THE UNIVERSITY OF ALBERTA

A SURVEY OF DIFFICULTIES ENCOUNTERED IN LABORATORY CHEMISTRY IN ALBERTA HIGH SCHOOLS, WITH SUGGESTED SOLUTIONS, AS EVIDENCED FROM A FOUR-YEAR EXPERIMENT CONDUCTED IN THE CHINOOK HIGH SCHOOL.

A DISSERTATION
SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR
THE DEGREE OF BACHELOR OF EDUCATION.

COLLEGE OF EDUCATION

BY
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CHINOOK, ALBERTA.

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THIS THESIS

IS

DEDICATED

TO

THE CHINOOK SCHOOL STAFF

E.Evelyn McDonald
M.Aurelia McLeod
W.M.Watson

AND

THE CHEMISTRY II CLASS OF 1941-42.

Laurel King
Robert Proudfoot
Donald Nicholson
Emily Zawasky
Queenie Ford
Helen Pfeifer
Jean Damsgard
Winnifred Marr

WHOSE

CO-OPERATION AND ENCOURAGEMENT

MADE EVERY TASK A PLEASURE.

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CHAPTER I.

PURPOSE OF THE SURVEY.

What is the fundamental problem confronting the Alberta high school chemistry teachers of today? Teachers may well ask themselves this question, for if they realize the existence of such a problem, even the mere knowledge of its presence will make for better teaching. If the nature and strength of an enemy is known, proper diagnosis will eventually result in the utilization of the correct weapons and methods of attack to overcome the foe, otherwise, ignorance will lead to ultimate disaster. There are a hundred and one localized difficulties besetting the chemistry teacher, and these tend to hide the real issue at stake, so it is only when the entire field of progressive education is viewed as a long-range unit from a point of vantage that the fundamental problem in chemistry teaching is brought into relief.

The heart of the educational system in Alberta pulsates in the body of men composing the Department of Education, so what could be more natural than to query the Supervisor of Schools, Dr. Newland, as to the basic problems of chemistry teaching.

"The fundamental problem concerning the teaching of chemistry in a modern high-school programme is, of course, that of attempting to relate the abstract principles of theory to concrete situations which have a meaning for the student in terms of his own experience. This is not quite the same thing as saying that the courses should be practical, because it is still possible to have students carry on work in chemistry which has no immediate practical value, but which, nevertheless, is very closely related to their own experience.

There is also the further problem of integration - a word about which we hear a great deal nowadays. It is the better

[1] opinion now that a General Science programme should extend throughout the three high-school grades, in which Chemistry, Physics and Biology should be integrated by means of certain projects or other activities in which the students can engage. I, of course, recognize the fact that projects at the high-school level are very much more difficult to set up than in the elementary grades, or even in the intermediate grades. Nevertheless, this is an important problem of the day."

If any study is to be really educative the pupil must be actuated by some compelling desire to enjoy and to know. Progress in chemistry is dependent upon a scientific purpose, a conscious need to learn the facts and their underlying cases of explanation. The educative value of chemistry, like any other subject, depends upon the degree to which the student makes it his own and identifies himself with it. To achieve this ideal it is imperative that laboratory instruction play a major role in all chemistry teaching. The establishment of a science laboratory in a high school is merely a counterpart to that of introducing the world into the classroom. The four walls that tend to limit the educational horizons to the classroom have been removed and the student encounters life situations. The services of chemistry to industry, to medicine, to the farm, to the welfare of the nation are understood in an elementary way. The student thus acquires an understanding of the significance and importance of chemistry in our Canadian national life, yes, and even beyond the bounds of Canada, for chemistry knows no territorial restrictions but promotes and encourages international study and co-operation. Thus it may be seen that chemistry teaching should depart from the traditional procedure, and should be presented from the standpoint of its fundamental relationship to society and the home.

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[1] H.C. Newland --- Supervisor of Schools.

The majority of textbooks that provide information in the field of laboratory chemistry have been written by Americans, for American schools, functioning under American conditions. The educational system of Alberta operates under conditions that are vastly different from those found in the country to the south, yet Alberta teachers are attempting "to fit square pegs into round holes" by using this only source of information that is available for them. Most educational authorities in the province are in agreement that the time is ripe for Alberta teachers to supply a long-felt want, i.e., informational pamphlets written by Alberta teachers for Alberta teachers. A modest beginning has been made in this very field by many graduates in education under the supervision of Dr. LaZerte, the Principal of the College of Education of the University of Alberta. Such a practice should be highly encouraged, for the staff of the College is constantly in touch with teachers, who through special aptitude, ability or interest would be able to conduct worthwhile researches in the various phases of education in Alberta. It is only through such experimentation that insight will be provided into the teaching problems, as well as making important contributions towards the perfection of progressive education in the high schools of the province. The ideal described above cannot be achieved in a few short years, nor with any degree of facility. It will necessitate motivation and long-term planning by the educational authorities, as well as ingenuity and perserverance on the part of teachers of ability. Nevertheless, the pioneer work in providing Alberta teachers with information adapted to their own particular needs must be implanted sometimes, and why not right now? This thesis is

an attempt to show that the results of a research can be of practical value to Alberta teachers.

Laboratory chemistry is a comparatively new field in science, as far as Alberta high schools are concerned, for only a short while back (1936) the Department of Education reported -

"Chemistry 2 is still largely taught as an information subject and that there is not enough emphasis placed on experimentation, observation and collateral reading. There is general criticism that the schools of the Province are inadequately equipped for the best results from the teaching of this subject."

Contrast this with the report in 1939,-

"Science laboratories continue to show improvement. Chemistry 1 and 2 have been enriched each year by the quite generous provision of facilities for experimental and demonstration work. The students in the smaller schools which have been equipped with science rooms are often more fortunate than those in large city classes."

and again in 1940,-

"Science equipment is increasingly satisfactory and laboratory space is much enlarged from year to year. Practically all schools offering Chemistry 2 now have well-equipped laboratories."

These reports would indicate that some of the greatest gains attributable to recent improvements in our educational system and programmes are in the field of laboratory science, especially in chemistry. There appears to be an awakening of an attitude of enquiry on the part of chemistry teachers in the province, in fact, the Department has deliberately given the teachers more scope for initiative in deciding what is to constitute the course best suited to their students and to the time available. Such motivation has produced energetic research, and the improvement of laboratory work in Alberta high schools is steadily gaining momentum. This progressive spirit has

inspired more than one teacher to make a personal contribution to a subject rich in activity possibilities. The four-year experiment conducted in the Chinook high school was an attempt to overcome to some extent the special problems involving practical chemistry in a small Alberta high school. These findings are now being consolidated in a thesis in order to provide a ready-reference guide for the chemistry teachers of the province, as well as giving an impetus towards "the adoption of progressive education" in the subject of chemistry. It is acknowledged that this contribution to the solution of problems connected with laboratory technique is scanty and feeble, but it is offered with good-will, and even if it only solves a single problem it will not have been written in vain.

Any survey of laboratory chemistry in Alberta high schools would yield small dividends if a cursory analysis was not provided showing the type of laboratory work that is being promoted in the other provinces. It is impossible to evaluate the relative standard of chemistry laboratory work in one province unless it is compared with the type of work that is being achieved in some of the other Canadian provinces. Immediately that such a comparison is attempted, difficulties beset one on every hand, the two foremost being, "What entities of laboratory work can be compared?", and "What weight is to be attached to each of the selected entities?" However, a glimmer of hope appears when one places the nine different courses of studies in laboratory chemistry of the senior high school grade side by side, and dares to look for common characteristics. Such a perusal might lead to the following selections in their order of importance:- (1) Approximate percentage of chemistry time devoted to laboratory work. (2) Percentage of "total passing mark" of the

senior high school chemistry given for laboratory work. (3) The number of chemistry experiments that are obligatory, i.e., must be performed by all students during the year. The writer was rather disappointed to discover that there were absolutely no figures available in any Canadian province that would indicate the average value of a chemistry laboratory per pupil taking senior chemistry. If such figures were available they would have furnished a sounder basis for making the comparison, because it can be assumed that the greater the financial effort the better will be the resulting educational system.

The chemistry syllabus usually failed to indicate all of the above noted features in respect to laboratory work in that particular province, so it was necessary to mail a questionnaire to each Deputy Minister of Education instructing him to have some responsible person supply the desired information. Even then, due to the variability of the educational systems surveyed, it was impossible in many cases to secure the desired information. This necessitated the utilization of the average index of as many entities as it was possible to procure.

The results of this evaluation indicate in a simple manner the sources of weakness of chemistry teaching in the Alberta high schools, i.e., the lack of sufficient experimental work. The general trend in Canada in the field of chemistry appears to be directed towards making this subject an experimental study with emphasis based on pupil experiments throughout the course. Thus one sees why a revision of the Alberta Chemistry 2 course is necessary from time to time -"never ending, still beginning". Our chemistry course must have regard for the past and look

QUESTIONNAIRE

1. Name of the province ----------

2. Chemistry text-book used in grade XII or equivalent to grade XII in your province. (i.e. the highest chemistry taught in the high school).

   Title ---------- Author ----------

   Publisher ----------

3. Name and author of the "laboratory manual" used in grade XII practical work.

   Title ---------- Author ----------

   Publisher ----------

4. The number of chemistry experiments that are "obligatory" (i.e., must be performed by all students) during the school year.

   ----------.

5. The approximate percentage of chemistry time devoted to laboratory work.

   ----------.

6. The percentage of "total passing-mark" of grade XII chemistry given for laboratory work.

   ----------.

7. How is the final standing in laboratory work determined? (check the one used).
   (1) By taking in consideration the year's work. (Teacher's judgment).
   (2) By a final examination in "laboratory work". (By an examiner).
   (3) By other means. (Describe the method used).

8. Give the qualifications that a teacher must possess in order to be able to offer instruction in this senior chemistry. (Minimum qualifications)

9. Summarize any outstanding feature in "Experimental Work in Practical Chemistry" that is characteristic of chemistry teaching in your province.

Signed ----------

Educational position ----------

TABLE I

COMPARATIVE EVALUATION OF LABORATORY CHEMISTRY
IN CANADIAN PROVINCES

Province	Percentage of time devoted to Laboratory Work.		Percentage of Total Mark Given for Laboratory Work.		Number of Obligatory Experiments		Average % Index	Rank
		% Index		% Index		% Index		
British Columbia	33	100	--	--	24	73	86.5	2
Alberta	20	61	15	50	27	81.8	64.3	6
Saskatchewan	30	91	28	93	33	100	94.5	1
Manitoba	20	61	--	--	25	76	68.5	5
Ontario	--	--	--	--	--	--	--	-
Quebec	--	--	--	--	15	45.5	45.5	7
N. Brunswick	33	100	20	67	25	76	81	3
Nova Scotia	--	--	20	67	24	73	70	4
P.E.Island	--	--	30	100	--	--	--	-

equally to the future. One generation of Canadian high school students receives from its predecessor an accumulated body of knowledge, sifts out what is worth keeping and transmits the product to the succeeding generation which, in turn must repeat the process for itself. Not only that, but the teaching methods of presenting this body of knowledge must be ever evolving, never static. A few years ago our teaching methods placed great emphasis on equations and on formal chemistry generally, but today the stress is directed towards connecting the subject at a maximum

number of points with the daily life of the students. The chemistry teachers can rest assured that in a comparatively short time Alberta will be conducting a broad practical program in laboratory work, thus necessitating an adjustment in teaching procedures, minimum equipment requirements and laboratory techniques in keeping with the best modern practice. The teachers should regard the present as a period of transition and devote it towards experiment and trial of the anticipated program. The chemistry teachers of the province would be thus co-operating with the Department of Education in the work of adjusting the content of the curriculum and the teaching procedures to the changing social conditions of the present day. It was with a view of assisting, in a small degree, any future revision committee in laboratory chemistry, that the writer undertook an experimental study of this particular branch of chemistry in Alberta high schools.

Granted, that the outstanding problem in chemistry teaching is that of "attempting to relate the abstract principles of theory to concrete situations which have a meaning for the student in terms of his own experience", and that laboratory instruction is the great agent in developing this ideal, what could be more useful to chemistry teachers than a knowledge of the actual difficulties encountered in laboratory chemistry in Alberta high schools? with of course, suggestions concerning their solution. This knowledge not to be gleaned from text-books written by authorities, who are as far removed from the actual classroom situations as the proverbial "beyond the blue horizon", but supplied by

inspectors and chemistry teachers who are in daily contact with actual conditions as they prevail in Alberta chemistry laboratories. An attempt has been made to transpose cross-sections of actual laboratory life in the smaller high schools of the province into a thesis of words, pictures and charts, a thesis based on the results of four years of experimentation in a small high school at Chinook, a thesis which might serve as a clearing-house for the exchange of ideas of over one hundred chemistry teachers who contributed to this survey, a thesis which it is hoped will make the teaching of laboratory chemistry in Alberta schools more interesting, more concrete, more vital, more closely related to the student's everyday life and the national life of Canada.

CHAPTER II

LABORATORY COSTS.

One side of laboratory chemistry that is absolutely barren of much sought-after information is the one associated with finance. A divisional or a town school-board desires to establish a chemistry laboratory in one of their high school centres, do they, or the principal, or the inspector, definitely know the average value of laboratory equipment per pupil, for which they will have to budget? Do they know the average yearly expenditure per pupil for supplies and chemicals, for which they will have to budget every year in the future? Do they know the various types of laboratory tables, with their respective costs, that are proving suitable under Alberta conditions? Do they know the minimum equipment and chemical requirements per pupil necessary to enable the students to perform all the compulsory Chemistry 2 experiments? It is reasonably safe to assume that the majority of replies to these questions would be in the negative, and we can't expect it to be otherwise, for there is not a single informational booklet that has been actually written based on laboratory chemistry in the smaller Alberta high schools. There are a few American text-books available on the market, supplying the necessary financial statements, but these returns are based on surveys made in the United States, without any regard whatever for conditions that prevail in Alberta. Outside of their use as comparative material, they have no practical value to school officials of the province.

It is difficult to realize the hardships that this problem entails when the smaller high school centre attempts to establish a chemistry laboratory. Here are just a few examples - lack of

any previous experience from which to draw information, complete ignorance as to what constitutes a standard laboratory under Alberta conditions, meager information about what should be purchased, the quantity necessary, the average price to be paid, and where it can be bought. The prevalence of such problems induced the writer to conduct a survey of the cost of chemistry laboratories in Alberta schools.

First, statistical sampling was utilized to obtain what must be considered as "thirty representative Alberta high schools". Then a survey sheet was drafted and mailed to the principal or the science teacher of each "sample school". The survey sheet examined the following features of each laboratory:-

(1) Maximum number of students that could be accommodated.

(2) Number of students actually taking Chemistry 2 during the present term. (1941-42)

(3) Cost of the permanent fixtures with description.

(4) The quantity and type of apparatus in actual use in Chemistry 2.

(5) The quantity of each chemical stocked in the laboratory definitely designated for the Chemistry 2 course.

(6) Quantities of chemicals, apparatus and equipment purchased or installed during the year 1941-42.

In order to establish a proper basis for computing the cost of chemicals or apparatus in a particular school it was compulsory to establish a "mean uniform price" for each chemical and each unit of apparatus. This price list was obtained by averaging the catalogue prices, for that particular article, of four leading supply houses in Canada, two in Ontario, one in

SURVEY SHEET NO.1 - General Information.

1. Name of High School ----------

2. Number of high school rooms in operation in the school ----------

3. Number of students actually enrolled in Chemistry 2 ----------

4. Number of students that can be comfortably accommodated in the Chemistry 2 laboratory ----------

5. Describe the type of chemistry tables (including individual cupboards) in use in your school, and what in your judgment would be the approximate cost of installing such tables. (The secretary of your school might have the actual cost figures available.)

   Cost ----------

6. List other permanent installations found in your chemistry laboratory with approximate cost of each item.

Fixture	Cost
----------	---------
----------	---------
----------	---------
----------	---------
----------	---------

Note

If snapshots of the chemistry laboratory, or of the chemistry tables, are included with this survey sheet when it is returned they will be greatly appreciated. Ten cents will be paid for each suitable negative sent in.

7. Name of the teacher making the survey ----------

8. Summarize any outstanding characteristics of your laboratory.

SURVEY SHEET NO.2 - Chemistry 2 Apparatus.

Please give the trade name, or a word of description about apparatus.

	QUANTITY
Alcohol lamps	
Balances	
Barometer	
Beakers	
Blowpipes	
Blowtorches	
Bunsen burners	
Burettes	
Charts	
Cork borers	
Collars and clamps	
Cobalt glass	
Combustion tubes	
Crucibles (Porcelain)	
)Lead(	
Deflagrating spoons	
Drying tubes	
Evaporating dishes	
Files	
Filter paper (packets)	
Flasks	
Funnels	
Glass tubing (in lbs.)	
Graduates	
Meker burners	
Mortars and pestles	

	QUANTITY
Pipeclay triangles	
Pipettes	
Platinum wire (No. of ins.)	
Kipp's Apparatus	
Glass retorts	
Rings and clamps	
Rubber tubing (No. of ft.)	
Stands	
Test tubes (No. of doz.)	
Test tube brushes	
Test tube racks	
Thermometers	
Thistle tubes	
Tongs	
Tripod stands	
U-Tubes	
Watch glasses	
Wire gauze	

List other Chemistry 2 apparatus you have in use.

SURVEY SHEET NO. 3. - Chemistry 2 Reagents.

	QUANTITY		QUANTITY
Acetic acid		Cobalt nitrate	
Alcohol (methyl)		Copper (any form)	
Alizarin paste		Copper sulphate	
Alum		Cupric bromide	
Aluminium metal		Cupric chloride	
Aluminium sulphate		Ferric chloride	
Ammonium carbonate		Ferrous sulphate	
Ammonium chloride		Ferrous sulphide	
Ammonium hydroxide		Glucose	
Ammonium molybdate		Hydrochloric acid	
Ammonium sulphide		Iodine crystals	
Ammonium oxalate		Iron filings	
Ammonium thiocyanate		Lead acetate	
Antimony metal		Lead nitrate	
Arsenious oxide		Lead peroxide	
Barium chloride		Lead (red)	
Barium nitrate		Lead monoxide	
Bismuth trichloride		Lithium chloride	
Bleaching powder		Litmus booklets	
Bromine		Litmus crystals	
Calcium carbonate		Magnesium ribbon	
Calcium carbide		Magnesium carbonate	
Calcium chloride		Magnesium chloride	
Calcium fluoride		Magnesium sulphate	
Calcium hydroxide		Manganese dioxide	
Calcium sulphate		Mercury	
Charcoal (animal)		Mercuric chloride	
Charcoal (wood)		Mercurous nitrate	

SURVEY SHEET NO. 4 - Chemistry 2 Reagents.

	QUANTITY		QUANTITY
Chloroform		Methyl orange	
Nitric acid		Sodium sulphite	
Paraffin wax		Sodium thiosulphate	
Phenolphthalein		Strontium chloride	
Potassium bromide		Sulphuric acid	
Potassium chlorate		Tartaric acid	
Potassium chromate		Zinc metal	
Potassium dichromate		Zinc sulphate	
Potassium ferricyanide		Zinc sulphide	
Potassium ferrocyanide		List other chemicals in stock in your school (those for Chemistry 2 only)	
Potassium hydroxide			
Potassium iodide			
Potassium metal			
Potassium nitrate			
Potassium permanganate			
Silver nitrate			
Stannous chloride			
Starch			
Sodium bicarbonate			
Sodium borate			
Sodium carbonate			
Sodium chloride			
Sodium hydroxide			
Sodium metal			
Sodium nitrate			
Sodium peroxide			
Sodium phosphate			

SURVEY SHEET NO. 5 - Maintenance.

In order to facilitate the compilation of the cost of maintaining an average high school laboratory please list the quantities of chemicals, reagents, apparatus, furnishings, etc., that have been purchased, or are to be purchased for your laboratory for this school term (1941-42).

ARTICLE	QUANTITY	ARTICLE	QUANTITY

Alberta, and one in British Columbia. The prices and specifications were selected from the catalogues published by these firms for the school year 1939. This was necessary, for at that time, the prices of chemistry reagents and apparatus were at a reasonably stable level, whereas at the present time, under war conditions, there is an enormous discrepancy in catalogue prices, and these cannot be guaranteed for any definite period of time. Utilizing this price-list and the completed Survey Sheets it was a simple matter to calculate the actual worth of chemicals and apparatus in that particular laboratory. The figures establishing the cost of the permanent fixtures were estimated by the chemistry teacher

or principal in charge of the survey in that particular "sample school". The total-cost figures were now divided by the pupil-load capacity of the designated laboratory, for the cost of a laboratory per student is certainly a figure of more significance than just the mere "total-cost". The introduction of the human element into a table of figures will make it consistently more interesting, as well as more practical.

An interesting side-light of laboratory finance is shown in the table, when one notices that it is immaterial whether a one-room or a three-room high school is being considered, the "average cost of a chemistry laboratory per student" is practically the same in both types of schools. This is a most desirable feature, for it illustrates the high degree of uniformity that is being maintained in the Alberta educational system. Equal educational privileges are being provided for both the urban and rural students in the field of laboratory chemistry.

In computing the average yearly expenditure for supplies and chemicals per pupil taking chemistry, a slightly different procedure had to be evolved. The "pupil-load capacity" of the designated laboratory could no longer be used, for the amounts of yearly supplies that are purchased are based on the actual number of students that intend to take Chemistry 2. Hence it was necessary to use the number of students actually enrolled in Chemistry 2 for the present term in all calculations. The "average price-list" mentioned in the previous section was also used in establishing the yearly maintenance expenditure for each laboratory. The yearly expenditure for supplies and chemicals per pupil in a particular school was obtained by dividing the total maintenance

TABLE II

COST OF A CHEMISTRY II LABORATORY

School	Pupil-load Capacity	Cost of Fixtures	Cost of Apparatus	Cost of Chemicals	Total Cost	Cost per Student
One-room High Schools						
Bowden	6	$ 70.00	$145.75	$ 63.25	$279.00	$ 46.50
Delburne	12	113.00	100.77	63.20	176.97	14.75
Gadsby	6	5.00	57.83	40.15	102.98	17.16
Lougheed	10	57.00	197.53	42.28	296.81	29.68
Sedgewick	12	125.00	118.92	49.75	293.65	24.47
Stavely	8	34.00	82.51	58.30	174.81	21.85
Veteran	10	15.00	85.15	29.55	129.70	12.97
Wayne	10	100.00	149.99	57.10	307.09	30.71
Two-room High Schools						
Arrowwood	14	69.50	103.84	60.05	233.39	16.67
Athabasca	15	40.00	89.82	40.85	170.67	11.38
Bassano	10	60.00	168.29	47.62	275.91	27.59
Carseland	10	66.00	145.38	40.50	251.88	25.19
Carstairs	10	59,00	213.85	68.75	341.60	34.16
Castor	8	23.50	128.82	57.35	209.67	26.21
Kathyrn	6	33.00	102.09	28.95	164.04	27.34
Mirror	20	71.00	274.51	72.50	418.01	20.90
Noble	10	75.00	133.82	32.35	241.17	24.12
Rimbey	12	60.00	175.69	42.35	278.04	23.17
Rosedale	6	20.00	122.70	61.25	203.95	33.99
Stirling	8	30.00	148.70	62.50	241.20	30.15
Tofield	8	118.00	192.22	83.40	393.62	49.20
Viking	12	750.00	349.97	110.28	1210.25	100.85
Warner	12	40.00	176.53	54.82	271.35	22.61
Three and Four-room High Schools						
Barrhead	15	57.00	219.89	80.78	357.67	23.84
Big Valley	16	37.00	91.93	42.35	171.28	10.71
Provost	22	97.00	224.24	74.75	395.99	18.00
Rocky Mt. House	12	141.00	207.98	61.60	410.58	34.21
Stettler (4)	30	110.00	258.37	64.97	433.34	14.45
St. Patrick - (Lethbridge)	16	104.00	172.65	71.35	348.00	21.75
Vermilion (4)	32	532.00	200.79	67.90	800.69	25.02
Totals						
30 high schools		3012.00	4840.53	1730.80	9583.31	819.60
Averages						
		100.40	161.35	57.69	319.44	27.32

TABLE III

MAINTENANCE COST OF A CHEMISTRY II LABORATORY

School	Number of Chemistry II Students	Total Cost per year per school	Cost per pupil per year.
One-room High Schools			
Bowden	8	$30.00	$ 3.75
Delburne	12	18.50	1.55
Gadsby	5	11.80	2.40
Lougheed	8	15.00	1.90
Sedgewick	5	8.95	1.80
Stavely	9	22.05	2.45
Veteran	3	5.40	1.80
Two-room High Schools			
Athabasca	17	32.00	1.90
Bassano	11	8.75	.80
Carseland	2	12.90	6.45
Carstairs	10	8.90	.90
Castor	11	20.00	1.80
Kathyrn	7	19.05	2.70
Noble	8	32.05	4.00
Rimbey	16	50.40	3.15
Rosedale	7	20.00	2.85
Stirling	8	24.30	3.05
Tofield	10	30.00	3.00
Warner	6	35.00	5.85
Westlock	12	88.70	7.40
Three and Four-room High Schools			
Big Valley	11	30.20	2.75
Provost	22	95.00	4.30
Rocky Mt. House	12	45.00	3.75
Stettler (4)	10	9.25	.95
St. Patrick (Lethbridge)	16	11.20	.70
Totals			
25 High Schools		684.40	71.95
Averages			
		27.38	2.88

expenditure by the number of students actually taking Chemistry 2. The average for the twenty-five representative schools produced a figure that could be termed "the average Alberta yearly expenditure for supplies and chemicals per pupil taking grade twelve chemistry.

It might be worthwhile to summarize the findings of this particular financial survey of Alberta High Schools in Chemistry 2 laboratory expenses:

1. Average value of permanent fixtures in a laboratory-$100.40
2. Average value of Chemistry 2 apparatus ----------$161.35
3. Average value of grade twelve chemicals ----------$ 57.69
4. Average "total value" of a Chemistry 2 laboratory --$319.44
5. Average value of a laboratory per pupil taking Chemistry 2. --$ 27.32
6. Average yearly maintenance expenditure per pupil ---$ 2.88

It was intended that the above figures should be valid for a number of years, but with the continued disruption (due to the war) in the prices of commodities on the world's markets, the computed results may be already classed in the doubtful category. Nevertheless, there are many feasible schemes that assert themselves, when an individual attempts to establish a corrective measure to be applied to the established "average-prices".

[1] With the National Defence Program rapidly absorbing raw materials, stocks of scientific apparatus are being affected day by day and hour by hour. Existing stocks are being fast depleted and replacement of certain items is next to impossible. Practically all metals and many other materials are required for defence production. This curtailment of materials and supplies, arising from defence needs, has made it impossible to stabilize future prices."

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[1] Director of Public Information.

The Canadian government regularly issues a "price increase index" of various commodities sold in the Dominion, indicating the extent to which they have risen in value due to uncertain conditions created by the war. If the "chemical-increase-index" is used in conjunction with the prices established in the survey, the "corrected" figures should be the bona fide prices for current use.

Another method is to procure a chemistry supply catalogue issued by a reliable firm for the year 1938-39 and check off every tenth chemical (for sampling purposes) from the list recommended for Chemistry 2, noting the amount, quality and price of each item. Now refer to the catalogue issued by the same chemical supply house for the year 1941-42, considering the prices of identical materials, making certain that the amounts and qualities are similar with your first list. The increase in the price of a chemical reagent in the year 1941-42 (prices in flux due to war) as compared with that in 1938-39 (prices stable, war in the early stages) may be attributed to the effects of the war. The computing of the percentage increase for each item, and then finding the average of these rates will no doubt produce a percentage figure that should prove quite reliable in estimating the effects of the national defence on the prices of chemistry supplies. The same procedure may be adopted in establishing a comparative rate for Chemistry 2 apparatus.

Utilizing the above method, and the figures supplied by an Alberta supply-house, it was discovered that the prices of chemical reagents in the province have increased by 37.54%,

TABLE IV

EFFECT OF THE NATIONAL DEFENCE PROGRAM
ON THE PRICES OF CHEMICALS

Chemical	Quantity	1938-39 Price	1941-42 Price	Increase in Price	% Increase in Price
Acid, Hydrochloric	1 lb.	$ .80	$1.10	$ .30	37.5
Acetone	½ lb.	.45	.50	.05	11.1
Ammonium Hydroxide	1 lb.	.75	1.10	.35	46.6
Arsenious Oxide	4 oz.	.40	.40	.00	00.0
Borax Crystals	1 lb.	.30	.30	.00	00.0
Calcium Sulphate	4 oz.	.40	.45	.05	12.5
Copper Turnings	1 lb.	.60	.80	.20	33.3
Ether, Sulphuric U.S.P.	4 oz.	.30	.40	.10	33.3
Hydrogen Peroxide	4 oz.	.30	.30	.00	00.0
Lead Nitrate C.C.	1 lb.	.80	1.25	.45	56.2
Litharge	4 oz.	.30	.40	.10	33.3
Manganese Dioxide	1 lb.	.30	.40	.10	33.3
Mercuric Oxide	1 oz.	.50	.75	.25	50.0
Phenolphthalein	1 oz.	.30	.40	.10	33.3
Potassium Chloride C.C.	1 lb.	.65	.95	.30	46.1
Potassium Sulphite	4 oz.	.55	.55	.00	00.0
Sodium Carbonate	1 lb.	.30	.60	.30	100.0
Sodium Phosphate	1 lb.	.50	.80	.30	60.0
Stannous Chloride	4 oz.	.45	1.10	.65	144.4
Zinc, Mossy	1 lb.	.50	.60	.10	20.0

Average % Increase in Price - 37.54%

while those of apparatus 26.71 %. These calculated increases integrated with the survey results should again provide figures that are functional even in a war environment.

The majority of the provincial Departments of Education make provisions of one type or another to establish a certain standard of laboratory instruction. Some authorities demand a certain "minimum monetary" outlay , others require qualified instructors, still others require certification by a high school inspector. Practically every Department of Education provides

TABLE V

EFFECT OF THE NATIONAL DEFENCE PROGRAM
ON THE PRICES OF CHEMISTRY APPARATUS

Name of Apparatus	Quantity	1938-39 Price	1941-42 Price	Increase in Price	% Increase in Price
Alcohol Lamp (glass)	1	$ .55	$ .75	$ .20	36.36
Balances (without case)	1	23.00	25.50	2.50	10.87
Barometer (3" dial)	1	4.00	6.00	2.00	50.00
Beaker 600cc	1	.45	.45	0.00	00.00
Burette (Mohr-50 cc)	1	1.00	2.00	1.00	100.00
Condenser (Liebig)	1	1.00	1.25	.25	25.00
Cork borers (6 Pieces)	1 set	1.00	1.00	0.00	00.00
Cylinder-graduated 50 cc	1	.45	.70	.25	55.55
Erlenmeyer flask 500 cc	1	.60	.60	00.00	00.00
Funnel (separatory)	1	1.20	2.00	.80	66.66
Glass tubing-hard glass	1 lb.	.75	.90	.15	20.00
Mortar and Pestel	1	.55	.65	.10	18.18
Platinum Wire in glass	1	1.00	1.10	.10	10.10
Pneumatic trough	1	1.10	1.25	.15	13.63
Spoon, deflagrating	1	.20	.20	0.00	00.00
Support, iron base	1	1.50	1.50	0.00	00.00
Test tubes, hard glass	1 doz.	1.40	1.50	.10	7.14
Thermometer	1	1.30	1.30	0.00	00.00
Tripod (122 mm)	1	.40	.75	.35	87.50

Average % Increase in Price - 26.71%

financial assistance towards the maintenance and continued improvement of laboratory facilities. The amount of financial aid is commonly based on the extent of "local-effort" towards the provision of a first class laboratory. It might prove interesting as well as instructive, to examine a few of the provisions used in maintaining a set-standard of laboratory work by this financial motivation.

Saskatchewan.- "At the time of the organization of a high school under the Secondary Education Act it shall

be provided with chemical and physical apparatus to the value of at least $200. In order to obtain the legislative grant there shall be expended annually by the high school board $75.00 until the maximum is reached. In apportioning the legislative grant on scientific apparatus, the maximum recognized shall be as follows:

Apparatus - chemical, physical and biological - $400.00

Nova Scotia.- For the school year beginning September, 1941 the Department will certify certain of the high schools for the teaching of science. In choosing the schools thus to be certified the Department will have regard to the following points:

1. The provision by the local school board of a separate room, or rooms, properly equipped for laboratory purposes.

2. The organization of the time-table in such a way as to provide regularly scheduled , and ample, laboratory periods in the sciences.

3. The provision by the local school board of qualified science instructors.

4. The conducting of a broad practical program in laboratory work with due emphasis both on student-experimentation and on instructor-demonstration.

Manitoba.- Practical tests will be conducted at the end of the year by examiners appointed by the Department of Education.

Quebec.- The students' Laboratory Books are to be submitted to the University of McGill for grading.

British Columbia.- The reports of the experiments shall be ready for inspection at any time. Each pupil will be required to submit to the Department of Education a note-book containing the reports of the experiments performed by him. The teacher is expected to initial each experiment.

Alberta.- This unit should be offered only in those schools where the instructor in Chemistry holds, at least, standing in Chemistry 2, or its equivalent, and where the laboratory equipment is adequate for performing all of the prescribed experiments.

The Department assists School Boards in installing Science laboratories by a payment under the School Grants Act, of 50% of the Boards' outlay for equipment. This grant is not however paid for consumable supplies, as for example acids, and other chemical substances.

The largest single expense item, as well as being the most important one, in connection with the establishment of the permanent fixtures in a science room is the laboratory table.

substantial and serviceable chemistry tables will motivate the students to participate in real experiments, not just aimless tinkering about with test tubes, or what not. A permanent "chemistry home" is provided for the student, and a sense of personal pride behooves that he use it to the best advantage. The regulations of the Department of Education of Alberta stipulate that, for the purposes of laboratory work, experiments performed in groups of two will be considered as an individual enterprise, in other words, it is compulsory to provide a chemistry table large enough so it could be subdivided into sections to accommodate two students to every compartment.

The financial and pictorial survey of chemistry laboratory tables in the smaller Alberta high schools reveals there are ten types that have proved both useful and economical under the variety of conditions prevailing in the province. The chief purpose in including the pictures is to illustrate to Alberta chemistry teachers how certain technical problems in the field of of "Chemistry Tables" have been overcome in the past, and how they may be dealt with in the future. The writer believes that "one picture is worth a thousand words", and hence the emphasis on illustrations throughout the thesis, with particular stress in the section dealing with chemistry tables. In the pictorial study, the cost and student-capacity of each table has been indicated in the short summary following the illustration. The names of the schools and the teachers making the survey have also been included.

Illustration No. 1

TOFIELD / by M.W.McDonnell.

The table is 6 ft. 9 ins. by 3 ft. 9 ins. and 3 ft. high. There are four lockers with deep drawers on each side. A reagent shelf, 6 ins. wide and 6½ ins. high extends down the centre. Three natural-gas outlets are also provided on each side.

(Capacity - 8 students. Cost - $75.00)

Illustration No. 2

VIKING - by W.S.Elliott.

Each table has installed six individual drawers and cupboards, as well as gas line connections. This table compares favorably with those found in the city-school laboratories.

(Capacity - 6 students. Cost - $95.00)

Illustration No. 3

SEDGEWICK - by C.E.Blakeney.

This is a double-sided table with three lockers and drawers on each side. A high reagent shelf extends down the centre.

(Capacity - 12 students. Cost - $50.00)

Illustration No. 4

VERMILION CENTRE - by W.G.Hay.

The 12 ft. long table is divided into four divisions containing a drawer and a cupboard, each equipped with a lock. The top is finished in black. A guard-rail 4 ins. high extends around the table.

(Capacity - 8 students. Cost - $50.00)

Illustration No. 5

ROSEDALE - by R.E.Yarwood.

An L-shaped table extending along the two walls of the room. The two shelves above the table are reserved for the chemicals and glassware. A very compact arrangement, which would prove useful in small laboratories where space is at a premium.

(Capacity - 6 students. Cost $20.00)

Illustration No. 6

ATHABASCA - by B.E.Walker.

Twenty-five feet of collapsible shelving (2 ft. wide) was built around the walls of the room used for typewriting purposes. When the laboratory periods for Chemistry 2 arrive, a committee of boys quickly dispose of the typewriters in one corner, raise all the shelving on its hinges and prop it up securely on folding legs. The long low typewriting tables are placed under the shelving, and the laboratory period commences. This is a temporary solution to a problem that often presents itself when due to an influx of many students from divisional points, the laboratory space in a small high school often proves in adequate. So, while a permanent plan is being evolved, and this takes time, the Chemistry 2 course need not be cancelled for that particular year, but can go on much the same as usual in spite of the increased enrollment. This is an interesting attempt to combine a chemistry laboratory and a typewriting room.

(Capacity - 15 students. Cost $10.00)

Illustration No. 7

VETERAN - by E.E.Green.

A 2 ft. wide table extends along the north wall of a small science room. Open shelves under the table provide a space for storing chemistry apparatus. A set of 4" wide shelves hold chemicals. (Capacity - 10 students. Cost - $15.00)

Illustration No. 8

MIRROR - by A.W.Frost.

A long counter table extends along the wall. The space below the counter is divided into ten cupboards, each provided with two shelves and a padlocked door. The top of the table was made of

fir flooring and painted black. The doors and the front of the cupboard were built of fir V-joint. A water tank equipped with a tap is located at the centre of the table above a sink.
(Capacity - 20 students. Cost - $40.00)

Illustration No. 9

CHINOOK - by J.C.Charyk.

These are ordinary tables constructed of second-grade lumber, with a reagent shelf built along one side of the table, while a remodelled apple-box provides a suitable locker. The top of the table is made acid-proof, while the rest is painted in cream and green. This type of laboratory table is one of the most economical to construct.
(Capacity - 2 students. Cost - $2.15)

CHAPTER III

PERMANENT LABORATORY FIXTURES.

Laboratory Tables

In the designing and the furnishing of a laboratory all items must be scientifically planned. The equipment should be built to fit particular needs, and the chemistry teacher is the logical individual upon whose shoulders this responsibility falls.

In planning the layout of the laboratory, the placing of the work tables is a matter of primary importance. Depending on the proportions of the rooom, a choice must be made between centre tables and wall tables. Both types were amply illustrated in the chapter. Where centre tables are used, the desirable width will vary between a minimum of four feet and a maximum of five feet. This represents the established practice in the majority of laboratories in the Alberta high schools. For working tables set against the wall, experience gained in constructing the Chinook laboratory shows it is desirable to limit the table width to 30 inches. The height of the table working-surface above the floor commonly ranges from 35 to 38 inches. 37 inches should be the usual height, as this has been found satisfactory for the average grade twelve student. In planning the shelving to go on the top of the laboratory working tables the limiting height is that which will not obstruct the vision of the laboratory workers. What is commonly considered the best plan is to place the first shelf at 14 inches above the table-top, and the second at 24 inches.

Checking the list of experiments that a Chemistry 2 student is obligated to perform, it is obvious that the table-tops must offer resistance to extremely severe service, must withstand acids, alkalis, heat, water, atmospheric moisture conditions, and

mechanical abrasion and abuse. It has been found under actual working conditions in the Chinook laboratory, that if the table-tops were constructed of laminated birch or maple, 1 1/5 inches thick, and finished with a special acid resisting treatment, they would offer excellent service under all types of trying conditions.

The classical method of treating laboratory table-tops is as follows:

"Solution No.1	Copper Sulphate	4.5 oz.
	Potassium Chlorate	4.5 oz.
	Water	36.0 oz.
Solution No. 2	Aniline Hydrochloride	5.0 oz.
	Warm Water	36.0 oz.
Solution No. 3	Potassium Bichromate (10% Solution)	3.0 oz.
	Hydrochloric Acid (10% Solution)	1.5 oz.
	Water	36.0 oz.

To stain natural wood apply two coats of No. 1 and allow to dry after each coat. Apply two coats of No. 2 and allow to dry after each coat. Apply one coat of solution No. 3 and allow to dry. Rub down with raw linseed oil and then with a dry cloth."

Another similar procedure is carried out with two solutions.

"Solution No. 1	Potassium Chlorate	$3\frac{1}{2}$ oz.
	Zinc Sulphate	$3\frac{1}{2}$ oz.
	Copper Sulphate	$\frac{3}{4}$ oz.
	Water	36 oz.

After drying apply Solution No. 2.

Solution No. 2	Aniline	$3\frac{1}{2}$ oz.
	Concentrated HCl Acid	$5\frac{1}{2}$ oz.
	Water	36 oz.

Allow it to dry for 24 hours, and then apply another coat of both 1 and 2 solutions. After permitting to dry, rub it down with paraffin oil."

The above two methods are recommended only if the table-tops have been constructed out of high grade lumber, Otherwise, these

preparations instead of producing the dense black finish they are suppose to give will be spotty, probably due to the difference in absorption of different parts of low-grade wood.

The best finishes for wooden tables are based on chlorinated rubber or nitrocellulose. Unfortunately, rubber and nitrocellulose are hard to get except for defence work. There is still a possibility that teachers could obtain some black nitrocellulose lacquer in their respective towns from existing retail stocks. This is the best material, for under normal conditions it is available in all parts of Alberta.

Still another method of finishing laboratory tables is by using a commercial preparation sold under the trade name of Lin-X Clear Gloss. It has been demonstrated many times to the public generally, showing its resistance to alcohol, muriatic acid and hydrochloric acid. The Lin-X Clear Gloss is not expensive, and hence would provide an economical way of finishing laboratory tables.

Table-tops may also be constructed of Alberene stone, chemstone or transite (naturally quarried stones highly resistant to chemical attack), but the financial outlay involved is beyond the majority of high schools for which this survey was intended. Nevertheless, this method has advantages, for it is the only permanently satisfactory material that could be used for finishing tables. Literature and data on the latter materials can be secured by writing to the Alberene Stone Corporation of Virginia, 419 Fourth Avenue, New York, (for the Alberene stone) and Canadian Johns-Manville Company, Limited, 199 Bay Street, Toronto, Ontario (for the Chemstone and transite).

It is generally understood that great improvements have been made in the last ten years in finishes of all kinds, especially in

Illustration No. 10

These table-tops in the Chinook laboratory have been offering resistance to severe service for the past four years. They have been finished in either Lin-X Clear Gloss (Sherwin-Williams Co. Ltd.) or Nitrocellulose Lacquer (British American Paint Co. Ltd.)

the production of durable and non-fading colors. The majority of the chemistry tables found in Alberta schools are painted in a black carbonized finish, thus presenting a very dull and unattractive appearance. What is to prevent the science teachers from integrating art and science by finishing the laboratory tables in pleasing shades of green, or grey, or ivory lacquer? The tables in the Chinook laboratory have been finished in a color scheme of ivory and green. A glance at the illustration above will no doubt convince the readers of the attractiveness of such a finish. Contrast the dullness of the chair in the foreground with the bright stimulating appearance of the tables. Surely an effective color scheme in the laboratory will have positive psychological results on the students' ability to appreciate and to study chemistry.

Sink Equipment.

Examining the survey results from over seventy-five schools, the writer can freely say without fear of contradiction that the sink equipment in the majority of chemistry laboratories in Alberta high schools is either inadequate or non-existent. Such a situation can be readily understood when one considers that very few Alberta villages or towns possess water-work systems. Such a marked deficiency in Alberta laboratories should be remedied as speedily as possible, for it is a known fact that the success of a laboratory is greatly influenced by the convenience and utility of plumbing and accessory fixtures.

In this matter of providing sink equipment, convenience of access from several working positions is of paramount importance. Sink equipment should be ample when laboratory time is valuable, and under Alberta conditions, economy of time is indeed a necessity. In the designing of laboratory sinks, care should be exercised to plan for ample depth to avoid the nuisance of splashing. A minimum of 10 inches inside depth will eliminate this disadvantage. The sinks should be built of a material that is chemically inert (acid and alkali resistant at least), as soapstone, Alberene stone, or even porcelain, while the plumbing connections should be of either lead, or plated nickel, or even chromium. The white porcelain sink is about the only available type in Alberta, so from the point of economy and utility, the writer recommends this particular model. In the absence of running water, the laboratory could be supplied with large tanks fitted with faucets, and placed above suitable sinks. The sink-outlet should be provided with connections to either a cesspool or an earthenware jar of adequate size.

Illustration No. 11

MILLET - by P.Griffiths.

An electric pump in the basement supplies the laboratory at Millet High School with running water.

Illustration No. 12

BOWDEN - by F.M.Riddle.

A galvanized water-tank, a tap, a porcelain sink, and an earthenware waste-bucket all co-operate in supplying the Bowden laboratory with a suitable water-system.

Illustration No. 13

An old coffee-percolator used in conjunction with individual pneumatic troughs, supply the Chinook laboratory with "running water". The faucets were already provided, while the "water gauge" solves the ever recurring problem of - when to refill.

Illustration No. 14.
LEDUC - by H.F.Chittick.
This laboratory overcomes the lack of running water by the utilization of two porcelain tanks arranged over suitable sinks..

Fume Hoods.

When it is necessary to generate noxious or poisonous gases, such experiments should always be conducted in a well-ventilated laboratory-hood which is a fundamentally essential feature of every properly constructed and equipped chemical laboratory. Many factors enter into the erection of a suitable fume hood that could be used in a small laboratory. Some of these factors are -

(1) Room space available and convenience of access.

(2) Number of students using the hood.

(3) Location of vent ducts.

(4) Amount of free-working space required within the hood.

In view of these and other factors which may enter in specific instances there can be no such thing as standard design. The experience gained in conducting the Chinook Experiment leads the writer to

recommend the following fume cupboard, which should prove quite adequate for the smaller high schools of the province, if certain modifications are made to meet local requirements. Secure a suitable bread-box, line it with quarter-inch asbestos, bolt a small second-hand electric motor over an aperture cut in the back of the box (use soft rubber washers), attach a five-foot hose to the place formerly occupied by the dust-bag, solder a pane of safety-glass over the door frame, instal a 1½ volt electric bulb in the ceiling of the cupboard, and the net result of all this craftsmanship should be a serviceable fume cupboard.

Illustration No. 15

The Fume Cupboard in the Chinook laboratory. The exchange of air in this closed hood is brought about by the continuous production of a partial vacuum in the interior of the cupboard.

Illustration No. 16

HOLDEN - by W.Brushett.

This hood's effectiveness depends upon a large volume of air moving into the hood to overcome the tendency of the gases to rise and escape. The large glass door offers little obstruction to light and visibility, and the students can continuously see what is happening.

The Balance Table.

The first necessity without which no laboratory is adequately equipped is the chemical balance, after this all other apparatus is supplementary. The financial outlay for a good chemical balance is ample proof that this unit of apparatus should require the best of care. It is important to realize that the sensitiveness of a balance

depends on the knife edge remaining sharp. The best knife edges are made of agate, but these are easily blunted by being chipped, if the balance is carelessly handled. A good balance table is hence an indispensable part of the permanent equipment of a laboratory. The table should be made as solid as possible by constructing it out of good substantial lumber and bolted together in order to eliminate any possibilities of vibration. Solidity is essential in fine balance work. A good average height for the table is 31 inches. Experience has shown that if the balance table is painted a white or ivory color the smooth surface will reflect the light and thus assist in removing the shadows that usually interfere with fine-scale reading. It is advisable to place the table in the best-lighted part of the room, away from any source of interference as air-currents or vibrations, in fact some of the better high school laboratories have specially constructed balance rooms.

The Wash-Corner.

It is safe to predict that after performing an experiment, and cleaning the equipment, the students' hands are soiled with chemicals of some form or other. Hence it is advisable to formulate a safety-ruling whereby students must wash their hands with a disinfectant soap before leaving the room. Notice the variety of poisonous chemicals that a chemistry student is expected to handle - Lead Nitrate, Mercuric Chloride, Copper Sulphate and the various acids. All this leads to one conclusion - the dire necessity of providing a wash corner for the students apart from the chemical sinks proper. A small section of the laboratory (preferably a corner nearest the water supply) should be reserved

Illustration No. 17

VIKING - by W.S.Elliott.
A small balance room, containing an excellent set of balances. It is with such laboratory equipment that the best results can be attained in Chemistry 2.

Illustration No. 18

The balance table in the Chinook laboratory. The heavy material and bolted construction of this table give it a solidity essential in fine balance work. The white surface of the table assists in lighting the finely divided scales.

for such a purpose and equipped as follows; a stand, a porcelain wash basin, towels, disinfectant soap and solution, hand lotion and mirror. The section of the wall constituting the wash corner should be protected by an oil cloth covering. The students usually take special pride in anything constructed for their own personal comfort and safety.

Illustration No. 19.

The students' personal wash corner - a simple guarantee against accidental poisoning.

CHAPTER IV.

PURCHASING CHEMICALS AND APPARATUS.

Considering the fact that laboratory chemicals and apparatus run into around twenty thousand items, educational authorities should realize that the problem of ordering supplies becomes a business which is highly technical. It is advisable, therefore, that Alberta chemistry teachers who will be the chief purchasing agents, should be educated in some measure to purchase these supplies economically and with facility. The multitude of letters received from Alberta teachers by suppliers of laboratory chemicals and apparatus indicate such an education is highly desirable.

Quality of Apparatus.

The entire secret in purchasing science supplies is contained in these words, "Equipment should be purchased in terms of quality". Too often equipment is purchased in terms of the lowest initial cost with the result that frequent replacements are necessary. It is advisable to consider the initial cost plus the length of useful life of an item, for if this is compared with the cost of frequent replacement of the cheaper product, the purchaser will find that the article of higher initial price is eventually the cheaper. In fact, the cost per year may be considerably less. The purchaser should insist in almost all instances on "Standard Made" articles. Such names as Pyrex, Mohr, Cenco, Welch, stand for materials of known quality. It cannot be emphasized too strongly that the better article is ultimately the cheaper.

Here are a few specific suggestions in ordering glassware:

1. Pyrex glassware, although slightly more expensive than the cheaper soft glass, in the long run is the most economical.

This applies even to test tubes, as well as beakers, flasks, etc.

2. It is not advisable to economize by cutting down the size of the flasks, as one of the most dangerous problems in the laboratory is the inserting of glass tubing or thistle tubing through the holes in rubber stoppers. Experience gained in the Chinook Experiment leads the writer to recommend that the minimum size flask should be either the 250 cc Erlenmeyer, or the 500 cc Florence flask. Also, if glass tubing is to be inserted into test tubes, experience would not recommend a test tube smaller than 6 X $\frac{3}{4}$ " for a 1-hole stopper, or 6 X 1 " for a 2-hole stopper. Glass tubing should be standardized at 6 mm., and rubber tubing at 3/16 of an inch.

3. Any recommended list of equipment should be carefully studied in order to avoid any unnecessary duplication, and also to see that rubber stoppers, glass tubing, watch glasses, funnels, etc., fit the apparatus with which they are intended to be used. For instance, a No. 5 Rubber Stopper will fit a 500 cc Pyrex Florence flask, a 250 cc Pyrex Erlenmeyer flask, or a 150 X25 mm Pyrex test tube, and has a hole large enough to take comfortably a 6 mm glass tube, thistle tube or funnel tube.

Quality of Chemicals.

The American Chemical Society recommends C.P. chemicals, but in the interest of economy for most Chemistry 2 work (except possibly for the "Test Experiments"), the chemicals need not be of the highest purity available. Generally speaking, the B.P. or U.S.P. or technical grades are all right except in the case of acids such as hydrochloric acid, nitric acid, sulphuric acid or ammonia. It is better to order these four items in the chemically

pure grades, mostly on account of the packing, for they are shipped in glass-stoppered, or Bell Closure bottles, and are very useful for laboratory work after the acid has been used. Much of the criticism of commercial chemicals in the past has been that commercial chemicals were supplied by drug houses and other uninterested suppliers in paper bags and cardboard cartons; and as very few chemicals are absolutely unhydroscopic, their condition deteriorates very rapidly when exposed to the atmosphere. They should be supplied in wide mouth screw cap jars, with black enamelled vinalite lined metal caps. Teachers should definitely specify that the chemicals are not to be supplied in paper bags, and their order should read that such chemicals be packed in bottles.

In order to supply commercial chemicals economically, it is necessary to set a minimum quantity on most of them of one pound. For instance, Copper Sulphate, which is worth in large quantities only 6¢ a pound is, when packed in one pound bottles, sold for 25¢ per pound; whereas, if it were to be packed in quarter-pound bottles, it would be necessary to charge 20¢ per quarter-pound. Large schools could purchase the same chemical in five-pound containers at 20¢ per pound, and in ten-pound containers at 15¢ per pound. This same idea applies proportionately to other Commercial Chemicals.

On the other hand, C.P. chemicals are not a luxury in the high schools, nor do they cost a great deal more than the B.P., U.S.P. or technical grades. It is better for the teacher and for the students to know that the chemicals being used are dependable

and that the presence of an undesignated impurity will not spoil the experiment on hand. If a teacher desires to purchase pure chemicals of British origin then it is necessary to specify British C.C. on the orders. The term C.C. means Certified Chemical and is the British nomenclature for C.P. A large number of Alberta high schools purchase nothing but C.C. for two reasons, first, C.C. is a certified chemical and secondly, it is of British manufacture. At the present time, however, it is not possible to complete an order with all British chemicals. The reason is obvious, but the Chemistry Supply Houses surveyed by the writer, endeavour at all times to do so.

When to Order.

It is much to the advantage of all concerned if the required apparatus and chemicals can be ordered about the end of June or some time during early summer. The material thus ordered may then be shipped during mid-summer and is on hand ready for school opening. The reliable Supply Houses often carry the account until the science teacher has had the opportunity of checking the material in the month of September, so that, by ordering early, it does not mean that the goods are paid for before actually seen and checked by the teacher. In the smaller schools this method, or time of ordering is sometimes impossible. Very often a new teacher takes over in the fall and ordering can only be done at that time after an inventory of requirements has been made. Unfortunately, too many schools leave it until well on into the fall to order. This is poor practice since the service is bad because of the large demands, stocks become short and deliveries are consequently slowed up.

By placing orders early, the school is assured of receiving their order in one shipment, which helps to cut down transportation charges materially. Please also remember that today conditions are not normal. The nation is at war and this affects supplies and deliveries considerably. The laboratory supply houses not only furnish schools with necessary equipment but on top of that are supplying large quantities of chemicals, glassware and other scientific instruments to the munitions' laboratories of which there are many throughout the land. Moreover, there is a demand for scientific equipment from the Air Force, the Medical Corps, the Signal Corps and Navy, all of which purchase laboratory apparatus in some form or other, and it is necessary that they be given priority in so far as deliveries and available supplies are concerned.

Where to Order.

It has been found that schools are better served by placing their orders directly with the actual manufacturer or distributor. In some communities, it is the habit to place the order with the local druggist, who then places the order where he receives the best price. In this way, it is difficult to assure that the school will obtain the quality of apparatus it requires, and also, as schools are entitled to "duty free" importation, and do not have to pay sales tax, their cost is often materially higher. When purchasing from an original source of supply all schools obtain the benefit of the above mentioned Duty Free privileges as it applies to apparatus not made in Canada. This privilege extended by the Dominion Government does not allow the resale of

laboratory supplies. The sale must be direct to the educational institution concerned. This privilege often shows savings of about 30 to 40%, and hence is another very good reason why supplies should be bought from the original source.

The Cost.

Unfortunately, under present world conditions, there is a very real possibility that certain supplies which have been considered essential for chemistry instruction, will be unobtainable until after the present re-armament program is concluded. For instance, at the present time, it is very difficult to obtain such things as ; balances, weights, and to mention only a few chemicals; Acetic Acid, Magnesium metal, Potassium Permanganate, Potassium Chlorate, Carbon Tetrachloride, Ether, etc. This is all the more reason why the teachers should obtain a price quotation before purchasing chemistry supplies, unless they can depend upon the integrity of the house with whom they are dealing, to charge them only fair and reasonable prices. The Supply Houses are very co-operative in this regard, as may be judged by the following extract taken from one of the survey letters:

"Wehave given you our idea previously in this letter; but might add that we would be pleased to edit any list that you might prepare of recommended equipment; and also quote you the prices prevailing at that time."

A guide to prices, however, is always obtainable through the Order Books published by the various suppliers of Laboratory Chemicals and Apparatus in Canada. The science teacher would be advised to make a careful comparative study of the various Order Books, noting about the various items desired, such things as

prices; quality; transportation cost; methods of packing; whether prices indicated are Duty Free since, as already intimated, this is a privilege to which schools are entitled. This comparative analysis will materially assist the teacher in purchasing his supplies at an economical price.

With regard to transportation, it is, of course desirable to place large enough orders so that they may be shipped via freight. Otherwise, it is generally necessary for orders to travel by express, as most chemicals are not permitted to be shipped by Parcel Post. There are also two chemicals which can only be shipped by freight, namely, Yellow Phosphorus and Carbon Disulphide. It is essential, when prices are being compared, to note whether or not the quoted prices are on a prepaid basis, for example one firm states,-

"We have made it a practice to quote all our prices on orders of $5.00 or over on a prepaid basis."

Another firm summarizes the problem in this manner,-

"With regard to freight charges, we might say that one of the advantages we enjoy over the Eastern laboratory supply houses, is that the freight charges from Vancouver to Alberta points are approximately one-half that from the Eastern cities, and often one-third."

Quantity to Order.

This can only be determined by experience and according to the number of pupils taking the Chemistry 2 course. Most of the lists issued are calculated on a basis of ten students, and if the number is less than this, it would be appropriate to state "minimum quantities in all cases". Then if there were any smaller units packed then that shown in the order form, they would be

supplied. An experimental study of the quantity of chemicals to order, leads one to suggest the purchase of small quantities by high schools in which Chemistry 2 is alternated with Physics 2, and where the class usually has from four to eight pupils. The larger amounts of chemicals would undoubtedly be so contaminated over a period of years that most of the better grade chemicals could not be used for work involving the tests in Chemistry 2.

It is the hope of the writer that this chapter on "Purchasing Chemicals and Apparatus" will advance education in Alberta in the field of chemistry, by preventing indiscreet buying, by encouraging teacher to stimulate a trend towards the establishment of definite equipment standards, by promoting economical buying, by reducing the number of unnecessary accidents in Alberta chemistry laboratories, and by emphasizing to all purchasing agents the desirability of good equipment.

CHAPTER V.

SAFETY IN THE CHEMISTRY LABORATORY.

Chemistry students are daily working with materials and equipment which might easily cause serious injury if not handled properly. These hazards encountered in chemistry laboratories should be quite obvious, yet accidents continue to occur because someone didn't think, didn't know the rules, or indulged in "horseplay", or because the instructor failed to give complete explicit directions. Four years' experience in Safety Education in the Chinook High School Laboratory, leads the writer to recommend to school officials and teachers alike, that several periods of the Chemistry 2 laboratory course be used to establish the background for a sound and well-balanced school safety program.

Accidents in the chemistry laboratory occur most commonly in connection with certain activities, and it is the duty of the teacher to familiarize the students with the precautions to be observed in these instances. An instructor must be conscious of safety in his actions to insure caution on the part of his students.

1. The method of putting glass tubing through rubber stoppers should be properly demonstrated before students attempt it.

2. Have dangerous chemicals such as sodium, potassium, phosphorus, potassium cyanide, mercury, gasoline, ether, carbon bisulphide, etc., properly stored, with students fully instructed about the reasons for such storage.

3. Emphasize suitable precautions for handling chemicals which may produce severe injury to the skin.

4. Special care should be exercised to insure accurate labelling of all chemicals issued to students or used in the laboratory.

5. Emphasize the importance of testing very small quantities of chemicals before large quantities are used.

6. Insist upon students' checking original ideas with the instructor before such ideas are tried out in the laboratory.

7. The chemical fire extinguisher, the fire blanket, the sand bucket and fire bell should be readily accessible, with students instructed about their use.

Every chemistry laboratory would be wise to adopt a brief but comprehensive set of safety rules. These rules, along with safety posters should be placed in conspicious parts of the laboratory room, as on the locker doors of the tables at which the students usually work, or on the door of the supply cupboard, or even on the bulletin board. The teacher should continually draw the attention of his students to these laboratory regulations.

No difficulty should be experienced in drafting a set of cardinal laboratory rules, for (1) the majority of chemistry laboratory manuals list them, (2) the Educational Service Department of the Central Scientific Company of Canada, 119 York Street, Toronto, issue a free pamphlet entitled "Laboratory Practices and First-Aid suggestions for High School Chemistry", (3) the National Safety Council, 20 North Wacker Drive, Chicago, publishes a magazine called "SAFETY EDUCATION" at a nominal cost of $2.00 a year. This forty-eight page publication contains a wealth of tangible, applicable material for teachers, principals,

Illustration No. 20
Safety Education in the Chinook Laboratory. Posters and safety regulations make the chemistry students conscious of the necessity of exercising caution in their experimental work.

supervisors and others in keeping abreast of safety education activities and trends. A folder describing this magazine, the coloured School Safety Posters, as well as an up-to-date list of free and inexpensive school safety materials are available from the Council.

The following is a list of "Precautions to be Observed in the Handling and Use of Chemicals", as used in the Chinook High

School. These rules were compiled after a careful study of several outstanding publications on the subject, issued by organizations primarily interested in promoting chemistry education. The requirements of the small Alberta high school were also taken into consideration.

PRECAUTIONS TO BE OBSERVED IN THE HANDLING AND USE OF CHEMICALS.

A. The Instructor.

1. Special care should be exercised to insure against accidents from particularly dangerous chemicals, such for example, as;

   Yellow Phosphorus - be sure the sticks are always completely covered with water and the container so sealed as to prevent evaporation.

   Metallic Sodium or Potassium - be sure they are always protected against contact with moisture, and are stored in kerosene in glass bottles sitting in metal cans. Inspect frequently to make certain the kerosene has not leaked away, exposing the sodium or potassium to the atmosphere.

   Potassium Cyanide - be sure to protect from moisture and consequent evolution of deadly hydrocyanic acid fumes.

   Mercury - all spilled mercury should be cleaned up promptly and not touched with bare hands.

   Carbon bisulphide - be sure that the container is so sealed as to prevent evaporation.

2. All inflammable, explosive, poisonous, or otherwise dangerous chemicals should be stored separately under lock and key and access to them should be only by a limited number of thoroughly informed and responsible persons.

3. All rubber and glass tubing and other apparatus (test tubes, beakers, Florence flasks especially) should be examined carefully for defects before being issued.
4. Inspect laboratory desks of students frequently to insure against improper or dangerous practices of any kind.
5. All students should be required to wear rubberized aprons, or other suitable protection to clothing while performing experimental work in a chemical laboratory.

Illustration No. 21

Laboratory Aprons. The types of aprons that have proved both useful and economical under actual working conditions in the laboratory of the Chinook High School. Exhibited by members of the Chinook School. Reading from left to right - Transite ($1.05), Evelyn McDonald: White Rubber ($1.25), Jessie Schmidt: Black Rubber ($0.65), Lois Robinson.

6. Good housekeeping is imperative. The dangers of a cluttered working surface, or of materials spilled on the floor are obvious.

7. Equipment should be designed and laid out so that there is always sufficient working room for every student and sufficient room for the storage and handling of materials without hazard.
8. Always provide and insist on the use of earthen-ware jars of adequate size as receptacles for chemical wastes of all kinds.
9. Do not purchase or requistion cheap chemicals or other laboratory supplies. The best materials whether chemicals or equipment, from a reliable source, together with proper instruction and supervision,is the best and cheapest insurance against accidents.
10. Experiments in which toxic or malodorus gases are generated should be performed in a hood equipped with a ventilating fan.

B. The Students.

1. Laboratory accidents are usually the result of carelessness or ignorance, or both.
2. Chemical apparatus and chemicals should be treated at all times with care and respect. Failure to do this may cause very serious injuries, such as blindness, burns, cuts, poisoning and suffocation.
3. In general, all acids and alkali reagents, especially in concentrated form, are caustic and dangerous. Therefore extreme care should always be exercised in handling them. Water is the best first aid measure and should be used very freely.
4. Liquid chemicals should be poured from bottles after removing and holding the stopper between two fingers of

the hand holding the bottle. The bottle should be held firmly and the operator's face kept as far away as possible. Take care of the drip from the lip of the bottle.

5. Concentrated sulphuric acid is one of the ordinary laboratory reagents. The wrong method of diluting it, in test tubes or other containers, has caused many a blinded eye, or a burned face, or ruined clothing or all three. Never pour water on concentrated sulphuric acid; always pour the concentrated sulphuric acid on the water.
6. Set up apparatus well back from the edge of the bench. Good housekeeping and neatness are essential; clean up your apparatus and glass-ware when your work is finished.
7. Because many chemicals and laboratory fumes attack and ruin jewelry, students should be warned not to wear jewelry during laboratory work.
8. The ends of all glass tubing should be fire-polished. Before inserting tubing into stoppers or rubber tubing, be sure that the hole is large enough to accommodate the glass. Moisten the tube and stopper thoroughly. Hold the stopper between the thumb and forefinger, not in the palm of the hand. Grasp the glass tube close to the end that is to fit in the stopper and twist it into the tube with a slight rotary motion. Have the tubing protrude all the way through the stopper so that the hole cannot close when the stopper is heated and attacked by solvents and other chemicals.
9. Keep your face away from any liquids or solids being heated in test tubes, beakers, casseroles, evaporating dishes, etc.

10. Never neutralize a chemical in the eye with any other chemical but use water freely, gently and continually until the doctor takes charge. A bubbler drinking fountain is a good device for washing the eyes.
11. When accidents do occur - regardless of their nature or cause - students should immediately call for assistance from those in charge.

Fire Protection.

Statistics taken from Fire Department records show that the most precious moments in combating a fire in the chemistry laboratory are those before the flames have had time to spread. It is obvious therefore, that if adequate means are at hand to extinguish the fire before it has had an opportunity to grow large and get beyond control, a great deal of the danger and loss annually incurred by fires in the laboratories can be eliminated. The majority of the laboratories in the Alberta high schools are not constructed of fireproof material, but wood. It is hence imperative that some adequate form of fire protection be provided. The smaller high schools are usually located in communities isolated from the protection of an organized Fire Department, thus the necessity for first aid fire-fighting appliances is doubly felt.

The fire hazards in the average chemical laboratory are quite varied, and because of the dangers permitting certain chemicals to mix or come in contact with each other, it is sometimes difficult to recommend one particular type of fire-extinguisher as an all-purpose unit.

1. There should be at hand at all times in every chemical laboratory, a liberal supply of sand with which to smother small laboratory fires.

2. A heavy blanket should be always at hand with which to smother fire by wrapping it about a person whose clothing has caught fire. Girls need to be warned about the possibility of getting their hair in Bunsen or alcohol burner flames.
3. A suitable fire-extinguisher should also be at hand in an easily accessible location of the laboratory for emergency use.

The Improved Pyrene Fire Extinguisher (vaporizing liquid, one quart type) has been found to be the best protection against laboratory fires. Pyrene is small enough for a child to operate, and it is effective against any kind of fire - alcohol, gasoline, chemical, or in fact any fire that might start in a laboratory. Pyrene works with a pump action and throws a stream of Pyrene liquid twenty to twenty-five feet, forming a gas blanket which, like a magician's command, instantly kills the fire and does not injure anything else it touches.

Another suitable type is the portable carbon-dioxide extinguisher as manufactured by the C-O-Two Fire Equipment of Canada Limited. Carbon Dioxide is stored in C-O-Two extinguishers as a liquid and discharged under its own pressure, without pumping. No matter how long C-O-TWO cylinders remain unused, the gas is just as effective as the day the cylinders were filled, as Carbon-Dioxide does not deteriorate. Carbon Dioxide extinguishes fire by diluting the oxygen content to a point where it will not support combustion, and also aids in extinguishing fire by its cooling effect. One of Carbon Dioxide's most valuable properties is its high rate of expansion (450 to 1). When liberated, the gas

is discharge by the force of its own expansion and penetrates to every nook and corner of the laboratory, even seeking out cracks and crevices where fire might lurk.

Perhaps more important than the type of fire control apparatus, is its availability and the training of the operator. If the fire apparatus can be reached and used instantly and intelligently a fire need never become serious. Teachers who desire detailed information on any of the above-mentioned extinguishers, would do well to write to Pyrene, Manufacturing Company, 91 Don Roadway, Toronto. This company issues "fire literature" of various kinds, giving detailed description of the operation, extinguishing agencies, and application to various types of hazards.

Illustration No. 22

The Chinook Laboratory is fortified for fire-fighting. A set of precautionary rules, a bucket of sand, a Pyrene fire-extinguisher, a blanket, an alarm bell, and well-trained student operators, assure a reasonable amount of protection against the outbreak of fire in a chemistry laboratory.

Storing Chemicals.

[1] "A good deal of the apparatus and many chemicals that were originally imported from enemy occupied countries are no longer available. The European countries supplied a great deal of these and some items will be absolutely off the market. For example, small things like Blowpipes of brass, formerly brought in from France, are now unobtainable. No American or Canadian firm will manufacture them on account of the price that would have to be charged. There are many other items in the same class. This all leads to the point that existing apparatus and chemicals in schools should be taken care of as never before."

It should not require a rapidly increasing National Defence Program to initiate in teachers a desire to instigate a programme of economy in their laboratory, for thrift is a sign of good management in any type of institution. One source of wastage may be attributed to the lack of proper information on the "storage of chemicals and equipment", so an effort was made in the Chinook Laboratory to provide this information by testing out various methods of storage as they suggested themselves to the writer.

SUGGESTIONS ON STORING CHEMICALS.

1. Do not store chemicals where fumes from them can get at balances or other apparatus with metallic parts, otherwise the fumes will soon ruin the apparatus. These two classes of materials should be placed in separate cupboards, making certain that the doors on the cupboards fit snuggly. It is advisable in the small laboratories to construct a case of clear-glass window panes as a protective cover for the analytical balances.

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[1] F.E. Osborne, Calgary, Alberta.

2. When placing reagents on shelves, one should provide ample space (1/4 to 3/8 of an inch) between the bottles so persons can grasp the bottles firmly when handling them, and at the same time prevent the accidental knocking down of adjacent bottles. This can be accomplished by tacking strips of half-round moulding on the shelves - one strip between adjacent bottles.
3. A dispensing shelf should be constructed and located in that part of the room which is easily accessible to each laboratory table. Access to this shelf by students should be regulated by definite enforced rules, while access to reserve stocks should be restricted to the chemistry teacher.
4. Labelled boxes of suitable size placed on the "current-shelves", should provide an economical way of housing such materials as Corks, Glass Tubing, Rubber Tubing, Burettes-Pipettes-Condensers, Clamps, and other small miscellaneous items.
5. Files, cork-borers, pliers, knives, forceps, etc., usually classified as hardware tools, should be arranged on the wall (using simple nail-shelves) above a small work-bench. This work-table, if provided with a small vice, a blow torch, an emery wheel, etc., should prove an ideal place for cutting or bending glass tubing, boring holes in corks, making minor repairs to the apparatus, or other laboratory practices too numerous to mention.
6. The heavy bottles containing the acids should be placed as near the floor as possible, and be well braced against falling.

Illustration No. 23
The storage of materials in the "Current Shelves". The materials stored include acids, liquids, distilled water, first-aid equipment, dispensing shelf, corks, tubing and burettes, condensers, pipettes.

7. The chemicals should be placed in a chemical-cupboard with the shelving divided into sections for the "anion" or "cation" classification, while the individual chemicals in each group should be arranged in alphabetical order according to chemical names.
8. A part of the apparatus cupboard should be reserved for the glassware, with the items arranged in alphabetical order according to the particular name of that glassware unit as,- Beakers, Crucibles, Cylinders, Dishes, Flasks,
9. Teachers and students should be thoroughly acquainted with the [1] procedure to use in the case of accidents. The First-

[1]The Central Scientific Company of Canada Limited, 119 York St., Toronto, produce a folder entitled, "First-Aid Suggestions in Chemistry", while the Fisher Scientific Co., Pittsburgh, Pa., issue a "Laboratory Emergency Chart".

Aid Kit should be located in a convenient place, and its use known by everyone. A supply of the following should be in the laboratory at all times: Vaseline, Burn Ointment, Carron Oil, 5% Sodium Bicarbonate, 5% Ammonium Hydroxide, 5% Boric Acid or 5% Acetic Acid, Ethanol, Zinc Ointment, Castor or Olive Oil, 3.5% Tincture of Iodine, Hydrogen Peroxide, Ferric Chloride Solution, Tubing for Tourniquet, Bandages, Gauze, Scissors and Adhesive Tape.

Illustration No. 24
First-Aid Equipment in the Chinook School is placed in a convenient place (current shelves), and ready for use at a moment's notice.

Illustration No. 25

VERMILION CENTRE - by W.G.Hay.
A Method of Storing Chemicals, and Apparatus. This splendid system of classifying and storing materials on shelves behind sliding glass doors, indicates a high degree of perfection in the art of "Chemistry Storage".

Illustration No. 26

BOWDEN - by F.M.Riddle.
A Method of Storing Glassware - A place for everything and everything in its place.

Illustration No. 27

PICARDVILLE - by A.S.Corneliuson.
Storage of Chemicals and Glassware.

Acids, bases and any other dangerous chemicals are kept in a locked cupboard, here, the middle section of the shelves is fitted with doors that are kept locked except during the laboratory period. Otherwise, the room is used freely for any work in science.

Illustration No. 28

The Classification (Cation) and Storage of Chemicals in the Chinook Laboratory.

CHAPTER VI

SUPPLEMENTARY MATERIALS FOR CHEMISTRY II.

An essential part of the equipment of every chemistry department is a collection of well chosen reference booklets, pamphlets, charts and sample materials available for constant use. This supplementary material provides an opportunity for the pupils to investigate all the questions which arise. They will profit by the training which comes from learning how and where to find the answers to questions. In addition, it will provide entertaining reading by which the pupils' interest in things chemical may be stimulated and developed. The Chemistry 2 course, via the recommended reading sections on Fertilizers, Rubber, Pulp and Paper, Oil, Rayon, etc. can be used to stimulate individual initiative and ability by the presentation of reports by individual class members. This could be made especially interesting if actual sample materials were available for the students. It has been the consistent practice of the writer to bring before each chemistry class attractive commercial booklets, samples, pictures, or at least something that would "bring to life" the inert material in the textbook. The writer believes so firmly in this method of teaching, i.e.,bringing the world into the classroom, that the major portion of a year was utilized in conducting a survey throughout Canada of possible materials that would make the teaching of chemistry in Alberta schools more interesting, more concrete, more vital, more closely related to the student's everyday life and the national life of Canada.

The majority of Canadian industrial concerns maintain educational services of some description or other in conjunction

with their particular interest, and it was the purpose of the survey to discover and make these facilities known to Alberta chemistry teachers. The request to the industrial firms was partially worded in this manner, "If your institution provides some educational service such as issuing pamphlets, brochures, illustrated charts, samples of materials, films, etc., in the field of ---------- and would be willing to make these available to Alberta chemistry teachers, please provide me with the necessary information and sample materials re your educational services".

An attempt was made to supplement every section of the Littler textbook with this "industrial educational service". Using the Canadian Manufacturers' Guide as a source book the names and addresses of over two-hundred industrial establishments were tabulated opposite the particular section in the textbook that there was any likelihood of supplementing. A personal letter was then addressed to each of the firms, requesting information concerning their particular educational service, and the possibility of its extension to Alberta schools. Considering the fact that Canada is at war, the response was amazing, for it produced nearly three hundred booklets or pamphlets, and twenty-five different sample units.

The majority of the industrial concerns were willing to co-operate, but unfortunately the war has caused a deferment of many educational services for the duration. Nevertheless, the firms that are on "defence contracts" have promised that, at the conclusion of the war they would co-operate most heartily

in supplying supplementary chemistry material for Alberta high schools.

Extracts from a few letters indicate that the industrial world is in complete sympathy with the progressive educational scheme of "Bringing the World Into the Classroom", and is willing to co-operate in furthering its realization.

"We will look forward with interest to your reply as to whether the information we have available will be of any use to you and your people". - Norton Company of Canada.

"If, in your opinion, this brochure would be of some value, we would be only too happy to provide Alberta teachers with a reasonable quantity." - Canadian Johns-Manville Co.

"We would, of course, deem it a privilege to supply teachers interested, in literature pertaining to the subject of storage batteries." - Williard Storage Battery Co.

"We are pleased to co-operate with you in the improvement of educational facilities in this way and trust that your survey will be completely successful." - Canadian National Carbon Co.

"We believe your scheme to be an excellent one, and one in which we are very interested." - Merck & Co.

"We have your letter of the 22nd ultimo, advising us what you are endeavouring to do and we wish to take this opportunity of congratulating you on your efforts." - Cheney Chemicals Limited.

"We think with you that it is in the National interest that the youth of Alberta receive authentic information on the activities of Canadian Companies in the pulp and paper field." -- National Cellulose of Canada.

"I am sorry we have no samples for distribution, but I hope that the above booklets will prove helpful and interesting, and we would be very pleased to send them out to any Alberta chemistry teacher who requests them."- Canadian Industries Limited.

"Under separate cover we have today forwarded a High School sample set, together with descriptive literature, and shall be pleased to have your comment thereon." --Consolidated Mining and Smelting Company.

"We are arranging to send you the covering pamphlets which we have and would be only too glad to co-operate further with you after the finish of the war." - Dominion Glass Company.

"We are very pleased to co-operate in your program and, therefore, have enclosed a few articles that can be provided." --Iodine Educational Bureau, Inc.

"We were very much interested indeed to receive your letter regarding lime, and we will be only too happy to assist you in any way we can." - Dominion Lime.

"Appreciating the motive behind your enquiry of October 11th relative to teaching of chemistry, we are glad to render you such assistance as we can." - Department of Mines and Resources.

"We think your idea is a good one and wish you success with this commendable venture." - Nichols Chemical Company.

"We wish to assure you that we are willing to co-operate with you, and at the present time we are doing some work in lining up information which will be forwarded to you within the course of the next few days." - Sherwin-Williams Co.

"It is always of interest to us to hear of a progressive educationalist who is striving to show the practical application of scientific and theoretical studies." - Lever Brothers Limited.

"I would like to say that I fully appreciate the program you are undertaking and agree that it is an excellent idea."

It would be a physical impossibility for every interested chemistry teacher to visit the Chinook Laboratory, and to judge for himself the relative value of this supplementary material, but a few pictures might give one a fair idea of the possibilities of this "Living Textbook".

Illustration No. 29
Results of the Survey - A Living Textbook. A display of a part of the 286 booklets that could be used to supplement practically every section of the Grade XII chemistry textbook. Notice how the titles of the booklets coincide with the chapter headings in the Elementary Chemistry by Littler.

Illustration No. 30
LIME - Samples - Lump Lime, Hydrated Lime, and of both High Calcium and Dolomitic Limestones.
Booklets - Snowflake Lime, Lime in Agriculture, Adhesive Lime Mortar.

Illustration No. 31

GASOLINE-OIL-PAINT-VARNISHES.
Samples - 20 samples of different grades of oil and gasoline. 5 samples of resin, 4 of linseed oil, 36 paint pigments.
Booklet - Oil Review.

Illustration No. 32

MINERALS - Samples - Asbestos, Carborundum, Antimony, and Mineral Collection of 38 items.
Booklets - Story of Asbestos, Asbestos, Aloxite, Chemistry Plays Its Part in Peace and War.

Illustration No. 33

RUBBER - CALCIUM CHLORIDE.

Samples - 6 grades of rubber, 1 bottle of latex, Calcium Chloride and Sodium Carbonate.

Booklets - Romance of Rubber, Story of the Tire, 15 leaflets on Calcium Chloride.

Illustration No. 34

FERTILIZERS-ORES-METALS-GYPSUM.

Samples - 6 fertilizers, Ores of Zinc, Cadmium, Lead, Purified Zinc, Lead, Cadmium, Bismuth. Gypsum rock, Paris Plaster, Gypsum Wall Board.

Booklets- Plant Food, Smelting Process, Gyproc.

SOURCES OF FREE SUPPLEMENTARY MATERIAL SUITABLE FOR CHEMISTRY II.

The Usefulness of Chemistry.

1. "Chemistry plays its part in Peace and War".
   --Canadian Industries Limited, Box 10, Montreal.

2. "Wonderful Cellophane".
   --Canadian Industries Limited, Box 10, Montreal.

3. "The Science of Everyday Things".
   --Canadian General Electric Co., Toronto, Ontario.

4. "C.I.L. Oval".
   --Canadian Industries Limited, Box 10, Montreal.

5. "Stainless Steel in Aircraft".
   --Electro Metallurgical Co., Welland, Ontario.

6. "Annual Report of the National Research Council of Canada".
   --National Research Council , Ottawa.

7. "Pioneers of Progress".
   --Canadian General Electric Co., Toronto, Ontario.

The Halogen Family.

1. "Iodine for Profitable Feeding".
   --Iodine Educational Bureau, 120 Broadway, New York, N.Y.

2. "The Value and Many Uses of Iodine as an Antiseptic and Germicide"
   --Iodine Educational Bureau, 120 Broadway, New York, N.Y.

3. "The Pharmacist Who Discovered Iodine".
   --Iodine Educational Bureau, 120 Broadway, New York, N.Y.

The Periodic Law.

1. Blotter with the Atomic Weights correct to 1939.
   --Merck & Co., 560 De Courcelles St., Montreal, Que.

Nitrogen - Phosphorus Family.

1. "Metallurgical and Chemical Operations".
   --Consolidated Mining and Smelting Co., Calgary, Alberta.

2. "The Story of "Aero" Cyanamid".
   --North American Cyanamid, Royal Bank Bldg., Toronto.

3. Samples of Refined Antimony.
   --Magnolia Metal Co., 2028 Manufacturer's St.,Montreal.

4. Samples of Refined Bismuth.
   --Consolidated Mining and Smelting Co., Calgary, Alberta.

Compounds of Silicon and Boron.

1. "Romance of Carborundum".
   --Canadian Carborundum Co. Ltd., Niagara Falls, Ontario.

2. "The Story of Glass".
   --Dominion Glass Co. Ltd., Recliff, Alberta.

3. "Vita Glass for Children".
   --Pilkington Bros., 11th Ave. East, Calgary, Alberta.

4. "Abrasives - Their History and Development".
   --Norton Company of Canada, Hamilton, Ontario.

5. "Monthly Publication P's & Q's".
   --National Silicates Ltd., P.O. Box 69, New Toronto.

6. "Carborundum Products for the Home".
   --Canadian Carborundum Co. Ltd., Niagara Falls, Ontario.

7. "General Ceramics Chemical Stoneware".
   --Emmans Ltd., Canada Cement Building, Montreal.

8. Samples of Fireclay.
   --Canadian Refractories Limited, Canada Cement Bldg.,Montreal.

9. Carborundum Wall Chart.
   --Canadian Carborundum Co. Ltd., Niagara Falls, Ontario.

Metal and Alloys.

1. "Electromet (Alloys)".
   --Electro Metallurgical Co., Welland, Ontario.

2. "The Canadian Mineral Industry 1938".
   --Department of Mines and Resources, Ottawa.

3. "Metallurgical and Chemical Operations".
   --Consolidated Mining & Smelting Co., Calgary, Alberta.

4. Pamphlet describing specimens of Minerals and Rocks.
   --Department of Mines and Resources, Ottawa.

Sodium and Its Compounds.

1. "Salt - Its History, Development, Uses and Chemistry".
   --Canadian Industries Limited, Box 10, Montreal.

2. "Cleansing Helps - Washing Soda".
   --Church & Dwight Ltd., Montreal.

3. "Baking Soda - Medicinal Purposes".
   --Church & Dwight Ltd., Montreal.

Some Commercial Fertilizers.

1. "Lime in Agriculture".
   --North American Cyanamid, Royal Bank Building, Toronto.

2. "Plant Food for the Prairies".
   --Consolidated Mining and Smelting Co., Calgary, Alberta.

3. Sample set of fertilizers.
   --Consolidated Mining and Smelting Co., Calgary, Alberta.

Calcium-Strontium-Barium.

1. "Adhesive Lime Mortars".
   --Dominion Lime Limited, Canada Cement Bldg., Montreal.

2. "The Story of "Aero Cyanamid".
   --North American Cyanamid Ltd., Royal Bank Bldg., Toronto.

3. "Calcium Chloride for Refrigeration".
   --Brunner, Mond Canada Sales, 620 Cathcart St., Montreal.

4. "Gyproc".
   --Gypsum, Lime and Alabastine Ltd., Calgary, Alberta.

5. "Snowflake Lime".
   --Snowflake Lime Ltd., Saint John, N.B.

6. "To End Dust".
   --Brunner, Mond Canada Sales, 620 Cathcart St., Montreal.

7. Samples of Limestone.
   --Snowflake Lime Ltd., Saint John, N.B.

8. Samples of Gyproc Wallboards, Massive Gypsum, Plaster of Paris.
   --Gypsum, Lime & Alabastine Ltd., Calgary, Alberta.

Magnesium - Zinc Family.

1. "The Story of Asbestos".
   --Canadian Johns-Manville Co. Ltd., Laird Drive, Toronto.

2. "Asbestos".
   --Asbestos Corporation Ltd., Thetford Mines, Que.

3. "Metallurgical and Chemical Operations.
   --Consolidated Mining and Smelting Co., Calgary, Alberta.

4. Samples of Magnesite.
   --Canadian Refractories Ltd., Canada Cement Bldg., Montreal.

5. Samples of Cadmium, Zinc Ore, Refined Zinc.
   --Consolidated Mining and Smelting Co., Calgary, Alberta.

6. Samples of Asbestos.
--Asbestos Corporation Ltd., Thetford Mines, Quebec.

Aluminium.

1. "Canada's Aluminium Industry".
--Aluminium Company of Canada, Ltd., 158 Sterling Road,Toronto.

2. "The Enchantment of Colors".
--Baribeau & Son, Levis, Quebec.

Iron Family.

1. "Stainless Steels and Their Uses".
--Electro Metallurgical Co., Welland, Ontario.

2. "Questions and Answers - Inks".
--Carter's Ink Co., Mount Royal Ave. and Drolet St.,Montreal.

3. "General Subject of Ink Manufacture".
--Reliance Ink Co., 520 McGee St., Winnipeg, Manitoba.

4. "The Steel Industry of Canada".
--Steel Co. of Canada, Ltd., Hamilton, Ontario.

5. "7 minutes with 7 metals" (Nickel).
--International Nickel Co., 25 King St., West, Toronto.

6. "Choice of Tool Steels".
--Atlas Steels Limited, Welland, Ontario.

7. "The Primary Iron and Steel Industry in Canada 1940.(Statistical).
--Dominion Bureau of Statistics, Ottawa.

8. "Alloys for the Cast Iron Foundry".
--Electro Metallurgical Co. of Canada, Welland, Ontario.

Copper and Silver.

1. "The Romance of Copper and Its Alloys".
--Anaconda American Brass Ltd., New Toronto, Ontario.

2. "Great Falls Department" (Electrolytic Copper Refinery).
--Anaconda Copper Mining Co., Great Falls, Montana.

Tin and Lead.

1. "Metallurgical and Chemical Operations".
--Consolidated Mining and Smelting Co., Calgary, Alberta.

2. "Principles of the Storage Battery".
--Willard Storage Battery Co., 269 Campbell Ave., Toronto.

3. Samples of Lead Ore and Refined Lead.
--Consolidated Mining and Smelting Co., Calgary, Alberta.

Gold and Platinum.

1. "Review of the Gold Mining Industry in Canada 1940".
   --Dominion Bureau of Statistics, Ottawa.

Manganese and Chromium.

1. "Chrome for Canada".
   --Canadian Refractories Ltd., 1050 Canada Cement Bldg. Montreal

2. "Chromium in Cast Iron".
   --Electro Metallurgical Co., Welland, Ontario.

3. Samples of Chrome.
   --Canadian Refractories Ltd., 1050 Canada Cement Bldg,Montreal.

Some Important Hydrocarbons.

1. "Oxy-Acetylene Welding and Cutting".
   --Dominion Oxygen Co., St. Boniface, Manitoba.

Natural Oil, Gas, and Tar.

1. "Carbon". Story of an interesting element.
   --Canadian National Carbon Co., 805 Davenport Road, Toronto.

2. "The Imperial Oil Review".
   --Imperial Oil Limited, Toronto 2.

3. "Wall chart of the By-Product Coke Tree".
   --Hamilton By-Product Coke Ovens, Hamilton, Ontario.

Starch, Sugars, and Cellulose.

1. "A Story of Pure Alberta Sugar."
   Canadian Sugar Factories, Ltd., Raymond, Alberta.

2. "Cane Sugar".
   --Atlantic Sugar Refineries, Ltd., Saint John, N.B.

3. "From Beet to Bowl".
   --Canada and Dominion Sugar Co., Ltd., Chatham, Ontario.

4. "The Kernel of Corn".
   --Canada Starch Co. Ltd., 49 Wellington St. E., Toronto.

Paper, Rayon, and Rubber.

1. "The Romance of Rubber".
   --Dominion Tire Factory, Kitchener, Ontario.

2. "How Wood is Made into Paper".
   --Abitibi Power and Paper Co., Toronto.

3. "The Book of Rayon".
   --Courtaulds (Canada) Ltd., Cornwall, Ontario.

4. "Pulp, Paper and Related Products".
   --Department of the Interior, Ottawa.

5. Chemistry Exhibit - Display of pulp, set of pictures, and 8 Booklets. ($1.00).
   --Hammermill Paper Co., Erie, Pennsylvania.

6. "The Story of the Tire".
   --The Goodyear Tire and Rubber Co., New Toronto, Ont.

7. "Making Sulphite Pulp, Groundwood Pulp and Newsprint at Bathurst."
   --Bathurst Power and Paper Co. Ltd., Bathurst, N.B.

8. Wall Chart of "Flow Graph for Viscose Rayon".
   Courtaulds (Canada) Ltd., Cornwall, Ontario.

9. School Exhibit of Rubber. (Wait until the war is over.)
   --Dominion Tire Factory, Kitchener, Ontario.

Alcohol, Acids, and Esters.

1. "The Story of Industrial Alcohol".
   --U.S. Industrial Chemicals, 60 East 42nd St. New York.

2. "Alcohol in Industry."
   --Gooderham & Worts Limited, Toronto.

3. "Soap - Its History and Manufacture".
   --Lever Brothers Ltd., Toronto.

4. "Chemical Sketches".
   --Canadian Industries Limited, Box 10, Montreal.

5. "Cooking System Service".
   --Canadian National Carbon Co., Ltd., 805 Davenport Road, Toronto, Ontario.

Foods and Vitamins.

1. "Vitamins in Nutrition".
   --Merck & Co., 560 De Courcelles St., Montreal, Que.

2. "Vitamin Reviews".
   --Merck & Co., 560 De Courcelles St., Montreal, Que.

The Structure of the Atom.

1. "Excursions in Science and Engineering".
   --Canadian General Electric Co., Toronto, Ontario.

What of the Future?

1. "The Change to Plastics".
   --Canadian General Electric Co., Toronto, Ontario.

2. "Chemical World of Tomorrow."
--Canadian Industries Limited, Box 10, Montreal, Quebec.

3. "Textolite".
--Canadian General Electric Company, Toronto.

4. "The General Electric House of Magic".
--Canadian General Electric Company, Toronto.

General.

1. "Development of Chemical, Metallurgical, and Allied Industries in Canada".
--Department of Mines, Ottawa.
This pamphlet includes a number of diagrams and charts covering such subjects as alkali industry - products, by-products, and industrial uses; coal derivatives; Utilization of atmospheric nitrogen - Cyanamide process; and the Iron industry.

2. "Chemicals and Allied Products in Canada 1937-38". (Statistical)
--Dominion Bureau of Statistics, Ottawa.

Appendix.

1. An Identification Chart of the Common Chemical Elements.
--Merck & Co., 560 De Courcelles St., Montreal, Quebec.

2. Sensitivity Chart of Qualitative Reactions.
--Merck & Co., 560 De Courcelles St., Montreal, Quebec.

Periodicals.

The primary purpose of any Chemistry Periodical is to promote the teaching and study of chemistry. In reality, a good periodical supplies the "missing link" between textbook facts and present-day developments in chemistry. The teacher and the class should profit by its use. The teachers should use it as a means of motivating interest in chemistry and of building up his own cultural professional background, while the pupil is provided with interesting readable articles of a general nature that should excite his fondness for chemistry. A periodical is new and novel with its monthly panorama of chemistry-in-the-news. No one can be

a teacher or student of chemistry and profit by taking a worthwhile publication.

There are several chemistry periodicals on the market today, that in some measure or other can be integrated with the Alberta Chemistry 2 course, namely, "The Chemistry Leaflet", "The Journal of Chemical Education" and "Current Science". In the Chinook Experiment, the writer subscribed to five chemistry periodicals, and determined the relative value of each to Alberta schools by basing his judgment on the response of three Chemistry 2 classes (Chinook School 1938-39, 1939-40, and 1941-42), under actual working conditions prevailing in the one-room high school. The financial outlay for the recommended periodicals might deter some schools from subscribing to them, so the writer conducted a survey for "free" science periodicals. No school needs to be without a comprehensive library of at least five science journals. If these publications are placed in a suitable magazine rack in the science corner of the classroom, they will provide the pupils with something "that really teaches chemistry to students without their realizing they are studying it".

TABLE VI.

CHEMISTRY PERIODICALS.

Name of Periodical	Address	Cost	When Published	Chief Value.
The Chemistry Leaflet (125 pages)	Pennsylvania State College State College Penn.	$2.35 U.S.	Monthly	Begins where the textbook leaves off, and places new material constantly in the hands of the teacher and student.
Journal of Chemical Education. (75 pages)	Easton, Penn.	$3.50 U.S.	Monthly	Its raison d'etre is the advancement of the study of chemistry, and it exerts its effort in behalf of both teacher and student.
Current Science (4 pages)	400 S.Front St. Columbus, Ohio.	$1.00 U.S.	Weekly	Activity page includes tests, exercises, experiments, activities and suggestions for home, club, or school. First three pages deal with general topics.
C.I.L. Oval (20 pages)	Box 10 Montreal	Free	Quarterly	Chemistry in Industry and in Everyday Life.
Imperial Oil Review. (30 pages)	Imperial Oil Bldg. Toronto 2	Free	Quarterly	Information about the Petroleum Industry.
P's & Q's. (2 pages)	Box 69 New Toronto	Free	Monthly	Information about Silicates.
The Merck Report (50 pages)	560 De Courcelles St. Montreal	Free	Quarterly	Published in the interests of Pharmacy and Medicine.
Cenco News Chats. (15 pages)	119 York St. Toronto 2	Free	Quarterly	A journal of scientific instruments and laboratory apparatus with significant information about new developments and procedures.
Canadian Chemistry and Process Industries. (75 pages)	366 Adelaide St. W., Toronto 2.	$3.50	Monthly	Application of Chemistry in Canadian Industries.
Safety Education (50 pages)	20 North Wacker Drive Chicago	$2.00	9 issues per year	A complete Safety Teaching Service for all Schools.

Illustration No. 35
Science Corner in the Classroom of the Chinook High School, showing the Magazine Rack containing the above mentioned chemistry periodicals.

Pictures.

Familiarity with the portraits of great chemists creates in the students' minds the feeling that they were but men, and that their achievements can be duplicated and even surpassed. This is stimulating to ambition, and thrusts upon the chemistry teacher the responsibility of decorating the laboratory or the classroom with pictures of distinguished chemists.

The "Journal of Chemical Education", Easton, Pennsylvania, issues three series of sixteen portraits each of outstanding chemists. For example, Series A includes Svante Arrhenius, Robert Boyle, Madame Curie, H. Le Chatelier, Sir William Ramsay, Dmitri Mendeleeff, Michael Faraday, etc. This is the set that the writer would recommend for Alberta high schools, since the names are already quite familiar to the Chemistry 2 students.

The portraits are well printed on separate sheets, 8" by 10½", suitable for framing, and have descriptive legends which increase their educational value. Anyone interested in chemistry will find these pictures a valued possession. The cost of a single set is one dollar.

Visual Instruction.

Teachers who still harbour any doubt about the value of visual instruction in chemistry need only to observe the method employed by the advertisers. When the nation's largest advertisers spend huge sums of money to tell their story through the medium of the picture, there can be no longer any doubt of the value of this technique in the chemistry classes. Psychologically, visual instruction quickens the learning process, and here is why. To learn, we require impressions either directly by experience through our own senses, or indirectly through the senses of others i.e., by means of symbols. This transition into symbols of everything seen, heard or felt, deters the learning process, for their interpretation depends on the students' past sensory experience. With the introduction of pictures, slides or films, a visual means of communication is produced in which symbolism, the mental crutch, is eliminated. The concrete object before us prevents the entanglement produced by faulty interpretation of the symbols.

The visual reproduction of many commercial processes in Chemistry 2, such as blast furnaces, which cannot be brought into class and in many instances cannot be visited, must necessarily be accomplished by pictures and diagrams. For this purpose, film-slides are unsurpassed. The writer has also found that chemistry film-slides are unexcelled for review purposes. The

outstanding features of a chapter can be vividly recalled in twenty minutes. For instance, the chapters in Littler's textbook on Metals and Non Metals (IX), Halogens (V), The Electron Theory (XXVIII) can be reviewed most thoroughly in the shortest time by showing the film-slides C-3 and C-8 of the "Principles of Chemistry" series.

It is imperative that the teacher possess a definite plan concerning how and when to use the film-slides, for they may easily encourage an attitude of passive receptivity; whereas the pupil must have an active part in this educative process. Preparation, participation and follow-up are just as much a part of student activities in connection with film-slides as with any formal lesson, for visual instruction may be made a part of the problem lesson, the project, the drill lesson, or the informational lesson.

The following procedure has grown out of investigations in the classroom use of films during the past several years.

1. If visual education in chemistry is to be adequate, it must be made an integral part of the lessons, not a haphazard showing of the film-slides upon their arrival at the school. The teacher should be sure that purposes for its study are established in the minds of every pupil in the class (to stimulate discussion, questioning and research, to supply information that could not otherwise be secured, to provide a basis for review, to enrich or extend the content of unit, to stimulate interest in the introduction of a new topic in chemistry).
2. It is uneconomical to put in film-slides actions which can be demonstrated by the teacher, for the latter is

superior.

3. The teacher should be well-acquainted with the content of the film, by having studied it or the accompanying hand-book in advance of its classroom showing. This will reveal the potential possibilities of the film and enable the resourceful teacher to adapt them to the specific interests and needs of his pupils.
4. It is desirable to show the film-slides in small units - no more than thirty minutes at a time.
5. Immediately after the showing of the film the teacher should ascertain by a variety of pupil activities, the extent to which the class study has achieved the purposes for which the film was shown.

The organization of the year's work in Chemistry 2 in conjunction with the film-lists provided below will facilitate the purposeful planning of the supplementary visual material of the course. The table of planning on page 90 is self-suggestive.

If projected pictures are to become a part of the the educational programme in chemistry, experience gained in the Chinook School has shown that the classroom must be provided with the following facilities:

1. Dark, inexpensive shades for all the windows. Ordinary blinds painted over with black paint, or thick black drapes mounted on heavy wire will serve to darken the room.
2. A source of electric current. An outlet should be provided at the back of the room in order to facilitate connecting the projector. The film-slide machines are

TABLE VII.

PURPOSEFUL PLANNING OF VISUAL MATERIAL IN CHEMISTRY II.

Topic in Littler's Chemistry	Name of Film	Source	Purpose for which the film is to serve.	Date required.
The Iron Family	Iron-Steel	S.V.E.	Commercial process for smelting Iron Ore.	March 1
Nickel	Nickel Mining	A.S.N.	Enrichment	March 2
Ionization and Neutralization	C-5	U.A.	Review	May 3
What of the Future?	Changing World	E.C.F.	Stimulate Interest	April 3
Structure of the Atom.	Cathode-Ray Tube	G.E.	Informational	April 1
Some Important Hydrocarbons.	C-7	U.A.	Introduction to Organic Chemistry.	April 2.

KEY:

S.V.E. - Society for Visual Education.

A.S.N. - Associated Screen News.

U.S. - Extension Department, University of Alberta.

E.C.F. - Erpi Classroom Films.

G.E. - General Electric.

March 1- First Week in March.

provided with two types of electric bulbs, so the high schools without a source of electricity in the school could still use a heavy-duty storage battery.

3. A screen of sufficient size with a good reflecting and light diffusing surface. An ordinary large window-blind covered with several coats of aluminium paint will provide a suitable screen which can be mounted easily, and quickly adjusted.

Illustration No. 36.

Visual Instruction Equipment in the Chinook School, showing the aluminium-painted screen, and the inexpensive film-slide projector.

List of Instructional Films Suitable for Chemistry 2.

Group A - Film-slides.

1. Department of Extension, University of Alberta.
   Available for rent at 25 cents per week or part of a week, outgoing postage is paid.

   1. C-1 Physical and Chemical Changes, Oxidation, Combustion, Allotropism.
   2. C-2 Electrolysis, Reduction, Multiple Proportion, Molecules, Crystallization.
   3. C-3 Metals, Non-Metals, Halogens, Flame Tests.
   4. C-4 Nomenclature, Formula Writing, Type Problems.
   5. C-5 Ionization, Neutralization, Nitrification.
   6. C-6 Calcium and Calcium Compounds, Gaseous Fuels, Liquid Fuels.
   7. C-7 A. Metallurgy; B. Organic Chemistry.
   8. C-8 The Electron Theory.
   9. 110 A Trip Through a Paper Mill.
   10. 111 Cane Sugar Industry.
   11. 118 Glass.
   12. 119 Gold.
   13. 123 Rubber.
   14. 124 Salt.
   15. 125 Steel.
   16. 126 Sugar Beets.
   17. 330 Story of Radium.
   18. 309 Modern Photography.

[1] Up to the present there has been little interest in Alberta in the use of chemistry films but we are prepared to add to our library on this subject as the demand becomes evident.

---

[1] H.P. Brown - Supervisor, Division of Visual Instruction, Department of Extension, University of Alberta.

2. Society for Visual Education, Inc., Chicago, Illinois.
The selling price of each film with manual - $2.00.

1. Facts and Laws.
2. Water.
3. Oxygen and Hydrogen.
4. The Atmosphere.
5. Carbon and Its Oxides.
6. Fire and Fuels.
7. Chlorine and Its Compounds.
8. Sulphur and Its Compounds.
9. Compounds of Nitrogen.
10. Laws and Theories.
11. Aluminium.
12. Copper.
13. Gold and Silver.
14. Lead.
15. Zinc.

3. Canadian General Electric Co. Ltd., 212 King St. W., Toronto.

The following illustrated lectures, complete with manuscript and film-slides, are available to schools and other educational institutions, and may be obtained on a permanent loan basis.

1. L-44 The Vacuum Tube in a Wider Field.
2. L-114 X-Rays.

Group B -Sound Films.

1. Erpi Classroom Films, Inc., 35-11 Thirty-fifth Ave., Long Island City, N.Y.

Sale prices for the films listed is as follows:- One-reel subjects 16 mm sound-on-film $50.00. These prices are subject to a discount of 10% to educational institutions. Terms: Net 30 days, Transportation Prepaid.

1. Oxidation and Reduction.
2. Molecular Theory of Matter.

3. Electrochemistry.

4. Colloids.

5. Velocity of Chemical Reactions.

6. Catalysis.

7. Chemistry and A Changing World.

2. Associated Screen News Limited, Montreal.
Free Film Service. Transportation charges from and to the library are payable by the exhibitor.

1. Nickel Mining. (5 reels in all)

2. Crystals. (Rental of $2.00 per day.)

3. Canadian General Electric Co. Ltd., 212 King Street, W.,Toronto.
The motion-picture films are intended for exhibition purposes in the interest of education, commercial development, and public welfare. For this purpose they are loaned without charge, except the cost of transportation.

1. S-2220 Mountains of Copper.

2. S-2229 Cathode-Ray Tube.

3. S-2464 Exploring with X-Rays.

4. S-2347 Excursions in Science No. 7 (Crystals).

4. The National Film Board of Canada, Ottawa.
Films are loaned from the National Film Board, for non-theatrical exhibition, to any responsible organization, institution or individual, on the following conditions:
(a) That a nominal Service Charge is met.
(b) That borrowers pay all transportation charges on shipments offilms.

1. S 15a From Gold Ore to Bullion.

2. S 45 Gold from Gravels.

3. S 16 The Royal Mint.

Group C - Silent Films.

1. Department of Extension, University of Alberta.
Available for loan at the usual rates. All 16 mm.

1. Historical Introduction to the Study of Chemistry.

2. The Carbon-Oxygen Cycle.

3. Nitrogen Cycle.

2. Anaconda American Brass Ltd., New Toronto, Ontario.
Motion pictures are available without charge from the above source.

1. Copper - Mining, Smelting and Refining.

2. Copper - Manufacture of Copper, Brass and Bronze.

3. Goodyear Tire and Rubber Co., Los Angeles, California.
Silent films are sent free upon request.

1. Rubber - Conquering the Jungle.

2. Rubber - Island of Yesterday.

3. Rubber - The Story of the Tire.

4. Canadian General Electric Co. Ltd., 212 King Street, W., Toronto.
They are loaned without charge, except the cost of transportation, and with the understanding that they will be used with care and will be returned, according to the shipping instructions immediately after exhibition.

1. No. 38 Atomic Structure. (Beyond the Microscope)

2. No. 42 The World of Paper.

3. No. 51 Liquid Air.

NOTE :

1. The films listed above under the Canadian General Electric Company's name can be secured by making arrangements for the use of same at the nearest C-G-E sale's office:

Lethbridge - 1306-7th Ave. South.
Edmonton - 10165 West 104th St.
Calgary - 4th St. West and 11th Ave.

2. The films listed under the name of "The National Film Board of Canada" can be secured from the Supervisor, Division of Visual Instruction, Department of Extension, University of Alberta, Edmonton, Alberta.

Minerals.

Dreary and ineffective lessons in chemistry are inexcusable in view of the possibilities of experimental demonstrations, and the laboratory method of instruction offers even better opportunities for student learning-activities. One of the most difficult problems in the teaching of the Chemistry 2 course is to bring-to-life the sections of the textbook devoted to a study of minerals. Every chapter appears to commence in the following manner, "The metal is found in nature chiefly as haematite, or smaltite, or magnesite, or calcite, and then a brief description of the ore is given. This provides an excellent opportunity for the introduction of supplementary material in order to motivate the learning process. The writer has found that the introduction of actual mineral specimens will usually frustrate the possibilities of a "dull lesson".

The Geological Survey prepares collections of minerals and rocks for educational purposes. Specimens of the following minerals and rocks applicable to the Chemistry 2 course, may be purchased according to size and quality at 5 cents, 10 cents, and 15 cents each: Apatite, Arsenopyrite, Asbestos, Barite, Chromite, Corundum, Feldspar, Fluorite, Galena, Gypsum, Haematite, Kaolin, Limestone, Magnetite, Manganese Ore, Mica, Niccolite, Smaltite, Pyrite, Quartz crystals, Serpentine, Stibine, and Talc (Soapstone).

In addition to the collection described above there is available also, for the use of teachers and students, sets of mineral chips, each set consisting of about 35 specimens, including all the above mentioned minerals suitable for Chemistry 2. (see illustration No. 32, page 75). The price of each set is 50 cents, postpaid in Canada.

An order for any of the mineral collections should be accompanied by a money order or certified cheque in favour of the Receiver General of Canada in full payment of the order. Postage stamps should not be sent. Collections, or individual specimens will not be sent C.O.D. Orders, and any correspondence concerning the collections should be addressed to F.C.Lynch, Chief, Bureau of Geology and Topography, Department of Mines and Resources, Ottawa.

Radio.

What part does radio play in supplementing the Chemistry 2 course? Daily, this source of learning brings the world to the students. It only remains for the teacher to explore and discover the programmes that would be applicable to the course. A suitable scheme is to make the students "radio conscious", and they will co-operate in "searching out" the valuable broadcasts. Reference to the daily radio programmes as published by the newspapers of the province will materially assist in the compilation of a Chemistry 2 Radio Guide. The writer has written to the outstanding radio stations in the west requesting them to publish several days in advance, any programme that might prove of value to chemistry teachers of Alberta. Here is one response to this appeal -

[1] On Thursday, January 22nd, at 9.30 p.m. we have an Actuality Broadcast over Station CFAC at Calgary, featuring a trip through our Calgary Refinery. We believe that you and your students will find this radio broadcast most interesting and educational. We therefore invite you to tune in.

---

[1] British American Oil Company, Calgary, Alberta.

Upon request, the Canadian Broadcasting Corporation, the National Broadcasting Company, the Columbia Broadcasting Company, the Mutual Broadcasting Company, the Department of Extension of the University of Alberta, and the Department of Education will send teachers a bulletin of educational broadcasts carried by their respective networks. It is preferable to concentrate on a few good broadcasts rather than on numerous mediocre programmes.

Illustration No. 37

Supplementing chemistry work by radio. The students must have an active part in this educative process, i.e., the solution of some problem in chemistry. Every broadcast should be listened to with a definite purpose in mind, and it is up to the teacher to supply this purpose. The students in the above picture are attempting to provide a solution to this problem, "How Turner Valley Crude Oil is refined so as to make it suitable for use in the automobiles."

Supply Houses.

When high schools are in the market for Laboratory Supplies and Chemicals, it is the desire of most chemistry teachers to

facilitate ordering by a careful study of several catalogues. It is only through such a perusal that the singular needs of a particular laboratory can be satisfied. A rich tradition of experience, adequate resources, and modern production facilities all continue to play a leading role in the manufacture of high quality and uniform products, so in the interests of "good ordering" a teacher should avail himself of this information about each firm and their products.

The following is a list of reliable Canadian Chemical Supply Houses who would be pleased to supply Alberta schools with catalogues of laboratory supplies.

1. Central Scientific Company of Canada Limited,
   129 Adelaide St. W., Toronto 2, Ontario.
   or
   850 West Hastings Street, Vancouver, B.C.
2. Cave and Company Limited,
   567 Hornby St., Vancouver, B.C.
3. The British Drug Houses (Canada) Limited,
   Toronto 2, Ontario.
4. Merck & Company,
   560 De Courcelles Street, Montreal.
5. F.E. Osborne,
   112 - 8th Ave. W., Calgary, Alberta.
6. Moyer School Supplies Limited,
   Edmonton, Alberta.
7. Fisher Scientific Company Limited,
   904 - 910 St. James, st., Montreal.

CHAPTER VII.

AN EXTENSION OF THE SURVEY.

Laboratory-Teaching.

The effectiveness of chemistry teaching in any educational institution can be quickly and accurately estimated by considering the type of laboratory work that is being done in the school. The students must be able to see and handle chemical facts directly if they are to know them. This presupposes a close relationship between the practical and theoretical work, and places upon the teacher the considerable burden of planning the work for the year in such a manner so as to achieve this end. Such a study involves an integration of the textbook material, the laboratory experiments in the manual, and the local conditions under which the subject is to be taught. There must be a suitable correlation among the three, and any one of them must not lag behind the other two.

The laboratory periods in Alberta schools are so brief that it is imperative for the teacher to instigate some plan of pupil-preparation with a view of introducing more extensive pupil-participation in the laboratory period. If the students wait until they are in the laboratory to study the assignments there will be considerable valuable time lost. The preliminary work should be a round-table discussion with a view of stimulating the student to go at his task with a clear idea of the purpose, the general method, and the significance of the experiment. In the actual laboratory work the teacher should again emphasize these ideals by indirect questioning of each group, and the

giving of assistance where necessary.

The criticism levelled against most of the laboratory periods is that the students perform their experiments by following the manual in "cook-book" style. It is a delusion to think that students will get any benefit by religiously adhering to a "chemistry recipe" during the laboratory period. The genuinely scientific method of study should lead to reflections, to inferences and to acceptable conclusions. The teacher's part in the laboratory period is active not passive, and that is why the writer prefers to call this type of instruction "elbow-teaching", with emphasis on the necessity of motivating "sustained-thinking" on the part of the students.

Laboratory Notes.

Department of Education regulations require that each student keep a laboratory note-book and write up therein in an approved form, a record of each experiment in which he or she has participated. Experience gained in the Chinook Laboratory would lead the writer to suggest that the following form be followed in writing up the experiment:

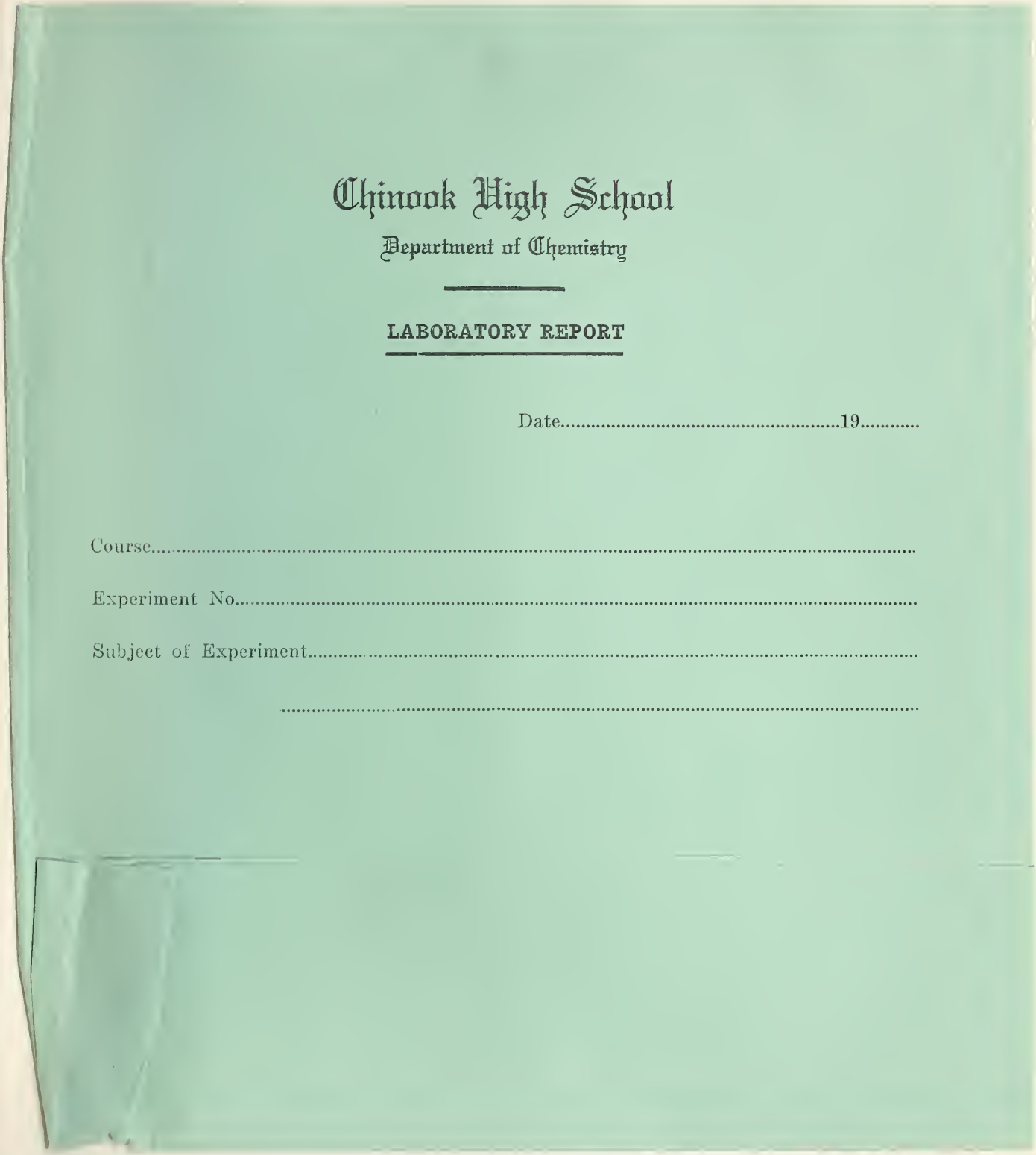
1. The title of the exercise.
2. Date.
3. Theory. (Emphasize the fact that theory and laboratory practices are integrated, and that much laboratory work involves little more than verification.)
4. What the student did.
5. Answers to all questions asked.
6. Calculations.
7. Conclusions.
8. A diagram of the set-up required for the experiment.

The notes should be reasonably neat, although accuracy, clearness and content of the report are more important. Since every teacher is now a teacher of English, it is necessary to insist that the students use the complete sentence form in writing out the report, but at the same time utilizing concise sentences.

The Chemistry 2 reports in the Chinook School are written on loose-leaf paper ($9\frac{1}{4}$" by $7\frac{1}{4}$"); enclosed in a standard folder, and submitted punctually at an appointed time. In place of having the reports littering the teacher's desk, a box of suitable dimensions mounted in a corner of the chemistry laboratory will provide a convenient receptacle for receiving the reports. (See illustration No. 35 on page 86).

It is indispensable to the success of instruction, as well as enabling the chemistry teacher to submit a fair estimate of the student's ability in laboratory work to the Department of Education, that the notebooks be examined regularly by the teacher. All the errors in English, and the mistakes in Chemistry should be indicated distinctly. The checking, if it is to be of any permanent value, must be done as soon as possible after the report has been submitted.

The marks assigned to the individual students should be transferred to the class-record sheet and posted on the Science Bulletin Board. Such a system provides the students with an incentive to do better work, and enables the chemistry teacher to arrive at a fair estimate of the student's laboratory work during the school term.



Chinook High School

Department of Chemistry

LABORATORY REPORT

Date.....19.....

Course.....

Experiment No.....

Subject of Experiment.....

.....

Illustration No. 38.

The chemistry folder in use in the Chinook High School.

TABLE VIII.

CHEMISTRY 2 RECORD-SHEET.

Title of Experiment	Number	Grading $\frac{xx}{10}$.								
Chlorides, Bromides, and Iodides.	17	9	10	9	9	8	9	8	10	
Sodium Hydroxide	21	9	9½	9	10	5	9	9½	10	
Other Compounds of Sodium	22	9	10	9	9½	9	9	10	9	
Properties of Sodium Thiosulphate.	25	9	10	A	9½	10	9	9	10	
Density of Oxygen.	27	6	10	8	6	4	9	6	10	
Some Compounds of Magnesium.	32	9	9	9	9	9½	9	9	9	
		Jean Damsgard	Queenie Ford	Laurel King	Winnifred Marr	Donald Nicholson	Helen Pfeifer	Robert Proudfoot	Emily Zawasky	

An Extract from the Chemistry 2 (Laboratory) Record-Sheet of the Chinook High School.

Schemes for Economy.

Rotation of Experiments - Lack of sufficient equipment is one of the major problems with which a teacher in the small high school has to contend; but, to a certain extent, there are ways and means of overcoming this deficiency. The equipment for the laboratory classes in grade twelve should, if possible, be sufficient for the whole class to work together at one time, but not necessarily on the same experiment. In place of each group performing the same experiment and creating a shortage of the necessary equipment, it is often advisable to perform a "battery" of experiments, each of which would require different equipment. The experiments could then be assigned in rotary fashion, until each group had performed every experiment in the series. The materialization of such a scheme necessitates a carefully plannedcourse, as well as the utilization of some scheme as exemplified below.

TABLE IX.

ROTATION OF EXPERIMENTS

Students	Group	Experiment
Jean Damsgard Helen Pfeifer	3	No. 15 - Hydrogen Bromide
Emily Zawasky Queenie Ford	7	No. 10 - Neutralization
Winnifred Marr Laurel King	5	No. 27 - Density of Oxygen
Robert Proudfoot Donald Nicholson	2	No. 34 - Zinc and Some of Its Compounds.

Columns I and II of the chart are made permanent, whereas Column III can be slotted, enabling the teacher to insert the title of the experiment opposite the group that is to perform it. The student will know a full week ahead, the experiment for which he will require any special preparation. Experiment No. 15 requires a retort and boiling tube, No. 10, a burette and pipette, No. 27, balances, barometer, thermometer, and pneumatic troughs, No. 34, Combustion tube, Kipp's apparatus, charcoal block and a blowpipe. Thus it can be seen that at no time in the performance of this "battery" of experiments , will there be too great a demand for any particular chemical or any unit of apparatus.

Hydrogen Bromide

Neutralization

Illustration No. 39

Zinc.

Density of Oxygen.

Illustration No. 39.
A laboratory period in the Chinook School. "Candid camera-shots", illustrating the actual operation of the scheme for the "Rotation of Experiments".

Chemistry Charts - No chemistry laboratory can dispense with such charts as the electromotive series, the "periodic table" or the "table of laws", for reference must be made continually to them, in order to remind the students of certain basic fundamentals of chemistry. The student is living in a "Society of Chemistry", while in the laboratory, and it is imperative that he should understand the constitution of the said Society. The codification of the laws will materially assist the student in becoming a "law-

abiding" citizen. In preparing these charts the teacher should have one aim in view, and that is to produce a chart of the highest legibility and usefulness to the students in the laboratory. Definitely avoid the inclusion of a mass of material which could only be read by a close inspection of the chart, but at the same time, provide all of the essential information which the chart should contain. There is no better way for the students to study the periodic table than to actually make the table. The "why" and the "wherefore" of every part of the "periodic table" will arouse the pupil's curiosity and keep it so, until he finds the answer to his problem.

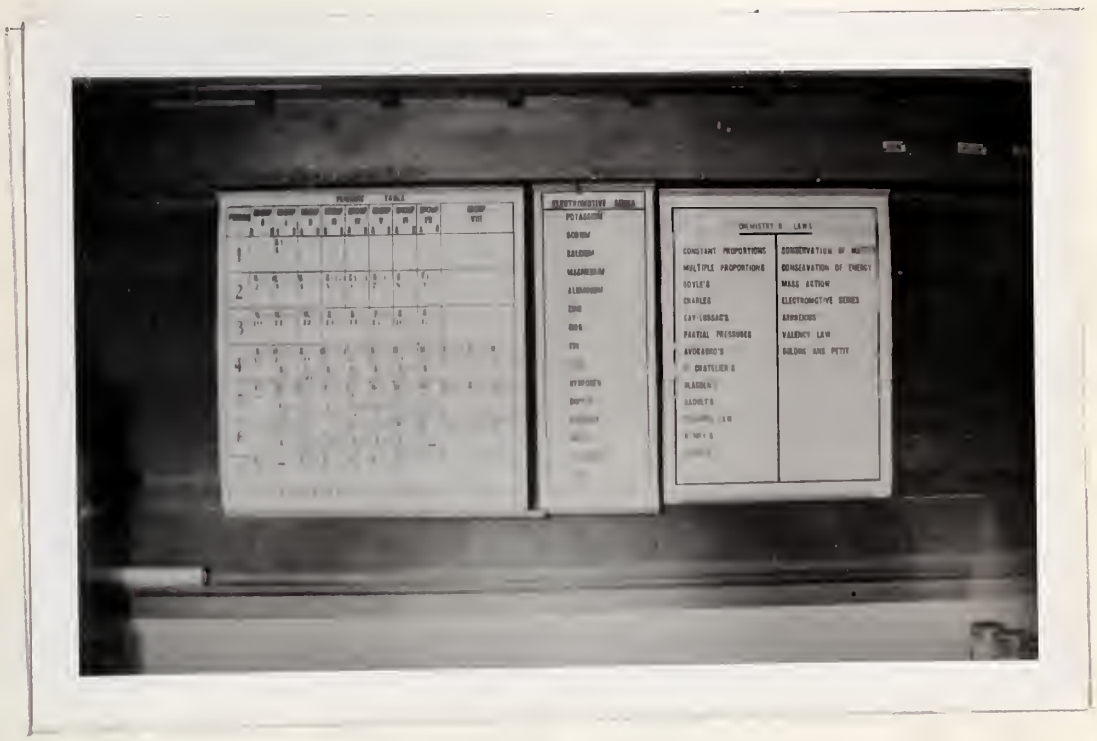


Illustration No. 40.

Pupil-made chemistry charts in the Chinook Laboratory.

Multi-service Arrangements - The continually increasing demand of the modern educational programme upon the available space in the school requires that every possible advantage be taken of facilities to economize this space. Where a room is to be used for a number of purposes it is especially desirable that it be the largest in the school, as well as the best ventilated and lighted. A combination typewriting and chemistry room has already been considered above, other dual-function rooms that have proved successful are: laboratory and science classroom, laboratory and art room, laboratory and bookkeeping room.

If the laboratory room is large enough it is possible to arrange the laboratory tables in the front half of the room, while a suitable number of pupil's desks could be placed at the back. This arrangement functions most admirably during demonstration-laboratory lessons in either science or art.

The laboratory-classroom combination necessitates that each table be equipped with a shelf for books. Certain advantages are secured if it is reserved exclusively for the science subjects, as all the equipment is at hand whenever required either for the laboratory period or the demonstration lesson.

The laboratory tables prove useful in the high schools where the bookkeeping option is offered, for the students can work to better advantage on these benches. The business forms used in this subject are of an inconvenient size for handling on the ordinary classroom desk, and a large working-surface becomes a necessity.

Illustration No. 41.

WAINWRIGHT - by M.D.Meade.
A combination Laboratory and Demonstration room. Since the blackboards are used extensively, it would not be feasible to have a raised shelf across the centre of each chemistry table.

Illustration No. 42.

LEDUC - by H.F.Chittick.
A Combination Laboratory and Classroom. This is a basement room, but it is well-heated, and well-lighted by both natural and artificial light. The walls and ceiling have been painted

white to make the room appear brighter. The room has plenty of cupboard space and is equipped with tables and folding chairs. However, the folding chairs have not proved satisfactory for the original intention was to fold them up when the laboratory work was being done at the table, but it is more satisfactory to push the chair into the table behind, as they make too much clatter when being folded.

Reading Sections - Considerable difficulty is usually encountered by the majority of teachers in adequately dealing with the authorized reading sections in Chemistry 2.

"The Introduction, Complex Silicates, pages 97-101, Chapter XII, Chromium, pages 234-236, Chapter XXII, XXIV, XXVI, and the Conclusion of the authorized textbook may be treated as required reading, and need not necessarily be dealt with in class."

It is a foregone conclusion, that students will derive very little benefit from these reading sections, if they are merely assigned as "required reading". Some other method must be utilized, if the maximum benefit is to be retained. A glance at the chapters designated as "required reading", reveals that they cover a variety of extremely interesting material - Natural Oil, Gas, and Tar; Paper, Rayon, and Rubber; Commercial Fertilizers, and "What of the Future in Chemistry". It requires very little effort on the part of the teacher to organize committees to make a study of these special topics, and report back to the entire class of their "findings". The writer has discovered that, the utilization of the supplementary material as suggested in Chapter VI in conjunction with these "student-presentations" will result in the manifestation of a great interest in the chemistry course.

Repairs - "An ounce of prevention is worth a pound of cure" might be used aptly to describe the "repair problem" in the

Illustration No. 43.
Chemistry 2 Committees Actively Occupied.

The Committee on the left is making a study of Commercial Fertilizers. They have at their disposal some five pamphlets and actual samples of fertilizers obtained from Trail. The two plants in the foreground were used by the group to experimentally prove that plants require certain elements as nitrogen, phosphorus, and potassium in order to maintain normal growth.

The Committee on the right is planning "How best to present their topic on paper". Actual samples of pulp can be seen on the table, and the chairman is assigning the topics to the individual members of the group. The outlines on the blackboard were planned by the students thus facilitating the work of organization. The classroom in the Chinook High School is adapted for committee work, being provided with movable chairs and tables.

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chemistry laboratory.

Heated containers if placed directly on the chemistry table will certainly destroy the finish, so it is advisable to fasten securely a piece of asbestos 6" by 6" to each table-top in order to provide a proper place for heated articles.

Strips of sandpaper attached to the sides of each table should provide the students with a convenient place on which to

strike their matches, instead of the usual practice of striking them on the table. Fire-clay crucibles on the top of each reagent shelf conveniently suuply a receptacle for used matches, bits of chemicals, discarded tubing, corks, or filter paper. There are a hundred and one ways of "saving" the laboratory equipment - the resourcefulness of the teacher is the keynote to success in this enterprise.

The caretaker in any school if properly approached by the chemistry teacher will prove a "tower of strength" to any scheme that the instructor may wish to put into effect. The manual training classes in many of the schools are finding an opportunity to put their theories into practical application by assisting in furnishing the laboratories.

Illustration No. 44.
Mr.W.M.Watson, the caretaker of the Chinook School, a jovial, co-operative skilled craftsman, and above all an educator, whose efforts in no small measure, have contributed to the success of Laboratory Chemistry in the Chinook School.

CHAPTER VIII.

SUMMARY, CONCLUSIONS, AND CRITICISMS.

In pioneer times, one school year was much like another. Teachers saw little change in textbooks, methods, equipment or needs. Therefore, teachers made little change in their habits. In modern times, each new year starts far ahead of the old one in materials, discoveries, and conveniences. It is the duty of each teacher to adjust his teaching methods to keep in harmony with this trend. The educational world of Alberta is a changing world. Changes are coming so rapidly in this day of "progressive education" that change itself no longer surprises. Science today dominates the world, and the Canada of tomorrow will need an increasing number of young people trained in science. Does the Chemistry 2 course in Alberta anticipate tomorrow's demand? The proof of the pudding is in the eating, and the proof of the value of chemistry as offered in this province, depends upon its success "in attempting to relate the abstract principles of theory to concrete situations which have a meaning for the student in terms of his own experience".

Unfortunately, laboratory chemistry in Alberta, is not given the prominence that it deserves, and as a consequence, chemistry instruction in the province does not compare favourably with that offered in the majority of the other provinces in Canada. The general trend in high school chemistry throughout the nation appears to be directed towards centralizing the course about laboratory experiments, so that there may be no question of the pre-eminence of first-hand knowledge. It is highly probable that in the very near future the Alberta chemistry course will follow

this trend.

In anticipation of this "laboratory-chemistry revolution", Alberta teachers should be familiarized with the laboratory procedures that have proved their effectiveness under actual conditions prevailing in the province. A survey of over seventy-five Alberta high schools was conducted in order to garner information that would prove of practical value to every chemistry teacher. The desirable information resolved itself into such topics as: laboratory costs, permanent fixtures, ordering chemicals and apparatus, precautions in the chemistry laboratory, supplementary aids, and finally, actual teaching procedures.

The writer has encountered personally, practically every difficulty that may be associated with laboratory chemistry, and four years of experimentation in the Chinook Laboratory has provided, in some measure at least, solutions to these problems. The author presents herein his "experiences" in establishing a chemistry laboratory in the Chinook High School, in the belief that other teachers, finding themselves under similar circumstances, would profit from such an exposition. The tendency of such a thesis would be to degenerate into a mass of useless and ambiguous terms leaving the reader at a loss to comprehend coherently the construction processes outlined. The writer believes that he has obviated this danger by introducing some fifty pictures, illustrating the various features associated with laboratory chemistry.

The results of this survey emphasize most emphatically that the only worthwhile type of instruction must be associated to a large degree with an "activity" programme. Hence, the objective of

this thesis was the distribution of helps for teachers of high school chemistry - helps which would make chemistry in Alberta schools more real, and its importance in daily living more intimately understood.

A survey of the "candid opinions" of high school students in regard to the value of the Chemistry 2 course would lead one to conclude that this objective is highly desirable; and who should be in a better position to judge than the people who will actively participate in its benefits?

[1] The author of our chemistry text has endeavoured to present the basic principles of this fascinating subject, and at the same time to indicate the part played by chemistry in our every day life. However, I believe that this latter motive could now be stressed a great deal more. Since the publication of this text, the world has been plunged into war - a war in which chemistry is playing a very important part.

Although the importance of chemistry in medicine is mentioned, it is not, in my opinion given due consideration.

Chemistry is also of importance in modern agriculture. I know that students of this agricultural province would like to see this fact enlarged upon in their textbook.

[2] I would like to impress upon the minds of those who will study chemistry in the future, that it is indeed an interesting and worthwhile subject. For instance, a young girl learning how to make her first cake might ponder over the question, "What makes the cake rise?" This might be answered simply, "Because of the presence of baking soda." But in order to know the chemical action that takes place, this girl must study chemistry. Many such everyday problems arise that, although it seems impossible to answer them in our common language, can be answered in the chemistry language of formulas and equations.

[3] Many of the problems that have perplexed me at home, have been solved simply and easily since my study of Chemistry 2 began.

[4] One thing in which we have had a good deal of practice is laboratory work. I think this should be done more frequently, as it provides experiences along the experimental line. It teaches one never to take any fact for granted but to set about to prove it for himself.

[5] I would say the textbook contains the basic facts in chemistry, but its chief fault lies in the fact that modern chemistry has progressed beyond the time of this book's writing.

[6]While I am far from being a brilliant student of chemistry, I am interested in the subject, and can appreciate its importance to the modern industrial civilization. Its greatest virtue, as far as I am concerned, is the manner in which it clearly points out the close connection between the highly-involved reactions of chemistry and the ordinary, everyday happenings in our normal life, to which we would usually not give a thought.

The laboratory manual, while it deals in great detail with the elements and compounds to be studied, does not leave enough to the imagination and ingenuity of the student himself.

A chemistry activity programme which will touch the senses of the students and create in them a greater manifestation of interest and pleasure in the chemical world, requires a considerable amount of supplementary material. The industrial world, realizing the practical value of such an educational system to the nation, are willing to co-operate most heartily in supplying free-of-charge a considerable amount of this supplementary material. Teachers are at a loss, however, to know just where this material can be secured, so the compilation of a comprehensive list of industrial establishments issuing illustrative material should prove of potential value to chemistry teachers throughout the province. Film-slides are now so generally accepted by schools everywhere that little introduction is necessary, outside of indicating where they may be secured, and at what cost (rental fee or purchase price). The use of the radio in the chemistry class receives its due consideration. A list of Canadian companies supplying chemicals and apparatus is appended, as an aid to teachers seeking information relative to their "ordering" problems. The 50-cent mineral collection as distributed by the Department of

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[1]Laurel King. [2]Queenie Ford. [3]Jean Damsgard. [4]Helen Pfeifer. [5]Robert Proudfoot. [6]Donald Nicholson. Chemistry 2 students of the Chinook High School (1941-1942).

Mines at Ottawa, should prove of value to teachers seeking for some way of stimulating interest in the study of the different ores.

Criticisms.

The entire thesis was written with one objective in view, i.e., the compilation of a practical source-book for the teachers of experimental chemistry in the smaller high schools of Alberta. It is the belief of the writer that the thesis contains many valuable hints for high school instructors in laboratory chemistry, but how will it be possible to disseminate this knowledge? A considerable amount of time, energy and money will be wasted unless the results of the survey are made available to every chemistry teacher in the province.

The National Defence Program requires practically every Canadian industry to devote its entire resources towards the war effort. As a result, the section on "Supplementary Material" is not as complete as it otherwise might be. It is the belief of the writer that if an identical survey was attempted under peace-time conditions the results would be much more satisfactory.

There is a grave danger associated with the "free material". Will the majority of teachers know how to use it in such a way so as to secure the maximum benefits? The industrial firms anticipate that their contributions towards "chemistry education" in the province will be exploited to the fullest extent, otherwise, what would be their purpose in maintaining an educational service. A teacher should not send away for any supplementary material, unless he has a definite purpose for it.

The story of laboratory chemistry in Alberta high schools has been told. It now remains for each and every chemistry teacher in the province to anticipate and be prepared for "Chemistry's World of Tomorrow".
