

10586

THE EFFECTIVENESS OF TRADITIONAL LABORATORY METHOD ON
STUDENTS' ACHIEVEMENT AT HIGH SCHOOL
LEVEL PHYSICS

A MASTER'S THESIS

in

Science Education

Middle East Technical University

By

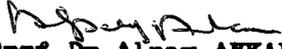
Havva SAYAR

September 1990

T. C.

Yükseköğretim Kurulu
Dokümantasyon Merkezi

Approval of the Graduate School of Natural and Applied Sciences


Prof Dr Alpay ANKARA
Director

I certify that thesis satisfies all the requirements as a thesis for the degree of Master of Science in Science Education.


Prof Dr ilker oZKAN
Chairman of the Department

We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master Science in Science Education.

Prof Dr F. Esen oZSAN
Supervisor



Examining Committee in Charge:

Prof Dr F. Esen oZSAN 
Assoc Prof Dr Ali TATLI 
Assoc Prof Dr Naif TÜRETKEN 
Assistant Prof Dr Tayfun ARI 
Assoc Prof Dr Selahattin oZDEMİR 

ABSTRACT

THE EFFECTIVENESS OF TRADITIONAL LABORATORY METHOD ON STUDENTS' ACHIEVEMENT AT HIGH SCHOOL LEVEL PHYSICS

SAYAR, Havva

M.S. in Science Education

Supervisor: Prof. Dr. F. Esen ÖZSAN

September 1990, 88 Pages

The purpose of this study is to investigate the effectiveness of "the traditional laboratory" method of instruction with respect to "the expository" method in achieving course objectives at different levels of Bloom's Taxonomy of Educational Goals - Cognitive Domain: (Bloom and others 1956) in physics at high school level.

This study includes the results of two treatments conducted separately. The samples of the treatments were Lycee I students at TED Ankara College during 1988-1989 and 1989-1990 academic years. In the first treatment 74 students and in the second treatment 198 students were involved. The students were divided into two comparable groups so that one of them exposed to the traditional laboratory method and the other one the expository method, randomly.

Physics Achievement Tests developed for this study were

used to collect the data. The test used during the first treatment consisted of 17 multiple-choice questions whereas the test used during the second treatment consisted of 48 multiple-choice questions at different levels of Bloom's Taxonomy of Educational Goals- Cognitive Domain.

Data are analyzed by using different statistical methods. Namely, student's t-test for two independent samples, two way analysis of variance and point biserial correlations.

The data analysis revealed that the difference between the means of upper level achievement scores of the traditional laboratory group and the expository group subjects was significant at $\alpha=.05$ level in favor the expository method.

Key words: Expository Method, Traditional Laboratory Method.

Scientific Code: 222.13.00

-iii-

ÖZET

KLASİK LABORATUVAR YÖNTEMİNİN LİSE ÖĞRENCİLERİNİN FİZİK DERSİNDEKİ BAŞARILARINA ETKİSİ

SAYAR, Havva

Yüksek Lisans Tezi, Fen Bilimleri Eğitimi Bölümü

Tez Yöneticisi: Prof. Dr. F. Esen ÖZSAN

Eylül 1990 88 sayfa

Bu çalışmanın amacı klasik laboratuvar yönteminin, lise öğrencilerinin, Bilisel Alanın Asamalı sınıflandırılmasının (Taxonomy of Educational Objectives: Cognitive Domain) (Bloom ve arkadaşları, 1956) farklı düzeylerde ki başarılarına etkisini anlatım yöntemiyle karşılaştırarak belirlemektir.

Bu çalışma sırasında, iki ayrı uygulama yapılmıştır. Birinci çalışmanın kapsamına 1988-89 öğretim yılında TED Ankara Koleji Lise I sınıflarından 2 tanesi -toplam 74 öğrenci- alınmıştır. ikinci uygulama 1989-90 öğretim yılında aynı liseden 6 Lise 1 sınıfı -toplam 198 öğrenci- ile yapılmıştır.

Çalışma verileri, araştırmacı tarafından geliştirilen Fizik Başarı Testleri kullanılarak toplanmıştır. ilk uygulamada kullanılan test de 17, ikinci uygulamada kullanılan

test de ise 48 çokdan seçmeli soru bulunmaktadır.

Veriler student's t-test'i, çift yönlü varyans analizi ve nokta çift serili kullanılarak analiz edilmiştir.

Yapılan analizler sonunda anlatım yönteminin Bilisel Alanın Asamalı Sınıflandırmasının (Bloom ve arkadaşları, 1956) üst düzeylerindeki hedeflere ulaşılmasında $\alpha=.05$ düzeyinde daha etkili olduğu görülmüştür.

Anahtar Kelimeler: Anlatım Metodu, Klasik Laboratuvar Metodu.

Bilim Dalı Sayısal kodu: 222.13.00

ACKNOWLEDGEMENT

I am deeply grateful to Prof. Dr. F. Esen ÖZSAN, my supervisor, for his continuous encouraging efforts and patience in directing this study, and constructive criticisms for the completion of this thesis.

I am also grateful to my colleagues and friend at Science Education Department who gave assistance and support at the certain stages of the study.

TABLE OF CONTENT

	Page
ABSTRACT.....	i
ÖZET.....	iii
ACKNOWLEDGEMENT.....	v
LIST OF TABLES.....	vi
I. INTRODUCTION.....	1
II. REVIEW OF LITERATURE.....	9
III. PROBLEMS, HYPOTHESES and EXPERIMENTAL DESIGN.....	36
3.1. The Problem.....	36
3.2. Hypotheses.....	36
3.3. Experimental Design.....	38
3.3.1. Population and Sample.....	39
3.3.2. Variables.....	40
3.3.3. Measuring Instrument.....	41
3.3.4. Analysis of Data.....	42
3.3.5. Treatment.....	44
3.3.6. Assumptions and Limitations.....	47
IV. FINDINGS, RESULTS and CONCLUSIONS.....	49
4.1. Results and Findings of Treatment 1.....	49
4.2. Results and Findings of Treatment 2.....	54
4.3. Conclusions.....	61
V. DISCUSSION, IMPLICATIONS and RECOMMENDATIONS.....	63
REFERENCES.....	66
APPENDICES.....	69

LIST OF TABLES

Table 3. 1	:Summary table for testing the significance of the difference between the means of obtained from the pre.administration of the achievement test to EG and CG subjects.....	40
Table 3. 2	:Identification of variables.....	41
Table 3. 3	:Statistical methods utilized for testing hypotheses.....	44
Table 4. 1	:Summary table for testing hypotheses 1.0 by using student's t-test for two independent samples (Treatment 1).....	49
Table 4. 2	:Summary table for testing hypotheses 1.1 by using student's t-test for two independent samples (Treatment 1).....	50
Table 4. 3	:Summary table for testing hypotheses 1.2 by using student's t-test for two independent samples (Treatment 1).....	51
Table 4. 4	:Summary table for testing hypotheses 2.1 by using two way analysis of variance (Treatment 1).....	52
Table 4. 5	:Summary table for testing the significance of the correlation between student's sex and scores (Treatment 1).....	53
Table 4. 6	:Summary table for testing Hypotheses 1.0 , 1.1 and 1.2 by using student's t-test for two independent samples (Treatment 2).....	54
Table 4. 7	:Summary table for testing the significance of the correlation between student's sex and upper level achievement scores on (PAT)2 (Treatment 2).....	55
Table 4. 8	:Summary table for testing the significance of the correlation between student's sex and lower level achievement scores on (PAT)2 (Treatment 2).....	56
Table 4. 9	:Summary table for testing the significance of the correlation between student's sex and their overall achievement scores on (PAT)2 (Treatment 2).....	56
Table 4.10	:Summary table for testing Hypothesis 3.0 by applying two way analysis of variance (Treatment 2).....	57

Table 4.11 :Summary table for testing Hypothesis 3.1 by applying two way analysis of variance (Treatment 2).....	59
Table 4.12 :Summary table for testing the Hypothesis 3.2 by two way analysis of variance (Treatment 2).....	60



CHAPTER I

INTRODUCTION

The purpose of this study is to compare the effectiveness of "the traditional laboratory method" and "the expository method" of the instruction in teaching physics at high school level.

Any new curricula introduced in science (such as: Physical Science Study Committee, Chem Study) are followed by numerous studies attempting to determine whether a new curriculum facilitates student's achievement more than the older one. Each curriculum aims to be attaining different educational goals, therefore it is difficult to declare the superiority of the new or the old one (Wasik, 1971). Renner (1982) pointed out that the objectives of both the new and the old curricula are to impart knowledge and the ability to use that knowledge to solve problems, but the new curriculum provides an opportunity to students to learn how to acquire, evaluate, and retrieve knowledge too. In order to achieve the subobjective of the new curriculum requires some process skills; such as:

1. Stating problem
2. Suggesting hypothesis
3. Experimenting
4. Observing
5. Collecting and analyzing data

6. Reexperimenting to verify data

7. Drawing conclusions from data

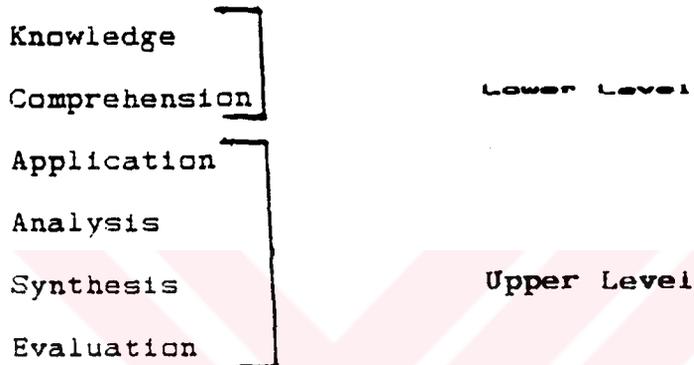
The skills that stated above can be gained through laboratory activities.

It may be concluded that the objectives of a specific course determine the method of the instruction.

Heath(1962) suggested that instead of attempting to carry out comparative curriculum experiments which probably can never answer the question of which is better, attention should be directed to determining characteristics that differentiate between two or more curricula under study. The present study attempts to compare the cognitive performance of physics students exposed to two different methods of instruction, namely the "expository" method and "traditional laboratory" method. The Taxonomy of Educational Objectives-Cognitive Domain (Bloom and others, 1956) was selected as the scheme for categorizing abilities. A hierarchical arrangement of the Taxonomy cognitive levels provides for and implicit ordering of cognitive processes by cognitive complexity. The cognitive levels are moving from simple to complex: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

The Taxonomy has been used as a frame-work in developing physics achievement tests to measure cognitive performance levels of the subjects of the study. Instead of testing the

data for each level separately, they are classified into two groups. Namely knowledge and comprehension levels were handled together and called lower level, the remaining four cognitive levels were called upper level as given below:



The specific classroom and assessment procedures corresponding to each cognitive levels of the Taxonomy (Sprinthall, and Sprinthall, 1977, pp.365-368) are summarized below:

Knowledge level

Students have to know specific facts, terms and methods.

The achievement performance at this level is assessed by direct questions and multiple-choice tests. The purpose is to test the students ability to recall the facts, to identify and repeat the information provided.

Comprehension Level

Students must show they understand the ideas, fact and theories.

At this level students are assessed on the basis of their capacity to act upon, or process, information. Objective or

multiple choice questions can be used.

Application Level

Students must be demonstrate that they can apply their ideas to real situations.

We have to go well beyond the usual procedures in order assess how well students apply what they learn. If, for example, we are teaching Simple Machines, the test would be to make a real simple machine.

Analysis Level

Analysis requires that students classsify or break material down into its components, understand the relationship between the components, and recognize the principle that organizes the structure on the system.

The ability to analyze material can be assessed in number of ways. For example, we might see whether students can identify the assumptions behind an argument.

Synthesis Level

Synthesis requires making something new, bringing ideas together to from a new theory.

Assessment should be designed to produce new ideas, methods or procedures.

Evaluation Level

It is most complex level of the cognitive domain. Students are developing the ability to create standards of judgement, to weight, to examine, to analyze.

In science education the objectives are categorized

in two groups (Robinson, 1965; NSTA, 1971; Renner, 1982.) :

1. Understanding products of science
2. Understanding process of science

A couple of instructional methods are suggested to achieve those objectives some of them emphasizes concept learning Ausubel is one of them. In Ausubel's theory (Moreira, 1978), what the learner already knows has a great importance and the new information must be relatable to them and arrangement of content is done from the most general abstract form to the more specific form.

Gagne (1974) admits different types of learning associated characteristic strategies of instruction one of them is called the "expository strategy" (from rule to examples) which he favors on the ground of consuming less learning time. The second strategy suggested by him is called "Guided Discovery" (from examples to rule) which he favors when longterm recall and transfer to similar learning tasks are required.

Renner (1982) suggests to follow an instructional strategy summerized as inform, verify and practice, if the objective is content achievement. But, in addition to content achievement, understanding process of science is considered he suggest to follow a strategy called "Learning Cycle" that requires a sequential instruction as :

1. Experience with the phenomenon through materials of discipline.

2. The introduction of the language of the phenomenon to label the new idea.

3. Organization of new idea with existing knowledge to expand that knowledge and newly acquired idea.

This strategy provides students learning through the materials of the discipline.

Gagne's and Renner's approaches are two extreme examples, the other approaches are intermediate between them. Most of them makes use of different types of laboratory works as verification, discovery.

Tamir (1976, pp 8-9) claims that there are four major rationales for using the laboratory in science teaching :

1. Science involves highly complex and abstract subject matter that elementary and some high school students fail to grasp without concrete objects and opportunities for manipulations.
2. Laboratory works give an opportunity to participate in and have an appreciation for the methods and spirit of science.
3. Practical experience promotes the development of skills with a wide range of generalizable effects, and,
4. Students enjoy activities and practical work and consequently become motivated and interested in science.

Shulman and Tamir (1973) have identified the goals of laboratory instruction as :

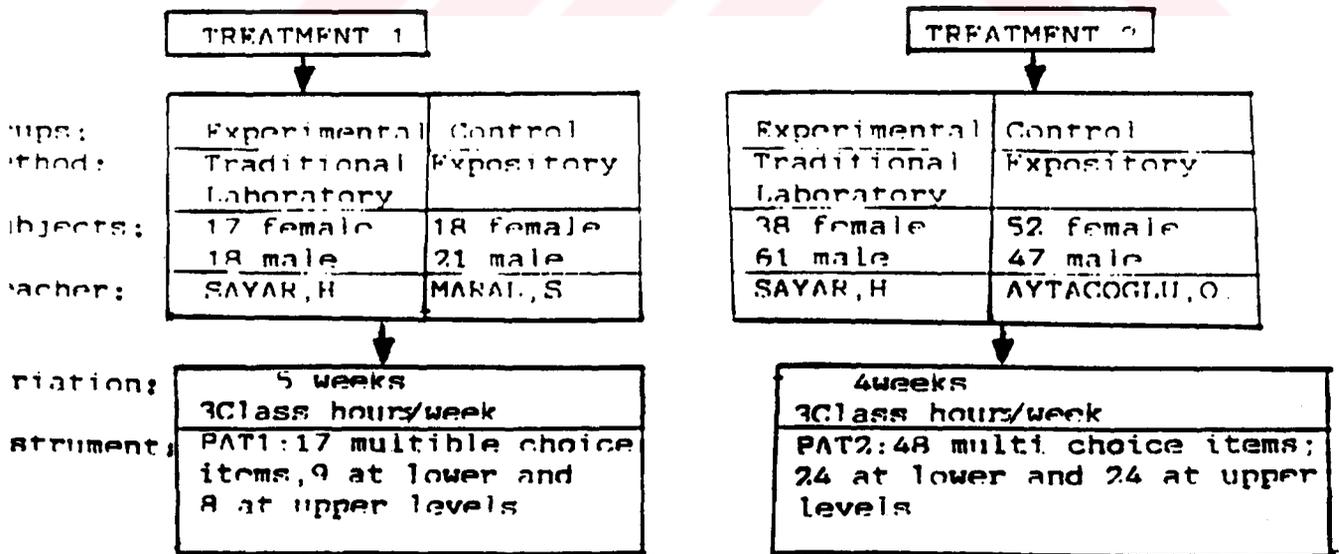
1. to arouse and maintain interests, attitude, satisfaction, open-mindedness and curiosity in science
2. to develop creative thinking and problem-solving ability
3. to promote aspects of scientific thinking and scientific method
4. to develop conceptual understanding and intellectual ability
5. to develop practical abilities, e.g., designing and executing investigations, observing, recording data, analyzing and interpreting results.

The purpose of this study is to compare the physics achievement performance of students exposed to "traditional laboratory" and "expository" methods interms of upper and lower level cognitive domains and interms of their overall achievement. For this purpose, a design called "Posttest-Only-Control Group" was used. The group exposed to the "traditional laboratory" method is called experimental group, and the group exposed to the "expository" method is called control group.

The instruction of experimental group had three phases. At the first phase concepts and principles were introduced and some example problems were solved. At the second phase, the

concept given in first phase was verified in laboratory and finally some problems. to expand the concept given were solved. The control group students were taught with the same sequence as the experimental group, but the verification of the concept was omitted. In both groups students were free to ask question.

For both experimental and control groups the same amount of time was spent to conduct the subject matter. Certain amount of total time was spent to verify the concept taught by experimental group, the control group students spent that time to practice and they did not have any concrete experience. The design used in this study is summarized in the diagram given below.



CHAPTER II

REVIEW OF LITERATURE

In this chapter, a review of the conceptual and the experimental research literature related to evaluating an instructional method according to the criteria suggested in the present study are given.

It seems reasonable to begin the discussion with the goals of science education and the methods and/or strategies suggested to realize the stated goals, to identify the relation between the goals of science education and instructional systems. Gagne' (1974) states different types of learning, recently they are called as intellectual skills. He relates each skills to a specific instructional strategy facilitating students' learning. He called the instructional strategies as "instructional conditions." It is necessary to provide suitable instructional conditions to produce desired changes in students. Gagne's intellectual skills are sequential ordered from simple to complex.

For higher order intellectual learning, Gagne' presents two alternative strategies-the "expository" (from rule to examples) strategy, which he favours on the ground of consuming less learning time in general, and "guided discovery" (from examples to rule) strategy, which he favours when long-term recall and/or transfer to similar learning tasks is required.

Özinönu (1976) underlines the interrelationships among learner, instructional process and outputs (i.e. terminal behaviours). When output or process changes, each induces changes on the other, and process is the major factor responsible for changes accrued in the learner.

Renner (1982) implies that the goals of science education have to reflect the true nature of science. "Science is the quest for knowledge". When one remembers that the complete name of the discipline is "natural science" or "the science of nature" than the content into which quests are to be conducted is easily identifiable. Science is a discipline which investigate the natural world and science education is a discipline devoted to discovering how to lead students to learn to investigate the natural world. The power of establishing the purposes of science education has led to conceptualization of the nature of the discipline of science. Therefore, whenever materials and instructional procedures are designed to teach science, the content selected must allow the questing nature of the discipline to be evident and obvious. Making sure that the facts, principles, and generalizations are clearly spelled out is not adequate. In fact, spelling out generalizations and principles maybe deleterious because students must experince the search in isolating the relevent information needed to invent the principles and generalizations. Furthermore, evaluation must not only concern itself with ascertaining if the students know information (as most standardized and

teacher -made-tests do) students must be evaluated upon how they would find something else.

Renner(1982) categories the purpose of science education into two groups:

- 1) mastery of content
- 2) leading students to adjust the understandings held about a field and/or concept.

He further categories instructional strategies which provide the attainment of the purposes stated above. If mastery of content is the unique purpose then to follow an instruction strategy summerized as inform verify, and practice can be functional. But, 1 and 2 both are considered as the purpose of science education, he suggests "learning cycle" as the instructional model Learning Cycle requires a sequential instruction as:

- 1) experience with the phenomenon through the materials of discipline.
- 2) the introduction of the language of the phenomenon to label the new idea, and
- 3) organization of the new idea with existing knowledge to expend that knowledge and the newly acquired idea

The major goal of science education is to develop scientifically literate and personally concerned individuals with a high competence for rational thought and action. This choice of goals is based on the belief that achieving

scientific literacy involves the development of attitude process skills, and concepts, necessary to meet the more general goals of all education. Such as:

1. Using rational process
2. Building competence in basic skills
3. Developing intellectual and vocational competence
4. Exploring values in new experiences
5. Understanding concepts and generalizations
6. Learning to live harmoniously with the biosphere

(NTSA. 1971)

Robinson (1965) regards today's teaching aids being adequate. It seems that the problems reside in much more profound questions: Have the students, as a result of doing the activities, reading and discussing what they have read indeed increased their "understanding of science?" What is the nature of science which they are to understand?. Can aspects of the nature of science be identified and so specified as to provide for guidance in the selection and organization of elements which are to be included in science curricula.

He clasifies into three groups the emphasis in science curricula:

- 1) Process of science
- 2) "Structure of science" as a discipline and the "process of inquiry"
- 3) Science concepts

According to Robinson, process and product of science

are considered being separable, identifiable and teachable, therefore science curriculums differ in their emphasizes. But he is doubtful and states the following questions: Can process be separated from product in science? How do product and process relate to the structure of science and what is meant by the structure of science?

Robinson prepared a dissertation to clarify the nature or structure of scientific knowledge. He analyzed six writings concerned with the nature and organization of scientific knowledge. He identified four aspects of the structure of science seemed significant for curriculum implementation:

- 1) the distinctions as between correlational and exact science,
- 2) the constructional nature of scientific reality,
- 3) the process of deservation and the emergence of rules of correspondence, and
- 4) the considerations which lead to the verification and acceptance of scientific theories.

Renner and Stafford(1972) stated three purposes of science education:

- 1) to develop in learners a command of rational powers,
- 2) to develop in learners the ability and confidence to inquire, and
- 3) to develop an understanding of the changing nature of the environment in terms of matter, life, energy and their interactions.

They did further classifications about the ways of involving the student with science, and stated the outcomes of each way. First, students reading about or being told about the process and products of the scientific enterprise. This science program makes a contribution to the development of reading ability.

Second, discussion among the students or between the students and the teacher of some scientific topic. But if the students are at concrete operational level, abstract discussions have little value.

Third, the teacher demonstrates something to learners or the students demonstrates to each other. This procedure provides an opportunity to learner to move from verbal abstraction to the concrete realism. The data produced by this procedure can be placed, by the learners in their cognitive structure and can be used to solve the problems facing them. In other words this procedure is more meaningful to concrete operational students than the two procedures stated above.

Fourth, inquiry-centered science teaching; The student is given objects and/or materials with which he needs experiences. He performs all manipulations, makes his own observations, records his own data, and makes his own interpretations. Most of the science educator regard this procedure as being the most effective way of the student involvement with science (Renner and Stanford, 1972; Purser and Renner, 1983; Ward and Herron, 1980; Crumb, 1965).

The last procedure demonstrates how the learner must use such rational powers as imaginations, analysis, synthesis, clasification, comparision and inference which are the essence of the ability to think.

Most of the researches related science education focused at science laboratories. Blosser(1988) tried to identify the reasons pushing researchers to investigate the effects of science laboratories on students performance so frequently. First reason he identified was that laboratory activities require more time and money than the other classroom activities. Second, laboratory works, require, generally, double class periods. Such a time frame presents scheduling problems for administrators. Third, one was curriculum development. Because educators need to test their new methods of curriculum and instruction. The last one was that most of the research done on the role of laboratory found no significant difference in achievement or attitude or lab skills between students given experiment based lessons and students given lecture-based lessons.

There are theoretical support to laboratory-based teaching. According to Piaget(1952), until formal operational level is attained by an individual, qualitative changes in tought takes place. Changes in tought continues life long by assimilation, accomodation and equilibration but the changes in tought are quantative after the completion of formal

operation period. An individual can solve complex verbal problems, hypothetical problems, or those involving the future at the end of formal operation. An individual at concrete operational or/and at transitional from concrete to formal operation needs some concrete experiences to learn a concept. Therefore laboratory work can be facilitate the concept learning for concrete operational and transitional students. Some methodological defects were shown being responsible from the contradicting situation of theories and research findings by Blooser. She found Sund and Trowbridge's list of six skills that laboratory work develops in students valuable.

They are:

- acquisitive skills, such as listening, observing, investigating, gathering data, and researching
- organizational skills, such as recording, classifying, organizing, outlining, and reviewing
- creative skills such as planning ahead, designing a new problem or approach, inventing, and synthesizing
- manipulative skills, such as using and caring for instruments, demonstrating, constructing, and calibrating
- Communicative skills, such as asking questions, discussing, explaining, reporting, writing and graphing
- safety skills, such as handling equipment, hazardous chemicals and dangerous situations(pp 57).

Pickering(1986) argued that organization is the limiting

factor of the laboratory education. His argument depends on his personal research project for over 10 years related to the laboratory education. Pickering explained the meaning of the organization as the structure of experiments, grading, and support, things that are rarely examined.

Klopfer (1969) discussed two major purpose of teaching science in schools and colleges. The first one is to provide the required science learning and to persue them to make a career in some phase of science or technology. There is no doubt today about society's need research scientists.

The second one is to contribute to the individual's scientific literacy. He discussed three component of scientific literacy:

- 1) understanding key concepts and principles of science
- 2) understanding how scientific ideas are developed
- 3) understanding the interaction between science and the general culture.

Klopfer aimed to show that inclusion of history of science in the science curricula can make the present-day learning of science more meaningfull for students.

He suggested three teaching strategies:

- 1) using of the history of science in case studies
- 2) supplementary reading of biographies of scientists
- 3) using scientists' original research papers to show how certain scientific theories envolved.

From the point of view stated above we can say that science education is a need for all people not only for individual who are planning to make career in science.

Science education fails to increase student appreciation for the totality of science, and for understanding its role in daily life. Ost and George (1965) give some examples to make this more apperent.

First, synthesis is neglected and analysis is over-emphasized in traditional science curriculum. Therefore, students spend much more time learning to take ideas apart than to assemble the "big picture".

Second, the distinction between product and process is over-emphasized in the traditional curriculum.

This artificial separation of product and process hides the complexity of science and the fact science is a way of dealing with the environment, not a body of knowledge and/or a method of discovering knowledge (pp. 15).

Third, textbooks implies that science is static and certain. This discourages an apprecitiation for incompleteness of knowledge and the dynamic nature of scientific progress.

Fourth, students should learn that science and scientists operate within a value-reliant system. Therefore, science curricula should include the subjective and value-laden side of science.

Ost and George, finally states that science education

has to increase students flexibility, allowing them to incorporate new knowledge into their conception of the environment. It will result with the transfer of science from the classroom to everyday life.

As a summary we can say that a scientific way of thinking has become survival tool for all individuals and science instruction is important in fostering creativity, flexible thinking, and self-worth.

Ramsey and Howe (1969) analysed researches on instructional procedures, in secondary school science, in terms of clearly defined outcomes. When the researchers' papers were analyzed according to instructional aims 97 were directed toward knowledge of content as the prime outcome expected, while 30 attempted to develop outcomes other than content knowledge-outcomes from the cognitive, affective and psychomotor domains. They did this however, from the content of the conventional class-teacher instructional arrangement only 34 studies used an instructional method other than the conventional one to attempt to develop outcomes other than knowledge achievement. They concluded that the instructional mean applied determines the outcomes so, the researchers have to manipulate the variables the outcome and the method.

Ramsey and How, from the analysis of researches for knowledge achievement concluded that the external arrangement imposed in terms of the course taught or pedagogical method used generally has made little difference to the knowledge

outcomes of students as measured by current tests.

The analysis of researches interms of "Understanding Scientific Enterprise" showed that the nature of course taught and the background and experiences of the theacher both seem to effect the gain in a student's understanding of the scientific enterprise.

They concluded from the researche papers analyzed that if an increased ability to think critically is a desired outcome, then an instructional procedure which is laboratory centered can be developed to increase this ability.

An inductive, problem-solving, and laboratory-centered approach can be expected to produce significant positive changes in students attitudes.

Most of the researchers investigated the relative effectiveness of a new instructional methods over old methods.

Wasik(1971) investigated the relative effectiveness of traditional physics curricula and Physical Science Studing Committee (PSSC) Physics curricula at high school level. He tested the following hypothess:

- 1) There will be no significance between group differences in relationship of academic uptitude and cognitive process
- 2) There will be a significant difference in favor of the non-PSSC sample on the Taxonomy process measure of knowledge
- 3) There will be significant differences in favor of the

PSSC sample of the Taxonomy process measures of Application and Analysis.

CEEB Physics Achievement Test was used to measure cognitive skills additional to recall and application of learned formulas.

Form LAC2 of the College Entrance Examination Board's Physics Achievement selected to provide estimates of student cognitive performance. The answer sheets of random samples of 370 students were selected from the identified PSSC and non-PSSC populations. The verbal and Mathematics Scholastic Aptitude Test (SAT) standardized scores were obtained for each candidate in the samples to provide measures of academic aptitude test. Items were categorized according to the Taxonomy of Educational Objectives-Cognitive Domain.

The findings of this research agreed with the opinion that PSSC instructional materials were more effective in developing higher cognitive process skills.

Babikian (1971) investigated the relative effectiveness of three instructional methods-discovery, laboratory, and expository methods-at eight grade physics.

He explained the strategies of each method as following:

1) Expository Method:

- (a) The concept is stated first, and then examples are given for further clarification
- (b) The teacher may make use of no audio-visual material but the chalkboard

- (c) Students are allowed to ask questions or to discuss the concept

2) Laboratory Method:

- (a) The concept is stated first, and then the procedure is described for the varification of the concept
- (b) The teacher may explain the concept if necessary
- (c) Students may ask questions
- (d) Students do not cooperate with each other

3) Discovery Method:

- (a) The teacher may explain the procedure but not the concept
- (b) Students may request assistance on procedural matters
- (c) Students may inquire about the concepts being discovered, but they get only "Yes" or "No" from the teacher
- (d) Students do not cooperate with each other

The research involved 22 Juncior High School classes and measure the acquisition of seven learning criterion tasks. A comprehensive test of 38 items was prepared. I.Q. scores of students obtained from the school records. He used pre-test, post-test and control group design.

Babikian concluded the following:

- 1) The expository and the laboratory methods are significantly more effective than discovery method

- for teaching science concepts to eight grade students. in respect to following criterion measures: overall achievement, verbalization of concepts, recognition of concepts, and the application of concepts to numerical problems.
- 2) Irrespective of method by which students in upper IQ group are instructed, they achieve significantly better than those in the lower IQ group in respect to the following criterion measures: overall achievement, verbalization of concepts, recognition of concepts, and the application of concepts to numerical problems.
 - 3) Irrespective of method used to instruct, boys achieve significantly better than girls, in respect to following criterion measures: overall achievement recognition of concepts, and transfer of concepts (pp 207).

Another research related to the effectiveness of PSSC physics and traditional physics programs conducted by Crumb(1965). A study population consisting of 1275 students was selected from twenty-nine rural and urban high-schools in USA. The Test on Understanding Science (TOUS) was administered at the beginning of school, and near the end of each semester as a measurement instrument.

Crumb found a significant difference in understanding science as measured by TOUS between those students who

studied the traditional physics and those students who studied PSSC physics. The difference favored those who studied PSSC physics.

In addition, there was some evidence to indicate that PSSC course may have a greater impact over the short period of one semester than does the traditional physics course.

In the last 10 year, a new method of science instruction (Learning Cycle) has been included into the methods being investigated. Learning cycle was developed by Dr. Robert Karplus and the persons who developed the Science Curriculum Improvement Study (Renner, Abraham and Birnie, 1988). This method depends on the opinion of Piaget about the way of understanding the world. According to Piaget one invariant process is used again and again to understand the world by the individuals (Piaget, 1952 pp. 3-7). That process begins with "assimilation" by the learners, of data from their environments into their mental structure where those data are processed. In processing the data the mental structure can be changed. This is called "accomodation" by Piaget. The learner now acquired a new concept. Assimilation and accomodation together are called " adaptation". Each new concept effects other concepts held by the learner. Therefore, the learner must organize the new concept with other concepts (Piaget, 1952).

In "Learning Cycle" a strategy parallel to the mental processing stated above is used. At the first phase of the

learning cycle, students are given directions and materials which they use to study what happens when they do something and to get data. This phase is called "exploration". The second phase is called "conceptual invention". The concept is identified and the language is assigned. The last phase of the learning cycle utilize the invented concept in many ways. Additional experiments might be carried out with the concept. Readings about the concept, problems and questions using the concept are all the ways expending new concept and relating it to other concepts.

Renner, Abraham and Birnie (1985) conducted a research to understand the learning cycle and investigate what elements of its structure account for its effectiveness. In order to do this, three variables were investigated:

- 1) sequence of phases
- 2) necessity of each phase
- 3) the form in which the students acquired data

The research was conducted in the Norman, Oklahoma, Senior High-School. Three classes were used taught physics by the same teacher, and 7 experiments were included.

Three types of data were collected. Student understanding of content was evaluated with Concept Achievement Tests (CATs), student attitudes were evaluated with the Birnie-Abraham-Renner Quick Attitude Differential (the BAR) and naturalistic data were collected through individual student interviews regarding student content understanding and student

opinions of physics, the teaching procedures used and how the learning was progressing.

They concluded from the statistical analysis that The CAT means showed that the form in which the phases of the learning cycle are experienced does not influence the level of achievement reached by the students collecting their own data, being given it in a written form, receiving it orally, collecting it through watching a videotaped demonstration or through watching a live teacher demonstration did not effect the content achievement of the students as measured by CATs.

The quantitative data from the BAR Quick Attitude Differential show that favorable attitudes were found among the regular-form learning cycle-group.

The naturalistic data from student interviews support the conclusion that the students were overwhelmingly in favor of regular-form learning cycle as opposed to getting data from some other form.

A research was conducted in the Norman, Oklahoma Senior High School involving three secondary-school physics classes in order to test that the necessity of each phase of the learning cycle. Three classes were taught by the same teacher and enrolled a total of 62 twelfth-grade students-39 males and 23 females. (Renner, Abraham and Birnie, 1988).

The conclusions of the research were stated in five items:

1) Providing just materials and directions for students and allowing them to explore is not efficient in learning concepts. That conclusion leads to have serious doubts regarding the "free exploring" environment, if the purpose of such an environment is to learn content and the structure of science.

2) Thoroughly explaining a concept before providing experiences with materials results with little or no conceptual understanding. The conclusion casts serious doubt upon the teacher-centered exposition teaching procedure and the through explanations provided by textbooks.

3) Explorations which produce data need to be followed by discussions-conceptual inventions.

4) All phases of learning cycle is necessary, but there can be specific conditions when one or more phases can be substituted for.

5) Students believe that all phases are necessary (Renner, Abraham and Birnie, 1988: pp. 56).

Renner and Schneider (1980) conducted a research to determine the effectiveness of expository and inquiry methods. The sample of study was consisted of 48 ninth-grade students from a rural junior high school in central Oklahoma. Inquiry instruction group consisted of 23 students and 25 students were assigned to the exposition group.

Each instruction group experienced the same content material for 12 weeks. Four physical science units were

presented to the students.

The instruction of expository group consisted of six phases:

- 1) Oral explanation session
- 2) Motion pictures and filmstrips
- 3) Reading assignment
- 4) Questions and problems
- 5) Supervised study, and
- 6) Demonstrations.

The instruction of inquiry group based upon the teaching concept designed and implemented by the Science Curriculum Improvement Study and called the "learning cycle" (Renner and Staiford; pp.218-226)

Content achievement and retention, intellectual development, and IQ were the dependent variables of the study.

At the end of each unit students were given two content examinations: a multiple-choice examination, and a free response examination. To measure students' retention of the concepts, three months following presentation of content material the students were retested.

The intellectual level of each student who participated in the study was assessed at the beginning and end of experiment, and three months later. The task was used to assess students' intellectual level was designed by Inhelder and Piaget (1958).

The IQ instrument was administered at beginning and

at the end of the treatment.

The analysis of data indicated that concrete instruction (learning cycle) group out scored the formal (expository) instruction group on the three-months-after-instruction, and end-of-the-unit administration of the examinations. The results suggested that the concrete instructional procedure was superior to the formal instructional procedure if knowledge and retention of content was an important objective of the course. The second significant results of the study was that the concrete instructional group exhibited greater gains in intellectual development than the formal instruction group as measured by Piagetian tasks. Third result was that concrete instruction group and formal instruction group did not differ in their effect on the learners' language IQ, nor their overall IQ.

Ward and Herron(1980) tested the effectiveness of traditional laboratory and laboratory designed according to the principles of learning cycle on the achievement of students who are at concrete formal intellectual development levels.

The subjects for the study were drawn from two introductory chemistry courses offered during 1977-1978 school year at Purdue University.

Learning cycle was utilized in only 3 of 13 laboratory experiments conducted by the students during the semester.

The Longest Test was used to determine students'

intellectual development level. It is a 28 item paper and pencil test. The achievement tests used in that study were designed to measure the extent to which the subjects understood the concept.

The traditional laboratory experiments exhibited the format outlined below;

- 1) Concepts to be studied in the experiment were explained before the experiment begins.
- 2) Observations and physical measurements were done.
- 3) Students were not encouraged to discuss or to share their ideas with other students in the laboratory.
- 4) Calculations were done and results were reported after all data had been collected.
- 5) Questions, if any, were usually asked after the experiment was concluded. These questions do not require making inferences from the data or stating hypotheses to be tested with data. Instead, they asked discription of the data (p.p. 391)

On the other hand laboratory experiment designed around the learning cycle exhibited the following format;

- 1) Observations and physical measurement were done.
- 2) Students were encouraged to discuss or to share their ideas with other students in the laboratory.
- 3) Questions calling for inferences hypotheses testing were asked during data the course of data collection.
- 4) Calculations and intermediate results were reported

during the course of data collection.

- 5) The concepts on which experiment was based were defined.
- 6) These concepts were applied in situations similar those at beginning of experiment (p.p.391)

The analysis of data indicated that, (1) the concrete students in the treatment group made significant advances toward the performance of their formal classmates, (2) there were no significant difference between the performance of concrete and formal students on questions requiring rule memorization, (3) there were no significant difference between the performance of formal students either in treatment group or in the control (traditional) group, (4) formal operational students did better on questions requiring formal reasoning than concrete students.

As a result, one can say that, students who are at concrete operational level suffer a disadvantage when compared to their formal classmates. Concrete and formal students appear capable of competing at an equal level only on material that requires nothing more than memorization of facts and formulas.

Purser and Renner (1983) investigated the following questions:

- (1) What is the influence of teaching methods upon content achievement of concrete and formal concepts by students differ in level of operational thought? (2) What influence does

concrete and formal teaching have upon the intellectual development of students?

They used pretest-posttest-control group design. 68 and 67 students were assigned to the experimental and the control groups respectively. Biology I was taught by two different methods of instruction-learning cycle and exposition- to ninth and tenth grade students in Yukon, Oklahoma, High School. The research took a time more than 8 months.

The findings of Purser and Renner agree with the finding of Ward and Herron(1980), such as:

1. The intellectual development gains made by the concrete instruction group was greater than did by formal instruction group.
2. The instructional method was irrelevant when the attempt was made to teach formal concepts.
3. Concrete instruction led to achievement of understanding of concrete biology concepts which was sufficiently higher than comparable mean for the group receiving formal instruction.

Spears and Zollman (1977) investigated the relative effectiveness of structured and unstructured laboratories on students' understanding the process of science. The Welch Science Inventory Form D was used as measuring instrument. They defined the laboratory designs as described below:

Structured Lab.

1. Pose a problem before class meeting
2. Inform students available equipments
3. State a procedure to solve the problem
4. Require students to answer questions about data
5. Require students to generalize from their data and defend their generalizations.

Unstructured Lab.

- Pose problem before class meeting
- Inform students available equipments
- Ask students to solve the problem
- Require students to draw conclusions from their data

The sample population was consisted of freshmen or sophomores students at Kansas State University. Man's Physics World I was taught by the design stated above.

They found that structured laboratory approach was more effective than unstructured laboratory to teach the process of science at college level.

Okebukola and Ogunniyi (1984) investigated the effects of cooperative, competitive and individualistic science laboratory interaction patterns on students' achievement and acquisition of practical skills.

They concluded that students working in the laboratory based on the cooperative learning conditions differs

significantly in achievement than the students working in the laboratory based on competitive and individualistic learning conditions, in favor of the cooperative group.

The mixed ability-cooperative group design is favorable for low and average achievers.

The competitive design is found favorable when the acquisition of the practical skills is the desired goal of the laboratory work.

The review of literature given so far reveals that the ways of science instruction should be compatible with the aspects of science as a body of knowledge and as a process (Crumb, 1965; Renner, 1982; Robinson, 1965; Blosser, 1988; Janners, 1988).

Most of the researches are comparing the methods in terms of certain tasks. Some of them compares new and old methods in terms of their effect on students' cognitive achievement levels (Wasik, 1971; Renner and others, 1985). There are a couple of researches investigating the effects of the methods on students' achievement at different levels of Piaget's cognitive developmental levels (Ward and Herron, 1980; Renner and Schneider, 1980). Most of these researches compare the models taking place at extreme ends, such as "learning cycle" and "expository" methods, or verification laboratory and discovery laboratory. No one compared the effects of verification laboratory and expository methods. There are some researches considering both of those methods in their

design. Babikian (1971) conducted one of them but he did not attempt to compare them.

In the present study the attempt was done to compare "expository method" and traditional laboratory method, since these methods are mostly used in physics instruction at high-school level in Turkey. Thus it is needed to investigate whether the goals of the physics instruction are achieved by these methods or not. This study intended to meet that need in terms of content achievement at different levels of the Bloom's Taxonomy of cognitive domain.

The hypotheses and the statistical methods used in this work are given in the next Chapter.

CHAPTER III

PROBLEMS, HYPOTHESES and EXPERIMENTAL DESIGN

3.1 The Problem

The present study, was undertaken to investigate the relative effectiveness of "traditional laboratory" and "expository" methods of teaching science concepts to achieve the objectives classified according to Bloom's Taxonomy of Educational Goals. As a subproblem, the relation between content achievement score and sex is investigated.

Bloom's Taxonomy of Educational Goals (knowledge, comprehension, application, synthesis, analysis and evaluation) assessments were already given in Chapter I. These levels are rearranged, to prevent the intervening effects of the levels, as it was explained in Chapter I.

3.2 Hypotheses

As temporary solutions to the problem stated above the following hypotheses are stated. In the hypotheses, the experimental group (EG) refers to those students exposed to the "traditional laboratory" method and the control group (CG) refers to those students exposed to the "expository" method of teaching science concepts. All hypotheses are stated in null form and tested for significance at $\alpha=.05$ (i.e. $p \leq .05$) level. Each hypothesis was followed by its symbolic

representation where the symbols have the following meaning:

μ =mean score

t =student's t-test

df =degrees of freedom

α =significance level

r_{pb} =the correlation coefficient between PAT scores and sex.

S^2_{factor} =Variance estimates for rows, columns and interaction.

S^2_{error} =Within group variance estimate.

1.0 There will be no significant difference between the means of EG and CG subjects' overall achievement scores as measured by PAT.

($H_{0.1.0}$: $\mu_{EG} = \mu_{CG}$, t, df, $\alpha = .05$)

1.1 There will be no significant difference between the means of EG and CG subjects' lower level achievement scores as measured by PAT.

($H_{0.1.1}$: $\mu_{EG} = \mu_{CG}$, t, df, $\alpha = .05$)

1.2 There will be no significant difference between the means of EG and CG subjects' upper level achievement scores as measured by the PAT.

($H_{0.1.2}$: $\mu_{EG} = \mu_{CG}$, t, df, $\alpha = .05$)

2.0 There will be no significant correlation between the students sex and their overall achievement scores.

($H_{0.2.0}$: $r_{pb} = 0$, t, df, $\alpha = .05$)

2.1 There will be no significant correlation between the students sex and their lower level achievement scores.

($H_{0.1} : r_{PB} = 0$, t, df, $\alpha = .05$)

2.2 There will be no significant correlation between the students sex and their upper level achievement scores.

($H_{0.2} : r_{PB} = 0$, t, df, $\alpha = .05$)

3.0 There will be no significant difference between the overall achievement scores of EG and CG subjects when they are classified according to their sex.

($H_{0.0} : S^2_{treatment} < S^2_{error}$, F, df, $\alpha = .05$)

3.1 There will be no significant difference between the lower level achievement scores of EG and CG subjects when they are classified according to their sex.

($H_{0.1} : S^2_{treatment} < S^2_{error}$, F, df, $\alpha = .05$)

3.2 There will be no significant difference between the upper level achievement scores of EG and CG subjects when they are classified according to their sex.

($H_{0.2} : S^2_{treatment} < S^2_{error}$, F, df, $\alpha = .05$)

3.3 Experimental Design

In order to explore the relative effectiveness of the "traditional laboratory" method and the "expository" Method in achieving course objectives at different levels of Bloom's Taxonomy of Educational Goals, "The Posttest-Only Control Group Design" is used.

The sample of the study, the variables, measuring tools and the statistical analysis used are defined briefly in following sections.

3.3.1 Population and Sample

This study includes two separate treatments. The population of the first treatment -it is called treatment 1- consisted of Lycee I students at TED Ankara College in 1988-1989 academic year. Two classroom among 21 of Lycee classes were assigned as the sample, totally 74 students involved.

The population of the second treatment -it is called as treatment 2- the students at TED Ankara College in 1989-1990 academic year at Lycee I level. Six classes among 20 of Lycee I classes were selected as the sample of the study. Three classes with 99 students formed a group, left three classes of the sample with the same size as the first group, formed another group. One of these groups was randomly assigned to the traditional Laboratory treatment which was named as experimental group (EG). The another group was assigned to the expository treatment which was called as control group (CG).

In order to determine whether a difference exists between the two groups interms of the previous knowledge related to the content of subject matter taught during the treatment, a pretest was introduced. The performance of experimental and control group subjects were compared by applying student's t-test for two independent sample. The difference between the

two groups means scores was not significant at $\alpha=.05$ level as seen in Table 3.1.

Table3.1 Summary table for testing the signnificance of the difference between the means obtained from the pre-administration of the achievement test by EG and CG subjects

GROUPS	N	X	S	S ²	df	t _α	t _t	P
EG	99	7.85	8.24					
				75.95	196	.285	1.960	P>.05
CG	99	8.5	9.19					

3.3.2. Variables

Students' achievement scores, as measured by PAT is the dependent variable (DV) of this design. This variable is continuous and interval type data can be obtained.

Two different types of teaching methods utilized in Lycee I Physics courses are the independent variable (IV) of the present study. These are "traditional laboratory" type of instruction in which the teacher presents the concepts, procedural instructions for their verification, and provides all of the equipment necessary for verifying the concept; and "exposition" type of instruction in which the teacher presents the science concepts to the students verbally.

Sex is the intervening variable (INV) of the present study. These variables of the study are tabulated in Table 3.2

Table 3.2: Identification of variables

Type-1	Name	Nature	Data	Type-2
DV	Achievement scores	Continuous	Interval	DV
IV	"Traditional Lab"	Discrete	Nominal	IV
INV	Sex	Discrete	Nominal	INV

3.3.3 Measuring Instrument

A physics achievement test called (PAT)₁, consisting 17 multiple choice items was prepared to measure the dependent variable, physics achievement in the first treatment.

These items were classified into two groups. That is 9 items at lower level and the remaining 8 items at upper level of Bloom's Taxonomy of Educational Goals.

In the second treatment to collect data again a physics achievement test called (PAT)₂ was prepared. (PAT)₂ contains 48 multiple choice items, 24 at lower level and 24 at upper levels of Bloom's Taxonomy of Educational Goals.

The reliability of the (PAT)₁ and (PAT)₂ were calculated by Kuder Richardson 21 method and they were found $r=.35$ and $r=.85$ for (PAT)₁ and (PAT)₂ respectively.

3.3.4 Analysis of Data

Campbell and Stanley (1973) state the appropriate statistical methods for the analysis of data in "The Posttest-Only Control Group Design" as stated below.

The simplest design would be the t-test. The design is perhaps the only setting for which this test is optimal however, covariance analysis and blocking on "subject variables" such as prior grades, test scores, parents occupation etc., can be used, thus providing an increase in the power of significance test very similar to that provided by a pretest (p.27).

Since the general design of the experiment involves "The posttest-Only Control Group Design", the dependent variable in the design is subjects content achievement which is assumed not to be resulted from other variables such as previous physics learning and the sex of the subjects prior to the experimental treatment. So, the experimental design should involve appropriate analysis of observed differences due to the differential treatments. For this purpose, the following statistical methods are used (Ferguson, 1981), which are tabulated in Table 3.3.

1. Student's T-Test for Two Independent Groups

This method is used to test the significance of difference asked by the Hypotheses 1.0, 1.1, and 1.2 student's t-test is computed as following:

$$t = (X_{ea} - X_{ca}) / (S_{xea} - S_{xca})$$

where $X_{EG} - X_{CG}$ shows the difference between the means achievement scores of EG and CG subjects. $S_{xE} - S_{xC}$ is the standart error of the differences between the means of EG and CG given by

$$S_{xE} - S_{xC} = S^2 (N_1 + N_2) / N_1 N_2 .$$

and $S^2 = (N_1 - 1) S^2_1 + (N_2 - 1) S^2_2 / (N_1 + N_2 - 2)$

Where N_1 and N_2 are the number of subjects in EG and CG. The observed t value (t_o) will be compared to the table t value (t_t) for degrees of freedom (df) at $\alpha=.05$ level.

2. Two Way Analysis of Variance

This method is used to test the hypothesis 2.1 which is in the form:

$$(H_{o2.1} : S^2_{factor} \quad S^2_{error}, F, df, \alpha=0.05)$$

Where S^2_{factor} is the variance estimates for rows, columns, and interaction effects and S^2_{error} is within group variance estimate, F is given by

$$F = S^2_{factor} / S^2_{error}$$

The observed F value will be compared with table value to make a decision.

3. Point Biserial Correlation

This method is used to test hypothesis 2.0 which is in the form: ($H_o: r_{pb} = 0, t, df, \alpha= .05$)

where r_{pb} is the correlation between students' scores on PAT and their sex, and given by

$$r_{pb} = (X_p - X_q) \quad p.q / S_x$$

where $S_{...}$ is the standard deviation of scores on PAT, defined as $(X-X)_{...}/N$, the quantities p and q are the proportion of male and female subjects $X_{...}$ and $X_{...}$ are the mean scores, on PAT, of male and female subjects.

In order to test the significance of correlation coefficient found, the following t-test is used.

$$t = r_{pbb} \sqrt{(N-2) / (1-r_{pbb}^2)}$$

The observed t-value will be compared with the table value for $df=N-2$ at $\alpha=0.05$ level.

Table 3.3: Statistical Methods Utilized for Testing of Hypotheses

Mode of Analysis	Number of HYP	H_{0}	α
Student's t-test for two independent variable	1.0, 1.1, 1.2	$X_E = X_C$.05
Point Biserial Corr. Test of Significance of Corr. Coef.	2.0, 2.1, 2.2	$r_{pbb} = 0$.05
Two Way Analysis of Variance	3.0, 3.1, 3.2	$S^2_{factor} < S^2_{error}$.05

3.3.5 Treatment

As stated previously, to determine the relative effectiveness of "exposition" and "traditional laboratory" methods of teaching science concepts, two treatment subjects were assigned. The researcher taught EG subjects and the CG

subjects were taught by another physics teacher (Şadi MARAL, özen AYTAÇOĞLU during the first and the second treatments respectively) at TED Ankara College. They were the regular physics teachers of those classes. The teachers cooperated in preparing lesson plans and assigning examples, homework problems. The first treatment was completed in 5 weeks. The teacher and students meet 3 times per week at the end of the treatment, the measuring instrument PAT was introduced.

During the second treatment 6 classes were assigned as the sample of the study. The subjects were taught by their regular physics teachers. At the beginning of the study a pre-test consisting of 48 multiple-choice questions was introduced at two occasions. The treatment was completed in 4 weeks. Teachers and students met 3 times per week. In the first week following the treatment the measuring instrument (PAT) is introduced which was introduced as pretest at beginning of the treatment.

The independent variables of the study are described as following:

1. Expository Method

It is a method of instruction in which the teacher presents the science concepts to the students verbally.

-The concept is stated first, and then examples are given for further clarification.

-The teacher makes use of no Audio-Visual material but the chalkboard.

-Students are allowed to ask questions or to discuss the concept.

2. Traditional Laboratory method

It is a method of instruction in which the teacher presents concepts, procedural instruction, for their verification and provides all of the equipment necessary for verifying the concepts. Its phases are as following:

-The concept is stated first, and then the procedure is described for the verification of the concept.

-The teacher may explain the concept if necessary.- Students may ask questions.-Each lab group has 4 members. As it is understood from the descriptions of the methods; the traditional laboratory methods differs from expository method only by use of verification type of laboratory work. In both two treatment groups, the students were provided with worksheets, which contained questions and problems for review.

CG subjects have much time to solve problem from worksheet than EG subjects because they spent some amount of their total in laboratory.

3. The List of Experiments Performed by EG subjects

Treatment 1:

- Motion: Velocity and Acceleration.....1 hour
- Changes in Velocity with Constant Force.....1 hour
- Frictional Force.....1 hour

3 hours

Treatment 2:

- Demonstration of Lab Equipments.....1 hour
- Steady Motion.....1 hour
- Accelerated Motion.....1 hour

After each lab session one hour lecture was hold to discuss the findings of the students.

The content listed below was covered in 5 weeks in which a total of 15 interaction hours took place, during treatment1

1. Motion on a Straight Line(Displacement, Velocity and Acceleration)

- 2. Newton's First Law of Motion.
- 3. Newton's Second Law of Motion.
- 4. Frictional Force.

During the second treatment motion on a straight line was instructed only.

3.3.6 Assumptions and Limitations

In this sub-section of the "Experimental Design", the assumptions and limitations involved in the design of the study are given.

3.3.6.1 Assumptions

-The total interaction time was not significantly different for experimental and control groups.

-Students in one group did not interact with students in other group at a significant level pertaining the effects of different treatments.

-Students learnings other than physics didn't modify or render any impact on results obtained by the study.

3.3.6.2 Limitations

-The population is limited to those students attending Lycee I physics course. It may be extended to all Lycee students with in the limits of socio-economic status with some modification only.

-Each treatment group (EG and CG) was supervised by a different teacher. The effect due to this variable was not investigated. But, in order to minimize the deviations printed lesson plans which contained the same concepts, the same questions, exercises and problem were prepared, and used by all teachers in this study. The laboratory works were carried by a single teacher with 9 experiment groups. Each group contains four individual students. This situation created interacting problems with students individually.

CHAPTER IV

FINDINGS, RESULTS AND CONCLUSIONS

In this chapter, the results obtained from the statistical analysis of data are given. The hypotheses were tested for significance at $\alpha = .05$ level using the methods mentioned in the section "Analysis of Data". In the following two sections (4.1 and 4.2). The results obtained from the testing of each hypothesis given in summary tables.

4.1 Results, and Finding of Treatment 1

Hypothesis 1.0 was tested by student's t-test for two independent samples. The results are given in Table 4.1:

Table 4.1: Summary Table for Testing Hypothesis 1.0 by Using Student's T-Test for Two Independent Samples

GROUPS	N	X	S	df	t_{α}	t_c	DECISION
EG	35	9.31	2.46	72	.918	2	Fail to Reject
CG	39	8.87	2.42				

Although the subjects in the experimental group achieved higher mean score than the subjects in the control group, the analysis indicate that difference observed on the means of overall achievement scores of the subjects in the experimental and control groups was not statistically significant at $\alpha = .05$

level. Thus, it may be concluded that students exposed to the traditional laboratory and students exposed to expository methods are almost comparable in terms of their overall achievement of the subject matter as measured by PAT.

In order to test Hypothesis 1.1 student's t-test for two independent samples was used. The results are given Table 4.2:

Table 4.2: Summary Table for Testing Hypothesis 1.1 by Using Student's T-Test for Two Independent Samples

Groups	N	X	S	df	t _o	t _c	DECISION
EG	35	6.09	1.74	72	0.432	2.00	Fail to Reject H ₀
CG	39	5.79	1.52				

Although the subjects in experimental group achieved a higher mean score than the subjects in the control group, the analysis indicated that the difference observed on the means of lower level concept achievement scores of subjects in the experimental and control groups was not statistically significant at $\alpha = .05$ level. Thus, it may be concluded that students exposed to traditional method and the students exposed to the expository methods are almost comparable in terms of their achievement at recognition and transfer of the concept to the new situations as measured by PAT.

In order to test Hypothesis 1.2 student's t-test for two independent sample was used. The results are given in Table 4.3.

Table 4.3 : Summary Table for Testing Hypothesis 1.2 by Using Student's T-Test for Two Independent Samples

GROUPS	N	X	S	df	t_{α}	t_c	DECISION
EG	35	3.17	1.34	72	.478	2	Fail to Reject
CG	39	3.07	1.51				

The analysis indicated that the difference observed on the means of upper level achievement scores of the subjects in experimental and control group was not statistically significant at $\alpha = .05$ level. Thus, it may be concluded that students exposed to traditional laboratory method and students exposed to expository method are almost comparable in terms of their achievement of the subject matter requiring application and analysis of the concept as measured by PAT.

In order to test hypothesis 3.0 two way analysis of variance was used. Testing of this hypothesis required the classification of subjects according to their sex. The mean scores on PAT by male and female subject are put in a four cells contingency table as given below.

		GROUPS	
		EG	CG
SEX	F	$N_{11}=17$ $X_{11}=9.24$	$N_{12}=18$ $X_{12}=9.33$
	M	$N_{21}=18$ $X_{21}=9.22$	$N_{22}=21$ $X_{22}=8.52$

The results are given in Table 4.4:

Table 4.4 : Summary Table for Testing Hypothesis 2.1 by Using Two Way Analysis of Variance Method

Source of Variation	Sum of Squares	df	Mean Square	F	P
Rows	.058	1	.058	.010	P>.05
Columns	3.632	1	3.632	.594	P>.05
Interactions	0.158	1	0.158	.026	P>.05
Within	427.68	70	6.11		

Analysis indicated that F value of row effects is .01 which is smaller than table value (3.95). Thus, it may be concluded that male and female students achieve the overall subject equally regardless of the treatments exposed to them.

F value of the columns effect is .594 which is smaller than table value. It implies there is no significant difference between the means of PAT scores of the students' in the experimental and control groups regardless of their sex. This fact is also reflected in testing hypothesis 1.0.

The interaction effects are .026 which is less than its table value at $\alpha=.05$ level, so it may be concluded that the two different treatments effected male and female subjects equally interms of their overall achievement scores.

In order to test hypothesis 2.0 point biserial correlation is used together with t-test for testing the significance of correlation coefficient found. The results of this analysis are presented in the Table 4.5

Table 4.5: Summary Table for Testing of The Significance of the Correlation Between Student's Sex and Scores

GROUPS	N	df	r_{pb}	t_{obs}	t_{table}	DECISION	$r^2_{pb} \times 100$
ALL	74	72	.42	36.71	1.99	$P < .05$	17.64
EG	35	33	.02	.11	2.042	$P > .05$.04
CG	39	37	.71	6.96	2.021	$P < .05$	50.0

As seen from Table 4.5, the correlation of sex to PAT scores for experimental group was not significant. Thus, being in either sex doesn't affect their PAT scores. Although the correlations for the control group and all group were significant, the variance explained by sex were 17.64 for all group and 50.00 for control group.

4.1 Findings and Results of Treatment 2

Hypotheses 1.0 1.1 and 1.2 were tested by applying student's t-test for two independent samples. The results of the analysis were given in the Table 4.6

Table 4.6: Summary Table for Testing Hypotheses 1.0, 1.1 and 1.2 by Using Student's T-Test for Two Independent Variables

Hypothesis	No Groups	X	S	df	t _s	t _c	DECISION
1.0	EG	12.64	6.70	196	0.60	1.96	Fail to reject H ₀
	CG	12.14	5.0				
1.1	EG	9.59	4.72	196	-2.11	1.96	Reject H ₀
	CG	11.02	4.78				
1.2	EG	21.57	8.40	196	-1.28	1.96	Fail to reject H ₀
	CG	23.14	8.84				

The analysis indicated that the differences observed between the means of experimental and control group subjects lower level and overall achievement scores are not significant at $\alpha = .05$ level It reveals that expository and traditional laboratory methods are equally effective on the student's overall achivement and lower level achievement.

The analysis of hypothesis 1.1 indicates that difference observed between the means of upper level achievement scores of experimental group subjects are significant at $\alpha=.05$ level.

Hypothesis 2.0, 2.1 and 2.2 were tested by applying Point Biserial Correlation with t-test for testing the significance of the observed correlation coefficient. The results are given in Tables 4.7, 4.8, and 4.9 respectively.

Table 4.7: Summary Table for Testing the Significance of the Correlation Between the Student's Sex and Their Upper Level Achievement Scores on (PAT)

Groups	df	r_{pb}	t_o	t_c	$r^2_{pb} \times 100$	P
EG	97	-.115	-1.14	1.98	1.32	$P > .05$
CG	97	-.391	-4.18	1.98	15.28	$P < .05$

The analysis indicates that the correlation between students sex and their upper level physics achievement scores is not significant for the subjects of the experimental group; but the correlation for control group subjects is significant at $\alpha = .05$ level 15.28 percent of variance of PAT scores is predictable from the sex of the subjects.

Table 4.8: Summary Table for Testing the Significance of the Correlation Between the Student's Sex and Their Lower Level Physics Achievement Scores on (PAT)

GROUPS	df	r_{pb}	t_o	t_c	p	$r^2_{pb} \times 100$
EG	97	-.031	+ .305	1.98	$P > .05$.096
CG	97	-.424	4.61	1.98	$P < .05$	17.97

The observed t value, for the control group is bigger than its table value with degrees of freedom 97 and $\alpha = .05$

level. Thus the correlation between student's lower level physics achievement scores on (PAT)₂ and their sex is significant at $\alpha=.05$ level; but the correlation is not significant for experimental group subjects.

Table 4.9: Summary Table for Testing the Significance of Correlation Between Students' Sex and Their Overall Physics Achievement Scores on (PAT)₂

GROUPS	df	r_{pb}	t_{c}	t_{c}	p	$r^2_{pb} \times 100$
EG	97	-.151	1.50	1.98	$P > .05$	2.28
CG	97	-.552	6.52	1.98	$P < .05$	30.47

The analysis reveals that the correlation between student's sex and their overall physics achievement scores on (PAT)₂ is significant at $\alpha=.05$ level for control group subjects 30.47 percent of the variance of the PAT scores is predictable by student's sex for the control group; but the correlation for the experimental group subjects is not significant statistically at $\alpha=.05$ level.

In order to test hypotheses 3.0, 3.1 and 3.2. Two Way Analysis of Variance was used. It requires the classification of EG and CG subjects according to their sex. The contingency table and summary table 4.10 of the analysis of Hypothesis is given below.

GROUPS

	EG	CG
F	$N_{11}=38$ $X_{11}=20$	$N_{12}=52$ $X_{12}=18.4$
M	$N_{21}=61$ $X_{21}=22.6$	$N_{22}=47$ $X_{22}=28.2$

Table 4.10: Summary Table for Testing $H_{03.0}$ By Applying Two Way Analysis of Variance

Source of Variation	Sum of Squares	df	Mean Squares	F	P
Columns	192.123	1	192.123	2.739	$P > .05$
Rows	811.611	1	811.611	11.570	$P < .05$
Interactions	177.931	1	177.931	2.537	$P > .05$
Within	13608.660	194	70.148		
Total	14719.540	197	74.718		

The table value of F is 3.89 for degrees of freedom $df_1=1$, $df_2=194$ and $\alpha = .05$. As it seen in Table 4.10, the observed F value (2.739) is smaller than the table value for column effects. It implies that both two ways of the instruction are equally effective on the overall physics achievement score of the subjects regardless their sex as it reflected in testing the hypothesis 1.0.

The observed F value for row effects (11.570) is greater than the table value (3.89) It implies that there is a

significant difference between the means of overall physics achievement scores of male and female subjects; regardless of the treatment exposed. The males achieved significantly higher mean score.

The interaction effects are not significant. Thus it may be concluded that there is no significant interaction between the two treatments and sex.

The contingency table for Hypothesis 3.1 is given below:

		GROUPS	
		EG	CG
SEX	F	$N_{11}=38$ $X_{11}=11.6$	$N_{12}=52$ $X_{12}=9.8$
	M	$N_{21}=61$ $X_{21}=12.0$	$N_{22}=47$ $X_{22}=14.1$

Contingency table for H...

The results are given in Table 4.11

Table 4.11: Summary Table for Testing $H_{03.1}$ by Applying Two Way Analysis of Variance

Source of Variation	Sum of Squares	df	Mean Squares	f	P
Columns	3.835	1	3.835	.113	$P > .05$
Rows	239.394	1	239.394	7.026	$P < .05$
Interactions	15.486	1	15.486	.455	$P > .05$
Within	6609.766	194	34.071		
Total	6877.273	197	34.910		

Table value of F is 3.89 for $df_1=1$, $df_2=194$ and $\alpha=.05$

The interaction effects and column effects are not significant because their F values are smaller than the table value. It may be concluded that there is no significant interaction between the treatments; and student's sex and the treatments are equally effective on the lower level physics achievement scores regardless of their sex.

The observed F value for row effects is greater than the table value. Thus the sex of the subject make a great difference in lower level physics achievement scores regardless the treatment exposed.

The males achieved significantly higher mean score than did the females.

The contingency Table for Hypothesis 3.2 is given below:

		GROUPS	
		EG	CG
SEX	F	N ₁₁ =38 X ₁₁ =8.9	N ₂₁ =52 X ₂₁ =8.6
	M	N ₂₁ =61 X ₂₁ =10.0	N ₂₂ =47 X ₂₂ =12.3

Contingency Table for H_{3a.2}

The results are given in Table 4.12

Table 4.12: Summary Table for Testing H_{3a.2} by Two Way Analysis of Variance

Source of Variation	Sum of Squares	df	Mean Squares	F	P
Columns	131.681	1	131.681	6.144	P<.05
Rows	218.732	1	218.732	10.205	P<.05
Interactions	53.064	1	53.064	2.476	P>.05
Within	4158.001	194	21.433		
Total	4330.207	197	22.996		

The observed F value of the column effects is greater than the table value of F(3.89). It implies that the upper level physics achievement scores of the experimental group subjects and the control group subjects differ significantly regardless of their sex, as indicated the results of

hypothesis 1.2, Thus it may be concluded that the expository method is more effective than the traditional laboratory methods in upper level physics achievement scores of the student.

The row effects are also significant at degrees of freedoms $df_1=1$, $df_2=194$ and $\alpha=.05$ level. It may be concluded that sex of students make a great difference in upper level physics achievement scores regardless of the treatment exposed, and the males achieved significantly higher mean score than did the females.

4.3 Conclusions

In the light of the finding obtained by different analyses it may be concluded that:

1. Traditional laboratory and expository methods of instruction are comparable when they are compared in terms of their effectiveness to achieve concepts at lower cognitive levels of Taxonomy of Educational Goals and in terms of students' overall content achievement at high school level physics.

2. In terms of students' achievement at upper levels of Taxonomy of Educational Goals the treatments 1 and 2 two gives different results. According to the results of the treatment 2 the expository method found more effective than the traditional laboratory method, but the results of treatment 1 did not indicate any difference between the effectiveness of

the methods.

3. The results of both treatments indicates a significant correlation between the achievement and sex for control group subjects. At all levels of the achievement, the girls exposed to traditional laboratory obtained a higher mean score than the girls exposed to the expository method did.



CHAPTER V

DISCUSSION, IMPLICATION AND RECOMMENDATIONS

The findings of statistical analysis and the conclusions based on the results which are given in the previous chapter illustrate that:

The hypothesis seeking to establish significant relationship between the different instructional approaches and students' content achievement scores were conformed for the achievement at higher levels of Taxonomy of Educational Goals with in the limitation of the study, in favor of the expository method.

There are a couple of research supporting the opinion that there is no significant difference among the teaching methods when they are compared interms of their effectiveness in teaching sciences concepts and principles at lower levels of Bloom's Taxonomy Educational Goals (Renner, 1984; Babikion, 1989; Spears and Callman 1977; Zingore and Collette 1968; Tamir, 1972).

It is seen that relative effectiveness of "traditional laboratory" and "exposition" methods will continue to be under-investigation of researchers. Because there is theoretical support to use of laboratory, especially for the learners who are at concrete and transitional-from concrete to formal-levels of intellectual development (Ward and Herron, 1980).

Babikian (1969) concluded from his research that "expository" and "traditional laboratory" methods are significantly effective in teaching science concepts when compared with discovery method at high school level, but he did not compare those two methods.

The analysis have done to determine whether a relation exists between the achievement of students, their sex and the way of instruction of subject matter revealed that the traditional laboratory method was more effective than the expository method.

This implies a need for reseaches to determine wheather there is a difference between intellectual development of males and females. Scince the laboratory is regarded as an opportunity to have concrete experiences for concrete operational students (Schneider and Renner, 1980).

In our country most of the students at high school level plan to continue their studies at university level. To do it, they have to pass enterance examination. The students are aware of that conditions and they prefers that their studies must be related to the content and structure of the enterence exam. Therefore, there is a need to identify an appropriate method to increase students performance on enterence examinations.

As a result of the present study reveals, there is a continuous need for further research seeking to establish the relationship between different teaching approaches and the

achievement of the learners. Below, a number of recommendations for further research is listed.

1) Research designs to test the effect of "traditional laboratory" and "expository" methods on the students' understandings of science are needed.

2) Research designs to test the effect of teachers understanding of the nature of science on students' understanding the nature of science and their attitudes toward science should be planned and relevant research on this point should be conducted.

3) Effective ways of teaching large groups should be investigated.

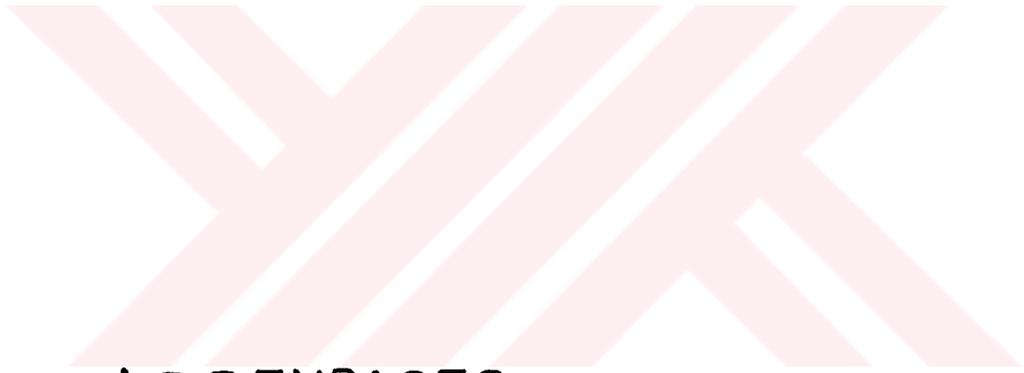
4) Research design to determine intellectual level of male and female students at lycee I level and effective ways of teaching them is needed.

REFERENCES

- Ausebell, D.P., The Psychology of Meaningful Verbal Learning. New York: Grune and Stratton, 1963.
- Babikian, Y., An Experimental Investigation to Determine the Relative Effectiveness of Discovery, Laboratory, and Expository Methods of Teaching Science Concepts, Journal of Research in Science Teaching 8(3);201-209 1971
- Bloom, B.S., Editor, Taxonomy of Educational Objectives, Handbook I: Cognitive Domain, McKay, New York, 1956.
- Bloom, B.S., Hasting J.T. and Madaus, G.P.F., Handbook on Formative and Summative Evaluation of Student Learning. New York McGraw Hill, 1971.
- Blosser, P.E., Labs-Are They Really as Valuable as Teachers Think They Are? The Science Teacher, May, 1988.
- Bruner, J.S., Toward a Theory of Instruction, the Belknap Press of Harvard University, USA, 1971.
- Crumb, G., Understanding of Science in High School Physics. Journal of Research in Science Teaching, 3:246-250, 1965.
- Ferguson, G.A., Statistical Analysis in Psychology and Education. New York, McGraw-Hill, 1981.
- Gagne, Robert M., Learning and Individual Differences. Columbus, Ohio: Charles E. Merrill Books, Inc., 1967.
- Klopper, L.E. and Cooley, W.W., The History of Science Cases for High Schools in the Development of Student Understanding of Science and Scientists. Journal of Research in Science Teaching. 1:33-47, 1963.
- Heath, R.W., Pitfalls in the Evaluation of New Curricula. Science Education , 46, 216, 1962.
- Kyle, W.C., Penick, J.E. and Shymansky, A., Assessing and Analyzing the Performance of Students in College Science Laboratories, Journal of Research in Science Teaching, 16(6): 545-551, 1979.

- Klopfer, L.E., The Teaching of Science and the History of Science, Journal of Research in Science Teaching, 6:87-95, 1969.
- Okebukola, P.A. and Ogunniyi, B.M. Cooperative, Competitive and Individualistic Science Laboratory Interaction Patterns-Effects on Students' Achievement and Acquisition of Practical Skills. Journal of Research In Science Teaching, Vol.21, No.9, pp. 875-884, 1984.
- Pella, M.O., O'Heara, G.T. and Gale, C., Referents to Scientific Literacy, Journal of Research in Science Teaching, 4:199-208, 1966.
- Piaget, J. and Inhelder, B., The Growth of Logical Thinking from Childhood to Adolescence. New York, 1958.
- Ost, D.H. and George, D., The Contradictory Faces of Science, The Science Teacher, 42(10): 14-16 December, 1975.
- Purser, R.K. and Renner, J.W., Results of two Tenth-Grade Biology Teaching Procedures, Science Education, 67(1): 85-98, 1983.
- Renner, J.W., The Power of Purpose, Science Education, 66(5): 709-716, 1982.
- Robinson, J.T., Science Teaching and the Nature of Science, Journal of Research in Science Teaching, 3:37-50, 1965.
- Schneider, L.S., and Renner J.W., Concrete and Formal Teaching Journal of Research in Science Teaching, 17(6): 503-517, 1980.
- Sund, R.B. and Carin A.A., Teaching Modern Science, Columbus, Ohio, Charles E. Merrill Pub. Co., 1980.
- Renner, J.W., Abraham, M.R. and Birnie, H.H., The Necessity of Each of the Learning Cycle in Teaching High School Physics, Journal of Research in Science Teaching, 25(1): 39-58, 1988.
- Renner, J.W., Abraham, M.R. and Birnie, H.H., The Importance of the Form of Student Acquisition of Data in Physics Learning Cycles, Journal of Research in Science Teaching, 22(4): 303-325, 1985.

- Nie, N.H. and Others, Statistical Package for the Social Sciences, New York, McGraw-Hill, 1975.
- Spears, J. and Zollman, D., The Influence of Structured Versus Unstructure Laboratory on Students' Understanding the Process of Science, Journal of Research in Science Teaching, 14(1): 33-38, 1977.
- Tobin, K., Student Task Involvement in Activity Oriented Science, Journal of Research in Science Teaching, 21(5): 469-482, 1984.
- Tamir, P., Understanding the Process of Science by Students Exposed to Different Science Curricula in Israel, Journal of Research in Science Teaching, 9(3): 239-245, 1972.
- Ward, C.R. and Herron, D., Helping Students Understand Formal Chemical Concepts, Journal of Research in Science Teaching, 17(5): 387-409, 1980.
- Wasik, J., A Comparison of Cognitive Performance of PSSC and NonPSSC Physics Students, Journal of Research in Science Teaching, 8(1): 85-90, 1971.
- Woodburn, J., Science Defined Versus Indefinable, The Science Teacher, December, 1967, 27-30.

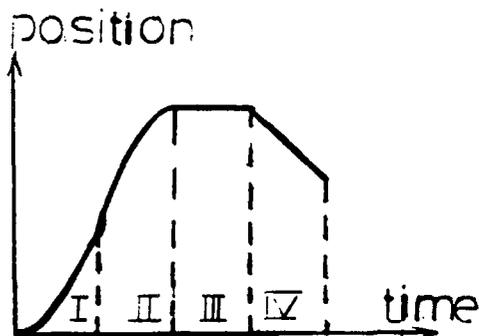


APPENDICES

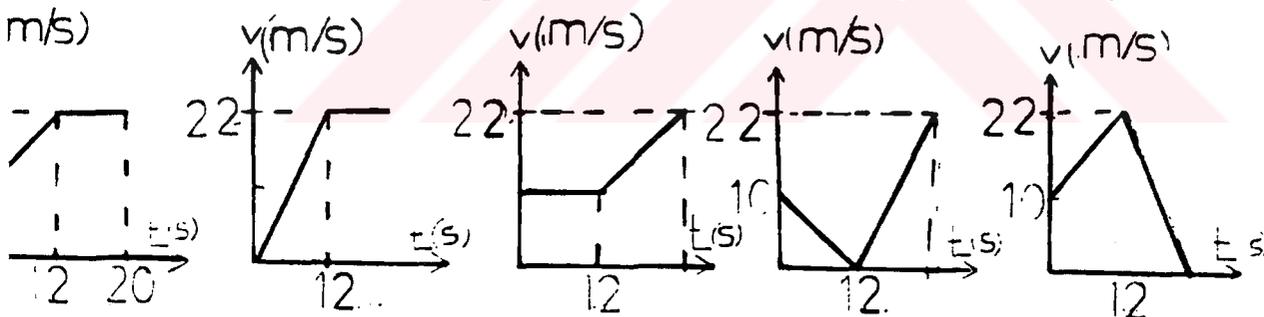
PHYSICS ACHIEVEMENT TEST (PAT),

1. Position-time graph of a body is given. In which time intervals does its speed decrease? (LL)

- A. I B. II C. IV D. II and IV E. I and II

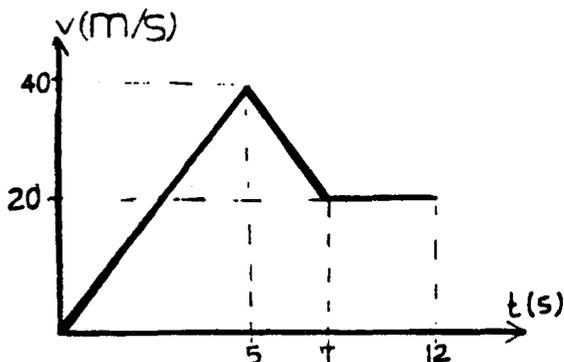


2. A body moving with a speed of 10 m/sec. speeds up at a rate of 1 m/sec² and it continues to move with the velocity attained at 12th sec. Which of the following can be velocity-time graph of the body? (LL)



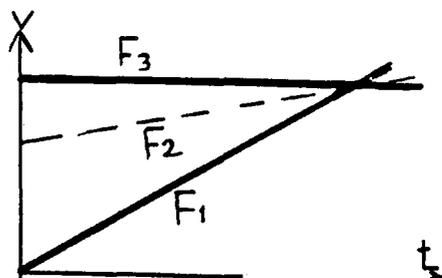
3. Velocity-time graph of a body is given. What is its displacement in 12 seconds? (LL)

- A. 220m B. 240m C. 260m D. 280m E. 340m



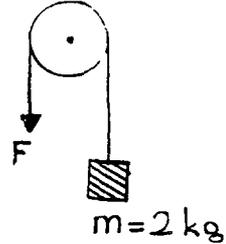
4. Velocity-time graph of three identical objects are given. What is the relation among forces F_1 , F_2 and F_3 acting on them? (LL)

- A. $F_1 = F_2 < F_3$ B. $F_1 = F_2 > F_3$ C. $F_1 < F_2 < F_3$
 D. $F_1 > F_2 > F_3$ E. $F_1 > F_3 > F_2$



5. In the given systems 2 kg mass moves upward with a constant acceleration of 2 m/sec^2 . How many newton is the force F ? (LL)

A. 8N B. 12N C. 16N D. 20N E. 24N

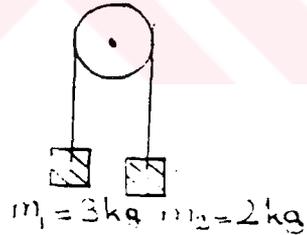


6. A body of mass 2 kg moves with an acceleration of 2 m/sec^2 . What is the resultant force acting on it? (LL)

A. 2N B. 4N C. 10N D. 16N E. 20N

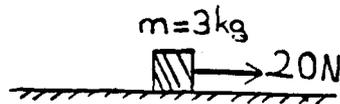
7. What is the acceleration of given system in m/sec^2 ? (LL)

A. 6 B. 4 C. 10 D. 2 E. 1



8. The body given in the fig. moves with constant velocity. What is the frictional force acting on it? (LL)

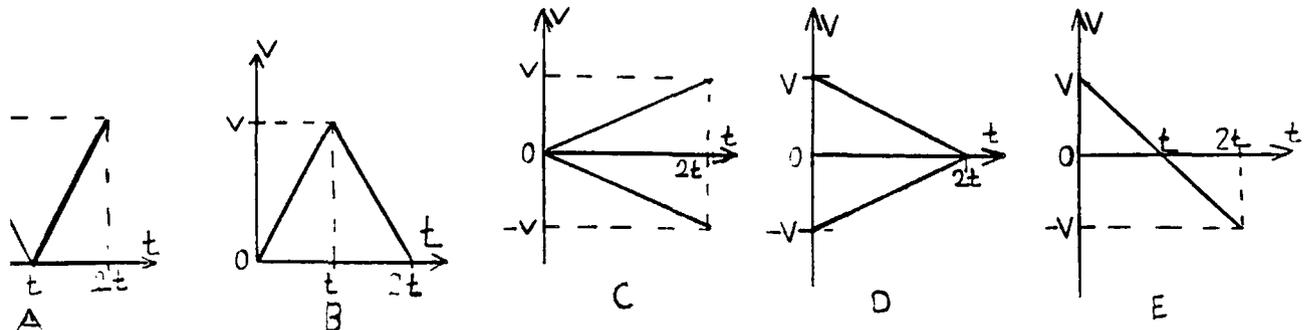
A. 0N B. 0.5N C. 5N D. 20N E. 30N



9. The acceleration of a body is "a" when the force acting on it is " F_1 ," and " $2a$ " when the force acting on it is " F_2 ". What is F_1/F_2 ? (LL)

A. 0.5 B. 1 C. 1.5 D. 2 E. 4

10. At $t=0$ a body has velocity " v ". It turns back to its initial position at the end of a time interval " $2t$ ". Which one of following can be velocity-time graph of the body? (UL)



11.

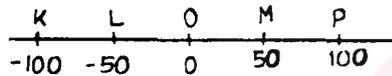


Figure.1

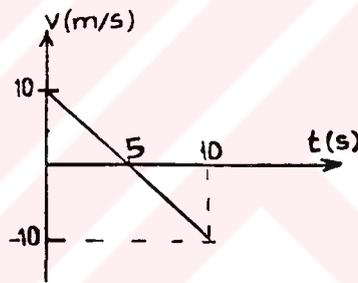
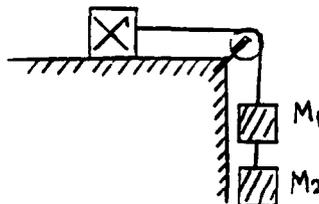


Figure.2

Velocity-time graph of a body that moves along a straight line as shown in Fig.1 is given Fig.2. If it starts from point "O" where will it be 10 seconds later? (UL)

- A. at K B. at L C. at O D. at M E. at P

12. In the given system friction force acting on "X" is equal to the weight of M_1 . If the rope between M_1 and M_2 is broken which one of the following can be true for the motion of "X"? (UL)



- A. Without knowing the mass of "X" a decision can not be made.
 B. It stops suddenly.
 C. It slows uniformly and stops.
 D. It speeds up.
 E. It moves with constant velocity.

3.

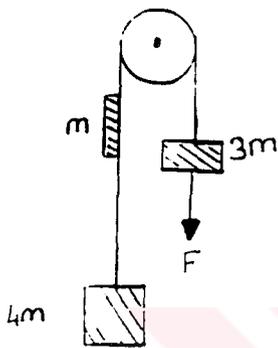


Fig. 1

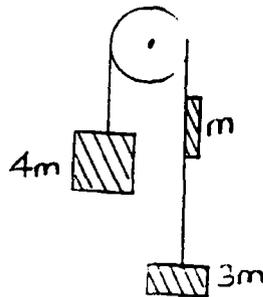


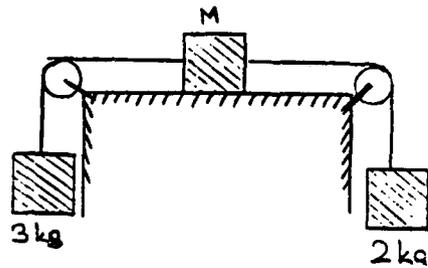
Fig. 2

The system given in Fig.1 moves by accelerating uniformly in the same direction with the force F . When the mass " m " takes the position shown in Fig.2. The force F is removed. After than what can be said about the motion of the system? (UL)

- A. It moves with constant velocity.
- B. Its motion does not change.
- C. It speeds up uniformly.
- D. It stops suddenly.
- E. It slows uniformly, stops, and change directions.

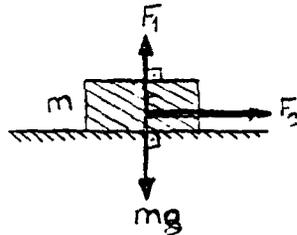
4. Friction force between " F " and horizontal plane is 10 N . Which of following statements can be true for the system? (UL)

- I. It may not move.
- II. It may move with constant velocity.
- III. It may move with constant acceleration.



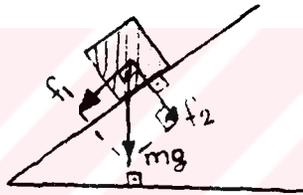
- A. I
- B. II
- C. III
- D. I and II
- E. II and III

The given system moves with constant velocity. Which one of following relations gives the coefficient of friction? (U L)



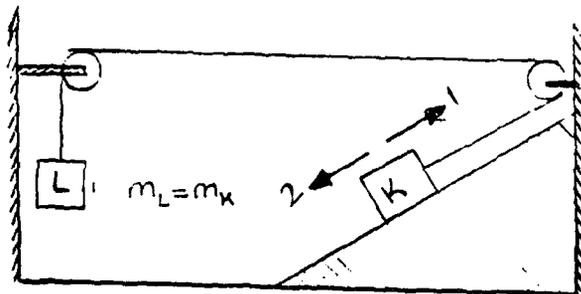
- A. F_1/mg B. $F_2/(mg-f)$ C. F_1/F_2
 D. mg/F_2 E. F_2/F_1

The body given in the figure slides down with constant velocity. Which of following relations gives the coefficient of friction? (U L)



- A. f_1/mg B. f_2/mg C. f_1/f_2 D. f_2/f_1
 E. mg/f_1

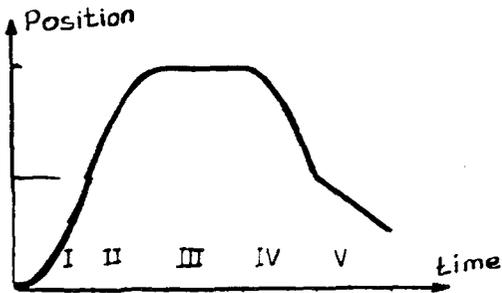
While the given system is in motion the rope is broken. What can be said about the motion of "K" after the rope is broken? (U L)



- A. It speeds up in direction 2.
 B. It speeds up in direction 1.
 C. It moves in direction 1 by slowing.
 D. It moves in direction 2 by slowing.
 E. It moves in direction 1 with constant velocity.

PHYSICS ACHIEVEMENT TEST (PAT)

Answer questions 1-5 according to the position-time graph given below.



In which time interval (s) does the body move with constant velocity? (LL)

- A. I, IV B. III, V C. V D. IV E. III

In which time interval (s) does the body move in positive direction? (LL)

- A. I B. I, II C. I, II, III D. IV, V E. III

In which time interval (s) does the speed of body increase? (LL)

- A. V B. III C. I and II D. I, IV E. II, IV

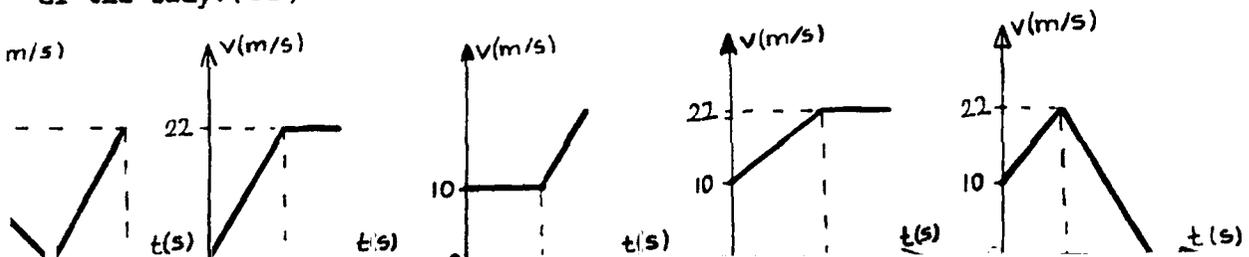
At the end of which time interval does the body change its direction of motion? (LL)

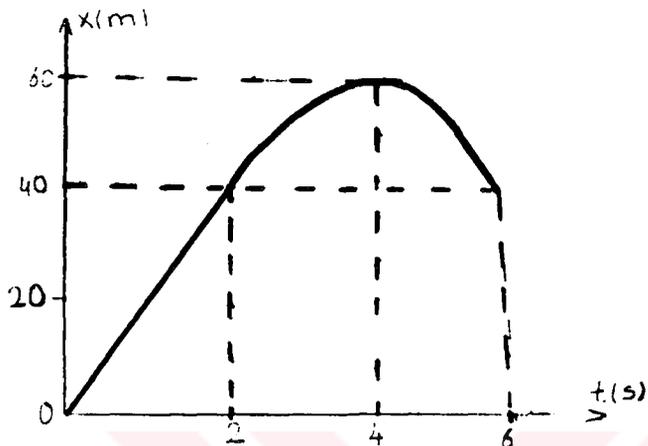
- A. I B. II C. III D. IV E. V

In which time interval(s) does the body have zero acceleration? (LL)

- A. I, II B. II, III C. III, IV D. IV, V E. III, V

A body moving with a speed of 10m/s speeds up at a rate of 1m/s² and it continues to move with the velocity attained at 12th. second. Which one of the following can be velocity-time graph of the body? (UL)





Answer questions 7-10 according position-time graph given above.

What is the velocity of the body at $t=4$ sec. in m/sec ? (LL)

- A. 60 B. 40 C. 20 D. 10 E. 0

What is the velocity of the body at $t=1$ sec. in m/sec ? (LL)

- A. 5 B. 10 C. 15 D. 20 E. 25

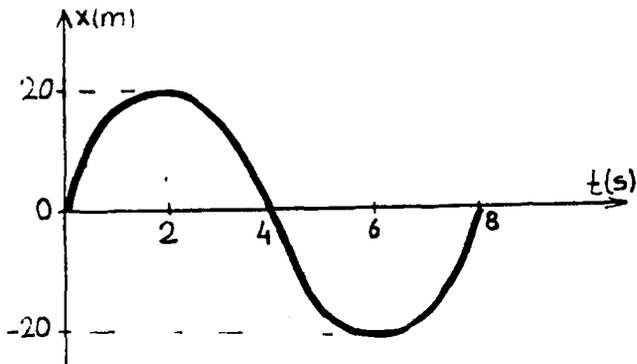
What is the average speed of the body in 8 sec. in m/sec ? (LL)

- A. 2,5 B. 5 C. 7,5 D. 10 e. 12,5

. What is the average velocity of the body in 8 sec in m/sec ? (LL)

- A. 2,5 B. 5 C. 7,5 D. 10 E. 12,5

Answer the questions 11-15 according to position-time graph below



11. What is the acceleration of the body between 0 sec and 2 sec? (UL)

- A. 0 B. 5m/s^2 C. -5m/s^2 D. 10m/s^2 E. -10m/s^2

12. What is the velocity of the body at $t=0$ sec in m/sec ? (UL)

- A. 0 B. 10 C. -10 D. -20 E. 20

13. What is the velocity of the body at $t=6\text{sec}$ in m/sec ? (LL)

- A. 0 B. 10 C. -10 D. -20 E. 20

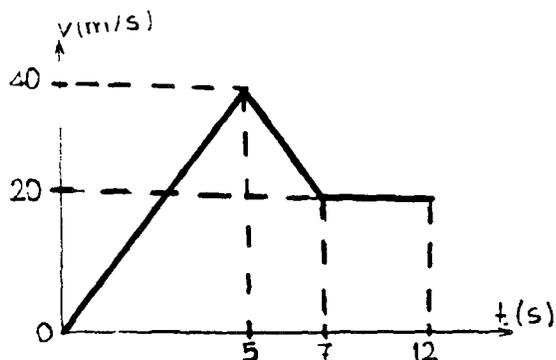
14. What is the displacement of the body in 8 sec? (LL)

- A. 20m B. 40m C. 60m D. 80m E. 0m

15. What is the distance travelled in 8 sec? (LL)

- A. 80m B. 60m C. 40m D. 20m E. 0m

16.



Velocity-time graph of a body is given above.
What is the displacement in 12 sec? (LL)

- A. 220m B. 240m C. 260m D. 280m E. 340m

17. What is the acceleration of the body between 7sec-12sec?
The v-t graph of the body is given in question 16.(LL)

- A. 2m/s^2 B. -2m/s^2 C. 8m/s^2 D. 20m/s^2 E. 0m/s^2

18.

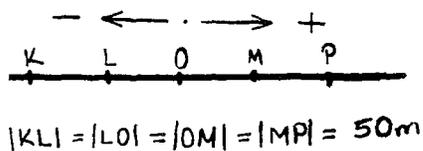


Figure.1

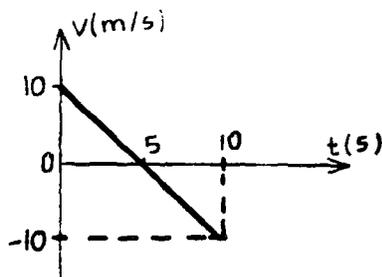
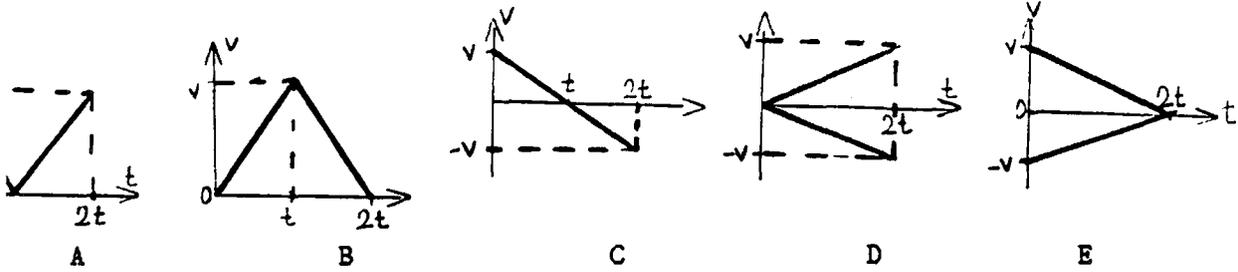


Figure.2

The velocity-time graph of a body moving along a straight line shown in Fig.1 is given in Fig.2. If it is at point "O" at $t=0\text{sec}$ where would it be 10 sec later? (UL)

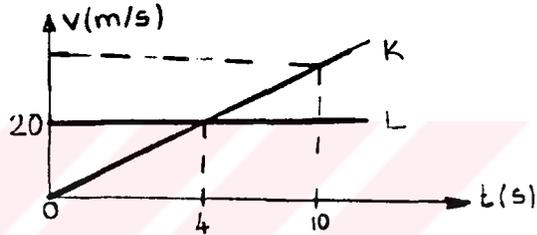
- A. at K B. at B C. at O D. at M E. at P

. At $t=0$ sec a body has a velocity "v". It turns back its initial position at the end of a time interval $2t$. Which one of the following can be velocity-time graph of the body? (UL)



. At $t=0$ sec the cars K and L are at the same place. What is the distance between them 10 sec later? (UL)

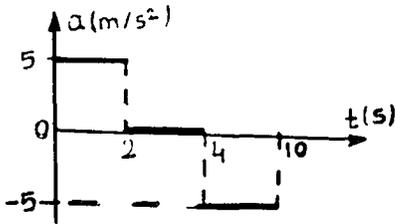
- A. 0m B. 25m C. 50m D. 200m E. 250m



. Assume that the cars given in question 20 are at different place at $t=0$ on a level highway. If they are at the same place at $t=10$ sec which of the following can be true for their positions at $t=0$ sec? (UL)

- A. K is 50m behind of L B. L is 50m behind of K
 C. K is 100m behind of L D. L is 100m behind of K
 E. They are at the same place.

Answer the questions 22-24 according to graph given below.



At $t=0$ $v_0=20$ m/sec

and $x_0=50$ m.

. What is the velocity of the body at $t=3$ sec.? (UL)

- A. 0 B. 10m/sec C. 20m/sec D. 30m/sec E. 40m/sec

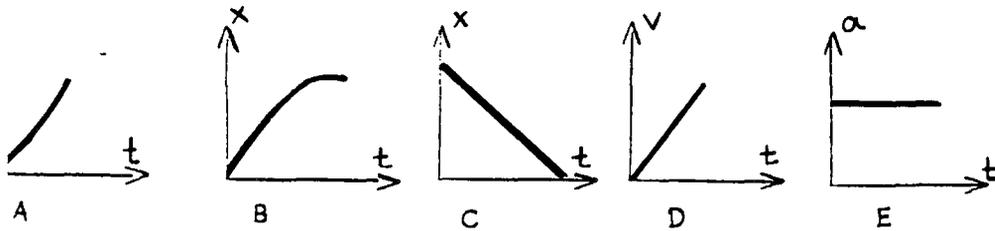
. What is the velocity of the body at $t=10$ s? (UL)

- A. 0 B. 10m/s C. 20m/s D. 30m/s E. 40m/s

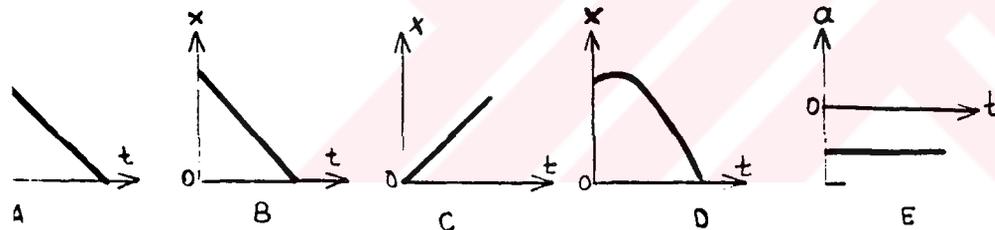
. What is its position at $t=10$ sec? (UL)

- A. 50m B. 100m C. 150m D. 200m E. 250m

Which of following graphs represents the motion of a car moving on a level road with constant velocity?

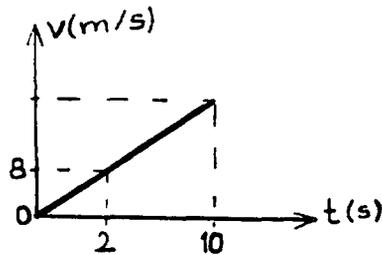


(LL). Which of following graphs can represent the motion of a car moving in reverse direction with constant velocity?



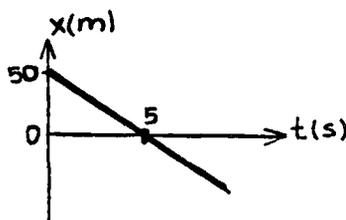
(LL). The velocity of a moving body changes with time as shown in adjacent figure. What is its velocity at $t=10$ sec, in m/sec?

- A. 16 B. 20 C. 28 D. 32 E. 40

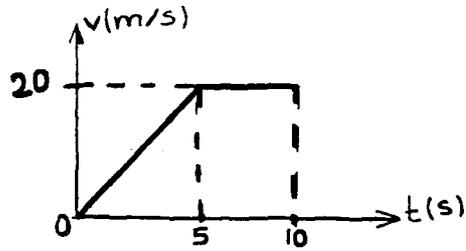


(LL). The position of a moving body changes with time as seen in adjacent figure. What is its velocity at $t=5$ sec in m/sec?

- A. 0 B. -10 C. 5 D. 50 E. -5

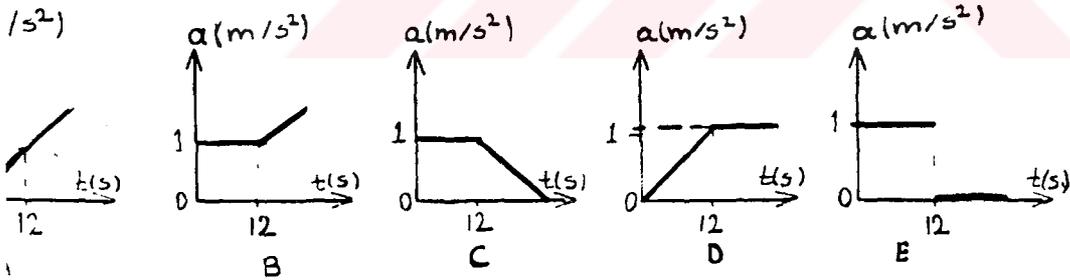


)(LL). The velocity of a moving body changes with time as in the adjacent figure. What is its acceleration between $t=5\text{sec}$ and $t=10\text{sec}$ in m/sec^2 ?

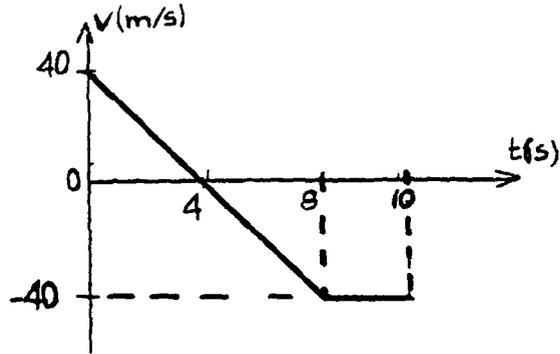


- A.0 B.1 C.2 D.4 E.8

)(UP) A body moving with a speed of 10m/sec accelerates and attains a velocity of 22m/sec in 12sec and then it continues to move with that velocity. Which of the following graph can represent its motion?



The velocity-time graph of a moving body is given in adjacent figure. Answer questions 31-34 according to this graph.



1(LL). At which instant does the body start to move in reverse direction?

- A. at $t=10\text{sec}$ B. at $t=8\text{sec}$ C. at $t=4\text{sec}$ D. at $t=6\text{sec}$ E. at $t=3\text{sec}$

2(LL). What is the acceleration of the body at $t=4\text{ sec}$ in m/sec^2 ?

- A. -5 B. 0 C. -10 D. 10 E. 5

3(LL). What is the displacement of the body in 10sec?

- A. 20m B. -20m C. 40m D. -160m E. 160m

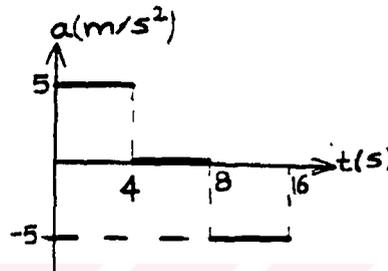
4(LL). What is the average velocity of the body in 10sec?

- A. 16m/sec B. 20m/sec C. 24m/sec D. 28m/sec E. 32m/sec

(UP). A car with a certain velocity, decelerates and stops in two seconds by displacing 20m. What is the initial speed of the car?

- A. 10m/sec B. 20m/sec C. 30m/sec D. 40m/sec E. 50m/sec

A car starts to accelerate from rest as shown in the adjacent figure. Use this graph to answer questions 36-38.



(LL). What is the velocity of the car at $t=6$ sec?

- A. 5m/sec B. 10m/sec C. 15m/sec D. 20m/sec E. 25m/sec

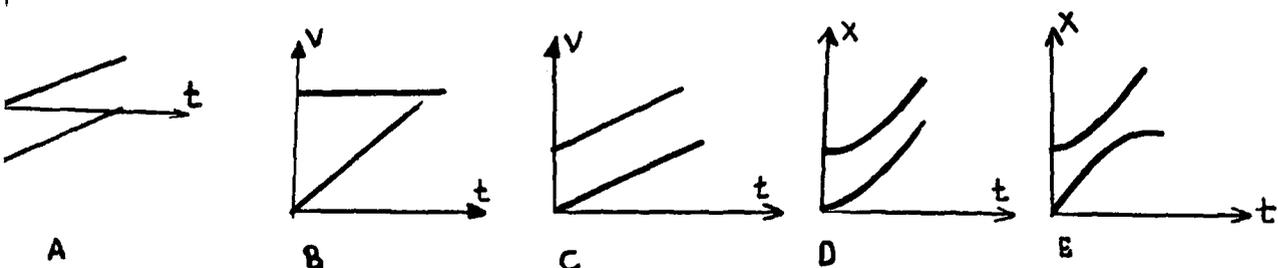
(LL). What is the velocity of the car at $t=16$ sec.?

- A. -5m/sec B. 5m/sec C. 20m/sec D. -20m/sec E. 0

(UP). What is the displacement of the car in 16sec?

- A. 40m B. 60m C. 80m D. 100m E. 120m

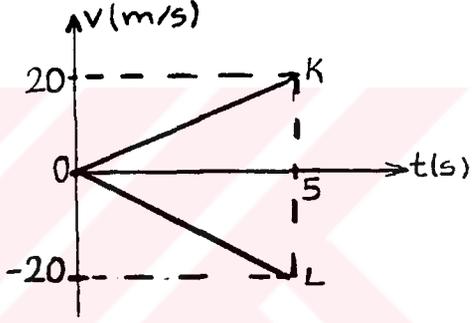
(LL). Which of the following graphs represents the motion of cars K and L that are moving toward each other?



0(LL). A train moving with a constant speed desalaterates a nd stops in 5sec by covering a distance of 50m. What is its acceleretion?

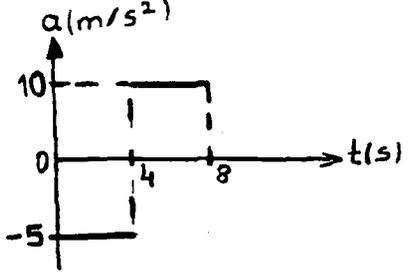
- A. 1m/sec^2 B. 2m/sec^2 C. 3m/sec^2 D. 4m/sec^2 E. 5m/sec^2

1(UP). Two cars K and L starts their motions from the same place as seen in figure. What is the distance between them 5 seconds later?



- A. 50m B. 100m C. 150m D. 200m E. 250m

2(UL). A body moving with a velocity of 20 m/sec accelerates as shown in the graph. What is the distance covered by the car untill it changes direction?



- A. 10m B. 20m C. 30m D. 40m E. 50m

3(UP). What is the velocity of the moving body given in question 42, at t=8sec?

- A. 10m/sec B. 20m/sec C. 30m/sec D. 40m/sec E.

44(UP). A car displaces 200m until it stops, decelerating uniformly in 10sec. What is the distance covered by the car during the last 2 seconds of its motion?

A. 2m B. 4m C. 6m D. 8m E. 10m

45(UL). A body moving with a constant acceleration 2m/sec^2 covers 24m during the tenth second. What is the initial velocity of the body?

A. 5m/sec B. 1m/sec C. 9m/sec D. 10m/sec E. 12m/sec

46(UL). Two motor cars start with a gap 2 min. How long after the departure of the second car is the distance covered by it equal to $\frac{1}{9}$ of the distance covered by the first car?

A. 0.5min B. 1min C. 1.5min D. 0.4min E. 2.5min

47(UL). A body starts moving with a uniform acceleration from the state of rest and covers the first 10m. in one second. How long does it take for the body to cover the first 100 meter of its path?

A. 0.1sec B. 0.2sec C. 0.3sec D. 0.4sec E. 0.5sec

48(UL). A train starts from a station with acceleration of 0.5m/sec^2 and attains the velocity of 60m/sec . What is the distance covered by it?

A. 100m B. 160m C. 200m D. 300m E. 360m

EXPERIMENTS PERFORMED DURING TREATMENT 1

In kinematics, it has been studied that if an object moves with constant velocity its acceleration is zero and it displaces equal distances in equal time intervals. Its $v-t$ and $x-t$ graphs are in the form of,

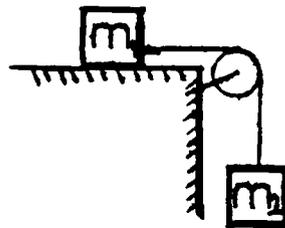
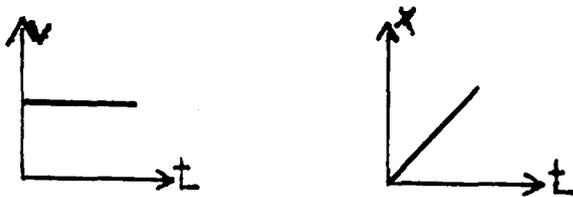
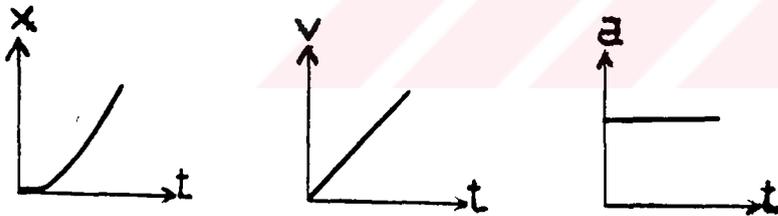


fig.1.

If the objects move with constant acceleration than the changes in its velocity in equal time intervals are the same, and its displacement changes proportional with the square of time as:

$$a = \Delta v / \Delta t \quad x = v_0 t + at^2/2$$

and its $x-t$, $v-t$, and $a-t$ graphs are as following:



In this experiment, using the system given in figure 1 the relations among x , v , and a will be investigated.

PROCEDURES

1. Set up the system shown in figure 1.
2. Let the system to move.
3. Record the position of the mass (m_1) for the equal in time intervals.
4. Sketch its displacement-time graph and make a decision about the type of the motion.
5. Compute the acceleration of the mass if it is accelerating.

EXPERIMENT 2

Newton's second law of motion states the acceleration "a" of an object or a system is directly proportional with the net force and inversely proportional with the total mass of the system or in a equation form

$$a = F_{net}/m$$

in this experiment the gravitational acceleration(g) will be investigated by using an Atwood machine shown in figure 1.

The light string and pulley are considered to be of negligible mass. While mass m_1 and mass m_2 are ascending and descending respectively, the unbalanced force is:

$$F_{net} = m_2g - m_1g = (m_2 - m_1) g \quad (Eq.1)$$

Then the friction of the pulley is neglected, by Newton's second law:

$$F_{net} = ma \quad \text{where } m = m_1 + m_2 \quad (Eq.2)$$

By equating Eq.1 and Eq.2 :

$$g = (m_1 + m_2) a / (m_2 - m_1) \quad (Eq.3)$$

is obtained.

To determine experimentally, the acceleration "a" of the system, the time "t" for descending mass to fall through a given distance "y" is measured. Then using the equation given below:

$$y = v_0t + (at^2) / 2$$

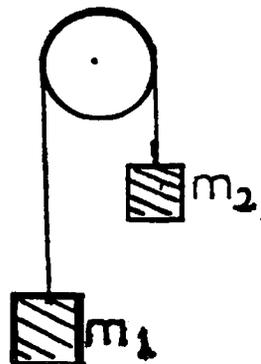
with the mass starting from rest, we will have:

$$y = (at^2) / 2$$

$$a = 2y / t^2 \quad (Eq.4)$$

PROCEDURES

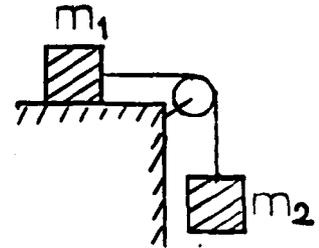
1. Set up the Atwood machine shown in figure 1. and join the end of tape which passes through the timer to the base of m_1 .
2. Let the system to move and start the timer.



3. Measure the distance covered in a certain time and compute "a" and "g".
4. State your conclusions and results.

EXPERIMENT 3

Newton's second law of motion states that acceleration "a" of a system is directly proportional to the unbalanced or net force acting on the system, and inversely proportional to the total mass of the system. For the system given in figure 1:



$$F_{net} = m_2g - f \quad (\text{Eq. 1})$$

where f is the frictional force between m_1 and horizontal table. According to second law of motion:

$$F_{net} = ma \quad (\text{Eq. 2})$$

where $m = m_1 + m_2$

by equating Eq.1 and Eq.2 we can obtain the equation of friction as following:

$$(m_1 + m_2) a = m_2g - f$$

$$f = m_2g - (m_1 + m_2) a \quad (\text{Eq. 3})$$

$$f = \mu m_1g \quad (\text{Eq. 4})$$

where μ is the coefficient of friction.

PROCEDURES

1. Set up the system shown in figure 1.
2. Start the timer and let the system to move.
3. By following the procedures of experiment 2 determine the acceleration.
4. Using Eq.3 compute the frictional force.
5. Using Eq.4 compute the coefficient of friction.

EXPERIMENTS PERFORMED DURING TREATMENT 2

EXPERIMENT 1

- Place the car on a level smooth table, and connect the end of the tape which is passing through the timer.
- By pushing the car into the motion, at the same instant start the timer.
- Plot graph of velocity of the car as a function of time.
- Determine the property of the motion.
- Discuss the results and state the conclusions.

EXPERIMENT 2

- Connect a strip of paper over the timer to the loaded car .
- Pull forward the car by a rubber standart stretch at constant length as shown in figure 1.
- Plot velocity time graph of the car and compute its acceleration.
- Discuss the results and state the conclusions.

T. C.
Yükseköğretim Kurulu
Dokümantasyon Merkezi