A COMPARATIVE STUDY OF THE PREPAREDNESS FOR FURTHER CHEMISTRY COURSES OF STUDENTS STUDYING SECONDARY SCHOOL CHEMISTRY OVER TWO TO SIX YEARS, AND THOSE STUDYING IT FOR ONE YEAR ONLY

By

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CHEMISTRY - LEBANON & U.S.A.

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PREFACE

This study is an attempt to compare the achievement in chemistry of American and Lebanese subjects. The American group comes from the American Community School in Beirut, and the Lebanese group consists of two groups, one from the Makkasid Boys School (Ali Bin-Abi Taleb) and one from the National Protestant Boys School in Beirut. The Lebanese groups have an average of 3.89 times as many hours of exposure to chemistry learning experiences.

Detection of any significant difference between the achievement of American and Lebanese groups was the main objective of the study. For this purpose an objective test was constructed, using items which teachers in both types of systems agreed upon as being essential learnings in secondary school chemistry. Without further, more specialized research, detailed conclusions will not be possible, but the directions and magnitudes of the differences found will, it is hoped, be suggestive of further research and curriculum experimentation.

I cannot conclude this introductory statement without expressing deep gratitude and indebtedness to Professor Frederick R. Korf, the Chairman of my thesis committee. Without his stimulating guidance, constructive suggestions, constant devotion of valuable time and persistent encouragement, this study would not have been fulfilled on time.

I am also grateful to the members of my thesis committee, Dr. George Hanania, Mr. Sadik Umar and Dr. Malik Badri for their help and guidance.

To the principals and chemistry teachers of the American Community School in Beirut, the Makkasid Boys School in Beirut and the National Protestant School in Beirut, I also wish to record my gratitude.

Finally I wish to register my gratitude to the students who cheerfully participated in the study, to Miss Anahid Lurchigian, who cheerfully finished the typing of this thesis under unusual pressure, and to Mr. Haytham Malluhi, my eldest brother, whose encouragement was the main motivating factor which helped me overcome a multitude of obstacles.

ABSTRACT

The thesis addresses itself to some possible serious short-comings in the system of chemistry teaching in Lebanon. It deals with the problem of comparing the preparedness in chemistry of two groups of students studying it under two different systems. The first group is the fifth secondary class at the American Community School in Beirut who take chemistry during one academic year only. The second group is the Lebanese Baccalaureate part I students at the Makkasid school and the National Protestant School in Beirut. These students have taken chemistry for two to six academic years.

A chemistry achievement test was constructed upon the common basic learnings in chemistry agreed upon by the chemistry teachers of the two groups as well as the chemistry teachers of the next higher level, that is the Freshman class at the American University of Beirut and the Lebanese Baccalaureat part II.

The test was administered to the two groups and its results were analyzed. It was found that the American group proved to be superior to the Lebanese group on the test in spite of the fact that the latter have studied chemistry for an average of 3.89 times as many hours of planned classroom exposure to chemistry than the American group.

The first chapter acquaints the reader with the system of education in Lebanon and the teaching of chemistry in it, through the following six steps:

(i) The development of education in Lebanon.
(ii) The system of education in Lebanon.
(iii) Kinds of secondary schools in Lebanon.
(iv) Aims of secondary education in Lebanon.
(v) Aims of teaching chemistry in Lebanon.
(vi) Some comments on the Lebanese Government requirements in chemistry.

The second chapter sets forth some modern aims and objectives of teaching chemistry.

The third chapter goes into the problem of constructing the test. The test was designed by the investigator to measure the achievement in secondary school chemistry of three groups of students, and was administered in three schools in Beirut.

The fourth chapter presents the administration and the results of the test.

The fifth chapter deals with the interpretation of the test results of the different groups.

The sixth chapter makes conclusions and recommendations, and strongly suggests further investigation of chemistry teaching in Lebanon in order to discover the causes and remedies for the apparent weaknesses in the present system.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE TEACHING OF CHEMISTRY IN LEBANON

Before dealing with the main topic of this study, it is useful to have a general idea about (A) the development of education in Lebanon (B) the Lebanese system of education (C) the kinds of secondary schools in Lebanon (D) the aim of secondary education in Lebanon (E) the aims of teaching chemistry in Lebanon (F) the Lebanese Government requirements in chemistry and (G) some comments on these requirements.

A. The Development of Education in Lebanon[1]

Education in Lebanon passed through three stages:

1. The Ottoman Domination from 1516 up to 1918.
2. The French Mandate from 1918 to 1943.
3. Independence from 1943 to date.

1. The Ottoman Domination

Under the Ottoman Regime, present Lebanon which came into being after World War I, consisted of two parts: Mount Lebanon, which was an independent sanjak, and a part of the vilayet of Beirut.

There were no government schools in Lebanon proper, or Mount Lebanon, under

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[1]The material for this part has been collected and adapted from a Report On Lebanon, by Atif Karam, Samia Al-Awar and Souad Nassar, 1956, p.p 11-14 an unpublished report in the Education Library of the American University of Beirut.

the Ottomans.[1] The millet system was prevalent and the different religious sects each had their own schools. A Lebanese public educational system did not really start until the French Mandate.[2] But there were 125 elementary schools in Beirut, 2 high schools, one in Tripoli and one in Beirut, an Arts and Crafts school, a Normal School, and a law school in Beirut.[3]

Missionaries played a great role in the educational development of the country. They founded two main types of schools, the Latin type, under which fall the French and Italian schools, and the Anglo-Saxon type, which includes English and American schools.[4]

It was during the 19th century that education really progressed, with the founding of the American University in 1866, the Jesuit College (later Université St. Joseph) in 1875, the French Mission Laique, and many other schools, including Russian and German schools.[5]

The study of the French language and culture was stimulated by a long-standing connection between the French and certain elements of the population. The study of English was encouraged by commercial connections with Anglo-Saxon countries, the existence of a number of American protestant mission schools, the emigration movement, and later by the predominance of British influence in neighboring Arab Countries.[6]

During the First World War, the Ottoman government took hold of most foreign schools, and removed the medical school from Damascus to Beirut. They founded

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[1]Translated from Arabic. Educational Yearbook, 1948-1949. Sati Alhusri. p. 314.

[2]The Education Yearbook of 1949. Article by Dr. Habib Kurani, titled "Lebanon, Educational Reform" G. B.Jeffrey, Chairman of Editorial Board, London, Evans Brothers Ltd., 1949. p. 449.

[3]Educational Yearbook 1948-1949, Sati Alhusri, op. cit, p. 315.

[4]Albert H. Hourani, Syria and Lebanon, Lodnon, Oxford University Press, 1946. p. 35.

[5]Ibid., p. 36

[6]Albert Hourani, Syria and Lebanon, p. 35.

a girls' college in Ainturah, and a normal school for girls.[1]

The attitude of the Ottoman authorities towards education has given the Lebanese school system certain basic characteristics which still exist, as follows:

a. Free schools (private non-sectarian schools)

Private schools have always existed in Lebanon. But, it must be said that this freedom left to schools was rather the result of the millet system, the indifference of the Turkish government toward education in general and the interest of local missionaries from various countries.

b. Confessional schools

Those who taught religion were also in charge of education. Religion had penetrated the whole structure of the school. Almost all schools were confessional.

c. National schools

Since religion and nationality were not differentiated, the confessional schools thought that they had the right to shape the "national soul". The concept of "Nation" was limited to that of "community". The schools were called national although in fact they were communal, for national loyalty during those days was not a force that determined educational policy. Loyalty to the community was the main factor.

2. The French Mandate

The French Mandate lasted from 1918 till 1943. Its aim was to assist people to become independent, and to help them develop economically, socially and culturally.[2] Education was important in the realization of this aim.

The French educators were sincere in the conviction that the most effective method of raising the intellectual, moral, cultural and aesthetic level of Lebanon, was to introduce the people to French culture and its logic, and the

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[1] Educational Yearbook 1948-1949, Sati Alhusri, p. 316.

originality of French scientific thought.[1] But after studying their efforts in Lebanon, one cannot but realize that France was seeking to encourage the Cultural assimilation of Lebanon. France was acting according to political expediency. The system which France established was contrary to the spirit of the mandate, the underlying principle of which was to help Lebanon achieve self-determination and independence.[2]

Under the French system, private secondary schools were not interfered with by the Mandatory authorities except that the French language was required to be part of their curriculum. While there were no public secondary schools during the Mandate. The old Law school and the Medical school existing under the Ottoman Regime were closed during the French Mandate.[3]

3. Independence

When Lebanon became independent in 1943, the number of public elementary schools was 248.[4] The new national government has concentrated on two things:

a. Increasing the number of public schools.

b. Defining aims and organizing their programs.

c. Stressing Arabic the national language.

In 1947, the number of public schools became 637.[5]

When Lebanon became independent, most of the officials who were in control of the Ministry of Education and Fine Arts were brought up in the French type of school. Thus when a national Educational Committee was formed to draw up an

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[1] Ibid., p. 452.
[2] Ibid., p. 456.
[3] Educational Yearbook 1948-1949, Sati Alhusri, p. 318.
[4] Ibid., p. 319.
[5] Ibid., p. 320.

educational program for Lebanon, the members were strongly inclined to adopt the French classical system prevailing at that time. Moreover the French and French types of schools outnumbered the Anglo-Saxon types, as shown in Table I

TABLE I

TOTAL NUMBER OF FOREIGN SCHOOLS IN LEBANON CLASSIFIED ACCORDING TO NATIONALITY WITH THE TOTAL ENROLLMENT OF STUDENTS IN EACH (1958-1959)*

	NATIONALITY							
	French	American	British	Italian	Greek	German	Danish	Total
Number of Schools	97	8	7	2	2	2	1	115
Number of Students	36,845	2134	2531	484	194	260	187	42,635

*From an unpublished report in the Education Library of the American University of Beirut according to government statistics 1958-1959.

The previous point is strongly supported by the fact that the Lebanese program of Education which was issued in 1946, proved to be a mere translation of the traditional French program. The only slight changes in it were:

a. The teaching of History, Geography and Civics in Arabic.

b. Sciences could be taught in Arabic,[1] English or French.

c. The English language was accepted to be equivalent to the French and English sections were opened for the Brevet and Baccalaureat examinations. But the private and public secondary schools teaching in French outnumber by far those teaching in English. For example only one of the four public secondary

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[1]No Lebanese Secondary School now teaches the sciences in Arabic. There was one trial, whereby the Makkasid School in Beirut, taught it in Arabic from 1944 to 1946. This was discontinued because some members of the council claimed that this would lead to weakening the students in their foreign languages.

schools in Beirut, uses English as a medium of teaching.[1] The following table gives the language-of-instruction distribution of schools in 1954-1955:

TABLE II

DISTRIBUTION OF SCHOOLS IN LEBANON ACCORDING TO LANGUAGE (1954-1955)*

Only Arabic - 110 schools	Arabic + English + French - 290
Arabic + French - 1280 schools	Arabic + French + Other - 58
Arabic + English - 230 schools	Arabic + English + Other - 5

*Zareh Kahkedjian and Leila Biksmati, Education in Lebanon, p. 18.

It should be mentioned here that the first public secondary school was opened during the year 1951. By 1961 there were 17.[2]

B. The Lebanese System of Education

There are three stages of pre-university education in Lebanon: the elementary stage, the higher elementary or intermediate stage, and the secondary stage. A student spends five years in the elementary stage, at the end of which he sits for the first government examination, called the "Certificat". This certificate is a prerequisite for sitting for the other higher government certificates, namely the intermediate certificate, called the "Brevet", and the secondary certificate, called the "Baccalaureat" part I and II.

If a student passes the "Certificat" examination, he is allowed to continue his studies for four "intermediate" years leading to the second government examination, namely the "Brevet". Strangely enough this certificate is not a

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[1]Interview with Mr. Muhammad Shbaklou, chemistry teacher at the Makkasid School in Beirut.

[2]From an unpublished mimeo. report in the Education Library at the American University of Beirut, according to statistics of the government.

prerequisite for sitting for the Baccalaureat part I and II.[1] Therefore some schools, such as the International College in Beirut, the British Boys School in Beirut, and the Rawdah School in Beirut, do not prepare their students for this certificate.

After the intermediate stage, a student studies for two more secondary years in order to sit for the third government certificate, specifically the Baccalaureat part I. There are three types of Baccalaureat part I, depending on the course of studies, namely Scientific, Literary and Ancient Languages.[2] If a student passes the Baccalaureat part I, he is permitted to study for one more year, at the end of which he sits for the fourth government certificate, the Baccalaureat part II, either Literary or Mathematics.

Students of French schools can sit for the French Baccalaureat because it is considered by the Lebanese Government to be equivalent to the Lebanese Baccalaureat.

Students of British schools, such as Brummana school, sit for a British certificate, namely the General Certificate of Education. Recently the Lebanese government accepted the Syrian Baccalaureat, the Egyptian Tawjihiyah and the General Certificate of Education (advanced level) as equivalent to the Lebanese Baccalaureat part II.[3]

C. Kinds of Secondary Schools in Lebanon

There are many kinds of secondary schools in Lebanon, but the majority of them fall under one of the following two major types:

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[1]In Syria the "Brevet" is a prerequisite for the Syrian Baccalaureat.

[2]The difference between one section and another is a matter of emphasis rather than an important difference in subject matter.

[3]Professor Frederick R. Korf, Director of the Office of Tests & Measurements at the American University of Beirut remarked that: "there is considerable current discussion as to whether the recognition of these Syrian and Egyptian equivalences will continue - and indeed whether any equivalences at all will be recognized in

1. The Anglo-Saxon type of school which includes

   a. American and British schools, missionary andprivate.

   b. National private schools which use the English language as the medium of instruction. These are influenced mainly by the American system, the British system, or both. But now, more and more they are following the Baccalaureate program. However there are great variations among these schools in matters of curricula, methods of teaching, etc.

2. The French type of school which includes

   a. French missionary schools.

   b. Government or "public" schools.

The system of public education in Lebanon today is the French system. The system is French not only in philosophy, aims, curriculum, method; but also in organization and administration.[1] Moreover most of the officials in the Lebanese Ministry of Education andFine Arts are still biased toward the traditional French philosophy of education.

3. Lebanese private schools following the French system

Although the French-type schools are still a majority if compared to the Anglo-Saxon ones, there is a clear trend towards an increase in the proportion of schools teaching in English. This parallels the spreading of the English language in business circles and the fact that most modern publications in the sciences and professions are published in English. This trend can be felt clearly in schools having both "English" and "French" sections.[2] Moreover, most French schools, about ten years ago, started teaching English as a second language

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[1]From an article on file in the Education Library at the American University of Beirut titled Lebanon, by Marla Ann Millon. p. 6.

[2]For example in the Makkasid School for Boys in Beirut there are two to three divisions in the English section for each division in the French section.

for their students.[1]

D. Aims of Secondary Education in Lebanon

The aim of secondary education in Lebanon as stated in the Lebanese Program of Studies[2] published in 1946 is:

> "The aim of secondary education is to train and select the gifted youth of the country for the right orientation of the mind, for carrying the major responsibilities of public life, and for enlightened specialization in the branches of higher education"

If we consider this aim of secondary education we find that its main purpose is to educate a limited number of students, that is the gifted or the elite who plan to continue their studies in one of the universities in Lebanon or abroad. But nowadays the students who plan to continue their higher studies are not the only ones who seek a secondary education. As a matter of fact many of them are not in school with the idea of continuing their higher studies; some because they cannot afford it and some because they are satisfied with a secondary education and would like to find jobs. The present aim, therefore, does not take care of all students of secondary school age. Therefore such an aim no longer meets the needs of the present Lebanese youth. A sound aim of education should make provision for the majority of students and not a small percentage of them. We should aim at educating the largest number possible and to give them a type of education suited to their ultimate roles in their society.

The way the government attempts to measure the achievement of this aim is through government examinations. In Lebanon, Government certificates are required for employment in the various ministries. Moreover such certificates are a necessity for the Lebanese student who is planning to continue his studies in any

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[1]For example the Azzarieh School in Jamhour started teaching English in 1955.

[2]Lebanon, Ministry of National Education - Program of Studies. A translation from the Arabic original by point IV, Department of Education.

university in Lebanon, such as the American University of Beirut,[1] St. Joseph University, The Lebanese University or the Arab University. According to Mr. George Za'rur,

> "All secondary schools in Lebanon were asked to present their students to sit for the Baccalaureat part I examination in June 1955 and for the Baccalaureat part II beginning in June 1956. Students graduating from secondary schools in and after June 1956, will not be allowed, later on, to practice any profession such as Medicine, Law, Engineering, Pharmacy and Dentistry unless they are holders of the Lebanese Baccalaureat part II".[2]

E. Aim of Teaching Chemistry in Lebanon

There is no definite aim given by the Lebanese Ministry of Education and Fine Arts for teaching chemistry in secondary schools, as there is no mention of the aim in the Lebanese program of studies published in 1946.

Mr. George Za'rur, in his thesis, thinks that:

> "The present day aim in the teaching of secondary school chemistry in Lebanon seems to be to prepare students for general public examinations and for higher studies".[3]

Now, if the above aim is true then the general public examinations are considered as an end in themselves, while they should be regarded as a means to an end which is the overall development of the student.[4]

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[1]Dr. Frederick R. Korf, Director of the Office of Tests & Measurements at the American University of Beirut stated that "It is still possible, as of 1964, to enter the American University of Beirut without a government certificate, through the university's entrance examinations. This route to a university education may or may not remain open."

[2]George Za'rur, Teaching of Chemistry in the Secondary Schools of Lebanon, 1957. pp. 6-7. Unpublished M.A thesis in Education at the American University of Beirut.

[3]Ibid., p. viii.

[4]Lawrence E. Cole and William F. Bruce, Educational Psychology, New York, World Book Company, 1950. p. 659.

"In spite of our advances in measuring some phases of growth, there is still much to be desired, particularly when we become interested in the whole - person-in--action. Yet we must face this problem too, as surely as we hold to our objective - to teach the whole child and to develop the Mature Person".

F. The Lebanese Government Requirements in Chemistry

The following is an English translation from the Arabic original, of the Lebanese Government requirements in chemistry as prescribed in the Lebanese Program of Studies published October 1946, p.p. 158-181.

HOURS PER WEEK FOR VARIOUS SCIENCES ACCORDING
TO THE GOVERNMENT PROGRAM OF OCT. 1, 1946
FOR SECONDARY EDUCATION

YEARS OF STUDY	SUBJECTS	HOURS PER WEEK
Ist & IInd Sec.	Physics, Chemistry & Biology	4
IIIrd & IVth	Physics, Chemistry & Biology	3
Vth & VIth Literary	Physics & Chemistry	3
Vth & VIth Scientific	Physics & Chemistry	6

FIRST SECONDARY

1. Simple experiments showing the properties of the following: air, oxygen, hydrogen, water, carbon & carbon dioxide.
2. An idea about the preparation of: Oxygen, Hydrogen and carbon dioxide.
3. A brief study of: Sulphur, Sodium chloride, calcium carbonate, the most important acids, bases and salts.
4. Properties of metals and alloys.

SECOND SECONDARY

1. Simple knowledge of: physical phenomena, chemical phenomena, mixtures and pure substances; kinds of substances, simple elements, complex elements, mixtures and compounds, analysis and synthesis.
2. Simple knowledge about: the method of naming chemical elements, the composition of matter, symbols and atomic weight, formulas and molecular weight, an idea about the law of Lavoisier and chemical equations.

3. Air: life and burning, rusting of metals (iron, copper and mercury) Lavoisier's experiments, analysis of air, applications, nitrogen in the air.
4. Oxygen: Preparation, important properties, burning of non-metals (phosphorus, sulphur and carbon). Properties of acids. Burning of metals (calcium, sodium), properties of bases. Oxides in general (iron, zinc and magnesium).
5. Water: Natural water, its composition, gases and solids dissolved in water, drinking water.
6. Pure water: Preparation, composition, electrolysis, composition by weight and volume, important properties.
7. Hydrogen: Preparation and imoprtant properties, its effect on copper oxide, characteristics.
8. Important chemical processes: oxides, acids, bases and salts.
9. Carbon: natural and artificial coal, important properties of carbon.
10. Carbon monoxide: properties and physiological effects, differences between it and carbon dioxide.

Some Remarks about the Chemistry Curriculum:

1. All the lessons should be reviewed at the end of the year.
2. It is helpful to give the students some practice with the symbols and formulas beginning with the first secondary and to give them practical exercises about their lessons.
3. This program is equal to the work of seven school months with an average of four periods per month.
4. The practical problems -exercises- should be chosen from the following:
   A. Calculation of the atomic weight.
   B. Calculating the weight of one liter of the gas at N.T.P.
   C. Calculating the density of the gas in comparison to air.
   D. Solving problems with one chemical equation; exercises which do not need except the calculation of volumes of gases and exercises in which we do not need the equation, cases where the masses of the two reacting substances are given and it is required to determine which of the two substances remains in excess.

THIRD SECONDARY

1. Reviewing the most important phenomena, chemical terms, oxides, acids, bases, salts, compounds free of oxygen and not acidic, meaning of combining force of non-metals, metals, and radicals, numerical laws of chemical combination.
2. Common salt: extraction and properties.
3. Nitrogen: occurance in nature, preparation and properties.
4. Ammonia: preparation of ammonia from ammonium salts, solution of ammonia, and its basic properties.
5. Natural sodium nitrate: properties, the effect of sulphuric acid on it.
6. Calcium carbonate: important properties.
7. Calcium: preparation, properties, kinds of calcium compounds used for building.
8. Carbon dioxide: preparation, important properties, differences between it and nitrogen.
9. Sulphur: occurance in nature, extraction, important properties, burning of sulphur.
10. Sulphur dioxide: preparation, properties and characteristics.
11. Sulphuric acid: preparation, properties and characteristics.
12. Sulphates: calcium sulphate, iron sulphate and copper sulphate.
13. Practical properties of metals and alloys.
14. Potassium and sodium: properties and basic character.
15. Important ores: oxides, carbonates, sulphates, general principles of metallurgy.

FOURTH SECONDARY

Organic Chemistry

1. Organic matter: composition, how to test for the elements present.
2. Methane and acetylene: important properties.
3. Cellulose: paper, gunpowder.
4. Flour: starch and gluten.
5. Glucose: ordinary sugar, information about its preparation and general properties.
6. Alcoholic fermentation: studying and carrying experiments about t he properties of ethyl alcohol, its change to ether and to soap.
7. Oxidation.
8. Vinegar: General information about fermentation (complex ferments, soluble ferments).

FIFTH SECONDARY

1. Comparison between physical and chemical phenomena, change of state, pure substances and mixtures, simple matter and complex matter.
2. Chemical reactions and combinations.
3. Information about the atomic and molecular theory.
4. Use of symbols, qualitative and quantitative meaning of symbols.
5. A chemical and experimental study of the following:
   A. Air: oxygen and nitrogen.
   B. Water: oxygen and hydrogen.
   C. Common salt: chlorine and sodium, hydrochloric acid, sodium hydroxide.
6. Analogies and similarities between chemical phenomena, ways of classifying metals and non-metals in families.
7. Chemical functions: acids, bases and salts.
8. Sulphur, hydrogen sulphide, sulphur dioxide, sulphur trioxide and sulphuric acid.
9. Nitrogen, nitric acid and ammonia.

SIXTH SECONDARY (SCIENTIFIC)

1. Phosphorus: phosphoric acid and phosphates.
2. Carbon: kinds of carbon, carbon dioxide and carbon monoxide.
3. Silicon and silicates.
4. Metals: Properties of metals and alloys, metallic families or groups.
5. Examples of basic metals: sodium, potassium, sodium hydroxide, potassium hydroxide, sodium chloride and sodium carbonate.
6. Examples of basic metals in the soil: calcium, soils rich in lime, lime and gypsum.
7. Iron: Pig iron, steel and iron sulphate.
8. Aluminum: alumine, aluminum sulphate and alums.
9. Copper: alloys and copper sulphate.

SIXTH SECONDARY (LITERARY)

1. A brief and practical knowledge of:
   A. Phosphorus, carbon, silicon and its natural derivatives, correlating it with properties of non-metals.
   B. Metals - properties of metals and alloys.
2. Brief and practical information about:
   A. Sodium, iron, aluminum, copper, calcium and its natural derivatives correlating its properties with those of metals.

G. Some Comments on the Lebanese Chemistry Requirements.

A careful study of the above requirements in Chemistry, especially as it is put in practice, warrants the following comments:

1. The three sciences Physics, Chemistry and Biology are taught as separate subjects.
2. The program supposes that a student studies chemistry for six consecutive years, while we find some schools teaching it for fewer years. (e.g., The International College in Beirut, two years; Rawdah School in Beirut, three years; Universal School - Aley, five years; Makkasid School for Boys in Beirut, six years).
3. The number of hours per week alloted to chemistry increases as the student approaches the end of his secondary education.
4. The curriculum mentions pieces of information collected from here and there without stressing general principles and laws. For example, in the fourth secondary the teacher is expected to teach methane and then jump to acetylene, but there is no mention of anything about ethylene, which is a necessary step before the student can understand acetylene.
5. Most of the information included is fragmentary and descriptive rather than experimental. For example in the first secondary there is a "brief study" of sulphur, sodium carbonate etc; in the third secondary sulphates - calcium sulphate, iron sulphate and copper sulphate.
6. There is little emphasis on laboratory work. The syllabus does not require specific experiments for each class. One consistently finds statements like, "an idea about", "a brief study of", "simple knowledge about", "information about", etc.

Although sometimes the preparation of the substance required is mentioned, or, as in the fourth secondary, Alcoholic fermentation, studying and carrying out experiments on the properties of ethyl alcohol.

7. This curriculum is rigid and does not allow room for individual differences among students. It requires the same material from all the students. It fits only those who are academically minded.

8. The present curriculum does not contain anything about the modern concept of the atom, the atomic theory and other modern findings in chemistry. However one of the requirements in the fifth secondary is a certain minimum of out-dated information about atomic and molecular theory.

9. There is no mention of the scientific method nor the development of scientific attitudes, interests and appreciations among students.

The following are some comments on the Government syllabus in chemistry for schools in Lebanon made by Dr. George Hanania, Chairman of the Department of Chemistry (1960-1963) at the American University of Beirut:[1]

First Year - I can see no justification for the teaching of "chemistry" as a distinct subject to this class. The study of natural phenomena should be included in a general science course.

Second Year - Since the work is supposed to comprise 28 hours only (seven months with an average of 4 periods per month) the material included in the syllabus cannot possibly be taught meaningfully. It is much better to omit the subject altogether.

Third Year - The teaching of chemistry could very well start here. It

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[1]In a letter received from Dr. George Hanania, Chairman of the Chemistry Department in January 1962. See Appendix.

should include (1) simple experiments on common substances, and (2) an introduction to chemical ideas and language. For instance, items number 1[1] and 2[2] from the syllabus of the first year, items number 1, 2, 3, 4, 5 and 6[3] from the syllabus of the second year, and items number 1, 2, 4, 8, 11, 12 and 15[4], may be included from the third year.

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3 These are:

1. Simple knowledge of: physical phenomena, chemical phenomena, mixtures and pure substances; kinds of substances, simple elements, complex elements, mixtures and compounds, analysis and synthesis.
2. Simple knowledge about: the method of naming chemical elements, the composition of matter, symbols and atomic weight, formulas and molecular weight, an idea about the law of Lavoisier and chemical equations.
3. Air: life and burning, rusting of metals (iron copper and mercury) Lavoisiers experiments, analysis of air, applications, nitrogen in the air.
4. Oxygen: preparation, important properties, burning of non-metals (phosphorus, sulphur and carbon), properties of acids, burning of metals (calcium, sodium), properties of bases, oxides in general (iron, zinc and magnesium).
5. Water: natural water, its composition, gases and solids dissolved in water, drinking water.
6. Pure water: preparation, composition, electrolysis, composition by weight and volume, important properties.

4 These are:

1. Reviewing the most important phenomena, chemical terms, oxides, acids, bases, salts, compounds free of oxygen and not acidic, meaning of combining force of non-metals, metals and radicals, numerical laws of chemical combination.

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[1] Simple experiments showing the properties of the following: air, oxygen, hydrogen, water, carbon and carbon dioxide.

[2] An idea about the preparation of: oxygen, hydrogen and carbon dioxide.

Fourth Year - It is not a good idea to devote this year to a descriptive study of some organic substances. It would be much better for the student (and the teacher) if the above suggestion (i.e. - the suggestion for the third year) was also taken up here. There would be (1) more simple experiments showing the properties of metals, non-metals, oxides, acids, bases, salts, gases etc. (2) further study of ideas, such as in items 1, 2, 3, 4, etc.[1] of the fifth year syllabus.

Fifth Year - Organic chemistry (from the fourth year syllabus) can now be introduced, emphasizing not the properties of substances but the practical aspects of oxidation, fermentation etc.

Sixth Year - This should be regarded as the first (and only) year of chemistry proper. The government syllabus, in my opinion, is of the wrong type. Instead of being essentially a memory study of the "preparation, properties, characteristics, and uses" of selected elements and compounds, it should integrate what the student has so far learnt in chemistry. This can be done best be reviewing the elementary, but modern, view of atomic structure and chemical bonding, the general types of

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Cont'd.

2. Common salt: extraction and properties.
4. Ammonia: preparation of Ammonia from Ammonium salts, solution of Ammonia, and its basic properties.
8. Carbon Dioxide: preparation, important properties, differences between it and nitrogen.
11. Sulphuric acid: preparation, properties and characteristics.
12. Sulphates: calcium sulphate, iron sulphate and copper sulphate.
15. Important ores: oxides, carbonates, sulphates, general principles of metallurgy.

1 These are:

1. Comparison between physical and chemical phenomena, change of state, pure substances and mixtures, simple matter and complex matter.
2. Chemical reactions and combinations.
3. Information about the atomic and molecular theory.

chemical compounds and their reactions; the fundamental types of chemical calculations; and a little knowledge of the properties and reactions of, say, carbon, sulphur, iron and copper and their compounds, based on laboratory work.

CHAPTER II

SOME MODERN AIMS AND OBJECTIVES OF CHEMISTRY TEACHING

The first chapter pointed out that the chemistry program of studies in Lebanon is an outmoded one which still heavily stresses subject-matter and neglects the needs of the learner. This is part of the reason for the high percentage of science failures[1] in the government Baccalaureat examinations part I and II. These failures are causing much criticizm by teachers, students and intellectuals, especially just after the annual publishing of examination results. Most of the local newspapers and magazines publish articles and opinions criticizing the prevailing system and asking for changes in it. It is hoped that these criticizms and a concern for the educational future of Lebanese youth will draw the attention of those who are responsible in the Ministry of Education and Fine Arts, and cause them to restudy the present system and change it according to more modern findings in Education and Psychology. A change should be in line with modern research supported aims and objectives whereby due attention is paid not only to the subject matter but also to the learner as an active participant.

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[1] Zareh Kahkedjian and Leila Biksmati, Education in Lebanon, p. 12.
"At the end of the academic year 1954-1955, only 25% of all candidates of the Baccalaureat part II obtained a grade of 50 (over 100) or more in sciences".

Mr. Abdul Kadir Hubayti suggested that:

"When considering the objectives of chemistry teaching, we should not think merely in terms of how much subject-matter can be memorized by students. Subject-matter is not an end in itself. It is a means to an end. The end is the growth of the student in desirable directions. Therefore, when considering the objectives of chemistry teaching we should think in terms of the students; that is, in terms of the desirable changes to be brought about in the thinking, attitudes, interests, appreciations and behavior of students".[1]

The following are some modern objectives for chemistry teaching, collected and adapted from the 46th yearbook of the National society for the study of Education[2] and from a thesis by Abdul Kadir Hubayti[3], which the writer believe to be sound.

1. Functional understanding of facts, concepts and principles of chemistry. To be functional facts of chemistry taught to the students should be of vital value to their lives and should help them adjust more effectively to the natural and to the social environment. Things studied in chemistry should have direct or potential application in the students' lives. Such topics as foods, vitamins, hormones, fuels, petroleum, dyes, atomic energy and its peace time uses are examples of functional understandings necessary for secondary school students.
2. Instrumental skills:- A student should be able:
   a. To read chemistry content with understanding, and to evaluate news, articles and popular writings on chemical development.
   b. To perform experiments with chemical equipment and to do simple research work in chemistry.

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[1] Abdul Kadir Hubayti, Modern Methods and Materials for the Enrichment and the Improvement of the Chemistry Curriculum in the Secondary Schools of Iraq, 1956. p. 74. Unpublished M.A thesis in Education in the American University of Beirut.

[2] National Society for the study of Education, Science Education in American Schools. 46th Yearbook, part I, Chicago: University of Chicago Press, 1947 p.p 19-41.

[3] Abdul Kadir Hubayti, Modern Methods and Materials for the Enrichment and

c. To understand graphs, tables, charts etc.

d. To make accurate measurements, observations, readings and titrations.

e. To make correct interpretations.

f. To form independent judgments.

g. To evaluate.

3. Problem solving skills. A student should be able:

   a. To locate and define a problem.

   b. To collect data (relevant to the problem) systematically.

   c. To generalize from facts.

   d. To test these generalizations by experimental or other means.

   e. To draw conclusions.

   f. To apply these conclusions to new situations.

4. Scientific Attitudes. A student should be able:

   a. To view facts objectively.

   b. To suspend judgment until facts are secured.

   c. To revise his opinion if the evidence warrants.

   d. To be open-minded.

   e. To have conviction in the universality of the cause and effect relationship.

   f. To have a spirit of inquiry.

   g. To accept the idea of change.

5. Appreciations. A student should be able:

   a. To appreciate the contributions of chemists and the implications of their research and findings to the wellbeing of individuals, society and to national affairs.

   b. To appreciate the contributions of the scientific method.

   c. To appreciate nature's laws and phenomena.

6. Interests. A student should be

   a. Interested in some phase of chemistry as a recreational activity or hobby which may be used to enjoy spare time.

   b. Interested in reading about chemistry.

   c. Interested in chemistry as a field for a vocation.

The above aims and objectives were not arranged in any order of importance. Moreover, these aims and objectives are high goals and progress towards them is highly desirable but no student is expected to achieve them all.

As mentioned earlier in chapter I, the Lebanese curriculum in chemistry mentions no aims and objectives for its teaching and the writer believes that some of these aims and objectives can be used in forming some of the goals of a new and revised chemistry curriculum for Lebanon. The author believes that the most important ones of them which are needed now are: number 1 the functional understanding of facts, concepts and principles of chemistry; number 3 the problem solving skills; and number 4 the scientific attitudes.

CHAPTER III

THE CHEMISTRY ACHIEVEMENT TESTS USED

Since an important part of this study is based on the achievement of two different groups of students in certain common topics in chemistry, it was necessary to find a way to measure this achievement. Teachers' grades could not be used effectively, because different teachers teach the different groups, and teachers usually use different criteria in grading their students. So it was decided to construct an objective chemistry test for this purpose.

A. The Purpose of the Test

Any good test should have a purpose. This purpose should be in mind before constructing the test. The more a test achieves its purpose the better. The purpose of this test was to measure the achievement of two different groups of secondary students in certain common basic essential learnings in chemistry agreed upon by the teachers of the different systems.

There are three different curricular ideas working in Lebanon at the same time. These are: <u>first</u>, the Lebanese students following the Lebanese program of studies which expects certain topics and learnings in chemistry, <u>second</u>, there is the American Community School in Beirut, which is similar to other high-schools in the United States of America, and which has its own requirements of topics and basic learnings in chemistry. <u>Third</u>, there is the American University of Beirut, which conceivably has other concepts concerning the best

topics and learnings in chemistry prior to its Freshman year. The important idea here is to find topics and basic essential learnings which are common to the three curricular ideas, and which each agrees are needed at the secondary school level.

B. The Construction of the Test

Since the achievement test was to be constructed about the identical basic essential learnings agreed upon by teachers of Freshman chemistry at the American University of Beirut, chemistry teachers of the Lebanese Baccalaureat part II (seventh secondary) and the chemistry teacher at the American Community School in Beirut, it is necessary to discuss how this was done.

The following list of forty-three different topics in chemistry were presented to Dr. George Hanania, who was responsible for the American University of Beirut Freshman chemistry course during 1961-1962. He was asked to check the topics which he thought were basic chemistry prerequisites for students who were planning to take Freshman chemistry at this university. Moreover, he was asked to add any other topics which he thought were required and basic and did not appear on the list. He kindly checked twenty-three items from the following list:

*1. Chemistry - definition and evolution in brief.
*2. Elements, mixtures and compounds.
*3. Methods of separating mixtures.
*4. Physical and chemical changes.
*5. Symbols of elements and their valencies.
*6. Atomic structure and chemical bonding.
*7. Formulas and equations.
*8. Simple gas Laws.
   a. Boyle's Law.
   b. Charle's Law.
   c. Absolute temperature.
*9. Kinetic molecular theory.
*10. Avogadro's Law.
11. Gay Lussac's Law.
*12. Dalton's Law of partial pressure.
*13. Graham's Law of Diffusion.
*14. Laws of chemical combination by weight.
*15. Equivalent weights of metals and methods for their determination.
*16. Atomic and molecular weights - simple and basic methods for their determination.
*17. Problems based on equations, equivalent weights and simple gas laws.
*18. Electrolytes - Acids, bases and salts.
*19. Oxygen and air-oxides.
*20. Hydrogen and water.
*21. Oxidation and reduction - old and modern views, balancing equations on basis of oxidation and reduction.
22. Chlorine - Hydrogen Chloride, Chlorides and oxychlorides.
23. Sulphur - Hydrogen sulphide and sulphides.
24. Oxides of sulphur, sulphuric acid and sulphates.
25. Nitrogen, Ammonia and Ammonium salts.
26. Oxides of Nitrogen, Nitric acid and Nitrates.
27. Carbon, its allotropic forms, carbonates and Bicarbonates.
28. Carbon dioxide, Carbon monoxide - Gaseous fuels.
29. Distillation of coal and wood.
30. Silicon, Silica and Silicates - glass.
31. Phosphorus, Phosphoric acids and phosphates.
*32. Ionic theory and Electrolysis.
*33. Solutions, Solubility curves and Equilibrium.
*34. Classification of elements.
   a. Metals and Non-metals.
   b. Displacement series of the metals.
   c. Periodic table and the important families of the elements.
35. Metallurgy.
36. Alkali metals:
   a. Potassium and its compounds.
   b. Sodium and its compounds.

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*The items which bear this sign were checked by Dr. George Hanania.

37. Alkali earth metals - calcium and its compounds.
38. Iron and its compounds - steels.
39. Aluminium and its compounds.
40. Copper and its compounds.
41. Alloys - basic properties, importance and important examples.
42. Titration - Acidimetry and Alkalimetry.
43. Problems involving titration.

The following note was also given by Dr. George Hanania, Chairman of the Chemistry Department 1960-1963, at the American University of Beirut.

I would advise the student who plans to study chemistry in the Freshman year at the American University of Beirut, to be prepared in the following:

1) English language.
2) Mathematics, with enough manipulative experience in Algebra, the use of logarithms etc.
3) Physics, the fundamental concepts of weight, heat, temperature scales, electricity, etc.
4) Chemistry. Two years are more than enough, assuming the teaching was from a modern viewpoint, namely including:
   (i) modern ideas on atomic structure and chemical bonding (very elementary).
   (ii) a laboratory study of properties, reactions etc.
   (iii) cutting down much of the descriptive material,
   (iv) emphasising the parallelism between theory and experiment in chemistry.

Then Mr. Sadik Umar, the chemistry teacher of the Lebanese Baccalaureat part II (seventh secondary) at the International College - Beirut, was asked to give us a list of chemistry topics and basic essential learnings in chemistry expected from students planning to take the Baccalaureat part II chemistry course. He kindly supplied the following list:

1. Physical and chemical changes.
2. Elements, mixtures and compounds.
3. Oxygen, Hydrogen and water.
4. Symbols, Formulas and Equations.
5. The Gaseous state, Laws of gases.
6. Laws of chemical combination.
7. Atomic and molecular weights - formulas.
8. Computations from equations.
9. Atomic structure.
10. Solutions, concentration of solutions.
11. Electrolytes - Acids, bases and Salts.
12. The Halogens.
13. Oxidation and Reduction.
14. Sulphur, its oxides and acids.
15. Carbon and Silicon.
16. Phosphorus.
17. Metals and Metallurgy.
18. The alkali metals and their compounds.
19. the alkaline-earth metals.
02. Iron.
21. Aluminum.
22. Copper.

Mr. Muhammad Shbaklou, the chemistry teacher of the Lebanese Baccalaureat part II at the Makkasid Boys School, was also asked to compile a list of the topics and basic essential learnings expected from students planning to take the Baccalaureate part II chemistry course. He kindly provided the list that follows:

1. Chemistry - definition and evolution in brief.
2. Elements, mixtures and compounds.
3. Methods of separating mixtures.
4. Physical and chemical changes.
5. Solutions - solubility curves.
6. Atomic theory.
7. Symbols, formulas and equations.
8. Boyle's and Charle's Laws - Absolute temperature.
9. Equivalent weights - important methods for their determination.
10. Kinetic molecular theory and gas Laws - Avogadro, Gay Lussac, Dalton's law of partial pressure, Graham's.
11. Laws of chemical combination by weight (4 laws).
12. Atomic and molecular weights - simple and basic methods for their determination.
13. Problems based on equations, equivalent weights and simple gas laws.
14. Oxygen and air - oxides - seven kinds.
15. Acids, bases and salts.
16. Hydrogen and water.
17. Oxidation and reduction - old and modern views - balancing equations on basis of oxidation reduction.
18. Chlorine, hydrogen chloride, chlorides and oxychlorides.
19. Sulphur, Hydrogen Sulphide and Sulphides.
20. Oxides of sulphur, Sulphuric acid and Sulphates.
21. Nitrogen, Ammonia and Ammonium salts.
22. Oxides of nitrogen, Nitric acid and nitrates.
23. Carbon and its allotropic forms, carbonates and bicarbonates.
24. Carbon dioxide, carbon monoxide - Gaseous fuels and Bunsen burners.
25. Distillation of coal and wood.
26. Silicon, Silica and Silicates - glass.
27. Phosphorus, Phosphoric acids and phosphates.
28. Ionic theory and electrolysis.
29. Structure of the atom - valency - elements and radicals of a fixed valency.
30. Classification of the elements.
    a. Metals and non-metals.
    b. Displacement series of the metals.
    c. Periodic table and the important families of the elements.
31. Alkali metals - Potassium, Sodium and Compounds.
32. Alkali earth metals - Calcium and its compounds.
33. Metallurgy - 8 important methods.
34. Alloys - basic properties, importance and important examples.
35. Aluminum and its compounds.
36. Copper and its compounds.
37. Iron and its compounds.
38. Titration - Acidimetry and Alkalimetry - problems involving titration.

Then, Mr. George Za'rur, the chemistry teacher at the Community School in Beirut, was asked to give us a list of his chemistry topics and basic essential learnings.[1] He referred the writer to the program which he follows in his chemistry

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[1]This school, like American high schools in the United States of America, offers chemistry for one year only in the fifth secondary (i.e. the year before the final year) five periods (48 minutes) per week plus one laboratory period of 48

textbook.[1]

The secondary school chemistry learnings proposed by these four chemistry teachers, namely Dr. Hanania for Freshman, Mr. Umar and Mr. Shbaklou for Lebanese Baccalaureate part II and Mr. Za'rur for the American Community School in Beirut; were compared. The following thirteen topics were found to be represented on all four lists:

Topic	Number of items constructed
1. Elements, mixtures and compounds.	(4)
2. Physical and chemical changes.	(4)
3. Symbols of elements and radicals and their valencies	(4)
4. Atomic structure and chemical linkage.	(4)
5. Formulas and equations.	(4)
6. Simple gas Laws.	(5)
a. Boyle's Law.	(1)
b. Charle's Law.	(1)
c. Absolute temperature.	(1)
d. Problems about these.	(2)
7. Atomic and molecular weights - simple and basic methods for their determination	(4)
8. Problems based on equations and equivalent weights.	(4)
9. Electrolytes - Acids, bases and salts.	(9)
10. Hydrogen and water.	(4)
11. Oxygen and air - oxides.	(6)
12. Ionic theory and electrolysis.	(4)
13. Solutions, solubility curves and equilibrium.	(4)

[1] G. Rowlins and A. Struble, Chemistry in Action, Boston, D.C. Heath and Co., 1956.

A thorough look at these common elements of the four lists may show that they constitute a basic core for any secondary chemistry course. That is, items like elements, mixtures and compounds; symbols of elements and radicals; atomic structure and chemical linkage; formulas and equations; atomic and molecular weights, form a very important part of any chemistry course. So, an achievement test built upon these common requirements should indicate a level of achievement which is comparable from school to school and from curriculum to curriculum.

An objective test was constructed about the previous thirteen topics, using a "test blueprint" or plan containing the number of items shown in parentheses after each item. The material about which the different items were made, was selected from material covered in the chemistry textbooks[1] used by the different experimental groups who took the test. In each case it was ascertained that the books used covered the item in question.

The procedures outlined by Thorndike and Hagen[2] were followed in the construction of items, which are all of the multiple-choice type. The general maxims for item-writing, as well as the specific maxims for multiple-choice items were followed. These are given by Thorndike and Hagen as follows:

General Maxims for Writing Objective Test Items

1. Keep the reading difficulty of test items low.
2. Do not lift a statement verbatim from the textbook.
3. If an item is based on opinion or authority, indicate whose opinion or what authority.
4. In planning a set of items for a test, take care that one item does not provide cues to the answer of another item.
5. Avoid the use of interlocking or interdependent items.

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[1]The textbook used in the American Community School was: G. Rawlins and A. Struble, Chemistry in Action.

The textbook used in the National Protestant School was: Sadik Umar, Sixth Year Chemistry, Mimeographed, 1960.

The textbook used in the Makkasid school was: A. C. Cavell, An Introduction to Chemistry, London, Macmillan Company, 1949, part I.

[2]Robert L. Thorndike and Elizabeth Hagen, Measurement and Evaluation in Psychology and Education, New York, John Wiley and Sons Inc., 1961, Chapter 4, pp. 60-95.

6. In a set of items, let the occurrence of correct responses follow essentially a random pattern.
7. Avoid trick and catch questions.
8. Try to avoid ambiguity of statement and meaning.
9. Beware of items dealing with trivia.

Maxims for Multiple-Choice Items

1. The stem of a multiple-choice item should clearly formulate a problem.
2. Include as much of the item as possible in the stem.
3. Don't load the stem down with irrelevant material.
4. Be sure that there is one and only one correct or clearly best answer.
5. Items designed to measure understandings, insights, or ability to apply principles should be presented in novel terms.
6. Beware of irrelevant grammatical cues.
7. Beware of the use of one pair of opposites among the options if one of the pair is the correct or best answer.
8. Beware of the use of "None of these", "None of the above", "All of these" and "All of the above" as options.
9. Use the negative only sparingly in the stem of an item.

Some adaptations of items from various published and unpublished chemistry achievement tests[1] were used, when it was found that they fitted the blueprint suggested by the thirteen basic topics.

An objective test was chosen instead of a subjective (essay type) because it offered the following advantages:

1. The task of an objective test is completely structured, that is, we are more sure that each examinee is presented with the same problem.
2. It provides an adequately representative sample of the topics covered.

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[1]Some of the items in the test were adapted from the following:

1. Joseph F. Castka, Cooperative Chemistry Test Form Z, Princeton, N. J., Educational Testing Service, 1950. (8 items.)
2. Kenneth E. Anderson, Anderson Chemistry Test Form AM, New York, World Book Company, 1951. (18 items.)
3. Elbert C. Weaver, Tests for Chemistry for our Times, New York, McGraw Hill Book Company, Inc, 1955. (9 items.)
4. Education Department, American University of Beirut, General Science Test, Form Ed. 305, January 1961. Stencile. (4 items.)

3. The examinee selects from among given alternatives.
4. It can be scored with high consistency from scorer to scorer.[1]

To sum up, the objective test confronts all the students taking it with the same problems and the scoring of the test is consistent from scorer to scorer because each item has a predetermined answer which eliminates the factor of opinion. So the scores of the different experimental groups taking the test could be compared with greater assurance.

After the construction of the test, it was reviewed by various teachers[2] of the experimental groups to eliminate any items which they considered inappropriate or unfair from the point of view of their conceptions of desirable secondary school chemistry learnings. In its final form, therefore, the test content accurately reflects the consensus of the chemistry, teachers' opinions from both sources of secondary school students as well as from those who will receive those students at the university level.

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[1]Robert L. Thorndike and Elizabeth Hagen, Measurement and Evaluation in Psychology and Education, pp. 48-49.

[2]The test was shown and left for some time with Dr. George Hanania, Chairman of the Chemistry Department at the American University of Beirut (1960-1963), and he kindly studied it and suggested certain changes. It was also shown to (but not left with) Mr. Muhammad Shbaklou, chemistry teacher of the Makkasid Boys School in Beirut, Mr. Touma Sawayya, chemistry teacher at the National Protestant school for Boys in Beirut, and to Mr. George Za'rur chemistry teacher at the American Community School in Beirut.

C. The Validity of the Test

The validity of a test is the extent to which the test measures what we want it to measure.[1]

Aside from the face validity inherent in the test by reason of the choice of items being made and reviewed by chemistry teachers, the correlation between chemistry grades and test scores for the three groups of students combined is + 0.31, and this is significant at the .01 level. Thus it can be said that the test is valid both from a content standpoint and through its ability to predict chemistry achievement. Detailed coefficients of correlation between test scores and teacher's midyear chemistry grades in the three subgroups are shown in table III:

TABLE III

COEFFICIENTS OF CORRELATION OF TEST SCORES VERSUS TEACHERS' CHEMISTRY GRADES

	School		
	American Community	Makkasid	National Protestant
Number of students	32	44	26
Coefficient of correlation	+0.76 Significant at the .01 level	+0.51 Significant at the .01 level	+0.29 Not significant*

*The numbers of cases is small, and this makes the standard error of the correlation coefficient so large that the detection of a real population correlation is far less likely than in the other two groups.

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[1]Robert L. Thorndike and Elizabeth Hagen, Measurement and Evaluation in Psychology andEducation, p. 160.

D. The Reliability of the Test

The reliability of a test is an estimate of how accurately it measures whatever it does measure.[1]

The reliability of the test was found to be +.81 by the use of the Kuder Richardson formula number 21.[3] This is a lower limit estimate of the test reliability, assuming that most examinees had time to finish the test. This assumption was met. The other assumptions implicit in the formula, if not met, would operate to lower the reliability. It is therefore a reliable test for its purpose. Revision of the test through item-analysis could undoubtedly increase its reliability considerably, but for purposes of group (as opposed to individual) comparisons, a reliability of +.81 is entirely adequate.[2]

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[1] Ibid., p. 174

[2] This is demonstrated clearly in Robert Thorndike and Elizabeth Hagen, Measurement and Evaluation in Psychology and Education. p. 190.

[3] For this formula, see for example Thorndike and Hagen, op. cit, p. 181.

CHAPTER IV

ADMINISTRATION OF THE TEST AND ITS RESULTS

A. The Experimental Groups.

There were two experimental groups of students in this study. The first group was the American group which was made up of thirty-two students (eight of whom were girls). These were the students of the fifth secondary (the year before the last) at the American Community School in Beirut. At this school chemistry is taught only for fifth year students and only for one year. Here students take six periods (48 minutes) per week, one of which is a laboratory session. In the laboratory students carry out the experiments by themselves according to a manual. The teacher's chemistry tests during the year were both subjective and objective.

The second experimental group was the Lebanese one. This was made-up of two sub-groups, as follows:

1. The Makkasid Boys School group.

The Makkasid group was made up of forty-four students. These were the students of the Lebanese Baccalaureat part I (sixth secondary) which is the class parallel to the last class in the American system. In this school chemistry is taught from the first secondary through the sixth. Students of the sixth secondary take three chemistry periods,(45 minutes) per week, one of them being a laboratory session. The laboratory period is primarily for

demonstration. The teacher's chemistry tests during the year were of the subjective, essay type only.

2. The National Protestant Boys School group.

This group was made-up of twenty-six students. These were also the students of the Lebanese Baccalaureat part I. In this school chemistry is taught from the second secondary through the sixth. Students of the sixth take three chemistry periods (50 minutes) per week. Students do not go to the laboratory regularly. The teacher's chemistry tests given to these students during the year were also of the subjective, essay type.

B. The Administration of the Test.

The test had been shown to the chemistry teachers of each of the experimental groups to eliminate any inappropriate items, but it had not been left with them. Then they were contacted and convenient dates were assigned for the administration of the test. The dates of the administration of the test were as follows:

American Community School in Beirut on February 8, 1963.

Makkasid School for Boys in Beirut on February 10, 1963.

National Protestant School for Boys in Beirut on April 1, 1963.

The following comments are related to the administration of the test:

1. The students were not informed before hand that they were going to have a chemistry achievement test covering certain topics.

2. All examinees had enough time to finish the test and to answer all the items on it, because the test was designed as a power test and not as a speed test.

3. No student was allowed to ask any questions during the test.

4. Students were encouraged to guess at an answer if they were not sure of it.

There were five alternatives for each question and the possibility of getting a correct answer by pure chance was 20 per cent. A correction for guessing was not used in the scoring process, since this would be inconsistent with encouraged guesses.

5. The students were seated far from one another, so that opportunities for cheating were minimized.

6. Extra copies of the test were not given to students so that there would be no chance for the test to be known by future examinees.

C. The Results of the Testing.

After the administration of the test, it was scored according to a prepared key. Each correct answer received one point, and the total score of a student was the sum of his correct answers.

The following tables show the scores received by each student on the test, his Midyear average teacher's grade in chemistry, and the number of semesters he studied chemistry including the semester in which the test was given:

TABLE IV

AMERICAN GROUP TESTS SCORES VERSUS
TEACHER'S MID YEAR-GRADES
(All these students had studied chemistry for one semester only)

	Test Score	Teacher's Grade (converted to 50=pass)
1.	54	89
2.	53	76
3.	53	94
4.	52	79
5.	52	75
6.	52	65
7.	51	75
8.	51	86
9.	50	75
10.	50	88
11.	49	74
12.	49	76
13.	49	70
14.	48	75
15.	48	73
16.	48	56
17.	47	71
18.	47	76
19.	46	76
20.	46	73
21.	46	65
22.	45	68
23.	44	69
24.	44	71
25.	44	79
26.	43	61
27.	42	65
28.	42	50
29.	41	65
30.	40	51
31.	39	64
32.	35	40

The passing grade for the teacher's grades of this group is sixty, but the passing grade is fifty in the Lebanese groups. Consequently the American

grades were converted to a Lebanese pass-equivalence according to the following formula:

$$(\text{American grade} - 60)\frac{5}{4} + 50 = \text{Lebanese grade}$$

This made the American grades equivalent to the unchanged Lebanese grades in terms of a passing grade of fifty. Thus an American 60 becomes a 50 to conform with the Lebanese system, while 100 remains invariant.

TABLE V

MAKKASID GROUP TEST SCORES VERSUS TEACHER'S MIDYEAR GRADES,
AND THE NUMBER OF SEMESTERS
STUDIED CHEMISTRY

	Test Score	Teacher's Grade	Number of semesters studied Chemistry
1.	57	73	11
2.	54	90	11
3.	53	90	11
4.	53	50	11
5.	53	45	9
6.	51	60	11
7.	49	65	11
8.	49	60	11
9.	49	90	11
10.	49	68	11
11.	48	83	11
12.	48	50	11
13.	47	60	11
14.	47	70	11
15.	46	83	11
16.	46	63	11
17.	45	53	11
18.	45	70	11
19.	45	65	11
20.	44	68	11
21.	44	55	11
22.	43	78	11
23.	43	75	11
24.	43	40	11
25.	43	50	9
26.	43	85	11
27.	43	55	11
28.	42	55	11
29.	41	58	11
30.	41	55	11
31.	40	50	11
32.	37	60	11
33.	37	75	7
34.	37	60	7
35.	37	53	11
36.	36	45	11
37.	35	10	11
38.	34	80	7
39.	34	53	11
40.	34	45	11
41.	32	45	11
42.	29	50	7
43.	28	40	7
44.	25	30	7

TABLE VI

NATIONAL PROTESTANT GROUP TEST SCORES VERSUS TEACHER'S MIDYEAR GRADES, AND THEN NUMBER OF SEMESTERS STUDIED CHEMISTRY

	Test Score	Teacher's Grade	Number of semesters studied Chemistry
1.	54	97	11
2.	46	91	5
3.	45	78	3
4.	44	92	7
5.	43	90	3
6.	43	59	7
7.	43	74	5
8.	40	89	3
9.	39	72	3
10.	38	68	5
11.	37	60	9
12.	36	89	5
13.	35	73	11
14.	34	73	5
15.	34	90	5
16.	34	77	5
17.	33	61	7
18.	31	71	5
19.	30	64	9
20.	29	49	7
21.	29	67	7
22.	29	99	9
23.	25	69	7
24.	24	87	11
25.	24	83	7
26.	23	76	3

CHAPTER V

INTERPRETATION OF RESULTS

1. It was found that half of the National Protestant school group (13 students) had studied chemistry from 3 to 5 semesters and the other half had studied it between 7 and 11 semesters. The following is a table of the means and standard deviations of test scores of these two groups:

TABLE VII

MEANS AND STANDARD DEVIATIONS OF TEST SCORES

	National Protestant School	
	Group I (3-5 sem. chemistry)	Group II (7-11 sem. chemistry)
Number of students	13	13
Mean (Average) test score	37.38	33.54
Standard Deviation of Test scores.	6.13	8.60

The Means and Standard Deviations of the test scores of the two groups were compared (Means by the t-Test and Standard Deviations by the F-Test) and meither of them showed a significant difference at the .05 level. Therefore the two groups could be considered as one group for future comparisons with other groups.

2. The Means of the test scores and teacher's grades in chemistry were calculated for the three groups and were found to be as follows:

TABLE VIII

MEANS OF TEST SCORES AND TEACHERS GRADES[1]

	School		
	American Community	Makkasid	National Protestant
Number of students	32	44	26
Mean of test scores	46.87	42.70	35.46
Mean of teachers grades	70.94	60.40	76.84

The mean test score of the American group proved to be significantly higher (at the .01 level) than either of the groups of Lebanese students. This means that on the whole the American group did better on the test than the other two Lebanese groups.

It is interesting to note that the mean test score of the Makkasid school is significantly higher than that of the National Protestant group, although the mean teachers grade of the Makkasid group is significantly lower than that of National Protestant group.

In spite of the fact that the mean of teacher's grades of the American group is not the highest among the three groups, the coefficient of correlation between the American group's test scores and their teacher's grades is + .76, which is significant at the .01 level (see TABLE III, p. 34). This means that there is a definite tendency for those who did well in their chemistry course to do well on the test, and vice-versa.

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[1]Standard deviations are:
For the test; ACS = 4.5, Makkasid = 7.3, N.P.S. = 8.2

The fact that the mean test score of the American group is the highest is important. It suggests that this group has grasped the different chemistry topics and basic essential learnings covered by the test[1] not only more completely than the two Lebanese groups studied, but in a far shorter period of time (one semester) as compared with the Makkasid group (an average of 10.3 semesters) and the National Protestant group (an average of 7 semesters).

The following is a comparative table of the actual total hours of exposure to chemistry teaching and learning experiences in the three schools under study:

TABLE IX

TOTAL HOURS OF EXPOSURE TO CLASSROOM LEARNING EXPERIENCES IN CHEMISTRY

	Group		
	American	Makkasid	National Protestant
Number of hours	81.6*	347.6	262.5
Total exposure	1	4.3	3.2

*This is taken as 1.

3. Although the Mean teacher's grade of the National Protestant school group was the highest (76.83), the coefficient of correlation between it and the test score was too low (+ 0.29) to be significant.[2] This means that success in their chemistry course is not as clearly related to success on the test as in the case of the American group. On the other hand, the correlation of test scores with teacher's grades in the Makkasid group was + 0.51 which, like the American correlation, is significant at the .01 level.

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[1] See page 30.

[2] See table III, page 34

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Perhaps the most important finding of this study is that it has clearly shown that the American group proved to do significantly better on the test than the two Lebanese groups. This is important because the Makkasid and National Protestant groups had 4.3 and 3.2 times as much exposure to chemistry teaching as the American group did. This suggests strongly that the Lebanese system as it is applied now is defective. Unfortunately, the test cannot reveal why one group proves to be better than the other, but it can clearly show (with a reliability of .81) that one group is superior to the other. Therefore, one can only speculate about possible factors and reasons which led to this conclusion. A brief discussion of some of these factors may be helpful.

Some possible reasons for the superior achievement of the American group are the following:

1. The method of teaching of the American group may be better than that of the Lebanese groups. This can be elaborated as follows:

a. The American method of teaching usually adopts modern trends in education such as the problem solving method, and stressing the understanding of principles and ideas more than the pure memorizing of factual information in chemistry. On the contrary, the Lebanese method of teaching is highly affected by the classical, verbalistic ideas of pedagogy, in which, for the most part, the student is required to memorize the material in order to reproduce

it in his examinations.

It might be worthwhile to mention here that the Lebanese student is haunted by the government examinations which are of the classical, essay type. Most of the time the student tries to reproduce the information in the textbook verbatim in order to have a better chance of passing.

b. The American group has regular laboratory work and individual experiments. This encourages observation and experimentation prior to the making of conclusions and generalizations. The Lebanese groups have little or no chance to do experiments individually. For the most part, those of them who go to the laboratory see demonstrationsonly.

2. The American group is studying chemistry according to an up-to-date curriculum which is more suited to the needs of students and nearer to the level of their mental development and abilities.[2] The Lebanese curriculum is overloaded with fragmentary, out-of-date descriptive material which regards the memorization of subject-matter as an end in itself rather than as a means to the end of the general development of the student.

3. The American group has had more objective tests than the Lebanese groups, which means that they are more accustomed to them and can thus comprehend their structure and requirements more easily, thus having more time to consider the content itself.

4. Since the American group study chemistry in English, their mother-tongue, it is reasonable to expect that their superior reading speed and comprehension[1]

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[1]Mr. Richard Yorkey, Professor of English at the American University of Beirut has said that "Reading tests given to Freshman students at the American University of Beirut indicated that they were about two times slower than similar students in the United States of America, which implies that these students need a longer time to read and understand the same assignment."

[2]Moreover, the dynamic aspect of the American curriculum may be a factor. That is, American courses change readily with new ideas and discoveries.

affected their scores positively. This might also help to explain their understanding of the course material in a shorter period of time.

5. Although the American group studied chemistry for a shorter period of time (one semester) than the Lebanese groups[1] they were taking double the number of periods per week. Perhaps material given more frequently in a shorter period of time is retained more effectively than the same material given over a longer period of time. This suggests an interesting research study.

6. The American group were given their chemistry course by one teacher while the Lebanese groups had several different teachers over the several years, and their teaching methods were undoubtedly not identical.

7. No intelligence tests are available to compare intelligence in the two groups. Possibly the American group is more intelligent, although this has not been demonstrated, and there is little evidence on the issue.

8. There is no assurance that the American and Lebanese groups came from similar socio-economic backgrounds. It appears likely, however, that dependents of Americans overseas would have a higher socio-economic status than average Lebanese school pupils.

9. There is some reason to believe that the American Community School students owe part of their superiority on the test to the fact that, from childhood, they have been encouraged to ask more questions, and have been more often deliberately guided toward an attitude of critical thinking.

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[1]The Makkasid group studied it for an average of 10.3 semesters and the National Protestant group studied it for an average of 7 semesters.

10. The American students had just studied the basic essential learnings and topics covered in the test, while the Lebanese students had taken most of these topics in the fifth secondary (the year before the one in which they were given the test). This difference in time may have negatively affected the achievement of the Lebanese students on the test. That is, they had had more time in which to forget the basic material.

Because the material is regarded by all concerned as being fundamental to further studies, however there is some reason to believe that allowing the year for forgetting may be detrimental to the students future studies.

Some of the recommendations which are justified according to the findings of this study are the following:

1. The fact that the American group did better on the test although they have studied chemistry over a much shorter period of time suggests that there may be little justification for teaching chemistry in Lebanon for a period so much longer than that used in the American system. Consequently, a

worthwhile experiment in chemistry teaching in Lebanon would be to reduce the number of years in a large trial group to one or two years only, and compare results.

2. The number of chemistry periods per week given to Lebanese students over, say, a two-year period, would have to be greater than at present to give the teachers and the students a better chance of finishing the required syllabus. This would also help to make up for the difficulties due to studying through a foreign language.

3. The present out-of-date Lebanese chemistry syllabus needs revision. Much of the descriptive material in it should be removed. Moreover the content of the new syllabus needs to be based on modern discoveries in chemistry, especially in topics dealing with atomic theory, chemical bonding, use of periodic tables etc. The different chemistry topics should be grouped in meaningful units (e.g the halogen family) and not mere fragmentary pieces of knowledge unrelated to one another, such as are now found in the Lebanese syllabus (e.g chlorine, apart from the other halogens).

4. Perhaps the teaching method is one of the major factors accounting for the higher scores of the American group on the test. Much has already been said about the need for improving the method of chemistry teaching in particular, and that of the sciences in general.[1]

5. Lebanese students should go to laboratories regularly in order to perform experiments individually. Learning by experience (especially through laboratory work in the case of chemistry) is an established feature of all modern science

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[1]See, for example, George Za'rur, Teaching of Chemistry in the Secondary Schools of Lebanon.

education, and needs no justification here.[1]

6. The present Lebanese Government syllabus does not mention any aims and objectives[2] for teaching chemistry in the secondary school. Modern aims and objectives[3] for teaching chemistry are absolutely necessary because the selection and organization of the chemistry syllabus is highly affected by them. Moreover, such aims and objectives tend to affect the method of teaching, the students' achievement, and the means of evaluation of that achievement.

7. More problem solving should be given to Lebanese students to train them to descriminate between alternatives rather than to depend on rote memorization; to think out problems rather than force them into preconceived mechanistic patterns consisting of memorized formulas without a clear relation to the real world. This can be accomplished both by a greater use of good objective tests and by improving the typesof essay tests used.

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[1]The reader who would like evidence concerning the outcomes to be expected from regular laboratory work should consult:

1. R. Will Burnett, Teaching Science in the Secondary School, New York, Rinehart and Company, Inc., 1957.

2. John S. Richardson and G. E. Cahoon, Methods and Materials for Teaching General and Physical Science, New York, McGraw-Hill Book Company, Inc. 1951.

3. Paul F. Brandwein et. al, A Book of Methods, New York, Harcourt, Brace and Company, 1958.

[2]See chapter I. p. 10.

[3]See chapter II. p. 20-23.

Concluding Statement

It has been shown that a large number of factors may help to explain the superiority in chemistry test achievement of the one-semester group over those who were exposed to an average of 3.89 times as many hours of organized chemistry learning experiences.

It is therefore impossible in a study of this kind to ascribe the difference to any one or any combination of the possible contributing factors. What the study does suggest strongly, however, is that immediate and imaginative experimentation in Lebanese chemistry teaching at the secondary school level is clearly in order. The results are overwhelmingly in one direction. They suggest clearly that essential secondary-school chemistry learnings, as identified and agreed upon by both Lebanese and American teachers, can be achieved with far more efficiency than they are now being achieved in the two Lebanese schools under study.

APPENDIX

CHEMISTRY ACHIEVEMENT TEST

Form AMX.

February, 1963

PLEASE PRINT

Name: _____ Date: _____

Grade or Class: _____ School: _____

Time : 60 Minutes.

Number of years you studied Chemistry _____

General Instructions

1. Your score will be the total number of correct answers. Therefore you will not lose credit by guessing on any item where you are not sure of the answer.

2. You may skip a question if you wish, and return to it later if you have time.

3. No questions should be asked after the examination has begun.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.
EVERYONE SHOULD BEGIN AND END AT THE SAME TIME.

Directions

Each of the incomplete statements below is followed by five choices. For each item select the choice which best completes the statement and put a circle around the letter of the choice.

Example:

The taste of an acid is

A bitter.
B sweet.
(C) sour.
D salty.
E like onion.

The letter C has been encircled because "sour" is the choice which best completes the statement.

Now answer the following sample item:

The formula for Hydrochloric acid is

A H_2SO_4.
B HNO_3.
C HCl.
D HBr.
E HF.

DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO

1. An element is

- A the simplest form of matter.
  B always found pure in nature.
  C never found pure in nature.
  D usually a gas.
  E positively charged.

2. One way in which compounds differ from mixtures is that compounds have

  A more elements.
  B fewer elements.
  C greater activity.
- D definite composition.
  E physical properties.

3. Which one of the following groups is made up entirely of non-metals

  A Calcium, Magnesium and Iron.
- B Phosphorous, Carbon and Chlorine.
  C Aluminium, Copper and Hydrogen.
  D Uranium, Radium and Bismuth.
  E Potassium, Silicon and Zinc.

4. A common property of metals is that they

  A form acidic oxides when burnt in oxygen.
  B are brittle.
  C are insoluble in Mercury.
- D react with Chlorine to form solid salts.
  E are insoluble in acids.

5. An example of a physical change is

  A lighting a cigarette.
- B magnetising a piece of Iron.
  C operating a car.
  D developing a film.
  E oxidation of Phosphorous.

6. The main difference between a physical and a chemical change is

- A a new substance is always formed.
  B much heat is often given out.
  C it is usually difficult to reverse the change.
  D often there seems to be a change in total weight.

7. Burning of wood is an example of

  A an endothermic reaction.
  B reduction.
- C chemical change.
  D neutralization.
  E catalysis.

8. During chemical changes, the only part of the atom which undergoes a change is the

- A orbital (planetary) electrons.
  B positrons.
  C nucleus.
  D nuclear protons.
  E neutrons.

9. The symbol of Manganese is

  A Mg.
- B Mn.
  C Hg.
  D Ag.
  E Mo.

10. Which one of the following molecules contains five atoms ?

  A $Ca_3(PO_4)$.
  B Na_2CO_3.
- C Al_2O_3.
  D $CaSO_4$.
  E NH_4OH.

11. The valency of an element tells

A its atomic weight.
B the solubility of its compounds.
C its stability.
-D how many electrons its atom loses, gains or shares.
E how many compounds can be formed.

12. In AgCl the valency of Cl is

- A -1.
B -2.
C -3.
D -4.
E -5.

13. Argon and Neon are inert elements because their atoms have

-A complete outermost rings.
B no electrons.
C chemical reactivity.
D no protons.
E no Neutrons.

14. Which one of the following has a mass almost equal to that of a Hydrogen atom and a charge equal but opposite to that of a Chlorine ion ?

A Positron.
B Electron.
C Neutron.
-D Proton.
E Alpha particle.

15. An element has an Atomic weight of 23 and its atomic Number is 11. The number of planetary electrons about the nucleus of the element is

A 0 .
B 12.
C 1.
D 44.
-E 11.

16. A particle composed of 18 electrons, 19 protons and 20 neutrons has an approximate weight equal to that of

A 57 electrons.
B 2 protons.
- C 39 protons.
D 37 neutrons.
E 57 neutrons.

17. Which is the correct formula for Ammonium Sulphate ?

A NH_4SO_4.
B NH_4SO_3.
C NH_4S.
- D $(NH_4)_2 SO_4$.
E $(NH_4)_2 SO_3$.

18. Which is the correct formula for Ferric Oxide ?

A FeO.
- B Fe_2O_3.
C Fe_3O_4.
D Fe_2O_2.
E Fe_4O_3.

19. One of the products in the following reaction ($Na_2SO_3 + H_2SO_4$ (dilute) ...) is

A SO_3.
B $NaHSO_4$.
- C SO_2.
D $NaHSO_3$.
E H_2S.

20. When Calcium chloride is added to Sodium Carbonate solution, Sodium Chloride and Calcium Carbonate are formed according to one of the following equations

A $CaCl_2 + NaCO_3$ ..... $CaCO_2 + NaCl$.

-B $CaCl_2 + Na_2CO_3$..... $CaCO_3 + 2NaCl$.

C $Ca_2Cl + Na_2CO_3$..... $CaCO_3 + NaCl$.

D $Ca_2Cl_2 + Na_2CO_3$ .... $Ca_2CO_3 + 2\ NaCl$.

E $CaCl_2 + NaCO_3$ .... $CaCO_3 + NaCl_2$.

21. In Boyle's Law, the condition that is held constant (unchanged) is

-A temperature.
B pressure.
C volume.
D solubility.
E temperature and pressure.

22. Both Boyle's and Charles' laws deal with matter in the state of

A liquid and gas respectively.
B solid.
C liquid.
-D gas.
E gas and liquid respectively.

23. The volume of a gas at Standard conditions (STP) or (NTP) that contains one gram-molecular weight is

A 2 liters.
B 62.4 feet cube.
C 11.2 liters.
D 10 liters.
-E 22.4 liters.

24. The pressure of a certain gas is 2 atmospheres when its volume is 1 cubic meter. When the volume becomes 0.01 cubic meters, the pressure will be

A 1/2 atmosphere.
B 20 atmospheres.
-C 200 atmospheres.
D 0.02 atmospheres.
E 100 atmospheres.

25. The volume (mls) of Hydrogen that remains unused when a mixture of 50 mls of Hydrogen and 20 mls of Oxygen is exploded, is

A 0 .
-B 10.
C 22.4.
D 35.
E 30.

26. The atomic weight of an element is equal to its

A equivalent weight divided by a small whole number.
B molecular weight divided by the valency.
-C equivalent weight multiplied by the valency.
D equivalent weight multiplied by 2 .
E molecular weight divided by 2 .

27. If the atomic weight of Calcium is 40 and its valency is 2, then its equivalent weight is equal to

A 10 .
-B 20 .
C 40 .
D 60 .
E 80 .

28. If the atomic weight of Oxygen is 16 , then its molecular weight is equal to

A 8 .
B 16.
C 64.
D 24.
-E 32.

29. The molecular weights of Nitrogen and Oxygen are proportional to their

-A densities.
B solubilities.
C temperatures.
D pressures.
E specific heats.

Questions 30 and 31 are based on the equation for the preparation of Oxygen by heating Potassium Chlorate. (atomic weights : K = 39, Cl = 35.5, O = 16).

30. To balance the equation, the number of molecules of Potassium Chlorate is

A 1 .
- B 2 .
C 3 .
D 4 .
E 5 .

31. To obtain 67.2 liters of Oxygen, how many grams of Potassium Chlorate will be required ?

A 74 .
B 122.5 .
C 200 .
- D 245 .
E 367.5 .

32. How many grams of water are produced when an excess of Hydrogen reacts with 32 grams of Oxygen. (Atomic weights : O = 16, H = 1)

A 18 .
B 64 .
C 35 .
D 72 .
- E 36 .

33. How many liters of Carbon Dioxide are produced by the complete combustion of 60 grams of Carbon ? (Atomic weights : C = 12, O = 16)

A 22.4 .
B 44.8 .
- C 112 .
D 67.2.
E 220 .

34. Substances which dissociate into ions when in water solutions are called

- A electrolytes.
  B reducing agents.
  C hydrates.
  D elements.
  E catalysts.

35. Neutralization reactions usually form water and

  A acids.
  B bases.
  C oxides.
- D salts.
  E drying agents.

36. Carbonic acid is a weak acid because

  A it gives two Hydrogen ions.
  B it forms carbonates.
- C it is unstable.
  D it does not form bicarbonates.
  E it changes phenolphthalein red.

37. Salts may be prepared by

  A burning a metal in Oxygen.
- B dissolving a metal in an acid.
  C the reaction of a non-metal with Nitric acid.
  D the treatment of an acidic oxide with water.
  E burning a non-metal in Chlorine.

38. Which one of the following gases is basic

  A Carbon dioxide.
  B Methane.
  C Carbon monoxide.
  D Sulphur dioxide.
- E Ammonia.

39. A good method for the preparation of Sulphuric acid is by the

A Solvay process.
B Blast furnace.
C electrolytic process.
-D Contact process.
E treatment of Sodium sulphate with Hydrochloric acid.

40. Bicarbonates are usually prepared from carbonates by

A heating solutions of carbonates.
B treating carbonates with dry Carbon dioxide.
-C treating carbonates with cold Carbonic acid.
D oxidizing Carbon with concentrated Sulphuric acid.
E heating metals with Carbon dioxide.

41. A good industrial method for preparing Sodium Hydroxide is by

A the electrolysis of fused Sodium chloride.
B treating calcium hydroxide with Sodium carbonate.
C treating Sodium with water.
D treating Ammonium hydroxide with Sodium chloride.
-E the electrolysis of Sodium Chloride solution.

42. A boy placed some Magnesium in a flask with some dilute Hydrochloric acid. As a result

-A Hydrogen was given off.
B Chlorine was given off.
C Oxygen was given off.
D Magnesium Chloride escaped.
E nothing happened.

43. Water reacts chemically with

A Silica to form Silica gel.
B Calcium hydroxide to form Calcium Carbonate.
C Phosphorous oxide to form Sulphuric acid.
D Sulphur dioxide to form Sulphuric acid .
-E active metals to form metallic hydroxides and Hydrogen.

44. The best chemical test for water is that it

A is colorless.
B is odorless.
-C changes white unhydrous Copper sulphate to blue.
D boils at 100 °C .
E freezes at 0 °C .

45. If Hydrogen is passed over hot Cupric oxide, red Copper is formed because

A Cupric oxide decomposes by heat.
B Hydrogen is a catalyst.
C Copper is stronger than Hydrogen.
-D Hydrogen is a reducing agent.
E the reaction is reversible.

46. The main constituent of air is

-A Nitrogen.
B Carbon Dioxide.
C Oxygen.
D water vapour.
E Argon.

47. When a glowing splinter is put into a jar of Oxygen .

A the Oxygen burns.
B the jar breaks.
C the splinter is put out.
D nothing happens.
-E the splinter bursts into flame.

48. Oxygen is prepared commercially mostly from

A Potassium Chlorate.
B Manganese Dioxide.
C Hydrogen peroxide.
-D liquid air.
E Mercuric oxide.

49. When Oxygen is prepared from the decomposition of Potassium Chlorate, Manganese Dioxide is added

A as a source of Oxygen.
-B as a catalyst.
C to slow the reaction.
D to increase the bulk of the Potassium Chlorate.
E as a reducing agent.

50. Which one of the following is an oxidizing agent ?

A Sodium Sulphate.
B dilute Sodium Hydroxide.
-C hot concentrated Sulphuric acid.
D Calcium Oxide.
E concentrated Hydrochloric acid.

51. Which one of the following is a neutral oxide ?

A Sulphur Dioxide.
B Sodium Oxide.
C Manganese Dioxide.
D Ferric Oxide.
-E Hydrogen Oxide.

52. Which one of the following is a weak electrolyte ?

A Sulphuric acid.
B Calcium Carbonate.
C Sodium Hydroxide.
D Potassium Chloride.
-E Acetic acid.

53. An ion differs from an atom because an ion has

A more Neutrons.
B fewer Neutrons.
-C an electric charge.
D more Protons.
E less Protons.

54. The electrolysis of water represents which one of the following chemical changes ?

A synthesis.
-B simple decomposition.
C simple replacement.
D double replacement.
E hydrolysis.

55. If a positive and a negative electrode are introduced into a solution of Copper Chloride, the Copper will be deposited on the negative electrode. This indicatess that

-A the Copper particles in the solution had a positive charge.
B the Copper particles had acquired a negative charge.
C the Copper particles were electrically neutral.
D the chloride particles were repelled by the Copper particles.
E Chlorine had a positive charge.

56. If a relatively small amount of solute is dissolved in a relatively large amount of solvent, the solution is called

-A dilute.
B saturated.
C ionic.
D volatile.
E super-saturated.

57. Litmus changes its color in one of the following ways

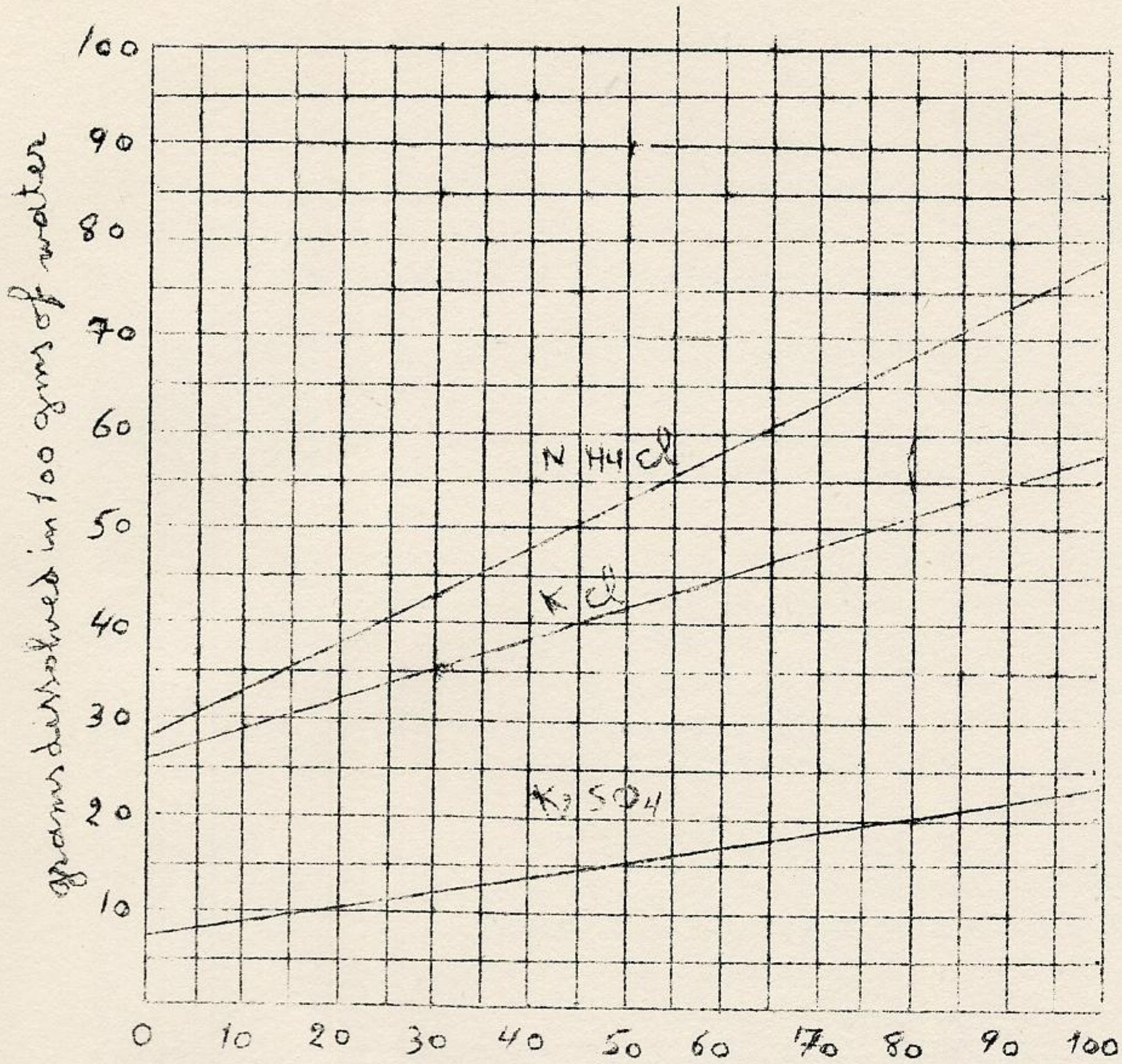
A with acid salts solutions pink.
B with bases it turns orange.
C with neutral solutions yellow.
-D with acids it turns red.
E with basic salts solutions has no effect.

58. In the Haber process, used for the preparation of Ammonia from its elements, the equation for the reaction is

$$N_2 - 3H_2 \rightleftharpoons 2NH_3$$

The reaction takes place about 10 % then it stops because

A the temperature decreases.
B the temperature increases.
-C it reaches equilibrium.
D the pressure decreases.
E the catalyst is used up.



Questions 59 and 60 refer to the above graph.

59. Cooling a saturated solution of NH_4Cl (contained in 100grams of water) from 80 ^{o}C to 55 ^{o}C will cause the deposition of how many grams of solid NH_4Cl ?

A 25 .
B 16 .
-C 12 .
D 2 .
E 8 .

60. Which salt will show a solubility of 37 grams per 100 grams of water at 35 ^{o}C ?

A $NaNO_3$.
B $Pb(NO_3)_2$.
C NH_4Cl .
D K_2SO_4 .
-E KCl .

Notes on the Government Syllabus in Chemistry

for Schools in Lebanon[1]

First Year - I can see no justification for the teaching of "Chemistry" as a distinct subject to this class. The study of natural phenomena should be included in a general science course.

Second Year- Since the work is supposed to comprise 28 hours only (seven months with an average of 4 periods per month) the material included in the syllabus cannot possibly be taught meaningfully. It is much better to omit the subject altogether.

Third Year - The teaching of chemistry could very well start here. It should include (1) simple experiments on common substances, and (2) an introduction to chemical ideas and language. For instance, items number 1 and 2 from the syllabus of the first year, items number 1, 2, 3, 4, 5 and 6 from the syllabus of the second year, and items number 1, 2, 4, 8, 11, 12 and 15, may be included.

Fourth Year- It is not a good idea to devote this year to a descriptive study of some organic substances. It would be much better for the student (and the teacher) if the above suggestion was also taken up here. There would be (1) more simple experiments showing the properties of metals, non-metals, oxides, acids, bases, salts, gases etc. (2) further study of ideas, such as in items 1, 2, 3, 4, etc. of the fifth year syllabus.

Fifth Year - Organic Chemistry (from the fourth year syllabus) can now be introduced, emphasising not the properties of substances but the practical aspects of oxidation, fermentation etc.

Sixth Year - This should be regarded as the first (and only) year of chemistry proper. The government syllabus, in my opinion, is of the wrong type. Instead of being essentially a memory study of the "preparation, properties, characteristics and uses" of selected elements and compounds, it should integrate what the student had so far learnt in chemistry. This can be done best by reviewing the elementary, but modern, view of atomic structure and chemical bonding, the general types of chemical compounds and their reactions; the fundamental types of chemical calculations; and a little knowledge of the properties and reactions of, say, carbon, sulphur, iron and copper and their compounds, based on laboratory work.

A general Comment on Pre-Freshman Chemistry

It is all very well to introduce chemistry into the secondary school structure, so long as the object is to teach the student to "think Scientifically". Prior to Worl War II it was natural to expect the school chemistry syllabus to

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[1]Unofficial communication received in January 1962.

be predominently descriptive since chemical theory had not advanced much then. After the war, however, the British and American educational systems (and the French to a lesser extent) witnessed a radical change in the approach to the teaching of chemistry, and this can be realised from the most cursory glance at textbooks of chemistry now and then. The Lebanese syllabus unhappily has not followed the post-war trend in education.

Modern advances in chemical theory and in the other sciences make it possible now to teach the fundamentals of school chemistry in a simpler, more elegant and yet more comprehensive manner than hitherto. Much of the purely descriptive material is completely unnecessary, and most of the rest can be neatly grouped into general properties of functional groups within the molecules.

To sum up, I would advise the student who plans to study chemistry in the freshman year at AUB to be prepared in the following:

1. English language.
2. Mathematics, with enough manipulative experience in algebra, the use of logarithms etc.
3. Physics, the fundamental concepts of weight, heat, temperature scales, electricity, etc.
4. Chemistry. Two years are more than enough, assuming the teaching was from a modern viewpoint, namely including:

   i) modern ideas on atomic structure and chemical bonding (very elementary).
   ii) a laboratory study of properties, reactions etc.
   iii) cutting down much of the descriptive material.
   iv) emphasising the parallelism between theory and experiment in chemistry.

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