An Evaluation of a Pre-Apprentice Upgrade Program at a Petro-Chemical Complex.

Carol Hopper Bader
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THE LOUISIANA STATE UNIVERSITY AND
AGRICULTURAL AND MECHANICAL COL., PH.D., 1978

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AN EVALUATION
OF A PRE-APPRENTICE UPGRADE
PROGRAM AT A PETRO-CHEMICAL COMPLEX

A Dissertation
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
in
The Department of Education

by
Carol Hopper Bader
B. A., Louisiana Tech University, 1971
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May, 1978
ACKNOWLEDGEMENTS

The author wishes to express sincere appreciation to the members of her committee, Dr. Sam Adams, Dr. Helen M. Cookston, Dr. Fabian Gudas, Dr. William M. Smith, and Dr. Barbara Strawitz, for their assistance during the progress of this study. She is especially indebted to her major professor, Dr. Eric L. Thurston, for his thoughtful guidance and helpful suggestions.

A special note of thanks is made to the petrochemical complex for allowing me to conduct the study at the plant. Many people aided in the accumulation of the data, but extra gratitude is due to the personnel who gave support when needed.

A very special person, Sarah T. Rentz, deserves much praise for the many services rendered in a variety of ways. She aided the author during every phase of the study and was always supportive of the work.

Finally the author extends appreciation to her family. Her husband, Lawrence E. Bader, offered encouragement, showed patience during many trying months of difficult work, and assumed many responsibilities he otherwise would not have had. The author also wishes to thank her parents, Virginia S. Hopper and Hugh L. Hopper, for years of love and inspiration which made this study possible.
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ABSTRACT

Problem

The purpose of this study was to determine the effectiveness, in part, of a petro-chemical plant's pre-apprentice upgrade training program.

The null hypothesis to be tested was that employees who were given a basic reading and math improvement program would not score significantly higher on selected modular training tests than employees who were not given training in the program. This hypothesis was broken down into four separate hypotheses—one for each of the modular tests that were compared.

Procedure

The subjects who participated in the study were long time employees of the plant, the majority of whom had not scored well on the pre-employment test battery. All were performing low skill jobs at the complex. Thirty-two of these individuals were placed directly into a pipefitter apprentice program and thus became the control group for the study. Forty-nine of the men studied were given pre-apprentice upgrade training. The forty-nine experimental subjects were put into pipe apprentice classes as soon as they passed the terminal objective
tests in both the reading and mathematics phases of the upgrade training program. Time limits varied for an individual's upgrade training from three months to one year.

The researcher randomly selected four modular tests from the pipefitter apprentice program for comparative purposes. They were Module A, Algebra; Module B, Applied Formulas, Tables, and Charts; Module C, Physics; and Module D, Personal Protective Equipment.

Analysis of Data

In order to test the hypothesis adequately an analysis of covariance was computed for the results of each modular test. The covariates used were the results from the pre-employment test battery. These tests were (1) Bennett Mechanical Comprehension Test (ME), (2) California Mathematics Test, Advanced (MA), (3) Personnel Questionnaire (LA), and (4) Test of Chemical Comprehension (CH). The F-ratio was tested for significance.

Findings

The following findings resulted from the study:

1. Pipefitter apprentices who were given pre-apprentice basic skills training received significantly higher scores on modular tests A, Algebra and C, Physics.
2. Pipefitter apprentices who had pre-apprentice training achieved scores equivalent to pipefitter apprentices who had no pre-apprentice training on Module B, Applied Formulas, Tables, and Charts.

3. Pipefitter apprentices who had no pre-apprentice training performed better on Module D, Personal Protective Equipment tests than did apprentices who had pre-apprentice training.

Conclusions

The experimental group performed as well as or better than the control group on the modular tests given by off-the-job professional instructors. They received poorer scores than the control group on the module taught by the on-the-job instructors who were all craftsmen rather than professional instructors.

The experimental group scored as well as or better than the control group on the modules that lasted several days or weeks. They scored poorer than the control group on the module that was taught and tested the same day.

The pre-apprentice program appeared to have been beneficial from the fact that the experimental group performed significantly better than did the control group on a majority of the tests. More research should be conducted
during the entire three-year apprentice program before more definite statements concerning the evaluation of the pre-apprentice training program could be made.
Chapter 1

INTRODUCTION

A major petro-chemical corporation had a number of low skilled employees who had not progressed to skilled positions. By upgrading these employees the petro-chemical complex could help meet its continuing need for first class mechanics through utilizing resources already within the organization. Also the employees themselves would derive personal satisfaction from the skills learned in a basic education program.

After union negotiations an upgrade program, termed "pre-apprentice training program," was established for these individuals. This training differed from former company programs in that (1) it was not focused on apprentice-related material but on basic mathematics and reading skills, and (2) while other upgrade programs lasted approximately six weeks, this one was scheduled for two years.

Reading consultant Robert Cunning, who developed the Fog Index for determining readability levels, worked with the pre-apprentice instructors and several of the regular plant employees in evaluating the reading and
mathematics levels of the pipefitter apprentice training modules. From these evaluations objectives and criteria were established for the reading and mathematics phases of the pre-apprentice programs. When a trainee met the objectives of the pre-apprentice classes, he entered the next pipefitter apprentice class. Employees completed the pre-apprentice training at varying times depending on the individual's initiative and ability (Hagen, 1976).

PURPOSE OF THE STUDY

The purpose of this study was to determine the effectiveness, in part, of a petro-chemical plant's pre-apprentice upgrade program.

STATEMENT OF THE PROBLEM

The problem was to evaluate an upgrade pre-apprentice program at a major petro-chemical complex. The null hypothesis to be tested was that the employees who were given a basic reading and mathematics improvement program would not score significantly higher on selected modular training tests than employees who were not given training in the program. This hypothesis was divided into four separate hypotheses, one for each of the selected modules which the researcher compared.
Importance of the Study

The importance of this study was to determine whether or not employees given time for basic education skills would do well in the apprentice training classes. The subjects in the study were paid their regular salaries for the hours they were in basic education classes. These people had the choices of 1) being enrolled in the training program, 2) being retained at their present jobs with a cut in pay, or 3) being released by the company with severance pay. All the utility people chose the pre-apprentice training program.

This research would add to the core of knowledge concerning adult learning in basic education. Additional job placements for educators have been opened in industry; people in education had to become more familiar with these positions so that academic and commercial fields could complement one another in the training and teaching of individuals.

This study also provided some additional data for the petro-chemical plant. As the time arose for a complete evaluation of the pre-apprentice program, the researcher hoped this dissertation aided the company in determining program effectiveness.

A final importance of this study was that the described program could help other industries who were interested in initiating upgrade programs for their
academically deficient employees. U. S. District Judge Edwin F. Hunter decreed that Cities Service Oil Company had to train and upgrade workers previously deemed to be "nonpromotable," (Baton Rouge Morning Advocate: March 2, 1977), so it appeared likely that basic education programs in industry would become the rule rather than the exception in the future.

Definition of Terms

Apprentice Module. An apprentice module was one specific unit of programmed learning. Often slides, tapes, and other audio-visual stimuli were incorporated into the training modules. Modules ranged in time from one day to four weeks for learning and testing. For the purposes of this study, test results from four randomly selected modules were compared. The apprentices were in the pipefitter apprentice program six months before the data from the last selected module could be obtained.

Apprentice Program. An apprentice program at this industrial complex usually consisted of three years of training for a specific job. As in the case of the former utility people, the apprentice program trained the employees to become first class pipefitters. The program consisted of on-the-job and off-the-job instruc-
tion. Much of the material for the off-the-job instruction was programmed.

**Entrance Test Scores.** All employees of the petrochemical complex were given a battery of tests before they were hired. This test battery included four standardized tests: 1) *Bennett Mechanical Comprehension Test* (abbreviated ME), 2) *Advanced California Mathematics Test* (abbreviated MA), 3) *Test of Chemical Comprehension* (abbreviated CH), and 4) a learning abilities test called *Personnel Questionnaire* (abbreviated LA). Percentile scores on all four tests were converted to scale scores. The researcher used the scaled scores on these four tests as covariates in the statistical comparisons of modular test results. Other terms for these same scores included "pre-employment scores," "entrance exam scores," and "initial employment scores."

**Off-the-Job Training.** Off-the-job training was the more formal educational training the employees received in the apprentice classes. The company furnished the instructors, materials, and meeting places while the employee attended class on his own time without pay. The off-the-job classes were the more academic classes in the apprentice program. These classes were taught by professional instructors.
On-the-Job Training. On-the-job training usually consisted of practical application of skills learned. The company furnished the instructors, materials and meeting places. It also provided the employee time off with pay from his job for these classes. These classes were ordinarily taught by regular plant employees who were skilled craftsmen in their fields.

Pre-Apprentice Program. Pre-apprentice program was the term used to designate the upgrade program for the employees formerly classed as "utility" personnel. The program was designed to improve reading and mathematics skills of educationally deficient employees who had been with the petro-chemical complex a number of years.

Successful Completion of Reading. Successful completion of reading meant that a trainee had met the objectives established for the reading phase of the pre-apprentice program. These objectives essentially were for a student to reach a goal of approximately the 9.3 instructional reading level as determined by the Fog Readability Formula.

Successful Completion of Mathematics. Successful completion of mathematics meant that a trainee had met the objectives established for the mathematics phase of the pre-apprentice program. These objectives included
mastery of the addition, subtraction, multiplication and division functions as well as mastery of the use of decimals, percentages, basic algebra, and basic geometry.

Utility Personnel. Utility personnel was a classification of employees hired for low skill manpower. For the most part the utility employee's scores on the pre-employment test battery were low.

Delimitations of the Study

This study was limited to eighty-one first year apprentices at a major petro-chemical industrial complex in the Gulf Coast Area. The experimental group of forty-nine came from the former utility personnel group who received pre-apprentice training. The control group of thirty-two was a set of former utility people who did not receive the pre-apprentice training. The time limits of the study were determined from the dates of the initiation of the program in the fall of 1976 until the time when the researcher obtained the modular apprentice test scores from the selected samples which was February, 1978.

Selection of the Subjects

The researcher had no control over the selection of the subjects in the pre-apprentice program. Trainees
for the upgrade program were selected because they had good work records with the company yet had low scores on the pre-employment test battery. The control group was like the pre-apprentice group in that it had low test scores and good work records. The control group was put into the apprentice program without the reading and mathematics training.

Instruments

The entrance examinations as described under Definition of Terms were given, scored, and compiled by the company's personnel employment staff.

The test for the modules were designed and revised by the company's professional writers. The tests were validated and were the property of the petro-chemical company. The modular tests were administered and scored by the instructors in the apprentice program. The following modular tests were randomly selected by the joint efforts of the researcher and the representatives of the company: (1) Module A, Algebra; (2) Module B, Applied Formulas, Tables and Charts; (3) Module C, Physics; and (4) Module D, Personal Protective Equipment.

Statistical Procedures

The researcher compared the scores of the experimental group with the control group on the four randomly
selected modular tests. Analysis of covariance was used for the comparisons with the pre-employment scores used as covariates. The experimental group consisted of forty-nine pre-apprentices who received basic training. The control group of thirty-two went directly into apprentice classes without basic training. Both groups consisted of people who had worked with the company for several years.

ORGANIZATION OF THE STUDY

The remainder of this study was organized in the following manner. A review of the literature related to the study was presented in Chapter II. The experimental procedures and sources of data of the study were explained in Chapter III. Chapter IV was a presentation and analysis of the collected data. The summary, conclusions, and recommendations for future study comprised Chapter V.
Chapter 2

REVIEW OF THE SELECTED LITERATURE

Historical Overview

Little job training existed in industry prior to World War I according to Wenig and Wolansky (1972). Industrial training became needed in World War I and was further implemented during the Second World War because of a greater demand for skilled and semi-skilled workers. Clark and Sloan (1964) studied the amount of training taking place in the armed forces and concluded that the services were training more men than all the private and public colleges combined. When these men returned from the armed forces, little necessity for industrial training was apparent since the military had taken over this role.

Wenig and Wolansky (1972) stated that as business management and line supervision began to realize the downfalls of their own training abilities and the hap-hazardness of their training and development programs, more training and development departments were added to industrial firms. Many larger corporations now have complete training and development divisions with directors to supervise projects.
As Evans (1971) pointed out, in earlier times industrial training was apparent only when a business was prosperous. If profits were low, training was quickly dropped and outside help was enlisted to boost the earning power of the organization. Now, however, most progressive companies have viewed employee training as a major economic stabilizing factor. Winston (1969b), Livingston (1971), and McKee (1969) believed that current management viewed training as a long term investment rather than short term investment.

Of course, the change to this point of view was not an easy transition to make. According to Lebergott (1968) several factors tended to retard industrial implementation of on-the-job instruction. First, during periods of stress, a company appropriated learned personnel from training institutions, armed services, and other similar industries. Second, by raising levels of pay, industries were able to attract skilled workers as needed from competitive companies. With this type of thinking, wages would be increased and this increase would be passed on in the form of higher prices for goods and services.

During the sixties management started viewing training as an economically sound investment. Likert (1967) demonstrated that besides the value of training as a long term investment, the educational process
could also be depreciated. The increased benefits of on-the-job training were emphasized by McKee (1969:27):

> Fortunately, there has been a growing realization of the value of training. It can be said without fear of contradiction, that American industry has reached the point where it is generally accepted that systematic job training will make significant contributions to achieving organizational objectives.

Besides having economically sound bases for training in industries, Wenig and Wolanski (1972) asserted that most companies found other benefits in their education on-the-job. Trained workers had fewer accidents, higher production records, less worker turnover, and less absenteeism.

Aside from the economic benefits derived from training, the pro-industrial education attitude has come about through the efforts of an organization called the American Society for Training and Development. Publications of training programs are spread through its magazine, Training and Development Journal. The American Petroleum Institute has been instrumental in disseminating information on training in its field, also.

The type of training received by a worker has been changing as well as the managerial views on training itself. Previously workers learned skills for a particular job. According to BiWeekly Manpower Report of Manpower Information Service (March 11, 1970) individuals no longer wanted narrow training. They desired a base from
which they could gain knowledge beyond the actual skills of job training. Garnter (1971) suggested these secondary skills allowed for vertical as well as horizontal mobility within an industry.

As noted by Wenig and Wolansky (1972) under-employment, influx of youth and women in the labor force, and the advancement of technology caused the federal government to initiate corrective educational programs. Three programs relating to industrial remedial training were (1) MDTA Act, On-the-job training, 1962; (2) MDTA training in redevelopment areas, 1961; and (3) Job Opportunities for the Business Sector, (JOBS), 1968.

The first program provided training and supervised work on a contract basis in industries. This OJT program was aimed at persons sixteen years of age and older who were under- or unemployed.

The MDTA training in redevelopment areas provided classroom and on-the-job training for residents of redevelopment areas as chosen by the Economic Development Administration.

The JOBS program (now called the National Alliance of Businessmen) encouraged private companies to hire, train, retrain and upgrade hardcore unemployed and under-employed persons eighteen years of age and older.

Burt and Stringer (1968) stated that one reason for federal governmental involvement in industrial training
was that public school educators lacked both the concern and ability to provide job training for the disadvantaged. Also the U.S. Department of Labor (1968a:174) was anxious to reduce the country's welfare rolls:

public support of occupational preparation can be justified if it adds social benefits equal to the cost over and above those which would have been privately provided... to "purchase" a job for a person who might be a burden upon himself or society is justifiable public policy.

Janson (1970) believed that industries' increased societal consciousness and concern for minority groups had changed training from job-skill content to worker-oriented content. For the hard core unemployed and the disadvantaged employee, worker-oriented contents included basic education in reading, mathematics, spelling, science and communications. Also personal deficiencies had to be corrected before successful training could take place. For this reason content studies often included legal services, financial counseling, health care, human relations and responsibility, drugs, recreation and personal appearance.

Workers became interested in nonfinancial as well as financial rewards. Elton Mayo's (1945) Hawthorne experiment at Western Electric in Chicago showed that increased production came about from something other than pay and job knowledge. Clark and Sloan (1958) stated productivity could usually be increased by train-
ing the below average employee and motivating the above average worker. Janson (1970) noted that the move of job training from knowledge merely to perform a job to knowledge in many related areas had been brought about through research concerning motivation and its relationship to productivity of the worker.

**Overview of Current Education in Industry**

Surveys of industrial training by the U. S. Department of Labor (1962, 1963, and 1971), Doeringer and Pione (1966), Utgaard and Davis (1970), and Shelley (1970) concluded the following statements concerning the methods of job training in the process of upgrading semi-skilled and skilled workers:

1) Training was mostly an informal process.

2) This training usually occurred on the line with instruction given by the foreman, supervisor, or another worker.

3) The most frequent technique was job instruction that took place on the production line.

4) Some training programs were designed to raise basic educational levels through formal classroom instruction.

5) Several surveys were outdated and may not have reflected current innovations in job training methods.
6) Mostly informal, on-the-job training techniques were basic upgrade methods. High risk industries such as air transportation and banking had formal training.

On the whole many problems still had to be corrected concerning training in industry. As Burt and Stringer (1968) suggested, there were six major reasons for slow progress in this area:

First, there was much duplication of programs throughout the various companies as demonstrated in the various published reports. Compared to the number of major employers in the United States those industries involved with upgrade programs were few.

Second, the number of persons who were termed "hard core" or "disadvantaged" who were trained, hired, and promoted was a small percentage of the total number of employees a company employed.

Third, the training cost for an individual in basic education (not including skill training) was high. The cost is prohibitively high for most companies in terms of a long range, continuing activity as a part of their regular programs of training.

Fourth, even though case studies have been published of successful upgrade programs, each industry has tended to consider its own program as an experimental effort.

Fifth, few employers have provided basic education programs for their employees who required special training for retaining initial jobs.
Sixth, some companies have hired the disadvantaged on their own volition, but most employers have become involved mainly as a result of government pressures to eliminate discriminatory hiring practices.

Selected Industrial Training Case Studies

According to Russel B. Flanders' personal communication with Dr. Wolanski (1968:v) concerning a survey of the Presidential Task Force on Occupational Training in Industry "the most serious information gap it [the task force] encountered was the lack of comprehensive data on the nature and scope of training in private industry." Most industries have seemed apprehensive about publishing reports concerning their upgrade programs. When articles have appeared about the basic education programs, there was a definite absence of data accompanying the reports. A few of these programs, however, the researcher has mentioned in connection with her program at the petro-chemical complex.

Republic Steel initiated a program called "Keys Training to Development Future Manpower" (Bi-Weekly Manpower Report of Manpower Information Service, June, 1971). This program for the disadvantaged was set up in five plants. The training included orientation sessions, remedial education, and group counseling. For work on-the-job, the "buddy" system was employed where the
disadvantaged worker was paired with an established worker. No statistics were given concerning the training's effectiveness.

D. R. Schienle (1971) studied the relationships between job-related remedial training and changes in attitudes toward self, family, and the work setting. He noted statistically significant gains in self concept among the experimental subjects. Improvements were attributed to the basic teaching philosophies of both improving basic skills as well as trainee attitudes. The workers' affective and cognitive areas were both involved.

Studies published by Richard Rowan and Herbert Northrup (1972) most closely resembled the project investigated by the researcher. Their work attempted to determine the impact of adult basic education programs on the upward mobility of the disadvantaged worker in Southern papermills. The objective of the remedial programs was to prepare the employees for upgrading. Remedial education became important when competence on the job was a major consideration for promotion. As Rowan and Northrup (1972:22) explained, "A person with less than a seventh grade education...in the South is likely to find himself unable to cope with the sophisticated controls and complicated requirements of a modern papermill job." The subjects for the studies were people
hired as laborers who thought they would always remain laborers. They also had been with the company for several years. The purpose of the programs was to upgrade educational skills of the employees anywhere from functional literacy through fifth or sixth grade levels to as high as needed to perform the more advanced work.

The companies Rowan and Northrup studied which were pertinent to this work included Crown Zellerbach in Bogalusa, Louisiana; Continental Can in Hodge, Louisiana; and Boise Southern at DeRidder, Louisiana.

At Crown Zellerbach the MIND (Methods of Intellectual Development) program was implemented. The MIND materials contained two basic components—reading and mathematics—in a carefully structured course. The trainee at the Bogalusa mill determined his own progress. The participants were given the Stanford Achievement Test and the Lorge-Thorndike mechanisms for grouping purposes. Trainees were offered 160 hours of classroom instruction. They were expected to attend two-hour classes five days a week on their own time. At the end of the completed 160 hours, the trainee was given $100.00. Out of the 162 applicants only 20 completed the 160 hours. The average increase in mathematics skills was 2.1 years while the average increase in reading skills was 0.7 years. Crown did not establish educational level goals as minimum indicators of promotion or transfer capability.
Some occupational movement among the trainees occurred after the completion of the program, but as Rowan and Northrup (1972:35) commented, "it was apparently unrelated to direct educational improvement."

The Continental Can Company in Hodge, Louisiana also used the MIND program. The trainees were given the Stanford Achievement Test which was used only as a determiner for starting levels of instruction. At first students were offered 160 hours of classroom training and were expected to attend two-hour classes five days a week on their own time. No monetary incentive was offered. Later sessions were cut to 80 hours, and two-hour classes were held every other day. There were 155 trainees who started the program with 71 students completing the sessions. Increases in grade levels for both math and reading were 1.5. Only one major job change occurred among the studied subjects. For training 155 people Continental Can paid a total of $40,723.

Boise Southern Company in DeRidder, Louisiana was a little different from the other companies mentioned. As the researchers Rowan and Northrup (1972:123) noted, Boise was not faced with the problem of "attempting to eliminate the present effects of past discrimination wherein old, disadvantaged employees must be educated for upgrading." Boise's idea was to recruit and educate new employees to perform jobs in all departments of
the mill. One-hundred candidates were selected and placed in eight-week training programs. Initially the employees were given the Stanford Achievement Test and the Bennett Mechanical Comprehension Test. A total of 81 of the 100 trainees completed the program. The material used at Boise was the Economic and Manpower Corporation Program (EMC) which was developed by a private, profit-making organization that specializes in manpower training and development. The DeRidder program was financed by the U. S. Department of Health, Education, and Welfare. Six months of instruction in the EMC program for 81 employees cost $86,619. In addition to the cost of training the company paid the employees $2.00 per training hour. A ninth grade functional level in reading and mathematics was established as a requirement for job progression at the Boise Southern plant. Post-instructional test scores showed all trainees reached ninth grade level or better in both reading and mathematics. It must again be noted that these results were for new employees selected from the ranks of "disadvantaged" workers. They were not the disadvantaged, unskilled worker already employed within the work complex.

On the whole the results for these upgrade programs were not impressive. The adult basic education programs promised more than they could deliver. There seemed to
be no correlation between training and promotion. Few disadvantaged workers completed the courses. Those who completed the sessions showed little improvement in arithmetic and practically none in reading. Packaged courses disregarded the cultural characteristics of the trainees. Finally, the programmed teaching method itself was deemed largely unsuccessful.

Trends in Industrial Upgrade Training

On the bases of the current works in the literature Wenig and Wolansky (1972) made several assertions concerning education in industry. By the year 2000 industrial organizations may have become partially a community college in order to upgrade their employees. Hardcore and disadvantaged individuals will have been trained by industries with governmental aid. Companies would have realized that training had become more economically beneficial over a long period of time. Job training in industry would be influenced by manpower training because manpower training was an economic benefit to the society as well as to the worker. Manpower projection and forecasting would increase. Finally the trend of cooperative work-study programs would continue to grow.
Chapter 3

EXPERIMENTAL DESIGN OF THE STUDY

The design of this study has attempted to isolate the single variable of upgrade training and to determine a cause-effect relationship between this factor and observed results in apprentice training, keeping all other factors constant.

The experimental framework of the study was the post-test-only design with scores on the pre-employment test battery used as covariates. This design eliminated the pretest altogether. Because a randomized control group was used and no pretest was given, the design controlled the main effects of history, maturation and pretesting. With this design no interaction effect of pretesting could occur. Another reason for the researcher's choice of the post-test-only design was the fact that pretesting would have been inconvenient and too costly to obtain.

Graphically the experimental design was represented by Van Dalen (1973:287) in the following manner:

<table>
<thead>
<tr>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>X</td>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
</tr>
</tbody>
</table>
In this study the X represented the exposure of the group to experimental treatment; the T referred to the posttest given; the R indicated random assignment to the treatment group.

**METHOD OF SAMPLE SELECTION**

One of the industry's refinery/chemical plants had 131 employees who were hired to do basic laborial jobs. These employees had not advanced into apprenticeship training. For years each of these subjects had performed unskilled labor at the plant. The company then decided to upgrade these employees into more skilled, better paying situations. The petrochemical complex chose thirty-two of these individuals to go directly into the pipe apprentice program without any upgrade training. These employees thus became the control group in the experimental study. The remaining nine-nine individuals received the basic education training and so became the experimental group. Not all subjects in the experimental group were posttested within the two-year time limits of this study because some of the employees had not met the terminal objectives in the mathematics and reading phases of the pre-apprentice training program.
ADMINISTRATION OF THE PRE-EMPLOYMENT TESTS

The four test scores used as covariates were results from the Bennett Mechanical Comprehension Test (ME), Forms S or T; the California Mathematics Test (MA), Forms W or Y; the Test of Chemical Comprehension (CH), Forms S or T; and the Personnel Questionnaire (LA), Forms LA-S or LA-T. These examinations were administered to all the individuals in the study prior to their employment with the industry. The tests were given, scored, and converted to scale scores by the professional testing staff of the corporation.

EXPERIMENTAL PROCEDURES

The upgrade program was designed to bring the educational skill of the disadvantaged workers up to the educational level of the materials used in the pipe apprentice materials. The program was not created to teach pipe material, but to teach basic education skills. The upgrade program was divided into two sections (reading and mathematics) each with its own set of objectives and criteria.

The reading section objectives and criteria were determined in the following manner. First, the reading instructors reviewed the applicable apprentice materials. Using Gunning's (1953) Fog Index Readability Formula,
they determined the readability levels of the apprentice material. These levels were found to be from 8.0 through 14.5. Dr. Robert Gunning who created the Fog Index was contracted to verify these results.

After the reading levels of the materials were ascertained, the types of reading involved in the materials were determined. The four major reading skills needed for success in the apprentice program were comprehension, vocabulary, sequencing, and study skills. From the review of the materials, terminal objectives in the four areas of reading were established (see Appendix A). After the objectives were derived, three parallel forms of the objective test were created from selections of the pipefitter apprentice program. (See Appendix B for a sample copy of the reading terminal objective test.) The comprehension section of the terminal objective test included paragraphs of approximately 280 words with a readability level of 9.3. Questions to measure inference, vocabulary and comprehension were written for all forms of the test. For the location of specific information section of the test, selections with equal readability levels were chosen. Five questions were picked from the apprentice materials for all forms. Readings with equal readability levels were selected directly from the apprentice materials for the sequencing segment of the test. The trainees then
had to sequence five steps taken from the readings. For the vocabulary section of the test, all forms had fifteen words which were parallel in structural makeup. These words were taken directly from the pipefitter apprentice materials.

The mathematics division of the upgrade program evaluated the formal mathematics modules in the pipefitter apprentice program. From these modules it was determined that an apprentice needed mathematics skills that included proficiency in addition, subtraction, multiplication, division, fractions, decimals, ratio/proportion, plane geometry and basic algebra. (See Appendix C for the mathematics terminal objectives.) Learning exercises and criterion tests were created for all the mentioned areas (See Appendix D for selected samples of criterion objective mathematics tests.)

When a trainee successfully completed the battery of criterion objective tests for either section of the upgrade training, he was graduated from that phase of the program. As a trainee passed both the reading and mathematics sections, he went into apprenticeship training.

The experimental group was administered the Adult Basic Learning Examination (ABLE) at the beginning of the pre-apprentice training as a measure of achievement. A form of this test was also given when an employee graduated from the upgrade program and at six-month intervals within the program.
For diagnostic and placement purposes the experimental group was given the Stanford Diagnostic Reading Test and the Diagnostic Mathematics Inventory.

When ten or more upgrade trainees successfully completed the pre-apprentice training in both areas, the company agreed to start a new pipefitter apprentice class.

ADMINISTRATION OF POSTTESTS

Four randomly selected apprentice module tests were chosen by the researcher and company employees for comparison purposes. In each test situation, the company instructor taught the module, gave one of several forms of the modular tests, scored the tests, and reported the test results.

Module A, Algebra was taught during the fourth through the sixth weeks of the pipefitter apprentice class by an off-the-job instructor. Nine hours of instruction time was scheduled for this module. As expected, the three segments of this modular test (see Appendix E) were basically concerned with mathematics skills.

During the seventh through the ninth weeks of instruction the pipe apprentices took Module B, Applied Formulas, Tables, and Charts. The module and test took nine hours of off-the-job time. A sample copy of the
test (see Appendix F) showed that the examination dealt with reading and mathematics skills.

The eighteenth through the twenty-fifth weeks of off-the-job training were concerned with Module C, Physics. This module was allotted twenty-four hours of classroom instruction. The researcher combined the scores on six segments of the C, Physics modular test to use for statistical purposes. The test for this module (see Appendix G) combines both reading and mathematics skills.

The final test used for the purposes of this study was from Module D, Personal Protective Equipment. This unit of study was taught during the orientation week of the pipefitter apprentice class by an on-the-job instructor. This module took four hours and fifteen minutes for teaching and testing. A sample copy of the modular test (see Appendix H) indicated that the test was primarily involved with reading rather than mathematics skills.

TREATMENT OF DATA

After the researcher obtained permission to use the data from the petro-chemical complex, the test results were compiled, coded, and transferred to IBM code sheets. It was then punched on computer cards. Analysis of covariance, which took into account any differences
in the initial starting points of the individuals, was the statistical procedure used on the data.

From the statistics the researcher determined whether or not any significant differences arose from the apprentice test scores between the experimental and the control groups.
Chapter 4

PRESENTATION AND ANALYSIS OF DATA

The purpose of this chapter was to present and analyze the data pertinent to the problem of evaluating an upgrade training program. The statistical procedure used to accomplish this goal was analysis of covariance. The subjects in this study were eighty-one apprentices at a major petro-chemical complex in the Gulf Coast Area. Forty-nine of these subjects were assigned to the experimental group, and thirty-two were assigned to the control group. The study lasted eighteen months during 1976-1978.

The following null hypotheses were tested at the .05 level of significance:

1. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test A, Algebra than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates.

2. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test B, Applied Formulas, Tables, and Charts than employees who were not given pre-
apprentice training when using the combined effects of the pre-employment test battery as covariates.

3. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test C, Physics than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates.

4. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test D, Personal Protective Equipment than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates.

Analysis of Data on Module A, Algebra for Experimental and Control Groups

Null hypothesis number one stated: The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test A, Algebra than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates. The analysis presented in Table 1 indicated that there was a significant difference ($F=32.52$) in the scores on Module A, Algebra between the control group and the experimental group. The experimental group who received
Table 1

Analysis of Covariance on Scores from Module A, Algebra, for Group (Experimental and Control), Mathematics Ability (MA) Test Scores, Mechanical Ability (ME) Test Scores, Learning Ability (LA) Test Scores and Chemical Ability (CH) Test Scores

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group (Experimental and Control)</td>
<td>1</td>
<td>600.79</td>
<td>32.52**</td>
</tr>
<tr>
<td>MA</td>
<td>1</td>
<td>13.28</td>
<td>0.72</td>
</tr>
<tr>
<td>ME</td>
<td>1</td>
<td>56.46</td>
<td>3.06</td>
</tr>
<tr>
<td>LA</td>
<td>1</td>
<td>0.43</td>
<td>0.02</td>
</tr>
<tr>
<td>CH</td>
<td>1</td>
<td>35.52</td>
<td>1.92</td>
</tr>
<tr>
<td>Error</td>
<td>75</td>
<td>1385.61</td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>80</td>
<td>2075.65</td>
<td></td>
</tr>
</tbody>
</table>

**Significant at the .01 level.
remedial mathematics and reading instruction performed significantly better on the modular test than did the control group. As noted in the table, no covariate had any significant bearing on the results of the Module A, Algebra tests. From the data given, null hypothesis number one was rejected.

Analysis of Data on Module B, Applied Formulas, Tables, and Charts for Experimental and Control Groups

Null hypothesis number two read: The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test B, Applied Formulas, Tables, and Charts than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates. There was no significant difference between the scores on Module B in the experimental group and those of students in the control group when using the combined effects of MA, ME, LA, and CH pre-employment test results as covariates. Statistics reported on Table 2 revealed no significant differences (F=2.72) between the control group and the experimental group in test results from Module B, Applied Formulas, Tables and Charts. As shown in Table 2 the covariates had no significant effect on the Module B test results. Because there was no significant difference between the scores of the two groups, the null hypothesis was accepted.
Table 2

Analysis of Covariance on Scores from Module B, Applied Formulas, Tables, and Charts for Group (Experimental and Control), Mathematics Ability (MA) Test Scores, Mechanical Ability (ME) Test Scores, Learning Ability (LA) Test Scores, and Chemical Ability (CH) Test Scores

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group (Experimental and Control)</td>
<td>1</td>
<td>36.78</td>
<td>2.72</td>
</tr>
<tr>
<td>MA</td>
<td>1</td>
<td>44.61</td>
<td>3.30</td>
</tr>
<tr>
<td>ME</td>
<td>1</td>
<td>0.42</td>
<td>0.03</td>
</tr>
<tr>
<td>LA</td>
<td>1</td>
<td>1.07</td>
<td>0.08</td>
</tr>
<tr>
<td>CH</td>
<td>1</td>
<td>38.75</td>
<td>2.87</td>
</tr>
<tr>
<td>Error</td>
<td>75</td>
<td>1013.36</td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>80</td>
<td>1134.25</td>
<td></td>
</tr>
</tbody>
</table>
Analysis of Data on Module C, Physics for Experimental and Control Groups

Null hypothesis number three claimed: The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test C, Physics than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates. Data presented in Table 3 showed the experimental group performed significantly better (F=22.97) on the Physics Module C than did the control group. No covariate demonstrated significant influence over the test results. Null hypothesis number three was rejected.

Analysis of Data on Module D, Personal Protective Equipment

Null hypothesis number four asserted: The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test D, Personal Protective Equipment than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates. Data on Table 4 indicated that there was a significant difference between the modular test results for test D for the two groups. However, consulting Table 5, Means Adjusted for MA, ME, LA, and CH, one noted that the employees in the control
### Table 3

Analysis of Covariance on Scores from Module C, Physics for Group (Experimental and Control), Mathematics Ability (MA) Test Scores, Mechanical Ability (ME) Test Scores, Learning Ability (LA) Test Scores and Chemical Ability (CH) Test Scores

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>1</td>
<td>584.84</td>
<td>22.97**</td>
</tr>
<tr>
<td>MA</td>
<td>1</td>
<td>26.78</td>
<td>1.05</td>
</tr>
<tr>
<td>ME</td>
<td>1</td>
<td>0.33</td>
<td>0.01</td>
</tr>
<tr>
<td>LA</td>
<td>1</td>
<td>0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>CH</td>
<td>1</td>
<td>2.44</td>
<td>0.10</td>
</tr>
<tr>
<td>Error</td>
<td>75</td>
<td>1909.40</td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>80</td>
<td>2748.91</td>
<td></td>
</tr>
</tbody>
</table>

**Significant at the .01 level.
Table 4

Analysis of Covariance on Scores from Module D, Personal Protective Equipment for Group (Experimental and Control), Mathematics Ability (MA) Test Scores, Mechanical Ability (ME) Test Scores, Learning Ability (LA) Test Scores and Chemical Ability (CH) Test Scores

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group (Experimental and Control)</td>
<td>1</td>
<td>60.33</td>
<td>11.03**</td>
</tr>
<tr>
<td>MA</td>
<td>1</td>
<td>10.47</td>
<td>1.52</td>
</tr>
<tr>
<td>ME</td>
<td>1</td>
<td>0.92</td>
<td>0.17</td>
</tr>
<tr>
<td>LA</td>
<td>1</td>
<td>25.91</td>
<td>4.74*</td>
</tr>
<tr>
<td>CH</td>
<td>1</td>
<td>12.27</td>
<td>2.24</td>
</tr>
<tr>
<td>Error</td>
<td>75</td>
<td>410.15</td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>80</td>
<td>546.89</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at the .05 level.  ** Significant at the .01 level.
Table 5
Means on Modular Tests Adjusted for Scores on Mathematics Ability Test, Mechanical Ability Test, Learning Ability Test, and Chemical Ability Test

<table>
<thead>
<tr>
<th>N</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 (Control)</td>
<td>15.32</td>
<td>40.52</td>
<td>112.21</td>
<td>75.57</td>
</tr>
<tr>
<td>49 (Experimental)</td>
<td>21.94</td>
<td>42.15</td>
<td>118.74</td>
<td>73.48</td>
</tr>
</tbody>
</table>
group performed significantly better \( (F=11.03) \) on Module D, Personal Protective Equipment than did their counterparts in the experimental group. Because of the better scores of the control group, the fourth hypothesis was accepted. Also of significant importance on Table 4 was the adjustment made for the Learning Abilities Test.
Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to determine the effectiveness in part of a petro-chemical plant's pre-apprentice upgrade program.

Statement of the Problem

The following null hypotheses were tested using the .05 level of significance:

1. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test A, Algebra than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates.

2. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test B, Applied Formulas, Tables and Charts than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates.
3. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test C, Physics than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates.

4. The employees who were given a basic reading and mathematics improvement program would not score significantly higher on modular test D, Personal Protective Equipment than employees who were not given pre-apprentice training when using the combined effects of the pre-employment test battery as covariates.

It was assumed that acceptance or rejection of these hypotheses would aid in the partial evaluation of the pre-apprentice program.

Procedure

All employees of the petro-chemical plant were given pre-employment tests prior to being hired. This study was limited to eighty-one of those employees who received relatively low scores on this series of tests. The results of this test battery were used as covariates in the statistical procedures of the problem.

The experimental group of forty-nine students went into pre-apprentice training classes. There they received remediation in basic education skills. As soon
as a trainee met the predetermined objectives of the pre-apprentice program, he entered into a pipefitter apprentice program.

The control group of thirty-two employees did not receive any remedial help. They went directly into a pipe program.

The researcher randomly selected four apprentice modules to use for comparative purposes in this study. They were Module A, Algebra; Module B, Applied Formulas, Tables and Charts; Module C, Physics; and Module D, Personal Protective Equipment. The apprentice instructors taught the modules, gave the tests, scored them and reported the test results.

Results from the pre-employment test battery and from the selected modules were tallied and coded.

**Analysis of Data**

An analysis of covariance was computed for each of the modular tests. The F-ratio was tested for significance at the .05 level. An analysis of covariance table was presented that included the covariates which were the results from the pre-employment tests. An adjusted means table was also presented to help explain the data further.
Findings

The following findings were drawn from the results of the study:

1. Pipefitter apprentices who were given pre-apprentice basic skills training received significantly higher scores on modular test A, Algebra and modular test C, Physics.

2. Pipefitter apprentices who had pre-apprentice training achieved scores equivalent to pipefitter apprentices who had no pre-apprentice training on Module B, Applied Formulas, Tables, and Charts.

3. Pipefitter apprentices who had no pre-apprentice training performed better on Module D, Personal Protective Equipment tests than did apprentices who had pre-apprentice training.

CONCLUSIONS

The experimental group performed as well as or better than the control group on the three modular tests given by off-the-job instructors. They received poorer scores than the control group on the modular test given by the on-the-job instructors. The off-the-job apprentice classes and the pre-apprentice classes were both academically oriented, and both were taught by professional instructors employed by the petro-chemical complex.
Also of interest was the fact that the experimental group performed as well as or better than the control group on modules that took several days of study. They received poorer results on the module that was taught and tested during one instructional period.

A complete evaluation of the pre-apprentice program was impossible to make from the data in this study. It appeared as though the program may have been beneficial from the fact that the experimental group performed significantly better than did the control group a majority of the time. More research must be conducted before more definite statements concerning the evaluation of the pre-apprentice program could be made.

RECOMMENDATIONS

From the data obtained and analyzed in this study the following recommendations were made for further research:

1. More research should be carried out longitudinally over the three-year apprentice program with the same groups.

2. The amounts of failure and remediation within the apprentice program for these groups should be analyzed.

3. Comparisons between the amount of time a trainee spent in the pre-apprentice program and the scores on apprentice tests should be computed and interpreted.
4. Apprentice groups that received pre-apprentice training because of low pre-employment scores should be compared with other apprentice groups that did not receive low pre-employment test results.

5. Multiple regression equations should be used to analyze different pre-employment test score results and modular test results to see which pre-employment score or combinations of scores would best predict test results for given modules in the apprentice program.

6. Comparisons should be made between the levels of the apprentice training materials and the actual levels of skill required to perform a particular craft.

7. The achievement test results collected during the upgrade program should be analyzed to determine if individual gains were made and if so, to what degree.
BIBLIOGRAPHY
BIBLIOGRAPHY


Morning Advocate [Baton Rouge, Louisiana], March 2, 1977.


APPENDIX A

TERMINAL OBJECTIVES FOR READING
READING OBJECTIVES

PRE-APPRENTICE TRAINING PROGRAM

COMPREHENSION

1. Given one reading selection of 280 words, representative of on and off-the-job pipefitting apprentice material, at a readability level of 9.3, the student will correctly answer no less than 90% of the 10 questions pertaining to the content.

LOCATING INFORMATION

2. Given 2 paragraphs, representative of on and off-the-job pipefitting apprentice material, the student will read and locate with 100% accuracy information within the selection as required by 5 questions.

SEQUENCING

3. After reading one given paragraph, representative of on and off-the-job apprentice material, a student will sequence five events from the selection in their proper order.

WORD ATTACK SKILL

4. When viewing a list of fifteen (15) multi-syllabic words, the student will decode the words with no less than 90% accuracy.
APPENDIX B

SAMPLE TERMINAL OBJECTIVE TEST FOR READING
I. COMPREHENSION FORM B

DIRECTIONS: Read the selection and answer each question by placing the correct answer in the blank. You will not be allowed to look back at the selection to answer the questions. Read Carefully.

Cocks, or plug valves, operate by the rotation of a tapered plug which has a slot cut in it. When the slot is at right angles to the line, it is closed. Cocks are used where a positive shutoff is required, as in gas service. Cocks may have either screwed or flanged ends. To retain ease of operation cocks must be greased on a regular basis and this presents maintenance problems, so they should only be used where absolutely necessary.

Ball Valves are similar, in principle, to a cock except that a ball is used instead of a tapered plug. They are used when a quick-opening, tight shutoff valve is required such as natural gas service or snuffing steam.

Butterfly Valves are generally used for low pressures and temperatures such as water service. Particularly in the larger sizes, their small face to face dimension makes them preferable to a gate valve.
Check Valves are used to prevent reverse flow in pipe lines. The swing check is the most common type and it may have either screwed or flanged ends.

Ball Check valves are used only in the small sizes, and usually have threaded ends.

Wafer type check valves require much less space than the swing type which makes them very useful in certain situations. This type is simply installed between a pair of flanges, hence its name "wafer".

Control Valves are used to control the flow automatically. They are usually actuated by compressed air and may have either screwed or flanged ends. There are many variations in the types of control valves but one symbol will suffice for all types.
I. COMPREHENSION

DIRECTIONS: Read the selection and answer each question by placing the correct answer in the blank. You will not be allowed to look back at the selection to answer the questions.

1. Which valve is used to control flow automatically?

2. What valve is used to prevent reverse flow in pipelines?

3. Because of a maintenance problem which valve should be used only where absolutely necessary?

4. Which valve would be used for shutting off natural gas or snuffing steam?

5. Which valve is generally used for low pressures and temperatures?

6. Which valve gets its name from being installed between a pair of flanges?

7. What does preferable mean?

8. What does rotation mean?

9. What does tapered mean?

10. Why are valves important in pipe work?
II. LOCATING INFORMATION - FORM B

DIRECTIONS: Read the selection and answer each question in the blanks on the answer sheet. You will be able to reread the selection to locate the answers.

GENERAL INFORMATION ON SPUR GEARS

Gears are used to transmit power where no slippage can be tolerated. Gears are more expensive to use than belts, but belts allow slippage. Your automobile fan is driven by a V-belt, because some slippage is allowable. The timing mechanism, however, which must have a split-second relationship with the crankshaft and pistons, is gear driven. The relative velocities of the gears in mesh depend upon their pitch diameters.

1. Both belts and gears are used to transmit \underline{__________}.

2. It is usually cheaper to transmit power by \underline{__________}.

3. When no slippage can be allowed, we specify \underline{__________} to transmit power.

4. The camshaft of your automobile opens and closes the valves of each cylinder at split-second intervals. The camshaft is driven by \underline{__________}.

5. The relative velocities of meshing gears depend upon their \underline{__________}.
III. SEQUENCING - FORM B

DIRECTIONS: Read the selection carefully. You will not be allowed to look back at the selection. After you have read the selection place in numerical order the list of items given on the answer sheet.

CONDITIONS: You will be given a standard Saddle and Beveling Burning Machine, a power source, and assorted lengths of 6" carbon steel pipe.

PERFORMANCE: You are expected to:
- Complete pre-checks
- Install correct gears and cam as per chart
- Make necessary adjustments
- Cut two pieces of pipe 12" long with a bevel on both ends
- Cut two pieces 6" long, with a 6" on 8" pipe intersection saddle
- Shut down machine
- Clean up equipment

CRITERION: Your performance will be judged on the correct and safe operation of the burning machine. You will not be judged on the accuracy of the task. The instructor will grade you on ten different checkpoints during the test. You are required to perform nine of the ten correctly in a period of 30 minutes.
III. Sequencing

DIRECTIONS: Read the selection carefully. Place in numerical order the list below. You will not be allowed to look back at the selection.

- Make necessary adjustments
- Shut down machine
- Cut two pieces of pipe 12" long with a bevel on both ends
- Complete pre-checks
- Clean up equipment
IV. MULTI-SYLLABIC WORDS

Form B

DIRECTIONS: Pronounce each of the following words to your instructor.

evaporation
ins tillation
firefighting
ignition
immersed
underlining
specifications
terminal
presentation
electrically
hydraulic
polyethylene
increment
circumstance
horizontal
APPENDIX C

TERMINAL OBJECTIVES FOR MATHEMATICS
1. Given 20 problems in common and mixed fractions, the trainee will correctly solve no less than 18 of the problems with 90% accuracy.

2. Given 20 problems in decimals and decimal equivalents, the trainee will correctly solve no less than 18 problems with 90% accuracy.

3. Given 25 problems in ratio and proportions, the trainee will correctly solve no less than 23 problems with 90% accuracy.

4a. Given 32 problems in percentages, the trainee will correctly solve no less than 30 problems with 90% accuracy.

4b. Given 8 word problems in percentages, the trainee will correctly solve no less than 7 problems with 90% accuracy.

5a. Given 20 problems in general algebraic fundamentals, the trainee will correctly solve no less than 18 problems with 90% accuracy.

5b. Given 10 problems in addition of algebraic expressions, the trainee will correctly solve no less than 9 problems with 90% accuracy.

5c. Given 10 problems in subtraction of algebraic expressions, the trainee will correctly solve no less than 9 problems with 90% accuracy.

5d. Given 10 problems in multiplication of algebraic expressions, the trainee will correctly solve no less than 9 problems with 90% accuracy.

5e. Given 10 problems in division of algebraic expressions, the trainee will correctly solve no less than 9 problems with 90% accuracy.

5f. Given 10 problems in simplifying algebraic expressions, the trainee will correctly solve no less than 9 problems with 90% accuracy.

5g. Given 10 problems in finding the unknown, the trainee will correctly solve no less than 9 problems with 90% accuracy.

5h. Given 10 problems in solving algebraic formulas, the trainee will correctly solve no less than 9 problems with 90% accuracy.

5i. Given 10 word problems in algebra, the trainee will correctly solve no less than 9 problems with 90% accuracy.

6. Given 10 problems in square roots, the trainee will correctly solve no less than 9 problems with 90% accuracy.

7. Given 25 problems in trigonometry, the trainee will solve no less than 23 problems with 90% accuracy.
APPENDIX D

SAMPLE TERMINAL OBJECTIVE TESTS FOR
MATHEMATICS
Pre-Apprentice Training Program

TEST

DECIMALS AND DECIMAL EQUIVALENTS

DIRECTIONS: Work all problems to their completion. Emphasis should be placed on setting up the problems in an organized manner. Block in all final solutions.
Decimals and Decimal Equivalents
TEST

1. $1.32 \times 2.475$

2. $0.132 \times 2.475$

3. $0.0132 \times 2.475$

4. $0.00132 \times 2.475$

5. $10.1 \text{ divided by } 1300$

6. $1.066 \text{ divided by } 1300$

7. $0.0125 \text{ divided by } 2.5$
8. One gallon of water weighs 8.337 pounds. How much will 10.21 gallons weigh?

9. One cubic foot of water weighs 62.4 pounds. How much will 6.32 cubic feet weigh?

10. One gallon contains 268.8 cubic inches. How many gallons are 17.14 cubic inches?

11. Water weighs 8.34 pounds per gallon. A drum will hold 53.7 gallons. How much would the water in a full drum weigh?

12. A water tank holds 79.2 gallons per foot of height. If the tank is filled to a height of 6.3 feet, how many gallons of water are in the tank?

13. A jet fuel tank holds 3146 barrels for each foot of height. If the tank is filled to a height of 18.9 feet, how many barrels does it hold?
14. You have to drill a bolt hole in a metal plate for a 9/32 inch bolt. The drill size should be 1/64 inch larger than the bolt. What size drill do you need?

15. You have a bolt hole to drill for a 3/8 inch bolt. The drill should be about 1/64 inch larger than the bolt. You have only these lettered-size drills to use: A, H, J, N, P, T, U, W. This table gives the sizes:

\[
\begin{align*}
A &= 0.234 \text{ inches} \\
H &= 0.266 \quad " \\
J &= 0.277 \quad " \\
N &= 0.302 \quad " \\
P &= 0.323 \quad " \\
T &= 0.358 \quad " \\
U &= 0.368 \quad " \\
W &= 0.386 \quad "
\end{align*}
\]

Which lettered drill would you select?

16. You have to drill a hole for a metric-sized rod. The hole size must be 7.62 millimeters. You have only these lettered drills: A, H, J, N, P, T, U, W. These lettered drill sizes are given in the previous problem and the conversion is one inch = 25.4 millimeters. Which drill would you select?

17. A barrel of crude oil contains 42 gallons. A barge customer wants to buy 156,000 gallons of oil but the tank gauges are in barrels. How many barrels would you load on his barge?
Decimals and Decimal Equivalents--Page 4

18. There are 60 minutes in one hour. How many hours is 15 min? 20 min? 25 min? 40 min? 110 min?

19. Determine the decimal equivalent of these:
   \[ \frac{1}{16} \quad \frac{7}{32} \quad \frac{1}{8} \quad \frac{2}{7} \quad \frac{1}{16} \]

   a. ___ b. ___ c. ___ d. 10___ e. 1___

   16 32 8 7 16

20. \[ 16 + 0.21 + 8 = \]
Pre-Apprentice Training Program

TEST

RATIO AND PROPORTION

DIRECTIONS: Work all problems to their completion. Emphasis should be placed on setting up the problems in an organized manner. Block in all final solutions.
Ratio and Proportion Test--Page 1

Which of the following are true proportions?

1. \( \frac{3}{5} = \frac{21}{35} \)

2. \( \frac{21}{5} = \frac{35}{3} \)

3. \( \frac{5}{35} = \frac{3}{21} \)

4. \( \frac{5}{12} = \frac{6}{14.4} \)
Ratio and Proportion Test—Page 2

5. \( \frac{3}{5} = \frac{21}{35} \)

6. \( \frac{21}{5} = \frac{35}{3} \)

7. \( \frac{5}{35} = \frac{3}{21} \)

8. \( \frac{5}{12} = \frac{6}{14.4} \)

9. \( \frac{7}{8} = \frac{8}{7} \)

10. \( \frac{5}{16} = \frac{50}{160} \)

11. \( \frac{7}{9} = \frac{56}{72} \)
Ratio and Proportion Test--Page 3

12. \( \frac{\frac{1}{52}}{3} = \frac{4}{\frac{1}{62}} \)

13. \( \frac{14.2}{23.6} = \frac{31.24}{51.92} \)

14. \( \frac{3}{8} = \frac{3.3}{8.8} \)

15. \( \frac{4}{13} = \frac{2}{\frac{1}{62}} \)

16. \( \frac{5}{7A} = \frac{10}{14A} \)

17. \( \frac{2.4B}{0.8} = \frac{6B}{2} \)

18. \( \frac{16.2}{3} = \frac{17.8}{3.6} \)
19. A solvent, SOL-X, is a blend of varsol and an additive, N-CHLOR, in the proportions of one quart of N-CHLOR to one barrel of varsol. To 11 barrels of varsol, how much N-CHLOR must be added?

20. If 4 men can do a particular job in 11 hours, how long would it take 6 men to do the same job? Note that the number of men needed is inversely proportional to the number of hours required.
21. An 8 1/2 pound ham costs $13.60. How much should a 9 pound, 12 ounce ham cost? (Suggestion: convert both weights to pounds and decimal fractions of a pound before setting up the problem. 16 ounces = one pound)

22. Two pulleys are belted together. The larger is 12" in diameter and makes 400 revolutions per minute. The smaller makes 650 revolutions per minute. The pulley diameters are inversely proportional to their speeds. What is the diameter of the smaller pulley?

23. The volume of gas varies directly with its absolute temperature if pressure is constant. A volume of gas was measured as 3,000 cubic feet when its temperature was 273° absolute. Assuming constant pressure, what will be the volume of this gas at 372° absolute?
24. The volume of a gas varies inversely as its absolute pressure if temperature is constant. If an amount of gas occupies 3,250 cubic feet at 125 pounds per square inch absolute pressure, what volume does it occupy at 400 pounds per square inch absolute pressure, assuming constant temperature?

25. An 800 foot length of copper wire has a resistance of 2.168 ohms. The longer the wire, the greater the resistance. What is the resistance of 3,000 feet of wire?
DIRECTIONS: Work all problems to their completion. Emphasis should be placed on setting up the problems in an organized manner. Block in all final solutions.
DIRECTIONS: Solve each of these multiplication problems.

1. \((x)(x)(x^3) = \)

2. \((x^2y)(-xy)(xy) = \)

3. \((a^2)(-ab^3) = \)

4. \((-x^2)(-3x)(-2x^3) = \)

5. \(2b^2 - 2b - 3a\)

6. \(8a - 3b\)
   \(4a + 2b\)

7. \(2x + y\)
   \(2x + y\)

8. \(5x + 3y\)
   \(5x - 3y\)

9. \(2a + b + 2c\)
   \(3a + b + 3c\)

10. \(3ab + 2ab^2\)
    \(5ab - 3ab^2\)
APPENDIX E

SAMPLE TEST FOR MODULE A, ALGEBRA
<table>
<thead>
<tr>
<th>Segment Number</th>
<th>Score Right/Total</th>
<th>Minimum To Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>/8</td>
<td>7/8</td>
</tr>
<tr>
<td>2</td>
<td>/8</td>
<td>7/8</td>
</tr>
<tr>
<td>3</td>
<td>/8</td>
<td>7/8</td>
</tr>
</tbody>
</table>

This test is divided into 3 segments corresponding to the segments of the programmed text. The minimum passing requirement for each segment is 7 correct answers out of 8.

Read problems carefully, and follow all directions. Show all work. You have 1 1/2 hours to complete the test.
ALGEBRA

Segment

- Minimum requirement for passing: 7 correct answers out of 8.

Calculate the value of the unknown quantity in each of these equations.

1. \( x - 6 = 8 \)
   \[ x = \quad \]

2. \( h = \sqrt{9^2 + 12^2} \)
   \[ h = \quad \]

3. \( a + 19 = 5a - 25 \)
   \[ a = \quad \]

4. \( \frac{65}{x} = 5 \)
   \[ x = \quad \]

5. \( 5(x - 2y) - (2x - 3y) = 3 \)
   \[ x = \quad \]

6. \( (k + 7) - (k - 26) = 6(k - 1\frac{1}{2}) \)
   \[ k = \quad \]

7. \( \frac{x}{5} - \frac{x}{10} = 2 \)
   \[ x = \quad \]

8. \( \frac{1}{x} + \frac{1}{16} = \frac{1}{8} \)
   \[ x = \quad \]
TEST

Segment - Minimum requirement for passing: 7 correct answers out of 8.

1. Solve \( B = \frac{0.785d^2h}{5.6} \) for \( d \).

\[ d = \underline{\phantom{000}} \]

2. Solve \( \frac{F_1}{F_2} = \frac{d_1^2}{d_2^2} \) for \( d_1 \).

\[ d_1 = \underline{\phantom{000}} \]
3. When the specific gravity of a substance is known, the API gravity may be calculated by the formula:

$$ API\ Gravity = \frac{141.5}{Specific\ Gravity} - 131.5 $$

To one decimal place, what is the API gravity of a kerosene whose specific gravity is 0.8255?

Answer ________________

4. The capacity in barrels of a cylindrical tank can be calculated by the formula:

$$ B = \frac{0.785d^2h}{5.0} $$

Where

- \( B \) = capacity in barrels
- \( d \) = tank diameter in feet
- \( h \) = tank height in feet

To the nearest barrel, how many barrels will a cylindrical tank hold that has a diameter of 115 ft and is 40 ft high?

Answer ________________
5. If a slide is placed in a slide projector 8 inches from the lens, and the image is sharp on a screen 360 inches from the lens on the other side, what is the focal length of the lens? Round off to the nearest hundredth of an inch.

Use the formula: \( \frac{1}{D_o} + \frac{1}{D_i} = \frac{1}{f} \)

Where:
- \( D_o \) = distance from object to lens
- \( D_i \) = distance from image to lens
- \( f \) = focal length of lens

Answer ___________________

6. When a motor, engine, or turbine is tested on a Prony brake, its brake horsepower can be determined by the formula:

\[ \text{bhp} = \frac{\pi d(F_1 - F_2) \text{rpm}}{33,000} \]

Where:
- \( \text{bhp} \) = brake horsepower
- \( \pi = 3.14 \)
- \( d \) = Prony brake drum diameter in feet
- \( F_1 \) = larger spring balance reading in pounds
- \( F_2 \) = smaller spring balance reading in pounds
- \( \text{rpm} \) = revolutions per minute

Find the brake horsepower of an engine that at 3,000 rpm produced Prony brake spring balance readings of 325 lb and 75 lb. Drum diameter was 2 ft. Round off to the nearest whole number.

Answer ___________________
7. A chain fall has an actual mechanical advantage of 16.2. If its large and small wheels have radii of 18 inches and 17 inches, what is the efficiency of the device, expressed in %? A formula for the actual mechanical advantage of a chain fall is:

\[ \text{AMA} = \frac{2RE}{R-r} \]

Where

- AMA = actual mechanical advantage
- R = radius of larger wheel
- E = efficiency as a decimal
- r = radius of smaller wheel

Answer

8. If an electric motor running at 3570 rpm develops 1,030 pound-feet of torque, what horsepower is it delivering? Round off to the nearest whole number.

\[ hp = \frac{TN}{5252} \]

Where

- hp = horsepower
- T = torque in pound-feet
- N = revolutions per minute

Answer
TEST

Segment - Minimum requirement to pass: 7 correct answers out of 8.

1. An experienced man can inspect the fire fighting and safety equipment on a certain process unit in 8 hours. A qualified trainee works with him, and the two complete the job in 4.8 hours. How long would it have taken the trainee to make the inspection alone?

Answer __________________________

2. A heavy fuel blend having a Viscosity Blending Value of 20.96 is to be made from reduced crude (Viscosity Blending Value 14.60) and gas oil (Viscosity Blending Value 56.41). What % of each component must be used? Round off to the nearest tenth of one per cent.

Reduced Crude ________________

Gas Oil ________________
3. A rectangle that has an area of 600 square inches is $1 \frac{1}{2}$ times as long as it is wide. Calculate its width and length.

Width _______________________

Length _______________________

4. Together, three gasoline loading pumps can pump 21,000 barrels per hour. The smallest can pump only half as much as the second. The third pumps 5,000 barrels per hour more than the smallest. What is the pumping rate for each?

Smallest _______________________

Second _______________________

Third _______________________
5. A train leaves a station and travels at 45 miles per hour. Two hours later a second train leaves the same station and travels in the same direction. How long must the second train travel at 60 miles per hour to overtake the first?

Answer

6. Pump P-102 can fill a tower with wash oil in 16 hours. Pump P-103 can fill the same tower in 24 hours. Assuming constant full pumping rates for both pumps, how long will it take them, working together, to fill the tower?

Answer
7. A painting contractor assigned 8 crews to paint the tanks in a tank field. Two crews were transferred before the work began, and each of the remaining crews was assigned 6 more tanks. How many tanks were there in the field?

Answer _______________________

8. For proper heat transfer, the fins on a particular finned heater must be 40 times as wide as they are thick. If the cross-sectional area of a fin is 10 in², what are the thickness and width of the fin?

Thickness _______________________

Width _______________________

Segment (Continued)
APPENDIX F

SAMPLE TEST FOR MODULE B, APPLIED FORMULAS, TABLES, AND CHARTS
APPLIED FORMULAS, TABLES, AND CHARTS

This test is divided into three segments. Each segment contains directions and also the minimum requirements for passing the segment.

You are allowed 1 1/2 hours for the entire test.
Minimum requirement for passing: 8 correct answers out of 10.

Below are several formulas identified by letters. Answer questions numbers 1, 2, and 3, by selecting the correct formula for each, and writing its identifying letter in the blank.

(a) \( B = 0.1399d^2 h \)

Where: 
\( B = \) barrels
\( d = \) diameter in feet
\( h = \) height in feet

(b) \( B = 0.093256d^3 \)

Where: 
\( B = \) barrels
\( d = \) diameter in feet

(c) \( G = 3.927d^2 h \)

Where: 
\( G = \) gallons
\( d = \) diameter of circular cross section in feet
\( h = \) height in feet

(d) \( V = LWH \)

Where: 
\( V = \) volume
\( L = \) length
\( W = \) width
\( H = \) height or altitude

(e) \( G = 0.04079991d^2 L \)

Where: 
\( G = \) gallons
\( d = \) diameter in inches
\( L = \) length in feet

(f) \( V = 0.262h(D + d + Dd) \)

Where: 
\( V = \) volume
\( h = \) height
\( D = \) diameter of one base
\( d = \) diameter of other base

1. To calculate the capacity of a pipeline in gallons, use formula _____.
2. To calculate a chemical plant sphere's capacity in barrels, use formula _____.
3. To calculate the capacity of a rectangular prism, use formula _____.

Solve problems numbers 4, 5, and 6, for unknown quantities as directed. Show work.

4. \( B = 0.1399d^2 h \). Solve for \( d \). 

\[ d = \]
5. \( E = \frac{PL}{AV} \). Solve for \( A \).

\[ A = \underline{\text{ }} \]

6. \( h^2 = a^2 + b^2 \). Solve for \( a \).

\[ a = \underline{\text{ }} \]

SOLVE PROBLEMS NUMBERS 7 THROUGH 10 AS DIRECTED. SHOW ALL WORK ON THESE PAGES OR ON ATTACHED SCRATCH PAPER.

7. A shaft 3.5" in diameter is to be turned in a lathe at a cutting speed of 120 feet per minute. To the nearest whole number, for how many rpm should the lathe be set?

Use the formula:

\[ N = \frac{12C}{\pi D} \]

Where:

- \( N \) = revolutions per minute (rpm)
- \( C \) = cutting speed in feet per minute
- \( \pi \) = (closely enough) 3.14
- \( D \) = diameter of work in inches

\[ N = \underline{\text{ }} \]
8. The area of a sector of a circle can be found by the formula:

\[ A = \frac{\pi r^2 \theta}{360} \]

Where: 
- \( A \) = area of a sector
- \( \pi \) = (closely enough) 3.14
- \( r \) = radius
- \( \theta \) = size of central angle in degrees

What is the area of the sector below?

\[ A = \]
9. How many BTU are required to raise the temperature of 350,000 pounds of asphalt from 125°F to 350°F? Asphalt has a specific heat of 0.55.

Use the formula:

\[ Q = M \cdot s \cdot dt \]

Where:
- \( Q \) = amount of heat in BTU
- \( M \) = weight in pounds
- \( s \) = specific heat
- \( dt \) = temperature change in °F

\[ Q = \underline{\phantom{0000}} \]
10. A formula for calculating heat transfer is:

\[ Q = UA\Delta T \]

Where:
- \( Q \) = rate of heat transfer in BTU/hour
- \( U \) = heat transfer coefficient, BTU/hour (ft\(^2\))(°F)
- \( A \) = area through which heat is flowing, in square feet
- \( \Delta T \) = temperature difference in °F

A 40 square foot area of steam line is bare of insulation. The pipe wall has a heat transfer coefficient of 15. Inside pipeline temperature is 400°F and outside temperature is 100°F. How many BTU/hour are lost through the bare section of line?

\[ \text{BTU/hr} = \underline{\phantom{0000}} \]
Minimum requirement for passing: 15 correct answers out of 18.

USE THE TABLE BELOW IN ANSWERING QUESTIONS NUMBERS 1, 2, AND 3.

<table>
<thead>
<tr>
<th>GALLONS PER MINUTE</th>
<th>BARRELS PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 gpm</td>
<td>7 B/H</td>
</tr>
<tr>
<td>20 gpm</td>
<td>14.3 B/H</td>
</tr>
<tr>
<td>30 gpm</td>
<td>21.7 B/H</td>
</tr>
<tr>
<td>40 gpm</td>
<td>28.6 B/H</td>
</tr>
<tr>
<td>50 gpm</td>
<td>35.5 B/H</td>
</tr>
<tr>
<td>60 gpm</td>
<td>42.3 B/H</td>
</tr>
<tr>
<td>70 gpm</td>
<td>49.1 B/H</td>
</tr>
<tr>
<td>80 gpm</td>
<td>55.8 B/H</td>
</tr>
<tr>
<td>90 gpm</td>
<td>62.6 B/H</td>
</tr>
</tbody>
</table>

1. How many barrels per hour correspond to 600 gpm?
   Answer: 92 B/H

2. How many barrels per hour correspond to 110 gpm?
   Answer: 8.6 B/H

3. How many barrels per hour correspond to 230 gpm?
   Answer: 11.4 B/H
REFER TO THE SECTION OF TABLE BELOW FOR ANSWERS TO QUESTIONS NUMBERS 4, 5, AND 6.

INCHES AND FRACTIONS CONVERTED TO DECIMAL FRACTIONS OF A FOOT

<table>
<thead>
<tr>
<th>Inches</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/32</td>
<td>0.0031</td>
<td>0.0125</td>
<td>0.0237</td>
<td>0.0353</td>
<td>0.0475</td>
<td>0.0543</td>
<td>0.0639</td>
<td>0.0741</td>
<td>0.0849</td>
<td>0.0963</td>
<td>0.1083</td>
<td>0.1203</td>
</tr>
<tr>
<td>1/16</td>
<td>0.0062</td>
<td>0.0250</td>
<td>0.0375</td>
<td>0.0500</td>
<td>0.0625</td>
<td>0.0750</td>
<td>0.0875</td>
<td>0.1000</td>
<td>0.1125</td>
<td>0.1250</td>
<td>0.1375</td>
<td>0.1500</td>
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<tr>
<td>3/32</td>
<td>0.0187</td>
<td>0.0562</td>
<td>0.0765</td>
<td>0.0968</td>
<td>0.1171</td>
<td>0.1375</td>
<td>0.1578</td>
<td>0.1781</td>
<td>0.1984</td>
<td>0.2187</td>
<td>0.2391</td>
<td>0.2594</td>
</tr>
</tbody>
</table>

4. What decimal fraction of a foot is equal to 9 1/32"?
Answer: ________________

5. 5 1/16" corresponds to what decimal fraction of a foot?
Answer: ________________

6. What decimal fraction of a foot corresponds to 6 3/32"?
Answer: ________________

QUESTIONS NUMBERS 7 THROUGH 18 CONCERN STEPS IN THE PREPARATION OF A TABLE OF CORRESPONDING VALUES. DO THE WORK REQUIRED TO ANSWER THESE QUESTIONS ON THE PARTLY RULED PAGE THAT FOLLOWS THE QUESTIONS.

USE THE FOLLOWING INFORMATION IN ANSWERING THE QUESTIONS.

To save time in the operation of a lathe, it is desirable to prepare a table showing cutting speeds in feet per minute related to revolutions per minute. To be included in the table are:

Cutting speeds (feet per minute): 20, 40, 60, 80, 100, 120, 140, 160, 180, and 200.

Diameters of work (inches): 1, 1 1/2, 2, 2 1/2, 3, 3 1/2, 4, 4 1/2, 5, 5 1/2, 6, 6 1/2

Use the formula:

\[ N = \frac{120C}{\pi D} \]

Where:
- \( N \) = revolutions per minute
- \( C \) = cutting speed in feet per minute
- \( n \) = (closely enough) 3.14
- \( D \) = diameter of work in inches
7. Write a suitable title for the table.

WRITE PROPER IDENTIFICATIONS FOR THE SECTIONS OF THE TABLE THAT WILL CONTAIN:

8. Cutting speeds in feet per minute.
9. Work diameters in inches.
10. Revolutions per minute.

11. Write in the cutting speeds and work diameters listed above.

REVOLUTIONS PER MINUTE CORRESPONDING TO SEVERAL WORK DIAMETERS AND CUTTING SPEEDS ARE LISTED BELOW. WRITE IN EACH OF THESE REVOLUTIONS PER MINUTE IN THE PROPER PLACE IN THE TABLE.

12. 3 1/2" diameter, 120 feet per minute,
    131 revolutions per minute
13. 1" diameter, 80 feet per minute,
    306 revolutions per minute
14. 5" diameter, 100 feet per minute,
    76 revolutions per minute
15. 1 1/2" diameter, 120 feet per minute,
    306 revolutions per minute
16. 6" diameter, 60 feet per minute,
    38 revolutions per minute
17. 4" diameter, 40 feet per minute,
    38 revolutions per minute
18. 2 1/2" diameter, 200 feet per minute,
    306 revolutions per minute
USE THIS SHEET IN ANSWERING QUESTIONS NUMBERS 7 THROUGH 18.

\[ N = \frac{12 \cdot C}{\pi \cdot D} \]
Segment 3

Minimum requirement for passing: 14 correct answers out of 17.

Find answers to questions numbers 1 and 2 from the chart below.

1. What % excess air corresponds to 2.8% oxygen in flue gas?

Answer: _________
2. If furnace flue gas contains 4.1% oxygen, what % excess air is going to the furnace?

Answer: _________________

FIND ANSWERS TO QUESTIONS NUMBERS 3 AND 4 FROM THE CHART BELOW.
3. A vertical cylindrical tank has a diameter of 85'. How many barrels does the tank hold per foot of height?

Answer:

4. How many barrels per foot of height does a vertical tank hold if its diameter is 60'?

Answer:

Find answers to questions numbers 5 and 6 from the chart below.

**RELATION OF A. P. I. GRAVITY TO SPECIFIC GRAVITY AND DENSITY**

<table>
<thead>
<tr>
<th>Specific Gravity</th>
<th>Pounds per Gallon</th>
<th>Pounds per Barrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>0.6</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>0.7</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>0.9</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Enter the chart at the degrees A.P.I. scale, intersect the desired curve, and read the desired value on the proper scale at the left.
5. An oil sample has an A.P.I. gravity of 45. What is its specific gravity?

Answer: 

6. What is the weight of a barrel of oil if its A.P.I. gravity is 45?

Answer: 

USE THE NOMOGRAM BELOW TO FIND ANSWERS TO QUESTIONS NUMBERS 7 AND 8.
7. The volume % of CO₂ in flue gas from a furnace is 10.5%, and O₂ is 2.5%. What % excess air is going to the furnace? 
   Answer: 

8. An analysis of furnace flue gas shows 12% CO₂ and 3% O₂. What % excess air is going to the furnace? 
   Answer: 

Answer questions 9 through 17 by doing the directed work on the partially completed intersection chart below.

ON THE CHART ABOVE PLOT THESE PUMPING RATES, ALL OF WHICH CORRESPOND TO A VELOCITY OF 3 FEET PER SECOND.
10. Diameter 12", pumping rate, 1,512 barrels per hour.
11. Diameter 8", pumping rate, 672 barrels per hour.
12. Diameter 6", pumping rate 378 barrels per hour.
13. Diameter 4", pumping rate 168 barrels per hour.
14. Diameter 3", pumping rate 94.5 barrels per hour.
15. Diameter 2", pumping rate 42 barrels per hour.
16. Diameter 1", pumping rate 10.5 barrels per hour.
17. Draw as smooth a curve as you can connecting all the plotted points.
APPENDIX G

SAMPLE TEST FOR MODULE C, PHYSICS
Name ____________________________
Date ____________________________

PRACTICAL SCIENCE

This test covers Segment Practical Science. All necessary directions are included, and also the minimum requirement for passing the segment. Follow directions carefully.
You are allowed 30 minutes' for this test segment.
Segment: Minimum passing requirement:
27 correct answers out of 30.

Complete each of statements 1 through 7 by filling in each blank with the correct word or group of words from the list below. You may use a word more than once. There are more words in the list than you need.

- weak acid
- orange
- carcinogenic
- carbohydrates
- red
- strong base
- hydrocarbons
- euphoric
- fluorocarbons
- weak base
- frostbite
- corrosive
- neutrons
- green
- strong acid
- acidosis
- burns
- abrasive

1. High boiling aromatic oils are considered to be ____________________ because they have caused cancer in laboratory animals.

2. Petroleum (crude oil) is a mixture of several hundred different ____________________.

3. Sulfuric acid is a ____________________.

4. Both strong acids and strong bases are very ____________________.

5. Safety showers and eyewash fountains are painted fluorescent ____________________.

6. Caustic soda is a ____________________.

7. If you leave caustic soda on you skin, it causes severe chemical ____________________.
Segment--continued

For each statement 8 through 17, underline the word or group of words in parentheses that correctly completes the sentence.

8. Chlorine gas is (colorless/very toxic and irritant/ odorless/non-toxic).
9. Ammonia is (pleasant smelling and bland/mild and harmless/strongly irritant and corrosive).
10. Hydrogen sulfide -H₂S- is (highly toxic/safe to breath/dangerous only in high concentrations).
11. If you get any chemicals in your eyes, you should wash it out (at the end of your shift/whenever it is convenient/immediately), using an eyewash fountain if available.
12. If you get any corrosive chemical on your skin you should wash it off (whenever it is convenient/at the end of your shift/immediately).
13. Exposure to high concentrations of benzene in air (can cause death/is harmless/never causes more harm than a skin rash).
14. After washing any chemical from your eyes, you should report to the (Employee Relations/Solvents and Specialties/Medical) Department.
15. Chemical reactions are involved in the operations of (only refineries/only chemical plants/both plants/neither plant).
16. Personal protective equipment can (often/seldom/never) prevent injury from chemicals.
17. The biggest reason for care in handling chemicals is that some are (dangerous if mishandled/expensive/likely to contaminate products).
Segment - continued

Mark each of statements 16 through 22 T or F (for true or false). These examples of typical warning signs will help you.
DANGER

ACID

CAUTION

THIS EQUIPMENT CONTAINS TOXIC MATERIAL
AVOID BREATHING VAPORS
AVOID SKIN CONTACT
18. The DANGER sign for hydrogen sulfide gives the formula for this material as H₂SO₄.

19. The warning sign shown for acid is a CAUTION sign (not a DANGER sign).

20. One of the signs says that if your skin becomes irritated from contact with high boiling aromatic oil, you are to report to the Medical Department.

21. The DANGER-CAUSTIC sign is used as a warning for sodium hydroxide.

22. The CAUTION sign shown that is used for benzene does not contain the word benzene, but does contain the words toxic material.
Below are the two sides of a CAUTION tag. Find in these illustrations answers to questions 23 through 30 and write them in the blanks provided.

- Segment: continued

**THIS SAMPLE OR EQUIPMENT CONTAINS OR HAS CONTAINED**

- [ ] HYDROGEN SULFIDE GAS
- [ ] OR THE FOLLOWING CORROSIVE OR TOXIC MATERIALS
  - [ ] PHENOL
  - [ ] SULFURIC ACID
  - [ ] CAUSTIC SODA
  - [ ] HIGH BOILING CRACKED OILS
  - [ ] (OTHER)

**DO NOT INHALE VAPORS OR LET LIQUID TOUCH SKIN.**
If skin contact occurs wash immediately with soap and water.

**TAKE NECESSARY PRECAUTIONS WHEN HANDLING OR WORKING ON THIS EQUIPMENT.**

*SEE OTHER SIDE*

---

**FOR ADDITIONAL INFORMATION SEE THESE SAFETY STANDARDS.**

- [ ] 139 HYDROGEN SULFIDE
- [ ] 141 CAUSTIC SODA
- [ ] 132 HANDLING HIGH BOILING AROMATIC OILS
- [ ] 133 HANDLING BENZENE, TOLUENE & XYLENE

---

*39040 A*
Concerning the materials listed, the tag says, "Do not ___________ vapors ... ."

The tag also says, do not "... let ___________ touch skin."

The tag says, "If skin contact occurs, _______________ ... ."

One side of the tag says, "For additional information see these Safety ________________ ."

Safety Standard No. _____ covers hydrogen sulfide.

Caustic Soda is covered by Safety Standard No. ____________ .

Safety Standard No. 132 covers the handling of high boiling ________________ oils.

Safety Standard No. 133 covers the handling of ____________, toluene, and xylene.
This test covers Segment Two of Practical Science. All necessary directions are included, and also the minimum requirements for passing the segment. Follow directions carefully. You are allowed 12 minutes for this test segment.
Most scientists believe that all matter is composed of extremely small particles, these particles are in constant random motion, some of them have much greater velocities than others, these particles are composed of smaller particles which are composed of still smaller fundamental particles. Which of the following best names this collection of beliefs? (Check one).

a. The molecular theory.

b. The Pythagorean theorem.

c. The theory of complex numbers.

d. Heisenberg's uncertainty principle.

e. The theory of celestial mechanics.

Complete statements 2 through 10 by filling in each blank with the correct word or group of words from the list below. There are more words in the list than you need. You may use a word or group more than once.

- velocity
- solid
- inertia
- volume
- force
- mass
- matter
- cohesion
- energy
- weight
- shape
- liquid
- capillary action
- density
- gas

2. Matter that has a definite volume but an indefinite shape is in the ___________________ state.

3. Anything that has weight and occupies space is called ____________.
TEST

Segment continued...

4. A _______________ is a push or a pull.

5. The actual amount of matter in a body is called the _______________ of the body.

6. _______________ is the ability to do work.

7. Matter that has both a definite volume and a definite shape is in the _______________ state.

8. Matter that assumes both the volume and the shape of its container is in the _______________ state.

9. The force of gravity acting on a body is called the _______________ of the body.

10. Resistance to a change in motion is called _______________.
This test covers Segment Three of Practical Science. All necessary directions are included, and also the minimum requirements for passing the segment.
Follow directions carefully.
You are allowed 17 minutes for this test segment.
TEST

Segment — Minimum requirement for passing: 9 correct answers out of 11

Questions nos. 1 through 5 are incomplete statements. Circle the letter beside the word or group of words that best completes each statement.

1. The density of a material is the ratio of its
   a. size and area.
   b. height and width.
   c. weight and volume.

2. A material is ductile if it can be
   a. deformed.
   b. drawn into fine wires.
   c. melted.

3. Stress and strain are
   a. equal.
   b. dimensionless numbers.
   c. proportional.

4. When the elastic limit of a material is exceeded, the material is
   a. melted.
   b. permanently deformed.
   c. drawn into fine wires.

5. When a material is subjected to a force greater than its ultimate strength, the material
   a. congeals.
   b. boils.
   c. breaks.
Show your work in solving the following problems. Note that each problem counts as several questions.

6-8 (Counts as 3 questions). A refinery sphere is designed to withstand a pressure of 87.6 psia. The greatest pressure it is expected to contain is 21.9 psia. What is the spheroid's safety factor?

Answer ____________________________

9-11 (Counts as 3 questions). An oak timber is 12" x 12" x 16' in size and weighs 832 lb. What is its density?

Answer ____________________________
This test covers Segment four of Practical Science. All necessary directions are included, and also the minimum requirements for passing the segment.

Follow directions carefully.

You are allowed 26 minutes for this test segment.
TEST

Segment - Minimum requirement for passing:
16 correct answers out of 21.

Complete statements 1 through 6 by filling in each blank with the correct word or words.

1. The specific gravity of a liquid is the density of the liquid divided by the density of ____________________.

2. In a liquid, internal friction is called ________________.

3. Pressure is force per unit of __________________________.

4. The height of a column is often called ________________.

5. The more readily a liquid can be changed to the vapor state, the higher its ________________.

6. A body that is placed in a liquid is buoyed up by a force equal to the weight of the ________________ ________________.

Complete each of statements 7 through 12 by underlining the correct word or group of words in parentheses.

7. The specific gravity of a liquid can be measured by using a (hydrofoil/hydrometer/hydrocarbon.)

8. A liquid (has/does not have) a definite shape.

9. A liquid (has/does not have) a definite volume.

10. A liquid can be compressed (very easily/very little).
11. A liquid has (very great/very little) elasticity.

12. Specific gravity has (the same units as force/the same units as weight/no units).

Solve the following problems, selecting the proper formulas from the group below. Show all work. Note that each problem counts as several questions.

- \( F = PA \)
- \( P = \frac{F}{A} \)
- \( A = \pi r^2 \)
- \( \text{in}^2 = 1 \text{ft}^2 \)
- \( \frac{F_1}{F_2} = \frac{A_1}{A_2} \)
- \( \frac{F_1}{F_2} = \frac{D_1^2}{D_2^2} \)
- \( \frac{F_1}{F_2} = \frac{s_2}{s_1} \)
- \( Q = Av \)

13-14. (Counts as 2 questions). A force of 9,000 lb. is distributed uniformly over an area of 2 1/2 ft. In psi, what pressure does this force exert?

Answer ____________________________
15-16. (Counts as 2 questions). What street level water pressure is required to raise water to the top of the Empire State Building (1,250 ft)?

Answer

17-19. (Counts as 3 questions). The pistons of a hydraulic press have diameters of 2.5" and 50". If a force of 25 lb is applied to the smaller piston, what force is exerted by the larger?

Answer
20-21. (Counts as 2 questions). Gasoline is being pumped through a 12" diameter pipe line at a velocity of 30 ft/sec. What is the flow in ft$^3$/sec?

Answer ____________________
Practical Science

This test covers Segment 5 of Practical Science. All necessary directions are included, and also the minimum requirements for passing the segment.

Follow directions carefully.

You are allowed 25 minutes for this test segment.
TEST

Section - Minimum requirement for passing:
15 correct answers out of 19.

Complete statements 1 through 6 by filling in each blank with the correct number from the list below. There are more numbers in the list than you need. You may use a number more than once.

- 76
- 0
- 460
- 62.4
- 34
- 14.7
- 760
- 29.92
- 100

1. At sea level, atmospheric pressure is very close to __________ inches of mercury.

2. Atmospheric pressure is about __________ centimeters of mercury.

3. Atmospheric pressure is roughly equivalent to __________ feet of water.

4. Atmospheric pressure is approximately __________ psia.

5. psia = psig + ____________.

6. Atmospheric pressure is __________ psig.

Complete statements 7 through 12 by filling in each blank with the correct word from the list below. There are more words in the list than you need. You may use a word more than once.

- vacuum
- pressure
- compressibility
- approximate
- gas
- gauge
- ductility
- absolute
- malleability
7. On the psia scale, zero indicates a perfect ________________.

8. In pressure measurement, psig means pounds per square inch ________________.

9. Gases have very good elasticity, resiliency, and ________________.

10. Any pressure lower than atmospheric pressure is a partial ________________.

11. In pressure measurement, psia means pounds per square inch ________________.

12. The density of a gas is its weight per unit of volume at a specified temperature and ________________.

Solve the following problems, selecting the proper formulas from the group below. Show all work. Note that some problems count as several questions.

\[ P_1 V_1 = P_2 V_2 \]
\[ R = F + 460 \]
\[ \frac{P_1}{V_1} = \frac{P_2}{V_2} \]
\[ \text{psia} = \text{psig} + 14.7 \]
\[ \frac{P_1}{P_2} = \frac{V_2}{V_1} \]
\[ \frac{T_1}{V_2} = \frac{T_1}{V_2} \]
13-15. (Counts as 3 questions). At suction conditions (30°F and 5 psig), a compressor handles 3,000 ft$^3$ of gas per minute. How many ft$^3$ per minute does the compressor handle at discharge conditions (50°F and 34.4 psig)?

Answer _____________________________

16-17. (Counts as 2 points). A sphere contains 30,000 ft$^3$ of hydrocarbon vapor at a pressure of 54.3 psig and a temperature of 90°F. If the temperature drops to 70°F, what is the new gauge pressure?

Answer _____________________________
18. If atmospheric pressure = 14.7 psia, what pressure in psia does 10 pounds of vacuum equal?

Answer _______________________

19. How many inches of mercury pressure are equivalent to 14 inches of mercury vacuum, if atmospheric pressure = 29.92 inches of mercury?

Answer ______________________

- cont.
Practical Science

This test covers Segment Six of Practical Science. All necessary directions are included, and also the minimum requirements for passing the segment.

Follow directions carefully.

You are allowed 29 minutes for this test segment.
TEST

Sorment - Minimum requirement for passing:
16 correct answers out of 21.

Complete statements 1 through 10 by filling in each blank with the correct word from the following list. There are more words in the list than you need. You may use a word more than once.

- velocity
- elasticity
- displacement
- force
- inertia
- position
- acceleration
- speed
- dyslexia

1. The distance a body moves in a specific direction per unit of time is the _________________ of the body.

2. The property of matter that causes it to resist any change in its state of motion is called _________________.

3. Motion in which velocity is not uniform is called _________________.

4. Motion is a change in _________________.

5. Inertia can be overcome only by the application of _________________.

6. The distance a body moves per unit of time is the _________________.

7. A _________________. is a push or a pull.

8. Pounds can be used as units of _________________.

9. Gravity is a _________________.
10. A change in position is called __________________________

Solve the following problems, selecting appropriate formulas from the group below. Show all work. Note that each problem counts as several questions.

- \[ a = \frac{v_2 - v_1}{t} \]
- \( \text{60 mph} = 88 	ext{ fps} \)
- \( v = \frac{s}{t} \)

11-13. (Counts as 3 questions). The brakes of a particular automobile can decelerate it at the rate of 20 ft/sec\(^2\). From 75 mph, how many seconds does it take to stop the car?

Answer ________________________________

14-16. (Counts as 3 questions). A bus travels 650 miles between two points, taking two 1 hr. rest stops. If it leaves at 10 a.m. July 1 and arrives at 1 a.m. July 2 what is its average traveling speed?

Answer ________________________________
17-19. (Counts as 3 questions).

\[
\begin{array}{c}
\text{What must force } F \text{ be to lift the 50 lb. weight?}
\end{array}
\]

Answer ____________________

20-22. (Counts as 2 questions). Convert 120 ft. per second to miles per hour.

Answer ____________________
APPENDIX H

SAMPLE TEST FOR MODULE D, PERSONAL PROTECTIVE EQUIPMENT
The enclosed test is divided into six segments. At the beginning of each segment, you will see the minimum degree of accuracy required to satisfactorily pass that segment. Carefully read and follow the directions for each question. You have forty-five minutes to complete this test.
PERSONAL PROTECTIVE EQUIPMENT TEST

Segment 1 - Criteria - Minimum requirement for passing: 8 correct answers out of 9.

Circle the letter by the statement which best answers the numbered statement about Personal Protective Equipment.

1. Personal protective equipment can best be defined as:
   a. The equipment an employee thinks will be the most practical for the job he is performing.
   b. the equipment the employee considers to be sufficient because he is going to be careful and work safely.
   c. the personal protective equipment worn by the individual to protect himself from hazards that cannot be eliminated or controlled by engineering design.
   d. the equipment which is really not necessary because the employee believes that all hazards can be eliminated.

2. The best way for an employee to learn how personal protective equipment helps prevent injuries is:
   a. agreeing that safety in general is the best policy.
   b. working closely with fellow employees and taking their advice on the equipment to use.
   c. reading trade magazines and literature on safety and protective equipment.
   d. learning the company's written policy regarding the use of personal protective equipment and that this policy can be found in the company's safety policy manual.

3. Personal protective equipment is effective and useful for the employee's protection:
   a. when it is properly maintained, kept clean and properly stored to prevent damage.
   b. only when it is issued by the safety department.
   c. only when it is issued by the supervisor.
   d. only if the equipment is new and still in the package.
4. When an employee is seeking a decision about personal protective equipment, he should:
   a. consult his fellow employee who has 30 years of experience.
   b. call only the safety supervisor.
   c. consult his supervisor.
   d. use his own good judgment.

5. Whenever repairs or replacements are needed on the personal protective equipment that you use, it should be done:
   a. by the person who will wear the equipment.
   b. at the authorized place designated by supervisors and company policy.
   c. by the supplier of the equipment.
   d. by the workers on the job.

6. The company recognizes that personal protective equipment is needed in many of its operations. Therefore the company provides protective items such as:
   a. all the clothing workers need to perform their jobs.
   b. the clothing needed to keep personnel dry and comfortable.
   c. protection for the head, the eyes and face, breathing, the body, hands, legs, feet and hearing.
   d. the safety shoes, which also give you very good foot protection when working at home.

7. Personal protective equipment should never be altered or modified because:
   a. the company wants to keep all of the protective equipment uniform in appearance.
   b. protective equipment is designed and tested to meet standards and requirements and it will do so only if maintained as manufactured.
   c. the safety department was not consulted about modifications.
   d. the company does not want to deviate from safety policies.

8. Personnel can learn how and where to obtain individual personal protective equipment by asking:
   a. other employees with whom they are working.
   b. safety department officers.
   c. their supervisors.
   d. the plant manager.
9. Workers can stay up to date on the written policy concerning the use of personal protective equipment by:
   a. reading the Safety Policy Manual and checking with their supervisors.
   b. reviewing the working rule book.
   c. trying to remember whether any revisions have been made.
   d. looking it up in other company publications.
Segment 2 - Criteria - Minimum requirement for passing: 4 correct answers out of 5.

Circle the letter beside the best answer in the following questions.

1. A safety hat is worn to:
   a. provide protection against the weather.
   b. keep the accident rate low.
   c. provide protection from falling objects and knock-against accidents.
   d. cooperate with the safety department.

2. The requirement by the company to wear head protection can best be accomplished by:
   a. wearing a safety hat except on the day the employee has a headache.
   b. wearing a hard hat because it is useful to sit on during lunch time.
   c. understanding all of the safety procedures.
   d. wearing an approved safety hat in all process or mechanical areas of the plant.

3. To find out the exact requirement of head protection in the plant you are working, employees should ask:
   a. a working cohort.
   b. their supervisor.
   c. lieutenant of plant protection.
   d. the plant manager.

4. The proper action to take if a safety hat becomes loss or cracked is to:
   a. attempt to find a used hat.
   b. patch the crack with epoxy.
   c. proceed at once to the authorized issue point and get the safety hat replaced.
   d. wait for a convenient time before doing anything.

5. Whenever an employee is working near or around open electrical equipment, he must wear the following type of safety hat:
   a. a special safety hat that is made of non-conductive material.
   b. a metal safety hat.
   c. any type of safety hat.
   d. a knit cap.
Segment 3 - Criteria - Minimum requirements for passing: 15 correct answers out of 18.

Circle the letter beside the best answer in the following questions.

1. Depending on the job being performed and its location in the plant, the purpose for wearing specific eye protection such as safety glasses, goggles or face shield is to:
   a. make the workman eligible for the "Wise Owl" award.
   b. try to have the best safety record among all the plants.
   c. provide the workman with as much protection as possible in an effort to eliminate all eye injuries.
   d. show visitors that personnel are safety-minded.

2. The plain and corrective lenses used in safety glasses must meet certain standards. Those used must meet the:
   a. standard set by local management.
   b. standard recommended by a good optometrist.
   c. standard provisions required by the American National Standard Institute specifications.
   d. standard agreed to so that the glasses won't be too heavy.

3. Personnel can learn the procedure for securing prescription safety glasses by asking:
   a. their optometrist.
   b. their supervisors.
   c. the plant manager.
   d. the employee relations office.

4. Each plant has a written policy on eye protection. Employees who have questions should ask:
   a. the training office.
   b. the department head.
   c. fellow employees.
   d. their supervisors.
5. The wearing of contact lenses within the plant is covered by a special policy; therefore personnel must:
a. study the safety rule book.
b. consult with their supervisor and the medical department before wearing them in the plant.
c. check with their eye doctor.
d. take an eye test.

- The company provides protection for the eyes and face. From the list at the right, write the letters of the 5 types approved for eye or face protection.

6. _______          a. prescription glasses
7. _______          b. face shield
8. _______          c. safety glasses, plano or prescription
9. _______          d. welding helmet
10. _______         e. contact lenses
                  f. polaroid sunshades
                  g. goggles, flexible fitting, chipping, welding
                  h. safety spectacles with side shields
Eye protection is required while performing operations in the plant. Match each working condition with the type of eye protection that is used. Working conditions are listed in Column I. Types of eye protection are listed in Column II. Each item in Column II may be used more than once.

<table>
<thead>
<tr>
<th>COLUMN I</th>
<th>COLUMN II</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Arc Welding</td>
<td>a. Safety Spectacles or Goggles</td>
</tr>
<tr>
<td>12. Using Hammers, Mauls, or Picks</td>
<td>b. Safety Spectacles with Side Shields</td>
</tr>
<tr>
<td>13. Sandblasting</td>
<td>c. A Face Shield in Addition to Goggles or Spectacles</td>
</tr>
<tr>
<td>14. Pouring or Handling Strong Acid, Caustic or Other Corrosives</td>
<td>d. Welding Shield</td>
</tr>
<tr>
<td>15. Using Stand Grinders or Wire Brushes</td>
<td>e. Sandblasting Hood</td>
</tr>
<tr>
<td>16. Using Portable Power Tools Except Wire Brushes &amp; Grinders</td>
<td></td>
</tr>
<tr>
<td>17. Opening all Process Equipment Not Containing Corrosive Materials or Extremely Hot Materials</td>
<td></td>
</tr>
<tr>
<td>18. Blowing With Compressed Air</td>
<td></td>
</tr>
</tbody>
</table>
Segment 4 - Criteria - Minimum requirements for passing: 12 correct answers out of 15.

Circle the letter beside the one most nearly correct answer in the following questions.

1. The work assignment for the day is to enter a vessel where an oxygen deficiency may develop. What Personal Protective Equipment is essential for this job?
   a. Good protective clothing, which will include safety glasses and protection for the feet.
   b. Protective hand and arm protection which will give the employee the necessary safety for this body area.
   c. Hose line air mask, supplying air from breathing air cylinders.
   d. Rubber boots, because there may be an oily residue in the bottom of this vessel.

2. An emergency situation occurs where an employee must enter a gaseous area to close a valve. Which would be the best designed and the quickest Personal Protective device?
   a. Any type of respirator will do to just go in to close off a valve, since it is a small leak.
   b. Since a gas leak is an emergency situation, it may be best to rush in and close the valve without any protection.
   c. A face shield should be worn since the face needs to be protected.
   d. A sling-pak or air-pak which will furnish the employee with fresh breathing air from a self-contained cylinder should be worn.

3. The dust respirator is a mechanical filter type device to protect the employee while:
   a. working in a purged vessel that has been opened for cleaning.
   b. handling powered chemicals, lime, filter clays, asbestos, coke, sand and cement.
   c. catching samples on a unit which has been down for inspection, repairs and downtime.
   d. cleaning out a tank that has been in slop service for a long period of time.
4. The chemical cartridge respirator is provided for an employee to give him protection when:
   a. working in small quantities of irritating gases, spray painting or using organic solvents outdoors.
   b. assigned to a chemical operating unit where one must be out among the equipment and exposed to various atmospheric conditions.
   c. handling the solids that come out of the unit separator during the regular clean-out procedure.
   d. handling any material that comes from the storehouse that would cause a dusty condition while unloading.

5. An employee should learn to correctly use the fresh air breathing mask by:
   a. having his face clean, which will protect him from a possible skin infection.
   b. checking to see if the face piece is going to be large enough to give him the full protection he needs.
   c. carefully adjusting it in fresh air paying attention to obtain an airtight fit with the face piece.
   d. putting on the face piece and having a positive attitude that the equipment is going to give him the protection it is supposed to.

6. While using a respirator, if it becomes evident that it is malfunctioning, the user should:
   a. check at once to see if it can be repaired so that it can be used without replacement.
   b. return to a fresh air area before trying to determine the cause of the malfunction.
   c. check the fresh air supply hose to see if it is plugged or just has a kink in the hose.
   d. pull it off to see if the cartridge is plugged or just needs to be dried out before using.
7. Respiratory protection is provided, maintained and inspected. As the user, you:
   a. must personally inspect and see that it is in proper operating condi-
      tion before entering the contaminated area.
   b. can be confident that an experienced employee has serviced this
      equipment and that it must be O.K. as issued.
   c. can assume that since the company is safety conscious, they are
      providing you with the best equipment money can buy.
   d. can let your fellow employees enter the contaminated area first and
      check out their equipment.

* Breathing protection is available for employees. Match the type of protection to use against the list of working conditions. Working conditions are listed in Column I. Types of breathing equipment are listed in Column II. Each item in Column II may be used more than once.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Spray Painting</td>
<td>a. Pressure demand, hose line air masks</td>
</tr>
<tr>
<td>9. Working in an area where there is a small quantity of irritat-</td>
<td>b. Self-contained emergency mask (fresh air-pak)</td>
</tr>
<tr>
<td>ing gas</td>
<td></td>
</tr>
<tr>
<td>10. Handling powered chemicals</td>
<td>c. Dust filter-type respirators</td>
</tr>
<tr>
<td>11. Emergency entry into an area where gases or fumes may be present</td>
<td>d. Chemical cartridge respirators</td>
</tr>
<tr>
<td>in high concentrations</td>
<td></td>
</tr>
<tr>
<td>12. Using a buffing machine</td>
<td></td>
</tr>
<tr>
<td>13. Cleaning the residue from a tank</td>
<td></td>
</tr>
<tr>
<td>14. Working inside a vessel where an oxygen deficiency could develop</td>
<td></td>
</tr>
<tr>
<td>15. Entering a gaseous area to close off a leaking valve</td>
<td></td>
</tr>
</tbody>
</table>
Segment 5 - Criteria - Minimum requirements for passing: 20 correct answers out of 24.
Circle the letter beside the one incorrect answer in the following statements. 1 through 7.

1. Protective gloves shall be used in operations where there is a probability of contact with
   a. injurious chemicals
   b. solvents
   c. instrument controls
   d. aromatics
   e. hot oil

2. An employee needs to maintain his protective gloves by:
   a. inspecting gloves for breaks before use.
   b. being sure that chemicals are washed from gloves after use.
   c. washing his hands with a good soap before using.
   d. cleaning any oil or grease from gloves after use.

3. Other types of protective gloves used for heat, welding, electrical and general work are:
   a. asbestos gloves.
   b. welders, leather gloves (also sleeves and jacket).
   c. tight fitting kid gloves.
   d. high voltage gloves (and leather protectors).
   e. leather palmed, cloth backed general work gloves.

4. There are few jobs, if any where the protection of a safety shoe is not advisable. They are designed to protect the toes from:
   a. falling objects.
   b. dropped objects.
   c. being pinched between objects.
   d. ingrown toenails.
5. Some foot protection is provided by the company when needed, such as:
   a. rubber boots with safety toes.
   b. metal foot protectors.
   c. rubber-soled work shoes.
   d. non-skid overshoes.

6. Some of the body protection items provided are:
   a. rubber or plastic aprons.
   b. acid suits.
   c. proximity suits.
   d. rain gear.
   e. clean khaki suits.

7. Miscellaneous protective equipment is provided to perform special jobs.
   Some of these items are:
   a. shin guards.
   b. life belts.
   c. life preservers.
   d. knee pads.
Body protection is available for employees. Match the type of body protection to use against the list of working conditions. Working conditions are listed in Column I. Types of body protection are listed in Column II. Each item in Column II may be used more than once.

<table>
<thead>
<tr>
<th>COLUMN I</th>
<th>COLUMN II</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. When working while exposed to acid splash</td>
<td>a. Rubber and Plastic Aprons</td>
</tr>
<tr>
<td>9. When working under an altitude hazard</td>
<td>b. Leather or Protective Aprons</td>
</tr>
<tr>
<td>10. When working on barges or directly over water</td>
<td>c. Acid Suits</td>
</tr>
<tr>
<td>11. When opening or working on equipment in chemical, aromatic or heavy catalytic cracked oil service</td>
<td>d. Rain Gear</td>
</tr>
<tr>
<td>12. When working on extremely wet jobs</td>
<td>e. Proximity Suits</td>
</tr>
<tr>
<td>13. To prevent burns from flying sparks, welders should wear:</td>
<td>f. Life Belts</td>
</tr>
<tr>
<td>14. When working within six feet of the edge of any roof</td>
<td>g. Life Preservers</td>
</tr>
<tr>
<td>15. When working in a vessel from the top and this is the only route of egress</td>
<td></td>
</tr>
<tr>
<td>16. Suits which are placed on some units for fire fighting protection</td>
<td></td>
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</tbody>
</table>
The wearing of your personal safety toe shoes is advisable under normal working conditions. Foot protection, when required, is made available for employees. Match the type of foot protection to use against the list of working conditions. Column I lists the working conditions. Column II lists the types of foot protection. Each item in Column II may be used more than once.

**COLUMN I**

17. Working where there is a possible falling object
18. Working where there is a possible pinch point
19. Working your regular job, but where a slip resistance sole would be helpful
20. Working in an area where protection is needed from chemical splash
21. Working your regular job under normal conditions
22. Working where there is a known exposure to foot injuries
23. Working in a very slippery area or where there has been an oil spill

**COLUMN II**

a. Rubber Boots with Safety Toes
b. Foot Protectors
c. Non-skid Overshoes
d. Safety Toe Personal Shoes

Circle the letter beside the one incorrect answer in the following statement:

24. An employee must inspect the body protective equipment he is going to use by:
   a. checking his gloves for breaks or tears.
   b. checking his boots or shoe soles for breaks.
   c. being sure his safety shoes are tied to prevent trash from entering and bothering him.
   d. being sure his apron or rain coat extends over the tops of his boots.
Segment 6 - Criteria - Minimum requirement for passing: 6 correct answers out of 7.

Circle the letter beside the one incorrect answer in the following statements. (1 through 3)

1. When working in areas posted with noise warning signs, an employee is provided with personal hearing protection devices such as:
   a. ear plugs or ear defenders.
   b. make-shift, do-it-yourself protectors.
   c. Swedish wool, disposable type.
   d. ear muffs (over the ear protectors).

2. Industry is constantly working to lower noise levels by:
   a. installing noise dampers such as mufflers, acoustical tile, pads and carpets.
   b. installing quieter machines and better operating methods.
   c. providing maintenance and repair of equipment for quietest operation.
   d. installing new lunch room facilities in all working areas.

3. Nobody is immune to the long-term effects of noise. Everyone is affected by excessive noise to some degree depending on:
   a. loudness.
   b. pitch.
   c. heredity.
   d. length of exposure.

Ear protection is available for employees. Match the type of ear protection to use against the list of working conditions. Working conditions are listed in Column I. Types of ear protection are listed in Column II. Each item in Column II may be used more than once; multiple answers are possible.

<table>
<thead>
<tr>
<th>COLUMN I</th>
<th>COLUMN II</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Working near high speed turbines</td>
<td>a. Ear Plugs</td>
</tr>
<tr>
<td>5. Working in the boiler shop</td>
<td>b. Swedish Wool</td>
</tr>
<tr>
<td>6. Working on construction jobs</td>
<td>c. Ear Muffs</td>
</tr>
<tr>
<td>7. Working in areas posted with</td>
<td></td>
</tr>
<tr>
<td>noise warning signs</td>
<td></td>
</tr>
</tbody>
</table>
VITA

Carol Ann Hopper Bader was born in Navasota, Texas on September 14, 1949. Her parents are Hugh Leo Hopper and Virginia Sibley Hopper. She attended C. E. Byrd High School in Shreveport, Louisiana from which she graduated in 1968. She received a Bachelor of Arts Degree in English from Louisiana Tech University in 1971 and a Master of Arts in English from Purdue University in 1973. The Education Specialist Degree in Reading was awarded to her by Louisiana State University in 1975.

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She is married to Lawrence Edward Bader.
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Major Field: Education

Title of Thesis: An Evaluation Of A Pre-Apprentice Upgrade Program At A Petro-Chemical Complex

Approved:

[Signatures of Major Professor and Chairman and Dean of the Graduate School]

EXAMINING COMMITTEE:

[Signatures of committee members]

Date of Examination:

April 19, 1978