THE EFFECTS OF PRE-LABORATORY QUIZZES ON STUDENTS'
PERFORMANCE ON LABORATORY REPORTS AND
ON LABORATORY RELATED QUESTIONS ON TESTS

by

SADIAH YUSOF

B.S., Kansas State University, 1983

————————————

A MASTER'S THESIS

Submitted in partial fulfillment of the
requirements for the degree

MASTER OF SCIENCE

Department of Physics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1985

.

Approved by:

Major Professor

ACKNOWLEDGEMENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

In the United States, the science laboratory was introduced
to the school systems in the late eighteenth century. Since then
educators have experimented with and developed several teaching
methods to instruct students in the laboratory. Some brought
appreciable effect on students' performance and attitudes in learning
science (Prigo et al, 1975; Spears and Zollman, 1979). Still some of
these techniques have succumbed to inflation, and difficulties in
maintenance and set up procedures (Gardner, 1979). Others faced
administrative difficulties as well as staff and student apathy
(Green, 1971; Friedman et al, 1976). The former found the students
tend to procrastinate even though there were deadlines. The latter
reported that most faculty were mildly negative about the results of
the self-paced course especially those that were not involved in it.

In the early 1960's there was a move to modernize laboratory
instructions. Some of the modernizations that took place include the
introduction of open-ended, self-paced, and computer simulation
laboratories. However, one of the earliest teaching techniques called
the verification or cookbook technique survived the modernization.
This is mainly due to financial considerations. It requires less
money to maintain the apparatus and staff than to renovate totally the
existing laboratory settings. In spite of its widespread use, few new

1

approaches have been developed to improve or supplement this conventional verification laboratory.

Building on the idea that improvement can occur with small changes in the laboratory, this research project investigated a supplemental procedure to a conventional laboratory situation. It is hoped that the additional procedure would improve the performance level of students enrolled in the laboratory classes yet minimize the the changes in overall procedures.

Statement of the Problem

This study was concerned with the effect of pre-laboratory quizzes with a very rapid analysis of results on students' preparation for the laboratory and on their performance on lecture tests. The effect was investigated by analyzing scores of lab reports and lecture test questions which were related to topics investigated in the laboratory. The quizzes were given at every laboratory session before any introduction to the experiment was presented. The results of each pre-laboratory quiz was analyzed and returned to the laboratory instructors a few minutes after the quiz was collected.

The main purpose of this study was to obtain answers to the following three questions.

1. Will the quizzes help prompt the students to prepare for the laboratory?

2. Will the quizzes help the students understand the experiment reflected by the laboratory score?

3. Will the quizzes improve their scores on the test questions that are closely related to or based on the questions answered by the experiment they had done?

Significance of the Study

It was hoped that the technique used in this study would cause an improvement in student performance and preparation without the necessity of replacing totally the conventional approach to teaching physics laboratory. In developing the method an existing set of laboratory experiments were used. Essentially no changes were made in the experiments or the written instructions given to students. The technique only requires quizzes to be given at the beginning of each laboratory session and a microcomputer to analyze the results.

It was also hoped that preparation for the quizzes would overcome some frustrations encountered by both students and instructors in laboratory situations. Often the instructors were faced with the task of going from one group to another explaining to the students what they were supposed to be doing. The students, in turn, were frustrated because they do not know what they were supposed to find, and why they were investigating a particular experimental problem.

Finally, the results of the pre-laboratory quizzes would pin-point certain deficiencies in the students' knowledge. Because the instructors received an item analysis of the results within a few minutes of the quiz's completion, they then would tailor the introduction based on this analysis. More emphasis would be placed on

the areas in which the pre-laboratory quizzes showed deficiency for large number of students. It was hoped that this could help the students later as they completed the laboratory experiment. As a secondary effect, the students might perform better when they encountered similar questions on their tests.

CHAPTER II

REVIEW OF RELATED LITERATURE

The role and usefulness of science laboratory has been a source of debate for the last few decades. Several researches have been done to clarify these roles and usefulness. However, educational research has provided mixed results.

Critics contend that college-level laboratories were not what they were meant to be. College laboratories seem to lag behind high school in terms of time spent effectively (Tamir, 1977). Laboratories involve more expenses and administrative work. They require more money to replenish supplies and repair or replace equipment. Scheduling double periods for laboratories is seen to be a time consuming administration process. Within the science education community, laboratories are criticized to over-emphasize demonstration or verification functions of laboratories (Blosser, 1983).

Leonard (1981) lists a number of research efforts that indicate that laboratories are a comparatively ineffective method of teaching science. Overall, he claims that they do not improve critical thinking, or heighten the understanding of science, nor do they improve students' scores on factual information or physical concepts underlying the experiments. Often, laboratories are only useful to illustrate the spirit of science, while the subject matter has to be transmitted by the teacher and the textbook.

Still, there are other aspects of the laboratory that are neglected in researches (Hofstein and Lunetta, 1982). Advocates of

5

the laboratories claim that laboratories are an essential part of educational experience. Many claim that laboratories are important for teaching and understanding processes of scientific thinking. They promote creative thinking and problem solving. They affect the intellectual development and gaining of practical skills and abilities (Hofstein and Lunetta, 1982). These are hypothesized to be especially true for laboratories that do not over-emphasize verification.

Several new instructional techniques have been developed to replace the conventional or verification of laws or cookbook approach to teaching laboratory work. These include self-paced, unstructured, open-ended, and most recently computer stimulation laboratories. The open-ended or unstructured or inquiry-oriented laboratory has been hypothesized to improve critical thinking. Ivany (1968) found that students in his divergent laboratory to be more effective investigators. They are more tuned to the reality of experimental work as a tool of discovering science. Rief and St. John (1979) conducted a study on a similar technique on college-level physics students. They found that 80% of the students are able to describe the experiment, state the central ideas behind the experiment, perform it and then modify the procedure when necessary. This is compared to only 40% of the students who had the usual laboratory instruction.

Green (1971) reported that self-paced or personalized laboratory increased mastery of subject matter. Students reported that they learn materials more thoroughly and effectively. Prigo et al (1975) reported similar results with their learning center.

6

Students also gain hands-on-experience. It also increases positive attitude towards science.

Computer simulation theoretically has the ability to provide each student the learning experiences and opportunities that otherwise would be "too costly, too risky, too time consuming, or not possible" (Becker, 1984). It has the ability to encourage students to perform tasks and solve problems by creating intellectually stimulating environments.

However, these new techniques did not fill the needs of all undergraduate students. Spears and Zollman (1979) found that unstructured laboratories are more useful for students who have had the experience in doing experiments. Open-ended laboratories are more suitable for students having formal thinking patterns(Toothacker, 1983). Similar results are hinted by Ivany (1968). Self-paced laboratories seem to induce procrastination and are difficult for students who are unable to manage their time properly (Green,1971). Tightening of the enforcement of deadlines is one of the reasons the self-paced laboratories are discontinued five years later (Friedman et al, 1976).

Computer simulations seem to exaggerate the over-emphasis on learning facts because it is harder to translate conceptual ideas into computer programs. It is not possible to anticipate all the necessary dialogue needed to carry out a meaningful instructional conversation with the student. Most programs require students to provide right answers rather than ask questions, organize ideas and then apply their understanding to new situations. They also do not help students to

7

learn to work productively with their peers (Becker, 1984). Furthermore, computer simulation would not be beneficial to students who need to acquire basic skills and confidence in handling and manipulating equipment.

Furthermore, many studies have shown that there was no statistical advantage of laboratory work on lecture-theory examinations. Kruglak (1953) found no significant differences between the means of groups receiving individual laboratory instruction or watching demonstration of the experiment with a group that has no laboratory at all on a pencil-paper test which measured knowledge of facts, principles, and application. A study by Brown (1958) showed no difference in laboratory skills of students who had taken laboratory in high school with those that did not. Also, another study by Lunetta (1974) showed no difference in student achievement between those completing a computer simulated and a conventional laboratory.

However, none of the studies mentioned has ever tested the effect of student preparation for the laboratory on their performance in laboratories - either performing or writing up the reports. None have mentioned the frustration most laboratory instructors have about students who came to laboratory without knowing which experiment they were expected to do let alone the conceptual ideas underlying it.

Based on the discussion above, this study investigated an instructional technique that was used as a supplement to the pre-laboratory phase in conventional instruction of a physics laboratory. A pre-laboratory quiz tested the background knowledge that was needed

to complete and understand the experiment. Pre-laboratory quiz should not make any difference on the performance on weekly tests and final examination. However, the pre-laboratory quiz should help the students identify the concepts they are going to investigate during the laboratory activities. It will help prompt the students to be prepared for the laboratory by reading the written instructions for the experiment and appropriate sections in the text. Also, the pre-laboratories quiz should help instructors by pinpointing the students' knowledge deficiencies.

CHAPTER III

METHODOLOGY

The major purpose of this study was to compare the effects of
pre-laboratory quizzes on students' performance on laboratory reports
and laboratory related questions on tests.

Subjects

Subjects for the study consisted of students enrolled in
Descriptive Physics course at Kansas State University. The
experimental group was made up of 155 students from Spring, 1985. The
control group consisted of 145 students who completed the course
during Spring of 1984.

Description of Course

Descriptive Physics is a one semester introductory physics
course which requires knowledge of algebra. During Spring 1984,
General Physics with Bioscience Essays by Jerry B. Marion was used as
the text. In Spring, 1985, its second edition, co-authored by William
Hornyak, was in use.

The course is divided into several parts. Students attend
three one-hour lecture each week. During the first lecture of each
week the general topic is introduced. General concepts and laboratory
objectives are discussed at this time. During the second lecture, the
topic is developed further while the last lecture is devoted to review
and summarization of the week's topic.

The second part of the course is the help sessions. At this time assigned problems and any questions pertaining to the week's work are discussed. Students are required to work on their assignment before these help sessions.

Quizzes are held every week on Wednesday evenings. They are scheduled as thirty minute quizzes and usually consist of five multiple choice questions. A comprehensive final examination is given at the end of the semester. It is made up of twenty multiple choice questions.

Students collect and analyze experimental data in the laboratory sessions. These laboratory sessions are scheduled to occur between the first and second lectures of the week. The experiments are related to certain aspects of the topic under discussion during the lecture period. During the laboratory sessions the students examine experimentally the topic in greater detail. The laboratory manual used is the Descriptive Physics Laboratory written by various members of the Kansas State University Physics Department staff. The laboratories are taught by student instructors.

Scores from three of the above portions of the course determine the students' final grade based on a preset scale. The total possible points are broken down as listed below:

Weekly Quizzes		500 points
Final Examination		200 points
Laboratories		300 points
	Total	1,000 points

Description of the Typical Laboratory Session

At the beginning of each week, the laboratory instructors met to discuss the topic of the experiment. They discussed the procedure and kind of data and analysis that were required. A possible point distribution to be used by all the instructors for grading purposes was also agreed upon. Lastly, they checked that all the apparatus were in working condition.

In the laboratory sessions attended by the control group, instructors started out the class by returning the previous week's laboratory reports to the students. After discussing and/or answering any questions pertaining to last week's work the instructors introduced the week's experiment. The introduction included the concepts behind the experiment, performing the experiment, data collection, and data analysis. Next, the students performed the experiment and collected the necessary data. After that was done, the instructors checked that the students had collected sufficient data. Then, the students could elect to leave the laboratory or stay on to analyze the data and finish the laboratory report. The reports were due 48 hours after the laboratory sessions.

Description of the Laboratory Session with Pre-Laboratory Quiz

During the weekly instructors' laboratory meeting, the procedure was similar except that a copy of the pre-laboratory quiz was made available to them. A copy of correct responses and possible students' mistakes were also distributed.

The laboratory sessions attended by the _experimental_ group were also similar with the following exceptions. First, a pre-laboratory quiz was given at the beginning of each laboratory period. The students answered the multiple choice questions by blackening the corresponding bubbles on the computer cards. The cards were collected and the laboratory co-ordinator immediately entered the responses into a microcomputer that analyzed the results. While waiting for the results, the laboratory instructors started the laboratory in the same way a typical laboratory session would begin. As soon as the pre-laboratory quiz results were handed to the instructor, he/she would start the introduction. The introduction was to be tailored according to the results of the pre-laboratory quiz. After this introduction, the scheduled laboratory activities were similar to the typical laboratory sessions.

Materials and Instrumentation

The pre-laboratory quizzes given to the experimental group consisted of five to ten multiple choice questions that covered the background knowledge needed to successfully complete and understand the experiment (See Appendix A). The subject matter included in the quizzes were taken from the appropriate sections in the text, and also the writeup in the laboratory manual.

Each pre-laboratory quiz had six different versions for the laboratory classes. Questions requiring some form of calculation were supplied with different sets of numbers or other information. For non-numerical questions, the four possible responses were scrambled in

different orders. This procedure prevented memorization of the numerical answers or the sequence of correct answers by students who might have some contact with other students in earlier classes.

The students' responses were entered into a microcomputer. The entering of these responses took about three minutes for a five-question pre-laboratory quiz to about five minutes for a ten-question quiz for a class of 25 students. The microcomputer reported the results in the form of a brief summary. It consisted of the question number and the number of students who had chosen each of the possible responses for that particular question (Refer to Figure 1).

		RESPONSES		
	1	2	3	4
1	1	(23)	0	0
2	(13)	0	3	8
3	6	1	3	(14)
4	(7)	0	16	1
5	0	17	(6)	1

Correct responses are circled.

DISCUSS QUESTIONS:

    4, 5

Fig. 1. Example of the brief summary used to report the results of pre-laboratory quizzes.

During the instructors' laboratory meeting, the instructors had also received a copy of the correct responses and possible mistakes that could be made by the students (See Appendix B). Using this information and the brief summary of the results of the pre-laboratory quiz, the instructors were to tailor the introduction.

More emphasis was to be placed on areas where the analysis showed a low percentage of correct responses from the students. This meant that the instructors were to point out to the students what kind of mistakes they were liable to make and go carefully and thoroughly through those calculations or procedures which the pre-laboratory quiz indicated were weak points for many students.

During the last week of laboratory sessions in Spring, 1985, the students were given a questionnaire to complete (See Appendix E). They were all but one multiple choice questions. The computer cards were completed anonymously. The instructors were also given a questionnaire (See Appendix F).

Sometime during the last weeks of the Spring Semester of 1985, the instructors were asked to grade copies of five different laboratory reports from a previous class (Fall of 1984). The reports were on the last experiment of the semester. They were to use the same point distribution that they were using to grade their own students' laboratory report. The purpose of this exercise was to gather information on the instructors' grading of laboratory reports.

Research Design

The research design for this was the posttest – only control group design. This design was chosen because it was only possible to take posttest measurement of the control group, and thus the experimental group.

Data Collection

The data collected from both groups consisted of the weekly and accumulative scores of the laboratory reports, laboratory related questions on weekly quizzes and on final examination (See Appendix C), and questions not related to laboratory work on the final examinations (See Appendix D).

For the experimental group the scores on pre-laboratory quizzes were included as part of the laboratory report score. Each pre-laboratory quiz was worth one-third of the possible points for the report. For each question on the pre-laboratory quizzes, laboratory related questions on the weekly quizzes, and laboratory related and unrelated questions on the final examinations, the percentage of correct and incorrect responses by the students were also collected.

Data were also collected from the students' and instructors' questionnaire. The grades given by the instructors to the five different laboratory reports from Fall of 1984 were also collected.

Data Analysis

Chi-square (χ^2) test of goodness-of-fit was used to analyze some of the data collected to determine whether the observed frequencies (percentages of correct and/or incorrect responses from

16

Spring, 1984). The test was done on laboratory related questions on weekly quizzes to find out the pre-laboratory quizzes made any difference on them.

The test was also used on laboratory related questions on the final examination. This was to determine whether the pre-laboratory quizzes had affected the responses to these questions.

Next, the test was performed to analyze the results of questions not related to laboratory work on the final examinations. This analysis was done for comparison with questions related to laboratory work.

Another statistical procedure used in the analysis was the t-test for differences between two independent samples. This test was chosen to help decide whether the observed difference between the two samples means occurred due to the presentation of the treatment (the pre-laboratory quizzes). Since this t-test can be performed as a directional statistics, it can be determined if the pre-laboratory quizzes positively or negatively affected the results from Spring of 1983 when compared to Spring of 1984.

The t-tests were done on the end of semester results of the accumulative laboratory work, the final examinations, as well as the accumulative scores of the weekly quizzes of both semesters. It was also performed on the responses to the students' questionnaire and the instructors' grading of the particular laboratory report.

No test was used to analyze the responses to the instructors' questionnaire.

17

CHAPTER IV

DISCUSSION OF RESULTS

Chi-square test of goodness-of-fit was used to analyze the data obtained from the weekly lecture quizzes (Refer to Table 1).

1985		1984		X^2	p
% Correct	% Incorrect	% Correct	% Incorrect		(df=1)
48.7	51.3	28.6	71.4	5.38	0.250
86.9	13.1	76.9	23.1	3.91	0.050
63.0	37.0	67.6	32.4	0.52	0.500
80.3	19.7	24.5	75.5	40.50	<0.001
40.0	60.0	52.4	47.6	2.97	0.001
69.3	30.7	40.7	59.3	13.31	<0.001
33.3	66.7	52.4	47.6	7.27	0.010
65.8	34.2	57.6	42.4	1.40	0.250
93.8	6.2	42.6	57.4	44.78	<0.001
38.1	61.9	79.3	20.7	80.02	<0.001
36.9	63.1	27.9	72.1	1.00	0.500
62.9	37.1	60.0	40.0	0.14	0.750
51.6	48.4	26.4	73.6	8.29	0.005
38.1	61.9	92.1	7.9	362.31	<0.001
$X^2 = 31.66$		$P < 0.010$		(df = 13)	

Table 1: X^2 - test of goodness-of-fit-for weekly quizzes for Spring 1984 and 1985.

Percentage of correct response to questions from Spring, 1984 served as the expected frequency and percentage of correct responses to similar questions from Spring 1985 was the observed frequency.

First, χ^2-test was run using two cells where percentage correct and percentage incorrect were used. The level of significance (p) ranged from 0.75 to less than 0.001 (df = 1). Ignoring results having probability of non-significance[a] more than 0.001, three out of five pairs indicated that correct responses from 1985 were significantly higher than responses from 1984.

A χ^2-test using the percentage of correct responses of 1984 as expected frequency and percentage of correct responses of 1985 as observed frequency yielded χ^2-value of 31.66 giving $p \leqslant 0.005$ (df = 1).

The results of the test indicated that the pre-laboratory quizzes influenced the outcome of certain questions on the weekly quizzes. However, as a whole it did not seem to change the percentage of correct responses significantly.

Next, there were five final examination questions that were related to the laboratory activities. A χ^2-test was performed with Spring 1984 and Spring 1985 as the expected and observed frequencies, respectively (Refer to Table 2).

[a] Throughout this paper the word significance refers to statistical significance.

1985		1984		χ^2	p
% Correct	% Incorrect	% Correct	% Incorrect		(df=1)
55.9	44.1	67.4	32.6	3.71	0.100
60.5	39.5	48.6	51.4	2.53	0.200
48.7	51.3	65.2	34.8	7.36	0.010
49.3	50.7	65.2	34.8	6.81	0.010

$\chi^2 = 12.94$ $p < 0.01$ $(df = 3)$

Table 2: χ^2-test of goodness-of-fit for final examination questions related to laboratory.

None of the question pairs appeared to show a significant difference between the two groups ($p < 0.001$). χ^2-test with percentages of correct responses serving as the frequencies only gave $p < 0.01$.

It appeared that the pre-laboratory quizzes did not, in any significant way, affected the students' performance on laboratory related questions in the final examination.

As a comparison, similar χ^2-test with two cells was done on eight final examination questions that were unrelated to laboratory activities (Refer to Table 3).

	1985		1984	χ^2	p
% Correct	% Incorrect	% Correct	% Incorrect		(df=1)
55.9	44.1	87.0	13.0	72.03	<0.001
29.6	86.2	61.2	38.8	56.69	<0.001
86.2	13.8	81.9	18.1	0.80	0.500
86.2	13.8	46.4	53.6	28.82	<0.001
64.5	35.5	72.5	27.5	2.05	0.200
50.0	50.0	69.6	30.4	12.00	0.001
49.3	50.7	22.5	77.5	8.78	0.010

$\chi^2 = 31.92$ $p \ll 0.001$ $(df = 7)$

Table 3: χ^2-test of goodness-of-fit for final examination questions not related to laboratory.

It can be observed that four of the questions showed significant difference between Spring 1984 and Spring 1985 ($p < 0.001$). Three of those questions indicated a higher percentage of correct responses to questions on Spring 1984 final examination.

As a whole, the eight questions unrelated to laboratory work showed a significant result ($p \ll 0.001$). This showed that there was a very significant difference between the responses to questions unrelated to laboratory work between Spring 1984 and Spring 1985. The group which performed better on these questions was the Spring 1984 class.

Another statistical test done on the data obtained was the t-test. t-tests were done on the total points for the students' end of semester's weekly quizzes, final examination, and laboratory total points (Refer to Table 4).

	1985	1984
Quiz Mean	299	310
Sum of Squares	874675	937300
	t = 1.22	(p < 0.200, df = 298)
Final Mean	113	126
Sum of Squares	287315	398680
	t = 2.34	(p < 0.020, df = 298)
Lab Mean	248	211
Sum of Squares	151981	219149
	t = 9.07	(p << 0.001, df = 298)
* Lab Mean	240	211
* Sum of Squares	93334	219149
	t = 6.31	(p << 0.001, df = 246)

*Excluding the laboratory sections taught by the third instructor.

Table 4: t-test for the end of semester results of Spring 1984 and 1985.

22

The t-value for the total points obtained on all weekly quizzes indicated that there was no significant difference ($p < 0.200$, df = 298). The t-test also produced no significant ($p < 0.020$, df = 298) when comparing the final examination points of both semesters. The same statistical procedure, however, resulted in a significant difference between the laboratory total points of the two semesters (t = 9.07, $p \ll 0.001$).

Thus, we observed that pre-laboratory quizzes did not significantly increase the students' final points on their weekly quizzes and on their final examinations. A significant result obtained in comparing laboratory final points could be due to inconsistent grading by one of the three instructors involved in the laboratory sections. This instructor gave essentially the maximum number of points for each report turned in by the students in his class for the last three laboratory sessions.

A t-test done using data obtained from classes not taught by this third instructor still showed a significant difference (t = 31, $p \ll 0.001$) between the results of the two semester. It can be concluded then that the pre-laboratory quizzes had affected the students' final laboratory total points.

In light of the above problem, a t-test was also done to determine the consistency of the instructors' grading. The grading of five laboratory reports from Fall 1984 and laboratory reports from their respective laboratory sections (Spring 1985) were used (Refer to Table 5). The reports were based on the same experiment with essentially the same experimental apparatus and instructions.

	Instructor 1	Instructor 2
Mean of laboratory reports from Fall 1984	11.40	9.50
Number of reports	5	4
Sum of Squares	5.2	33.0
Mean of laboratory reports from Spring 1985	13.98	12.76
Number of reports	43	42
Sum of Squares	202.82	293.62

Instructors 1 and 2 (Fall 1984):

$t = 1.21$ ($p < 0.200$, $df = 7$)

Instructors 1 and 2 (Spring 1985):

$t = 2.29$ ($p < 0.010$, $df = 83$)

Instructor 1 (Fall 1984 and Spring 1985):

$t = 2.56$ ($p < 0.02$, $df = 46$)

Instructor 2 (Fall 1984 and Spring 1985):

$t = 1.16$ ($p < 0.20$, $df = 44$)

Table 5: Instructors' grading of laboratory reports from Fall 1984 and Spring 1985.

The results showed no significant difference in the grading of each instructor on the two sets of laboratory reports. The t-test

24

also indicated no significant result between the two instructors in grading the five laboratory reports and the grading of reports on the same experiment in Spring 1985 (p ≤ 0.010). No tests were done on the grading of the third instructor who gave full credit for each laboratory report turned in for the last three experiments of the semester.

Next, students enrolled in the physics class during Spring 1985 completed a questionnaire. Each question was analyzed by determining the frequency of the possible responses (See Appendix E). The mean of questions 4 and 7 to 20 were also calculated. There were no significant differences ($\pm \sigma$) found for these questions between each of the six laboratory sections, between the three instructors, and the laboratory as a whole.

Most of the students were males in their freshman year in the College of Architecture and Design. On average, the students took their last algebra class about 3 semesters before enrolling in the physics class. Almost all took the class because it was a requirement and nearly 50% expected to get a 'b' for the course. Most of them enjoyed the laboratory sessions.

On the whole the pre-laboratory quizzes prompted the students to prepare for each laboratory session by reading the laboratory writeup and the appropriate sections in the text. However, they did not refer back to the pre-laboratory quizzes when they were preparing for their weekly quizzes even though some of the questions were quite similar.

25

Lastly, the questionnaires that the instructors completed were also analyzed. All three enjoyed teaching the laboratories but they felt that they did most of the talking during class. They also felt that the students depended too much on their help with the experiments. On the other hand, they thought that the pre-laboratory quizzes made the students prepare for the laboratory sessions but the quizzes did not change the quality of the reports turned in.

Two of the instructors tried to explain the intended purpose of the pre-laboratory quizzes but all of them did not adhere to the instructed guidelines of incorporating the results of the quizzes with their introduction. One instructor admitted to not even trying because he thought it was "too much of a hassle". Thus, it can be concluded that instructors were not too appreciative of the changes that they had to make to adjust to the new guidelines that had been set.

However, all of the instructors thought the quizzes should be given in future classes but suggested that a few changes should be made. For example, making sure the questions were not too rigorous and scheduling the laboratories well behind the lecture in terms of materials covered.

In summary, the results were close to what was expected on the weekly quizzes and final examination. However, the pre-laboratory quiz significantly increased the laboratory report score. Also, it prompted the students to read their laboratory manual and text before the laboratory session.

CONCLUSION

The pre-laboratory quizzes did increase the students'
score on their laboratory reports (p < 0.001). The laboratory reports
require the students to present, analyze and interpret data. Thus, it
would seem that the pre-laboratory quiz helped the students in
analyzing, interpreting, and reporting the knowledge they gained from
the laboratory activities. However, it did not make any difference on
the scores of questions related to laboratory work on the weekly
quizzes or the final examination. The pre-laboratory quizzes did not
seem to promote long-term retention of the physical concepts learned
in the laboratory.

The pre-laboratory quiz did prompt students to prepare for
the laboratory activities by reading the experimental writeup and text
before coming to class. The pre-laboratory quiz helped them
understand the principle and concepts which they were going to
investigate and learn from the laboratories.

On the other hand, most students found the quizzes
frustrating because of a lack of co-ordination between laboratory and
lecture. Most of them commented that it was not fair to give the pre-
laboratory quiz unless the topic has already been discussed in
lecture. Some suggested that the pre-laboratory quiz should be a
take-home quiz so it will give them an idea of what the laboratory was
all about.

Furthermore, the study was complicated by the apathy of the instructors involved. Since the instructors did not make the best of the opportunity to introduce and concentrate on certain physical concepts more thoroughly than other, the students had no idea of what they really should know. The instructors objected to giving and keeping records of the results of the pre-laboratory quizzes in addition to the laboratory reports eventhough they did not have to hand grade these themselves. The main purpose of the pre-laboratory quizzes was never realized because of the instructors' objections.

If the same procedure was to be used for future classes, it is strongly suggested that a few changes be made. Firstly, more time should be spent in letting the instructors adjust to the new guidelines. Help should be given on how they can use the analysis of the pre-laboratory quizzes to their advantage in instructing their students. The instructors need also be helped to realize why the changes had to be made. They need to understand that the changes were to help the students, not the instructors.

The same type of 'orientation' should be set up for the students. Several minutes during the first course lecture should be devoted to explain in detail how the pre-laboratory quizzes can be beneficial to the students.

Another change that might be considered is the nature of the questions on the pre-laboratory quiz itself. They should be less rigorous and reduced in number. The number of questions could be cut down to only include the ones that really make the students think about the whole concept involved instead of just substituting numbers

into equations that were memorized. For example, students could be asked to explain about the idealized motion of falling body instead of calculating the distance the body falls in 2 seconds (See pre-laboratory quiz #2 in Appendix A). They could be asked to draw graphs to illustrate their answer. The pre-laboratory quiz should be more descriptive rather than riddled with calculations. The quizzes will be harder to grade but the outcomes might be worth the extra work.

Another beneficial change could be to specify what topic(s) the students should concentrate on when reading to prepare for the laboratory sessions. This is especially helpful when the scheduling of the laboratories prevents an earlier discussion of the topic.

In conclusion, there is a need to get the co-operation of instructors and enlighten the students on the purpose of the pre-laboratory significantly increased students' score on their laboratory reports. Most importantly, the pre-laboratory quizzes made most of the students prepare for the laboratory sessions. This reduces the instructors' uncertainty of what to say during the introduction of the experiment. The instructors then could concentrate more on developing rather than introducing the physical concepts examined by the experiments.

BIBLIOGRAPHY

Becker, H.J. Computers in Schools Today: Some Basic Consideration. American Journal of Education, 23(11): 22 (1984).

Blosser, P.E. What Research Says? School Science and Mathematics, 83(2): 165 (1983).

Brown, S.C. Do College Students Benefit from High School laboratory Courses? American Journal of Physics, 26(5): 334 (1958).

Friedman, C.P., Hirshi, S., Parlett, M. and Taylor, E.F. The Rise and Fall of PSI in Physics at MIT. American Journal of Physics, 44(3): 204 (1976).

Hofstein, A. and Lunetta, V.N. The Role of the Laboratory in Science Teaching: Neglected Aspects of Research. Review of Educational Research, 52(2): 201 (1982).

Ivany, J.W. The Divergent Laboratory. American Journal of Physics, 36(11): 1072 (1968).

Gardner, M. Ten Trends in Science Education. The Science Teacher, 46: 30 (1979).

Green, B.A. Physics Teaching by the Keller Plan at MIT. American Journal of Physics, 39(7): 764 (1971).

Kruglak, H. Achievement of Physics Student with and without Laboratory Work. American Journal of Physics, 21(1): 14 (1953).

Lunetta, V.N. Computer Dialogs. The Physics Teacher, 12: 355 (1974).

Prigo, R.B., Korda, A. and Walker, W.D. Multi-purpose Physics Learning Center: A Working Model. American Journal of Physics, 43(12): 1049 (1975).

Rief, F. and St. John, M. Teaching Physicists Thinking Skills in the Laboratory. American Journal of Physics, 47(11): 950 (1979).

Spears, J. and Zollman, D. The Influence of Structured versus Unstructured Laboratory on Students' Understanding the Process of Science. Journal of Research in Science Teaching, 14(1): 33 (1977).

Toothacker, W.S. A Critical Look at Introductory Laboratory Instruction. American Journal of Physics, 51(6): 516 (1983).

APPENDIX A

One Version of Pre-laboratory Quiz

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 1: Recording and Communicating Data

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

For questions 1 –3, the table and graph below represent the distance a
car travelled in an experiment.
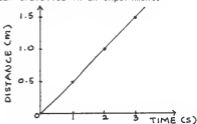
TIME (S)	DISTANCE (m)
0	0.0
1	0.5
2	1.0
3	1.5

1. What is the value of the slope of the graph above?

    a) 0.5 m/s
    b) 0.5 m
    c) 1.0 m/s
    d) 2.0 m/s

2. What is the average speed the car is travelling at during the
   experiment?

    a) 0.5 m/s
    b) 1.0 m/s
    c) 2.0 m/s
    d) 0.0 m/s

3. If the car continues at this speed, how far would it travel in 4
   secs?

    a) 4m
    b) 3m
    c) 2m
    d) 2.5m

33

4. For another experiment, the graph below was obtained. What can you say about the speed of the car?
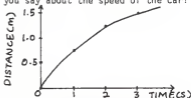
TIME (S)	DISTANCE (cm)
0	0.00
1	0.75
2	1.25
3	1.50

a) It is travelling at a constant speed of 1 m/s.
b) It is travelling at a constant speed of 0.5 m/s.
c) It is not moving at a constant speed.
d) It is moving at constant speed which cannot be determined by the information given.

5. Which of the labelled points has the highest acceleration?
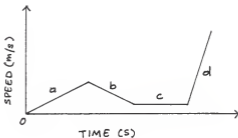
DESCRIPTIVE PHYSICS LAB QUIZ
Expt 2: Reaction Time

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

For questions 1 –3 an obbject fall from a certain height above the
ground. For this particular situation you can use the equation below.

$$y = 1/2 \ gt^2$$

1. Which value of 'g' should you use if you know the time of fall in
   seconds and you want the height y to be in meters?

   1) 980 m/s²
   2) 32 m/s²
   3) 32 ft/s²
   4) 9.8 m/s²

2. If the object reaches the ground in 2 seconds, what is the height
   from which it was dropped?

   1) 19.6 m
   2) 9.8 m
   3) 32 m
   4) 64 m

3. Another object was dropped from a height of 15 m. How long does
   it take to reach the ground?

   1) 3.06 s
   2) 1.75 s
   3) 0.6 s
   4) 1.2 s

4. In an experiment, the distance an object falls for a time interval
   of 5 seconds is investigated. The distances for 5 trials are
   0.9 m, 0.7 m, 0.5 m and 1.0 m. What is the average distance the
   object travels in the 5 seconds interval?

   1) 0.5 m
   2) 1.0 m
   3) 0.78 m
   4) 3.9 m

35

5. Heidi's reaction time to touch stimulus is (0.4 ± 0.1) seconds. How long would it take before she started to scream after she felt a large spider land on her bare arm?

   1) exactly 0.4 s
   2) between 0.3 s to 0.5 s
   3) between 0.3 s to 0.4 s
   4) between 0.4 s to 0.5 s

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 3: Accelerated Motion

Write your name on the test sheet. On the computer card, fill in your name and student number. Blacken the corresponding bubbles. Work through the problem and blacken your answer choice on the card corresponding to the question on the test. Return both the test sheet and computer card to your instructor.

1. What is the SI unit for aceleration?

   1) m^2/s
   2) m/s^2
   3) m/s
   4) m

2. Slope of a graph is given by:

   $$\text{slope} = \frac{\text{change in } y}{\text{change in } x} = \frac{\Delta y}{\Delta x}$$

   If you are plotting time in seconds on x-axis, what quantity should you plot on y-axis to obtain the value of the acceleration from the slope of the graph?

   1) height
   2) distance
   3) speed
   4) acceleration

3. Objects each of the mass listed below are dropped. Which mass will reach the floor first when dropped from the same height? (Ignore air resistance)

   1) They all strike floor at the same time.
   2) 1 kg
   3) 5 kg
   4) 2 kg

Questions 4 - 6 refer to the experimental situation shown in the diagram below. The two masses are attached together by means of a string. Assume there is no friction between the masses with table and pulley.
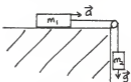

4. Use the symbols in the diagram to find the equation relating m_1, m_2, g and a.

   1) $m_1 g + m_2 g = m_2 a$
   2) $m_1 a + m_2 g = m_2 a$
   3) $m_1 g + m_2 a = m_2 g$
   4) $m_1 a + m_2 a = m_2 g$

5. The experiment is repeated several times with m_1 constant but changing m_2. What happens to the value of the acceleration 'a' of both masses?

   1) increases as m_2 increases
   2) decreases as m_2 increases
   3) stays the same since m_2 does not affect acceleration of the system.
   4) stays the same since m_1 is constant.

6. A similar experiment was done with m_2 = 50g. The result is shown graphically below.
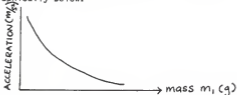
What relationship can you obtain from the graph?

   1) acceleration increases as m_1 increases.
   2) acceleration decreases as m_1 increases.
   3) acceleration increases as m_2 increases.
   4) acceleration decreases as m_2 increases.

38

For questions 7 - 9 refer to the graph below for speed versus time of a moving car.
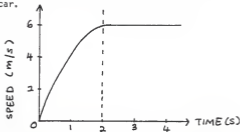
7. Which statement below best describes its motion during the first 2 seconds?

   1) It has stopped moving.
   2) It is travelling at a constant speed.
   3) It is decreasing its acceleration.
   4) It is increasing its acceleration.

8. For times greater than 2 seconds which statement best describes the motion?

   1) It has stopped moving.
   2) It is travelling at a constant speed.
   3) It is decreasing its speed.
   4) It is increasing its speed.

9. What will the speed of the car be at t = 10 s?

   1) 12 m/s
   2) 10 m/s
   3) 6 m/s
   4) 0 m/s

10. From Newton's Laws, force F is related to mass m and its acceleration a by the equation,

$$F = ma$$

If you pushed, with a constant force of 5 N, two objects of mass 1 kg and 2 kg, which mass will move with a higher acceleration? (Assume no friction between masses and floor)

   1) Both masses will move with same acceleration.
   2) Not enough information is given.
   3) 1 kg
   4) 2 kg

39

DESCRIPTIVE PHYSICS LAB QUIZ
Expt: 4: Energy and Work

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

1.
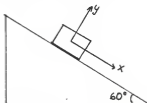
A block of wood weighing 8 N is placed on an incline tilted at an
angle of 60°. What is the force along x-axis shown above? Assume
frictionless surfaces.

1) 8 N
2) 6.9 N
3) 8.7 N
4) 4 N

2. A force of 10N is exerted on a box of mass 1 kg. How much work
has to be done to move the box 3 m?

1) 10.0 J
2) 29.4 J
3) 4.0 J
4) 30.0 J

3. How much potential energy is stored in an object of mass 6 kg at
the top of a cliff 6 m high?

1) 36.0 J
2) 58.8 J
3) 352.8 J
4) 216.0 J

4. A toy car of mass 50 kg is moving at a constant speed of 3 m/s. What is the kinetic energy of the car?

   1) 450 J
   2) 225 J
   3) 150 J
   4) 50 J

5. Sitting at the top of a hill an object has 900 J of gravitational potential energy. As the object rolls down the hill, 350 J of work is done against friction. How much kinetic energy does the object have when it reaches the bottom of the hill?

   1) 550 J
   2) 900 J
   3) 1250 J
   4) Insufficient information is given to calculate the kinetic energy.

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 5: Buoyancy

Write your name on the test sheet. On the computer card, fill in your name and student number. Blacken the corresponding bubbles. Work through the problem and blacken your answer choice on the card corresponding to the question on the test. Return both the test sheet and computer card to your instructor.

1. Two forces are acting on a block of wood as shown. The magnitude of $\vec{F_1}$ is greater than that of $\vec{F_A}$. What is the magnitude of the <u>resultant</u> force acting on the block?

   1) $F_1 - \vec{F_A}$
   2) $\vec{F_A} - F_1$
   3) No resultant force
   4) Resultant force could not be determined.

2. In the diagram below, the magnitude of the force $\vec{F_A}$ is equal to that $\vec{F_B}$. In which container will the pressure be greater?

   1) In container A
   2) In container B
   3) The pressure is the same in both containers.
   4) There is no pressure exerted on the fluid.
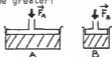
3. If we drop a block of wood in water, why doesn't it sink to the bottom?

   1) There is no force acting on the block to pull it to the bottom.
   2) The force exerted upwards by the water exceeds the force of gravity acting on the block.
   3) There is no force acting on the block in water.
   4) The forces acting on the block are not in equilibrium.

4. An object is immersed in a container of water. Using Archimedes' Principle, which property of the object can we measure?

   1) The change in height of the water level is the volume of the object.
   2) The weight of water displaced is the weight of the object.
   3) The volume of water displaced by the object is the volume of the object.
   4) Archimedes' Principle could not be used.

5. Ice which has a density of 0.9 g/cm^3 is placed in a fluid medium that has density of 0.5 g/cm^3. What happens to the ice?

1) It floats to the top.
2) It stays <u>partly</u> submerged in the fluid.
3) It sinks to the bottom.
4) Insufficient information is given to answer the question.

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 6: Heat Balance

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

DIRECTIONS: For questions 1 to 6 use the following set of responses.
Each response is used only once, more than once, or not at all.

        1) radiation
        2) condensation
        3) conduction
        4) convection

1. Which of the above is not a process of heat transfer?

2. A glass case placed over a heat source will prevent which type of
    heat transfer process from occurring?

3. Which process is responsible for the cooling down of a hot object
    placed in a vacuum?

4. A beaker of water is heated by a hot plate. Which process is
    mainly responsible in distributing the heat from the water at the
    bottom of the beaker to the rest of the volume of water?

5. A cylindrical rod of copper is heated at one end. By which
    process can the heat be transferred to the other end of the rod?

6. A white disc and a projection lamp are placed 20 cm apart. Both
    are in a vacuumed chamber. The lamp is turned on and it slowly
   heats the disc. Which process transfers energy from the lamp to
    the disc?

7.
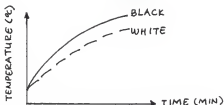
Two objects of different colors are heated. Their tempertures are recorded every minute. A graph of tempterure versus time is plotted above. What conclusion can you draw from this graph?

1) Black and white objects absorb energy at the same rate.
2) Color does not affect the amount of energy abosrobed.
3) White object absorbs energy faster than black.
4) Black object absorbs energy faster than white.

8.
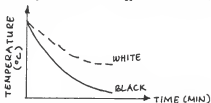
The two objects in question 7 are cooled. What conclusion can you obtain by looking at the graph above?

1) White object cools down faster than black.
2) Black object cools down faster than white.
3) Both objects cool down at the same time.
4) No conclusion can be reached due to insufficient information.

9. What happens to the temperature of an object being heated when it reaches equilibrium with its surroundings?

1) Its temperature rises and then drops down immediately as equilibrium is reached.
2) Its temperature keeps rising.
3) Its temperature starts decreasing.
4) Its temperature stays the same.

10. Which of the following statements is _false_?

1) Heat can be lost by an object due to invisible electromagnetic radiation.
2) All of the heat transfer processes result in a net movement of matter.
3) Heat can be conducted from a hot object to a cold object in contact with each other when both are insulators.
4) Heat can be transferred by conduction when the objects in contact are conductors.

45

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 7: Phase Changes in Water

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
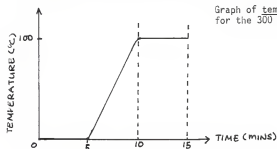and computer card to your instructor.

Below are some abbreviationns that will be used in this quiz.

Q = amount of heat energy
m = mass
ΔT = change in temperature
c = specific heat capacity
H_v = heat of vaporization
H_F = heat of fusion

1. Which equation represents how much heat is required to melt ice
   without raising its temperature?

   1) $Q = mc\Delta T$
   2) $Q = mH_F$
   3) $Q = H_F$
   4) $Q = H_v$

For questions 2 to 5 use the following information.

Graph of temperature versus time
for the 300 g of ice

$c = 4.2 \times 10^3$ J/kg C

$H_v = 2.3 \times 10^6$ J/kg

$H_F = 3.3 \times 10^5$ J/kg

46

2. Find the amount of heat absorbed by the water immediately after all the ice has melted and before it boils.

1) 4.2×10^4 J
2) 9.9×10^4 J
3) 1.26×10^5 J
4) 6.9×10^5 J

3. How much heat is being absorbed during the <u>first 5</u> minutes?

1) 4.2×10^4 J
2) 9.9×10^4 J
3) 1.26×10^5 J
4) 6.9×10^5 J

4. How much heat is being absorbed during the <u>last 5</u> minutes?

1) 4.2×10^4 J
2) 9.9×10^4 J
3) 1.26×10^5 J
4) 6.9×10^5 J

5. What is the total energy absorbed by the ice to turn it to vapor?

1) 9.15×10^2 J
2) 8.16×10^4 J
3) 7.9×10^5 J
4) 2.25×10^5 J

47

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 8: Equipotential and Electric Field

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

1. Which of the following is not a unit of electric field strength?

   1) Newton/coulomb
   2) volt/meter
   3) joule/coulomb
   4) All of the above are units of electric field strength.

2. In which direction does the electric field of an isolated positive
   charge point?

   1) towards the charge
   2) away from the charge
   3) It has no direction since it is not a vector.
   4) towards another charge closest to this positive charge.

3. Choose the incorrect statement.

   1) Voltage is the potential difference between the points.
   2) Voltage is the work required to move a unit charge between two
      points.
   3) Voltage is the amount of force required to move a unit charge
      between two points.
   4) Voltage is directly related to electric potential.

4. A voltmeter measures a potential difference of 4 volts between two
   points that are 2 cm apart. What is the electric field strength
   between these two points? Assume that the field is uniform.

   1) 1 V/cm
   2) 2 V/cm
   3) 4 V/cm
   4) 0.5 V/cm

5. Of the following, which shows the correct electric field lines for the various charged objects?
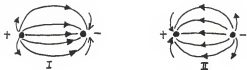
1) I
2) II
3) I and II
4) Neither I nor II

6. What is an equipotential line?

1) a line that joins all points of same potential
2) a line that joins all points of similar electric field direction
3) a line that joins all points of same electric field strength
4) a line that joins positive charge to negative charge

7. Below is a schematic drawing of potential lines for a set of charged objects. The potential difference between each successive line is 1 V. Where will the electric field strength be the greatest?
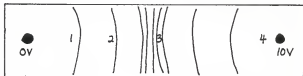
8. Based on the drawing question 7, in which direction would the electric field point?

1) points from 10 V object to 0 V object
2) points from 0 V object to 10 V object
3) points from both objects towards the center
4) points in all directions

9. For two parallel plates, where will the electric field strength be the greatest?
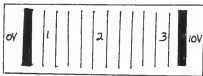
(4) The field strength is the same everywhere between the plates.

49

10. How are the electric field lines oriented at the surface of a conductor?

1) The lines are parallel to the surface.
2) The lines are perpendicular to the surface.
3) The lines are at an angle greater than 90° to the surface.
4) The lines are at an angle less than 90° to the surface.

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 9: Current and Magnetic Field

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

1. Which of the following does not have magnetic fields associated
   with it?

   (1) wire carrying current   (2) magnet   (3) the Earth
   (4) All of the above have magnetic fields associated with them.

2. If a current I is following through a long straight wire (as
   drawn), which direction is the magnetic field oriented?

   (1) It points to the north.
   (2) It points to the west.
   (3) It encircles the wire.
   (4) There is no field present.

3. Now, if the wire is bent into a circular loop, how would the
   resulting magnetic field be at the center of the loop oriented?

   (1) It points to the north.
   (2) It points to the west.
   (3) It encircles the wire.
   (4) There is no field present.

For question 4 and 5:

   A solenoid consists of a long helical spiral of wires. Its
   magnetic field is given by
   $$B = 4\pi K_m nI$$
   where K_m is magnetic force constant,
      n is the number of turns per meter,
   and I is the amount of current.

4. What happens to the field when amount of current is increased
   and n is held constant?

   (1) field strength decreases
   (2) field strength increases
   (3) field strength does not change since n is connstant
   (4) field strength is not affected by changing I

5. We now let a constant amount of current flow through the solenoid but increase the number of turns in the solenoid. How does this effect the magnetic field inside the coil?

(1) field strength decreases
(2) field strength increases
(3) field strength does not change since I is constant
(4) field strength is not affected by changing n

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 10: Generator

write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

1. If you have a bar magnet and a wire loop connected to an ammeter,
   how could you induce current to flow in the loop?

   1) We cannot induce a current in the loop since no battery is
      present.
   2) Current can be induced by moving the magnet back and forth
      through the loop.
   3) Current would flow if the magnet is placed stationary in the
      center of the loop.
   4) There would be a current flow if the wire loop has more than
      one turn.

2. A square wire loop with sides of 0.2 m is placed in a magnetic
   field of 0.5 Tesla as drawn below. Calculate the resulting
   magnetic flux.

   1) 0.10 Weber (Wb)
   2) 0.02 Wb
   3) 0.20 Wb
   4) 12.50 Wb

3. For the wire loop in question 2, how could you increase the amount
   of magnetic flux through the loop without changing the magnetic
   field strength?

   1) Decrease the size of the loop.
   2) Increase the size of the loop.
   3) Tilt the surface of the loop at an angle to the magnetic field
      lines.
   4) The magnetic flux cannot be changed.

4. In an AC generator, the armature coil is rotated in a <u>constant</u> magnetic field. Which of the following statement(s) is(are) true?

   1) The current changes direction as the magnetic field varies with time.
   2) The current changes direction as the perpendicular component of B varies with time.
   3) The amount of current produced is constant as the coil is rotated in the magnetic field.
   4) All of the above statements are true.

5. The EMF for a generator is given as

$$\mathcal{E} = \frac{\Delta \phi}{\Delta t} = \frac{\Delta (B_\perp A)}{\Delta t}$$

where ϕ is the magnetic flux. The graph of $\mathcal{E}$ versus angle of orientation θ of coil is drawn below. Why is $\mathcal{E}$ at $\theta = 90°$ equal to zero?
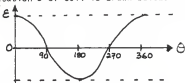
   1) Δt is equal to zero.
   2) Area A of the coil decreases to zero.
   3) $B_\perp$ is zero.
   4) Current I in the coil is zero.

DESCRIPTIVE PHYSICS LAB QUIZ
Expt 11: Circuits

Write your name on the test sheet. On the computer card, fill in your
name and student number. Blacken the corresponding bubbles. Work
through the problem and blacken your answer choice on the card
corresponding to the question on the test. Return both the test sheet
and computer card to your instructor.

1. In which of the circuits below are the two bulbs in series with
   each other?

      (1)   (2)   (3)   (4)

2. A light bulb is connected to a 6V battery. The voltage across it
   is measured. Then a second similar bulb is connected in series to
   the first. What would the voltage across the first bulb be
   compared to the earlier arrangement?

   1) The voltage stays the same.
   2) There will be no voltage across the bulb.
   3) The voltage decreases.
   4) The voltage increases.

3. A resistor is connected to a 6V battery. Then a second similar
   resistor is connected in parallel to the first. What happens to
   the voltage across the first resistor?

   1) The voltage stays the same.
   2) There will be no voltage across the resistor.
   3) The voltage decreases.
   4) The voltage increases.

For questions 4 - 7.

We have two bulbs in series. The individual voltage drops and current across the bulbs are listed below.

Bulb 1	Bulb 2
$V1 = 4V$	$V2 = 4V$
$I_1 = 1A$	$I2 = 1A$

4. What is the total voltage of the circuit?

1) 1 V   2) 4 V   3) 5 V   4) 8V

5. What is the total current flowing through the circuit?

1) 1 A   2) 2 A   3) 4 A   4) 8 A

6. What is the resistance of bulb 1?

1) 8 Ω 2) 4 Ω 3) 2 Ω 4) 0.25 Ω

7. What is the total resistance of the circuit?

1) 0.25 Ω 2) 2 Ω 3) 4 Ω 4) 8 Ω

For questions 8 - 10

The bulbs are now connected in parallel. The voltage drops and current across the bulbs are listed below.

Bulb 1	Bulb 2
$V1 = 4V$	$V2 = 4V$
$I_1 = 1A$	$I2 = 1A$

8. What is the total voltage of the circuit?

1) 8 V   2) 4 V   3) 2 V   4) 1 V

9. What is the total current?

1) 1 A   2) 2 A   3) 3 A   4) 4 A

10. What is the total resistance?

1) 0.5 Ω 2) 2 Ω 3) 4 Ω 4) 8 Ω

APPENDIX B

Notes to Instructors

1. Go through calculation of slope

    slope = $\dfrac{\text{rise}}{\text{run}}$

    rise = change in vertical coordinate (y)
    run = change in horizontal coordinate (x)

    ---> slope = $\dfrac{\text{change in } y}{\text{change in } x}$ = $\dfrac{\Delta y}{\Delta x}$

    (Make sure that they do not use data points to find the slope!)
    * Do an example of the calculation.

2. For distance versus time graph.

    slope = $\dfrac{\Delta \text{distance}}{\Delta \text{time}}$ = speed

    - straight line ---> constant speed

      relationship ---> directly proportional

3. Moving at constant speed.

    Use equation for line:

        y = mx
        v = mt   , m = slope

    ---> can predict what happens at t = 4s.

4. Not straight line ---> speed is changing at different times. (You
    can draw different tangent lines to the curve to show how the slope
    and thus the speed changes.)

5. Slope = $\dfrac{\Delta \text{speed}}{\Delta \text{time}}$ = acceleration

    steeper slope ---> higher acceleration. (Explain what is
    happening at the different portions of the graph.)

1. Go through the equation and subsititue the units of each of responses.

   _or_   use $g = \dfrac{2y}{t^2}$

   given t in seconds, y in meters.

   $$\left[\: g \: \right] = \dfrac{[m]}{[s^2]} = \left[m/s^2 \right]$$

2. Substitute the known variables into equation. Stress the fact that it is squared and they have to use the correct value of g.

3. Manipulate the equation for them and solve for t. Make sure that they _know_ that they are supposed to take the square root of $\left(\dfrac{2y}{g} \right)$, not $\dfrac{\sqrt{2y}}{g}$ (most common mistakes).

4. Define what is average value.

   Total d $= d_1 + d_2 + d_3 + d_4 + d_5$

   # trials = 5

   Average d $= \dfrac{\text{total d}}{\#\text{trials}} = \dfrac{d_1 + d_2 + d_3 + d_4 + d_5}{5}$

5. Understanding $\overline{t} \pm \Delta t$:

   $\overline{t}$ = average time

   Δt = approximate error of the trials. (deviation of the trials above and below the calculated average t)

   $\Delta t = \dfrac{\pm \text{highest} - t_\text{lowest}}{2}$

   $\overline{t} \pm \Delta t$ gives the <u>range</u> of reaction time within which you reacted to the stimulus.

   for example: range of t is given as (0.5 ± 0.1) seconds; <u>then</u> you can react from $(0.5 - 0.1)$s to $(0.5 + 0.1)$s <u>after</u> the stimulus is seen, felt or heard.

1. Go through definition of acceleration.

$$a = \frac{\Delta v}{\Delta t}$$

units for Δv = $\left[\frac{m}{s}\right]$

units for Δt = $\left[s\right]$

Therefore, $[a]$ = $\left[\frac{m}{s} \cdot \frac{1}{s}\right]$ = $\left[\frac{m}{s^2}\right]$

2. Go through definition of slope and acceleration.
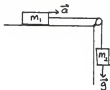
$$slope = \frac{\Delta y}{\Delta x} \qquad ; \qquad acceleration = \frac{\Delta v}{\Delta t}$$

Compare both equation:
Given $\Delta x = \Delta t$
So, to get slope = acceleration, $\Delta y = \Delta v$

3. Any object falling freely near surface of the earth will experience a pull of gravity resulting in acceleration of g = 9.8 m/s² . This is true regardless of mass, shape, size <u>when</u> air resistance is ignored.

4. Have to show them the equation of forces:

$$m_2 g - T = m_2 a \qquad -(1)$$
$$T = m_1 a \qquad -(2)$$

(2) into (1):
$$m_2 g - m_1 a = m_2 a$$
$$m_2 g = m_2 a + m_1 a$$

NB: In some test versions m_1 and m_2 are interchanged. Also for questions 5 & 6.

5. Go through equation of forces as in (4). Then simplify equation:

$$(m_2 + m_1) a = m_2 g$$

$$a = \left(\frac{m_2}{m_1 + m_2}\right) g$$

Since it is hard for the students to visualize that a is 'proportional' to m , you might have to stick in some numbers into the equation to show how m affect a:

eg: Let $m_1 = 10$ g = constant

<u>Case 1</u> $m_2 = 20g$ ---> $a = 2/3g = 0.67g$

<u>Case 2</u> $m_2 = 40g$ ---> $a = 4/5g = 0.8g$

6. Have to go through the responses and eliminate them one by one.

7. Slope is not a straight line. Therefore it is not at a <u>constant</u> speed. The slope is a curve at gradually becomes horizontal ---> decreasing speed. If increasing speed, slope gradually becomes vertical.

8. Horizontal slope –
    $$slope = \frac{\Delta v}{\Delta t} \quad , \Delta v = 0$$
    $$\Delta v = v_i - v_2 = 0 \quad , \text{acceleration} = 0$$

    Therefore speed is the same.

9. From 8, the car is travelling at a constant speed. It is safe to assume that at any time greater than 2 seconds, it will travel at the same speed.
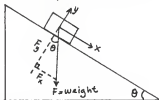
10. $F = ma = 5N$

    For $m = 2$ kg
    $a = \frac{F}{m} = \frac{5}{2}$ m/s^2 = 2.5 m/s^2

    For $m = 1$ kg
    $a = \frac{5}{1} = 5$ m/s^2

    Therefore, mass $m = 1$ kg has higher acceleration.

1. Resolve components of forces for incline plane.

$$\text{Sin } \theta = \frac{F_x}{F}$$

$$F_x = F \text{ Sin } \theta$$

2. Definition of work

$$W = F \times d$$

Make sure that they know d is measured parallel to F. Give examples:

(i)

(ii)

Therefore d $\neq$ h

3. Definition of potential energy:

$$PE = mgh$$

Due to its position at the top with respect to the bottom of the cliff.

4. Definition of kinetic enrgy:

$$KE = 1/2 \, mv^2$$

5. Energy can be transformed.

Give a few examples.

Then discuss about the problem in (5). The object has an energy reservoir of 800 J. In rolling down the hill some of it (150J) is lost to friction between the surface of the object and the hillside. Since it is also moving its total energy is being converted to kinetic and frictional energy.

1. In this case the magnitude is a positive scalar. Thus, the magnitude of the resultant force is $F_1 - F_2$ when $F_1 > F_2$.
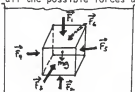
2. $P = \dfrac{F}{A}$, A = Area

   Since $F_A = F_B = F$

   Then $P_A = \dfrac{F}{A_A}$; $P_B = \dfrac{F}{A_B}$

   Thus magnitude of P depends on the Areas the force is acting on. P would be larger when Area A is smaller.

3. Go through all the possible forces acting on a cube in water.

$\vec{F_4}$ is balanced by $\vec{F_5}$ $\left.\begin{array}{l}\\\\\end{array}\right\}$ horizontal forces adds up to **zero**.

$\vec{F_3}$ by $\vec{F_6}$

Vertical forces

$\vec{F}_{net\ up} = \vec{F_2} - \vec{F_1} - m\vec{g}$

$(\vec{F_2} - \vec{F_1})$ is net force due to the water

Let $(\vec{F_2} - \vec{F_1}) = \vec{F_w}$

$\vec{F}_{net\ up} = \vec{F_w} - mg$

If $F_w > mg$, object floats to the top.

$F_w < mg$, object sinks.

4. Definition of Archimedes' Principle. Volume of object is equal to the volume of water displaced when the object is <u>fully immersed</u> in water.

5. Notice that the fluid medium is relatively less dense than ice.

   Since the object (ice) is 'heavier' than the fluid medium it will sink to the bottom.

   NB: H_2O = 1.0 g/cm^3

   For Comparison

   $\rho(H_2O)$ = 1.0 g/cm^3 & $\rho(Al)$ = 2.7 g/cm^3

   Al will sink in H_2O.

1 to 6:

Give definition of each process. If possible give other examples or interpret the questions to get to the correct answer. Usually students know what the processes are and now heat is supposed tobe transferred. But when faced with novel examples they do not know what process is involved.

7 & 8

Just to check if they can still remember how to interpret data in graphical form. If they had this incorrect you will have to go through the slopes and the variables (x, y) and how they are supposed to be related from the curve drawn on the graph.

For eg. #7

Both start out with same temperature but at a certain time (draw dotted line for same time), the temperatures are different. The rate is the amount of temperature change per unit interval of time.
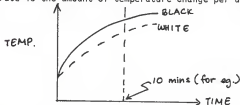
9. Taken out from laboratory manual. At equilibrium amount of heat lost to the surrounding is equal to the amount of heat gained. The net amount of heat energy stored in the object remains the same. Since temperature is a measure of amount of heat in the object and the net heat does not change, temperature does not change either ---> constant temperature.

10. Go through each true statement and clarify them.

Invisible EM radiation - eg microwave.

Only convection results in a net movement of matter

   eg - a certain volume of hot air rises and being replaced by cool air.

1. Explain
   H_V = heat of vaporization – energy per unit mass to break/make bonds of solid/liquid

   H_F = heat of fusion – energy per unit mass to break/make bonds of solid.

   There is no energy that is used to raise the temperature of ice (or other element) involved.

   Therefore $Q = mH_F$ when $\Delta T = 0$ for ice

2. Between freezing and boiling points the heat is used to raise the temperature of water. The heat absorbed depends on the heat capacity of H_2O (capacity/ability to hold in heat)

   $$Q = mc\,\Delta T \quad , \quad \Delta T = 100°C - 0°C = 100°C. \quad \text{(remember to change mass to kg)}$$

3. During the 1st stage (see graph on next page) still at freezing point ($\Delta T = 0$ C). Heat is used to break up the bonds of ice molecules.

   $T = 0°C$, $Q = mH_F$ (mass in kg)
   $\Delta T = 0$ C

4. During the last stage.

   $T = 100°C$, $\Delta T = 0°C$
   $Q = mH_V$

   ---> heat is used to break up bonds of H_2O to vapor.
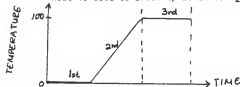
5. Total energy involved.

   1st stage : $Q_1 = mH_F$

   2nd stage : $Q_2 = mc\,\Delta T$

   3rd stage : $Q_3 = mH_V$

   $$Q\text{total} = Q_1 + Q_2 + Q_3.$$

1. $E = \dfrac{\Delta v}{\Delta d}$ ---> volt/meter.

    also $F = Eq$ ---> $E = \dfrac{F}{q}$ ---> newton/coulomb

2. Electric field E is a vector.

    For positive - away

    For negative - towards

3. Voltage $= \Delta \vec{\phi} =$ potential difference 2 points. $\vec{\phi}$ is work required to move a charge between 2 points.

4. $E = \dfrac{\Delta V}{\Delta d}$ for uniform field

5. $\vec{E}$ from positive to negative charges.

6. equipotential = equal potential

    In the laboratory manual equipotential line is defined as a line that joins points of same potential. In the expt., voltage is measured with respect to one of the source being at 0V. Thus, equipotential line can also be drawn by joining points of same voltage.

7. $E = \dfrac{\Delta V}{\Delta d}$

    ΔV between successive lines is 1V. So, d determines the value of E. Smaller d will result in larger E.

    eg. $d_1 = 2$ cm $E_1 = (1V)/2$ cm $= 0.5$ v/cm.

          $d_2 = 4$ cm $E_2 = 1V/4$ cm $= 0.25$ v/cm.

8. $\vec{E}$ Points from '+' to '-'. In this case 10 V source is more positive
than 0V.

$$\overline{\quad \underset{0}{|} \quad \underset{5}{|} \quad \underset{10}{|} \quad}$$
$$- \;\longleftarrow\!\!\!\underset{\vec{E}}{_\times}\!\!\!--- \;+$$
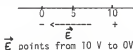
$\vec{E}$ points from 10 V to 0V

(Similar to question #2)

9. Similar to #7

Now ΔV is 1V and d = constant between eacch successive line.

E = constant everywhere.

10. $\vec{E}$ is always perpendicular to the surface of a conductor.

1. magnet - field produced by its poles.

Similar to '+' & '-' charges.

Earth - due to its poles but the Earth's magnetic field is like a bar magnet with the south pole near the Earth's geographic north pole.

Wire carrying I - due to the net magnetic field of the moving electrons (e) and stationary protons (p). If it is not flowing both e & p are stationary and each field is randomly oriented. Therefore no net field.

2 & 3 ---> Use right hand rule. (Show them how to use it).

#2 : Thumb points in direction of I.
      fingers - the direction of field.

#3 : fingers - the direction of I
      Thumb - direction of field.

4 & 5 ---> Remember expt 1 ---> understanding relationship of variables.
      $4\pi K_m$ is a constant.
      $\vec{B}$ is affected only by n and I

#4 : B is directly proportional to I (n constant).
      As I↑ , B↑

#5 : B is directly proportional to n (I constant)
      As n↑ , B↑

NB: Read ** first (Turn to next page)

1. From last week - $\vec{B}$ can be induced by I. So, I can be induced by
   <u>changing</u> magnetic flux.   Therefore the magnetic field of the
   magnet provides the changing flux when the magnet is moved back
   and forth through the loop.

2. Definition of flux:
   $$\phi = B_\perp A$$

   where $B_\perp$ is B that is perpendicular to the plane of the
   loop and A is area of the loop.

3. This requires the student to understand the relation of ϕ with B
   and A.   with $B_\perp$ constant, ϕ is proportional to A. To increase ϕ
   A has to increase.

4. For a generator,

   $$\phi \propto B_\perp$$
   where $B_\perp = B \cos \theta$ (Area of loop is constant)
                                   , θ is ∡ between B and the plane
                                     of the loop <u>not</u> between B and the
                                     normal of the plane.

   referring to equation in #5 :
   $$E = \frac{\Delta (B_\perp A)}{\Delta t} = EMF$$

   EMF is produced by induction and EMF <u>causes</u> current to flow.
   Therefore current depends on the changing perpendicular component
   of B ($B_\perp$) with time.

   - Magnetic field does not change since it is stated that B is
     constant.
   - The amount of I is not constant as the coil is rotated in the
     magnetic field ---> it depends on the amount of $B_\perp = B \cos\theta$

5. Understanding of formula:

$$E = \frac{\Delta(B_\perp A)}{\Delta t}$$

$\Delta t \not\to 0$ or $\longrightarrow E \to \infty$
$A \not\to 0$ since Area does not change EMF is zero causes I to be
zero. $B_\perp$ is zero since at $\theta \ast 90°$, B and are of the loop
are parallel $\longrightarrow$ no ϕ

** Descriptive Physics uses changing component of B instead of
changing Area cutting the magnetic field lines. Also θ is angle
between B and the plane of loop not normal of the plane.

1. Checking to see if the students can recognize parallel and series
   circuits. This _does not_ mean that they know how to hook up the
   bulbs in the experiment.

2. For series circuit:

   I is constant, voltage change.

   As more bulbs (similar ie. same resistance), voltage drops.

3. For parallel circuit:

   V is constant, I changes.

   Theoretically, V is constant as you add more resistors.

4 - 7 _For Series:_

   5) Individual current = total current
      I_{TOTAL} $= I_1 + I_2$

   4) Voltages add up
      V_{TOTAL} $= V_1 + V_2$

   6) Resistance R_1 $= \frac{V_1}{I_1}$, $R_2 = \frac{V_2}{I_2}$

   7) Total resistance $R_T = \frac{V_T}{I_T} = \frac{V_1}{I_1} + \frac{V}{I_2}$ $= R_1 + R_2$

   Make sure these are clear to the students. Especially calculation
   on resistances.

8 - 10 <u>For parallel</u>

8) Voltage is constant
   $V_{TOTAL} = V_1 = V_2$

9) Total current $I_{TOTAL} = I_1 + I_2$

10) Resistance:

$R_1 = \dfrac{V_1}{I_1}$, $R_2 = \dfrac{V_2}{I_2}$

$\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2} = \dfrac{I_T}{V_T}$ and remember to find the inverse.

The common error is forgetting to find the inverse when finding total resistance.

APPENDIX C

Question Related to Laboratory

on Weekly Quizzes and Final Examination

QUIZ QUESTION SET #1

PRE-LABORATORY QUIZ

If the object reaches the ground in 2 seconds, what is the height from which it was dropped?

1) 9.8 m
2) 19.6 m
3) 1960 m
4) 64 m

WEEKLY QUIZ (1985)

If an object falls from rest with a constant acceleration of 9.8 meters/sec^2, how far would it fall in 5 seconds if air resistance can be ignored? (meters)

1) 25   2) 50   3) 125   4) 250

WEEKLY QUIZ (1984)

If an object falls from rest with a constant acceleration of 9.8 meters/sec^2, how far will it fall during the third second that it is falling? (meters)

1) 10   2) 20   3) 25   4) 30

QUIZ QUESTION SET #2

PRE-LABORATORY QUIZ

Objects each of the mass listed below are dropped. Which mass will reach the floor first when dropped from the same height (ignore air resistance)?

1) 5 kg
2) 2 kg
3) 1 kg
4) They all strike the floor at the same time.

WEEKLY QUIZ (1985)

If the following objects were dropped at the same time from the top of Cardwell Hall, which one would reach the ground first (do not disregard air resistance)?

1) a tiny dog
2) a very large cat
3) an average size mouse
4) any cow
5) They would all arrive at the same time

WEEKLY QUIZ (1984)

If the following objects were dropped from the top of Cardwell Hall, which one would reach the ground first?

1) a small styrofoam ball.

2) a large styrofoam ball.

3) a large steel ball.

4) They would reach the ground at the same time.

PRE-LABORATORY QUIZ

For questions 7 -9 refer to the graph below for speed versus time of a moving car.
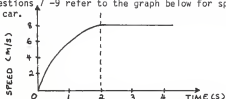
Which statement below best describes its motion during the first two seconds?

1) It is increasing its speed.
2) It is decreasing its speed.
3) It is travelling at a constant speed.
4) It has stopped moving.

For times greater than 2 seconds which statement best describes the motion?

1) It is increasing its speed.
2) It is decreasing its speed.
3) It has stopped moving.
4) It is travelling at a constant speed.

WEEKLY QUIZ (1985)

Which of the following graphs of velocity versus time best represents the motion of an object thrown straight up from the time it is released going up until the time it has fallen back to where it was released (air resistance can be ignored) ?
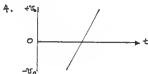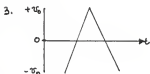
WEEKLY QUIZ (1984)

Which of the following diagrams represents a mass moving with a constant, positive acceleration?
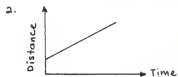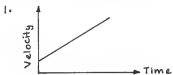
QUIZ QUESTION SET #4

PRE-LABORATORY QUIZ

Sitting at the top of a hill an object has 500 J of gravitational
potential energy. As the object rolls down the hill, 120 J of work is
done against friction. How much kinetic energy does the object have
when it reaches the bottom of the hill?

    1) Insufficient information is given to calculate the kinetic
       energy.
    2) 620 J
    3) 500 J
    4) 380 J

WEKLY QUIZ (1985)

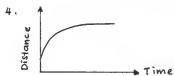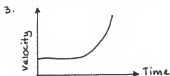If a 0.5 kg block slides down a ramp that is 1.5 m long and 0.3 m
high, and it speed at the bottom is 2.0 m/s, how much work would have
been done against friction while the block was sliding? (J)

    1) 0.15   2) 0.3   3) 0.5   4) 1.5

If a 0.5 kg block slides down a ramp that is 1.5 m long and 0.3 m
high, and it speed at the bottom is 2.0 m/s, how much additional work
would have to be done on it to stop it? (J)

    1) 1.0   2) 0.75   3) 0.5   4) 1.5

WEEKLY QUIZ (1984)

How much work is required to pull a 3 kg block 10 m up an incline to a
height of 5 meters if there is a frictional force of 8 N between the
block and the incline? (J)

    1) 150   2) 30   3) 300   4) 70

QUIZ QUESTION SET #4 – Contd .....

How much work is required to pull a 4 kg block 20 m up an incline to a
height of 5 meters if there is a frictional force of 8 N between the
block and the incline? (J)

    1) 40   2) 200   3) 160   4) 360

FINAL EXAM (1985)

If a 1.0 kg block slides down a ramp that is 1.5 m long and 0.3 m
high, and it speed at the bottom is 2.0 m/s, howmuch work would have
been done against friction while the block was sliding? (J)

    1) 1.0   2) 2.0   3) 0.5   4) 1.5

FINAL EXAM (1984)

How much work is required to pull a 2 kg block 10 m up an incline to a
height of 5 meters if there is a frictional force of 5 N between the
block and incline? (J)

    1) 100   2) 50   3) 150   4) 250

QUIZ QUESTION SET #5

PRE-LABORATORY QUIZ

Ice which has a density of 0.9 g/cm2 is placed in a fluid medium that
has density of 0.5 g/cm . What happens to the ice?

1) In sufficient information is given to answer the question.
2) It stays <u>partly</u> submerged in the fluid.
3) It floats to the top.
4) It sinks to the bottom.

WEEKLY QUIZ (1985)

If a rock has a density that is three times the density of water, what
will be the buoyant force on it when it is immersed in water if it
weighs 12 N in air? (N)

1) 6   2) 2   3) 3   4) 4

What would be the weight of the water displaced by a floating block of
wood that has a density of 0.45 kg/m and a mass of 2 kg? (N)

1) 20   2) 2   3) 3.0   4) 4.5

WEEKLY QUIZ (1984)

What would be the weight of the water displaced by a floating block of
wood that has a density of 0.65 kg/m and a mass of 2 kg? (N)

1) 20   2) 2   3) 0   4) 6.5

What would be the net force on the block described above? (N)

1) 20   2) 2   3) 0   4) 6.5

FINAL EXAM (1985)

What would be the weight of the water displaced by a floating block of
wood that has a density 0.65 kg/m and a mass of 5 kg? (N)

1) 14   2) 5   3) 0   4) 50

FINAL EXAM (1984)

What would be the weight of the water displace by a floating block of
wood that has a density 0.65 kg/m and a mass of 2 kg? (N)

1) 20   2) 2   3) 0   4) 6.5

QUIZ QUESTION SET #6

<u>PRE-LABORATORY QUIZ</u>
Which of the above is not a process of heat transfer?

1) convection
2) radiation
3) condensation
4) conduction

<u>WEEKLY QUIZ</u> (1985)

Which of the following heat transfer processes will not occur in the absence of gravity?

1) radiation
2) conduction
3) convection
4) all of the above (i.e. all will occur in the absence of gravity)

<u>WEEKLY QUIZ</u> (1984)

Which of the following heat transfer processes will not occur in the absence of gravity?

1) radiation
2) conduction
3) convection
4) all of the above (i.e. all will occur in the absence of gravity)

PRE-LABORATORY QUIZ
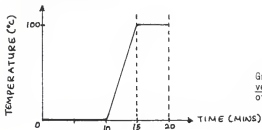
Graph of <u>temperature versus time</u> for 300 g of ice

$c = 4.2 \times 10^3$ J/kg C

$H_v = 2.3 \times 10^6$ J/kg

$H_F = 3.3 \times 10^5$ J/kg

Find the amount of heat absorbed by the water immediately after all the ice has melted and before it boils.

1) 6.9×10^5 J
2) 1.26×10^5 J
3) 9.9×10^4 J
4) 4.2×10^4 J

WEEKLY QUIZ (1985)

If an aluminum cup having a mass of 0.1 kg is at a temperature of 20°C and 0.1 kg of water at 90°C is poured into it, what will be the temperature of the cup and the water at equilibrium if no heat is lost? (C)

1) 27   2) 48   3) 55   4) 78

WEEKLY QUIZ (1984)

If a 100 g lead ball at a temperature of 20°C is dropped into 100 g of water at 100°C, what will be the equilibrium temperature if no heat is lost to the container and surroundings? (deg C)

1) 27   2) 37   3) 67   5) 97

QUIZ QUESTION SET #8

<u>PRE-LABORATORY QUIZ</u>

A voltmeter measures apotential difference of 2 volts between two
points that are 4 cm apart.   What is the electric field strength
between these two points? Assume that the field is uniform.

1) 1 v/cm
2) 2 v/cm
3) 4 v/cm
4) 0.5 v/cm

<u>WEEKLY QUIZ</u>(1985)

The next three question relate to a uniform electric field between two
charged parallel metal plates separated by a distance, d = 0.1 meter,
with a potential difference (voltage) of 100 volts between the plates.

What is the strength of the electric between the plates? (N/C)

   1) 40   2) 10   3) 400   4) 100

<u>WEEKLY QUIZ</u> (1984)

The next three questions relate to a uniform electric field between
two charged parallel metal plates separated by a distance, d = 0.25
meter, with a potential difference (voltage) of 100 volts between the
plates.

What is the strength of the electric field between the plates? (N/C)

   1) 40   2) 0.0025   3) 400   4) 25

<u>FINAL EXAM</u> (1985)

The next two questions relate to a uniform electric field between two
charged parallel metal plates separated by a distance, d = 0.2 meter,
with a potential difference (voltage) of 100 volts between the plates.

What is the strength of the electric field between the
plates? (N/C)

   1) 20   2) 500   3) 200   4) 50

QUIZ QUESTION SET #7 — Contd....

The next two questions relate to a uniform electric field between two charged parallel metal plates separated by a distance, $d = 0.1$ meter, with a potential difference (voltage) of 20 volts between the plates.

What is the strength of the electric field field between the plates? (N/C)

    1) 20   2) 0.02   3) 400   4) 200

QUIZ QUESTION SET #9

PRE-LABORATORY QUIZ

A solenoid consists of a long helical spiral of wires. Its magnetic field is given by

$$B = 4\pi K_m n I$$

Where K_m is magnetic force constant,
      n is the number of turns per meter,
and   I is the amount of current.

What happens to the field when amount of current is increased and n is held constant?

    1) field strength increases
    2) field strength decreases
    3) field strength does not change since n is constant
    4) field strength is not affected by changing I

We now let a constant amount of current flow through the solenoid but increase the number of turns in the solenoid. How does this effect the magnetic field inside the coil?

    1) field strength increases
    2) field strength decreases
    3) field strength does not change since I is constant
    4) field strength is not affected by changing n

WEEKLY QUIZ (1985)

Suppose you use the method from last week's lab to precisely measure the earth's magnetic field strength at a particular location. If you set the coil for a horizontal field of all micro tesla at an angle of 90 deg to the earth's field, and the compass needle points at an angle of   30 deg north of the coil's field, what would be the strength of the earth's field at that point? (micro tesla)

    1) 15   2) 20   3) 25   4) 30

In doing the measurement above, which of the following would have no effect on the value that you measured?

    1) The number of loops in the coil
    2) The strength of the current in the coil
    3) The direction of the current in the coil
    4) All of the above would affect the value measured
    5) None of the above would affect the value measured

86

WEEKLY QUIZ (1984)

The following questions refer to a copper coil, such as the one used
in last week's lab, which carries a D.C. current and therefore
produces a magnetic field. Initially the field is oriented
perpendicular to the earth's field and is equal to it in strength.
All questions refer to the resultant magnetic field, i.e. the earth's
field plus the coil's field.

What will be the strength of the resultant magnetic field relative
to the earth's field?

    1) 1.0   2) 1.4   3) 2.0   4) 2.8

Which of the following would cause the resultant field to increase?

    1) increasing the number of turns in the coil
    2) increasing the current through the coil
    3) decreasing the angle between the two fields
    4) any one of the above

If the direction of the current through the coil were reversed, which
of the following would describe the change in the resultant field?

    1) There would be no change.
    2) It would become zero.
    3) It would change in direction but not in strength.
    4) Both the direction and the strength would change.

QUIZ QUESTION SET #10

PRE-LABORATORY QUIZ

In an AC generator, the armature coil is rotated in a <u>constant</u> magnetic
field. Which of the following statement(s) is(are) true?

1) The current changes direction as the perpendicular component
   of B varies with time.
2) The current changes direction as the magnetic field varies
   with time.
3) The amount of current produced is constant as the coil is
   rotated in the magnetic field.
4) All of the above statements are true

WEEKLY QUIZ (1985)

Which of the following is only used, in normal applications discussed
in class, with alternating current?

1) A transformer
2) An electric motor
3) A galvanometer
4) all of the above
5) none of the above

WEEKLY QUIZ (1984)

Which of the following is true of the current that would be produced
by an AC generator rotating at constant speed and connected to a light
bulb?

1) It would be greatest when the magnetic flux (number of field
   lines) passing through the generator coil is greatest.
2) It would be proportional to the sine of the angle between the
   direction the coil is moving and the direction of the magnetic
   field.
3) It would be directly proportional to the resistance of
   the light bulb.
4) All of the above.

QUIZ QUESTION SET #11

The bulbs are now connected in parallel. The voltage drops and current across the bulbs are listed below.

Bulb 1	Bulb 2
$V_1 = 4V$	$V_2 = 4V$
$I_1 = 2A$	$I_2 = 2A$

What is the total resistance?

1) $1\,\Omega$ 2) $2\,\Omega$ 3) $4\,\Omega$ 4) $8\,\Omega$

WEEKLY QUIZ (1985)

Which of the following is a true statement?

1) In a series circuit the voltage is the same across every element.
2) In a parallel circuit the current is always the same through every element.
3) In all circuits the current is the sum of the current through each element.
4) In all circuits adding more elements increases the total current through the circuit.
5) None of the above

WEEKLY QUIZ (1984)

Three resistors of 3, 5, and 7 ohms, are connected in parallel. What is the net resistance across the parallel circuit?

1) $3.5\,\Omega$ 2) $6.5\,\Omega$ 3) $15\,\Omega$ 4) $1.5\,\Omega$

FINAL EXAM (1985)

Which of the following is a true statement?

1) In a series circuit the resistance is always the same across every element.
2) In a parallel circuit the voltage is always the same across every element.
3) In all circuits the current is the sum of the current through each element.
4) In all circuits adding more elements increases the total current through the circuit.
5) None of the above

QUIZ QUESTION SET #11 — Contd....

<u>FINAL EXAM</u> (1984)

Five resistors of 3, 5, 7, 9, and 11 ohms, are connected in parallel.
What is the net resistance across the parallel circuit?

1) 1.1 Ω 2) 3.3 Ω 3) 6.6 Ω 4) 12 Ω

APPENDIX D

Questions Not Related to Laboratory

on Final Examination

QUESTIONS NOT RELATED TO LABORATORY ON FINAL EXAMINATION

1985

1. If a projectile, thrown horizontally, travels 180 meters during the time it falls 180 meters to the ground, what is its horizontal velocity? (m/s)

1) 10   2) 100   3) 30   4) 6

2. If a car is travelling 30 m/s when the brakes are applied, and it travels 120 meters which would it travel before coming to rest, what is its average deceleration (ie, the negative acceleration that results from breaking)? (m/s)

1) 0.5   2) 1.5   3) 3   4) 6

3. In which of the following processes is potential energy stored in the intermolecular forces between the molecules of water?

1. when ice is melted at constant temperature
2. when water is vaporized at constant temperature
3. all of the above
4. none of the above

1984

Rheba Rebound, the basket ball star is travelling horizontally at 3m/s when she throws the ball straight upward at 4 m/s. What is the maximum height above her hands that the ball reaches (m)

1) 0.8   2) 0.45   3) 1.2   4) 1.5

If a car which has a mass of 2000 kg is travelling at a speed of 20 m/s, on a level road, what is the average force required to bring it to a stop in 100 sec.? (N)

1) 2000   2) 800   3) 4000   4) 400

Which of the following is a measure of the average translational kinetic energy of the molecules of any mass?

1. temperature
2. thermal energy
3. heat
4. specific heat

92

4. How long would it take to heat 0.5 kg of water from a temperature of 20 C to 100 C if heat is added to it at a rate of 500 watts? (sec)

1) 0.8   2) 40   3) 335   4) 418

5. How much work would be required to move a positive charge of 1.0 coulombs from the negatively charged plate to the positively charged plate? (J)

1) 0.1   2) 1.0   3) 10   4) 100

6. Which of the following has the units of energy?

1) volts   2) volts x watts
3) volts x coulombs   4) none of the above

7. If the air in a metal tube of length L is not set into vibration, which of the following is the wavelength of the fundamental mode?

1) 2/3 L   2) 2 L   3) 1/4 L

If 1 kg of ice is mixed with 0.5kg of steam at a pressure of 1 atmosphere, what temperature will they come to at equilibrium, if no heat is lost to the container or environment? (deg C)

1) 0   2) 10   3) 90   4) 100

How much work would be required to move a positive charge of 0.1 coulombs from the negatively charged plate to the positively charged plate? (J)

1) 0.2   2) 2.0   3) 20   4) 200

Which of the following has the units of energy?

1) volts   2) volts x watts
3) volts x coulombs   4) none of the above

Which of the following cannot be waves?

1) ocean waves
2) seismic waves travelling through the earth
3) sound waves in the air
4) standing waves on a string

APPENDIX E

Students' Questionnaire and Results

Your thoughtful answers to these questions will provide helpful information in evaluating the laboratory course. To maintain confidentiality, please <u>do not</u> write your name on the questionnaire or on the computer card. Write the day and time of your laboratory section in place of your name on the computer card.

Directions: For questions 1 to 6, describe your status by blackening the appropriate space on the computer card.

1. What is your classification?

    1 — Freshman

    2 — Sophomore

    3 — Junior

    4 — Senior

    5 — other

2. To which sex age group do you belong?

    1 — Female, under 25

    2 — Male, under 25

    3 — Female, 25 or over

    4 — Male, under 25 or over

3. In which college are you enrolled?

    1 — Architecture and Design

    2 — Agriculture

    3 — Arts and Sciences

    4 — Business and Administration

    5 — other

Directions: For questions 1 to 6, describe your status by blackening
the appropriate space on the computer card.

4. How long ago did you take your last algebra class (either in high
   school or college)?

   1 — 1 semesteer

   2 — 1 year

   3 — 1 1/2 to 2 years

   4 — more than two years

   5 — I did not take any algebra course.

5. Why did you take this course?

   1 — I took it because this course was a requirement.

   2 — This course was requirement, but I would taken it anyway.

   3 — It was an elective to fulfill a distribution requirement.

   4 — I wanted to take the course even though it did not fulfill
       any requirements.

   5 — others

6. What grade do you expect to receive in this course?

   1 — A

   2 — B

   3 — C

   4 — D

   5 — other

Directions: For questions 7 – 19, describe your attitudes toward and behavior in this course. Use the following code:

1 – Definitely false

2 – More false than true

3 – In between

4 – More true than false

5 – Definitely true

7. I read the laboratory manual to prepare for the laboratory sessions.

8. I read the appropriate materials in the text book to prepare for the laboratory sessions.

9. I would not have read the lab manual even if there were no pre-laboratory quizzes.

10. I would not have read the appropriate materials in the text book even if there were no pre-laboratory quizzes.

11. The pre-laboratory quizzes gave me an idea of what I was expected to learn during the laboratory sessions.

12. The pre-laboratory helped me understand the instructions given and procedure used in the lab session.

13. The pre-laboratory quizzes did not help me understand why the particular procedure was used.

14. I did very poorly on the pre-laboratory quizzes.

15. The pre-laboratory quizzes helped me learn more from the lab sessions.

16. I like this physics course (both lecture and laboratory).

17. I enjoyed the laboratory sessions.

Directions: For questions 7 - 19, describe your attitudes toward and behavior in this course. Use the following code:

1 - Definitely false

2 - More false than true

3 - In between

4 - More true than false

5 - Definitely true

18. I found the pre-laboratory quizzes were <u>not</u> helpful when I studied for the weekly tests.

19. I would suggest that the pre-laboratory be given in future classes in this course.

20. Describe your reaction to taking the pre-laboratory quizzes.

1 - It was a waste of time.

2 - It was frustrating.

3 - It did not make any difference.

4 - It was helpful.

5 - other _____.

21. On the back of the computer card, write any comment(s) you would like to make about the laboratory sessions and/or the pre-laboratory quizzes.

QUESTION		RESPONSES				
		1	2	3	4	5
1.	What is your classification?	71	34	23	17	2
2.	To which sex-age group do you belong?	36	100	3	8	NA
3.	In which college are you enrolled?	83	17	35	2	10
4.	How long ago did you take last algebra class?	42	19	35	50	1
	Mean = 2.619, σ = 1.221					
5.	Why did you take this course?	119	15	9	3	1
6.	What grade do you expect to receive in this course?	27	72	38	9	1
7.	I read the manual to prepare for the laboratory sessions.	8	22	28	51	38
	Mean = 3.605, σ = 1.179					
8.	I read the appropriate materials in the text book to prepare for the laboratory sessions	32	53	32	24	6
	Mean = 2.449, σ = 1.124					
9.	I would not have read the lab-oratory manual even if there were no pre-laboratory quizzes	35	47	29	20	16
	Mean = 2.558, σ = 1.288					
10.	I would not have read the app-ropriate materials in the text book even if there were no pre-laboratory quizzes.	25	35	37	32	18
	Mean = 2.884, σ = 1.274					

		1	2	3	4	5
11.	The pre-laboratory quizzes gave me an idea of what I was expected to learn during the laboratory sessions.	17	30	35	45	20

mean = 3.143, σ = 1.228

12.	The pre-laboratory quizzes helped me understand the instructions given and procedure used in the laboratory session.	17	44	48	32	6

Mean = 2.769, σ = 1.047

13.	The pre-laboratory quizzes did not help me understand why the particular procedure was used.	10	42	45	34	16

Mean = 3.027, σ = 1.110

14.	I did very poorly on the pre-laboratory quizzes.	24	39	60	17	7

Mean = 2.619, σ = 1.042

15.	The pre-laboratory quizzes helped me learn more from the laboratory session.	12	34	52	39	10

mean = 3.007, σ = 1.050

16.	I like this physics course both lecture and laboratory)	22	25	47	39	14

Mean = 2.986,   = 1.194

17.	I enjoyed the laboratory sessions.	15	26	43	50	13

Mean = 3.316, σ = 1.127

18.	I found the pre-laboratory quizzes were not helpful when I studied for the weekly tests.	4	33	43	33	34

Mean = 3.408, σ = 1.151

	1	2	3	4	5

19. I would suggest that the pre-laboratory quizzes be given in future classes in this course.   32 24 39 21 31

Mean = 2.966, σ = 1.426

20. Describe your reaction to taking the pre-laboratory quizzes.   20 50 42 31 4

Mean = 2.517, σ = 0.970.

APPENDIX F

Instructors' Questionnaire

Please respond to each item on this questionnaire. Please read each question carefully and check and/or write your responses in the spaces given. Extra sheets can be attached if the spaces are insufficient. Do not write your name on any sheet your turn in.

1. Did you enjoy teaching these laboratory sessions?

_____ Yes

_____ No

_____ Sometimes

_____ Other; please explain.

2. How would rate your interaction with your students?

_____ There existed a two-way communication between us.

_____ I do most of the talking.

_____ They do most of the talking.

_____ other; please explain.

3. How do you feel about the pre-laboratory quizzes?

_____ It was unnecessary for all of my students.

_____ It was unnecessary for some of my students.

_____ It was a waste of my time.

_____ It was helpful to most of my students.

_____ other; please explain.

4. Do you think the quizzes motivate the students to be prepared for each experiment?

_____ Yes

_____ No

_____ other; please explain

5. Have the quizzes helped you in pinpointing certain weaknesses and/or strengths your students have?

_____ Yes

_____ No

_____ other; please explain.

6. Did you tailor your introduction according to the results of the quiz?

_____ Yes; please explain how you did it.

_____ No; please explain why.

7. Do you think the laboratory quizzes helped your students in understanding your instructions for each experiment?

_____ Yes

_____ No

_____ other; please explain.

8. Do you think your students tend to finish the experiments faster than you would anticipate because of the pre-laboratory quizzes?

_____ Yes

_____ No

_____ other; please explain

9. Do your students stay behind after they are done with taking data to start on their laboratory reports?

_____ Yes, many of them did.

_____ Yes, a few of them did.

_____ No, none of them did.

_____ other; please explain.

10. When do your students ask questions?

_____ During the laboratory.

_____ Immediately after they are done with the experiment.

_____ During my office hours.

_____ On the day the reports are due.

_____ A few minnutes before the dateline.

_____ other; please explain.

11. Do you think the quizzes helped the students in any way?

_____ Yes; please explain how.

_____ No; please explain why.

12. How would you think their laboratory reports would be different (for eg, in quality) if they had _not_ taken the pre-laboratory quizzes?

13. Do you think you made clear to the students the benefits of the qizzes at the beginning of the semester?

_____ Yes, even though the students already knew about them.

_____ Yes, but the students did not seem to care.

_____ No, since the students should already have known about them.

_____ other; please explain.

14. How do you feel about the kinds of questions the students asked during the lab?

15. Check the statement(s) that apply to your students.

_____ They depended too much on my help.

_____ They only needed help some of the time.

_____ They can be left alone after my initial instructions.

_____ other; please explain.

16. Would you suggest we continue giving the quizzes for future classes in this course? Why?

17. Are there any other comments concerning the pre-laboratory quiz you would like to make?

THE EFFECTS OF PRE-LABORATORY QUIZZES ON STUDENTS'
PERFORMANCE ON LABORATORY REPORTS AND
ON LABORATORY RELATED QUESTIONS ON TESTS

by

SADIAH YUSOF

B.S., Kansas State University, 1983

AN ABSTRACT OF A MASTER'S THESIS

Submitted in partial fulfillment of the
requirements for the degree

MASTER OF SCIENCE

Department of Physics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1985

The effects of pre-laboratory quizzes on laboratory reports and laboratory related questions on tests were investigated. The mean of lab report scores of students given a pre-laboratory quiz at the beginning of each laboratory session was significantly higher ($p < 0.001$) than the mean of laboratory report scores of students not given the pre-laboratory quiz. However, the pre-laboratory quiz did not affect the scores of questions on the weekly quizzes and final examination. The pre-laboratory quizzes prompted most students to prepare for the laboratory session by reading the experimental writeup in the laboratory manual and appropriate sections in the text.