( R_1 = 15 \text{ Ohms} \)
   \( R_2 = 30 \text{ ohms} \)

3. \( I_2 = 8 \text{ amps} \)
   \( R_1 = 30 \text{ ohms} \)
   \( R_2 = 7.5 \text{ ohms} \)
   \( E_T = 60 \text{ volts} \)
   \( R_T = 6 \text{ ohms} \)

4. \( I_T = 16 \text{ amps} \)
   \( R_1 = 6.6 \text{ ohms} \)
   \( R_2 = 20 \text{ ohms} \)
   \( R_T = 5 \text{ ohms} \)
INFORMATION SHEET NO. 9

SUBJECT: Method of using circuit terminals.

1. SPRING EXTENDED
2. INSERT END OF RESISTOR
3. SPRING COMPRESSED
4. END OF SPRING
5. IN PLACE
6. CIRCUIT BOARD
7. RESISTOR END IN PLACE
The Presence of Voltage and Continuity Tester is a very handy device around the home. The voltage indicating section of the unit can be used to determine the presence of voltage at wall outlets, terminals of a toaster, iron, hot water kettle, or at any other place where voltages are in excess of 65 volts. Voltage will be present when the neon bulb glows.

The Continuity Tester section of the combined tester unit is very handy in determining whether or not an extension cord has an open circuit, if a switch is serviceable, or if an electrical circuit has a break in the wiring.

Materials and components for the tester will be found in your S.L.K. They consist of the following:

- 1 only 1.5 pen lite dry cell
- 4 only insulated pin jacks (2 red, 2 black)
- RL - 1200 - ohm, 1/2 watt resistor
- S1 - S.P.D.T. Slide switch
- 1 - NE 2 neon bulb
- 1 - Battery holder

Miscellaneous

- Rubber Grommet
- Plastic box
- Wire
- Solder
- Machine screws and nuts, etc.
- Set of test leads

Schematic Diagram of Tester
PRESENCE OF VOLTAGE
AND CONTINUITY TESTER

PROCEDURE IN CONSTRUCTING UNIT:

1. Refer to pictorial diagram showing placement of parts in plastic box.

2. Mount the Insulated Tip Jacks (4) and secure in position with machine nuts.

3. Mount the slide switch and secure in position with machine screws.

4. Mount rubber grommet over A.C. voltage neon bulb.

5. Position 1.2 volt bulb; battery holder; neon bulb and the resistor in plastic case.

6. Run the wire leads of each component part to the respective terminal points.

7. Solder wire leads to each terminal point.
   *Note:* Refer to pages 95, 96, 97 and 98 in the text Electricity and Electronics for correct method of soldering.

8. Carefully check all wiring and connections after soldering of all connections has been completed.

9. Place 1.5 volt battery in holder.

10. Insert small ends of test leads into insulated tip jacks of plastic case marked "Circuit Continuity".

11. Touch test lead ends together: Pen-lite bulb should glow.

12. Remove test lead ends from pin-jacks and plug into "Presence of Voltage" pin jacks.
   *IMPORTANT:* PLACE SWITCH TO A.C.

13. Test for presence of voltage by inserting test lead probe ends into wall outlet; neon bulb should glow.
   *Important:* Make certain the plastic lid of tester is closed when using tester. This procedure will avoid the hazard of a dangerous shock when testing for presence of voltage.
PRESENCE OF VOLTAGE
AND CONTINUITY TESTER

PLASTIC LID

SLIDE SWITCH

1.2 VOLT BULB

1.5 VOLT PEN LITE CELL:
BATTERY HOLDER

RESISTOR 1200 OHMS

(PRESENCE OF VOLTAGE)
TEST LEAD PLUG-IN

(TIP JACK MOUNTING NUT)

NEON BULB

CIRCUIT CONTINUITY
TEST LEAD PLUG-IN

INSULATED TIP JACK
SLIDES

NO. 1: Method of inserting electrical terminals into circuit board

NO. 2: Method of removing resistor from electrical terminal

NO. 3: Measuring resistance

NO. 4: Parts of the Power Supply

NO. 5: Power Supply to connections to electrical terminal

NO. 6: Polarity of Power Supply and Meter

NO. 7: Measuring Current

NO. 8: Parts of the project tester

NO. 9: Internal wiring of tester

NO. 10: Tester and presence of voltage (outlet plug)

NO. 11: Tester and continuity test (extension cord)
LAB EXPERIMENTS

LAB NO. 1: USING A MULTIMETER TO MEASURE RESISTANCE.

LAB NO. 2: DETERMINING CORRECT METER READINGS FOR FOUR DIFFERENT POINTER POSITIONS WITH RANGE SELECTOR SWITCH AT X1; X10; 1K; and 100K.

LAB NO. 3: MEASURING RESISTORS IN SERIES.

LAB NO. 4: DETERMINING THE CORRECT VOLTAGE READING FOR FOUR DIFFERENT POINTER INDICATION.

LAB NO. 5: MEASURING TERMINAL VOLTAGE AND VOLTAGE DROPS ACROSS THREE INDIVIDUAL RESISTORS IN SERIES.

LAB NO. 6: DETERMINING THE CORRECT CONVERTED CURRENT UNITS FOR MILLIAMPERES AND AMPERES.

LAB NO. 7: MEASURING CURRENT FLOW IN A SERIES CIRCUIT.

LAB NO. 8: APPLYING THE PRINCIPLE OF OHMS LAW TO DETERMINE THE UNKNOWN VALUE OF TOTAL CURRENT (I) IN A SERIES CIRCUIT.

LAB NO. 9: OHMS LAW CALCULATIONS.

LAB NO. 10: MEASURING RESISTANCE IN A PARALLEL CIRCUIT.

LAB NO. 11: MEASURING VOLTAGE IN A PARALLEL CIRCUIT.

LAB NO. 12: MEASURING CURRENT IN A PARALLEL CIRCUIT.
TAPES

TAPE NO. 1

INTRODUCTION TO THE PARTS OF THE SELF LEARNING KIT.

TAPE NO. 2

LESSON 1: USING THE MULTIMETER TO MEASURE RESISTANCE

TAPE NO. 3

LESSON 2: RESISTORS AND THE RESISTOR COLOUR CODE

TAPE NO. 4

LESSON 3: HOW TO MEASURE VOLTAGE WITH A MULTIMETER

TAPE NO. 5

LESSON 4: THE POWER SUPPLY

TAPE NO. 6

LESSON 5: HOW TO MEASURE CURRENT WITH A MULTIMETER

TAPE NO. 7

LESSON 6: APPLICATION OF OHMS LAW TO A SERIES CIRCUIT

TAPE NO. 8

LESSON 7: CHARACTERISTICS OF PARALLEL CIRCUITS

TAPE NO. 9

LESSON 8: CONSTRUCTING THE PROJECT