THE DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF

INDUSTRIAL SCIENCE 203

AT

KILDONAN EAST REGIONAL SECONDARY SCHOOL

A MAJOR THESIS PRESENTED TO
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BY

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ABSTRACT

No suitable science curriculum materials existed for the vocational students at Kildonan East Regional Secondary School. This study is concerned with the development, implementation and evaluation of the Industrial Science Course 203.

The population for whom the course is intended consists of students that range in age from seventeen to twenty years. Their communication and mathematical skills range from a grade five rank to a grade ten rank with the majority of the population at a grade eight level. The course content is activity orientated and is based on laboratory work that aligns itself with the students' vocational requirements. The content consists of single concept activities that are expressed in terms of behavioural objectives. The course was implemented in a highly structured manner that gives students a reliable routine. The structure is designed to give the students maximum security, success, and a feeling of accomplishment.

The effectiveness of the course was measured by:

a) Compiling and analyzing the results of tests and laboratory activities that were submitted by the teachers involved in the study.

b) Evaluating the results of a semester end achievement test.

c) Evaluating the results of an attitude scale. Form A of the Purdue Master Attitude Scale was used as a pre and posttest.

The evaluation indicates that the students accomplished the goals of the course. The evaluation also indicates that the positive attitude that the students had formed in the 103 Science Course increased as a result of the 203 course.

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CHAPTER I

INTRODUCTION

Rationale

At the beginning of the academic year 1971 - 1972 the first comprehensive schools in Manitoba opened their doors to the student public. Kildonan East Regional Secondary schools (KERSS) was one of the first to start its operation. Kildonan East serves the eastern suburbs of the city of Winnipeg.

During the first two years of operation it became very apparant that the existing Industrial Science Curriculum, which consisted of the traditional courses of IME, IPS, BSCS, Chem Study and PSSC was not meeting the needs of many of the students attending the school. These courses were developed for University bound students; ninety-five percent of the KERSS students are not university bound. Lloyd M. Cooke (1975) in his address to the NSTA National Convention recognizes this type of situation. He stated that the teaching of science to the disadvantaged student becomes a challenge. In fact,

> The Challenge becomes an overwhelming problem when students are below grade level in the three R's disinterested in science, and in school and sometimes openly rebellious.

He also stated that in order for these students to learn,

> It should be a standard practice to help a student achieve success early. There are few disciplines and few areas of learning to which students are exposed that offer as many success opportunities as do science classes. Here the student can be encouraged to carry out experiments that lead to verification of basic laws. Almost no place else can you do this.

The author and the science teachers at Kildonan East had come to a similar conclusion; the vocational students must be offered a new and improved curriculum suited to their needs and interest. An extensive search of literature and known resources revealed that no suitable curriculum materials in the Industrial Science area existed. A decision was made to construct our own curricular materials. Edward C. Buller and the author accepted the responsibility of compiling and constructing a science program for three years of industrial science education.

The development of this alternative Industrial Science curriculum began during the spring term of the academic year 1972 - 73. The first year of Industrial Science 103 was implemented in the first semester of the 1973 - 74 academic year. Edward C. Buller monitored the implementation of the course and completed the initial evaluation in the spring of 1975.

The second year Industrial Science 203 was completed by September, 1974 and was implemented in the first semester of the 1974 - 75 academic year. The author monitored the implementation of the Industrial Science 203 course and conducted the evaluation in accordance with this study.

Identification and Statement of the Problem

The purpose of this study is:

i) To trace the development of the course materials for the Industrial Science 203 course by describing the specific steps taken in constructing the curriculum,

ii) To describe the teaching techniques developed to implement the science 203 course,

iii) To evaluate the course and teaching techniques by seeking answers to the following questions:

a) To what extent did the students meet the instructional objectives of Industrial Science 203?

b) To what degree did the students maintain the attitude acquired as a result of the 103 course of study?

Limitations of the Study

Industrial Science 203 was developed to meet the needs of a very special situation. Since the first implementation of the course in the first semester of the 1974 - 75 academic year the requirements of the provincial Department of Education have changed greatly. The course has become optional. Consequently, students that are registering in the course tend to be more motivated than the original population and may thereby have a more positive attitude toward science than originally anticipated.

The rapid change in technology as related to the vocational areas is changing the course demands. One of the most revolutionary changes that occurred during the period in question is the dramatic advent of the cheap multifunction pocket calculators. It is therefore evident that this study and its results are most relevant to the stated interval of time.

The vocational students, and students in general identify a course of studies very closely with the teacher responsible for the course. This study dealt with five individual classes taught over two semesters by three different teachers. The study makes no effort to isolate any of the teacher variables.

The sample number involved in the study is relatively small. This is because of the optional nature of the course and the wide choice available to the students in their second year.

Kildonan East usually experiences an eight to ten percent withdrawal rate during each semester of the second year. The students that withdraw are usually experiencing insurmountable difficulties in their vocational and academic endeavours. These students are not part of the study population. The fact that they are omitted will tend to skew the study results toward the positive sector.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Before setting up the Industrial Science Courses an attempt was made to find curriculum materials pertinent to the circumstances at KERSS. A search of known resources did not produce the necessary materials.

Therefore the following parameters were designed to provide a framework for a search of literature that would allow the writer to construct curriculum materials pertaining to the described student population:

i) Characteristics and problems of the disadvantaged student,

ii) Successful teaching strategies for the disadvantaged student,

iii) Curriculum structures concerned with the disadvantaged student,

iv) Curriculum structures for vocational students,

v) Curriculum evaluation,

vi) Similar studies.

Problems for the Disadvantaged Student

With the advent of the comprehensive schools in Manitoba many students who formerly dropped out of school now remain in school for the full twelve year term, which brings about a whole set of new problems.

As E. C. Kelly (1971) writes:

> The dropouts in school and out are legion. In some ways they seem faceless. Our society being what it is they have no place in it except in school. They are wasting their time often deteriorating rather then improving. They constitute our greatest waste. They can give us our greatest opportunity.

The Nuffield project in England concerns itself with similar students and suggests a direction:

> Rapid technological changes mean that their world is likely to be different in many ways from the present, we can help them to appreciate that changes will occur and to have some understanding of the scientific and technological factors involved.
>
> For that reason a narrowly vocational approach is unsuitable; interest in possible future jobs can be a form of motivation for some but if present trends continue many of our people will have a variety of jobs for some years after leaving schools.

The education of the vocational students must be as general as possible. This, hopefully, will enable them to cope with a rapidly changing technological society and fluctuating employment conditions.

Another problem that many schools are grappling with, is that of the sporadic attendance of the students in question. R. W. Bybee (1974) gives a possible reason for this situation:

> If a student has continually been told he is a failure and underachiever who can't cope with science, the conditions are established for fear, anxiety or non involvement to be associated with science classes---so why try.
>
> At upper grade levels this type of fear is seen in an overt rejection of class or school "you can't fail in school if you aren't there".

Attendance is one of the chief problems plaguing the industrial courses. In fact attendance or lack of it could be used as an indicator as to whether or not the courses are satisfying the students needs.

Teaching the Disadvantaged Student

The science teachers experienced considerable difficulty in attempting to employ techniques and methods that were successful in academic classes. These students require very structured and activity orientated instruction. The students had to be given a great deal more personal encouragement and success. R. W. Bybee (1974) suggests a set of five parameters of science teaching:

1. Provide activities that are an academic challenge to the student while opportunity for success is at a maximum.

2. Give personal encouragement to each student as often as possible.

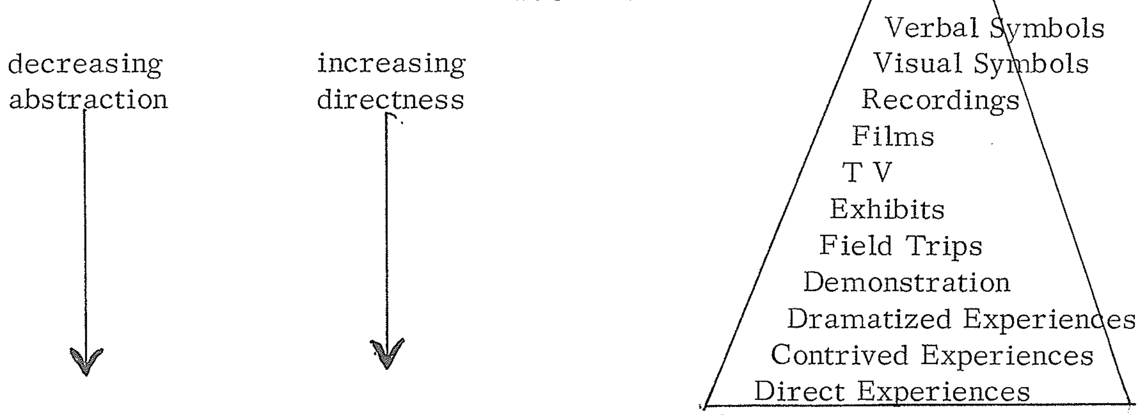
3. Encourage cooperation rather than competition.

4. Allow students some freedom within defined limits.

5. Accept errors and mistakes as part of developing learning and growing.

In his description of learning processes of slower learners D. Manning (1971) uses Edgar Dales' pyramid of methods:

FIGURE I



It is apparent that any effective teaching must utilize the base of the pyramid. Science is ideally suited to operate in this area.

J. Merrit (1972) brings in another dimension in the teaching of secondary students and one that is often neglected:

> The work must have significance not only for the pupils as adolescents but also because it is concerned with realistic matters of adult stature and it needs to be remembered that many of these pupils will already be assuming responsibilities of an adult kind outside the school situation.

Students in the senior grades of secondary schools range in age from seventeen to twenty-one. They are generally well acquainted with the realities and the responsibilities of the industrial world and therefore should be treated as adults.

The teaching techniques must be well organized and give the student structure. As Allan Ornstein (1969) states in his paper on "Techniques and Fundamentals for Teaching the Disadvantaged":

> These children in particular demand a strict structured workable routine. They need and want a teacher who can assure them the stability they usually do not receive at home.

Russel C. Doll and Daniel V. Levine (1972) further emphasize the need for structure in their paper "Toward a Definition of "Structure". They list the following four components of an effective teaching structure:

1. Structure involves the choice and sequencing of instructional experiences and materials in accordance with the particular learning problems and characteristics of the disadvantaged student.

2. Structure involves the initiation of procedures and arrangement to obtain order, so that teaching and learning can begin.

3. Structure involves the systematic choice and creation of situations and educational materials which provide disadvantaged students with experiences of success in the school.

4. Structure involves the use of requirements and ground rules in such a way as to:

   a) Clearly define what students are expected to do,
   b) Require participation on the part of the student,
   c) Provide for increasing student participation in setting subsequent ground rules,
   d) Ensure that students understand as thoroughly as possible the rationale underlying the activities and assignments.

Curriculum Concerns

Science should be a preferred subject to the vocational student. It allows him to reap rewards that were previously denied to him in many academic subjects. Science is directly related to most of the vocational areas and requires similar manipulative activities. He can see things happening and has to respond in terms of his experience in the laboratory.

J. Merrit (1972) in commenting on the Nuffield project in England describes the role that Science must play in order for it to be meaningful to the student:

> Science must be experienced at first hand and, if something of its flavour is to be savoured and something of its spirit caught there is need for a considerable measure of empirical work at this stage. Its spirit should be one of investigation and opportunity to experience this as necessary. It is important that inert ideas should be avoided and first hand observation and experiment should provide essential opportunities for acting and thinking scientifically.

He goes on to give the general objective of science teaching:

1. Accurate observation,
2. Deducing generalizations,
3. Inferring results from a concept or generalization,
4. Simple experimental design,
5. Forming hypothesis,
6. Verbal fluency, literacy and numeracy,
7. Self-discipline and self-programming.

The National Committee on Employment of Youth (1969) describes a vocational science curriculum as follows:

> -----The curriculum must emphasize the concrete rather than the abstract; the uses and application rather than the rules, theory and formulas. It must be person orientated, as well as craft or trade orientated with strong emphasis on behavioural objectives.-----

Harvey Goldman (1971) in his paper on "Nature of Curricular Relevance" states:

> A relevant curriculum is active rather than passive. It is based on the assumption students learn by doing.
>
> A relevant curriculum should be based on experiences with which children are familiar and in which they are interested.

To make a course meaningful to vocational students the course cannot afford to give them the impression that the activities are kept on an elementary level because of their lack in computation skills. These students work with sophisticated equipment and carry out meaningful projects such as constructing entire residential homes and fitting these with all conveniences.

To overcome this difficulty the course was designed to present real situations and computations. To facilitate successful mathematical experiences for the students electronic calculators were purchased.

Donald R. Quinn (1976) supports this technique by stating:

> ---a lack of proficiency in computational skill could close many vocational avenues for students. Fey (1974) reported that 61 percent of a sample consisting of teacher, mathematicians, and laymen agreed with the statement: "Weakness in computational skill acts as a significant barrier to learning of mathematical theory and applications." The group voted 84 percent agreement for the statement: "Speed and accuracy in arithmetic are still essential for a large segment of business and industrial workers and intelligent consumers."

Curriculum Design

A desirable curriculum design should be able to satisfy the needs of the student and secondly modify his behaviour to bring it into harmony with the environment in which the student must function.

Jeanne Freeman (1974) suggests three approaches or theories of curriculum design:

> The First Curriculum Theory ----- The intellectual discipline orientation holds that education serves to impart the content and skills of the organized fields of knowledge-----this philosophy set in motion curriculum projects that continue to pervade schools i.e. PSSC, IPS, Chem Study.
>
> This emphasis on knowledge limits students' ability to express other dimensions of their personalities.

Attempts to water down this type of curriculum to suit the vocational students did not meet with much success. The concepts and ideas present an unrelated situation to the students. Science became meaningless and something to be disliked and avoided. As Jeanne Freeman further quotes:

> The Second Curriculum Theory holds that education should

develop and fulfill the individual students talents, needs, interest and abilities (Combs 1962, Rogers, 1971). In contrast to the subject matter curriculum, content, organization, methodologies and activities are designed to suit the student's needs. Curriculum designers determine the appropriateness and effectiveness of varied materials, resources and strategies.

The goal for the teacher is to expand and intensify students experiences. The teacher is a craftsman who through empathy, openess and understanding creates a rich, varied, open safe growth climate for students. (Rogers, 1971)

The Third Theory ----- the behaviour controlled orientation holds that education serves to control the student and shape him into a socially acceptable product (Skinner, 1971). This view creates a technology of behaviour designed to condition the individual by scientifically controlling and shaping his environment. i.e. Performance Based/ Competency/ Accountability/ Behavioural Objectives movement. (Zifferblatt 1973, Popham 1970) Efficiency and effectiveness are the major goals. (Krasner 1973)

The teacher performs a single role as behaviour modifier whose primary function is to control and shape behaviour.

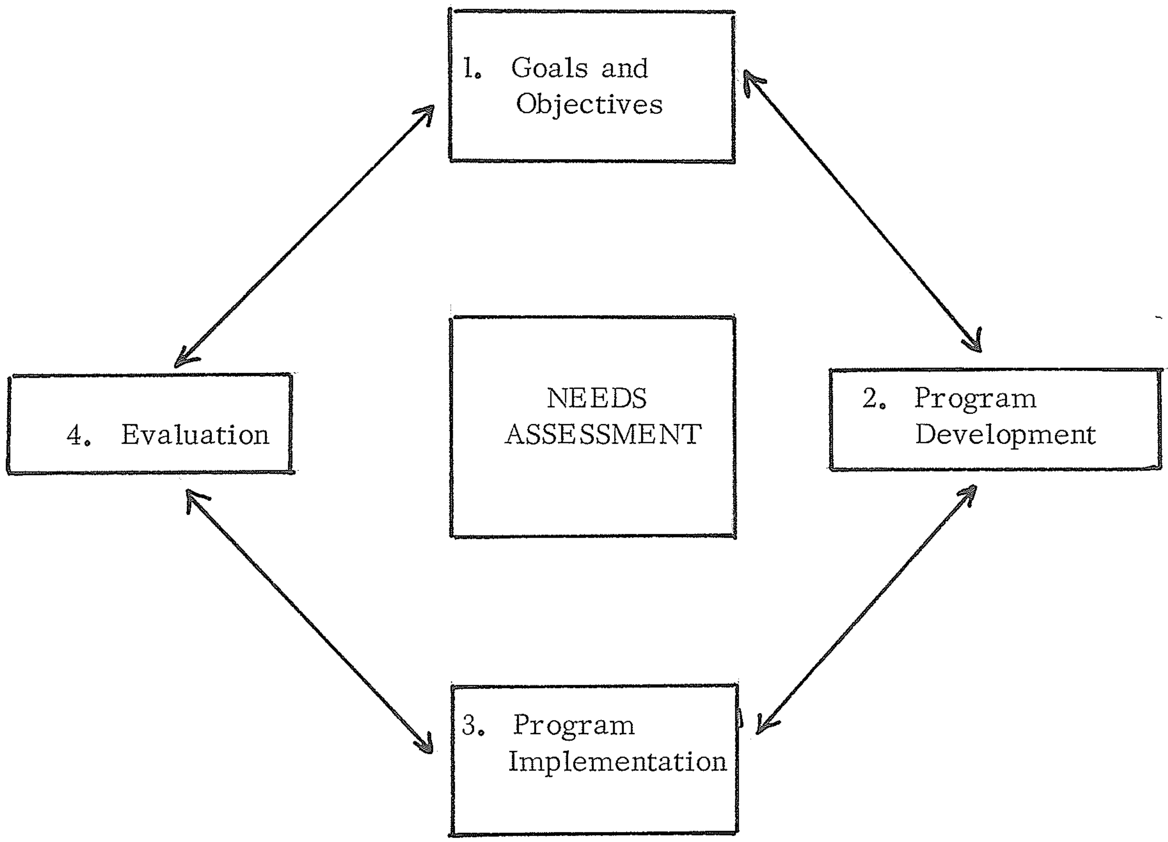
In considering the foregoing descriptions of teaching techniques and characteristics of curriculum for the disadvantaged student, the logical approach seems to be one that is based primarily on the second theory; relying on the products of the first theory for resources and employing the methodology and techniques of the third to achieve the desired goals.

The Manitoba Teachers (1975) Society recently issued a pamphlet entitled "Curriculum Development". In this pamphlet the committee presents a curriculum development model:

(Refer to figure II on following page)

FIGURE II

Curriculum Model 1

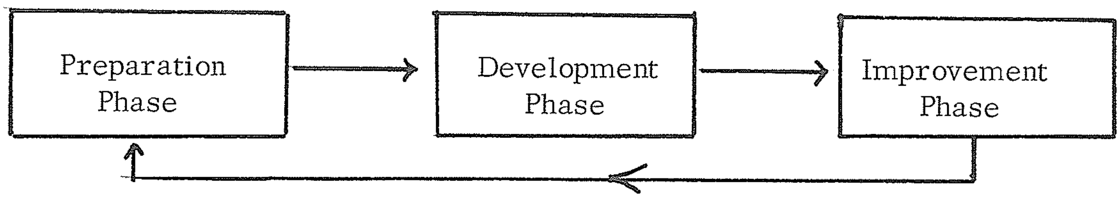


The model revolves about a continuous assessment of student need. The student needs then influence statement of goals and objectives, program development, program implementation, program evaluation. The model represents a very fluid condition that is continuously modified by its central theme of needs assessment.

R. F. Mager and K. M. Beach (1968) offer a simpler model:

FIGURE III

Curriculum Model 2



The preparation phase includes the assessment of needs and circumstances, the setting of criteria, and the writing of course objectives. The developmental phase involves sequencing of content, selection of procedure and course tryout. The improvement phase involves comparison of performance with objectives, comparison of objectives to the original requirements, and revision and tryout.

There are ample examples in educational literature describing various models of curriculum development. Many recent models follow the following pattern:

1. Describe the persons at whom the effort is aimed.
   That is, needs.

2. List the goals.
   That is, "What is the course designed to achieve?"

3. Develop the course.
   That is, behavioural objectives, content and methodologies.

4. Implement the course.
   That is, use the designed course and make necessary adjustments in accordance with needs.

5. Evaluate the course.
   That is, were the original goals achieved?
   Were the needs satisfied?

6. Modify the course to correct inconsistencies in the goals.

7. Rerun the cycle.

Evaluation of Curriculum

A newly developed curriculum must be evaluated after initial implementation. The evaluation can take two forms. First, the immediate evaluation (formative) and subsequent modification while the course is in progress. Secondly, an overall evaluation (summative) and modification at the conclusion of the course. The evaluation should center on the following questions:

i) Is the content appropriate for the population?
ii) Are the methods employed successful?
iii) Is the student reaction favourable?

R. F. Mager (1968) sees a similar system:

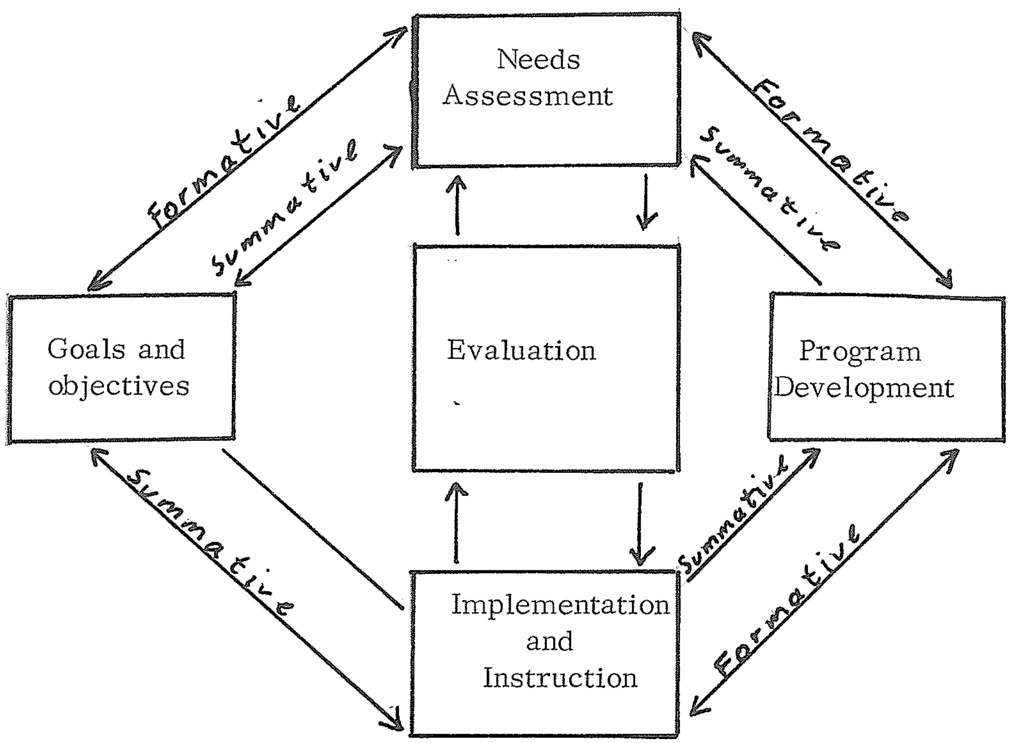
> One is on assessment of whether our students appear to be as willing to approach our subject at the end of our influence as they were when it began. The other is the assessment of the process. In other words, results evaluation tells us something about how well we are doing; process evaluation tells us how we might do it better.

The Manitoba teachers Society (1975) also presents a second and more complex model:

(Refer to Figure IV on following page)

FIGURE IV

Evaluation Model



The model uses the terms formative and summative evaluation. Michael Scriven (1962) originated the terms and makes the following distinction:

> Formative is "in course" evaluation and subsequent modification. Summative is "end of course" evaluation and looks at the total picture and its implication.

Similar Studies

Two recent criterion referenced studies dealing with similar subjects and subject matter are reported below:

The Coordinated Vocational Academic Education (CVAE) Evaluation report 1972 described the development and field testing of Vocationally related Mathematics and Science Curriculum. Evaluation of the program was based on specific performance objectives. The students involved attained 88.7% to 99.8% success in attaining the specific performance objectives and general attitude toward science improved. The designed curriculum was considered successful.

A study completed by E. C. Buller in 1975 dealt with the development and evaluation of a tenth grade Vocational Science Course. Evaluation was based on student attainment of specific learning outcomes. Of the students involved over ninety percent attained satisfactory scores. The attitude of the students toward science improved considerably. The designed curriculum was considered successful.

Summary

The review of literature suggests that a proposed course of study may have the following characteristics:

i) Activities that are meaningful in the student's world,
ii) Activities that allow a first hand experience for the student,
iii) Activities that provide immediate feed back and a good measure of success,
iv) A structure on which the students can rely and in which they can feel secure,
v) The goals must be short termed and within the reach of the students,
vi) Success for the student must be built into every aspect of the course,
vii) A mathematical and literary level that is well within the range of the student's ability,
viii) Encourage cooperation rather than competition.

The evaluation of the course of studies can be criterion referenced dealing only with the study groups. A combination of a measure of competency in attaining specific objectives and measurement of change in student attitude toward science would give an indication of the effectiveness of the course.

CHAPTER III

COURSE DEVELOPMENT AND IMPLEMENTATION

Student Description

The development of the alternative course was initiated by obtaining information describing the prospective students from the following sources:

1. Student interviews,
2. Standardized mathematics and reading ability tests,
3. Guidance department files,
4. Conversations with other science instructors,
5. A search of relevant literature.

From these sources the following list of characteristics was compiled:

1. A student registered in a 2nd year of vocational education program.

2. A student who has completed Science 103.

3. A student who shows a very limited interest in "book orientated" and/or abstract subject matter.

4. A student who almost invariably shows a great deal of interest in "apparatus orientated" subject matter, and a corresponding interest in carrying out straightforward practical experimentation.

5. A student who in the classroom-lecture environment is often difficult to communicate with.

6. A student who scores low in both reading and mathematical skills. (see Tables I, II, III)

7. A student who likes to operate from the safety of a large group.

8. A student who responds readily to unaccustomed success in academic tasks.

9. A student who at times has attendance difficulties.

10. A student who sees little use in subject matter that does not readily relate to his set of values.

11. A student who responds readily to highly structured and organized activity.

(Refer to Tables I, II, III on the following pages)

TABLE I

RESULTS OF CBST MATHEMATICS TEST

FEBRUARY AND SEPTEMBER 1975

GRADE ELEVEN, GRADE RANKING

Group	Percent of Population					
	I	II	III	IV	V	Total
Grade Rank	N = 17 %	N = 16 %	N = 14 %	N = 21 %	N = 16 %	N = 84 %
5	0	0	0	0	0	0
6	0	6.2	14.3	9.5	18.8	9.5
7	17.6	12.5	28.6	28.6	31.3	23.8
8	35.2	31.3	35.7	38.1	25.0	33.3
9	35.2	37.5	14.3	19.0	25.0	26.2
10	11.7	12.5	7.1	4.7	0	7.1
11	0	0	0	0	0	0

Table I represents the results of the Canadian Basic Skills Test grade eight level given to the five sections of Science 203 students involved in the study. The percentage distribution shows that the majority of the students rank at grade eight and below. This is considerably lower than the grade eleven academic students.

TABLE II

RESULTS OF CBST MATHEMATICS TEST

GRADE TEN AND ELEVEN 1974-75

GRADE RANKING

	Percent of Population			
Grade Rank	X Course 100 N = 58 %	X Course 101 N = 42 %	X Course 103 N = 53 %	XI Course 203 N = 84 %
4	0	0	1.8	0
5	0	0	18.8	0
6	0	12.5	35.8	9.5
7	6.4	18.6	18.8	23.8
8	22.0	25.0	13.2	33.3
9	38.4	32.2	11.3	26.2
10	25.6	10.1	0	7.1
11	5.3	2.0	0	0
12	3.1	0	0	0

Table II represents the results of the Canadian Basic Skills Test given to Grade X Academic classes, Grade X Vocational classes, and to the Grade XI Vocational classes involved in the study. Approximately sixty percent of the Grade XI students tested are the same students that appeared on the Grade X Vocational column. It can be seen that the Grade XI Vocational students have made some gains but still place considerably lower than the Academic students in Grade X.

TABLE III

SUMMARY OF SEQUENTIAL TEST OF EDUCATIONAL

PROGRESS (STEP READING TEST)

GRADE X SEPTEMBER 1975

	Number of Students	
Percentile Rank	Academic 100 & 101 N = 72	Vocational 103 N = 52
0 - 10	5	19
11 - 20	13	15
21 - 30	10	12
31 - 40	8	5
41 - 50	4	4
51 - 60	13	1
61 - 70	6	1
71 - 80	5	3
81 - 90	6	2
91 - 100	4	0

* Refer to explanation on the following page.

* Table III represents the summary of the STEP reading test administered to a sample of academic and vocational students at Kildonan East Regional Secondary School in September of 1975. As can be seen from the table, eighty-five percent of the sample of vocational students are below the thirtieth percentile rank which is significantly lower than the academic students.

The best overall description is perhaps given by Burrichter and Ulmer (1972) in their pamphlet dealing with "Special Techniques that Work in Teaching the Culturally Deprived". Their definition of such a person is:

> The culturally deprived person is one who has had virtually no alternatives made available to him by the total society which brought about his birth and nurtured him to the point at which the professional comes in contact with him. The point of contact can be the elementary school or any point beyond through to the adult programs. He is the person who has never really felt OK as a human being and is generally going to spend the rest of his life trying desperately to search out and find persons, situations and values through which he can be somehow recognized as having status as a human being.

Summary of Tables

The three tables present an unfavourable academic profile of the student. The age range of the population is from a minimum of sixteen years to a maximum of twenty years. Their mathematical and literary skills are generally those of a thirteen to fifteen year old.

Student Needs

To attain a relevancy of the science course to the vocational areas and to establish the student needs in those areas the vocational instructors at KERSS were approached. Based upon the information gathered from the vocational instructors, a matrix was then constructed of general and specific concepts as related to each of ten vocational areas. This matrix of concepts we then presented to each vocational instructor in individual conferences where it was compared to their instructional objectives and modified accordingly. The sum total of information on the matrix was then allocated to the three vocational science courses (103, 203, 303) according to student ability and vocational course timing requirement. These three course outlines were again submitted to the vocational instructors for final modification and approval.

General Course Criteria

It became very apparent that the course must rely heavily on laboratory work. It has to create an atmosphere that is similar to that of the vocational areas; that is, the student is required to perform manipulative tasks that provide immediate feedback. It was concluded that the course should be developed in accordance with the following:

1. The laboratory activities will generally be limited to single step activities with a single objective. The activities have immediate and practical results.

2. The laboratory activities will stress:

   a) group responsibilities,
   b) time deadlines,
   c) organization,
   d) safety, and
   e) opportunity for self-initiated activities.

3. The laboratory activities will provide students with opportunities to practice their manipulative skills.

4. The course will stress practical mathematical manipulation and will include a considerable amount of practical science mathematics designed to give quick and practical results. The mathematics will be supported by the use of electronic pocket calculators. The calculators have been in use at KERSS for three school years. It was found that the calculators greatly accelerate the rate at which the student can work and learn science concepts that involve mathematical interpretation. A side benefit that appeared after using calculators is that students were starting to learn and interpret mathematical operations. Apparently, previous to their use of the calculators,

they became so bogged down in arithmetic calculations that they were often unable to achieve their real objective.

These findings are supported by the National Association of Teachers of Mathematics (1974) NCTM which has studied the calculator situation for many years. The following NCTM position statement accompanied the formal endorsement:

> With the decrease in cost of the mini-calculator, its accessibility to students at all levels is increasing rapidly. Mathematics teachers should recognize the potential contribution of this calculator as a valuable instructional aid. In the classroom, the mini-calculator should be used in imaginative ways to reinforce learning and to motivate the learner as he becomes proficient in mathematics.
>
> Jon L. Higgins, an associate professor of mathematics education at The Ohio State University, wrote in an issue of an NASSP Curriculum Report (October 1974):
>
> "Teachers would be well-advised to begin experimental classwork with pocket calculators, focusing on their use as a basic tool in successful problem solving.
>
> Concurrently, school administrators and other decision makers should make funds available for the purchase of such equipment for classroom use, for the calculator must be viewed not as a technological curiosity but as an essential implement in the newest mathematics."

Donald R. Quinn (1976) summarizes the above statements with the following:

> Calculator research completed to date would seem to suggest that students:
>
> a) learn to operate calculators easily at almost any grade level,
> b) compute better with calculators than without,
> c) are able to tackle more "real-life" problems,
> d) suffer no loss in paper-and-pencil computational ability, and
> e) enjoy using calculators.

5. The laboratory activities will require simple and accurate written reports.

6. Evaluation will be based on:

   a) Practical laboratory tests,
   b) Frequent specific task quizzes based on one or two days work,
   c) Periodic single concept tests,
   d) Laboratory credits,
      1) completing a laboratory exercise,
      2) completing a written report,
      3) completing the above work within a given time limit,
   e) Subjective evaluation of work,
      1) work habits,
      2) subjective evaluation of cooperation with peers,
      3) special credit for self-initiated laboratory projects.

Criteria for Content Selection

After listing the characteristics of the typical Kildonan East Vocational Student and identifying the general strategy of the course, the following content criteria was set up to satisfy the previously stated requirements:

a) provide a continuance to the 103 course,

b) ensure a high degree of student motivation,

c) ensure a high degree of student success,

d) ensure a high degree of student participation,

e) provide training in the scientific method,

f) improve the general scientific literacy,

g) support the students' vocational training, and

h) increase the use of mathematics in everyday life.

The selected content appears in Table IV.

TABLE IV

COURSE OUTLINE INDUSTRIAL SCIENCE 203

KILDONAN EAST REGIONAL SECONDARY SCHOOL

Physics	Mathematics	Chemistry
Speed	Measurement	Acids & Bases
Velocity	- Short time intervals	- Indicators
Color	- Long time intervals	- Strength
Mirrors	- Distance	- Neutralization
Lenses	Trigonometry	Electrochemistry
	- Right triangle	- Chemical cells
	Graphing	- Storage cells
		- Plating Process

Table IV is the general course outline for Industrial Science 203 as developed at Kildonan East Regional Secondary School.

Intended Learning Outcomes

The pattern that was employed to write the intended learning outcomes is suggested by Gronlund (1970). The pattern moves from a general instructional objective to specific measurable learning outcomes. Twenty-eight general instructional objectives were set out. These were subdivided into 143 specific learning outcomes each of which is easily measured by a laboratory test or written test. The instructional objectives and specific learning outcomes are shown in Appendix A.

Laboratory Exercises

The laboratory exercises appear in Appendix B. The exercises were written with particular attention to the strategy objectives. They are single objective activities giving direct results. Eighty-five of the specific learning outcomes are satisfied by the students' participation in the laboratory exercises. The majority of the remainder are attained by the students' conclusions and observations resulting from the exercises.

Each content section is preceded by a list of activities and their combined purpose. The format that is employed gives each exercise a purpose--a list of necessary material, a general design explanation, a data collection device and a conclusion.

The exercises are not intended as student handouts but as teacher guides.

Implementation

Once the course materials had been developed the course was implemented. The following instructional design was developed for the implementation in accordance with the suggestions by Doll and Levine (1972).

i) Rationale of the Topic

The student must be convinced that the topic has a practical value in life and is related to his vocational area. This can be accomplished through a combination of teacher lecture, demonstrations and general class discussion. The students are then given a plan of sub-topics and their investigations covering the concept.

ii) Pre Laboratory

The teacher, through lecture and demonstration, describes the laboratory activity and particularly stresses safety. The next step is to have the student establish the purpose of the laboratory in his own words. At this time, the student can proceed with the writing of purpose, data and calculations. Under data, the student should organize data columns or questions posed by the laboratory. He should not be allowed to set up equipment before this is done.

iii) Laboratory Activity

Students should work in pairs of their own choice. Safety and consideration for others must be stressed at all times. The teacher must be a constant source of praise and friendly criticism. Most important, the teacher must be a fountain of genuine encouragement for good observations and variations. If the students discover side-effects of experiments, they should be encouraged to examine them by their own designs. Many of the experiments, by design, require a considerable amount of calculations.

To retain the students' concentration on the purpose, the calculators are appropriate at this point. They are an invaluable aid to them in the manipulation of data because they allow students to take and treat considerably more data than was previously possible.

On completion of the experiment, students must clean all apparatus and their work area. Their apparatus should be returned by them to its point of origin. Damaged apparatus should be turned in to the teacher with a short report on the cause of damage. No threats or penalties should accompany average accidental damage.

iv) Post Laboratory

Students should be encouraged to write their own conclusions in line with the initial purpose of the activity. Wherever possible, class data should be collected and summarized by the teacher. The students can then make modifications to their individual conclusions. Written laboratory reports are handed in at this point. The teacher must carefully scrutinize and comment on the quality of English usage in the reports. This must be done in a positive manner.

v) Drill on the Theory Covered by the Laboratory

The laboratories are followed up by extensive drill in the form of verbal question and answer sessions, brief notes supplied by the teacher, and student worksheets, when feasable.

vi) Quiz on Theory

If the theory lends itself to a short quiz, it should be given at this point. The quiz must allow the student a great deal of success. This reward aspect of the quiz will greatly enhance student morale and confidence. The quiz should be unannounced, short, and come at the end of intense student work. An additional side benefit is improved attendance if the quizzes are frequent and unannounced. Students who miss a quiz should not be allowed to write it.

vii) Repeat of Sequence

To keep student interest and motivation high, the above sequence can be repeated in a cycle of approximately three hours of class time, or approximately three days in the semester system.

viii) Summary of Activities

At the end of a series of investigations and activities on a concept, the teacher supplies a summary. The summary is based on the initial plans formed during the rationale discussion. The teacher should solicit the information from the students by asking them to look back at the investigations and restate the conclusions in their own words. This should be followed by a pre-test exercise highlighting the desired learning outcomes of the section. Because of the students' difficulty with mathematics, as stated in the course objectives, mathematical manipulations should be stressed wherever appropriate. Lengthy and/or complex arithmetic manipulation can be supported by the use of electronic calculators. The calculators greatly increase the scope of the exercises and also allow the students to work with realistic data and examples relevant to their shop area.

ix) Testing

The major test on the section must resemble the pretest activity very closely. The test should contain enough simple items to allow any student a good chance at a passing grade, if he has participated. The test may be a practical laboratory test with a written report, a written test, or a combination of both. If the students are allowed to use their notes and laboratory books, their attitude towards the tests improves and also encourages them to maintain notebooks and labs that they can interpret. Evaluation samples are presented in Appendix G.

x) Use of Assignments

The traditional concept of homework seemed to have very little meaning to the students. Invariably, teachers would find that the assignments were not completed. In fact their efforts seemed to meet almost obstinate resistance. On informally questioning the students, a variety of reasons became apparent. Many students do not have a home environment condusive to school work. Many students rely on after school or night work for their income and most students had acquired the habit of not doing any work at home.

A questionaire incorporating the most frequent responses was administered to 109 "03" students (see Appendix E). The following data was obtained from the questionaire:

1. Thirteen do the required homework,
2. Forty-two have a home environment not condusive to school work,
3. Sixty-five work after school,
4. Twenty-one depend on their after school work for their livelihood,
5. Fifty-eight have not done any significant amount of homework in the last four years.

It appears that class time must be allotted if assignments are given to the students.

xi) General Classroom Management

Teacher talk must be kept to a minimum. The listening span of the student is generally very short. Hand outs that contain notes or laboratory activities are usually not effective. Many of the students have difficulty reading and interpreting. An alternative approach is to explain the necessary item in short parcels, ask the student to paraphrase what was said, and then the teacher records the student's words. The student then in turn copies the notes and instructions into his notebook. This procedure maintains student involvement especially if the session is rapid fire and kept short.

A great deal of time is spent on mathematical problem solving. The following routine has been found successful:

1. Set a simple verbal problem dealing with the proportions involved.

2. Attach symbols to the variables and have the students redo problems employing the variables.

3. Follow up the problem with the solutions.

4. Set written problems one at a time, have the students attempt to solve the problems.

5. Take up the problems one at a time.

6. Supply the students with a problem lab that contains a majority of problems that were covered. To challenge the students include several

examples that do not follow the pattern. These should be placed at the end of the problem laboratory.

7. The students work should be collected on completion and credited to his evaluation.

Congruency of Industrial Science 203 with General Course Criteria and Literature

To demonstrate the congruency the section on time and distance was selected as a sample. The section consists of the following laboratory exercises: (see Appendix G)

i) Estimation of time using the senses,
ii) Precise measurement of time using clocks,
iii) Precise measurement of time using stroboscopes,
iv) Application of the stroboscope to practical situations,
v) Comparison of direct distance measurement to calculation of distances,
vi) Calculation of large distances using trigonometry,
vii) Application of the concepts of measured time and distance to compute average speed.

An examination of the listed exercises will show that the activities follow the outlined criteria listed below:

i) The activities are limited to single objectives,
ii) They require group cooperation,
iii) They give the students opportunity to practice their manipulative skills,
iv) They stress practical mathematical manipulation,
v) They involve the vocational activities of the student,
vi) They provide ample opportunity for involvement and success,
vii) The skills involved will have a practical value to the student,
viii) They have a high motivational value to the student,
ix) Their implementation provides the necessary structure to give the student security.

Summary

Chapter III describes a student that has little interest in academic content and has not experienced much success in the schools he has attended. If he were given a choice by society he would withdraw from formal education.

To satisfy the needs of this individual an industrial science course was constructed. The science course should support and reinforce the vocational area. The content it offers should be practical and contain single step objectives that are similar to those of the vocational areas.

The student responds well to a structured setting. To implement the course, a routine incorporating a content structure, an evaluation program, and mathematical manipulation of data in a laboratory setting was created. The routine was designed to give the student a maximum opportunity at success and security.

CHAPTER IV

EVALUATION DESIGN

The Problem

This study had three components: course development, course implementation and course evaluation.

The course development and implementation was described in Chapter III. The course evaluation may be stated in the form of three hypothesis:

i) The semester end achievement test will show that ninety percent of the students in the sample will score fifty percent* or better.

ii) Achievement tests administered periodically throughout the semester will show that more than ninety percent of the students in the sample will score fifty percent or better.

iii) Pretest and posttest scores on the Purdue Master Attitude Scale will show no significant change in the students attitude toward science 203 when compared to attitude towards science 103.

Description of Population and Sample

On the average Kildonan East offers three sections of science 203 each academic year: two in one semester and the third in the second semester or vice versa depending on demand. The students are drawn from

* The fifty percent criteria is based on the traditional pass mark of fifty percent employed by Kildonan East, and is a standard that is recognized by the Department of Education of Manitoba.

ten different vocational areas and are assigned to each section according to time table requirements.

This study deals with three classes that were processed in the spring semester of the 74-75 academic year and two classes from the fall semester of the 75-76 academic year. The five classes were assigned to three different instructors. The classes had the following population:

Group I - seventeen,
Group II - eighteen,
Group III - fifteen,
Group IV - twenty-two, and
Group V - seventeen.
The total population of the sample was eighty-nine.

Experimental Procedure

i) Achievement at the end of each semester was measured by a twenty-eight item test prepared by the writer. (see Appendix C)

The format of the test is similar to the format employed by the instructors during the semesters. Content validity was verified by consulting with the three instructors involved in the study.

The test was intended for an eighty minute class period and includes the specific learning outcomes that could be measured by a written test.

The test has a long answer format consistent with the instructional design. Each problem on the test was assigned a value according to the number of specific learning outcomes it encompassed. Each learning outcome carried a value of one.

The reading level of the test was measured by the reading specialist at Kildonan East who ranked the test at approximately the grade eight level using the Cloze technique.

ii) Student achievement during the semester was measured by teacher-made written tests, practical exercises, and laboratory records.

iii) The Purdue Master attitude scale Form A was used for both pretest and posttest.

The Purdue scale was used in order to provide compatability of results with a study completed by E. C. Buller in 1975. At the time of implementation of Industrial Science 103, 203, and 303 a search was made for an effective Attitude Scale. At that time the science department made a decision to employ Form A of the Purdue Master Attitude Scale at all levels. The form was chosen for its simplicity and reliability in scoring and its readability. (see Appendix D)

Statistical Procedures

i) Each specific learning outcome included in the achievement test carries a value of one. The breakdown is shown in the key in Appendix C. Each test received a score out of a possible mark of sixty-four. The scores were then converted to percentage marks, and the number of students that scored fifty percent or better was determined. The results of the test were then summarized by calculating standard deviation arithmetic mean and preparing a graphical plot of the mark distribution. This was done for each section and then repeated for the total sample.

ii) Student achievement during the semesters was recorded by tabulating the teachers test marks, laboratory marks, and final mark. The final mark is a cumulative record of all quizzes and achievement tests administered by the teachers. Achievement of specific learning outcomes that cannot be measured by written tests are reflected by the laboratory marks reported by the teacher. These marks were based on laboratory procedures and practical tests administered by the teacher.

iii) The Purdue Master Attitude Scales were scored using the weighted scale published by Remmers. The scale appears in Appendix F. The score of each pretest and posttest was tabulated by section and the arithmetic mean calculated. To provide an overview a graphical plot of the distribution of the scores of each section and the total sample was prepared.

To determine the significance of any change in the means the "t" test for dependent samples was applied to the pretest and posttest scores of each section. All graphical plots and statistical data appear in Chapter V.

CHAPTER V

DATA AND ANALYSIS OF DATA

Identification of Statistical Grouping

The population of this study consisted of eighty-nine students divided into five class groups. For the purpose of this study the groups are referred to as groups I, II, III, IV and V. The five groups received instruction from three different teachers. For the purpose of this study the teachers are referred to as teachers A, B and C. Teacher A instructed groups I and IV, teacher B group II and teacher C groups III and V. Groups I, II and III received their instruction during the spring semester of 1975 and groups IV and V were processed in the first semester of the 75 - 76 school year.

Data and Analysis

This section presents the statistical data and the consequent analysis. This data and analysis is organized in the following manner:

i) Tables V to VII and Figures V and VI refer to the semester end achievement tests.

ii) Tables VIII and IX refer to laboratory scores reported by the teachers.

iii) Tables X and XI refer to cumulative test and quiz marks reported by the teachers.

iv) Tables XII and XIII refer to final grades reported by the teachers. The final grades are composite marks reflecting the students' scores on teacher tests, laboratory marks and the semester end achievement test. The final marks were arrived at by the teachers using the following formula:

> Fifty percent of test mark average plus forty percent of laboratory mark average plus ten percent attitude mark given at the teacher's discression equals final year mark.
>
> Seventy-five percent of year mark plus twenty-five percent of semester end achievement test equals final grade.

v) Table IV and Figure VII refer to the results of the attitude tests.

vi) Tables pertaining to the individual scores of students on achievement and attitude tests are presented in Appendix H.

(Refer to following Tables)

TABLE V

SEMESTER END ACHIEVEMENT TEST SUMMARY

AND PERCENTAGE OF STUDENTS

SCORING MORE THAN FIFTY PERCENT

	Number of Students	Percent of N
Group I n = 15	14	93.33
Group II n = 17	17	100.00
Group III n = 13	12	92.31
Group IV n = 22	18	81.82
Group V n = 17	16	94.12
Total Sample n = 84	77	91.67

Table V indicates that 91.67% of all students scored fifty percent or higher on the semester end achievement test.

TABLE VI

SEMESTER END ACHIEVEMENT TEST SUMMARY

MEAN AND STANDARD DEVIATION

OF PERCENT SCORE

	Group I	Group II	Group III	Group IV	Group V	Total Sample
Mean	72.00	60.67	71.15	68.50	73.40	68.71
Standard Deviation	15.32	8.20	18.85	17.60	15.39	14.92

Table VI represents the arithmetic mean and the standard deviation of each group and of the total sample in the semester end achievement test. The mean of Group II is slightly lower but is still within one standard deviation of the other means.

FIGURE V Graphical Distribution of Semester End Achievement Test Marks

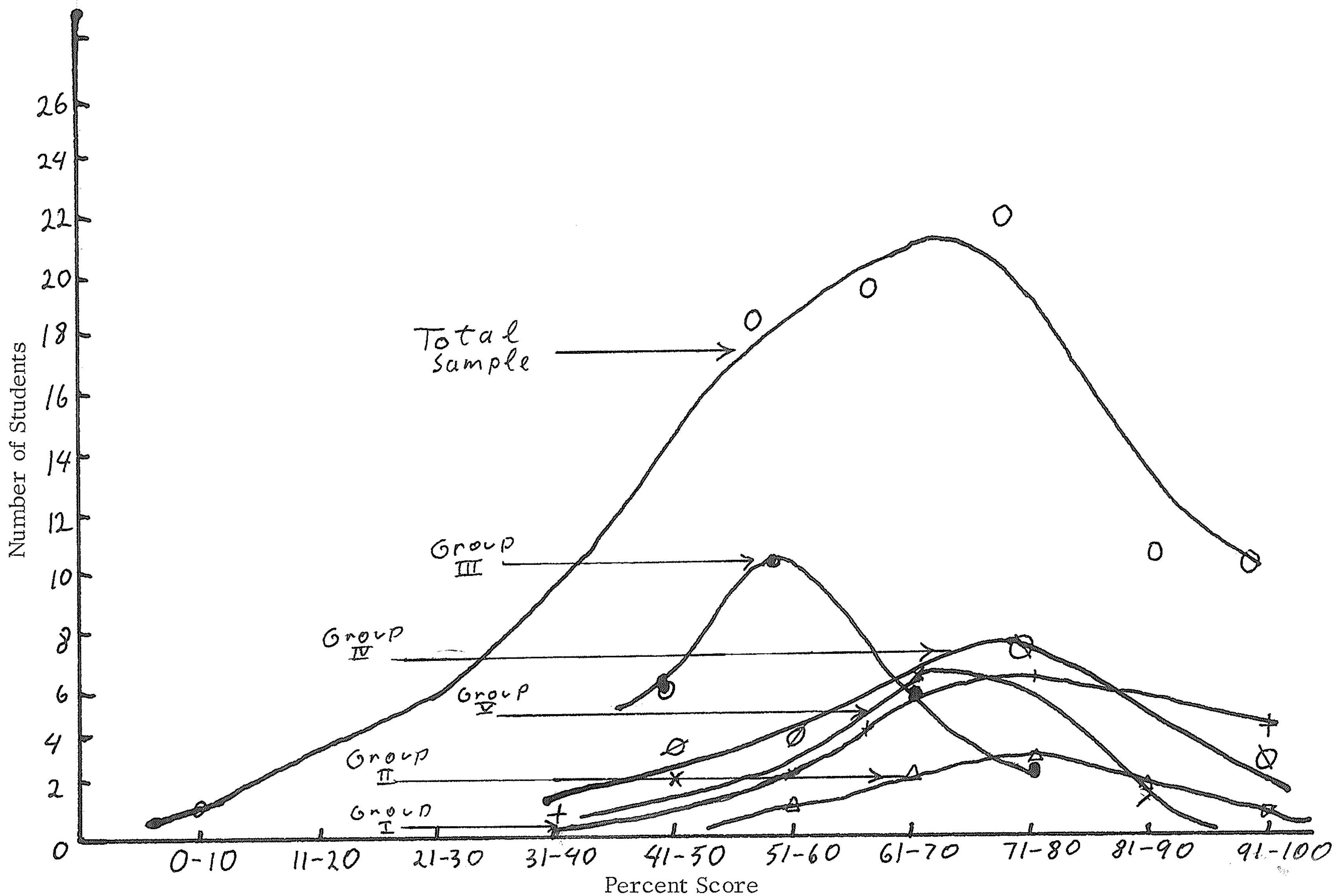


TABLE VII

ITEM ANALYSIS OF SEMESTER END

ACHIEVEMENT TEST

Item Number	Percent of Students with Correct Answer n = 84	Item Number	Percent of Students with Correct Answer n = 84
1	72	15	86
2	53	16	78
3	61	17	51
4	79	18	53
5	68	19	52
6	96	20	68
7	95	21	69
8	96	22	76
9	80	23	91
10	89	24	51
11	69	25	76
12	92	26	45
13	72	27	38
14	82	28	81

Table VII indicates that 92.85% of the test items were answered correctly by fifty percent or more of the total population. Some difficulty appears on items seventeen to nineteen. These items deal with solutions and molarity. A reorganization of these sections seems indicated. Another area of difficulty appeared in items twenty six and twenty seven. These items deal with chemical formulas of products in electrochemical cells. The low success on these items indicates that the emphasis on formulas of products should be decreased.

FIGURE VI Graph of Percent of Students Having Correct Responses Against Item Number of Semester End Achievement Test

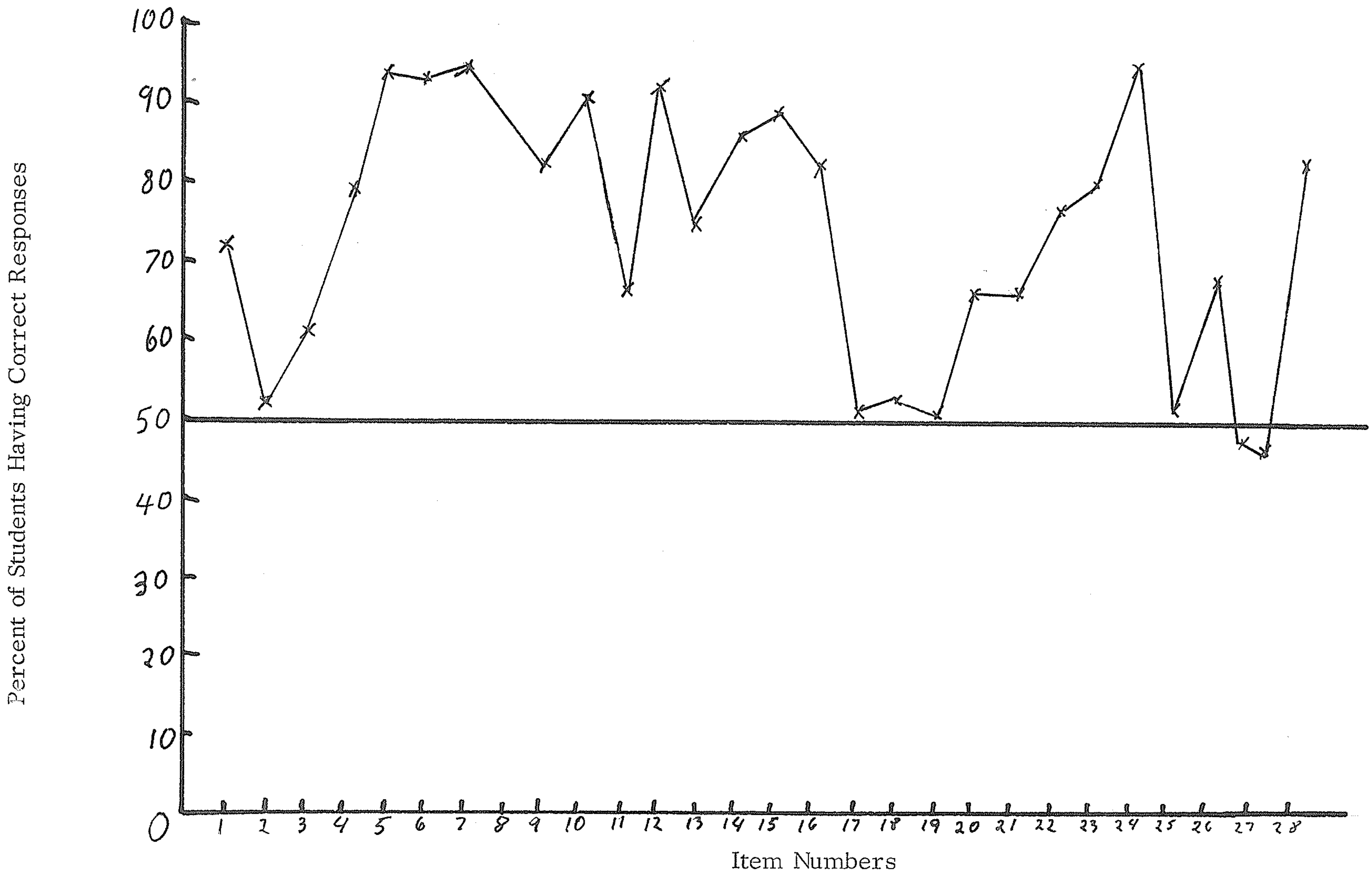


TABLE VIII

TEACHER LABORATORY MARK SUMMARY

AND PERCENT OF STUDENTS

SCORING MORE THAN FIFTY PERCENT

	Number of Students	Percent of N
Group I n = 15	15	100.00
Group II n = 18	18	100.00
Group III n = 13	11	84.61
Group IV n = 22	22	100.00
Group V n = 17	16	94.11
Total Sample n = 85	82	97.64

Table VIII shows that 97.64% of the students scored fifty percent or more in their laboratory exercises.

TABLE IX

SUMMARY OF TEACHER LABORATORY MARKS MEANS AND STANDARD DEVIATION

	Group I	Group II	Group III	Group IV	Group V	Total Sample
Mean	78.81	79.94	64.85	73.32	62.94	72.32
Standard Deviation	11.42	9.68	12.43	10.12	11.02	12.58

Table IX represents the arithmetic mean and standard deviation of each group and of the total sample. Group III and Group V have a considerably lower mean as compared to the other groups. Groups III and V both received their instruction from teacher C. Teacher C was a first year instructor at the time and had difficulty with the organizational aspects of the course routines. As stated in the review of literature, this type of student requires a high degree of structure to function successfully.

TABLE X

TEACHER TEST MARK SUMMARY AND PERCENT

OF STUDENTS SCORING MORE THAN FIFTY PERCENT

	Number of Students	Percent of N
Group I n = 15	15	100.00
Group II n = 18	17	94.44
Group III n = 13	12	92.31
Group IV n = 22	21	95.45
Group V n = 17	17	100.00
Total Sample n = 85	82	96.47

Table X shows that 96.47% of the students in the sample scored more than fifty percent on the teacher-made tests.

TABLE XI

SUMMARY OF TEACHER TEST MARKS

MEANS AND STANDARD DEVIATION

	Group I	Group II	Group III	Group IV	Group V	Total Sample
Mean	77.20	60.38	73.00	74.00	77.30	72.21
Standard Deviation	8.02	9.07	14.15	11.22	12.04	12.56

Table XI represents the arithmetic mean and standard deviation of each group and the total sample. With the exception of Group II the means are fairly uniform. The mean of Group II is about one standard deviation lower than the other means. Group II was instructed by teacher B. A similar deviation of Group II occurred in the means of the Semester End Achievement Test. Teacher B seems to have placed more emphasis on the laboratory aspects of the course.

TABLE XII

FINAL MARK SUMMARY AND PERCENT OF STUDENTS SCORING MORE THAN FIFTY PERCENT

	Number of Students	Percent of N
Group I n = 15	14	93.33
Group II n = 18	18	100.00
Group III n = 13	12	92.30
Group IV n = 22	21	95.45
Group V n = 17	17	100.00
Total Sample n = 85	82	96.47

Table XII shows that 96.47% of the students scored more than fifty percent on the final grades assigned by the instructors.

TABLE XIII

SUMMARY OF FINAL COURSE MARKS

MEANS AND STANDARD DEVIATION

	Group I	Group II	Group III	Group IV	Group V	Total Sample
Means	73.60	73.30	67.15	73.39	70.35	70.39
Standard Deviation	11.70	8.51	10.28	12.32	9.34	10.63

Table XIII represents the arithmetic mean and the standard deviation of each group and of the total sample. All means and standard deviations are clustered around the same value, indicating very uniform final evaluation by all instructors.

TABLE XIV

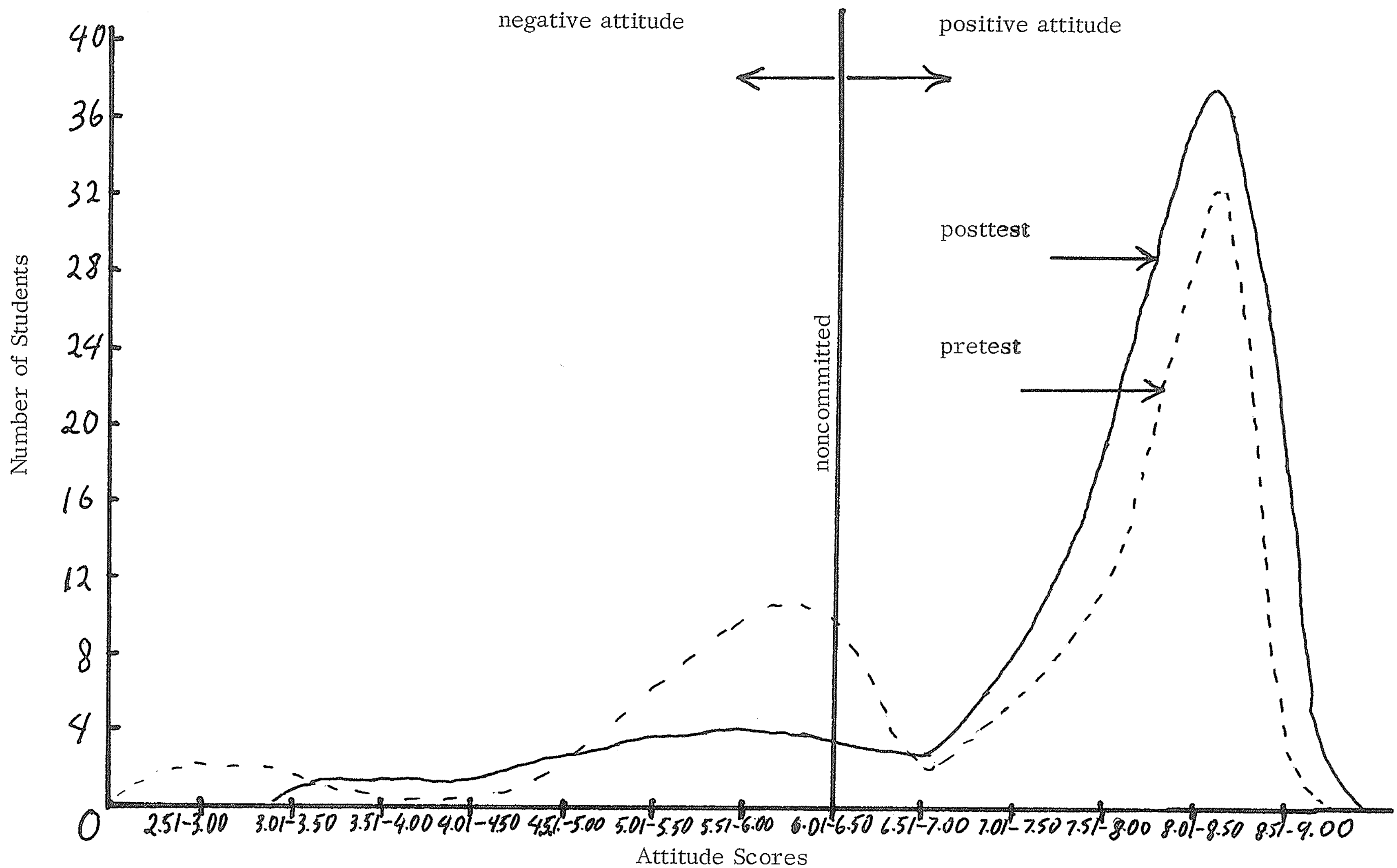
SUMMARY OF PRETEST AND POSTTEST SCORES

PURDUE MASTER ATTITUDE SCALES

	Group I	Group II	Group III	Group IV	Group V	Total Population
Pretest Mean	7.91	6.65	6.71	7.44	6.78	7.11
Posttest Mean	7.96	7.27	6.43	7.78	7.50	7.47
T-Test for Significance at .05 level	-0.19	-1.35	0.51	-1.00	-1.44	-1.80

Table XIV represents the pretest and posttest means of the Purdue Master Attitude scales Form A and the T .05 values for the difference in means. All groups with the exception of Group III showed an increase in the value of the means. The T value of all groups showed no significant change in means. However, the change in means for the total sample has T = -1.80 which indicates a significant change at the T .05 level. To summarize, the individual groups made no significant gains in attitude, but the means of the total sample indicate a significant positive gain in attitude of the population in question.

FIGURE VII Graphical Distribution of Pretest and Posttest Scores, Purdue Master Attitude Scale



CHAPTER VI

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Purpose of the Study

The purpose of this study was:

i) To trace the development of Industrial Science 203 by describing the specific steps taken in constructing this curriculum.

ii) To describe the techniques developed to implement this curriculum.

iii) To evaluate the effectiveness of Industrial Science 203.

Course development and teaching techniques were dealt with descriptively and are presented in Chapter III. Course evaluation was treated statistically and are presented in Chapter V.

Hypotheses

The course evaluation was stated in the form of three hypotheses:

i) The semester end achievement test will show that ninety percent of the students in the sample will score fifty percent or better.

ii) Achievement tests administered periodically throughout the semester will show that more than ninety percent of the students in the sample will score fifty percent or better.

iii) Pretest and Posttest scores on the Purdue Master Attitude Scale will show no significant change in the students attitude toward Science 203 when compared to attitude toward Science 103.

Conclusions and Discussions

General Conclusion

i) More than ninety percent of the students in the sample scored fifty percent or better in the semester end achievement test.

ii) More than ninety percent of the students in the sample scored fifty percent or better on achievement tests administered periodically throughout the semester.

iii) The means of the attitude tests for the individual groups showed no significant change in attitude of the students toward Science 203 when compared to their attitudes toward Science 103. However, the means of the total sample showed a significant increase in positive attitude at the 0.05 level of significance. The hypothesis is therefore rejected and it is concluded that there was an increase in positive attitude for the total sample.

The analysis of all student achievement data both formative and summative, suggests that all tasks were accomplished at a much higher level than the traditional fifty percent "pass mark".

Other indicators of the effectiveness of the Industrial Science 203 course that were not considered in this study are the retention of students in this course and, secondly, the number of students registering in the course. As was mentioned in the review of literature, the dropout rate for this type of student population is high. Previous to the implementation of the new Industrial

Science courses the dropout rate was fifteen to twenty percent. The sample in this study showed a dropout rate of less than ten percent. Also, the number of students opting for the course is increasing at a higher rate than the student population is increasing. In the 74-75 school year, four class sections of Science 203, totalling approximately seventy students, were offered. In the current 75-76 school year, five class sections totalling over ninety students were offered.

The analysis of the attitude data shows that the positive attitude that the students in the sample had attained in the Industrial Science 103 Course was maintained in the Industrial Science 203 Course. The combined data of the total sample suggests that the positive attitude was not only maintained but also that it was significantly increased.

It appears, therefore, that the Industrial Science 203 Course as taught at Kildonan East Regional Secondary School provided an effective and satisfying continuation for the students of the Industrial Science Course.

Summary

Industrial Science 203 is a course specifically designed for vocational students in their second year of vocational education. This study indicates that the course is successful in accomplishing its stated aims. The success of this course can be partially attributed to the use of realistic and concise behavioural objectives. These objectives clearly communicate to the teacher, and thereby to the student, what is to be done and what is expected. Other factors such as its high degree of structure, its practical nature and its limited dependancy on the student's literary and mathematical abilities contributed to student success. The student's success in achieving the objectives and the rewards associated in achieving them, brought about an increase in positive attitude.

The study also raises several questions. The Purdue Master Attitude Test does not take into account the school atmosphere nor the teacher attitude towards the students.

A question that poses itself - is just how much effect did the teacher attitude have? Was the teacher attitude influenced by working with realistically prepared behavioural objectives instead of a traditional content outline? A second question that might be asked is - would the described principles and techniques work just as well in a different school? Answers to these questions would contribute greatly in preparing curriculum for the students described in this study.

Suggestions for Future Curriculum Development

Although science is an optional course at KERSS there is considerable demand for a science course at the 303 level. A course has been developed along similar lines to the 103 and 203 but with a much stronger emphasis on mathematics. It would be beneficial to the teachers and students if a similar study were carried out in evaluating the effectiveness of Industrial Science 303.

During the course of this study and the study completed by E. C. Buller (1975) it was noted that the students work well if the goals are short term and are orientated towards a single concept. In other words, if the students can see a tangible goal and reward in the near future their willingness to work towards it increases. Curriculum developed to take advantage of this fact could take the form of self-contained modules that do not require the long term commitment from the student that present courses do. This study has already influenced plans to modularize the science program at KERSS. Starting with the Fall Semester of 1976 some introductory work will be done by the science department in implementing a modular program. The modules will be designed in accordance with the student requirements and characteristics set out in this paper. A study monitoring the implementation and comparing the effectiveness of a modular approach to the traditional could considerable increase the scope of science education for these students.

A third area touched on by this study is the use of electronic calculators to support science courses. Very little work has been done in this area of science curriculum development. As stated by Donald R. Quinn, (1976):

> Although I recognize this need for computational proficiency perhaps the more pragmatic issue is the method of computing -- paper and pencil vs. calculator. Speed, accuracy, and understanding, particularly at the market place, are desireable characteristics.

The electronic calculators were used during the course of this study but no efforts were made to quantitatively study the effects of their use. Qualitative effects that were noted in this paper require detailed study. There is no doubt, however, that a science curriculum designed to incorporate the calculator is effective.

BIBLIOGRAPHY

Buller, E.C. Development and Evaluation of Vocational Science 103, Thesis presented to Faculty of Graduate Studies, University of Manitoba. 1975

Burrichter, A.W. and Ulmer, C. Special Techniques that Work in Teaching the Culturally Deprived. Prentic Hall, Inc., 1972 Englewood Cliffs, New Jersey. (Page 185)

Bybee, R.W. Personalizing Science Teaching. N S T A Publication 1974

Canadian Teacher's Federation. The Poor at School in Canada Canadian Teachers Federation Publication, Revised Edition 1972

Cooke, Lloyd M. Science for the Disadvantaged Student, Problems and Opportunities. Address to the Third General Session, Los Angeles, NSTA, 1975. The Science Teacher, Vol. 492, No. 5, May 1975.

CVAE Academic Curriculum Project. Evaluation Report Education Service Center Region 1, Edinburgh, Texas, 1972. (ERIC Ed. 066289)

Doll, R.C.; Levine, D.U. "Toward a Definition of Structure" in Opening Opportunities for Disadvantaged Learners. Teachers College Columbia University, New York, 1972. Pages 152-157.

Fey, J.T., Ed. Where Do You Stand? Computational Skill is Passe. The Mathematics Teacher 1974, 67-485-488

Freeman, Jeanne. A Burkean Analysis of the Classroom. 1974. Eric Cat. No. Ed. 094-494

Goldman, Harvey. "The Nature of Curricular Relevance" Leeper, R.R. Curricular Concerns in a Revolutionary Era. P. 112

Gronlund, Norman E. Stating Behavioural Objectives for Classroom Instruction. Collier Macmillan, London, 1970. P. 7

Halsey, A.H. (Ed.) Educational Priority. Her Majesties Stationarers Office, London, 1972.

Hurd, Paul D. Science Technology and Society - New Goals for Interdisciplinary Science Teaching. The Science Teacher Volume 42, No. 2, 1975.

Huston, Peter H. A Study of Value Orientation as a Characteristic of Secondary School Students and Teachers. Journal of Research in Science Teaching.

Kelly, E.C. "The Dropout" in Leeper, R.R., Curricular Concerns in a Revolutionary Era, Readings from Educational Leadership Association for Supervision and Curriculum Development, 1971. Page 147.

Mager, R.F. Preparing Instructional Objectives. Fearon Publishers Lear Siegler Inc., Belmont, California, 1969.

Mager, R.F. and Beach, K.M. Developing Vocational Instruction Fearon Publishers/Lear Siegler Inc., Belmont, Calif. 1967. Page 39

Mager, R.F. and Beach, K.M. Developing Attitude Toward Learning Fearon Publishers/Lear Siegler Inc., Belmont, Calif. 1968. Page 69

Manitoba Teachers Society. Curriculum Development. Distributed to Winnipeg Schools by Manitoba Department of Education, 1975.

Manning, D. Toward A Humanistic Curriculum. Arizona State University Harper and Row Publishers Ind., 1971. Page 98.

Merrit, J. and Harris, A. Curriculum Design and Implementation. London Open University Press. 1972. pp. 78, 84, 107.

National Committee on Employment of Youth. A Guide to the Development of Vocational Education Programs and Services for the Disadvantaged, National Committee on Employment of Youth, New York, 1969. (Eric Ed 035-743) Page 11

Ornstein, A. C. and Vairo, P. D. (Eds) How To Teach Disadvantaged Youth. McKay, New York, 1969. Page 141

Quinn, Donald R. Calculators in the Classroom. NASSP Bulletin January 1976. Pages 77, 79.

Sayre, Steve and Ball, Daniel W. Piagetion Cognitive Development and Achievement in Science. Journal of Research in Science Teaching, Volume 12, Issue 2, 1975. John Wiley & Sons, Toronto

Scriven, M. "The Methodology of Evaluation" in Typer et al (Eds.) Perspectives of Curriculum Evaluation. Rand McNally, Chicago 1962. Pages 39-83

Springer, U. K. Recent Curriculum Developments in France, West Germany and Italy. Teachers College Press, Columbia University New York, 1969.

The National Council of Teachers of Mathematics Newsletter, Reston, Va. 1974. Pages 3, 11

Ward, Marjorie E. Cartwright, Some Contemporary Models for Curriculum Evaluation. University of Pittsburg, Pennsylvania State University, 1975. (Eric Ed. 081236)

APPENDIX A

OBJECTIVES FOR SCIENCE 203

General Instructional Objectives	Specific Learning Outcomes
Understands the measurement of time	- measures time in seconds, using eyes, ears, and touch - measures time using instruments - converts rotation units to time units - expresses long times in terms of personal experience. i.e. legal age, life time in years
Recognizes a right triangle	- draws a right triangle - identifies the hypothenuse - locates the 90° angle - measures the complementary angles correctly using a protractor
Understands the measurement	- measures distances directly using meter sticks and metric tapes
Understands the three basic trigenometric functions	- identifies the side opposite an angle - identifies the side adjacent to an angle - restates the basic functions of an angle in terms of opposite, adjacent and hypothenuse - computes the angles in a triangle given an angle and a side
Computes long distances	- lays out a line of sight to a distant object - measures a base line perpendicular to the line of sight - measures the included angle - calculates the distance to the distant object
Analyses linear motion	- measures distance and time simultaneously - computes speed - computes distance and time using distance = velocity x time

Recognizes light as the ultimate source of energy	- lists natural sources of light - lists artificial sources of light - explains the energy source of artificial light in his own words. i.e. traces the source back to the sun
Understands human vision	- differentiates between luminous objects reflection absorption
Understands color vision	- lists the three basic colors of light - identifies the complements of the basic colors - predicts the complement given any two basic colors - lists the three basic pigments - explains in his own words the subtractive reflection of colors - predicts correctly the combination of several pigments and colors
Comprehends the principles of specular reflection by a plane mirror	- locates the image in a plane mirror by the use of parallax - locates the image in a plane mirror - describes the characteristics of the image - constructs a ray diagram showing the formation of an image in a plane mirror - describes in his own words application of plane mirrors
Comprehends the principles of specular reflection by a curved mirror	- locates the focal point of a concave parabolic mirror by using a distant source and a screen - draws a ray diagram showing the formation of a focal point for different mirrors - locates the real image formed by the mirror using a screen - plots a graph relating Si and So - observes the relationship between So and virtual images - draws ray diagrams showing the formation of real images - computes the location of images using $SiSo = f^2$ - observes the virtual image formation by a convex mirror - describes in his own words practical application of curved mirrors

Demonstrates refraction in transparent solids	- traces a light path through a parallel sided block - measures the incident and refracted angle using a protractor - calculates the relative index of refraction using $\frac{\sin\theta_i}{\sin\theta_r} = n$
Knows how to calculate the index of refraction of a liquid	- traces a light path through a semi-circular transparent container - identifies incident angle and refracted angle - measures incident and refracted angles - calculates the relative index of refraction using $\frac{\sin\theta_i}{\sin\theta_r} = n$
Comprehends the use of refractive index	- predicts light paths in substances given one angle and the refractive indes - identifies materials by finding their refractive index experimentally
Understands the conditions necessary for total internal reflection	- arranges prisms to totally reflect light - lists examples of total internal reflection in every day use - traces totally reflected light paths in prisms
Comprehends the cause of refraction	- restates the definition of refraction - matches light speeds with given indecies of refraction qualitatively - draws a qualitative light path, given relative speeds of light
Recognizes lenses as refractive instruments	- traces light paths through a convex prism - identifies their intersection as focal point

Understands the principles of image formation by a lens	- locates the focal point of a convex lens using a distant source and a screen - locates the real images formed by a convex lens using a screen - plots a graph relating Si and So - states in his won words the relationship between Si and So - draws ray diagrams showing the formation of real images - observes the relationship between Si and virtual images - computes the location of images using $SiSo = f^2$ - observes the virtual images formed by a diverging lens - describes in his own words several applications of lenses - describes in his own words the operation of a complex optical instrument of his choice
Recognizes an acid or base	- identifies an acid or a base with an indicator - identifies various shop materials as acidic or basic by using indicators - recognizes pH numbers as indicating an acidic or basic condition
Understands the chemical formation of an acid	- produces several acids - recognizes the formula of an acid - recognizes the hydrogen ion in an acid formula - writes simple balanced equations describing the reactions
Understands the chemical formation of a base	- produces several simple bases - recognizes the formula of a simple base - recognizes the OH^- ion in a base formula - writes simple balanced equations describing the reactions

Comprehends the neutralization process	- performs several titrations, neutralizing an acid with a standard base - performs several titrations neutralizing a base with an acid - writes simple balanced equations describing the reactions - identifies the products of a neutralization. i.e. salt and water - finds the relative strength of acids and bases used in the vocational area by titration
Comprehends the mole concept	- calculates the molar weights of acids and bases used previously - defines molar weight in his own words - predicts weights of salt produced in a neutralization - mixes acid solutions of definate molar strength - finds the molarity of an acid by titration - finds the molarity of a base by titration - finds the molarity of several shop acids and bases
Understands the formation of ions in solution	- tests several solutions for conductivity - identifies the ions in the solutions - explains the charge of ions in his own words - identifies anode, cathode and electrolyte - explains the corresponding movement of ions in solution
Understands the plating process	- conducts several plating experiments - explains the function of anode and cathode - identifies the ions involved in the reaction - writes simple balanced half reactions - visits a local plating firm - writes a report on the processes of the plant - lists industrial application of the process - identifies occurences of the process in his vocational area

Comprehends simple voltaic cells	- constructs several voltaic cells - measures the voltage generated by the cells - identifies the ions involved in the reactions - explains the cause of the electrical energy in his own words - writes simple half reactions for the reactions - lists the commercial applications of the cells - inspects several commercial cells - identifies the components of the cells
Recognizes a battery	- constructs a battery of cells in series - measures the voltage and current of several combinations - connects the cells to several electrical implements i.e. light bulbs, small electric motors - constructs a battery of cells in parallel -measures the voltage and current supplied by the battery - connects the cells to several electrical implements - explains the advantages and disadvantages of each type of arrangement
Understands the operation of a storage cell	- constructs a lead storage cell - identifies the anode and cathode in the charging process - recognizes the operation of ions in the charging equation - identifies the products of the charging process - identifies the positive and negative poles on discharge - recognizes the movement of the ions in the discharge equation - identifies the products in the discharge process - measures the voltage of a charged cell - constructs a series and a parallel combination - measures the voltage of each combination - measures the voltage of a commercial 6V and 12V battery - finds the number of cells in each type

APPENDIX B

SECTION I

Section one contains seven investigations dealing with the concepts of time, distance, time and distance.

The section is designed to get the student out of the classroom. This allows them to apply the concepts to their vocational areas and other more practical surroundings.

Content:

Time #1: estimation of time using the senses.

Time #2: precise measurement of time using clocks.

Time #3: precise measurement of time using stroboscopes.

Time #4: applying the stroboscope to practical situations.

Distance #1: Comparison of direct distance measurement to calculation of distances.

Distance #2: Calculation of large distances using trigenometry.

Time and Distance: Applying the concepts of measured time and distance to compute average speed.

SCIENCE 203

PHYSICS | Time #2 | Instruments

PURPOSE: To measure time using extensions of senses - instruments - watches.

MATERIALS: Watch (wristwatch, room clock)
stop watches

DESIGN: Time various activities, i.e. heart beat (before and after exercise), holding breath, etc.
Pendulums of various lengths.

DATA:

Object	Trial 1	Trial 2	Trial 3	Trial 4	Average

CONCLUSION: Improvement of senses by using instruments.

SCIENCE 203

PHYSICS | Time #3 | Instruments

PURPOSE: (a) To measure frequency using light strobe (demonstration)
(b) Using hand strobe to measure frequency.

MATERIALS: Light strobe (timing light)
Rotating object with various speeds
Hand strobe

DESIGN: Demonstration and explanation using calibrated light on rotating object. Explanation of hand strobe.

DATA: Handstrobe - # of slits ______________

# of turns in 5 sec. ______________

# of glimpses in 5 sec. ______________

frequency in rps ______________

frequency in rpm ______________

period in sec. ______________

Check with light strobe to verify results

SCIENCE 203

PHYSICS | Time #4 | Instruments

PURPOSE: To measure the rotation rate of rotating devices in the shops using a hand strobe.

MATERIALS:
clock with sweep second hand or stopwatch.
hand strobe
chalk for marking
rotating mac-ines - car engine, lathe, compressor motors, fans, etc.

DESIGN: Students go to the shop areas in pairs, select an object and mark the object. The rotation is then measured using the hand strobe.

DATA:

	Trial 1	Trial 2
Number of slits open		
Number of turns in 5 seconds		
number of glimpses in 5 seconds		
frequency in rps		
period of revolution		

CONCLUSION: Statement of observation.

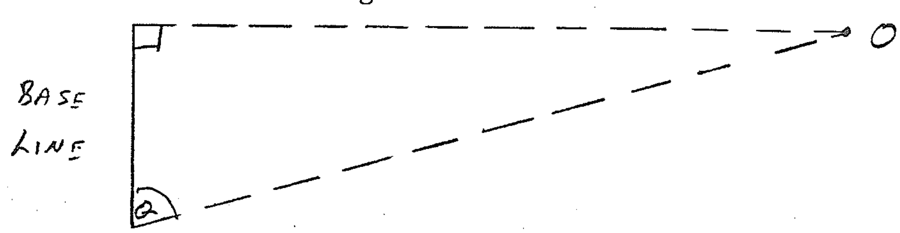
SCIENCE 203

PHYSICS | Distance #1 | Measurement

PURPOSE: (a) To measure a large distance using a meter stick (50 m)
(b) To measure a base line and angle. To calculate the measured distance.

MATERIALS: meter stick or metric tape
protractors
graph paper

DESIGN:
(a) Students measure a large distance with tape or meter sticks.
(b) Students measure a base line at 90° to the line of sight.
(c) Students measure the inclused angle between base line and line of sight.



DATA:

Measurement	=	____________	m
Base Line	=	____________	m
Angle	=	____________	o
Calculation of length		____________	m

CONCLUSION: Acomparison of two methods.

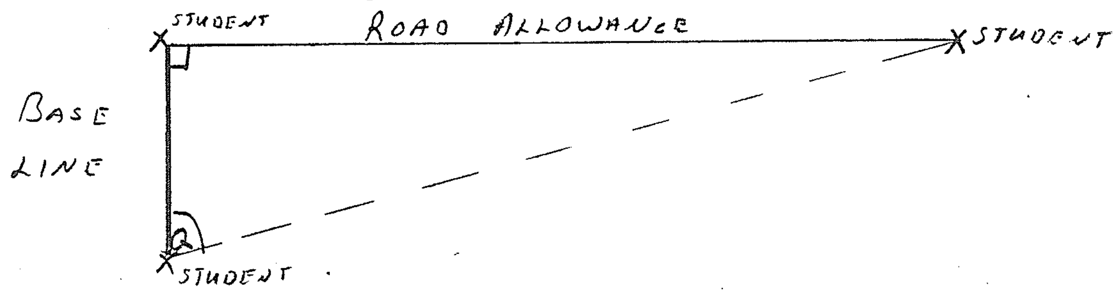
SCIENCE 203

PHYSICS | Distance #2 | Trigenometry

PURPOSE: To calculate large distances using trigenometry.

MATERIALS: a car with odometer calibrated in 1/10 kilometers or 1/10 mile.
metric tape or meter stick
protractors
graph paper

DESIGN: Students work in threes and select a distant object along a road allowance (over 300 m). Lay out a base line and measure the the included angle.



DATA:

Base line ______________ m

Angle ______________ o

Calculation of distance ______________ m

Distance measured by car ______________ m or mile

CONCLUSION: Comparison and a statement on validity of the process.

SCIENCE 203

PHYSICS | Distance & Time | Speed

PURPOSE: To compute the speed of a car or runner.

MATERIALS:
- Car or runner
- metric tape or meter sticks
- graph paper
- protractor
- stop watches

DESIGN: Student measures a large distance (500 m) and times a car for the distance. From the data, student computes the average speed.

DATA:

	Trial 1	Trial 2
Distance		
Time		
Speed		

CONCLUSION: Statement of results.

SECTION II Light & Optics

Contents:

Color #1: primary colors.

Color #2: primary colors plus their complements.

Color #3: primary pigments.

Reflection #1: location of an image in a plane mirror using parallax and lines of sight.

Reflection #2: angles of incidence and reflection.

Reflection #3: drawing of ray diagrams for images formed by a plane mirror.

Reflection #4: locating the focal point of a concave mirror.

Reflection #5: relationship of image distance and object distance for a concave mirror.

Reflection #6: relationship of image size and object distance for a concave mirror.

Refraction #1: tracing a refracted light path and measuring incident and refracted angles.

Refraction #2: tracing a light path through a prism including an internal reflection.

Refraction #3: calculating the index of refraction of a transparent solid.

Refraction #4: calculating the index of refraction of a liquid.

Refraction #5: finding the focal point of a converging lens.

Refraction #6: the relationship of image distance and object distance for a converging lens.

Refraction #7: the relationship of image size and object distance for a converging lens.

SCIENCE 203

LIGHT | COLOR #1 | Teacher Demonstration

PURPOSE: To identify the primary colors of light.

MATERIALS:
3 overhead projectors
3 cardboard blackouts with circular holes
1 primary green gelatin filter
1 primary blue gelatin filter
1 primary red gelatin filter
1 white screen
dark room

DESIGN: Each projector projects a primary color. Overlapping beams give the complements. All three overlapped gives white.

Green + Blue = cyan
Blue + Red = magenta
Red + Green = yellow

CONCLUSION: Three primary colors are red, blue, green. The additive process gives the above results.

SCIENCE 203

LIGHT | COLOR #2 | Teacher Demonstration

PURPOSE: To identify the primary colors and their complements.

MATERIALS:
2 overhead projectors
2 cardboard blackouts with circular holes
red, blue and green gelatin filters
yellow, magenta and cyan gelatin filters
white screen
dark room

DESIGN: One projector projects the primary colors the other the complement.

Primary	+	Complement	=	white
red	+	cyan	=	white
blue	+	yellow	=	white
green	+	magenta	=	white

CONCLUSION: The three complements are cyan, yellow and magenta.
A primary plus its complement gives white.

SCIENCE 203

LIGHT — COLOR #3 — Teacher Demonstration

PURPOSE: To identify the primary pigments and their combinations.

MATERIALS:
1 overhead projector
yellow, magenta and cyan gelatin filters
white screen
darkened room

DESIGN: The superimposed filters give the color mixtures

cyan + yellow = green
magenta + yellow = red
magenta + cyan = blue

all three filters give black.

CONCLUSION: The primary pigments are the complements of light. The pigments are yellow, magenta, and cyan. The mixtures give the above results.

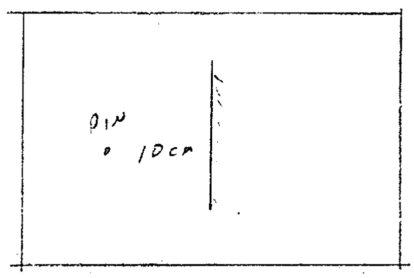
SCIENCE 203

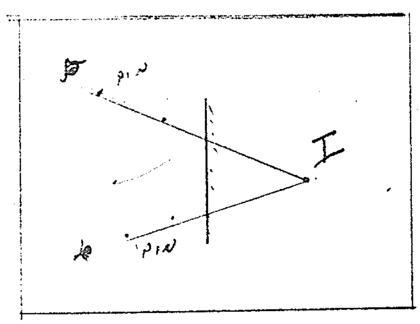
LIGHT — REFLECTION #1 — PLANE MIRRORS

PURPOSE: To compare image distance and object distance in a plane mirror
(a) by the use of parallax
(b) lines of sight

MATERIALS:
3 or 4 sheets of paper
straight pins
1 metric ruler
1 plane mirror
1 carboard underlay
2 rubber bands
1 block to support mirror

DESIGN: students use lines of sight to locate images.





CONCLUSION: Image distance = object distance.

SCIENCE 203

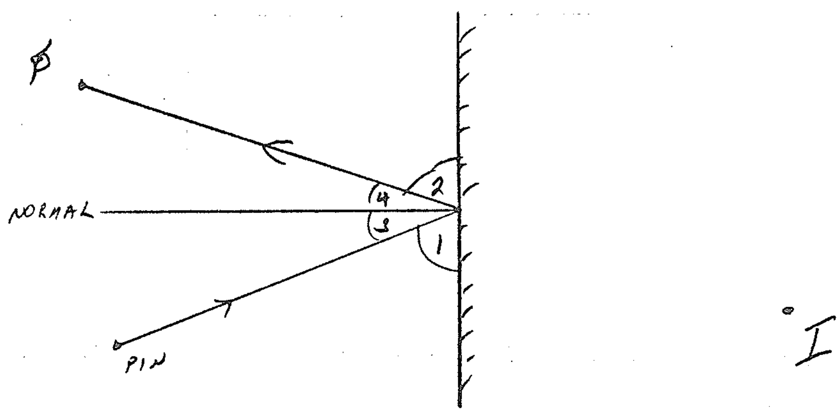
LIGHT | **REFLECTION #2** | **PLANE MIRRORS**

PURPOSE:
1. To compare angles of impact and rebound
2. To establish the normals, angle of incidence and angles of reflection

MATERIALS:

3 or 4 sheets of paper
straight pins
1 metric ruler
1 plane mirror
1 cardboard underlay
2 elastics
1 block to support mirror
1 protractor

DESIGN:



1. Measure angles 1 and 2 and compare
2. Establish and draw in Normals
3. Measure and label angles 3 and 4 as incident and reflection

CONCLUSION:

SCIENCE 203

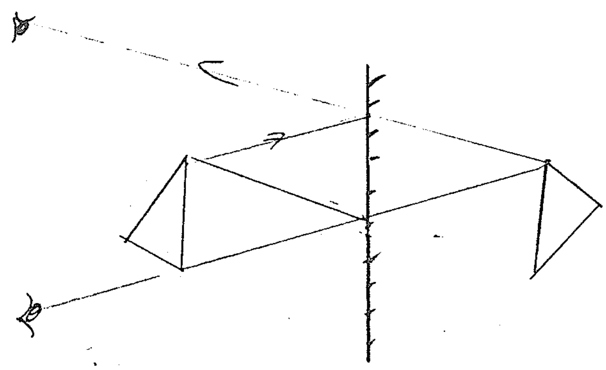
LIGHT | REFLECTION #3 | PLANE MIRRORS

PURPOSE: To locate and draw the image formed by a plane mirror

MATERIALS:

3 or 4 sheets of paper	1 carboard underlay
straight pins	2 elastics
1 metric ruler	1 block to support mirror
1 plane mirror	1 protractor

DESIGN: Construct a simple two dimensional figure and locate by lines of sight



CONCLUSION: The image is an exact duplicate in size to the object but laterally inverted.

SCIENCE 203

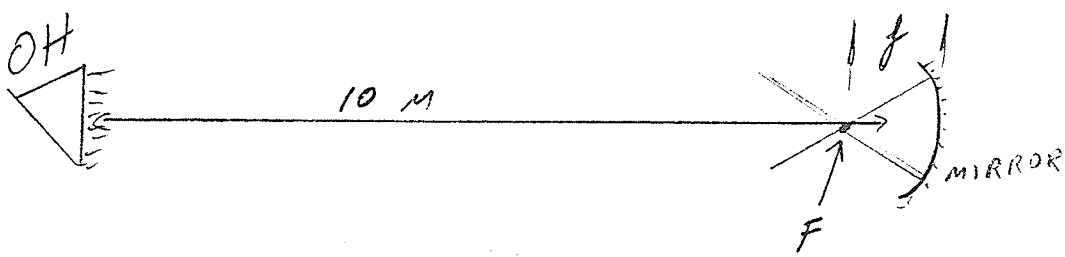
LIGHT | REFLECTION #4 | CURVED MIRRORS

PURPOSE: To locate the focal point of a concave parabolic reflector

MATERIALS:
1 parabolic mirror
1 sheet of plain paper
1 metric ruler
1 OH projector for the class or Image of the sun

DESIGN: Overhead projector focused to length of room, student locate filament image.

Or, image of sun



CONCLUSION: Focal length is ...

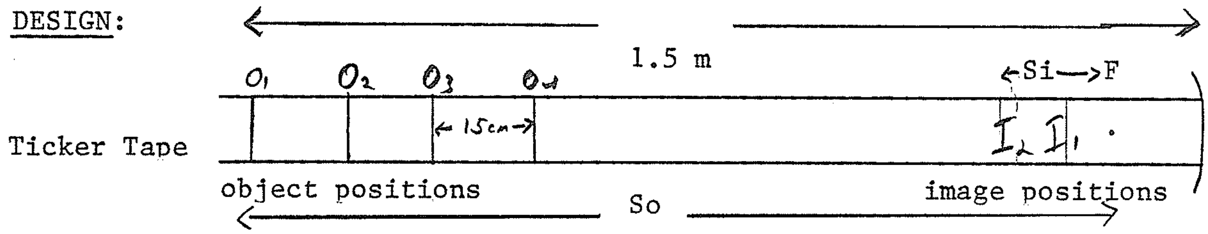
SCIENCE 203

LIGHT — **REFLECTION #5** — **CURVED MIRRORS**

PURPOSE: To form real images.
To find the relationship between image distance and object distance from focal point.

MATERIALS:
- 2 m of PSSC ticker tape
- 1 candle stub - 4 cm
- 10 cm masking tape
- Lump of play dough to hold mirror
- 30 cm x 20 cm stiff paper or cardboard
- 1 meter stick
- 1 mirror

DESIGN:



DATA: Use graph to locate other positions

O	So	Si

CONCLUSION: Si is inversely proportional to So

SCIENCE 203

LIGHT | **REFLECTION #6** | **CURVED MIRRORS**

PURPOSE: To find the relationship between distance of object from focal point and image size.

MATERIALS:

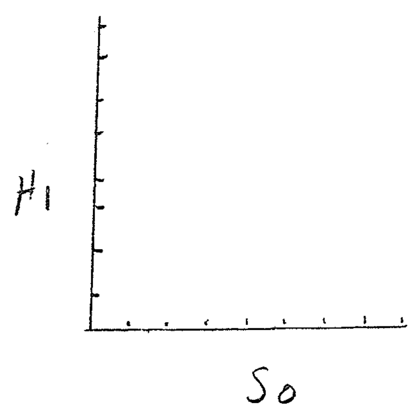
2 m PSSC ticker tape
10 cm masking tape
20cm x 30cm stiff paper or cardboard
1 mirror
1 candle stub - 4 cm
Lump of play dough to hold mirror
1 meter stick

DESIGN: Similar to #5 but measure image size on each trial.

DATA:

Position	So	Hi
1		
2		
3		
4		

Graph data: Hi vs So



CONCLUSION: Inverse relationship between Hi and Si.

$SiSo = f^2$ $\qquad$ $Hi = \frac{Hof}{So}$

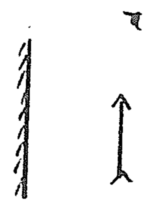
SCIENCE 203

Problem Lab

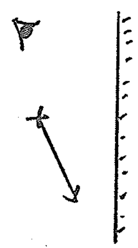
I Plane Mirrors

Complete the following ray diagrams to show how the eye sees the image of the object.

(a)

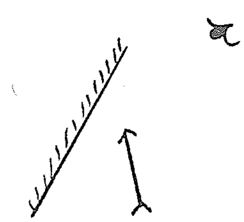


(b)



(c)

(d)



(e)

(f) If you are 1 m and 70 cm tall, how large a plane mirror would you require to see yourself from head to toe?

II A concave spherical mirror has a focal length of 6 cm. An object 2 cm high is placed at the following distances from the mirror.

(a) 14 cm (b) 12 cm

(c) 9 cm (d) 6 cm

1. In each of the above cases construct an accurate ray diagram to find the location and size of the image.

2. Label Hi, Ho, Si, So, f.

3. Check your diagrams by using the relationships:

$$Si = \frac{f^2}{So} \qquad Hi = \frac{Hof}{So}$$

SCIENCE 203

LIGHT

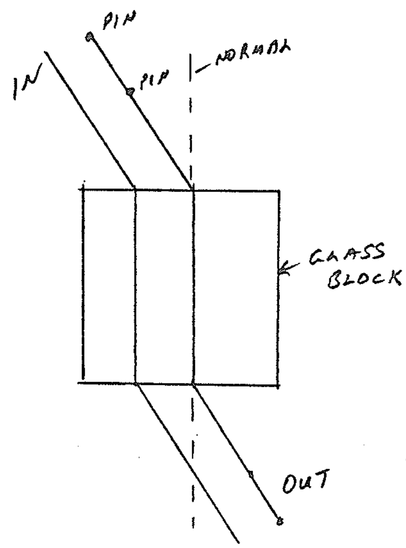
REFRACTION #1

PURPOSE: To trace light paths through a parallel sided glass block
To identify and measure incident and refracted angle

MATERIALS:

- 1 glass block
- 1 metric ruler
- 1 protractor
- pins
- 1 cardboard underlay
- sheets of paper

DESIGN:



DATA:

CONCLUSION: If light hits a surface at 90° it does not bend.
If light travels through a block with parallel sides it exits at the same angle and it entered.

SCIENCE 203

LIGHT

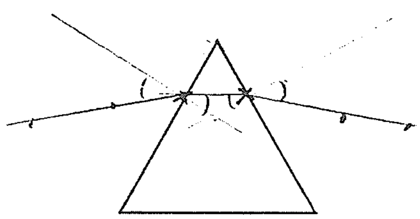
REFRACTION #2

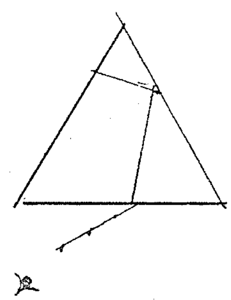
PURPOSE: To trace light through an equilateral prism
To trace light through an equilateral prism including an internal reflection.

MATERIALS:

- 1 equilateral prism
- 1 metric ruler
- 1 protractor
- pins
- sheets of paper
- cardboard underlay

DESIGN:





DATA: Sheet 1 Sheet 2

CONCLUSION: Light bends towards the thicker end of the prism.
Light can reflect internally if the angle at the surface is great enough.

SCIENCE 203

LIGHT

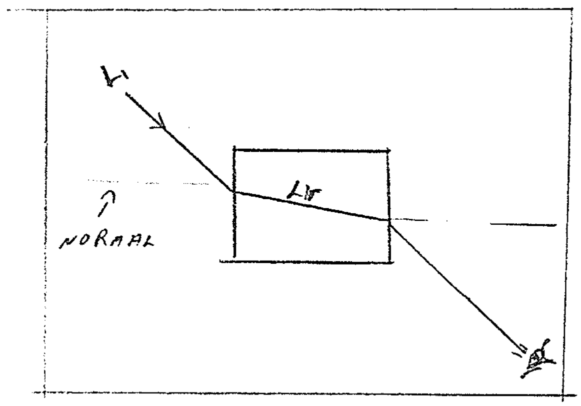
REFRACTION #3

PURPOSE: To find the index of refraction of glass.

MATERIALS:

1 glass block
1 protractor
1 Sin Table
pins
cardboard underlay
sheet of paper

DESIGN:



$$\text{Index} = \frac{\sin Li}{\sin Lr}$$

Collect class data and get an average value.

CONCLUSION: The index for glass is ________

SCIENCE 203

LIGHT

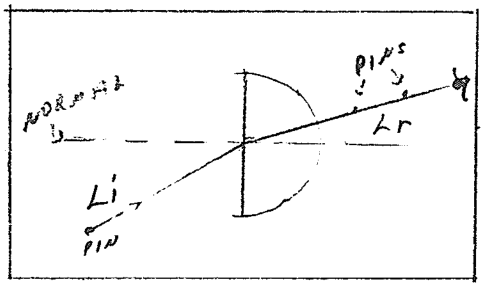
REFRACTION #4

PURPOSE: To find the index of refraction of water and alcohol.

MATERIALS:

1 PSSC cheese box	pins
1 protractor	water
1 cardboard underlay	alcohol
paper	

DESIGN:



Take two readings, one from each side.

DATA: Water Alcohol

Take the class average for each

CONCLUSION: The index for Water is ________

The index for alcohol is ________

SCIENCE 203

LIGHT

REFRACTION #5

PURPOSE: To locate the focal point of a converging lens

MATERIALS: Similar to Reflection #4

SCIENCE 203

LIGHT

REFRACTION #6

PURPOSE: To form real images.
To find the relationship between image distance and object distance from focal point.

DESIGN: Similar to Reflection #5.

SCIENCE 203

LIGHT

REFRACTION #7

PURPOSE: To find the relationship between distance of object from focal point and image size.

DESIGN: Similar to Reflection #6.

SECTION III: Chemistry

Contents:

SCIENCE 203

CHEMISTRY | Acids & Bases #1 | Indicators

PURPOSE: To identify the behavior of indicators in the presence of an acid or a base.

MATERIALS:
weak acid solution
weak basic solution
red litmus paper
blue litmus paper
phenolpthalein solution
4 100 ml beakers
1 eye dropper

DESIGN:

	Color: Acid	Color: Base
Blue litmus		
Red Litmus		
Phenolpthalein		

CONCLUSION: Summary of behavior of indicator.

SCIENCE 203

CHEMISTRY — Acids & Bases #2 — Lab Solutions

PURPOSE: To identify solutions as either acidic or basic

MATERIALS:
Neutral solution
4 acid solutions labelled with the chemical formula
4 basic solutions labelled with the chemical formula
2 100 ml beakers
8 strips red litmus paper
8 strips blue litmus paper
1 eye dropper
phenolpthalein

DESIGN:

Solution	Color		
	red litmus	blue litmus	phenolpthalein
1			
2			
3			
4			
5			
6			
7			
8			
9			

CONCLUSION: Fill in the chemical formula in the appropriate spot.

	1	2	3	4	5	6	7	8	9
Acid									
Base									
Neutral									

SCIENCE 203

CHEMISTRY | Acids & Bases #3 | Shop Solutions

PURPOSE: To identify various shop solutions as acidic, basic or neutral.

MATERIALS: 8 solutions commonly used in various shops (i.e. battery acid, vinegar, detergents, fluxes, cosmetics, etc.)
red and blue litmus paper, phenolpthelein
beakers.

DESIGN:

Solution	Color: red litmus	blue litmus	phenolpthalein
1			
2			
3			
4			
5			
6			
7			
8			
9			

Conclusion: Fill in the name of the solution in the appropriate spot.

	1	2	3	4	5	6	7	8
Acid								
Base								
Neutral								

SCIENCE 203

CHEMISTRY | Acids & Bases #4 | pH

PURPOSE: Measurement of pH of several solutions and identifying as acidic or basic.

MATERIALS:
pH paper
8 solutions ranging from strong base to strong acid (indlude shop solutions)
8 100 ml beakers
blue and red litmus paper

DATA:

Solution name	pH #	red litmus	blue litmus
1			
2			
3			
4			
5			
6			
7			
8			

CONCLUSION:

Name of solution	Acid	Base	Neutral
1			
2			
3			
4			
5			
6			
7			
8			

SCIENCE 203

CHEMISTRY | Acids & Bases #5 | Titration

PURPOSE: To neutralize three acids with a standard base to determine their relative strength.

MATERIALS:
1 burette
standard basic solution NaOH
3 acids of varying concentration
3 100 ml beakers
phenolpthalein

DESIGN:

Acid	Volume Acid	Volume Base	Ratio of Volume of Base to volume of Acid
1			
2			
3			

CONCLUSION: Ordering of acid names and formulas in order of strength.

SCIENCE 203

CHEMISTRY — Acids & Bases #6 — Titration

PURPOSE: To neutralize three bases using a standard acid to determine their relative strength.

MATERIALS:
1 burette
standard acid solution HCl
3 bases of varying pH
3 beakers
phenolphthalein

DESIGN: Similar to #5

CONCLUSIONS: Similar to #4

SCIENCE 203

CHEMISTRY | Acids & Bases #7 | Titration

PURPOSE:
(a) To determine the relative strength of several shop acid solutions.
(b) To determine the relative strength of several shop basic solutions.

MATERIALS:
standard base used previously
standard acid used previously
battery acid from a fully charged battery
battery acid from a dead or weak battery
basic solutions (i.e. baking soda, Draino, Ajax, Beauty Culture solutions)
beakers

DESIGN:

DATA:

	Volume	Base Volume	Ratio of volume Base/Acid
Acids			
1			
2			
3			
Bases		<u>Acid</u>	<u>Acid/Base</u>
1			
2			
3			

CONCLUSION: Ordering of acids according to relative strength

Ordering of bases according to relative strength

SCIENCE 203

CHEMISTRY | Acids & Bases #9 | Molarity

PURPOSE: To find the molarity of an acid and a base by titration.

MATERIALS:
standard base solution previously used
standard acid solution previously used
burette
beakers
weak acid solution   shop acid
weak base solution   shop base

DESIGN:

DATA:

	Volume	Volume Standard Base
Acid		
1		
2		
Base		
1		
2		

CONCLUSION: Molarity of Acid 1 ________   2 ________

Molarity of Base 1 ________   2 ________

SCIENCE 203

CHEMISTRY | Acids & Bases #8 | Molarity

PURPOSE: To prepare standard solutions of an acid and a base

Materials:
Cent-O-Gram balance
5 g of NaOH
5 ml of Concentrated HCl
4 small beakers

DESIGN:

DATA:

Weight of NaOH	__________
Molar weight of NaOH	__________
Volume of H_2O used	__________
Molarity of NaOH solution	__________
Molarity of HCl	__________
Volume of HCl used	__________
Volume of H_2O used	__________
Molarity of HCl solution	__________

CONCLUSION: Molarity of NaOH solution

Molarity of HCl solution

SCIENCE 203

CHEMISTRY | Electrochemistry #1 | Conductivity

PURPOSE: To classify six solutions as conductive or non-conductive.

MATERIALS:
6 250 ml beakers
6 labelled solutions
conductivity indicators

DESIGN:

Name of Solution	Good Conductor	Poor Conductor	Non Conductor
1			
2			
3			
4			
5			
6			

SCIENCE 203

CHEMISTRY | Electrochemistry #2 | Plating

PURPOSE: To classify ions according to their tendency to take electrons.

MATERIALS: Strips of metals: Al, Zn, Ni, Sn, Pb, Cu
Sand paper
Salt solutions for Al, Zn, Ni, Sn, Pb, Cu, Ag

DESIGN: Student dips the metal into the solution. If plating occurs then ion in solution is stronger (electron affinity) than the metal.

DATA:

Metal	Al	Zn	Ni	Sn	Pb	Cu
Solution						

x plating
- no plating

CONCLUSION: List metals in order of their electron affinity.

SCIENCE 203

CHEMISTRY | Electrochemistry #3 | Plating

PURPOSE: To copper plate several objects using DC current.

MATERIALS:
$CuSO_4$ solution
Dilute HCl
Emery cloth
1/2" x 6" strip of copper
250 ml beaker
wire connectors
centogram or equivalent balances

DESIGN:
initial weight of copper strip
final weight of copper strip

initial weight of object to be plated
final weight of object to be plated

Cathode reaction
Anode reaction

CONCLUSION: Descriptive comparison to #2

SCIENCE 203

CHEMISTRY — Electrochemistry #4 — Voltaic Cells

PURPOSE: To construct voltaic cells using the metals of exp. #2 and measure their electrical potential.

MATERIALS:
200 ml beaker
metal strips used in #2
dilute HCl
voltmeter
wire connectors

DESIGN: Students construct voltaic cells using the metal combinations from Exp. #2 and measure their electrical potential.

DATA:

Metals	Cu Volts	Pb	Sn	Ni	Zn	Al
Al						
Zn						
Ni						
Sn						
Pb						
Cu						

CONCLUSION: listing the combinations in order of voltage produced.

SCIENCE 203

CHEMISTRY | Electrochemistry #5 | Voltaic Cells

PURPOSE:

(a) To construct a voltaic cell using Zn and carbon.
(b) To construct a battery of two or more cells and measure their potential.
(c) To use the battery to operate a small electric motor or light bulb.

MATERIALS:

3 250 ml beakers
6 Zn strips
6 carbon strips
Dilute HCl
6 connector wires
1 electric motor or light bulb and socket
1 voltmeter

DESIGN:

Students construct the cells as in Exp. #4. Measure their potential then the cells are connected in series and voltage is recorded; then in parallel and voltage is recorded. The combination is then connected to light bulb or motor and the behavior observed.

DATA:

potential of a single cell ____________

potential of two cells in series ____________

potential of three cells in series ____________

potential of two cells in parallel ____________

potential of three cells in parallel ____________

qualitative effect of batteries on motor or light bulb ____________

CONCLUSION: Statement of effect of series connection vs parallel connection.

SCIENCE 203

CHEMISTRY | Electrochemistry #6 | Storage Cells

PURPOSE:
(a) to construct a lead storage battery
(b) To charge a cell and measure its charged voltage.
(c) To discharge a cêll.

MATERIALS:
sulfuric acid
250 ml beaker
lead strips
sand paper
2 wire connectors
volt meter
small battery charger (DC source)

DESIGN: Students construct the cell and charge with a variable DC source and observes the changes on the lead strips. Measures the voltage of the charged cell. Then discharges cell and observes changes on lead strips.

DATA:

charging voltage ______________

time of charge ______________

appearance of lead strips + ______________

- ______________

voltage of charged cell ______________

appearance of discharged lead strips + ______________

- ______________

CONCLUSION: Teacher assisted explanation of process.

SCIENCE 203

CHEMISTRY | Electrochemistry #7 | Storage cells

PURPOSE:

(a) To construct a battery of three storage cells in series and measure its potential.
(b) To construct a battery of six storage cells in series and measure its potential.
(c) To operate a small automotive appliance with the six-celled battery.

MATERIALS:

3 250 ml beakers
sulfuric acid
6 lead strips
sandpaper
4 wire connectors
volt meter
small battery charger (DC source)
car head light or light bulb

DESIGN: Students construct the three cells and charge them. During charging he observes the behavior of the strips. The voltage of the cell is then measured. Two sets of cells are then connected to make the six cell battery. The voltage is again measured. The battery is then connected to an automotive light bulb.

DATA:

3 cells in series - voltage ____________

6 cells in series - voltage ____________

time of operation of 12V light ____________

CONCLUSION: Statement of results with interpretation.

SCIENCE 203

CHEMISTRY | Electrochemistry #8 | Storage Cells

PURPOSE: Teacher demonstration of commercial 12 V cell.

MATERIALS: Commerical lead battery
volt meter
battery hydrometer
jumper cables
demonstration battery (if available)
battery charger

DESIGN: Teacher demonstrates voltage of the battery, of two batteries in series and in parallel. Collection of gas given off by the battery. Burning of the gas given off.

DATA: voltage of one battery ______________

voltage of two batteries in series ______________

voltage of two batteries in parallel ______________

specific gravity of acid in charged battery __________

specific gravity of acid in discharged battery ______

CONCLUSION: Statement of results with respect to number of cells.
A statement with implications of "jumping" batteries.
A statement with regards to specific gravity.
A statement with regards to the gas produced by the battery.

APPENDIX C

SCIENCE 203

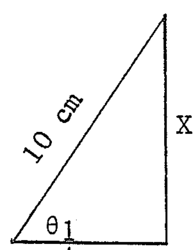
COMPREHENSIVE TEST

INSTRUCTIONS: Answer all questions in the space provided.
Show all that you had to do to arrive at your answer.
Show all necessary units, i.e. cm, sec., etc.

Values

3 1. Construct a right triangle having an included angle of 60°, a hypothenuse of 5.0 cm and an adjacent side of 2.5 cm.

3 2. Given the triangle below find θ_1 and the unknown side.

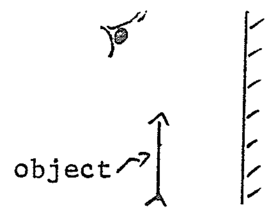


3 3. A student lays out a base line of 50 m and measures an angle of 60° to a distant point. What is the distance to the object?

1 4. A motorcyclist riding a 750 cc Honda 4 is cruising at 100 km/hr north. What distance will he have covered in 6 hours?

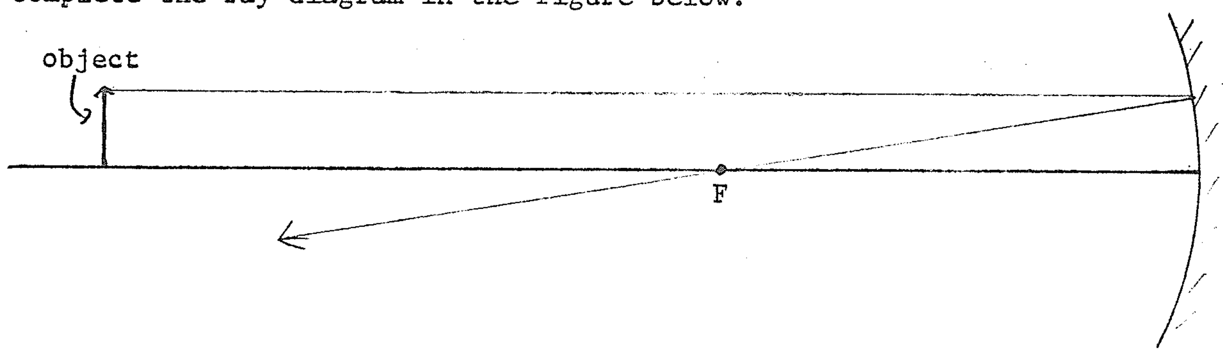
5. If a yellow jacket is illuminated by a pure red light, what color
2 will the jacket appear to be?

6. Locate the image of the object as formed by the mirror below.
2



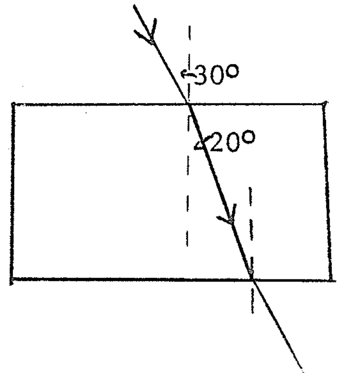
7. In the above diagram, #6, draw in the rays and lines of sight.
2

8. Complete the ray diagram in the figure below.
3



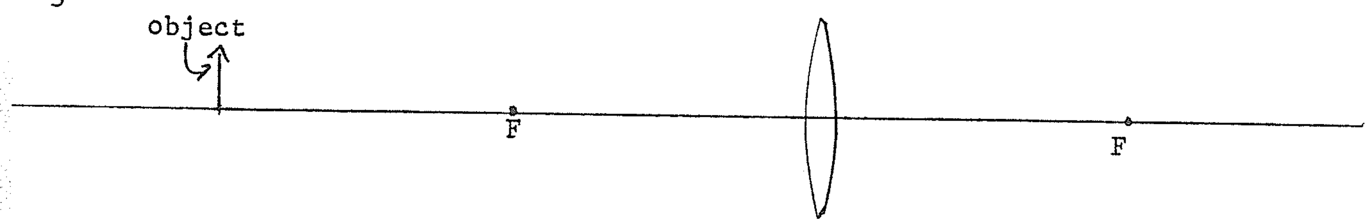
9. An object 1 cm high is placed 6 cm from the focal point of a
3 concave mirror. The mirror has a focal length of 10 cm. Find
the location of the image and the size of the image.

10. A ray of light travels into a piece of plastic as in the diagram
3 below. Find the index of refraction of that piece of plastic.



2 11. Light moves at approximately 3×10^8 m/sec. What would its speed be in the piece of plastic mentioned in question #10?

3 12. Complete the diagram below to show the formation of the image.



3 13. A converging lens has a focal length of 10 cm. An object 1 cm high is placed 5 cm from the focal point. Find the location of the image and its size.

1 14. From the given formulas, select an acid.

$PbSO_4$ HNO_3 NaCl CaOH

1 15. From the given formulas select a base.

CaOH $CuSO_4$ HCl H_2SO_4

1 16. A student test an unknown solution with pH paper and the paper indicates a pH of 8. Does he have an acid or a base?

3 17. A student has to prepare 1 leter of a 2 molar solution of sodium hydroxide (NaOH). How much sodium hydroxide should he weigh out?

3 18. A student has to prepare 500 ml of 1 molar sulphuric acid for a battery from a stock 10 molar solution. How much of the stock solution should he use?

3 19. In an experiment to determine the molarity of 10 ml of an acid, 20 ml of 1 molar sodium hydroxide (NaOH) was used. What is the molarity of the acid?

2 20. In a typical acid-base reaction such as $NaOH + HCl \rightarrow$ two products are formed. Write the chemical formulas of the products.

1 21. Distilled water is a non-conductor while tap water will conduct electricity. What is present in tap water that is not present in distilled water?

For the next three (3) questions use the electromotive series at the end of the test.

3 22. From the following combinations of salts and metals select the ones in which spontaneous plating will occur.

(a) zinc chloride ($ZnCl$) Nickel (Ni)
(b) silver fluoride (AgF) Copper (Cu)
(c) mercurous oxide (HgO) Gold (Au)
(d) copper sulphate ($CuSO_4$) Lead (Pb)

3 23. If the following combinations of metals were dipped into sulphuric acid, what voltage would be produced?

(a) Mg (magnesium) and Zn (zinc)
(b) Pb (lead) and Fe (iron)
(c) Cu (copper) and Au (gold)

1 24. In a Zn - Carbon combination, Zn is dissolved in the acid. At which electrode will the electrons collect?

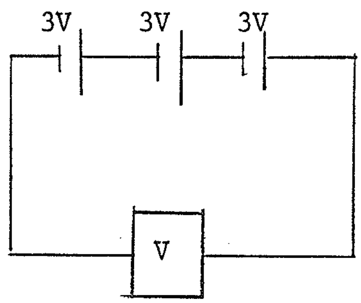
1 25. Three lead storage cells produce the following voltage:
(a) 1.8 volts (b) 2.0 volts (c) 2.2 volts
In which of these batteries would the acid concentration be the highest?

26. When a lead storage cell discharges one of the electrodes becomes
1 spongy and light grey. What compound is formed?

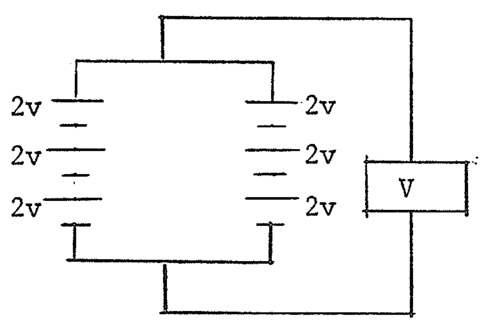
27. In a voltaic cell two different substances have to be immersed in
1 the electrolyte. What substance is formed on one of the lead electrodes?

28. What is the combined voltage of the following arrangements of cells?
3

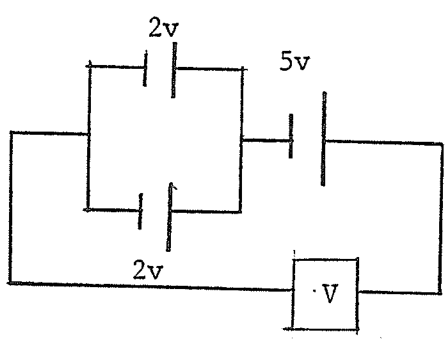
(a)



(b)



(c)



APPENDIX D

A SCALE TO MEASURE ATTITUDE TOWARD ANY SCHOOL SUBJECT

Form A Edited by H. H. Remmers

Date__________________

.me (optional)______________________________ Sex (circle one) M F

;e__________________________ Grade__________________________

rections: Following is a list of statements about school subjects. Put a plus sign before each statement with which you agree about the subjects listed at the left of ɜ statements. The person in charge will tell you the subject or subjects to write at the head of the columns to the left of the statements. Your score will not affect ur grade in any course.

1. No matter what happens, this subject always comes first.
2. This subject has an irresistible attraction for me.
3. This subject is profitable to everybody who takes it.
4. Any student who takes this subject is bound to be benefited.
5. This subject is a good subject.
6. All lessons and all methods used in this subject are clear and definite.
7. I am willing to spend my time studying this subject
8. This subject is a good pastime.
9. I don't believe this subject will do anybody any harm.
10. I haven't any definite like or dislike for this subject.
11. This subject will benefit only the brighter students.
12. My parents never had this subject, so I see no merit in it.
13. I am not interested in this subject.
14. This subject reminds me of Shakespeare's play -- "Much Ado About Nothing."
15. I would not advise anyone to take this subject.
16. This subject is a waste of time.
17. I look forward to this subject with horror.

APPENDIX E

ASSIGNMENT QUESTIONAIRE

Circle the best answer:

1. Do you complete your assignments at home?	yes	no	partially	
2. Do you complete your assignments at School?	yes	no	partially	
3. How much homework have you done in the last four years of school?	a lot	some	very little	none
4. Do you work after school?	yes	no		
5. How many hours do you work after school?	1 2 3 4 5		more than 5	
6. Do you depend on this job to pay for your room and board?	yes	no	partially	
7. Do you have difficulty doing your assignments at home?	yes	no		

8. If your answer to question #7 was yes, please state why.

APPENDIX F

SCORING

The median scale value of the statements endorsed is the attitude score. If an odd number of statements is endorsed, the scale value of the middle item of those endorsed gives the score. For example, if three items are endorsed, say, for example, items Nos. 2, 3, and 5, the score is the scale value of item No. 3, i.e., 9.2, a highly favorable attitude.

If an even number of items is endorsed, say, for example, items Nos. 1, 2, 3, and 4, the score will be halfway between the scale values for items Nos. 2 and 3 i.e., 9.4. The indifference point on all scales is 6.0. Scores above 6.0 indicate a favorable attitude, scores below 6.0, an unfavorable attitude.

This method of scoring, much more rapid and convenient than Thurstone's method (averaging the scale values of the items endorsed) was extensively validated by Sigerfoos.

Note that these scales require no norms beyond the scale values that follow. The norms are, so to speak, "built in," since what is being measured is the affective value of an attitude object defined by the scale values of the items endorsed by respondents.

Scale Values for Forms A and B

Item	Scale Value	Item	Scale Value	Item	Scale Value	Item	Scale Value
1.	10.3	5.	8.5	9.	6.0	13.	3.1
2.	9.6	6.	8.1	10.	5.5	14.	2.6
3.	9.2	7.	7.7	11.	4.7	15.	2.2
4.	8.9	8.	6.5	12.	3.6	16.	1.6
						17.	1.0

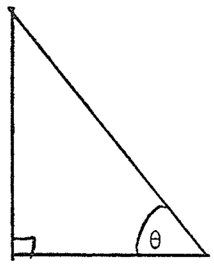
APPENDIX G

SCIENCE 203

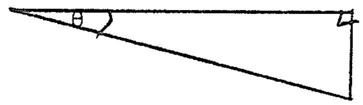
TRIGONOMETRY - Quiz

1. Label the sides of the following triangles:

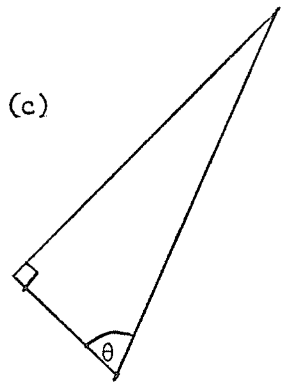
(a)



(b)

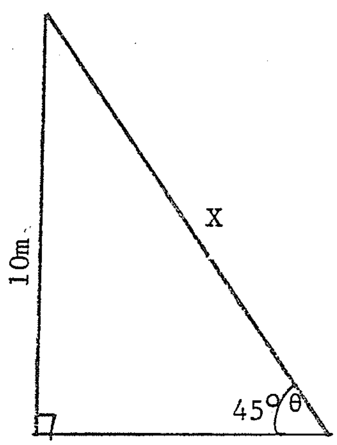


(c)

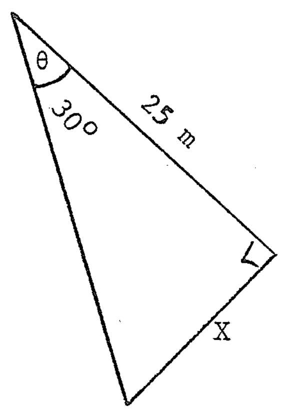


2. Calculate the length of the unknown side (X) of the following triangles:

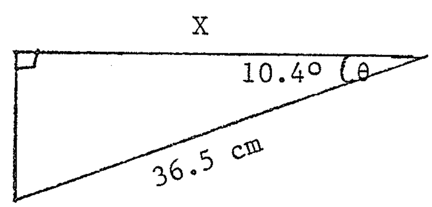
(a)



(b)



(c)



3. Calculate the length of the remaining side in the triangles (a), (b) and (c) above.

SCIENCE 203

PROBLEM LAB - Distance - Time - Velocity

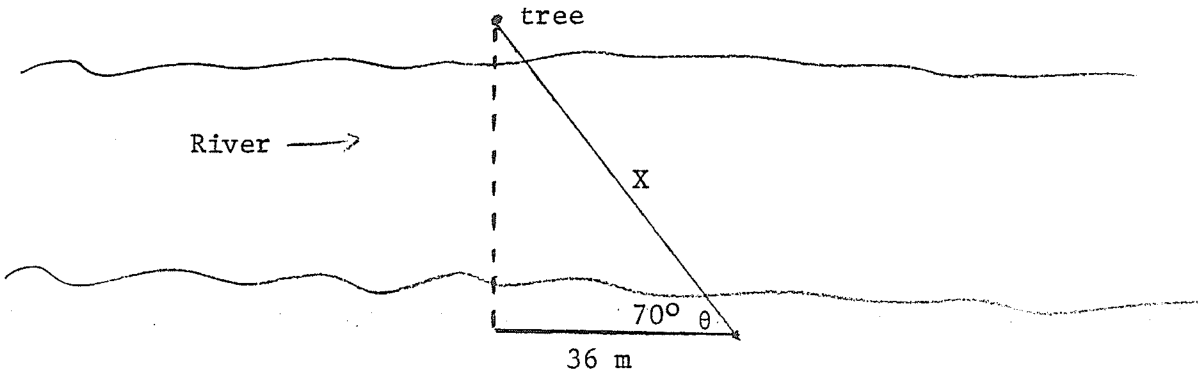
1. A surveyor has to find the height of a mountain and takes the following measurements:

   (a) Distance from mountain - 1000 m

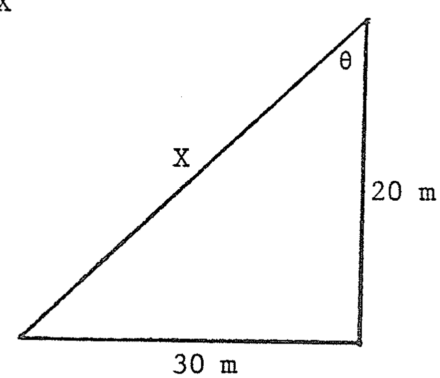
   (b) Angle of elevation - 68°

   How high is the mountain?

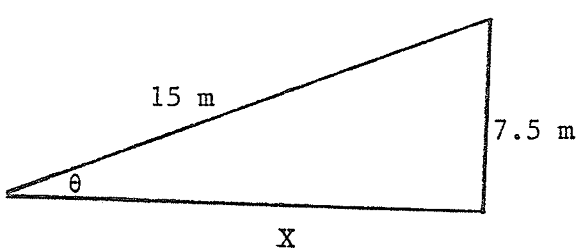
2. Find X



3. Find θ and X



4. Find θ and X



5. A 12 slit strobe makes 15 revolutions in 10 seconds to stop the shaft of the electric motor. Find the period and the frequency of the motor.

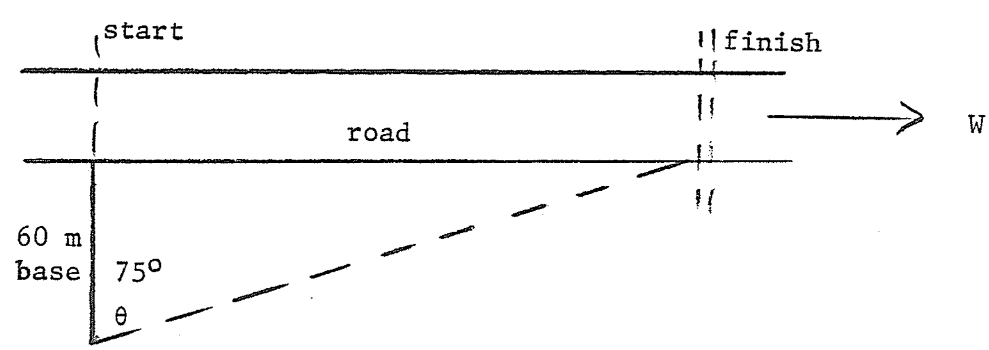
6. A 6 slit strobe makes 20 revolutions in 10 seconds to make four markers appear on a flywheel. Find the period and frequency of the fly wheel.

7. An aircraft flying at 200 km/hr North is in the air for 2.8 hours. How far did it travel?

8. A K.E.R.S.S. student riding a Harley Davidson takes 1.5 hours to travel to Dauphin - 320 km. Find his velocity.

9. How long would an aircraft take to fly to Toronto from Winnipeg - 2000 km. The aircraft is capable of 650 km/hr.

10. A car required 8.9 seconds to cover the distance. Find his speed.

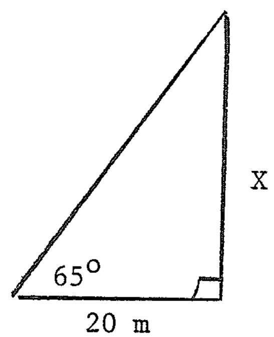


SCIENCE 203

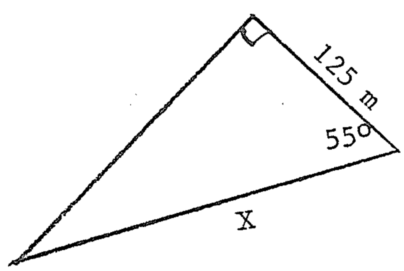
TEST - Distance, Time, Velocity

INSTRUCTIONS: Show all relevant work for full credit.
Do not forget units

I (a) Find the unknown side



(b) Find the unknown side

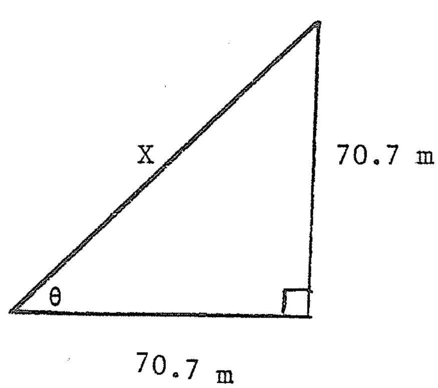


(c) A surveyor has to find the height of a building and takes the following measurements:

(1) Distance from the building - 125 m
(2) Angle of elevation - 58°

How high is the building?

(d) Find the angle θ and the side X



II (a) A 12 slit strobe makes 8 revolutions in 5 sec to stop the motion of an engine shaft with one marker. Find

(1) The frequency in rps

(2) The period in seconds

(b) A 750 cc Kawasaki is capable of 190 km/hr. If the driver maintains this velocity on a test track in an Easterly direction for 1.5 hrs What will his displacement be?

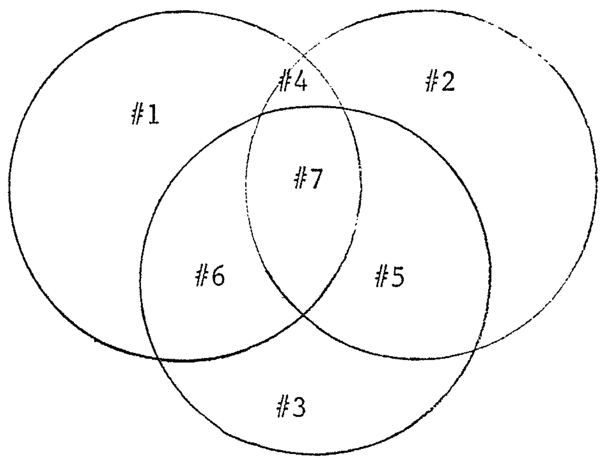
(c) An aircraft is heading North at 650 km/hr. How long will it require to travel to Churchill from Winnipeg? (1500 km)

(d) A 56 Chev covers the 1/4 mile (400 m) in 12.8 sec. What is his speed?

SCIENCE 203

Quiz #1

Light - Color



I The above circles represent the light of three projectors on a screen. Each of the circles represents a primary color. State the color of each numbered area:

#1 #2 #3 #4

#5 #6 #7

II Give the color in each of the following situations:

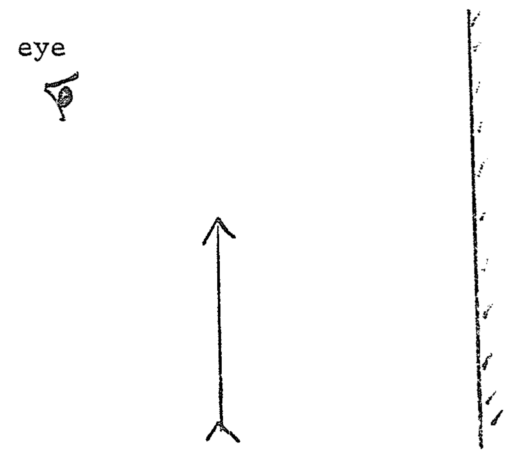
1. Red light on a yellow surface ________________
2. Red light on a blue surface ________________
3. Red and blue light on a white surface ________________
4. Green light on a black surface ________________
5. Blue light on a black surface ________________
6. What primary colors would you use to produce orange? ________________
7. What colors would the Canadian flag have if it is illuminated by green light? ________________

SCIENCE 203

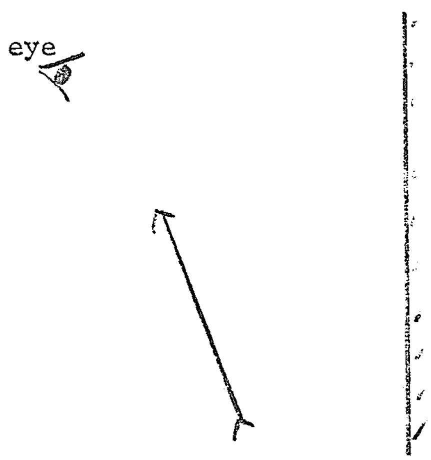
Quiz #2

Complete these ray diagrams:

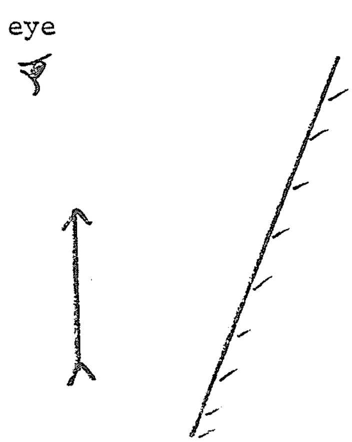
(a)



(b)



(c)



SCIENCE 203

Quiz #3

Concave Mirrors

Construct accurate ray diagrams for the following specifications:

(1) focal length = 6 cm   height of object = 2 cm
distance of object from mirror = 14 cm
label Si, So, Hi, Ho, f

(2) focal length = 5 cm   height of object = 5 cm
distance of object from mirror = 8 cm
label Si, So, Hi, Ho, f

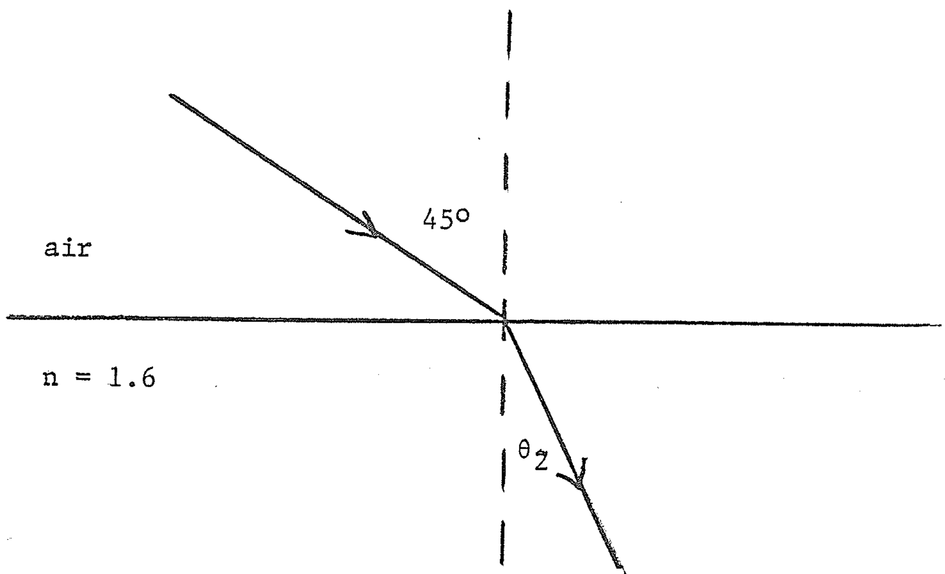
SCIENCE 203

Quiz #5

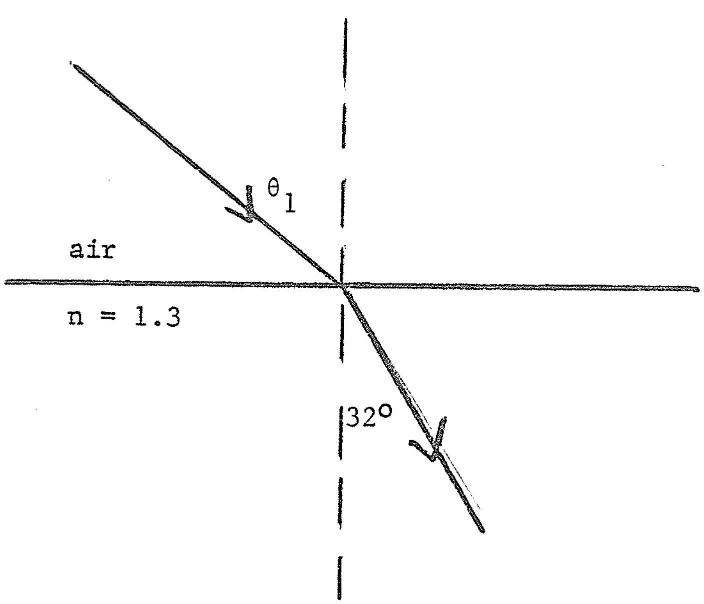
Refraction

Using the relationship $n = \frac{\sin \theta_1}{\sin \theta_2}$ find the missing angle in each of the following situations:

(1)



(2)



SCIENCE 203

Quiz #4

Concave Mirrors

Using the relationships $SiSo = f^2$ and $Hi = \frac{Hof}{So}$ find the location and size of the image for the following situations:

(1) focal length = 15 cm

distance of object from focal point = 20 cm

(2) focal length = 22 cm   size of object = 5 cm

distance of object from mirror = 27 cm

SCIENCE 203

Test

Color & Reflection

Directions: Show all relevant work for full credit.

I Colors: Give the apparent color(s) in each case:

(a) A white surface illuminated by green and red ____________

(b) A black surface illuminated by yellow ____________

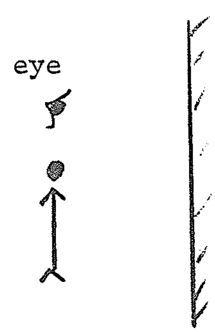
(c) A green car illuminated by red light ____________

(d) The Canadian flag illuminated by blue light ____________

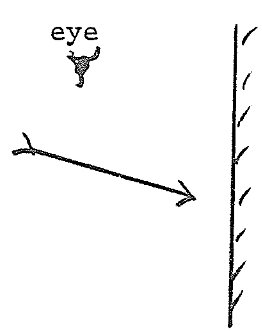
(e) How does a color TV create magenta? ____________________

II Reflection from a plane mirror: Complete the following ray diagrams:

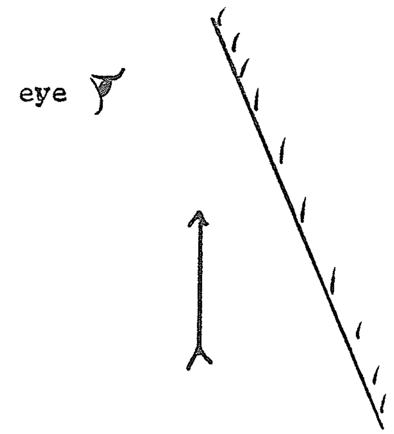
(a)



(b)

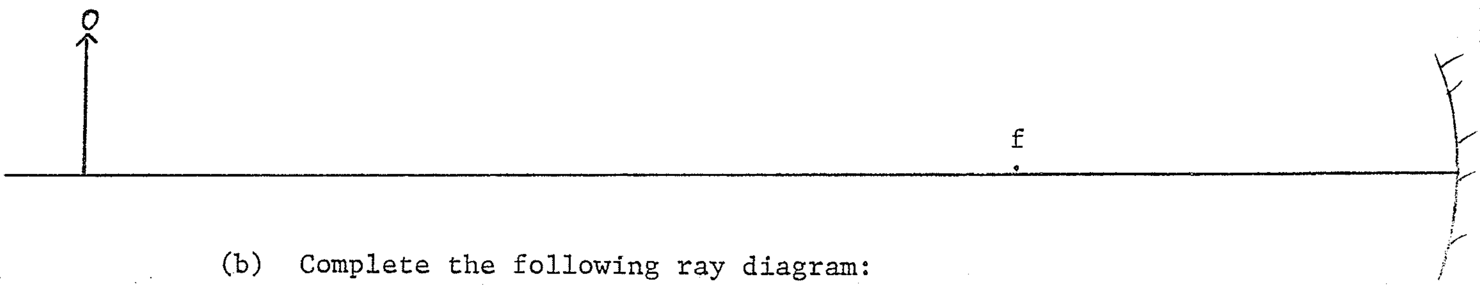


II (c)

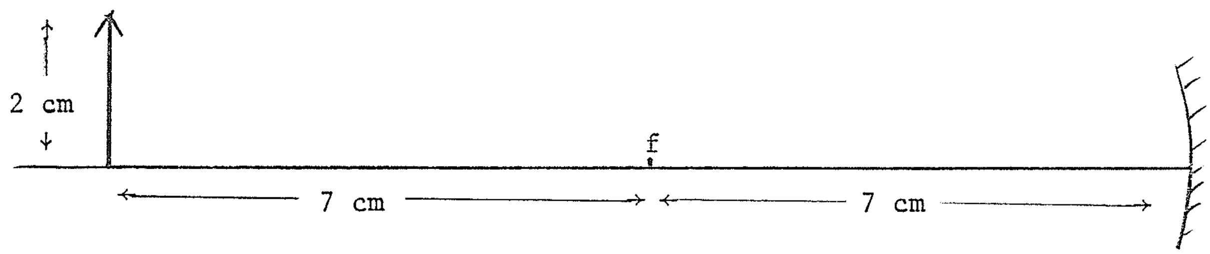


III Complete the following ray diagram to show the image formation.

(a) Label Ho, Hi, So, Si, f



(b) Complete the following ray diagram:



Calculate the location of the image using $SiSo = f^2$

Calculate the size of the image using $Hi = \frac{Hof}{So}$

IV A concave parabolic mirror has a focal length of 10 cm. An object is placed 30 cm from the mirror. The object is 2 cm high.

Find (a) location of image Si

(b) size of image Hi

SCIENCE 203

Quiz #6

Lenses

1. Using a scale draw an accurate ray diagram for the following specifications:

   focal length = 20 cm   height of object = 10 cm
   distance of object from lens = 60 cm

2. Using the relationships $S_iS_o = f^2$ and $H_i = \frac{H_of}{S_o}$ find the height of the image and its location from the above data.

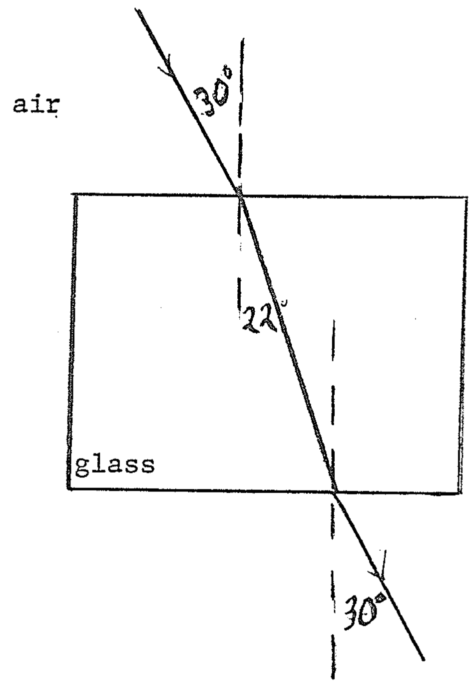
SCIENCE 203

TEST - Refraction and Lenses

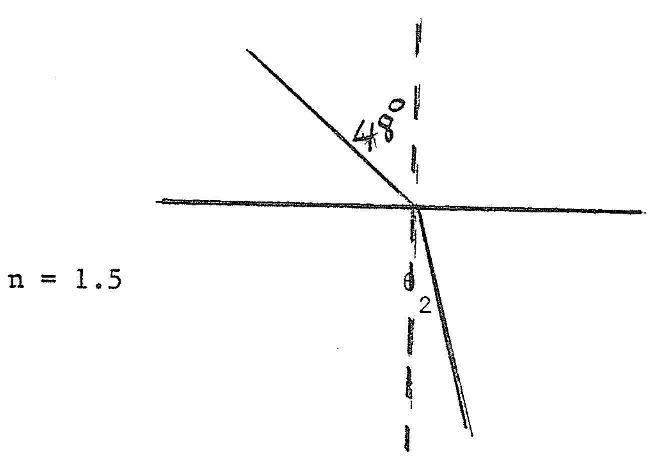
DIRECTIONS: Show all relevant work for full credit.

I REFRACTION

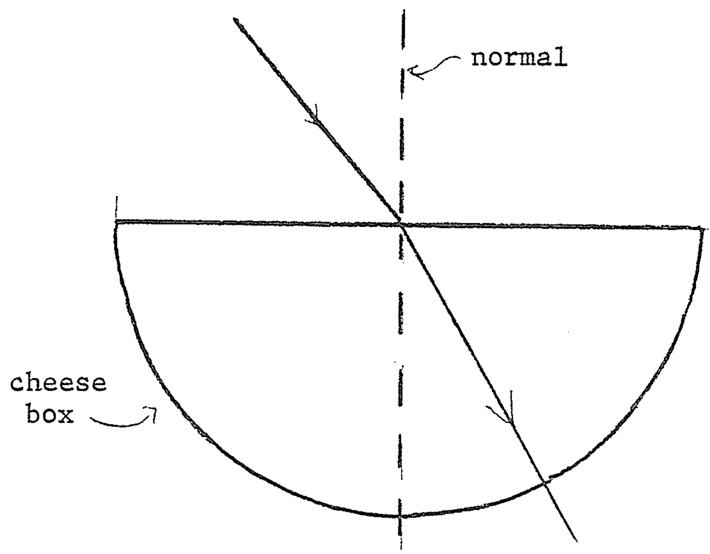
(a) Find the index of refraction for the block of glass depicted below.



(b) Find the unknown angle.



(c) A student performing an experiment to determine the index of refraction of a liquid obtains the following diagram.



What is the index of refraction of that liquid?

(d) The speed of light in air is approximately 3 x 10^8 m/sec. What is the speed of light in a liquid that has an index of refraction of 1.4?

II <u>LENSES</u>

(a) Draw a scale ray diagram for the following specifications:

A convex lens has a focal length of 20 cm. An object 5 cm high is placed 40 cm from the lens. Locate the image and find its size. Label So, Si, f, Ho, Hi.

(b) Check the above diagram by calculating the image position and image size.

SCIENCE 203

QUIZ #1

Acids & Bases

1. How would you prepare 200 ml of 3 molar solution of barium hydroxide?

2. How would you prepare 20 ml of 1 molar nitric acid (HNO_3) froma 10 molar stock solution?

SCIENCE 203

Chemistry QUIZ #2

1. State in which of the following combinations spontaneous plating occurs:

	Salt	Metal	
(a)	$CuSO_4$	Au	__________
(b)	ZnCl	Ni	__________
(c)	CaCl	Zn	__________
(d)	$PbSO_4$	K	__________
(e)	MgCl	Ca	__________

2. (a) If the following elements were dipped into an acid bath and a voltmeter placed between them, what would the reading on the voltmeter be?

(b) Indicate which would be positive and which would be negative.

			Voltage
(i)	Li	Na	________
(ii)	Bi	Ca	________
(iii)	Ag	As	________
(iv)	Sn	Ag	________
(v)	Hg	Al	________

SCIENCE 203

TEST - Electrochemistry

I Atomic structures:

(a) Draw a diagram of a calcium (Ca^{++}) ion.

(b) Draw a model of a Chlorine (Cl^{-}) ion.

II 1. In which of the following combinations will spontaneous plating occur. (write yes or no in the blank)

	Solution		Metal		
(a)	zinc chloride	ZnCl	Nickel	Ni	______
(b)	silver fluoride	AgF	Copper	Cu	______
(c)	mercurous oxide	HgO	Gold	Au	______
(d)	copper sulphate	$CuSO_4$	Lead	Pb	______
(e)	aluminum chloride	$AlCl_3$	Iron	Fe	______

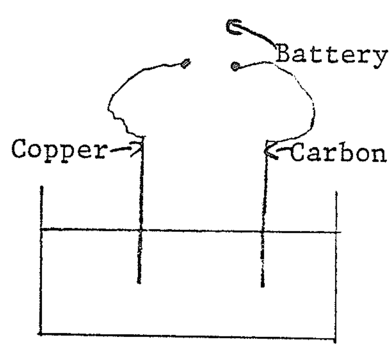
2. In the diagram below copper is to be plated on a carbon rod.

(a) What type of electrolyte has to be used?

(b) Which strip must be the cathode?

(c) When a Cu^{++} ion is plated, how many electrons does it pick up?

(d) Insert the symbol for a battery into the diagram. (Make sure it is in the proper direction.)



III Predict the voltage that will be produced by the following com combinations if they are dipped into H_2SO_4.

(a) Mg (magnesium) and Zn (zinc) ________________

(b) Pb (lead) and Fe (iron) ________________

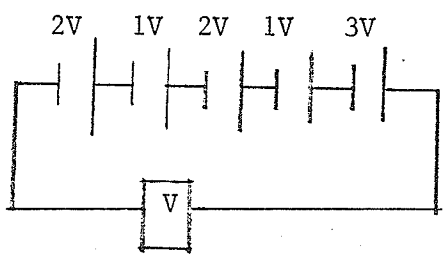
(c) Cu (copper) and Au (gold) ________________

(d) Li (lithium) and Hg (mercury) ________________

(e) Al (aluminum) and Sn (tin) ________________

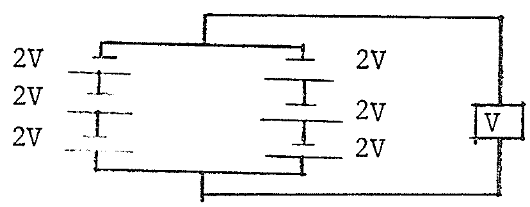
IV Predict the combined voltage indicated by the following diagrams:

(a)



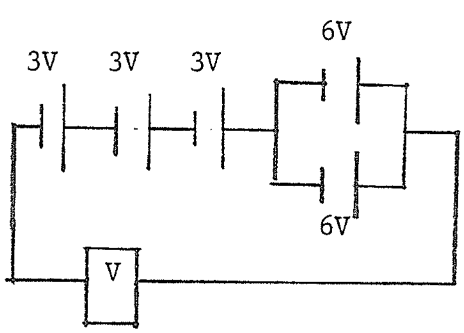
____

(b)



____

(c)



____

V The lead storage batteries in the diagram below are fully charged.

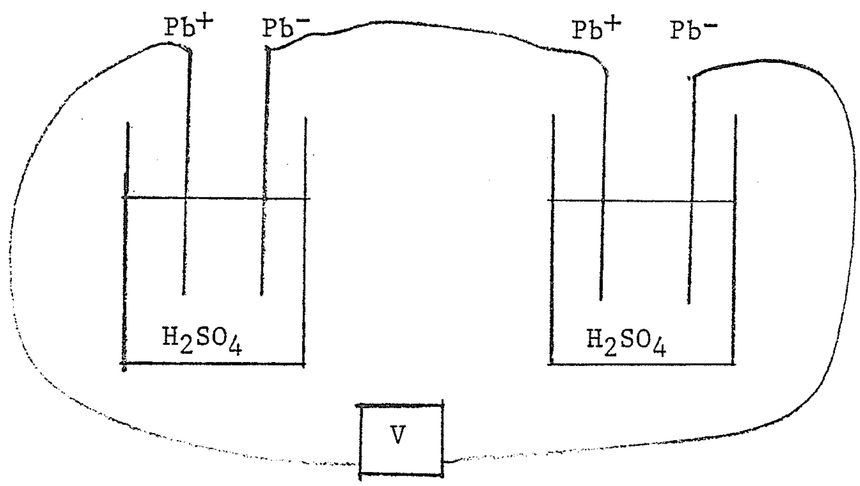
(a) What would a voltmeter read?

(b) What products are formed as the battery discharges?

(c) Cells have to have two dissimilar substances. A lead cell has two lead strips. What happens to one of the strips to make them dissimilar?

(d) Which cell would have a higher acid concentration?

cell A produces 1.5 V; cell B produces 2 V; cell C produces 2.2 V



Electromotive series:

Lithium	Li	3.0 Volts
Calcium	Ca	2.9 "
Magnesium	Mg	2.4 "
Aluminum	Al	1.7 "
Zinc	Zn	.8 "
Chromium	Cr	.7 "
Nickel	Ni	.25 "
Tin	Sn	.14 "
Lead	Pb	.13 "
Bismuth	Bi	- .32 "
Copper	Cu	- .52 "
Mercury	Hg	- .78 "
Silver	Ag	- .8 "
Gold	Au	-1.5 "

APPENDIX H

TABLE 1

SEMESTER END ACHIEVEMENT TEST

PERCENT SCORE

Group I n = 15		Group II n = 18		Group III n = 13		Group IV n = 22		Group V n = 17	
74	67	76	64	79	21	100	46	74	62
80	100	72	52	77	85	53	90	83	78
88	46	61	58	83	66	0	95	67	100
56	69	52	69	75	51	85	83	95	91
76	56	53	52	92	88	69	91	89	67
80	88	51	56	79	66	72	55	73	42
61	77	78	53	63		45	80	80	54
50		56	56			49	79	57	69
		66	67			71	72	67	
						51	62		
						96	63		

Table 1 represents the percent score of the semester end achievement test. The scores range from a low of 0 in Group IV to highs of 100 in Groups I, IV, and V. Seven students scored less than 50%.

TABLE 2

LABORATORY MARKS REPORTED BY TEACHERS

PERCENT SCORE

Group I n = 15		Group II n = 18		Group III n = 13		Group IV n = 22		Group V n = 17	
70	91	91	90	78	71	95	79	69	55
78	91	89	76	63	45	80	70	64	58
92	85	90	75	74	69	50	70	64	72
69	88	62	90	79	75	80	69	73	72
88	65	64	77	70	68	75	82	70	30
71	67	89	87	40	58	65	58	69	60
78	91	88	81	53		70	78	67	54
58		71	78			70	78	70	51
		71	70			73	78	72	
						85	74		
						79	55		

Table 2 represents the percent score of the students' laboratory performance. The scores reflect the number of laboratory excercises that the student completed successfully. Three students scored less than 50%.

TABLE 3

TEACHER TEST MARKS

PERCENT SCORE

Group I n = 15		Group II n = 18		Group III n = 13		Group IV n = 22		Group V n = 17	
69	90	71	67	83	74	94	60	75	74
75	78	70	58	86	38	64	74	76	85
90	78	60	35	67	83	69	87	66	96
79	60	52	65	63	83	84	90	92	92
77	68	57	71	78	62	73	58	80	71
85	79	58	52	82	62	69	73	85	53
81	71	76	62	88		73	82	87	87
78		51	55			66	75	74	63
		62	65			68	82	62	
						89	73		
						49			

Table 3 represents the overall percent score of teacher-made tests and quizzes. The scores range from a low of 35 in Group II to a high of 96 in Group V. Three students scored less than 50%.

TABLE 4

FINAL COURSE MARKS PERCENT SCORE

Group I n = 15		Group II n = 18		Group III n = 13		Group IV n = 22		Group V n = 17	
70	82	81	89	80	75	95	59	71	62
76	78	85	72	76	42	65	77	73	71
89	87	71	61	72	78	45	88	70	88
76	80	62	73	68	62	83	88	86	80
79	72	63	65	70	60	73	68	70	57
79	61	75	74	69	58	68	70	73	55
60	42	85	74	63		64	80	72	71
73		76	78			63	75	73	55
		76	61			66	75	69	
						89	74		
						86	55		

Table 4 represents the final grade assigned by the teacher. The final grade represents a combination of all evaluation instruments used by the teacher. Three students scored less than 50% and consequently failed the course.

TABLE 5

PRE-TEST AND POST-TEST SCORES

PURDUE MASTER ATTITUDE SCALE

WEIGHTED SCORES

Group I		Group II		Group III		Group IV		Group V	
Pre-Test n=17	Post-Test n=14	Pre-Test n=20	Post-Test n=16	Pre-Test n=12	Post-Test n=10	Pre-Test n=20	Post-Test n=21	Pre-Test n=18	Post-Test n=17
8.10	8.70	7.30	6.50	7.50	7.25	5.50	8.80	7.70	6.00
8.10	8.50	5.25	6.25	6.50	7.50	8.30	7.90	8.50	8.50
8.10	8.10	5.75	5.50	6.75	3.60	6.00	8.10	6.50	8.50
8.30	7.05	8.50	5.75	5.75	5.75	6.50	4.55	7.70	5.50
8.50	8.30	5.50	8.10	5.75	6.00	8.10	8.10	2.60	7.90
8.10	7.70	2.60	8.50	6.00	8.50	8.10	8.10	7.70	7.90
6.25	6.00	8.10	6.00	6.00	8.50	8.30	8.30	8.10	8.10
8.10	7.90	7.50	6.50	6.00	6.50	8.50	8.10	8.10	7.70
8.30	8.30	6.50	5.50	6.00	6.00	8.70	7.25	7.10	4.30
8.50	8.30	7.90	8.10	8.10	4.70	8.60	6.85	6.50	8.10
7.25	8.50	8.10	7.50	8.50		8.50	8.50	7.30	7.90
6.25	7.90	8.10	8.10	7.70		5.75	8.10	8.50	8.10
7.70	7.45	6.25	8.50			7.70	6.50	5.00	7.05
8.10	8.70	6.50	8.50			6.00	8.30	8.20	8.10
8.30		4.55	8.50			7.70	8.50	7.10	8.50
8.30		7.70	8.50			6.00	5.75	6.50	8.10
8.30		7.70				7.90	8.30	5.20	7.30
		8.10				8.10	8.30	3.20	
		5.50				7.90	8.10		
		5.50				7.70	8.50		
							8.50		

* Refer to explanation on the following page.

*Table 5 represents the pretest and postest weighted scores of the Purdue Master Attitude Scale (Form A). The pretest was administered on the first day of classes and the posttest after the students had received their final grade.