A STUDY OF THE CAUSES OF FAILURE IN SECONDARY SCHOOL PHYSICS IN LEBANON

BY

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Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Arts in the
Education Department of the
American University of Beirut
Beirut, Lebanon

June, 1958.

P H Y S I C S

C A U S E S   O F   F A I L U R E

N A M E K

A C K N O W L E D G M E N T S

In the preparation of this thesis valuable help was extended to me by various sources. I am particularly indebted to Prof. Emile J. Dumit for his guidance, Dr. Habib A. Kurani for his encouragement, and Professors Jibrail M. Katul, Frederick R. Korf and Nikula J. Shahin for their suggestions.

I am grateful to the Lebanese Ministry of Education and the Registrar of the American University of Beirut for statistical data, the various School Directors for permitting me to include the detailed data of the analysis of examination papers in my thesis, and to the sample of Physics Teachers and Students for their cooperation.

A B S T R A C T

The purpose of this study was to discover the causes of the large percentage of failures in the physics courses given in the secondary schools of Lebanon. Due to its close connection with the situation, the Freshman class of the American University of Beirut was also included.

Five means were used in collecting evidence on the problem, namely, (a) statistical records of schools and official examinations, (b) questionnaires administered to teachers and students, (c) content analysis of corrected examination papers for determining categories of errors, (d) a study of examination questions, and (e) observation in the field concerning class procedures, laboratories and textbooks. Whereever possible the data was given statistical treatment for determining levels of significance and contingency between fail and pass groups by the application of the sign test and the chi-square test. Samples of schools, students, teachers, and examination papers were carefully selected so as to make them representative of the whole population. There were two distinct types of schools and examinations: (a) Anglo-American type and (b) Latin type. Secondary education culminates in the official Baccalauréat examinations.

A study of the records of schools, official examinations and the data of this research revealed a significant percentage of failure in the physics course. The responses of 1046 students indicated that the causes were mainly: (a) lack of interest, (b) insufficiency or lack of laboratory work and demonstrations, (c) loaded curriculum and methods of teaching, (d) difficulty in mathematics and technique of problem solving, and (e) difficulty of the course - particularly mechanics, magnetism and electricity. The responses of 30 teachers revealed that (a) pupils lost interest in physics because they were not yet mature, because they were weak in mathematics and language, or because they were not originally interested, (b) demonstrations were used for certain topics only, (c) laboratory work was given mainly in Anglo-American type schools, (d) insufficient individual attention was given to students, (e) students memorized subject material with little comprehension and (f) mechanics, magnetism and electricity were the most difficult branches of physics.

The content analysis of 791 corrected examination papers revealed that the largest per cent of errors made by students were in laws or principles and the mathematical application of these in the solution of physics problems. This pattern is common to students of both types of schools in Lebanon. It was also observed that the methods of teaching were mainly the traditional ones of lecture-recitation-examination.

The evidence was interpreted and the following conclusions were reached:

a - Students are given insufficient concrete experiences upon which they could build abstract concepts.

b - Problem solving abilities and technique are not well developed in pupils.

c - The curriculum is loaded and not well organized.

d - Methods of student guidance and selection are lacking, and this results in a large percentage of misplaced pupils.

e - Failing students have significantly more difficulties in mathematics;

f - The official examinations are of a narrow type, and chance is permitted to be a large factor in a pupil's success on the official examinations.

g - Means of motivating pupils were undeveloped.

This study is by no means complete in its scope. While the research work was devoted to identifying the causes of failures in physics, it was felt that several concomitant aspects of the problem require separate study. Among them the following aspects are deemed particularly worthy of further investigation: (a) to what extent do personal factors such as health, intelligence, and attitudes influence failure ? (b) to what extent are the official physics examinations valid ? and (c) what methods can be recommended for use in existing schools in Lebanon to improve the teaching of physics and thus reduce the incidence of failure ?

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

PURPOSE AND SCOPE OF THE STUDY

I. THE PROBLEM

Physics courses form an integral part of every type of secondary school curriculum in Lebanon. Any difficulty in this field affects directly a large part of the student body and deserves, therefore, careful consideration and study. Indeed, personal teaching experience and general opinion of teachers do indicate that there is a large percentage of failure among the students who take physics courses in the secondary schools of Lebanon. If failures in physics do not account for the largest number of failures in secondary school courses, it may be said with confidence that they contribute a major part of the total number of failures.

This problem manifests itself in the results of the Lebanese Baccalauréat examinations, par I, and in the work of the Freshman physics classes of the American University of Beirut. The situation in the Freshman class is of such immediate concern to secondary education that it was deemed desirable to include it in the present study.

The purposes of this study are:

a) to discover the extent of physics failure;

b) to help determine the causes of the problem;

c) to reveal whatever further investigations are needed.

II. IMPORTANCE OF THE PROBLEM

As a science physics has played an important and dynamic part in the birth and development of the present scientific age. It is the essential foundation course for all potential workers in the fields of science, engineering and technology. The improvement of the teaching of science and of physics in particular has become one of the most critical problems in education today.[1] Any difficulty in this field is a serious

1. Bureau of Secondary Curriculum Development, Physics Handbook, New York State Education Department, (Albany, 1956), p. (5).

challenge to those responsible for education. The youth of the country are living in an age shaped by science. In the words of Elbert P. Little: "Modern man, whether he is aware of it or not, lives out his life in constant association with the methods of scientific research and the consequences of scientific research.[2]

2. From These Beginnings, The Science Teacher, XXIV, (November, 1957), p. 316 A.

The problem of failure in secondary school physics in Lebanon has at least a few grave consequences. It is causing psychological and intellectual distortion and suffering among the students. They are not only suffering the consequences of frustration, but their time is lost in work and effort without satisfactory results. The energy of the nation as a whole is affected. It has, indeed, become a chronic situation.

It is hoped that this study may accomplish two things: (a) discover the prevailing conditions in the teaching procedures, in the physics curriculum, in the equipment, and in the interests of students, which give rise to this problem; and (b) serve to some extent to improve the educational situation by helping those connected with the problem to remove the basic causes and thus helping students to realize the objectives of the physics program without the present high rate of failure.

III. DELIMITATIONS

1. This research is concerned with the specialized physics courses only.

2. The classes considered are those up to and including Baccalauréat I (scientific) and the Freshman Science.

3. The study was confined primarily to boys schools. A few coeducational classes were included.

IV. DEFINITION OF TERMS

1. "Secondary school physics," i.e., the physics given in classes up to and including Baccalauréat I and Freshman classes.

2. "Baccalauréat", i.e., the first part of the Lebanese Baccalauréat. This examination is given at the end of six years of secondary education.

3. "Latin type schools", i.e., schools which have an organization and a curriculum similar to French type schools.

4. "Anglo-American type schools," i.e.; schools which are based on American or English type schools.

5. "Significant at the 1 % and the 5 % levels." A result at the 1 % level means that the difference or disproportion in question could not have arisen by chance sampling from a population where the difference or disproportion is actually nil, except once in 100 such samples. If the 5 % level is indicated, one such sample out of 20 might be expected to show the same difference or disproportion when only chance is operating.

CHAPTER II

RELATED STUDIES AND RESEARCH

Studies in Lebanon. Research is entirely lacking in this field and no publications have been found except some articles in a few periodicals and papers.[3] These deal

3. Lucien, George, 90 % des candidats-bacheliers ont échoué. Pourquoi ? L'Orient, N°- 9201, October 16, 1956, p. 4.

mainly with the very high overall percentage of failure in the official examinations and some attempts at diagnosing the causes. However, educators and teachers of physics are aware of the high percentage of failure in physics. They make this fact known in their meetings and discussions.

Research in this field in the United States. Although it seems there has been very little research which deals specifically with this problem,[4] yet there are a few studies very

4. Personal communication from George G. Mallinson, ed., School Science and Mathematics, March 19, 1958: from Professor Paul DeH. Hurd, March 21, 1958: from Frank W. Hubbard, Secretary-Treasurer, American Educational Research Association, March 19, 1958. See Appendix B.

much related to it. Failure in physics in the United States takes another form also - in 1950, less than 6 per cent of high school students were enrolled in physics classes, compared to 15 per cent in biology and 7 per cent in chemistry.[5]

5. Hurd, Paul DeH., "The Case against High School Physics", School Science and Mathematics, LIII, (1953), p. 439. See also: Heiss, Elwood D., et al., Modern Science Teaching, (New York, The MacMillan Co., 1950), p. 17.

A few investigations will be mentioned here to show facts pertinent to this study.

Maurice Finkel states that during the spring of 1956, a survey was instituted in an attempt to discover why more high school students were not interested in entering a science career.[6] Certainly, physics is one of these science careers.

6. Finkel, Maurice, "A Science Career: How the High School Affects the Choice," The Bulletin, XLI, (September, 1957), p. 45.

The findings as stated by the author are the following:

> As a result of personal contact with many principals, in addition to the information provided by the questionnaires, it appeared that a large proportion of them: (a) were not too well informed in regard to the nation's need for personnel trained in science; (b) were more interested in keeping poorly qualified students out of science areas than in guiding potential scientists into the field; and (c) were apparently quite blind to the academic inadequacies of their science teachers as well as to the inadequate science teaching situations that were due to overcrowded laboratories, old science texts, and the lack of supplementary science activities.
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> . . . .
>
> The questionnaires returned by the science teachers revealed an interesting situation. There was evidence indicating that a large proportion of them: (a) carried at

least two periods of supervisory duties each day; (b) were in many cases teaching non-science subjects; and (c) were often teaching a science in which they had not specialized and, in many cases, had not even an undergraduate minor. Few of these teachers had taken any graduate work in either their teaching field or in any related science or mathematics. However, most of them had taken some graduate study in professional education. Most of them did not provide formal laboratory periods along with their regular class instruction.

. . . .

A large majority of the high-school students who participated in this survey were well aware of the: (a) inadequate facilities, space, and time spent in the laboratories; (b) and of the need for more supplementary science activities and for modern science texts. The better science students complained that they were constantly retarded by the slow pace set by the teacher for the mediocre student. Many of these students recognized the academic unpreparedness of their teachers.[7]

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7. Finkel, Maurice, Pages 45-46.

Further on, Finkel concludes that apparently a large proportion of all students have a natural interest in science, but some place along their school career this interest is dampened and that the problem may be not just to interest students in science but to keep their native interest in this area alive.[8]

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8. Finkel, Maurice, p. 46.

In another study, Paul DeH. Hurd gives data which show that although the influence of physics has grown in the world of science for the past 50 years, yet the per cent of students in high school physics classes has dropped consistently. He says that science teachers have not been unaware of the enrollment problem in physics and that much has been written to suggest improving the situation. In order to ascertain the major factors and course of events that have led to the decline of physics, he made a sequential analysis of pertinent committee reports on physics teaching for the last half century.[9] He ends his survey with the following conclusion:

9. Hurd, Paul DeH., "The Case against High School Physics," School Science and Mathematics, LIII, (June, 1953), pp. 439-40.

> A review of the data seems to indicate that physics with its traditional objectives, organization and content has lost its place as a high school subject. It does not fit into either the high school or the college pattern of modern education. Over fifty years of continuous emphasis upon the need to make high school physics more functional in terms of the everyday life of the learner has been largely ignored by those responsible for elementary physics courses. The educational thinking which foreshadowed the decline of physics has at the same time defined the science course to replace it. Although the content of this new course is somewhat vague, its point of view and objectives are clear.[10]

10. Hurd, p. 449.

Paul DeH. Hurd has also pointed out that many feel that the large percentage of failure in high school physics is due to the old fashioned content of physics courses and the general lack of modern applications all of which serve to dull the interest of students and to create the feeling that the course is not worth while.[11] He writes:

11. Personal communication, March 21, 1958. See Appendix B.

> The outstanding physicists of the United States have become concerned with this problem... and have developed a new kind of physics course which (it is felt) will help to solve the problem... There is a growing feeling in the United States that probably not more than twenty-five to thirty per cent of the high school students will ever be capable of handling a course in physics successfully.
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> Most of the articles regarding failure in physics courses point out that the failure is due to a lack of a sound background in mathematics. In fact, many (United States) college scientists would rather a student took an extra year of mathematics in high school if he is going on to college rather than to take high school physics.[12]

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12. Personal communication from Professor Paul DeH. Hurd, March 21, 1958. See Appendix B.

Some of the studies mentioned in the Forty-Sixth Yearbook of the National Society for the Study of Education contain findings relevant to the present study.[13] It was found

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13. Henry, Nelson B., ed., The Forty-Sixth Yearbook of the National Society for the Study of Education, (Chicago, University of Chicago Press, 1947), I, pp. 211-212.

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that a large proportion of students memorize physics concepts and only a few understand; that pupils often could recall the formulas and work out the answers to problems and still not understand the principle involved; and that ability to recognize the mathematical concepts is just as closely correlated with success in physics as is mathematical ability, itself.

A major study, which is not completed yet, is that of the Physical Science Study Committee - organized in 1956, under a grant from the National Science Foundation, and administered by the Department of Sponsored Research of the Massachusetts Institute of Technology. The effort of this Committee is directed towards saving the standard high school physics course from the critical situation into which it has fallen. The specific aims of this study as quoted by Francis L. Friedman in an article, A Blueprint, are the following: "(1) To plan a course of study in which major developments of physics, up to the present time, are presented in a logical and integrated whole; (2) to represent physics as an intellectual and cultural persuit which is part of present-day human activity and achievement; and (3) to assist physics teachers, by means of various teaching aids, to carry out the proposed program."[14]

14. The Science Teacher, XXIV, (November, 1957), p. 320 A.

It is hoped that by such a curriculum physics would become more interesting to students, enrolment would increase and consequently the supply of scientists would be enriched. Meanwhile, it would help the student, not going to college, to adapt himself better to this scientific age.

Study in this field in France. The present investigation could not identify any study in France which deals specifically with the problem of failure in physics. The matter was referred to Institut Pédagogique National in Paris. The absence of such a research was confirmed by the latter institution.[15]

15. See Appendix B.

Research in this field in England. The available research literature from the United Kingdom contained no study of direct concern with the present investigation. However, information coming from the National Foundation for Educational Research in England and Wales, states that a study is currently being carried out in that country which may be relevant to this subject. The study is entitled. "Failures of students at the university in relation to Higher School Certificate and General Certificate of Education results."

16. See Appendix B.

Related research. W.L. Summer reports that five main causes of failure in arithmetic were decided on by the Nottingham, England, University Department of Education after an analysis of the work of 30.000 children. (1) Mechanical processes had not been learned. (2) Statements were not set down correctly; figures were badly made and not recognized even by children who had made them. (3) The content and method of mathematical work had changed little in the last 40 years so that problems set were very unrealistic. (5) The achievement tests set in many selection examinations led to stereotyped work in primary schools.[17]

17. The Perennial Problem, The Education Digest, XXII, (September, 1956), p. 35.

In the United States, Curtis studied the number and types of mathematical terms needed to explain principles of physics. Smith and Washton point out that her findings were as follows: "The study suggested that students were required to have a knowledge of arithmetic, simple algebra, geometry, and the fundamentals of trigonometry in order to understand high-school physics textbooks. The greatest amount of mathematics was needed in the study of mechanics and the least in the study of atomic energy."[18]

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18. Review of Educational Research, XXVII, (October, 1957), p. 350.

Billingslea, Bloom, Perkins, Michael and others made several studies in the emotional aspects of learning that appear to have direct bearing on mathematics and science education. Summarizing the implications of these studies, Donovan A. Johnson points out:

> These studies suggest that the science and mathematics teacher must meet the social and emotional needs of students if he expects maximum achievement. The anxious student makes many errors, has difficulty in learning complex material, produces little work, and is distracted in problem analysis. The classroom with a learning climate that takes into account the needs of the student encourages superior learning of concepts, better attitudes, better reasoning skill, more participation in discussion, and fewer drop-outs. On the other hand there is some evidence that anxiety may stimulate easy learning. This suggests that complete adjustment or lack of anxiety may mean a low level of motivation for learning. The key to the whole problem appears to be the learning climate established by the teacher.[19]

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19. Review of Educational Research, XXVII, (October, 1957), p. 405.

Conclusion. The teaching of sciences in the secondary schools in Lebanon is based to a very large extent on the method and content of science teaching in the schools of France, England and the United States. Consequently, some of the findings of the present study may be expected to be quite in agreement with the conclusions of the foregoing studies.

CHAPTER III

METHOD AND PROCEDURE

I. THE METHOD OF RESEARCH

The present study involved the development of several methods of collecting evidence on the problem, namely: (a) the administration of a questionnaire to students; (b) the administration of a questionnaire to physics teachers and an interview with them; (c) the analysis of corrected examination papers; (d) the study of Baccalauréat as well as school examination questions; and (e) observation in the field. To the results of the questionnaires and the content analysis it was possible to give a statistical treatment.

Student questionnaire. The questionnaire was intended to collect information on the following items: (1) choice of course; (2) interest in physics; (3) loss of interest; (4) experimental demonstration; (5) laboratory work; (6) mathematical background; (7) difficulty of the subject; (8) method of study; (9) student-teacher relation; (10) attitude to the course; and (11) students' own opinion on the problem. A sample of the questionnaire is included in Appendix A. The reader can easily get an opinion about the particular form of each question. This questionnaire was composed in English and in

French. It was conducted by the investigator himself or the students' teacher of physics. Sometimes the help of another teacher was needed. In all cases, however, the purpose of the investigation was explained to the respondents and the procedure of checking their answers made clear. They were encouraged to express their opinions freely. Recording of name was left optional.

Teacher questionnaire. Here, too, information about the following topics was required: (1) personal data; (2) interest of students in the physics course; (3) the physics curriculum; (4) experimental demonstration; (5) laboratory work; (6) method of teaching; (7) attitude to the course; (8) difficulty of the subject; (9) problem solving; (10) teaching load; (11) evaluation and examination questions; and (12) teachers' own opinion on the problem. A sample of this questionnaire is included in Appendix A. It was, also, composed in English and in French. Very often the investigator had to get an interview with each teacher, discuss the problem with him and ask him to fill in the questionnaire.

Content analysis. A convenient sample of corrected physics examination papers was taken from several schools. After careful study, the mistakes of students, as marked by the teacher himself, were grouped into definite categories. Then the frequency of each kind of mistake was checked against the category into which it fell. Finally the data were treated statistically to discover significant biases in them.

Similarly, samples of the Lebanese Baccalauréat examinations as well as those of individual schools were investigated and analyzed to determine the types, and structures of the questions.

Statistical treatment of the evidence. In general the percentage of a particular datum was used as first evidence of its significance. The results of the analysis of the questionnaires, the corrected examination papers, and the examination questions were studied first on this basis. Whenever opinion could be paired into "agree" and "disagree" the "sign test" was used to indicate the significance of its deviation from the null hypothesis. For example, in the case of question 13 a of the student questionnaire or question 7 of the teacher questionnaire and all similar ones, any opinion mark to the left of the "no opinion" point was considered as "disagree" and any opinion mark to the right of the "no opinion" point was taken as "agree". The sum of the frequencies were compared to a table of critical values of *r* published by Dixon and Massey.[20] The letter *r* denotes the number of times the

20. Dixon, Wilfrid J. and Massey, Frank J., Jr. *Introduction to Statistical Analysis*, (New York, McGraw-Hill Book Co., 1951), Appendix, Table 10, p. 334.

less frequent sign, i.e.; opinion, occurs. For large values of N, i.e. number of cases in a sample, the table of values of *r* was extended using the formula

$$r = (N-1)/2 - k\sqrt{N+1}$$

where k is equal to 1.2879 and 0.9800 for the 1 % and 5 % levels of significance respectively.[21]

21. For more information on this test, see, Ibid., pp. 247-252.

The student body that turned in the questionnaire was classified into two groups: (a) those who were passing in physics; and (b) those who were failing in physics. A separate statistic was made for each group. To find if the responses of the two groups were significantly different from each other to any of the questions asked, the "chi-square", test was applied.[22] A similar treatment was given to the categories of mistakes in the sample of corrected examination papers.

22. For details of this test, see, Ibid., pp. 184-189, and, Walker, Helen M. and Lev, Joseph, Statistical Inference, (New York, Henry Holt and Co., 1953), pp. 81-103.

Observation in the field. Direct observation was confined to classes, laboratories and textbooks. Everyone of the schools in the sample studied was visited by the investigator more than once. Some physics classes were attended and observed in actual session. Laboratories were visited whereever they existed. The use of physics books was studied mainly with the purpose of determining the type, and the suitability of each one.

II. THE NATURE OF THE SAMPLE

The Schools. There were seventy-eight secondary schools for boys in Lebanon at the time this investigation was started. A list of these institutions was obtained from the Ministry of Education. The sample was chosen by four professors of the Education Department of the American University of Beirut and the Inspector General of Secondary Education at the Ministry of Education. Finally, a convenient majority of schools was taken up by the investigator as a representative sample. These schools can be grouped into two major types: (a) Anglo-American type of schools, and (b) Latin type of schools. The institutions which ultimately participated in the present study, were the following:

Anglo-American Type Schools: Total 15 schools

1. American University of Beirut - Freshman Science Class
2. International College - Preparatory Section
3. National Protestant College, Beirut
4. Broummana High School, Broummana
5. Souk-el-Gharb National College, Souk-el-Gharb
6. Shweir High School, Dhour el-Shweir
7. Shweifat National College, Shweifat
8. A.G.B.U. Hovagemian-Manougian School, Beirut
9. British Syrian Training Mission School, Beirut

10. Makassed al-Islamieh College, Beirut
11. Gerard Institude, Saida
12. Tripoli College, Tripoli
13. Armenian Evangelical College, Beirut
14. Zahleh Evangelical High School, Zahleh
15. Daoudiah College, Abey

Latin Type Schools: Total 8 Schools

1. Collège Oriental, Zahleh
2. Al-Amilieh College, Beirut
3. International College - Section Secondaire, Beirut
4. Tariq al-Jadideh Official School, Beirut
5. Zahleh Official School, Zahleh
6. Collège de la Sagesse, Beirut
7. Collège Arménien, Beirut
8. Collège des Trois Docteurs, Beirut

The students. The sample of students were conveniently chosen from among the students of the fourth, fifth and sixth years in Anglo-American type schools. Either the whole or sections of each class were taken. Similarly students of the *troisième*, *seconde* and *première* classes, either the whole or sections of each class of the Latin type schools were chosen. In some institutions the upper classes were coeducational. Therefore, 59 girl students were included in this study. The distribution of students according to classes and schools is shown in Table I.

T A B L E I

STUDENT DISTRIBUTION IN THE SAMPLE

School	Number of Students 4th Year	5th Year	6th Year	Total
* 1. A.U.B. Freshman Physics 101	-	-	-	17
Freshman Physics 102	-	-	-	28
Freshman Physics 104	-	-	-	71
2. I.C.-Preparatory Section	-	79	34	113
3. National Protestant College	44	37	-	81
* 4. Broummana High School	-	27	21	48
* 5. Souk-el-Gharb National College	17	15	-	32
6. Shweir High School	-	10	5	15
* 7. Shweifat National College	32	-	18	50
8. A.G.B.U. Boys School	17	14	-	31
9. British Syrian Mission School	-	21	8	29
10. Makassed al-Islamiah College	19	36	20	75
11. Gerard Institute	-	32	23	55
*12. Tripoli College	9	15	15	39
*13. Armenian Evangelical College	-	29	17	46
*14. Zahleh Evangelical School	-	8	2	10
15. Daoudieh College	7	3	3	13

16. Collège Oriental	25	19	-	44
17. Al-Amilieh College	19	13	3	35
18. I.C.- Section Secondaire	-	23	28	51
19. Tariq al-Jadideh Official School	-	20	13	33
*20. Zahleh Official School	-	24	7	31
*21. Collège de la Sagesse	-	52	17	69
*22. Collège Arménien	-	6	10	16
23. Collège des Trois Docteurs	-	14	-	14
Total	189	497	244	1046

* The sample includes girl students.

The Teachers. The sample, a total of 30 teachers, was a convenient sample because it was made up of those who were teaching physics mainly in the schools where the student questionnaire was conducted. Eighty one per cent of these teachers had an academic degree equivalent to a B.A. or higher. Only 27 % of the sample was teaching in Latin type schools. The mean of teaching experience was 9.5 years and 53 % of the sample had an experience of more than five years. Besides the sample, a few teachers expressed their opinions to the investigator without giving a written statement.

The examination papers. The sample of corrected physics examination papers was made up from available term or final examinations, given during the academic years 1956-57 and 1957-58. There were 659 papers from Anglo-American type schools and 132 Baccalauréat papers. The distribution of these papers according to schools and classes are shown in Table II.

TABLE II

DISTRIBUTION OF EXAMINATION PAPERS

1. A.U.B. Freshman Science	
Physics 101, February, 1957	139 papers
Physics 102, June, 1957	96 "
Physics 104, June, 1957	79 "
2. National Protestant College	
Fifth Secondary Class, June, 1957	32 "

Fifth Secondary Class, February, 1957	39 papers
Fourth Secondary Class, February, 1957	45 "
3. Souk-el-Gharb National College	
Fifth Secondary Class, March, 1957	24 "
Fourth Secondary Class, March, 1957	23 "
Third Secondary Class, March, 1957	36 "
4. Makassed al-Islamieh College	
Fourth Secondary Class, June, 1957	45 "
5. Broummana High School	
Sixth Secondary Class, June, 1957	19 "
Fifth Secondary Class, June, 1957	27 "
6. I.C., Preparatory School	
Sixth Secondary D, March, 1958	25 "
Fifth Secondary B, March, 1958	30 "
7. Zahleh Official School	
<u>Classe de 2 e</u>, April, 1957	25 "
8. Tariq al-Jadideh Official School	
<u>Classe de 2 e</u>, June, 1957	19 "
<u>Classe de 3 e</u>, June, 1957	24 "
9. A.G.B.U. Boys School	
Sixth Secondary, March, 1958	7 "
10. I.C., Preparatory School	
Sixth Secondary C, March, 1958	28 "
11. I.C., <u>Section Secondaire</u>	
<u>Classe de 1 e</u>, March, 1958	29 "
Total	791 papers

The examination questions. The sample consisted mainly of the official Baccalauréat physics questions given in Lebanon during the period 1948-57, and nineteen sets of term or final examinations taken from the following institutions: (1) American University of Beirut; (2) National Protestant College; (3) Souk-el-Gharb National College; (4) Makassed al-Islamieh College; (5) Broummana High School; (6) International College; and (7) A.G.B.U. Boys School. The Baccalauréat questions were taken from the annuals published by Vuibert.[23a]

23a. Vuibert, A., Annales du Baccalauréat, Sciences Physiques, Fascicule 1 bis, 10 vols., (Paris, Librairie Vuibert, 1948-57).

The physics textbooks. There are four categories of science textbooks in current use in Lebanon - French, English, American and Lebanese textbooks. Accordingly the sample used in the present study was also composed of these four types. It was made up of the following books.

A - Freshman Science textbooks

(1.) Sears, Francis Weston, and Mark W. Zemansky College Physics, Cambridge, Mass., 2 vols., (Addison-Wesley Publishing Co.), 1953. Used in the physics course 101-102.

(2.) White, Harvey E., Modern College Physics, New York, (D. Van Nostrand Co.), 1953. Used in the physics course 103-104 till 1957.

(3.) Durbin, Frank M., Introduction to Physics, Englewood Cliffs, (Prentice-Hall Inc.), 1955.

Used in the physics course 103-104.

B - American Textbooks

(4.) Dull, Charles E., et.al., Modern Physics, New York, (Henry Holt and Co.), 1955.

(5.) Millikan, Robert Andrews, and Henry Gordon Gale, New Elementary Physics, Boston, (Ginn and Company), 1944.

C - English Textbooks

(6.) Whiteley, W., General Physics, London, University Tutorial Press), 1957.

(7.) Shackel, R.G., Concise School Physics, London, (Longmans, Green and Co.), 1947.

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(13.) Une Réunion de Professeurs. Cours de Physique, Classe de Première C et M., (Librairie Générale de l'enseignement Libre), 1947.

(14.) Peschard, Marcel, and Georges Eve. Physique, Classe de Première C et Moderne, Paris, (Les Editions de l'Ecole), 1955.

E - Teacher's own textbook

(15.) Haddad, Yakub S.- Light and Electricity.

(16.) Bakhos, Jean, - Optique, Electrodynamique et Magnétisme.

III. THE NATURE OF THE EVIDENCE

As it was mentioned above, there were 78 secondary schools for boys at the time this study was started. The schools which ultimately participated in this investigation, a total of 23, may be considered as a representative cross-section of all types of schools in the country. A few institutions of the original sample were not included due to various factors such as disapproval of investigation, loss of the questionnaires, or lack of time. The result was a smaller group of Latin type schools. Some of the schools are typically Lebanese, while others are mission schools. Some were founded during the nineteenth century and have a long tradition behind them; a few are comparatively of recent date and are therefore in the process of adopting modern methods and traditions. These schools represent, also, the major denominations in Lebanon. It is worthy to note here that most of the secondary schools in this country are run by private institutions or by churches. The state had only four secondary schools for boys in 1956-57.

The student sample was drawn from the school sample described above. Either all or a large majority of the students in a class were given the questionnaire and asked to check their answers under the supervision of a teacher or the investigator himself. The variety and the number of students in the sample as a whole make it representative of the student body of the schools investigated.

The number of teachers in the sample is not large. However the sample was more representative than its size shows because there were a few teachers who taught in more than one school. On the other hand, the majority of the teachers were teaching in Anglo-American type schools and probably the results of the questionnaire were more indicative of the situation in this type of school than in all the secondary schools of Lebanon. Keeping this fact in mind, the writer tried to get the opinion of educators on the situation in Latin type schools, and these were given due consideration when interpreting the results of teacher questionnaire.

The student and the teacher questionnaires were composed mainly of direct or opinion testing questions. As such, their validity was maintained by their nature. However, to be sure of this validity requirement the questionnaires were read by several professors and teachers and their suggestions were taken into consideration. The student questionnaire was given a trial test on a group of students of the Preparatory Section of the International College and on another group in the A.G.B.U. Boys School. The French translation of these questionnaires were not as satisfactory as the original English text.

When these questionnaires were administered to students and teachers, several weak points became evident. The term <u>demonstration</u> in question five was not clear to students in Latin type schools. Some considered it to mean mathematical proof of a law or theory because they had rarely seen experimental demonstrations. Questions 12 and 13a, also, of the student questionnaire met difficulties. Some classes had taken only one or two branches of physics and knew very little about the rest. Principles and laws were declared to have been memorized rather than problems. So the inclusion of these three items in one question raised a problem with some students. Questions 1, 2 and 3 of the teachers' questionnaire had, similarly, to face a problem because the situation proved to vary from class to class.

In spite of such shortcomings as those mentioned above, it can be said that the validity of the questionnaire was based on the fact that the questions were designed to reveal whether recognized methods of good teaching were actually followed. As an example, it may be stated that some sort of experimental work or experimental demonstration is needed to let the student understand and digest physical concepts or principles. So they were asked whether they do experiments or observe closely demonstrations performed by the instructor. Where the returns showed that there was a grave omission in such methods of teaching, and a large number of failures, it could be inferred that the omission was in all probability at least partially responsible for student failures. Furthermore, the questionnaire was used over a period of at least four months. The responses of the students from various schools indicated a high degree of uniformity.

The opinion answers of the students were largely subjective in nature. However, the statistical analysis of the results made them objective. The content analysis of the mistakes in examinations was performed with strict attention to objectivity. In general the evidence can be considered to be objective because the analysis was done on basis of definite criteria. For example, to classify a student failing or passing in physics, his mark in the school records or in a major examination was taken as the decisive factor. Or, when identifying kinds of errors in an examination, only the markings of the teacher on the paper itself were taken as indications of mistakes, categories were made only for these teacher - indicated mistakes.

CHAPTER IV

RESULTS: A STATEMENT OF THE EVIDENCE

I. THE PERCENTAGE OF FAILURE IN PHYSICS

It was evident from the statistics made available by the Registrar of the American University of Beirut that the percentage of failure in the physics courses given to the Freshman class was large. The distribution of the lower two categories of grades in each course over a period of four years is shown in Table III. Courses numbered 101 and 102 are given to students who expect to continue their studies in the mathematical sciences or professions such as physics or engineering. Those who expect to continue in the non-mathematical sciences, such as biology, medicine or pharmacy take courses numbered 103 and 104. The per cent of failure is given per semester. A separate calculation made it possible to show the per cent for the year courses numbered 101-102 and 103-104. It may be seen from Table III that the per cent of failure in Physics 101-102 has a range of 31-37 while that of Physics 103-104 has a range of 17-29.

The results of the Lebanese Baccalauréat Examinations show, too, that the percentage of failure in physics is high. According to the statistics made available by the Ministry of Education, see Table IV, the per cent of students who took a grade of 10/20 or below during the period 1953-1957 had a range of 56-81. The investigator considered a grade of 10/20 as corresponding to the failing grade of less than 60/100 used in the Anglo-American type schools.

TABLE III

PERCENTAGE OF FAILURE IN THE PHYSICS COURSES OF THE FRESHMAN CLASS OF A.U.B., 1953-1957

School	Semester	Freshman Physics	No. of Grades Issued	% of students in D	% of students failed
1956-57	First	101	145	23	29
	"	103	118	24	29
	Second	102	101	29	11
	"	104	83	22	-
	Year	101-102	-	-	37
	"	103-104	-	-	29
1955-56	First	101	142	26	23
	"	103	76	35	12
	Second	102	111	30	12
	"	104	62	26	6
	Year	101-102	-	-	33
	"	103-104	-	-	17
1954-55	First	101	132	26	20
	"	103	97	29	14
	Second	102	104	26	14
	"	104	85	24	12
	Year	101-102	-	-	31
	"	103-104	-	-	25
1953-54	First	101	227	29	27
	Second	102	164	30	8
	Year	101-102	-	-	33

TABLE IV

PERCENTAGE OF FAILURE IN THE PHYSICS EXAMINATION OF THE BACCALAUREAT I, 1953-1957

Year	Number of Students	Number of Students in 10/20 or Below	% of Students Failed
1957	1596	1062	66
1956	1304	982	75
1955	949	725	76
1954	1082	881	81
1953	924	515	56

The sample of corrected examination papers was another source which revealed that the percentage of failure in physics is high. As shown in Table VI, page 61 , there were 265 failing and 394 passing papers in the Anglo-American type group. This gives a failure of 40.2 % among the students. Similarly as shown in the same table, there were 44 failing and 88 passing papers in the Baccalauréat group. This gives a percentage of 33.3 %. Indeed, the percentage of failure in the whole sample is 39 %.

Among the students who answered the questionnaire, a total of 1046 students, there were 332 who were failing in physics. This number makes up 31 % of the sample. Here is another indication that the per cent of failure in physics is high and agrees quite well with the other sources mentioned above.

II. THE RESPONSES OF STUDENTS

The student questionnaire was formulated with the purpose of obtaining from the students information regarding various aspects of the problem. These aspects were mentioned in Section I of Chapter III. For reference purposes the responses of the students are stated here in the order of the items which appeared in the questionnaire text. The students were classified into two groups, those who were passing and those who were failing in physics. Herein they are called "Pass Group" and "Fail Group" respectively.

Question 1. Indicate the reason why you are taking physics.

	Pass Group		Fail Group	
	Freq.	%	Freq.	%
a) I have chosen it	249	33	78	23
b) It is required	462	60	238	70
c) I don't know	30	4	18	5
d) Other reasons	23	3	5	2

Results: It seems that a significant proportion of both the pass and the fail group takes physics because it is required.

Question 2. Do the subjects discussed in physics attract your interest to know about them ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) No	61	9	81	25
b) Yes	634	91	242	75

Results: (A) The pass group contains a significant greater proportion of those who declare to have an interest in the physics subjects.[23]

(B) A significant proportion of both the pass and the fail group claims to have an interest in the physics subjects.[23]

Question 3. Does your interest to learn physics (a) continue or (b) do you lose interest ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) Continue	543	79	159	52
b) Lose interest	147	21	144	48

Results: (A) The pass group contains a significantly greater proportion of those who claim to have a continuing interest in physics.[23]

(B) A significant proportion of the pass group claims to have a continuing interest in physics.[23] The proportion in the fail group is not significantly different from 0.5.

Question 4. If you began to learn physics with interest and then lost this interest, what were the reasons ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) Language difficulty	66	14	54	19
b) Course too abstract	82	18	79	27
c) No practical application	171	36	89	31
d) No experimental demonstration	110	23	43	15
e) Other reasons	43	9	22	8

Results: (A) A significant proportion of the pass group claims to lose interest because of the lack of practical application and experimental demonstration.[23]

23. At the 0.01 level.

(B) A significant proportion of the fail group claims to lose interest because of the lack of practical application, course being too abstract, and having language difficulty.[23]

Question 5. How much demonstration does the teacher give you ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) None at all	64	9	28	9
b) For a few topics	273	39	136	43
c) For most topics	244	35	109	35
d) For each topic	107	15	29	9
e) No opinion	18	2	14	4

Results: It seems that a significant proportion of both the pass and the fail group has demonstrations for a few topics or for most topics.

Question 6. If the teacher gives demonstration, is it (a) before the discussion, (b) as an introduction, or (c) after the discussion ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) Before the discussion	147	24	53	19
b) As an introduction	83	13	49	17
c) After the discussion	391	63	183	64

Results: (A) A significant proportion of the pass group claims teachers give demonstrations after the discussion.[23]

(B) A significant proportion of the fail group claims, too, teachers give demonstrations after the discussion.[23]

Question 7. Do you do laboratory work ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) No	333	47	159	51

23. At the 0.01 level.

b) Yes	375	53	152	49

Results: The proportion in the pass group or in the fail group is not significantly different from 0.5.

Question 8. If you do laboratory work check any one of the following:

	Pass Group Freq.	%	Fail Group Freq.	%
a) I really enjoy it	224	39	64	24
b) It helps me to understand the topic	290	51	152	58
c) I am not interested it is required	37	7	25	10
d) I do not understand it often	20	3	21	8

Results: (A) It seems that a significant proportion of the pass group claims to enjoy laboratory work and get help for understanding physics.

(B) It seems that a significant proportion of the fail group claims, also, to enjoy laboratory work and get help for understanding physics.

Question 9a. Do you find difficulties with mathematics and the solution of numerical problems ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) No	413	59	93	29
b) Yes	290	41	229	71

Results: (A) A significant proportion of the pass group claims to have no difficulty in mathematics.[23]

(B) A significant proportion of the fail group claims to have difficulty in mathematics.[23]

Question 9b. If you do find difficulties show in which aspect of the problem.

	Pass Group Freq.	%	Fail Group Freq.	%

23. At the 0.01 level.

a) Arithmetical computation	88	15	34	9
b) Algebraic formulas	81	13	71	18
c) Geometry or trigonometry	116	19	88	23
d) Higher mathematics	75	12	59	15
e) Units	124	20	55	14
f) Understanding	126	21	84	21

Results: (A) A significant proportion of the pass group indicates having difficulty in units and understanding.[23]
(B) A significant proportion of the fail group indicates having difficulty in geometry or trigonometry and understanding.[23]

Question 10. The numerical problems teachers give are:

	Pass Group Freq.	%	Fail Group Freq.	%
a) Too many	153	22	68	21
b) Very few	65	9	30	9
c) A fair amount	492	69	227	70

Results: It seems that a significant proportion of both the pass and the fail group claims a fair amount of problems are given.

Question 11. a) Are the problems interesting ? b) Do they relate to practical experience ? c) Are they drill without practical interest ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) Problems interesting	467	51	158	42
b) Related to experience	315	35	119	31
c) Drill without interest	130	14	101	27

Results: It seems that a significant proportion of both the pass and the fail group considers the given problems to be interesting.

23. At the 0.01 level.

Question 12. Put a mark (✓) beside the branch of physics which you think is most difficult.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Mechanics	253	37	136	42
b) Heat	52	8	34	10
c) Sound	66	10	29	9
d) Light	65	10	31	10
e) Magnetism and Electricity	148	22	63	19
f) Modern Physics	51	7	20	6
g) Laboratory Work	41	6	12	4

Results: (A) A significant proportion of the pass group claims mechanics, magnetism and electricity to be the most difficult branches of physics.[23]

(B) A significant proportion of the fail group claims, too, mechanics, magnetism and electricity to be the most difficult branches of physics.[23]

Question 13a. Students often memorize principles, laws, or problems of physics.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Disagree	328	52	142	49
b) Agree	307	48	145	51

Results: The proportions in the pass group or in the fail group are not significantly different from 0.5.

Question 13b. This memorization does not mean necessarily that students understand them.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Disagree	204	32	103	36
b) Agree	426	68	180	64

23. At the 0.01 level.

Results: A significant proportion both of the pass group and the fail group thinks that memorization does not mean understanding.

Question 14. Students are given very little opportunity in physics courses to observe physical events or phenomena, instruments, or machines.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Disagree	184	31	74	29
b) Agree	404	69	183	71

Results: A significant proportion of both the pass and the fail group claims students are given little opportunity of direct observation.[23]

Question 15. When a pupil fails in a physics exam most teachers discuss the matter with him and try to encourage him.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Disagree	238	42	145	52
b) Agree	335	58	136	48

Results: (A) A significant proportion of the pass group claims that teachers discuss exam results and encourage students.[23]

(B) The proportion in the fail group is not significantly different from 0.5.

Question 16. Students feel afraid of a physics course before they take it.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Disagree	288	48	111	41
b) Agree	309	52	157	59

Results: (A) The proportion in the pass group is not significantly different from 0.5.

(B) A significant proportion of the fail group

23. At the 0.01 level.

claims to be afraid of physics courses before taking it.[23]

Question 17. Students spend more time to study and prepare physics than any other lesson.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Disagree	283	48	100	38
b) Agree	310	52	167	62

Results: (A) The proportions in the pass group is not significantly different from 0.5.

(B) The fail group contains a significantly greater proportion of those who claim to spend more time to study physics.[23]

Question 18. With whom do you study your physics lesson ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) With one or more friends	90	12	75	21
b) Alone	603	81	248	70
c) With the help of a teacher	50	7	34	9
d) Others	2	-	-	-

Results: It seems that a significant proportion of both the pass and the fail group studies physics alone.

Question 19. Besides your textbook do you read books or articles pertaining to physics ?

	Pass Group Freq.	%	Fail Group Freq.	%
a) Yes	280	40	86	27
b) No	424	60	231	73

Results: (A) A significant proportion of the pass group claims to read no books or articles besides the physics textbooks.

(B) The fail group contains a significantly greater proportion of those who claim to read no books or ar-

23. At the 0.01 level.

ticles besides the physics textbook.[23]

Question 20. Estimate your ability in physics.

	Pass Group Freq.	%	Fail Group Freq.	%
a) Unsatisfactory	7	1	16	5
b) Weak	24	4	98	31
c) Average	249	35	140	44
d) Good	362	51	58	18
e) Excellent	62	9	7	2

Results: (A) It seems that a significant proportion of the pass group claims to be good in physics.
(B) It seems that a significant proportion of the fail group claims to be average in physics.

Question 21. If you have other remarks on the subject of physics with regard to original lack of interest, or loss of interest, or cause of failure, write them briefly in your own words.

Categories of Causes of Failure mentioned by some students were:	Pass Group Freq.	%	Fail Group Freq.	%
1. Laziness; not working hard	7	3	4	3
2. Teacher not explaining according to ability of students	9	3	7	4
3. Teacher not understanding student; no give and take	9	3	10	6
4. Teacher lacks a good knowledge of physics	17	6	6	4
5. No laboratory work, no practical application or interpretation	35	13	18	12
6. Method of teaching	43	16	14	9
7. Teacher not investigating causes of failure	5	2	3	2

23. At the 0.01 level.

8. Questions made for bright students, hard problems	1	0,5	4	3
9. Background	7	3	14	9
10. Carelessness	1	0,5	2	1
11. Poorly constructed examinations	4	2	2	1
12. Mechanical work; memorization and not understanding	12	5	5	3
13. Physics curriculum; division of subjects; short time for the course; not enough practice	33	13	10	6
14. Fear and strain	7	3	7	4
15. Disappointment	6	2	8	5
16. Subject hard and abstract	22	8	15	10
17. No interest in physics	17	6	24	15
18. Textbook not interesting; not satisfactory	18	7	1	1
19. Language difficulty	4	2	2	1
20. No guidance	5	2	1	1
Totals	262	100	157	100

Results: (A) Significant proportions of the pass group claim failure in physics to be due to: (a) method of teaching; (b) lack of laboratory work and practical interpretation; and (c) the physics curriculum.[23]

(B) Significant proportions of the fail group claim failure in physics to be due to: (a) lack of laboratory work and practical interpretation; (b) lack of interest; and (c) the subject being hard and abstract.[23]

23. At the 0.01 level.

Summary of the Students' Responses

The following responses of the students were found to be significant:

1. Physics is a required course in the curriculum of the secondary schools in Lebanon.

2. At least 75 % of the students claim to be interested in the topics studied in physics. A significant proportion of the pass group continue to be interested in physics. Loss of interest is ~~to be~~ due mainly to lack of experimental work.

3. Probably 60 % of the times experimental demonstrations are given after the discussion of a topic.

4. Eighty per cent of the students declare that laboratory work helps them to understand physics better.

5. A very significant proportion of failing students have difficulty in mathematics.

6. Mechanics, magnetism and electricity are the most abstract and difficult branches of physics according to the students.

7. It seems students resort to memorization. A significant proportion is aware of the fact that this does not mean understanding.

8. About 70 % of the students say that they are given very little chance to observe physical phenomena and apparatus.

9. There is some indication that failing students get little attention from the teacher after examinations. However there is strong evidence that this same group felt afraid of physics before taking the course.

10. A significant proportion of the students say that they do little reading outside their textbooks.

11. Students declare that the causes of failure are mainly **five** factors:

(a) Method of teaching;

(b) Lack of sufficient laboratory work and practical experience;

(c) Heavy physics curriculum in particular and loaded school curriculum in general;

(d) Subject hard and abstract;

(e) Lack of interest in physics.

III. THE RESPONSES OF TEACHERS

The questionnaire submitted to physics teachers collected evidence on various aspects of the problem of failure. The types of information demanded were stated in Section I of Chapter III. The results of their responses are shown in this section and a sample of the questionnaire is included in Appendix A for comparison purposes.

Question 1. Are your students interested in physics ?

	Frequency	%
a) Only a few	11	33
b) The majority	22	67

Results: The proportion in the responses is not significantly different from 0.5.

Question 2. To what do you attribute lack of interest ?

Categories of Causes	Frequency	%
a) Carelessness; wasting of time	5	9
b) Method of teaching	5	9
c) Lack of maturity; no aptitude	10	19
d) Original lack of interest	6	12
e) Failing to grasp practical applications	5	9
f) Low-earning possibilities in physics	2	4
g) Background of mathematics and language	12	23
h) Books	2	4

i) Subject and program difficult	5	9
j) No experimental work	1	2

Results: A significant proportion of the teachers claims that students are not interested in physics because of their background in mathematics and language, lack of maturity and original lack of interest.[24]

Question 3. Is the physics curriculum suitable to the ability of the students ?

	Frequency	%
a) Difficult to majority	6	20
b) Suitable to majority	25	80

Results: A significant proportion of the teachers claims that the curriculum is suitable to the majority of students.[23]

Question 4. Do you consider the available text-books suitable ?

	Frequency	%
a) Unsuitable	10	32
b) Suitable	21	68

Results: The proportion in the responses is not significantly different from 0.5.

Question 5. To what extent do you give demonstrations as a basic introduction to each topic ?

	Frequency	%
a) None at all	2	7
b) Less than some topics	8	26
c) More than some topics	14	47
d) Each topic	6	20

Results: It seems that a significant proportion of the teachers give demonstrations to some topics.

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23. At the 0.01 level.
24. At the 0.05 level.

Question 6. Do you give laboratory work to your students ?

	Frequency	%
a) No	3	9
b) Rarely	4	13
c) Sometimes	9	28
d) Yes	16	50

Results: A significant proportion of the teachers claims to give laboratory work to students.[24]

Question 7. Class sizes in physics are so large that teachers find it most difficult to pay attention to every pupil.

	Frequency	%
a) Disagree	11	34
b) Agree	21	66

Results: The proportion in the responses is not significantly different from 0.5.

Question 8. Do you give individual attention to weak students ?

	Frequency	%
a) Rarely	10	31
b) Less than sometimes	6	19
c) More than sometimes	11	34
d) Always	5	16

Results: It seems that a significant proportion in the teachers sometimes give attention to students.

Question 9. Do you give individual attention to students in laboratory work and discuss with them what they are doing and whether they understand what they are doing ?

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24. At the 0.05 level.

	Frequency	%
a) No	6	22
b) Yes	21	78

Results: A significant proportion of the teachers indicates that individual attention is given to students in the laboratory.[23]

Question 10. Teachers of physics often do not check with the students to make sure that they have understood the fundamentals which are necessary prerequisites to further understanding.

	Frequency	%
a) Disagree	10	43
b) Agree	13	57

Results: The proportion in the responses is not significantly different from 0.5.

Question 11. On what do you lay stress when deriving the laws of physics ?

	Frequency	%
a) Mathematical derivation	25	53
b) Experimental derivation	22	47

Results: The proportion in the responses is not significantly different from 0.5.

Question 12. What do you think are the usual mistakes of students in solving problems of physics ?

	Frequency	%
a) Mathematics	14	26
b) Units	14	26
c) Understanding	21	40
d) Other reasons	4	8

23. At the 0.01 level.

Results: A significant proportion of the teachers declares that students make mistakes of understanding in solving problems.[24]

Question 13. In the physics courses students very often face language difficulties.

	Frequency	%
a) Disagree	15	45
b) Agree	18	55

Results: The results in the responses is not significantly different from 0.5.

Question 14a. Pupils in physics classes tend to memorize statements, illustrations and laws as these are presented in their textbooks or notes.

	Frequency	%
a) Disagree	7	20
b) Agree	27	80

Results: A significant proportion of the teachers claims that students resort to memorization.[23]

Question 14b. This memorization does not imply understanding.

	Frequency	%
a) Disagree	8	28
b) Agree	21	72

Results: A significant proportion of the teachers indicates that memorization does not imply understanding.[24]

Question 15. Teachers of physics are required to teach too much physics.

	Frequency	%
a) Disagree	16	57

23. At the 0.01 level.
24. At the 0.05 level.

b) Agree	12	43

Results: The proportion in the responses is not significantly different from 0.5.

Question 16. Students have a common fear of physics even before they take the course.

	Frequency	%
a) Disagree	8	35
b) Agree	15	65

Results: The proportions in the responses is not significantly different from 0.5.

Question 17. Which branches of physics do you think your pupils find most difficult ?

	Frequency	%
a) Mechanics	21	45
b) Heat	1	2
c) Light	4	8
d) Sound	5	11
e) Magnetism and Electricity	11	24
f) Modern Physics	4	8
g) Laboratory work	1	2

Results: A significant proportion of the teachers thinks that mechanics, magnetism and electricity are the most difficult branches of physics.[23]

Question 18. The type of exam questions used most often are:

	Frequency	%
a) Problems	15	32
b) Problem - question combination	18	38

23. At the 0.01 level.

c) Objective questions	3	6
d) Essay questions	3	7
e) Various types combined	8	17

Results: It seems that 70 % of the teachers use problems or problem-question combination.

Question 19. Briefly state some of the causes which you feel contribute most to the failure of physics students.

Categories of Causes	Frequency	%
a) No interest	9	13
b) Weak background	6	9
c) Weakness in mathematics	6	9
d) No motivation; literary milieu	4	6
e) Insufficient drill	5	7
f) Poor comprehension of examinations	5	7
g) Inattention and laziness	11	17
h) Improper use of scientific terms	4	6
i) Unsuitable books or texts	3	5
j) Rare performance of experiments	3	5
k) Incompetant teachers	5	7
l) Set up of classes	2	3
m) Memorization anc copying	2	3
n) Fear of physics	1	1,5
o) Subject abstract	1	1,5
Totals	67	100

Results: The proportions in the responses are not significantly different from the expected ones.

Summary of the Teachers' Responses

The following points were found to be significant in the responses of the teachers:

1. There is an indication that there are as many students interested in physics as those not interested. Three main factors for the lack of interest are mentioned, namely, (a) lack of maturity or no aptitude; (b) original lack of interest; and (c) weak background of mathematics and language.

2. The physics curriculum is considered by a significant proportion of the teachers to be suitable to the majority of the students.

3. Probably 70 % of the teachers perform demonstrations for some topics of physics.

4. A significant proportion of the teachers claim to give individual laboratory work to students.

5. Probably less than 50 % of the teachers pay individual attention to the weak students in their physics classes. However, a significant proportion pays attention to every student in laboratory work.

6. Understanding the facts given is stated to be the main difficulty with students when solving problems.

7. A significant proportion of teachers state that pupils tend to memorize principles, laws, statements or illustrations without much comprehension.

8. A significant majority of teachers, too, thinks that mechanics, magnetism and electricity are the most difficult branches of physics.

9. None of the causes for failure in physics indicated by the teachers is significant. Probably the lack of interest, inattention and laziness are the main factors.

IV. TYPES OF MISTAKES MADE BY STUDENTS IN PHYSICS EXAMINATIONS

The corrected physics examination papers were analyzed for identifying the types of mistakes that students usually make. It was thought that these categories would reveal some aspects of the problem as to why so many fail high school physics. The Physics Department of the American University of Beirut and nine other schools made papers available to the investigator. These schools were the following: National Protestant College, Souk-el-Gharb National College, Makassed al-Islamieh College, Broummana High School, Preparatory School and Section Secondaire of the International College, Zahleh Official School, Tariq al-Jadideh Official School, and A.G.B.U. Boys School. The corrected examination papers were either term or final examination papers. Before exposing the results of the content analysis, it would be helpful to define a few of the terms used in Tables V and VI, on pages 60 and 61.

It was found that there were nine major categories of mistakes made by students in the sample chosen, namely:

1. Experimental application of laws, i.e., the student is unable to apply a law or a principle in a practical experimental setup for finding physical magnitudes - for example, not being

able to use Archimedes' principle to determine the specific gravity of an irregular body, or, not being able to use Faraday's laws of electrolysis in electroplating.

2. Mathematical application of laws, i.e., although stating a particular law or formula correctly, the student is unable to apply it to solve a mathematical problem.

3. Principles or laws, i.e., the student has no knowledge of or makes mistakes in laws or principles of physics. Often, he cannot state them even in symbols.

4. Apparatus or machines, i.e., the pupil makes mistakes in describing the composition or the operation of an apparatus or a machine used in the physical sciences.

5. Computation, i.e., mistakes of basic mathematical operations whether arithmetical, algebraic, geometrical, trigonometrical or more advanced operations.

6. Units, i.e., mistakes in units used for the measurement of physical quantities and taken into consideration by the teacher who corrected the paper.

7. Serious lack of comprehension, i.e., the student shows complete ignorance of the topic so that his answers are disorganized and unrelated to what is required in the question or problem. Sometimes the paper is blank.

8. Definitions, i.e., errors in the definition of physical

concepts or in the explanation of physical phenomena.

9. Presentation, i.e., the logical organization and development of an essay type examination. This type of mistake occurs particularly in the question de cours question of the Baccalauréat. The neatness of the examination papers are also considered.

The frequencies of mistakes were tabulated together with percentages. Here, too, the papers were classified into passing and failing ones on the basis of the mark given by the teacher who corrected them. The papers of the Latin type schools, that is the Baccalauréat form of exams, were treated as a separate unit, and the results were later added to those of the Anglo-American type exams to find out the trends in the whole sample. A résumé of the results of the whole sample is given in Table V, and full details are found in Table VI, on page 61.

Conclusion. On the assumption that the frequency of mistakes in each of the nine categories in Table V were equally distributed the significance of the data was tested by the use of the chi-square test and it was found that the actual distribution of the frequency of mistakes was significantly different from chance expectation at better than the 1 % level, i.e., the difference or disproportion in the distribution of mistakes could not have arisen by chance sampling from a population where the difference or disproportion is actually nil, except once in 100 such samples.

The significant types of mistakes which students of this sample made were in two categories. By far the largest per cent of errors was in the laws or principles of physics, 31-32 % and in the mathematical application of these in the solution of problems, 27-28 %. Either the student has not yet grasped the law or if he is able to state it as a formula he cannot use it to solve a problem based on it.

The per cents of mistakes in the various categories for the "pass group" and for the "fail group" run parallel with each other except in a few cases. Students in the "pass group" are apt to make more mistakes in computation than those in the "fail group", 10 % against 5 %. May be the teachers pay more attention to this point because a passing student's solution of a problem is often correct except for this aspect of it. It was also found that the failing group has a large per cent of serious lack of comprehension. This is a logical outcome of their situation.

The above mentioned outcomes of the analysis of mistakes are applicable to the various groups within the whole sample with some reservations here and there. In general the Anglo-American group and the Baccalauréat group examinations follow the same pattern of percentages in the categories of mistakes. The results of the individual sets of examination papers seem to fit also into the general pattern except for a particular

TABLE V

CATEGORIES OF MISTAKES IN THE SAMPLE OF 791 PHYSICS EXAMINATION PAPERS, INCLUDING 482 PASS AND 309 FAIL PAPERS *

Categories of Mistakes	Pass Group Freq.	Pass Group %	Fail Group Freq.	Fail Group %
1. Experimental application of laws	98	4	69	3
2. Mathematical application of laws	583	27	636	28
3. Laws or principles	707	32	700	31
4. Apparatus or machines	176	8	153	7
5. Computation	229	10	121	5
6. Units	124	6	84	4
7. Serious lack of comprehension	27	1	278	12
8. Definitions	181	8	195	8
9. Presentation	76	4	35	2
Totals	2201	100	2271	100

* The average number of mistakes in the Pass Group is 4.57 per student, and in the Fail Group it is 7.35 per student.

TABLE VI

CATEGORIES OF MISTAKES IN THE SAMPLE OF PHYSICS EXAMINATIONS DISTRIBUTED ACCORDING TO SCHOOLS AND CLASSES, INCLUDING 659 ANGLO-AMERICAN AND 132 BACCALAUREAT TYPE EXAMINATIONS.

School	Date	Class	Group	No. of Students	Experim. application of laws		Mathem. application of laws		Principles or laws		Apparatus or Machines		Computation		Units		Serious Lack of Comprehension		Definitions		Presentation		Total	
					f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
A.U.B. Physics 101	Feb'57	Fresh	Pass	64	–	–	74	27	122	45	–	–	32	12	9	3	/	–	35	13	–	–	273	100
	"	"	Fail	75	–	–	221	36	234	38	–	–	15	3	10	2	57	9	72	12	–	–	609	100
A.U.B. Physics 102	June'57	"	Pass	70	–	–	206	44	214	45	–	–	34	7	21	4	–	–	–	–	–	–	475	
	"	"	Fail	26	–	–	113	40	134	46	–	–	15	5	18	6	11	3	–	–		–	281	
A.U.B. Physics 104	June'57	"	Pass	59	27	8	90	28	90	28	57	18	45	14	11	4	–	–	–	–	–	–	320	
	"	"	Fail	20	18	9	74	36	59	29	27	13	18	9	7	4	–	–	–	–	–	–	203	
National Protestant Col.	11.2.57	4	Pass	29	–	–	5	6	21	24	31	36	8	10	/	/		–	20	23	–	–	86	
		"	Fail	16	3	4	12	16	10	14	28	39	2	3	–	–	5	7	13	17	–	–	73	
National Protestant Col.	11.2.57	5	Pass	21	11	16	18	26	18	26	6	8	9	13	3	4	–	–	5	7	–	–	70	
	"	"	Fail	18	14	16	14	16	20	24	7	8	12	14	3	4	15	18	–	–	–	–	85	
National Protestant Col.	June'57	5	Pass	9	–	–	5	17	8	28	6	21	5	17	2	7	3	10	–	–	–	–	29	
	"	"	Fail	23	–	–	33	27	27	22	14	12	15	13	–	–	29	24	3	2	–	–	121	
Souk el Garb College	20.3.57	5	Pass	18	–	–	15	29	13	25	–	–	11	22	1	2	–	–	11	22	–	–	51	
	"	"	Fail	6	–	–	14	43	5	15	–	–		–	2	6	5	15	7	21	–	–	33	
Souk-el-Garb College	20.3.57	4	Pass	16	–	–	7	19	12	32	–	–	4	11	2	6	–	–	12	32	–	–	37	
	"	"	Fail	7	–	–	12	33	8	22	–	–	–	–	–	–	10	28	6	17	–	–	36	
Souk-el-Garb College	22.3.57	3	Pass	20	–	–	20	36	9	16	–	–	5	8	1	2	1	2	20	36	–	–	56	
	"	"	Fail	16	–	–	28	33	22	26	–	–	7	8	2	2	15	17	12	14	–	–	86	
Makassed College	6.6.57	4 AB	Pass	28	7	7	7	7	34	35	18	19	10	11	20	21	–	–	–	–	–	–	96	
	"	"	Fail	17	5	7	3	4	17	24	8	12	11	16	7	10	19	27	–	–	–	–	70	
Broummana High.	June'57	6	Pass	10	2	8	2	8	9	36	5	20	3	12	1	4	–	–	3	12	–	–	25	
	"	"	Fail	9	4	9	3	7	13	29	10	23	1	2	2	4	6	13	6	13	–	–	45	
Broummana High.	June'57	5	Pass	18	4	6	12	19	18	28	1	2	6	10	6	10	–	–	16	25	–	–	63	
	"	"	Fail	9	1	2	10	24	14	33	–	–	1	3	2	5	–	–	14	33	–	–	42	
Preparatory School	Mar.'58	6 D	Pass	20	18	16	14	12	30	26	15	13	9	8	1	1	1	1	26	23	–	–	114	
	"	"	Fail	5	7	17	5	11	9	21	9	21	3	7	–	–	1	2	9	21	–	–	43	
Preparatory School	Mar.'58	5 B	Pass	12	–	–	21	25	17	21	–	–	13	16	15	19	2	2	14	17	–	–	82	
	"	"	Fail	18	–	–	30	18	42	26	–	–	11	7	14	9	31	20	32	20	–	–	160	
Total			Pass	394	69	3	406	28	615	34	139	8	194	11	94	5	8	1	162	10	–	–	1777	100
Total			Fail	265	52	3	572	30	614	32	103	5	111	6	67	4	204	11	174	9	–	–	1897	100
Baccalaureat Type Examinations																								
Zahlah Sec. School	11.4.57	2e	Pass	9	–	–	7	30	3	13	10	44	–	–	3	13	–	–	–	–	–	–	23	
	"	"	Fail	16	–	–	15	20	14	19	17	22	–	–	–	–	20	26	–	–	10	13	76	
Tariq el-Jadidah Sch.	June'57	3e	Pass	22	–	–	9	19	8	17	1	2	4	9	1	2	–	–	–	–	24	51	47	
	"	"	Fail	2	–	–	1	11	3	34	–	–	–	–	2	22	2	22	–	–	1	11	9	
Tariq-el-Jadidah Sch.	June'57	2e	Pass	12	8	21	4	11	5	13	7	18	3	8	7	18	–	–	–	–	4	11	38	
	"	"	Fail	7	–	–	5	12	10	25	13	33	4	10	4	10	2	5	–	–	2	5	40	
A.G.B.U. Boys School	13.3.58		Pass	6	2	5	14	32	8	19	3	7	1	2	–	–	3	7	6	14	6	14	43	
	"		Fail	1	1	6	3	18	3	18	1	6	–	–	2	11	4	23	1	6	2	12	17	
Preparatory School	Mar.'58	6 C	Pass	25	8	5	38	25	42	28	7	5	12	8	2	1	11	7	1	1	30	20	151	
	"	"	Fail	3	1	3	7	21	10	30	2	6	–	–	–	–	6	18	1	3	6	19	33	
Séction Secondaire	19.3.58	1e A	Pass	14	11	9	15	12	26	21	9	8	15	12	17	14	5	4	12	10	12	10	122	
	"		Fail	15	15	7	33	17	46	23	17	9	6	3	9	4	40	20	19	10	14	7	199	
Total			Pass	88	29	7	87	20	92	22	37	8	35	8	30	7	19	5	19	5	76	18	424	100
Total			Fail	44	17	5	64	17	86	23	50	13	10	2	17	5	74	20	21	6	35	9	374	102
Grand Total			Pass	482	98	4	583	27	707	32	176	8	229	10	124	6	27	1	181	8	76	4	2201	100
Grand Total			Fail	309	69	3	636	28	700	31	158	7	121	5	84	4	278	12	195	8	35	2	2271	100

examination lacking or including a category of mistakes as a result of the questions asked. Such a situation can be seen in the results of the A.U.B. physics 102 and 104 examinations, and the Anglo-American group examinations lacking errors in "presentation" simply because this aspect is not considered by the teachers while correcting the papers.

V. THE EXAMINATION QUESTIONS

The types of examination questions. It was found out that there were several types of physics examination questions in use in the schools of the sample chosen - short essay questions, multiple choice questions, and diagrams. Each type of school has its own form of examination, making use of particular combinations of the above types.

The examinations given to the Freshman class of the American University of Beirut are usually made up of short problems, definitions, diagrams, short essay and multiple choice questions. In term or final examinations the range of the types of questions is wide. In monthly quizes the range is narrow. A sample examination is included in Appendix C.

In Anglo-American type high schools the examinations are usually a set of more than five questions with a choice. These may include definitions, short problems, short essays, essay-problem combinations, and diagrams. A sample is also included in Appendix C.

The Latin type schools and the Lebanese Baccalauréat use examinations which are composed of long essay questions with a choice of one out of three and a long problem with several requirements interconnected. The long essay question is called question de cours. It may include a set of definitions. Two samples are given in Appendix C. The pattern of these examinations has seen no essential change for many years.

The structure of the Questions. The questions used in physics examinations given in Anglo-American type schools are distinguished by being composed of short statements leading directly to what is required as an answer. The student is not expected to carry on a detailed discussion of principles while solving problems. It would be considered satisfactory if he shows in mathematical sequence how he got the answers and qualify them by their proper units. Several examples are shown below to illustrate these points.

1) Explain the process of electroplating. A circular disc of iron of radius 7 cm. is wanted to be plated by copper to a thickness of 0.05 mm. The current used in the process is 4 amperes; what is the time required to do so. (At.wt. of copper being 63.5, density of copper is 8.9 g/cm and the solution is $CuSO_4$).
   Source: Second term examination of the 6 th Secondary, March 1958, Preparatory School, International College.

2) Define the following: dyne, resultant of forces, center of gravity, acceleration, period of the pendulum, power, erg.
   Source: Second term examination of the 5 th Secondary, March 1957, Preparatory School, International College.

3) A coil of wire has a self inductance of 0.2 henry is suddenly connected to a battery which has an E.M.F. of 8 volts. At an instant when the current in the coil is increasing at the rate of 30 amperes per second, the net E.M.F. in the complete circuit is A. 14 volts B. 8 volts C. 2 volts D. -6 volts.
   Source: The final examination in physics 102 of the Freshman class, June 1957, A.U.B..

4) Draw the diagram of an electric bell, label its parts and describe how it works. Similarly draw the diagram of a simple telegraphic circuit, label its parts and describe how it is operated.
Source: First semester examination of the 4 th secondary; February 1957, National Protestant College.

The long essay question, question de cours, used in the examinations given in the Latin type schools is a mere statement of a topic with its delimitations. The student is left free to develop the topic logically and discuss the laws, principles, experimental procedures and applications in full detail. Here is an example of a question de cours given to the Baccalauréat Class of the Section Secondaire of the International College in March, 1958:

Choose one question de cours:

1. The law of reflection. Plane mirrors. Applications.
2. The law of refraction. Indices of refraction. Total reflection.
3. Dioptre plan (combination of two transparent media separated by a plane surface). Plates with parallel faces.

In the Latin-type schools and the Lebanese Baccalauréat the physics examination contains usually one long problem. These problems have a complex structure and several parts interconnected with each other. The student has to read it very carefully and repeatedly, in order to be able to follow the line of thought. The following is an example translated from the problem given to the Classe de Seconde of the Section Secondaire of the International College, also, in March 1958:

A large crystal of candy sugar is suspended under the platform A of a balance. A standard weight heavier than the piece of sugar is placed on the other platform B. It is noticed carefully that in order to establish equilibrium a weight P_1 = 52.9 gm is added on the platform A. (The string with which the piece of sugar is suspended has a negligible weight).

The block of sugar is taken down. Some weights P_2 = 71.7 gm are now placed on the platform A to establish equilibrium again.

Now the block of sugar is again suspended at the original place, but this time immersed in acetone which has a density of 0.79 gm/cm^3. To reestablish equilibrium a total weight of P_3 = 62.2 gm has to be placed on the platform A.

What is the weight of the sugar ? What is its density ?

What would be the value of the weight P_3, if instead of acetone, carbon tetrachloride of density 1.63 gm/cm^3 was used ?

The types of topics given in the question de cours of the Lebanese Baccalauréat during the period 1948-1957 are summarized in Tables VII and VIII and their distribution shown. The question de cours may contain a choice question on chemistry because this is included in the physics examination syllabus according to the Lebanese program. Tables IX and X show the types of subjects with which the questions in the Baccalauréat problem deal and their distribution.

T A B L E VII

DISTRIBUTION OF QUESTION DE COURS TOPICS

IN THE BACCALAUREAT EXAMINATIONS.

June-July Sessions, 1948-1957 *

Topics	Year								
	48	50	51	52	53	54	55	56	57
The microscope				1					
The astronomical telescope								1	
Galileo's telescope				1			1		
The human eye								x	x
Prisms; deviation								1x	
Total reflection								x	
Laws of refraction							x		
Plate with parallel faces								x	
Thin lenses							1		
Converging lenses									x
Definitions							x		1
Electrical resistance	1					1			
Faraday's laws	1		1	1					
Magnetic field of a current	1					1			
Action of a magnetic field due to a current			1						
Accumulators					1				
Polarization of a cell						1			
Gramme machine generator					1				
Electrical circuits			1		1				
Galvanometer shunts									x
EMF by opposition method							x		
Chemistry topic							xxx	xx	1xx

* Questions of 1949 and 1950 not available. Each 1 represents one topic and each x represents one part of a question made up of several minor parts.

T A B L E VIII

DISTRIBUTION OF QUESTION DE COURS TOPICS

IN THE BACCALAUREAT EXAMINATIONS.

September-October Sessions, 1948-1957 *

Topics	Year 48	50	51	52	53	54	55	56	57
The microscope						1			
The magnifier		1	1			1			
The human eye							1		
Prisms, deviation					1		x		
Laws of refraction			1			1			
Plate with parallel faces									1
Plane mirror				1					
Diverging lenses					1				
Lens formulas			1						
Definitions									x
Electrical resistance							x	x	1
Wheatstone bridge							x	x	
Joule's law					1			1	
Faraday's laws				1			1		
Magnetic field of a current							x		x
Daniell cell									x
Moving coil galvanometer								1	
Electrical circuits		1							
Galvanometer shunts		1							
EMF by opposition method									x
Electro-magnets				1					
Chemistry							x	xx	

* Questions of 1948 and 1949 not available. Each 1 represents one topic and each x represents one part of a question made up of several minor parts.

T A B L E IX

DISTRIBUTION OF THE TOPICS IN THE PROBLEM OF THE BACCALAUREAT EXAMINATIONS

June-July Sessions, 1948-1957 *

Topics	Year								
	48	50	51	52	53	54	55	56	57
The microscope	1								
Magnification					11				
Angular magnification	1								
Images, lenses	1		11			1			
Images, mirror-lens	1								
Images, thin lenses						1			
Plate with parallel faces						1			
Refraction			1		1	11			
Power of a lens	1				1				
Wheatstone bridge									1
Resistance									1
Internal resistance							1		
Resistivity of a coil							1		
Current in a circuit				1			1	1	1
Faraday's laws				11				1	1
Cell combinations				1				1	1
Joule's law, heat								1	
EMF of a generator							1		
Tangent galvanometer							1		

* Problems of 1949 and 1950 not available

T A B L E X

DISTRIBUTION OF THE TOPICS IN THE PROBLEM OF THE BACCALAUREAT EXAMINATIONS

September-October Sessions, 1948-1957 *

Topics	Year 48	50	51	52	53	54	55	56	57
The Astronomical telescope		11							1
The human eye									1
Magnification							1		1
Angular magnification		1							1
Images, lenses							1		1
Images, lens-mirror							1	11	
Images, concave mirror								1	
Tracing rays; lens-mirror		1					1	1	
Plate with parallel faces		11						1	
Resistance			1						
Internal resistance				1					
Resistivity of a coil			1						
Current in a circuit			1	1					
Faraday's laws						11			
Cell combinations					11				
Joule's laws, heat					1				
EMF of a generator				11		1			
Tangent Galvanometer						1			
Circuit diagram			1		11	11			

* Problems of 1949 not available

It has become apparent from the study of Tables VII, VIII, IX and X, that (a) the range of topics given in the Baccalauréat examinations is narrow; (b) variations were introduced in the question de cours since 1955; (c) the problem given is either from optics or from magnetism and electricity; never both branches are included in any one examination; and (d) at least 50 % of the topics must have a practical experience on the part of the students for full comprehension, which, on the whole they do not have.

VI. THE CURRICULUM AND TEXTBOOKS

The Curriculum. This study is not concerned with the evaluation and criticism of the physics textbooks in current use in the high schools in Lebanon. However, some consideration was given to them with the sole purpose of finding out their relation, if any, to the problem of failure in physics. It would help this purpose to describe, first, the physics curriculum.

Because the overwhelming majority of the high schools in Lebanon are private institutions and are free to a certain extent to plan their own programs, there are four types of physics curricula - the Lebanese, the Latin or French, the English, and the American. The first three have very many points in common. Their programs are basically cyclical in nature. However, their application in the school curriculum has ended in discontinuous, illogical and psychologically unsound programs. Some physics is given in each class from the first secondary up to the sixth. Simple notions are introduced in the lower classes and then elaborated and expanded upon the following years. This is done in successive years or in every other year. Thus, the same topic is not continuous from year to year. The American type curriculum includes one or two courses of specialized physics after three successive years of general science and one year of biology. If it is taken up in one year a general survey of all branches of physics is presented to the pupils. While, if taken up in two years, it is divided into mechanics, heat and sound the first year, and into optics, magnetism and electricity the second year.

The Lebanese curriculum requires that physics be given in each one of the six years of secondary education. First year notions on gravity, heat, light, magnets and effects of the electric current are taken up. In the second year notions on gravity, hydrostatics and forces are further expanded. Properties of gases, atmospheric pressure, Boyle's law and heat are covered in the third year. Optics, magnetism and electricity are all introduced in the fourth year. In the fifth year the subjects of mechanics and heat are studied on a more advanced level. In the sixth year optics, electricity, magnetism and electro-magnetism are treated mathematically. At the end of the fifth year the students have to select either the science program or the literary program.

The Latin or French curriculum is similar both in scope and in content to the Lebanese curriculum. As a matter of fact the latter one is derived directly from the first. To illustrate this point it might be mentioned that in the fifth year, i.e., the classe de seconde, mechanics of force, work, power, gravitation and hydrostatics, and heat are given. Similarly in the classe de première, optics, electricity, magnetism and electromagnetism are taken up. These are quite in line with the Lebanese Baccalauréat program.

Because some schools prepare their pupils to sit for the "General Certificate of Education" examinations, a curriculum similar to the English curriculum is adopted by some institutions. Physics is treated systematically as a unit in a general science course given during the first three years of high school, the other units being chemistry and biology. Beginning with the fourth year physics becomes more mathematical. Attempts are being made to give the major branches of physics - mechanics, heat, light, sound, magnetism and electricity as a whole unit during the first four years. However in the upper two classes this curriculum may follow entirely the Latin type so that the pupils can sit for the Baccalauréat examinations.

It can be seen from the foregoing outline that the physics curriculum in this country is complicated as a result of the existence of these various types. The main factor behind this situation is that although the majority of the students sit for the Lebanese Baccalauréat, probably 25 % sit either for the French Baccalauréat or for the British "General Certificate of Education" or try to get a recommendation to enter the American University of Beirut.

In theory practical experience, experimental demonstration and laboratory work is recommended and expected. In general the Anglo-American type schools do provide for experimental work on the part of their students. The government schools are still in a transit period. The Latin type schools have all shades of practical experience in physics, from complete verbal instruction to a satisfactory balance between the verbal and the experimental. Verbal teaching is considered by some to be theoretical teaching. But these are fundamentally different from each other. Verbal teaching, relies on verbal description of things without actual observation and experience. Theoretical discussion on the other hand is the reasoning on the abstract level using symbols representing physical entities and based on the results of observation and experimentation.

VII. OBSERVATION IN THE FIELD

The observations of the investigator while visiting schools and laboratories and attending class sessions are incorporated in the discussion in Chapter V, the interpretation of the results. It would suffice to state here the major facts observed on the field.

1) The average number of pupils in a physics class in Anglo-American type schools is approximately 25-30. In Latin type schools classes have a slightly larger number of students.

2) At least 50 % of the schools in the sample had either no laboratory facilities at all or hardly sufficient for demonstration purposes. The per cent of physics laboratories in Latin type schools or government institutions is even lower than the above one. Individual laboratory work is given mainly in the fifth year to classes preparing for the Baccalauréat and in the sixth year for the other type of classes. Laboratory periods are sometimes used for lecture-discussion in order to finish the Baccalauréat program or give more instruction therein.

3) There is a severe shortage of capable instructors in physics. Students were found often complaining of this situation. School directors, too, were conscious of the problem. An experienced physics teacher was often seen rushing

from one school to another to instruct various classes.

4) The teaching methods were found to be entirely of the traditional type. Lecture-discussion-examination cycle is the rule in a large majority of the schools. Instruction is verbal and although in some schools demonstration equipment is available it is not put into efficient use.

CHAPTER V

AN INTERPRETATION OF THE RESULTS

I. APPROVED METHODS OF PHYSICS TEACHING

Psychological foundations. There are a few psychological foundations of method in science instruction in general which are worth outlining before discussing the method of physics teaching.

1. It can be said that there are three psychological stages in science through which man passes: (a) wonder; (b) utility; and (c) systematizing. The young child's first reaction to the phenomena of Nature is one of wonder. Soon there comes a period when he tries to realize their utility and is curious to find how things work and attempts to control. Finally when he is fully mature he tries to systematize his scientific knowledge. The average pupil when leaving high school, has hardly entered this last stage.[25]

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25. Summer, W.L., The Teaching of Science, (Oxford, England, Basil Blackwell, 1947), pp. 28-29.

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2. Pupils progress through levels of maturity. At each level they should take an active part in rich and varied experiences. Their understanding grows and expands through continuous experience.

3. Science concepts can be grouped into two categories, concepts which are gained through simple sensory perception and concepts which gain their meaning from theories proposed by the theoretical scientists who use their imaginations and investigations in the field of pure mathematics. These two aspects of concept formation result in a hierarchy of concepts from the simplest to the most complex requiring mental activity on an advanced level.

4. There are several types of factors which condition learning, (a) environmental factors, (b) physiological factors, and (c) psychological factors, namely motivation. This implies that various means of motivation should be used by the science teacher to develop and maintain interest and enthusiasm in students.

5. "The psychological principles of readiness, exercise, and effect indicate that there is a close relationship between interest, attention, and effort. When the pupils are in a state of readiness to act and the act is accompanied by satisfaction, learning results and habits of thinking and acting are formed as a result of exercise and study."

6. As it was stated in paragraph N°- 3 above, it is assumed that understanding of science principles and concepts will change as learning progresses. A cycle of teaching and learning is necessary for bringing about this enlargement of concepts and principles.

7. It is believed, also, that if a pupil is going to acquire skill in anything he must have a repetitive practice in that skill. Problem solving skill, for example, or the development of attitudes, interests and appreciations need a lot of practice. This can be attained best by a cyclical pattern of learning.

8. A learning cycle according to Dewey is a process made up of five steps: (a) seeing the problem or difficulty; (b) analysing the problem; (c) collecting evidence on the problem; (d) interpreting the evidence; and (e) conclusion and application.[26]

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26. Statements numbered 2, 3, 4, 5, 6, 7 and 8 are adaptations from : Heiss, Elwood D., et al., Modern Science Teaching, (New York, MacMillan Company, 1950), pp. 43, 45, 49-52, 54, and 83-84.

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9. The general trend of studies in the United States on concept formation tends to verify accepted principles of learning, namely: (a) learning that is meaningful is more effective than learning that lacks significance. (b) Learning takes place somewhat in proportion to the involvement of the learner in learning activities. (c) The role of the teacher as a guide or participant in pupil-teacher planning stimulates learning. (d) Manipulation and sensory learning continue to demonstrate superiority over verbal learning. (e) The goal acceptance by the learner appears to be involved in the learning situation.[27]

27. Johnson, Donovan A., Implications of Research in the Psychology of Learning for Science and Mathematics Teaching, Review of Educational Research, XXVII, (October, 1957), p. 402.

Fundamental Principles of Method in Science Teaching. The method of physics teaching is derived from the general method of science teaching. Both methods have to conform to two aspects of learning activity: (a) method of education in teaching and learning in general; and (b) method of science in acquiring of knowledge in particular. The first aspect of the method was stated briefly in the first part of this chapter.

The scientific method is pivoted around two approaches of acquiring knowledge, the inductive and the deductive. The inductive approach starts first with observation and experimentation and then runs into reasoning on the abstract plane, analysis and discussion of data, leading finally to the conclusion. The deductive approach takes up the theorem which is to be proved and on basis of premises of verified principles or laws uses analytic and synthetic methods to come to the conclusion. The inductive method should be the main approach in physics teaching up to college level. However, induction and deduction are not absolutely separable into purely one or the other approach. Usually they are blended so that one of the two is dominant.[28]

28. The content of this section has been adapted from: Dumit, Emile J., Teachers' Guide in Science Teaching, to be published soon in Arabic, and memeographed sheets in

English on Science Teaching; used for training students at the American University of Beirut.

The method of Science. The scientific method begins from observation and experimentation and advances into abstraction and generalization. The process is developed on basic notions; as follows: (a) recognition of individual entities; perception of properties, characteristics and qualities; (b) recognition of similarities, differences and contrasts; (c) perception of space relations; (d) awareness of time and time sequances of events; and (e) comprehension of space-time, cause and effect relations and the concepts of function and variation. All of these notions lead ultimately to the formation of general concepts of law and order in the universe. The transition from the particular and the concrete to the general and the abstract starts early in life, but remains relatively long on an elementary level.

As was stated above the scientific method is fundamentally the method of induction and deduction. Induction is based on the faith in the uniformity of nature, without which there could not be any science. Rules of deduction are inductively verified, i.e., they are ultimately based on experience of the inductive type. Deduction may be used to derive more general laws from less general ones, as in geometry and mechanics; or it may be used in applying general laws to particular cases.

Simple relations are apprehended directly by experience. Other relations are subtle, and require a great deal of reasoning based on experience in order to be revealed. The apprehension of such relations, as well as reasoning on the plane of abstract and generalized thought; and the ability to concentrate attention and thought are the main difficulties of the average individual in the way of understanding. Individuals are distinguished according to their degree of excellence in these abilities. This is a fundamental point to be taken into account in education and teaching.

Scientific theories are an attempt at the apprehension of truth and reality beyond the range of sensory experience. But, actually, they are generalisations of a higher order than the individual laws of nature recognised in science. The individual laws of nature concerned come out as particular cases deduced from the generalisations of the theory, e.g. Dalton's atomic theory, the kinetic theory of gases, the wave theory of light.

In teaching, scientific theories should not be presented till after the study of the main facts and laws which the theory tries to interpret and generalise. Thus the atomic theory would come after the laws of definite chemical composition, and multiple proportions... etc.; the theory of ionization after experience of the laws of conduction and electricity in electrolytes and gases.

Hypotheses are occasionally used, though not necessarily. Once a hypothesis is made, deductive reasoning is applied to it to arrive at a conclusion which can be tested experimentally. Intuition plays a part in scientific investigation. Intuitions have to be verified by reason as hypotheses are.

Intuition and imagination should be encouraged with the proviso that they should be regulated by reason.[29]

29. Ibid.

Techniques of instruction.

A. The techniques of instruction in physics are basically those of science in general. These depend on the type of outcome that is sought in any learning experience. The approved methods for developing functional knowledge in physics can be grouped under the following headings: (a) lecture method; (b) demonstration method; (c) laboratory method; (d) textbook method; (e) the unit problem method; and (f) the individual method. Development of functional knowledge includes development of meaning and understanding of particular things as well as understanding and meaning of various things such as functional facts, concepts, laws, principles, theories, as well as evidence that supports generalizations, conclusions, and ideas.

B. The lecture technique is the traditional method of teaching physics. It has become very common now to supplement the lecture with demonstrations and visual aids. The chief advantage of this method is that it provides an efficient means of covering subject matter and somewhat insures that the pupils will receive the material in a concise and logically organized manner. On the other hand the students remain passive recipients of information. This method is being used less than it used to be.

C. As a device for developing understanding in the students of facts, concepts, and principles the demonstration method has proved very successful. When this is employed in conjunction with lecture-discussion it becomes a very efficient tool for logical presentation and development of content, on one hand, and pupil's skill in accurate observation, recording data, interpreting data, and formulating conclusions. It is also very useful in the derivation and application of principles.

D. The laboratory method in physics is used in conjunction with some other techniques. The Thirty-First Yearbook of the National Society for the Study of Education summarizes the things that laboratory instruction should accomplish in general as follows:

> (1) The development of simple laboratory techniques, such as weighing, glass bending, microscopic manipulation, etc..
> (2) Proving and establishing for the pupil himself principles which have long since been well established and generally accepted.
> (3) Using the laboratory as an instrument for object or 'thing' teaching, according to the historical concepts of Pestalozzi, Comenius and Basedow.
> (4) Using the laboratory for the purpose of developing better understanding and interpretations of the principles of science, as a means of better illustration.
> (5) To produce training in scientific method.
> (6) As a means of possible training in the experimental solution of the pupils' own problems.
> (7) The use of the laboratory as a workshop for the study of science problems which arise in the science class or in the life of the pupil.[30]

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30. "A Program For Teaching Science", National Society for the Study of Education, Thirty-first Yearbook, (Chicago, University of Chicago Press, 1932), I, p. 270.

E. To get optimum results lecture, demonstration and individual laboratory work techniques should be coordinated into a logical and well planned system. Laboratory work must be in step and correctly timed with the main sequence of topics in the course as far as possible. Observation and experience should precede discussion. Therefore, the division of the necessary experience between lecture demonstration and laboratory work requires careful selection and planning, keeping in view the suitability of the laboratory work to the development of skills involved in the work and training in scientific enquiry over and above the actual experience for the understanding of the specific subject matter.[31]

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31. Dumit, Emile J., mimeographed sheets on Teaching Science used for training students at the American University of Beirut.

F. The modern trend in laboratory work, particularly in the United States, is to organize and plan it on simple procedures which will train the pupils in the methods of scientific enquiry. This implies giving the students fewer experiments. The plan is being currently worked out by the Physical Science Study Committee at the Massachusett's Institute of Technology.

G. The physics textbook is still the most influencial factor in determining the content of the physics course. As such its proper selection and use is important. Rather than considering the text as the course itself the instructor should take it as a core material enriching it with reference literature and texts as wide as possible for adapting the text to the needs of the students, thereby giving the pupils a training in the habit of collecting information from references as a help to solve their problems.

H. The unit problem method is directly an outgrowth of a new organization of the physics curriculum. The common method is to state the topic of the unit as a broad problem or principle such as "how is the energy of heat put to work ?" or "what are the principles which control the simple machines ?" These broad problems are then broken down into smaller and more specific learning problems for purposes of instruction. It is a flexible method which needs very careful planning and cooperation on the part of the teachers and the pupils and resorts to the method of lecture-demonstration the textbook method, the laboratory method and the individual method, to attain its aims most effectively.

I. The individual method is an application of the principle that pupils vary widely in their interests and abilities. The instructor devises a scheme by which a pupil or a group of pupils in a particular class are allowed to progress through the work at their own rate. In most cases the students assume a lot of responsibility for their own learning.[32]

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32. The content of sections A, B, C, G, H, and I, are adaptations from, Heiss, Elwood D., et al., Modern Science Teaching (New York, MacMillan Company, 1950), pp. 113-126.

J. Projects and extra curricular activities can be used not only as means of motivation and acquisition of functional knowledge but also to build up interests, attitudes, and to provide for individual differences and inclinations, especially where the course is standardized for all.

K. Where schools are not equipped with laboratory apparatus for individual experimental work, the class periods should partake of the techniques of lecture, discussion, and group laboratory work simultaneously. This is very effective especially when the classes are not too large. Lecture-demonstrations lose part of their effectiveness when the class is too large unless very special arrangements are made. The fundamental problem is, then, to build teaching and learning on experience.

II. INTERPRETATION OF THE RESULTS

The percentage of failures in physics. The facts point out very significantly that the percentage of failures in physics is high in the secondary schools in Lebanon. Freshman class statistics, Baccalauréat results, school records as reflected in the pass and fail group proportions, and the analysis of corrected examination papers all show at least a 30-40 % failure in physics. Actually in a good proportion of the classes the percentage is still higher. Teachers often resort to adjusting the grade distribution into a normal distribution thereby reducing the percentage of failure.

The physics program and selection. Physics is a required course in all types of schools in this country, because all of them prepare students for the universities. Only in the upper two classes, including the Freshman class, the pupils are allowed to choose between two programs, one leading to the sciences and professions and the other to the arts or literary studies. It is doubtful whether such a curriculum fits the needs and interests of young people. In item N°- 1 of the questionnaire, 60-70 % of the students indicated that physics is a required course. Only a small percentage said that they would have chosen it. There is some indication that fewer students of the fail group would have elected physics if it was left optional. Such a situation carries the potentialities of student failure within itself. Student selection methods are almost non-existant in this country. It is left to the wish of the pupil and the desire of his parents to decide what he should study in the academic program. Some advice is given by the school authorities based mainly on his marks in the school subjects. Trial and error play their part. Even there are some reasons to think that examinations in general and the Baccalauréat in particular, are meant to be instruments of student selection. When one is aware of the high percentage of failure it becomes amazing.

The teachers' opinion in item N°- 3 of the questionnaire pointed out significantly that the physics curriculum was suitable to the ability of the majority of students. If so, why then the large number of failures ? Because of the absence of modern methods of selection the majority of the high school population is made up of pupils of average ability. In the words of Laybourn and Bailey, "It has been often remarked, and with some truth, that the ordinary child of average ability gets less attention than either the ablest or the least able of his contemporaries. Interest tends to focus on the extremes, as is witnessed by the widespread concern for the treatment of backwardness and the understandable sympathy of the teacher with the clever or precocious pupil."33

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33. Laybourn K., and C.H. Bailey, Teaching Science to the Ordinary Pupil, (London, University of London Press, 1957), p. 6.

Physics: a difficult course. When one surveys the progress of the physics syllabus in relation to the development of the science since the middle of the nineteenth century he is struck with the complexity of the course as it stands today. As Elbert P. Little puts it, "Textbooks grew in size and consequently diminished in comprehensibility. Because Newtonian mechanics rapidly ceased to serve as a unifying concept, the subject compartmentalized: physics insensibly became several distinct and disconnected subjects - mechanics, optics, heat, sound, electricity, the atom, the nucleus - grouped into one, it seemed, primarily for pedagogic purposes".[34] Such a situation is

34. Building a New Structure, The Science Teacher, XXIV, (November, 1957), p. 316 B.

not a happy one. The course has become too voluminous. Consequently a cyclic method of teaching and learning is very difficult to preserve because that would imply a heavily loaded curriculum, as is often the case. Or, an interrupted and illogical program is scheduled.

The other factor which makes physics a difficult science, particularly for the vast majority of students in the high schools is inherent within the subject itself. Physics is made up of a vast closely knit array of concepts, principles, laws, theories, and hypotheses together with their practical applications and philosophical implications. As was explained in part I above it is an absolute requirement for the pupil to comprehend these in their real sense and to do so he must begin by the simplest practical laboratory or home experiences and then build upon them until generalizations and abstract level is reached. Once there is a break in the chain of concept building even the simplest form of physics becomes an abstract incomprehensible course.

A significant proportion of teachers in item N°- 17 of the questionnaire, and students in item N°- 12 pointed out that mechanics, magnetism and electricity were the most difficult branches of physics. These branches are indeed rich in abstract concepts and mathematical operations. When these are taught verbally students surely would find them difficult and point out that they lose interest in physics because it is too abstract, item N°- 4 of the questionnaire.

The content analysis of the corrected examination papers for finding out the types of errors that students made gave two outstanding types of mistakes. The proportion of errors that students made in laws and principles, on one hand, and errors in applying these laws for solving mathematical problems, on the other hand, were found to be very significant. This piece of evidence indicated, too, that pupils had not understood the basic concepts, principles, and laws of physics. They had probably memorized them and when faced with the problem of explaining and applying them they were left helpless. As a result students are frustrated and declare that physics is difficult and abstract.

The interest of students in physics. According to item N°-2 of the questionnaire students pointed out significantly that physics was interesting. Teachers were divided on this point. In general pupils of the sixth secondary were more interested than those of the fifth secondary. Probably this is due to the desire of the first group to pass the Baccalauréat examination in which physics stands prominent; or, it may be their desire to excel and get a recommendation to the Freshman class. In the latter class the situation was similar, the interests of the students were basically utilitarian and not a general interest in physics as a science.

The interest of the fail group was significantly different from that of the pass group. There was a strong evidence that they were the ones who lost interest in physics. The principal causes were cited to be (a) lack of practical application; (b) course too abstract; and (c) language difficulty. In contrast to these, teachers mentioned the following factors for the loss of interest: (a) lack of maturity; (b) weak background of mathematics and language; and (c) original lack of interest. The causes cited by the teachers were characteristic of the fail group.

It was also observed that teachers very often resorted to calling the attention of their students to the danger of failing in the course as a means of making them interested in the physics course. Once these students pass their exams they would remember very little of the content of physics.

Method of teaching: lecture-discussion. In all types of schools in Lebanon the general method of teaching physics was found to be the traditional lecture-discussion technique. In a few schools practical demonstration and laboratory work were used concomitantly. The treatment was often extremely dull and concentrated on the derivation of laws and numerical problems. There was a slight evidence in the response of teachers, item N°- 11 of the questionnaire, that they used mathematical methods of deriving laws rather than experimental derivation. Of course this resulted in a lot of rote learning as evidenced by teachers responses to items N°- 14a and N°- 14b of their questionnaire and pointed out by the students themselves in items N°- 13a and N°- 13b. Students were found to be very fond of note taking and very indifferent to reading outside their textbooks. See item N°- 19 of the student questionnaire. Baccalauréat students, however, were seen to be eager for books dealing with types and examples of physics problems. Such a lecture-discussion technique was found to give good results in the official examinations.

Method of teaching: demonstration. In general secondary schools were found to be poorly equipped with demonstration apparatus. However there was a widespread desire on the part of teachers for using this technique in their teaching procedures, more so in schools where the students had no access to individual laboratory work.

The responses of pupils, items N°- 5 and 6 of their questionnaire and that of teachers, item N°- 5, all pointed out significantly that some demonstrations were performed in the physics classes. Very often these took place after the discussions, which procedure was educationally and scientifically unsound. Most probably this situation turned the technique of demonstration into a means of interesting and amusing the pupils rather than training them in the scientific method of induction based on careful observation. Indeed some teachers were observed to crowd the demonstrations into a particular interval of the class period rather than distribute them throughout the whole lecture or discussion period.

Students complained, too, that they were given few chances to observe physical phenomena, apparatus, or machines, see item N°- 14. The situation in the Freshman class of the American University of Beirut is quite different. The students of that institution gave positive responses for these aspects of physics teaching.

Method of teaching: laboratory work. The Latin type schools in general were found to give no individual laboratory work to their students. There were a few important exceptions to this. While the Anglo-American type schools did provide at least some sort of laboratory work. As a result of this situation the response of students to item N°- 7 in their questionnaire did not prove to be significant. In item N°- 8 a very significant proportion confessed that either laboratory work helped or would help students to understand physics better. Similarly teachers were divided, namely, 50 % said they do give laboratory work. However, they claimed to give individual attention to students in laboratory work and discuss with them what they were doing. It was observed also that laboratory work was often performed by the students as a routine duty without real understanding of its significance.

Much experimental work can be done with home-made apparatus. But in this country there is a general feeling among teachers and students that experimental work can be done only with special equipment accomodated in expensive laboratories. To those of such opinion W.L. Summer says:

> With the physical sciences in particular there grows up in the child's mind a feeling that the 'laws' of chemistry and physics only apply when proper flasks, test-tubes, Bunsen berners are used. Everything should be done to dispel this, though there is no reason to despise the proper 'tools' when one is fortunate enough to possess them; indeed the care and maintenance of apparatus, and the best way of handling it, is as important in science as in the crafts.[35]

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35. The Teaching of Science, (Oxford, England, Basil Blackwell, 1947), p. 18.

Mathematical background and problem solving. This investigation revealed significantly that pupils do find difficulty in mathematics in general and those who failed in physics had indeed weak mathematical background; see student response in item N°- 9a. The pass group claims that the difficulty lies mainly in three places: (a) understanding the problem, (b) units; and (c) trigonometry and geometry. The fail group mentions mainly: (a) understanding and (b) trigonometry and geometry. See item N°- 9b of the student questionnaire. Teachers, too, are of the opinion that the main difficulty of students lies in understanding the physics problem; see item N°- 12. The students claim, also, that physics problems are interesting and a fair amount is given to them. They feel satisfied with the amount of practice they get. See items N°- 10 of the questionnaire, as well as N°- 11.

While analysing the errors in the corrected examination papers it was observed that students preparing the Baccalauréat were quite competent in their mathematics and strong in logical deduction of numerical solutions. Yet the general trend indicated that pupils had insufficient training and practice in the mathematical application of the laws of physics to solving problems. See tables V and VI on pages 60 and 61.

Many physics teachers believe that there should be more instruction in mathematics for those students who plan to go to college. They even recommend less courses in physics in the secondary classes so that students may get more training in the use of mathematics for solving physics problems.[36]

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36. See for example the quotation from Professor Paul DeH. Hurd on page 9.

Types of mistakes in physics examinations. The analysis of the errors in the corrected examination papers revealed significant proportions of mistakes in laws or principles and their mathematical application in solving problems. This situation was almost the same in the Anglo-American and the Baccalauréat type examinations. Probably, this result is due to the rote learning of laws and concepts on the part of the students on one hand and insufficient training in the procedures of mathematical solution of problems on the other hand. The Anglo-American type group had more instruction in individual laboratory work than the Baccalauréat or Latin type group. It is doubtful whether this training was of much help to students in making them understand the abstract concepts. There was, also, some indication that the Baccalauréat group resorted more to memorization and made more mistakes in the description of apparatus and machines, than the Anglo-American.

Physics examinations. The types of physics examination questions and their structure were described in Chapter IV. In this section an attempt is made to find the relation between examination questions and failure in physics.

There are two types of examinations in Lebanon, (a) internal, i.e. examination conducted by the schools for their own students, and (b) external, namely, the Baccalauréat examination conducted by the Ministry of Education. In general it can be said that these examinations aim to measure (a) knowledge of subject matter, and (b) progress in the attainment of utilizable skills, such as problem solving ability or logical presentation. The Baccalauréat examination is used also to test the efficiency of the Schools. They are used, too, as a guide in student selection and vocational placement. A large per cent of the questions are of the traditional essay-problem type. As such these examinations encourage memorization and cramming. (See samples in Appendix C).

After the study of the sample examinations, both the Anglo-American type and the Baccalauréat type, and particularly the latter the following remarks can be made:

1°- Some of the questions which seemingly are applications to realistic situations and actual practice are misleading, giving distorted ideas about actualities in common use, such as questions on electrical instruments, generators or batteries.

2°- Obsolete material is still retained, e.g., cells in series and banks of cells in parallel.

3°- The composition of a few problems are quite artificial, calling for mental gymnastics in abstract symbols. They do not represent any actual application or any operation which actually obtains results in practice, either in pure science or in technology.

4°- A single problem may contain a series of minor problems apparently connected in a main topic but actually built up artificially. A mistake in one will vitiate the student's work in the succeeding steps due to substitution of values already incorrect. Although only a few marks are reduced if the consecutive steps are correct, yet the average student is found mixed up with the whole situation. Some may claim that such types of problems have their own purpose behind them.

5°- There are questions requiring detailed information about instruments and apparatus which in a significant proportion of cases the student has never seen or observed carefully.

6°- In Latin type examinations, particularly in the Baccalauréat, a long essay type question '<u>question de cours</u>', and one long problem is given. The first part may be made up of several minor topics. Such examinations are narrow in range, thereby increasing the probability of chance. The Anglo-American type questions are wider in range and therefore more comprehensive in subject-matter. (See tables VII, VIII, IX and X on pages 67-70). In such examinations one problem is given each time. It is on one topic - either optics or electricity and magnetism - and never on both. Thereby, chance necessarily becomes a large factor in a pupil's success on the official examinations.

7°- The long essay type of question in the Baccalauréat requires understanding, reasoning and ability to organize information in a logical sequence and present it in a well expressed language. This is done either by painstaking memorization of sample answers or by use of real ability and understanding. This emphasis follows in the footsteps of the French concept of liberal education or "culture générale" which according to M. Bouglé implies "une gymnastique de l'esprit".[37]

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37. Usill, Harvey V., ed., The Year Book of Education, 1938, (London, University of London, Institute of Education, 1938), p. 286.

As a conclusion, it can be said that the official general examinations tend to reveal what the student cannot do. Such examinations may be taken as an indication of the contents of the curriculum. The main point in this respect is that in the administration of the course most schools do not supply the experiences necessary for the understanding of the complex concepts, processes, operations, and apparatus which the student is required to explain in detail in a final examination. Students are ridden by examinations and resort to memorization.

Other results. There was a significant proportion in the fail group which indicated that students have an attitude of fear towards physics courses even before they take them. The old students impress the new ones with the difficulty of the course. There is a tendency on the part of students to overestimate their own ability in physics; see item 20 of the students' questionnaire.

Enquiry about the methods of study of the students reveal the following significant responses: (a) Students in general resort to memorization of laws, principles, formulas and concepts. Sometimes they memorize problems too; items N°- 13a and b of students' questionnaire and items N°- 14a and b of teachers questionnaire. (b) The fail group spends more time studying physics than any other lesson; see item N°- 17 of the students' questionnaire. (c) In general they do very little or no outside reading in physics.

There was also some evidence that students in a few schools had language difficulty. This is due mainly to physics being taught either in French or in English and not in Arabic; see items N°- 4 and N°- 13 of the students' and teachers' questionnaires respectively. The textbooks were claimed to be suitable to the majority of students; item N°- 4. However there is no satisfactory text in English for the Baccalauréat program, except Yakub Haddad's book, because it was specially written for that purpose.

There was also some indication from observation that the teacher-student relationship was not satisfactory. Extra-curricular activity was almost non-existant. Fail group claimed they had insufficient individual attention after examinations. See items N°- 15 and N°- 7 of the students' and teachers' questionnaires respectively.

There was, also, some evidence from observation that teachers were overloaded with physics courses, particularly those who were instructors in more than one school; see item Nº- 15 of teachers' questionnaire. Although most of them were competent teachers in their field, probably a good proportion of them had no courses in educational methods and techniques when in college.

CHAPTER VI

CONCLUSION

This study indicates that there is a large percentage of failures in the physics courses given in the secondary schools in Lebanon. Due to the complete lack of data for the other subjects it can be said with confidence that even if the per cent of failure in physics is not the largest it is one of the largest; the other being probably mathematics. The curriculum considers it as a required course to be taken by all the high school student population making a distinction only between the one given to science students in the upper two classes, including Freshman, and that given to arts students. Such a situation puts the problem of failure in physics in the forefront of the academic problems in this country. The causes are inherent in the educational system and the methods of teaching.

Some of the conclusions arrived at in this study were embodied in the interpretation of the results in chapter V. This research makes no claim to define all the causes of failure in physics. However there is sufficient evidence to conclude that the most important causes of failure in the physics courses of the secondary schools in Lebanon are the following:

1°- Education is made to fit the requirements of the official examinations rather than the individual needs of students.

2°- In an overloaded curriculum the physics course is too voluminous. It seems that it is not well organized psychologically and logically.

3°- Efficient guidance and psychological tests are not used for selection and placement of pupils in the proper academic fields. Some pupils having no ability or interest in physics, are frustrated and fail in the course.

4°- The majority of students find physics a difficult science - particularly mechanics, electricity and magnetism. This implies that special methods for teaching the subject adequately are necessary.

5°- Students get very little practical experience either in classroom demonstrations, laboratory work or direct observation. They are not trained in the elementary method of scientific enquiry. Teaching is rather verbal. A great stress is laid on abstract treatment. The vital relation between abstract treatment and experimental basis is not made clear to the students. They are left in the dark with regard to the fundamental aspects of method - induction and deduction on one hand and their relation and interconnection on the other hand.

6°- Problem solving ability and technique are not well developed in the average student. Often, he suffers from his inadequate mathematical background and lack of practice. Passing an examination requires a great ability in problem solving technique, in which the student has not received sufficient instructions. Indeed, while at school, he is given many problems as exercise and homework, which does not imply a systematic organized general technique which may be applied to particular problems successfully. Besides that, some problems given in examinations are of the mental gymnastics type which are neither fair to the student - in revealing his qualifications to pass - nor are they good means of evaluating the correct methods of teaching.

7°- The types of questions given in the examinations can be considered as a factor leading to failure, because (a) at least 50 % of them require practical experience which students often do not have, (b) they are narrow in subject matter range and hence chance plays a great part in them.

8°- Teacher-student relationship is not encouraging. Pupils, particularly failing ones, do not receive sufficient individual attention from their teachers.

9°- The educational milieu does not have a scientific atmosphere to act as a motivating force for pupils and students in the study of physics. People are literary minded.

This study is by no means complete in its scope. While the research work was devoted to identifying the causes of failures in physics, it was felt that several concomitant aspects of the problem require separate study. Among them the following aspects are deemed particularly worthy of further investigation: (a) to what extent do personal factors such as health, intelligence, and attitudes influence failure ? (b) to what extent are the official physics examinations valid ? and (c) what methods can be recommended for use in existing schools in Lebanon to improve the teaching of physics and thus reduce the incidence of failure ?

In closing this study an urgent recommendation for the improvement of the situation is presented to those responsible for the education of the youth of this country. Methods of teaching physics must be reconsidered and new techniques developed and disseminated among physics teachers, many of whom have not had specific training in physics teaching. Such methods should be disseminated by means of conferences, courses for in-service teachers, summer institutes, and teachers' guide books.[38]

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38. See for example:
    (a) Bureau of Secondary Curriculum Development, Physics Handbook, Albany, New York, State Education Department, 1956.
    (b) Dumit, Emile, J., أصول تدريس العلوم, Teachers' Guide in Science Teaching, to be published soon.

A P P E N D I X

APPENDIX A

I. QUESTIONNAIRE ADMINISTERED TO STUDENTS

Fellow Student,

An investigation is being made to find out the difficulties which students face in their physics courses. Your cooperation in answering the questions below will be much appreciated. The information given by you is confidential. Thanks for your contribution.

Name: ____________________ School: ______________

Age: ____________________ Class: ______________

Hometown: ________________

Schools attended: ______________________________________

Number of Teachers who taught you physics: ________________

Directions: Please put a check mark (√) on the lines below at the proper place. Show to which side you are inclined even if you have no opinion by putting the mark (√) near the no opinion point. In case of other types of questions either check the answer you choose or briefly answer what is asked.

1. Indicate the reason why you are taking physics.

   (a) I have chosen it.
   (b) It is required.
   (c) I don't know.
   (d) Other reasons (please state) ....

2. Do the subjects discussed in physics attract your interest to know about them ?

.____________.____________.____________.____________.

Surely No   Rarely   No Opinion   Often   Surely Yes

3. Does your interest to learn physics

   (a) continue   or (b) do you lose interest ?

4. If you began to learn physics with interest and then lost this interest, what were the reasons ?

(a) Language difficulty
(b) Course too abstract
(c) No practical application
(d) No experimental demonstration
(e) Other reasons (please state) ....

5. How much demonstration does the teacher give you ?

None at all	For Few Topics	No Opinion	For Most Topics	For Each Topic

6. If the teacher gives demonstration, is it

(a) before the discussion ?
(b) as an introduction ?
(c) after the discussion ?

7. Do you do laboratory work ?

No	Rarely	No Opinion	Sometimes	Yes

8. If you do laboratory work check any one of the following:

(a) I really enjoy it.
(b) It helps me to understand the topic.
(c) I am not interested; it is required.
(d) I do not understand it often.

9a. Do you find difficulties with mathematics and the solution of numerical problems ?

Not at all	Rarely	No Opinion	Sometimes	Very much

9b. If you do find difficulties show in which aspect of the problem.

(a) Arithmetical computation
(b) Algebraic formulas
(c) Geometry or trigonometry
(d) Higher mathematics
(e) Units
(f) Understanding

10. The numerical problems teachers give are:

(a) Too many;
(b) Very few;
(c) A fair amount.

11. (a) Are the problems interesting ?
(b) Do they relate to practical experience ?
(c) Are they drill without practical interest ?

12. Put a mark (√) beside the branch of physics which you think is most difficult.

(a) Mechanics (b) Heat
(c) Sound (d) Light
(e) Magnetism and Electricity (f) Modern Physics
(g) Laboratory work

13a. Students often memorize principles, laws, or problems of physics.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

13b. This memorization does not mean necessarily that students understand them.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

14. Students are given very little opportunity in physics courses to observe physical events or phenomena, instruments, or machines.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

15. When a pupil fails in a physics exam most teachers discuss the matter with him and try to encourage him.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

16. Students feel afraid of a physics course before they take it.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

17. Students spend more time to study and prepare physics than any other lesson.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

18. With whom do you study your physics lesson ?

(a) With one or more friends (b) Alone
(c) With the help of a teacher (d) Others (please state)..........

19. Besides your textbook do you read books or articles pertaining to physics ?

(a) Yes (b) No

20. Estimate your ability in physics.

Unsatisfactory	Weak	Average	Good	Excellent

21. If you have other remarks on the subject of physics with regard to original lack of interest or loss of interest, or cause of failure, write them briefly in your own words.

II. QUESTIONNAIRE ADMINISTERED TO TEACHERS

Fellow Teacher,

An investigation is being made to find out the causes of failure in secondary school physics. Your cooperation in answering the questions below will be very much appreciated. The information given is confidential. Thanks for your contribution.

Name: ____________________ School: ____________________

Address: ____________________ Classes taught: __________

Academic Degree: ____________________

Years of Experience: __________

Number of courses taught this year besides physics: __________

Physics text books used: ______________________________

Directions: Please put a check mark (√) on the lines below at the proper places. Show to which side you are inclined even if you have no opinion by putting the mark near the no opinion point. In case of other types of questions either check the answer you choose or briefly answer what is asked.

1. Are your students interested in physics ?

Only a few	More than a few	No Opinion	Less than Majority	Majority

2. To what do you attribute lack of interest ?

(a)
(b)
(c)

3. Is the physics curriculum suitable to the ability of the students ?

Difficult to majority	Difficult more than suitable	No Opinion	Suitable more than difficult	Suitable to Majority

4. Do you consider the available text books suitable ?

Unsuitable	Unsuitable more than suitable	No Opinion	Suitable more than unsuitable	Suitable

5. To what extent do you give demonstrations as a basic introduction to each topic ?

None at	Less than some topics	No Opinion	More than some topics	Each Topic

6. Do you give laboratory work to your students ?

No	Rarely	No Opinion	Sometimes	Yes

7. Class sizes in physics are so large that teachers find it most difficult to pay attention to every pupil.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

8. Do you give individual attention to weak students ?

Rarely	Less than sometimes	No Opinion	More than sometimes	Always

9. Do you give individual attention to students in laboratory work and discuss with them what they are doing and whether they understand what they are doing ?

No	Less than sometimes	No Opinion	More than sometimes	Yes

10. Teachers of physics often do not check with the students to make sure that they have understood the fundamentals which are necessary prereguisites to further understanding.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

11. On what do you lay stress when deriving the laws of physics ?

(a) Mathematical derivation (b) Experimental derivation

12. What do you think are the usual mistakes of students in solving problems of physics ?

(a) Mathematics
(b) Units
(c) Understanding
(d) Other reasons (please state) ....

13. In the physics courses students very often face language difficulties.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

14a. Pupils in physics classes tend to memorize statements, illustrations and laws as these are presented in their textbooks or notes.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

14b. This memorization does not imply understanding.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

15. Teachers of physics are required to teach two much physics.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

16. Students have a common fear of physics even before they take the course.

Disagree totally	Disagree more than agree	No Opinion	Agree more than disagree	Agree totally

17. Which branches of physics do you think your pupils find most difficult ?

(a) Mechanics
(b) Heat
(c) Light
(d) Sound
(e) Magnetism & Electricity
(f) Modern physics
(g) Laboratory Work

18. The type of exam questions used most often are:

(a) Problems
(b) Problem-Question combination

(c) Objective Questions (d) Essay questions
(e) Various types combined

19. Briefly state some of the causes which you feel contribute most to the failures of physics students.

APPENDIX B

CORRESPONDENCE

I. Letters similar to the following one were sent to various research and Education Institutions in the United States, England, France, and Germany.

Yakub R. Namek
American University
Beirut, Lebanon.

March 10, 1958.

....
....
....

Dear Sir,

I am a graduate student in the Education Department of the American University of Beirut, and a teacher of Sciences in the International College.

The education curriculum of this country, Lebanon, is such that there is a large percentage of failure among the students who take physics courses, both in the high-school and in the Freshman classes. I am working on an M.A. thesis entitled, "A study of the causes of failure in the secondary school physics in Lebanon," and have been doing some research work in this field.

May I beg your kind attention to indicate to me any research or study in line with the above problem done in .... I am writing this to you with the hope that you might know something about such studies in ....

Thank you very very much for your help and cooperation.

Very respectfully Yours,
Y. R. Namek.

II.

WESTERN MICHIGAN UNIVERSITY
SCHOOL OF GRADUATE STUDIES KALAMAZOO, MICHIGAN

March 19, 1958

Mr. Yakub R. Namek
American University
Beirut, Lebanon

Dear Mr. Namek:

I just received your letter of March 10 concerning your interest in the investigation entitled "A Study of the Causes of Failure in the Secondary School Physics in Lebanon." It certainly sound like something that would be both interesting and significant. Unfortunately, however, I have no knowledge of any similar studies that have been undertaken in the United States.

Quite recently I was appointed chairman of the committee of the National Association for Research in Science Teaching to prepare the Fifth Digest of investigations in the field of high school science. I am working with Dr. Kenneth Anderson, of the University of Kansas, who is chairman of the Fourth Digest. Both of our committees have been studying investigations in the field of science education. To the best of my knowledge, we have not yet covered anything that deals specifically with this field.

I am going to suggest that you write Dr. Thomas Osgood, editor of the American Journal of Physics, at Michigan State University, East Lansing, Michigan. It may be that in his capacity as editor of that journal, he may be able to direct you to someone who would have this kind of information. I cannot, of course, be too optimistic about your success. However, he may have information which is not in my hands at the present time.

My best wishes to you.

Sincerely,

GGM:bk

George G. Mallinson, Editor
School Science and Mathematics

III.

SCHOOL OF EDUCATION STANFORD UNIVERSITY
STANFORD, CALIFORNIA

March 21, 1958

Mr. Yakub R. Namek
The American University
Beirut, Lebanon

Dear Mr. Namek:

I am afraid there has been very little research done in the United States as to why so many fail high school physics. Many feel that it is due to the old fashioned content of physics courses and the general lack of modern application. This serves to dull the interest of students and to create the feeling that the course is not worth while.

The outstanding physicists of the United States have become concerned with this problem, and thraugh some very sizeable grants of money have developed a new kind of physics course which we feel will help to solve the problem. A descriptionof this course and the details concerning its planning may be obtained from the Physical Science Study Committee, Massachusetts Institute of Technology, Cambridge, Massachusetts. There is a growing feeling in the United States that probably not more than twenty-five to thirty per cent of the high school students will ever be capable of handlinga course in physics successfully.

Most of the articles regarding failures in physics courses point out that the failure is due to a lack of a sound background in mathematics. In fact, many of our college scientists would rather that a student took an extra year of mathematics in high school if he is going on to college rather than to take high school physics.

I hope this information is of some help to and good luck on your study.

Sincerely,

Paul DeH. Hurd
Associate Professor of
Education

PH:rs

IV.

AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

A Departmenf ot the National Education Association
1201 Sixteenth Street, N.W., Washington 6, D.C.

March 19, 1958

Mr. Yakub R. Namek
The American University
Beirut, Lebanon

Dear Mr. Namek:

Perhaps the best answer we can give to you in reply to your letter of March 10 is to send copies of the December 1955 and the October 1957 issues of the Review of Educational Research.

In these I think that you will find clues to studies of pupil failures in many subjects but perhaps not much bearing directly upon failures in physics.

My pre-research guess is that pupil failure traces back essentially to the same causes in most subjects but various factors may loom larger under a given set of conditions. As principal of an elementary school I often studied individual children who were failing. Usually I approached each case by going through the following steps:

1. Physical examination to make sure that eyesight and hearing were not involved.

2. Intelligence tests to make sure that the pupil was at least of "normal intelligence."

3. Examination of background school experience to make sure that the pupil had been taught the essential learnings that preceded his present studies.

4. Tests of reading and skills to make sure that he was able to read the textbook and use other materials.

5. Interviews and tests to make sure that he was not being "blocked" by attitudes--such as his dislike of the teacher, fear of equipment, etc.

6. Interviews with the teacher to discover possible leads as to why the pupil was failing. Sometimes I found that the teacher did not understand the pupil or was expecting more of him than one could expect in view of his health and background.

Usually, by going through these steps, I found clues as to the reasons for failure. We tried to remove these conditions by medical treatment, drill, re-teaching, or other means.

It is my judgment that the reasons for failure are quite individual in each case. I believe also that correction of failure calls for individual instruction and treatment. The exceptions to this would be where the teacher and the curriculum were completely out of adjustment with a group of children.

Cordially yours,

Frank W. Hubbard
Secretary-Treasurer

FWH:eb

V.

MINISTERE DE L'EDUCATION NATIONALE

INSTITUT PEDAGOGIQUE NATIONAL
29, rue d'Ulm - PARIS Ve

Paris, le 5 Avril 1958

Réf.: 2ème B./N°- 1474

Monsieur Yacoub NAMEK
International College
American University of Beyrouth
BEYROUTH (Liban)

Veuillez trouver ci-dessous la réponse à votre question relative à les échecs dans les classes de physique des écoles secondaires en France (votre lettre du 22 mars).

L'INSTITUT PEDAGOGIQUE NATIONAL

REPONSE

Aucune enquête n'a été faite en France sur cette question, à notre connaissance.

VI.

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION
WASHINGTON 25, D.C.

April 7, 1958

Mr. Yakub R. Namek
The American University
Beirut, Lebanon

Dear Mr. Namek:

Your recent letter to the U.S. Office of Education has been referred to me for answer. I am very happy that you have written because I am anxious to make contact with science teachers in other countries.

The problem which you are studying is certainly an important one in this country as well as in yours. At the moment I am, however, not able to recall any studies which have been done on the problem in this country.

We have just completed our annual survey of the research in science education in the United States and as soon as the bulletin is published, I will send a copy to you.

. . . .

Sincerely yours,

Ellsworth S. Obourn
Specialist for Science

VII.

NATIONAL FOUNDATION FOR

EDUCATIONAL RESEARCH

IN ENGLAND AND WALES

Director
W.D. WALL, B.A. Ph.D.

79 Wimpole Street
LONDON-W-1
Tel: WELbeck 1128/9

AY/MBC

23rd April, 1958.

Mr. Yakub R. Namek,
The American University,
Beirut,
Lebanon.

Dear Mr. Namek,

I have been able to discover only one investigation currently being carried out in this country that is likely to be comparable with your inquiry. This is a study entitled 'Failures of students at the university in relation to Higher School Certificate and General Certificate of Education results'. It is being supervised by Mr. J. L. Longland, Director of Education, County Education Offices, St. Mary's Gate, Derby.

Yours sincerely,

Senior Research Officer

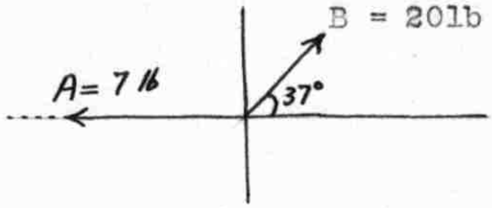
A P P E N D I X   C

I. FRESHMAN PHYSICS 101 FINAL EXAMINATION
February 1957

A Sample of examinations given to the Freshman class at the American University of Beirut.

NAME: ____________ g = 980 cm/sec2   Time: 2 1/2 hours
50 %   Div. ....

I 1. Use the method of rectangular resolutions to find the magnitude and direction of the resultant of vectors A and B.



2. An airplane taking off from a landing field has a run way of 1200 ft. If it starts from rest, moves with constant acceleration, and makes the run in 20 sec with what velocity did it take off ?

3. The top of an incline plane is 20 m above the horizontal plane. An object 10 kgm slides down the frictionless incline, what is its energy when it reaches the foot of the incline ?

4. Use the graphical method to find an expression for the work done in stretching a spring.

5. a) What is the momentum of a 10 gm mass whose velocity is 30 cm/sec ?
   b) At what velocity will a 5 gm mass have the same momentum ?
   c) If the two bodies were moving in opposite direction and stick together after collision what would be the resulting velocity ?

6. A toothpick (a piece of wood) is 4.0 cm long and floats on water. The water film on one side has a surface tension of 50 dynes/cm. On the other side there is a little camphor which reduces the surface tension to 40 dynes/cm. What is the resultant force acting on the toothpick ? How will it move ? Check (√) the correct answers:

   (1) The toothpick is in equilibrium
   (2) It will move towards the water

(3) The net force is 10 dynes
(4) The net force is 40 dynes
(5) The toothpick moves towards the camphor.

7. How much would the tendon of a man's leg be stretched by the weight of 2000 newtons, if the tendon is 10 cm long and 0.50 cm in diameter ? Young's Modulus is 1.5 x 10^9 dynes/cm^2.

8. A pendulum clock calibrated to make one complete swing once a second at a temperature of 10°C when the temperature is 35°C the clock will be:

(1) Slow
(2) Fast
(3) No change
(4) Has a period of $\sqrt{1 + 25a}$ sec where a is the expansion coef. of the pendulum.

9. Define: Node; Amplitude; Water equivalent.

10. A boy is whistling at a frequency of **243**/sec. He finds that the echo of his whistling when reflected from an approaching train makes **12** beats with the original. With what speed is the train approaching ? The speed of sound in air is 340 m/sec.

II. A mass m of 20 kgm is sliding on a frictionless horizontal table; a rope attached to m passes over a pulley on the edge of the table and another mass M of 40 kgm is attached at the other end of rope.
a) Make a diagram of the forces applied on M and m.
b) Calculate the acceleration with which the system is falling and the tension in the rope.
c) The rope will withstand a tension of 592 newtons without breaking. If it is used to raise M (by pulling on m) what are the maximum acceleration and the least permissible time with which M can be lifted 2.5 meters ? What is then the force applied on m ?

III. $u_T = \sqrt{\frac{F}{\mu}}$ $u_L = \sqrt{\frac{Y}{\rho}}$ $T = 2\pi\sqrt{\frac{m}{k}}$

A string 120 cm long is vibrating at its fundamental frequency. The mass of the string is 30 gm and it is stretched with a tension of 16 x 10^6 dynes. The amplitude of vibration at the antinode is 3 cm.

(a) Find the velocity of the wave in the string.
(b) Find the frequency of vibration.
(c) Explain briefly how there can be a standing wave

and a wave velocity at the same time.
(d) What is the maximum transverse velocity of a piece of string at the antinode.

IV. a) Discuss the mechanism by means of which transfer of energy takes place in the process of convection. In which ways is the transfer of heat by conduction and radiation different ?

b) We observed that the forces keeping a solid together can be replaced by springs. Then we assumed every atom to be joined by springs, with the proper force constant, to its neighbours. On the basis of this model of a solid, explain the expansion of solids.

c) The law of Dulong and Petit tells us that the product of the atomic weight and the specific heat is roughly 6 cal/gm-atomic wt-C°.

A calorimeter, having a heat capacity of 30 cal/°Cg. contains 100 gm of water at 20°C. 10 gm of a metal X are heated in an oven up to 282°C and rapidly transferred to the calorimeter. The final temperature is 22°C. What is the atomic weight of the metal.

II. FIFTH SECONDARY TERM EXAMINATION
PREPARATORY SCHOOL, INTERNATIONAL COLLEGE
March, 1957

A Sample of examinations given in Anglo-American type schools.

II Term Examination   Physics 5th Secondary   March 1957

NOTE: Answer Six Questions only.

I. Define the following: Dyne, resultant of forces, center of gravity, acceleration, period of the pendulum, power, erg.

II. a) State Newton's Laws of motion.
b) A gun weighing 100 Kg. fires a shot weighing 2 Kg. with a velocity of 600 meters per second. Find the backward velocity of the gun.

III. The coefficient of friction between a certain body and the plane on which it is resting is 0.2; the weight of the body is 10 lb. Find the distance that that body will move in 20 seconds when acted upon by a force of 6 lb.

IV. A uniform beam 20 ft. long and weighing 100 lb. is carried by two ropes at its ends. Find the tension in each rope when two weights of 200 lb. and 80 lb. are suspended at 5 ft. and 12 ft. respectively from one end.

V. A stone 20 g. in weight is shot vertically upward with a velocity of 98 meters per second. Find

a) The time it remains in the air.
b) The highest point it reaches.
c) At what height is it after 12 seconds.

VI. How much work is done by a man weighing 180 lb. in climbing a hill 220 ft. high. If his actual climbing time is 2 minutes, what is the horse power he develops while climbing.

VII. A car starts from rest, accelerates at the rate of 3 ft./sec for 1.5 minutes, then travels with uniform velocity for 15 min. after which it was retarded and brought to rest in 25 sec. Find

a) its maximum velocity. b) the total distance it travelled.

III. A SAMPLE OF LEBANESE BACCALAUREAT PHYSICS EXAMINATION

given in the June-July Session, 1957

Time: 3 hours

Discuss fully and quantitatively whenever possible, one of the following three main questions:

I. The microscope: principle; tracing of rays; focusing power, magnification.

II. Aluminum: natural state; production; physical and chemical properties.

III. All the following:

a) myoptic eye; correction.

b) Shunting a galvanometer.

c) The image of a virtual object obtained by a converging lens.

d) The preparation of phosphorous.

e) The action of sulfuric and nitric acids on copper. State under what conditions will each of the two acids attack copper. Write the formulas for the reactions.

Required Problem

Given two unknown resistances x and y (where x is larger than y) and a battery of e.m.f. = 12 volts and internal resistance 4 ohms.

1) To determine the values of the resistances the following measurements were made:

a) The resistances x and y were placed as the two branches of a Wheatstone bridge. The slide wire of the bridge is one meter long. The balance point is at 60 cm. Make a diagram of the circuit and find the relationship between x and y.

b) The battery given above is connected in series with a 9.6 ohm resistamce and an ammeter. The two resistances x and y are connected in parallel and the combination is then inserted in series with the rest of the circuit. When the circuit is closed the ammeter reads 0.75 ampères. Calculate the value of x and y.

2) In the circuit of (b) the resistance x is replaced by a voltameter containing acidulated water and having a counter e.m.f. of 1.2 volts and an internal resistance of 2 ohms. Calculate the current in the various branches of the circuit. Indicate the nature of the gases evolved and calculate their volume at the end of 16 minutes 5 seconds. (The volumes are measured at N.T.P.).

3) Given 20 dry cells, each having an e.m.f. of 1.5 volts and an internal resistance of 2 ohms. They are connected in such a way as to make one battery of m parallel sets, each containing n cells. The terminals of this battery are connected to the two resistances x and y given above but now put in series. Give the expression for the quantity of heat Q developed in the combination (x + y) in one minute as a function of n. Show that the 20 cells may be connected in such a way as to give maximum value of Q. Find the value of this maximum and the corresponding values of m and n.

IV. A SAMPLE OF PHYSICS EXAMINATION GIVEN IN
LATIN TYPE SCHOOLS
MAKASSED AL-ISLAMIAH COLLEGE

June, 1957

<u>4 th Year</u> <u>Physics</u> <u>Time: 100 min.</u>

I - Write in details all that you know about one of the following:

a) Convex lens:- Its power, Magnification, Equation, Uses, etc...

b) Electrolysis:- How and why does it take place; What happens in the process; Mass delivered or deposited etc...

II - A current of 10 amperes is passed in a copper-manganese coil which is immersed in one liter of pure water at 12°C. If the wire of the coil is 2.25 meters in length, and 2 m.m.sq. in cross sectional area, calculate its resistivity if the temperature is raised to 84°C after 5 minutes.

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