CHEMISTRY IN NEW ZEALAND

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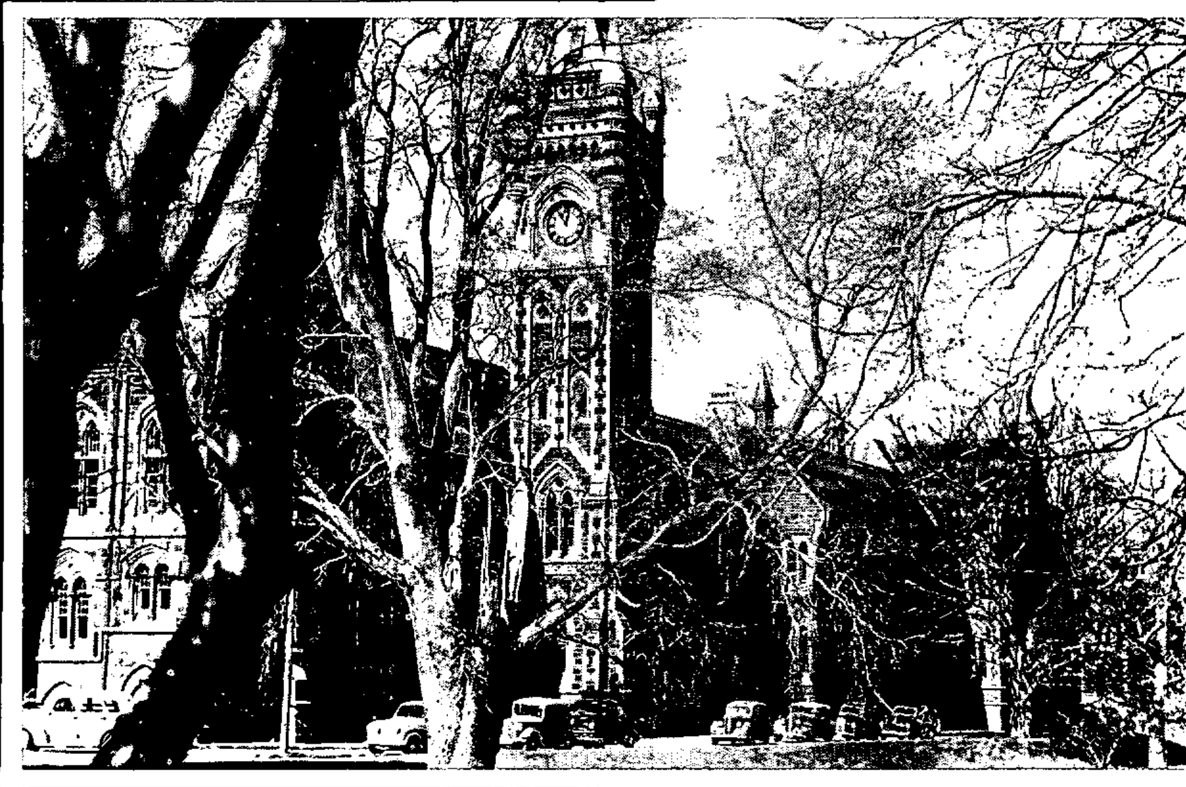
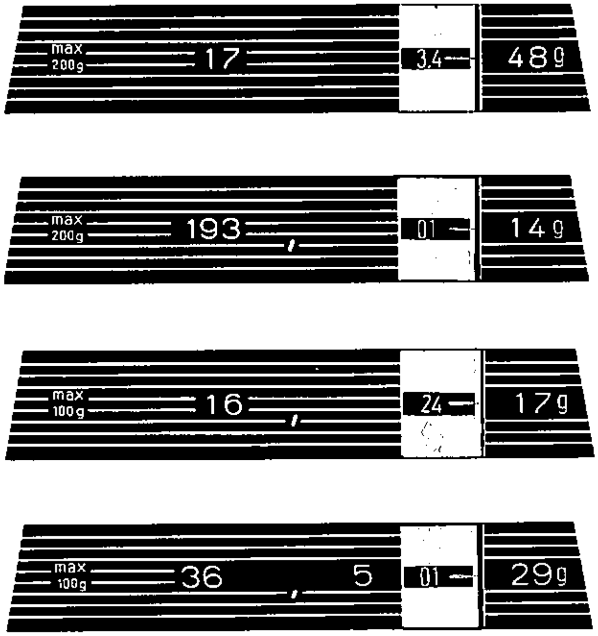


CONFERENCE ISSUE

Vol. 33, No. 4, August 1969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Journal of
The New Zealand
Institute of Chemistry

Vol. 33, No. 4, August 1969

Published bi-monthly by the New Zealand Institute of Chemistry Inc. (P.O. Box 250, Wellington)

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Printed by David F. Jones Ltd., 108 Tory Street, Wellington.

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The Journal of the N.Z. Institute of Chemistry has an audit circulation Certificate of New Zealand Advertisers. Latest audited circulation (March 1969) 1150.

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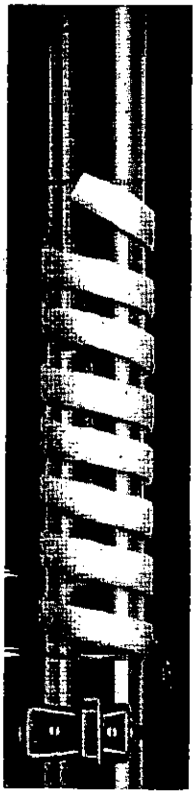

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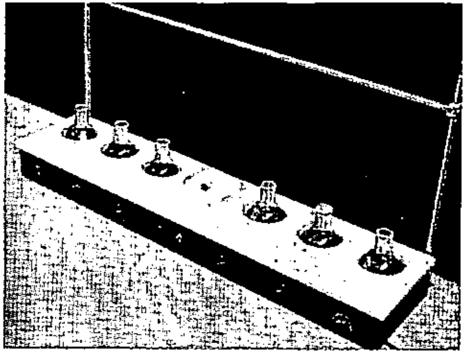

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Welcome to Dunedin for the 1969 Conference

THE Institute Conference is being held in Dunedin in the same month as the celebrations of the foundation of university education in New Zealand. Dunedin in 1869 was the largest city; the discovery of gold had made it the wealthiest; and the traditional concern of the Scottish founders with education made the step inevitable. Among the first four chairs established in the University of Otago (1870) was one in Natural Science (Chemistry and Mineralogy), and specific reference was made to "the application of these sciences to agriculture and mining". The first professor, J. G. Black, served for over forty years and the chemistry department has spanned the first century with only four departmental heads. The second century will be very different. The new pattern has already emerged; multiple professorships, research schools, and a new building planned for its purpose instead of adapted from one designed for pre-clinical medicine (anatomy and physiology) and chemistry.

The Otago Chemical Society (1929) was formed with Black's successor, Professor J. K. H. Inglis, as its first President. While Otago chemists joined fully in the establishment of the Institute in 1930, the ordinary monthly meetings continued to be those of the Otago Chemical Society up to the end of 1935. The proceedings of the Otago Branch of N.Z.I.C. were limited to committee meetings and an A.G.M. As the two bodies always elected the same officers, the distinction was a subtle one. But then the university was both the University of Otago and a constituent college of the University of New Zealand.

Whatever there is in a name, the connection between the university departments of chemistry and the local branches of the Institute characteristic of the country has continued in Dunedin as elsewhere. So the welcome to New Zealand chemists on August 26th will be from both the Institute Branch in its fortieth year and the University at the end of its hundredth. It will be a warm welcome.

PROFESSOR N. H. PARTON,
Conference Chairman.

NEW DIMENSIONS IN ANALYTICAL CHEMISTRY

by Professor Lloyd Smythe
Chemistry Department, University of New South Wales
Guest Lecturer, Conference 1968

Introduction

In this review I will outline some of the new and rapidly changing areas to show how developments are leading to a new appreciation of what modern analytical chemistry really is and how it can make significant contributions to scientific progress. This necessitates an extremely selective approach on my part. If I can paint a picture of what I believe are the rapidly moving and exciting areas, and leave you with a few references to follow up those areas which are of personal interest, I will not be too worried about many of the necessary omissions I have had to make.

The historical origins and roots of analytical chemistry have until the last two decades caused it to be the Cinderella academic subdivision of chemistry. When many of the famous schools of chemistry arose in the second half of the 19th century, the role of analytical chemistry was relegated to service functions. Many of the more important inorganic compounds had by then been analysed and their formulae determined. The flourishing schools of organic chemistry which stemmed from the German schools, and in turn the German dyestuffs industry, demanded careful elemental analyses of organic compounds so that formulae could be determined. Geologists demanded accurate chemical analysis of minerals and a great deal of the early inorganic chemistry concerned tedious, demanding and accurate analysis of minerals, the success of which was often judged by the fact that all the constituents determined added up to exactly 100 percent. If we couple these service functions to the generally tedious and uninspired tertiary level training in analytical chemistry involving the old "cookery book" qualitative and quantitative analysis, it is little wonder that very few graduate scientists, engineers and others compelled to undertake the courses, thought of analytical chemistry with any regard. The academic chemists themselves thought of it with even less regard. Who would ever think of trying to interest a promising young research worker in analytical chemistry? Such research would be the absolute last resort after promising topics in organic chemistry, physical chemistry and inorganic chemistry (in that order up until about 1946) had been exhausted.

An eminent Australian chemist Professor Sir Ronald Nyholm, now at University College, London, in several lectures and reviews spoke of the post-World War II renaissance in inorganic chemistry and showed that this largely stemmed from the great industrial development of the war years and in particular the enormous war-time work on transuranium chemistry. Consequently, we can now all bring to mind periods of considerable development in organic, physical and inorganic chemistry.

I am happy to predict that we will now see a renaissance in analytical chemistry of a type which is a far cry from the type of which most graduate scientists have dim memories.

Chairs of modern analytical chemistry and flourishing schools are now fairly commonplace in North America and Europe. In the United Kingdom there are now three chairs of analytical chemistry—at Birmingham (Belcher), Belfast (Wilson) and Imperial College (West). Tradition dies hard though —the thin end of the wedge is in with the "Red Brick" universities but it will be some time before the hallowed precincts of Oxbridge succumb to a subject matter and training which is now obviously being demanded by industry and modern scientific research.

In Australia, an excellent start has been made with the establishment of the first Chair in Analytical Chemistry at the University of New South Wales. Much depends on how successfully the new school can demonstrate to general scientific research, industry and skeptical chemistry academics that it has a genuine place and role.

New Instrumental Methods

Analytical chemistry is now firmly centered around complex and often expensive physico-chemical instrumentation. This does not mean that classical wet chemical analysis is outmoded but rather that it now is an important supplement or precursor to instrumental chemical analysis.

The rapid trend to instrumentation in the past 15 years is recognised very widely. I think the remarks of P. B. Hamilton, a leading U.S. biochemist, in a recent review[1] are typical: "The scope of analytical techniques and instrumentation now used in biochemistry has grown to be enormous, far beyond the knowledge and judgement of most single individuals. If any scientific moral could be drawn from this review it is that biologists, physiologists, biochemists, organic and physical chemists, etc., are a vanishing breed, their places being taken by scientists, people trained in analytical techniques with a broad knowledge who bring disciplined mental apparatus to bear on problems at hand, whatever they may be. It is high time the linguistic curtains were raised". An interesting statement with which you may or may not agree.

The first area I want to deal with is spectrometry. This is a large and important area of analytical chemistry instrumentation comprising the areas shown in Table 1.

The most important general trend is towards automation and data processing in the larger research and industrial centres.

It is obvious that the necessary instrumentation is generally expensive and requires justification for purchase in terms of sample load, speed, precision, etc. It follows that a slower, simpler instrument may still be more suitable for research purposes or control, where fewer samples are involved.

One of the most dramatic developments in recent years is the appearance of a bewildering range of excitation sources, and the good ones have revolutionised spectrometry. One might think that this is a somewhat old, well-worked-over field. At present however, it is very exciting. Table 2 gives details of some promising spectrometry excitation sources.

I would like to draw your attention to some interesting features of these sources. Perhaps the first feature is the very large temperature range of the excitation sources ranging from 550°K in the cool nitrogen hydrogen diffusion flame to temperatures of the order of 50-100,000°K in the case of the plasma jet and laser probe. One might well ask what factors govern the choice of the source? A notable advance has been the evaluation of many of the factors governing such a choice and the derivation of useful general equations. The work of Winefordner and his school at the University of Florida is outstanding in this respect and should be consulted by all who are working in this field.

A second important feature is the appearance of a great variety of interesting flame excitation sources, which means that we are approaching the stage when a particular flame will be selected to increase sensitivity of the wanted elements and depress the excitation of unwanted species. The flame temperature range is now approximately 500°-3200°K with a choice of controlled oxidising or reducing conditions, special premixing, and as a more recent choice, additives such as Ar, CO and heavy metals to produce certain enhancements. We have already approached the stage when cool and/or reducing flame excitation can be used for non-metal determinations such as P, S, halogens, etc. Many Australian and New Zealand chemists will have had the privilege of attending some of Professor T. S. West's lectures a few months ago. West's school of analytical chemistry

TABLE 1
SPECTROMETRY IN ANALYTICAL CHEMISTRY

Type	*Some Applications*
EMISSION (Arc, Spark, Flame)	Determination of elements, isotopic composition
MASS (Gaseous Ionization, Surface Ionization, Spark Source, Laser Source, Field Ionization)	Gas, isotopic and structure analysis; determination of elements
SPECTROPHOTOMETRY	
Absorption in solution (Absorptiometry)	Very wide range of chemical analysis
Absorption in flames (AAS)	Determination of elements (>60)
Emission in solution (Spectrofluorimetry)	Organic and inorganic analysis
Emission in flames (AFS)	Determination of elements
RAMAN	Organic and inorganic structure analysis
INFRARED	Chemical analysis, structure analysis
ULTRAVIOLET	Chemical analysis, structure analysis
N.M.R.	Organic, bio- and organometallic structure analysis
E.P.R. (E.S.R.)	Inorganic, organic and organometallic structure analysis
X-RAY ABSORPTION AND EMISSION (including electron microprobe)	Determination of elements, phases and structure analysis
MÖSSBAUER	Structure analysis (e.g. Fe, Sn compds.), pressure effects, particle size, surface absorption, oxidation states, nuclear parameters.

NOTE: AAS = atomic absorption spectrophotometry
AFS = atomic fluorescence spectrophotometry
N.M.R. = nuclear magnetic resonance
E.P.R. = electron paramagnetic resonance
E.S.R. = electron spin resonance.

has made outstanding contributions in this area. It is a good example of how a flourishing school can be built up in a short period. He currently has over 25 Ph.D. students and was co-author of over 30 papers last year.

In a smaller way, Dale in the A.A.E.C. Chemistry Division has been carrying out some interesting work with D.C. plasma jet excitation and an air + oxygen-acetylene premixed flame, both applied to flame emission spectrophotometry.

Table 3 illustrates some of our results comparing plasma jet (Spex) with acetylene-air flame (Unicam) by substituting one source or the other in front of a 0.5 Ebert plane grating monochromator (Jarrell-Ash) coupled to an EMI 6256B photomultiplier. The detection limits should not be regarded as absolute but the comparisons are perfectly valid.

It is interesting to note the decreased sensitivities for plasma jet to flame (column 2) for the series Sr, Cr, In, Na, K. This is due to greatly increased ionization (beyond the optimum) for these elements in the high temperature plasma.

The next comparison in Table 4 illustrates the enhancement factors of from 4-120 for a number of elements by adding oxygen to an air-acetylene flame (Dale). This flame also completely overcomes the interference effects of phosphate on calcium and magnesium, and partially eliminates the effect of aluminium on calcium.

In order to save space I have summarised other developments in applications of new spectrometry instrumentation in tabular form. Table 5 lists some of these new developments.

The first three methods were listed because I feel that analytical chemists will be in-

TABLE 2

SOME PROMISING SPECTROMETRY EXCITATION SOURCES

Type	*Advantages*	*Applications*	*Authors and References*
Plasma Jet (D.C. and H.F.)	High Temp. 3,000°-50,000°K	FES	Margoshes and Scribner, 2 Webb, Wildy, and Wordingham, 3 Kirsten and Bertilsson, 4 Dale, 5
Hollow Cathode Lamps (High Intensity, Selective Modulation)	Improved signal-to-noise ratio	AAS ES	Sullivan and Walsh, 6 Bowman, Sullivan and Walsh, 7 Willis, (Review), 8
R.F., Torch Discharges	Suits small samples	ES	Runnels and Gibson, 9 Yamamoto and Murayama, 10
Microwave Excited Electrodeless Lamp	Emits sharp intense lines	AAS AFS	Dagnall, Thompson and West, 11
Laser Probe	High Temp. 3,000°-100,000°K	ES AAS	Moenke, 12 Mossotti, Laqua and Hagenah, 13
Continuum Source. High Intensity (e.g. Xe)	Improved signal-to-noise ratio Requires scanning monochromator	AAS AFS	Fassel, Mossotti, Grossman and Kniseley, 14 Veillon, Mansfield and Winefordner, 15
Flames (a) Air-Hydrogen	Cool flame	ES AAS	Dagnall, Thompson and West, 16
(b) Nitrous Oxide-Hydrogen	High Temp. Strongly Reducing	ES AAS	Dagnall, Thompson and West, 17
(c) Nitrogen-Hydrogen Diffusion	Cool, reducing flame. 550°-1100°K	ES AAS	Dagnall, Thompson and West, 18
(d) Separated Air-Acetylene	Stable. Reduces flame radiative background	AAS AFS	Kirkbright, Semb and West, 19
(e) Argon-Hydrogen-Entrained Air	Increased sensitivity	FES	Zacha and Winefordner, 20
(f) Nitrous Oxide-Acetylene	High Temp. ~ 3,000°K	AAS	Amos and Willis, 21
(g) Air + Oxygen — Acetylene	High Temp. 2,500°K	FES	Dale, 5

NOTES: FES = Flame Emission Spectrometry; AAS = Atomic Absorption Spectrometry; AFS = Atomic Fluorescence Spectrometry; ES = Emission Spectrometry.

TABLE 3
COMPARATIVE SENSITIVITIES — PLASMA JET AND ACETYLENE-AIR FLAME

Element (in aqueous solution)	*Sensitivity of Plasma Jet Relative to Flame*	*PLASMA JET*		*FLAME*	
		Detection Limit p.p.m.	*Line (Å)*	*Detection Limit p.p.m.*	*Line (Å)*
B	> 1000	1	2498	Not detected at 1000 p.p.m.	2498
Be	> 1000	0.05	3130	Not detected at 1000 p.p.m.	2349
Zn	> 200	5	2062	Not detected at 1000 p.p.m.	2139
Si	> 1000	1	2516	Not detected at 1000 p.p.m.	2881
Mo	> 100	5	2816	Not detected at 500 p.p.m.	3798
Hf		2	2641	——	——
Al	> 70	2	3962	Not detected at 1000 p.p.m.	——
Zr		10	3392	——	——
Cd	100	3	2265	300	3261
Mg	50	0.1	2796	5	2852
Sb	> 40	25	2528 or 2598	Not detected at 1000 p.p.m.	2068
V	20	5	3110	100	VO Band Head
Bi	4	100	3068	400	3068
Pb	2	25	2203	50	4058
Ca	1	0.05	3934	0.05	4227
Co	1	1	2286	1	3527
Ag	1	5	3281	5	3281
Ni	1	10	2216	10	3525
Mn	0.4	0.5	2576	0.2	4031
Sr	0.2	0.1	4077	0.05	4607
Cr	0.1	10	3579	1	4254
In	0.02	50	2306	1	4511
Na	0.002	1	5890	0.002	5890
K	> 0.003	Not detected at 300 p.p.m.	7665	1	7665

TABLE 4
SENSITIVITIES ($\mu g/ml$) FOR THREE PREMIXED FLAMES

Element	*Line (Å)*	*Detection Limits*			
		Air-Acetylene	*Air-Oxygen-Acetylene (φ)*		*Oxy-Acetylene (*)*
Ag	3281	0.5	0.05	(10)	0.3
Al	3961	60	0.5	(120)	0.2
Ba	5536	0.05	0.005	(10)	0.03[a]
Ca	4227	0.01	0.0005	(20)	0.005
Co	3529	1	0.1	(10)	1[b]
Cr	4254	0.1	0.005	(20)	0.1
Cu	3274	1	0.1	(10)	0.1
Fe	3720	1	0.2	(5)	0.7
Li	6708	0.005	0.001	(5)	0.001
Mg	2852	0.5	0.05	(10)	0.2
Mn	4031	0.1	0.025	(4)	0.1
Mo	3798	1000	30	(33)	0.03
Ni	3525	4	1	(4)	0.6
Pb	4058	20	2	(10)	3[c]
Sr	4607	0.004	0.0004	(10)	0.004
V	4379	140	2.5	(55)	0.3

(φ) Enhancement factors in brackets.

(*) These detection limits are included as a guide only, and no direct comparison is intended. It is understood that they will vary for different instruments and flame conditions.

a Ba 4554Å line used. b Co 3454 Å line used. c Pb 3683 Å line used.

TABLE 5
APPLICATIONS OF NEW SPECTROMETRY INSTRUMENTATION

Type	*Cost A$ (approx.)*	*Applications*	*Authors and References*
N.M.R. (High resolution and wide line)	50,000	H and F in organic compounds; specific organic molecules in mixtures; functional group determinations.	Paulsen and Cooke, 22. Chapman and Magnus, 23.
		Analysis of oils, moisture, oxy acids of P, deuterium, fluorine compounds. Numerous structure investigations.	Heeschen, 24.
E.P.R. (E.S.R.)	50,000	Structure of paramagnetic inorganics. Determination of free radicals (organic and inorganic).	Atkins and Symons, 25. Fischer, 26. Koenig, 27.
		Determination of H, OH, Cl, Br and I in gas phase. Review.	Westerberg, 28. Eargle, 29.
Mössbauer (with MCA)	17,000	Nuclear parameters. Finger-print spectra. Surface adsorption. Solid phases in metals.	De Voe and Spijkerman, 30.
Isotopic X-ray	5,000	Portable analysers. On-stream analysis (ores and coatings).	Baker and Gerrard (Eds.), 31.
		Analysis of alloys, metals, solutions. Review.	Watt, 32. Rhodes, 33. Campbell and Brown, 34.
Gamma (with MCA)	20,000	High resolution radiochemical analysis. Computer-coupled resolution of spectra. Non-destructive automatic neutron activation analysis (with Ge(Li) detector).	Birks, 35. Yule, 36. Palmer, 37. Prussin, Harris, Hollander, 38. Storrer, 39.
Spark Source Mass	50,000	Trace elements in metals, ceramics, non-metals, etc.	Owens, 40. Schuy, 41.

creasingly concerned with them in the future. For a large variety of applications in science it is no longer sufficient to describe a material by indicating the amount of a particular element that is present. In addition to this, it is important to indicate the chemical state and/or the compound in which the element exists in the material. It is this information which correlates most often with the physico-chemical properties of the material. These methods and instruments are at present mostly confined to the larger research institutions but it is interesting to note that N.M.R. is now widely in use in the oil industry for chemical control and analysis. Further interesting applications of E.P.R. and Mössbauer spectrometry can be expected.

Isotopic X-ray spectrometry or energy dispersion X-ray analysis is a rapidly developing aspect of spectrometry. The use of isotopic X-ray sources (α, β and γ) coupled with energy dispersion techniques based on electronic pulse amplitude discrimination and selective X-ray filters has resulted in a range of portable, inexpensive X-ray spectrometers suitable for the quantitative semi-micro determination of a selection of elements for on-line and field applications.

Some of the isotopic sources used are: Po 210, Cm 242 - α emitters exciting low-energy X-rays; Pm 147, M 3 - β emitters (Bremsstrahlung production); Pu 238, Am 241, Gd 153 - γ-ray excited X-ray sources.

Gamma spectrometry is of more specialised interest to those working in radiochemical analysis. Very real advances have resulted from the use of new semi-conductor detectors (e.g. Ge(Li)) and computer resolution of spectra. This is tending to reduce but not eliminate the need for radio-chemical separation of constituents of complex mixtures such as may be produced on neutron activation of a complex matrix in N.A.A.

TABLE 6

MISCELLANEOUS INSTRUMENTS OF INTEREST TO ANALYTICAL CHEMISTS

Name and Cost	*Uses*	*Authors and References*
Electron Microprobe (A\$40,000)	Composition of discrete phases in metals and ceramics	Thiesen, 42.
Scanning Electron Microscope (A\$50,000)	Observation of topographic details (e.g. 150μ depth of field vs. 2-10μ	Catley, Nixon and Pease, 43.
Sealed-Tube Neutron Generator (A\$1500 — A\$6000)	On-line non-destructive analysis, bore-hole logging.	Coleman and Pierce, 44.
	General fast (14 MeV) NAA (flux = 2×10^9 n/cm^2/sec.)	Kaman Nuclear, 45.
Electrograph (A\$5000)	Multi-purpose electrochemical analysis (coulometry, chronopotentiometry, polarography, electrogravimetry, etc.)	National Instrument Labs., Inc., 46.
Field Ion Microscope	Surface studies on metals, semiconductors, thin films, adhesives.	Gomer, 47.

Spark source mass spectrometry with a high capital cost is still in limited general use. It is an extremely useful trace element method for high purity materials with sensitivities frequently in the range 0.01-0.001 p.p.m. However, there are difficulties with non-conducting materials.

In Table 6 I have listed five instrumental methods of interest to analytical chemists. I can briefly comment on each of these:

Electron Microprobe

This is a non-destructive method suited to high ($>0.1\%$) local concentrations of elements in a small area or sample of about a cubic micron. Under ideal circumstances one can determine and locate as little as 10^{-14} g of an element.

Scanning Electron Microscope

This instrument permits direct viewing of specimens with resolution and magnification intermediate between those of light microscopy and conventional electron microscopy. The depth of field ($\sim 150\mu$) compares with 2μ for light microscopy and 10μ for electron microscopy. This permits observation of topographic details.

Four modes of operation are possible, each relying on different phenomena associated with the interaction of an electron beam with a solid: high energy backscatter; low energy secondary electron emission; electron-beam induced current; cathode luminescence. Each mode reveals complementary information.

Sealed-Tube Neutron Generator

Tubes up to 8 inches diameter with power supply and control unit are used. The tubes have a life of 100-200 hours at half-rated yield and a mixture of tritium and deuterium gas is used to continuously replenish the tritium target. The tube gives a good usable flux of 2×10^9 n/cm^2/sec. 14 MeV neutrons which can be used to activate about 20 elements. The neutrons can also be thermalized in a paraffin block to give a yield of about 10^7 n/cm^2/sec. for a useful range of activations with elements of appreciable cross section. Applications have been listed in Table 6.

Electrograph

The "Electrograph" is a multipurpose electroanalytical instrument of compact multipurpose design. Many so-called multipurpose instruments are a nuisance with their attendant difficult changeovers, but this instrument seems to offer a great deal for its price.

Field Ion Microscope

Maximum resolution of the field ion microscope is about 2.5 Angstrom units—about equal to the spacing between atoms in a metal surface. It is a remarkably simple device consisting of an extremely small, sharp tip of single crystal cooled by liquid H_2 immersed in a vacuum system containing a small quantity of He. Opposite the tip is a fluorescent screen. The tip is positive and the screen negative and a high voltage is applied giving 450 million volts/cm. developed around the tip. When an electrically neutral He atom diffuses to a point just above an atom in the tip, the intense electric field strips off an electron. This ion, now having a positive charge, is propelled toward a point on the screen corresponding to the position of the atom over which it was ionized.

The Influence of Autoanalysers and Data Processing in Analytical Chemistry

There is little doubt that automation will greatly influence analytical chemistry during the next twenty years. This is not to say that such techniques will replace the present integrated complex of physico-chemical instrumentation and more classical "wet" methods, but rather that autoanalysers and data processors will greatly influence the through-put and reliability of data arising from instruments and repetitive determinations.

Already small, inexpensive digital computers are firmly established for the control and data handling of mass spectrometers, gamma ray spectrometers and other instruments. There has also been an explosion in the number of publications on autoanalysers during the past two years. Anyone interested in a review of these developments may care to consult a forthcoming paper[48].

I have space to briefly mention only three aspects of this new dimension in analytical chemistry.

Autoanalysers

Two typical examples are to be seen in automatic colorimeters or spectrophotometers. One typical automatic colorimeter system has a basic cost of A$7,000 (Technicon). Another manufacturer provides an automatic spectrophotometer with digital presentation of absorbance values and capable of measuring from 1-50 samples at up to 10 preset wavelengths.

Small Digital Computers or Data Processors

A small digital system, the PDP-8/I (Digital Equipment Corp.) costs approximately A$12,000 and is suitable for use with a number of physico-chemical instruments such as mass spectrometers, X-ray spectrometers, N.M.R.-E.S.R. spectrometters, etc.

Table 7 shows some recently reported applications of computer techniques to spectroscopy and related fields, illustrating what can be done with such computers. One important aspect, for example, is signal averaging, whereby one can make digital addition of spectral scans to increase signal to noise ratio and bring weak signals out of the background.

Curve Resolvers

The Dupont Curve Resolver costs approximately A$9,000. It is a special purpose anolog computer for the rapid resolution of overlapping peaks in experimental curves.

Applications include the resolution of seven into ten peaks in a pyrolysis chromatogram. Many diverse analytical chemistry methods such as chromatography, electrophoresis and spectrometry produce curves which are sums of peaks or distribution functions. Frequently these peaks overlap, and the curve must be reduced to component parts in order to accurately interpret results. This curve resolver generates on each of its function generator channels (say 6 channels) peak shapes corresponding to Gaussian, Lorentzian or other distributions. Individual peak parameters of height, width and horizontal position are independently varied on each channel until the resulting summation curve from all channels exactly matches the original curve.

I saw this curve resolver demonstrated at a conference in U.S.A. in 1966. After five minutes' instruction many of those at the exhibition were using the instrument without difficulty.

TABLE 7

APPLICATIONS OF COMPUTER TECHNIQUES TO SPECTROMETRY AND RELATED FIELDS

Method	*Some Examples*
EMISSION	Direct reader output signals → concs., % T → rel. intensities and intensity ratios, background correction, matrix corrections for interelement effect.
FLAME AND AA	Investigation of experimental parameters, interelement effect studies, output → concentrations.
ABSORPTION	Smoothing of digitized abs. spectra by least squares, correction of band shapes and wavelength errors, peak searching and matching.
X-RAY AND ELECT. PROBE	Fitting working curves and calc. concs., interelement corrections, control of diffractometer operation, file search, Fourier analysis of single crystal patterns.
NMR	Digital addition scans and smoothing (improves signal/noise ratio), peak enhancement, corrections for instrumental drift.
MASS	Correction for line widening (due to focusing errors), evaluation of complex spectra, peak matching.
NAA	Evaluation of complex spectra, photopeak area calcs., peak resolving.
GC	Determination of integrated peak areas from digitized signals, correction for baseline drift, auto. fraction collection, on-line control analyses.

New Separation and Preconcentration Methods for Trace Elements

The most important separation methods used in analytical chemistry depend on distribution of the element of interest between two phases, followed by physical separation of both phases.

Volatilization, liquid-liquid extraction, precipitation, electro-deposition and ion exchange fall into this category.

There is generally a practical limit to sample size in trace element determinations, the average range being 0.1-10 g. Instead of processing several tens to several hundred grams of a solid or solutions of 10 to a few hundred litres, attention is paid to improvements in separation and preconcentration procedures. I only have space to mention some of the improvements.

Analytical Distillation and Volatilization

As a separation and concentration method for trace elements, the literature has not revealed any interesting advances during the past decade.

Liquid-Liquid Extraction

The developments in this field are truly bewildering and it is impossible to generalize.

Morrison's work[49] gives a simplified classification for primary and mixed systems. Even this scheme, prepared in 1964, does not include the large class of amine extractants operating as ion association and co-ordination systems.

Some of the most significant developments have concerned the extraction of transition elements using primary amines, long chain amines, high molecular weight amines and quaternary ammonium salts. A comprehensive table prepared by Freiser[50] lists many applications of these extractants. In amine extraction systems it has been found that aqueous phase reactions predominate so that extraction follows an inverse order to the case of hydration. Thus, for simple acids, extraction follows the order: primary > secondary > tertiary amines and $\mathrm{C10}_4^- > I^- > Br > Cl$. It has also been shown that steric factors and tendency to aggregate modify basic strengths of amines in extraction processes. The extraction of UO_2Cl_2 by amines involves an ion association rather than coordination.

Precipitation

At first thoughts most analytical chemists would not have noted many advances in precipitation or gravimetric techniques. Yet there has been a significant advance in the understanding of precipitation processes. An increasing number of studies are being made of the kinetics of precipitation processes using such techniques as light scattering and stopped flow spectrophotometry. The influence of adsorbed films on particle growth and of ultrasonic stirring on nucleation are examples of two such studies.

Significant advances have been made in our knowledge of the mechanism of precipitation from homogeneous solution (as seen in a review by Cartwright, Newman and Wilson[51] and the induction of homogeneous nucleation—for example via the electrochemical generation of precipitants by Klein and Driy[52].

Electrodeposition and Electrochemistry Studies

In this very large field all I can usefully do in the space available is to select three areas in which the advances appear to be of interest. These are:

(a) Optical methods for observing electrode-solution interfaces. Involves the use of transparent electrodes and internal reflection spectroscopy by Mark and co-workers[53].

(b) Thin layer cells for studies of electrochemistry by Reilly and co-workers[54] and a review by Reinmuth[55]. Most thin layers fall into two categories:

bounded layers—those from which no electroactive material can enter or leave except at the electrode, e.g. use of thin Mg-amalgam films;

non-bounded layers—those at which the concentration of electroactive material in the boundary other than the electrode is maintained constant, e.g. use of membrane-coated electrodes with convection assuring constant concentration at the edge of the membrane in contact with bulk solution.

(c) Electrolytic sample dissolution. For example, the automated anodic dissolution of a steel sample followed by spectrophotometry by Barabas[56].

Ion Exchange

There have been both "gains" and "losses" in the applications of ion exchange for separations in analytical chemistry. Present trace element methods such as AAS, AFS, GC, and NAA have eliminated the need for many ion exchange separations.

The "gains" are represented by the appearance of some new ion exchange materials which are shown in Table 8.

Amplification and Cascade Reactions

These reactions can be conveniently listed under the general heading of separation preconcentration methods. I do not propose to deal with these reactions in any great detail, since they were well described by T. S. West during a recent lecture tour of Australia and New Zealand.

I would remind you that the basic principle is to apply an amplification reaction in which one original test-ion is responsible for the production of several other ions of the same or of a different species. The reaction is attributed to Leipert whereby one equivalent of I^- is oxidised by Br_2 via $10^{-}{}_{3}$ to $3I_2$ giving 6:1 amplification. West[57] recently applied this principle to the determination of phosphorus. "The PO_4^{3-} is converted to phosphomolybdate, in which 12 molybdate ions are associated with each PO_4^{3-} ion ($12\ MoO_3 .PO_4$) and the complex is extracted away from excess molybdate and other ions by means of butanol-chloroform. The extract is then put in contact with a pH9 buffer which re-extracts the phosphate ions and the associated molybdate ions into the buffer. In this

TABLE 8

SOME NEW ION EXCHANGE-CHROMATOGRAPHY MATERIALS

Material	*Examples*	*Uses*	*References*
Chelating Resins	4-acetoxy-styrene } polymers divinyl benzene }	Increased selectivity	Packham, 57.
Cellulosic and Dextran Derivatives	Cellulose cont. O, N, P, S functional groups. Gel filtration — "Sephadex"† Gel permeation — polystyrene cross-linked with divinyl benzene.	Inorg. and org. separations. Organic and biological analysis especially non-polar media.	Muzarelli, 58. Pescock and Saunders, 59. Cazes, 60.
Inorganic Exchangers	Zr phosphate and molybdate. Salts of heteropoly acids and related compounds (e.g. phosphomolybdates, ammonium hexacyano cobalt ferrate, etc.)	Increased stability at higher temperatures. Separation of alkali metals, etc.	Huys and Baetsle, 61. Inoue, 62 Inczedy, 63. Amphlett, 64.
Redox Copolymers	Hydroquinone-quinone derivates added to preformed polystyrene matrices.	Control of oxidation state during separations (e.g. removal of O_2, reduction Fe(III) → Fe(II).	Kun, 65. Kadlec and Brodsky, 66.

NOTE: †"Sephadex" is a modified dextran obtained by fermentation of sugar. The linear macromolecules of dextran are cross-linked giving a three-dimensional network of polysaccharide chains.

medium these are no longer chemically combined, so that molybdate ions can now be made to react with the sensitive reagent, 4-chloro-2-aminobenzenethiol to give an easily measured complex. This amplification procedure results in an effective molecular extinction coefficient of 360,000 for PO_4^{3-}, so that solutions as dilute as 0.008 p.p.m. P may easily be determined. By contrast the standard molybdenum blue procedures have values of about 27,000". A similar procedure can be applied for Si determinations.

Weisz[68] has developed repetitive (cascade) reactions. Examples are the determination of CrO_4^{2-}, Ag^+ or Tl^+. In the case of silver, the Ag^+ is precipitated as Ag_2CrO_4. This is reacted with $BaCl_2 \rightarrow 2AgCl + BaCrO_4$. This is then reacted with excess $AgNO_3 \rightarrow 2AgCl + Ag_2CrO_4$. The reaction with $BaCl_2$ is then repeated $\rightarrow 4AgCl + BaCrO_4$. This is converted to $4\ AgCl + Ag_2CrO_4$ and the cascade repeated n times. In the nth operation the reaction with $Cl^- \rightarrow 2n(AgCl) + 2AgCl$ and finally $2(n+1)AgCl$. The amplification is therefore $1:n+1$.

Recent Developments in Trace Element Analysis

Many of the interesting developments and new dimensions have already been outlined. Under this heading, I only wish to comment on an important trend in the work of analytical chemists during the next few decades.

It is becoming increasingly clear that quantitative results for the concentration of trace elements will not be sufficient in many scientific areas. Information will be required on the nature and form of the constituents. Physico-chemical methods such as: N.M.R., E.P.R., Mössbauer, electron microprobe, scanning electron microscope, field ion microscope, infrared, U.V. and Raman will be increasingly used by analytical chemists, in addition to the more familiar methods.

It can be seen that the new dimensions in analytical chemistry are a reality and many exciting challenges and much interesting work can be expected.

New Approaches to Teaching Undergraduate Analytical Chemistry

In British Commonwealth universities analytical chemistry courses and research have a very long way to go to achieve recognition and respectability alongside inorganic, physical and organic chemistry.

Within the past two years there have been numerous discussions concerning the role of analytical chemistry in chemistry curricula[69-77]. Does it have a place? Should it engage in a headbutting competition with the other branches of chemistry for instruction time?

Unfortunately many of our academic colleagues rush to answer such question in the negative, without bothering to inform themselves of the pros and cons of the situation. This attitude is undoubtedly influenced by their own memories of the largely unsatisfactory, piecemeal instruction in analytical chemistry coupled with a view of what I will call the "fashionable areas" for post-graduate research in chemistry. It must be obvious that some areas of chemistry are currently "fashionable": co-ordination chemistry, molecular spectroscopy, natural product chemistry, etc.

The pressure for a changed concept in analytical chemistry is not necessarily arising from academic discussions. A very large pressure is currently emanating from industry (control and research) and the employers of chemists. The reason is simply that analytical chemists may even constitute the largest single group of chemists in the whole professional area and their training is important.

In Australia, Royal Australian Chemical Institute surveys have revealed on successive occasions that chemists involved directly in analytical chemistry constitute the second largest group after organic chemists[78]. Probably even more are *indirectly* involved than would be the case for the other branches, so that cumulative effort and involvement in analytical chemistry is perhaps now greater than any other branch of chemistry.

If we appreciate this, it is not difficult to see how a successful department of analytical chemistry can arise. One of the best recent examples is that of T. S. West at Imperial College. West was appointed to a newly-created Readership in 1963 and following considerable all-round success, to a Chair in Analytical Chemistry in 1965. Some idea of the birth of a successful department and of new dimensions in the teaching of analytical chemistry can be gauged from the fact that he currently has 25 Ph.D. candidates in analytical chemistry and West was co-author of 30 high quality papers in 1967.

This did not happen by chance or by a headbutting competition with the other branches of chemistry. West is meeting the current need by recognition of the potential to be tapped.

The question as to what should be done to bring such developments about is a lengthy one. My own ideas can be summarized in the following way:

(1) Publicising an acceptable definition of what constitutes modern analytical chemistry, so that chemists can bring to mind an entity that replaces their older picture of analytical chemistry.

(2) Introduction of advanced analytical chemistry associated with physico-chemical instrumentation at the third year level in a B.Sc. course. This may seem to be putting the cart before the horse but it has more advantages than may at first be apparent.

For example:

(a) The two years' groundwork in all aspects of chemistry can serve as a good foundation for the modern approach.

(b) The greatest impact on basic chemistry degree graduates either leaving the university or continuing on with research can be made at this stage.

(c) All-round support from industry, grants from other areas, etc., will be easier to gain at this level—once it is shown what can be done.

(d) It is possible to work back to earlier years of instruction once the more advanced level is established.

(e) At the third year level of instruction outside specialist lecturers can be obtained at moderate cost to cover areas where there is insufficient expertise or instrumentation within the department.

(3) Introduction of "analytical chemistry thinking", ultimately at all stages of instruction. What I mean by this is expressed well by the remarks of S. Siggia, University of Massachusetts[76]:

> "However when I look at 'fundamental principles" in regard to analysis, I see more than just fundamental *physical* principles. The analytical chemist must also be inbred with *fundamental* analytical principles and an *analytical pattern of thinking.* These fundamental analytical principles concern themselves with a constant awareness of: (1) accuracy and precision; (2) sources of error; (3) the use of several approaches to firm up a conclusion (confirmation); (4) significance of data".

Finally I would conclude with one reasonable definition of analytical chemistry by G. H. Ayres, University of Texas[73]:

> "I maintain that analytical chemistry is a discipline in its own right, including principles, reactions, theories, explanations, calculations, applications, technique, etc.; it affords the type of training both in the classroom and in the laboratory that is needed by all chemistry students (as well as by students in certain related fields) and that is not likely to be obtained in any other course or by piecemeal treatment in other courses".

References

[1] P. B. Hamilton. Biochemical Analysis. A Review. Anal. Chem., *38* (5), 19R (1966).

[2] M. Margoshes and B. F. Scribner. Spectrochim. Acta, *2* 138 (1959).

[3] M. S. W. Webb, P. C. Wildy and M. L. Wordingham. U.K. Report AERE R4990 (1965).

[4] W. J. Kirsten and G. O. B. Bertilsson. Anal. Chem., *38*, 648 (1966).

[5] L. S. Dale. Private Communication. Aust. A.E.C. (1968).

[6] J. V. Sullivan and A. Walsh. Spectrochim. Acta, *21*, 721 (1965).

[7] J. A. Bowman, J. V. Sullivan and A. Walsh. Spectrochim. Acta, *22*, 205 (1966).

[8] J. B. Willis. Rev. Pure and Applied Chem., *17*, 111 (1967).

[9] J. H. Runnels and J. H. Gibson. Anal. Chem., *39*, 1398 (1967).

[10] M. Yamamoto and S. Murayama. Spectrochim. Acta, *23A*, 773 (1967).

[11] R. M. Dagnell, K. C. Thompson and T. S. West. Talanta, *14*, 551 (1967).

[12] H. Moenke and L. Monke-Blankenberg. "Introduction to Laser Micro-Emission Spectral Analysis" (Technical-Physical Monographs, Vol. 21), Akad. Verlagsges. Geest and Portig, Leipzig, Ger., 1966.

[13] V. G. Mossotti, K. Laqua and W. D. Hagenah. Spectrochim. Acta, *23B*, 197 (1967).

[14] V. A. Fassel, V. G. Mossotti, W. E. Grossman and R. N. Kniseley. Pittsburgh Conf. Anal. Chem. Appl. Spectry. 1965; Spectrochim. Acta, *22*, 347 (1966).

[15] C. Veillon, J. M. Mansfield and J. D. Winefordner. Anal. Chem., *38*, 204 (1966).

[16] R. M. Dagnall, K. C. Thompson and T. S. West. Anal. Chim. Acta, *36*, 269 (1966).

[17] R. M. Dagnall, K. C. Thompson and T. S. West. Analyst, *92*, 153 (1967).

[18] R. M. Dagnall, K. C. Thompson and T. S. West. Analyst, *92*, 72 (1967); *ibid.*, *92*, 506 (1967).

[19] G. F. Kirkbright, A. Semb and T. S. West. Talanta, *14*, (1011) 1967.

[20] K. Zacha and J. D. Winefordner. Anal. Chem., *38*, 1537 (1966).

[21] M. D. Amos and J. B. Willis. Spectrochim. Acta, *22*, 1325, 2128 (1966).

[22] P. J. Paulsen and W. D. Cooke. Anal. Chem., *36*, 1713 (1964).

[23] D. Chapman and P. D. Magnus. "Introduction to Practical High Resolution NMR". Academic Press, N.Y. (1966).

[24] J. P. Heeschen. NMR (Review of Analytical Chemistry Applications). Anal. Chem., *40*, 560.

[25] P. W. Atkins and M. C. Symons. "The Structure of Inorganic Radicals". (Elsevier, Amsterdam, 1966).

[26] H. Fischer. "Landolt-Bornstein, New Series, Gp.11", Vol. 1. (Springer-Verlag, Berlin, 1965). German and English.

[27] E. Koenig, *ibid.*

[28] A. A. Westerberg. J. Chem. Phys., *43*, 1550 (1965); *ibid.*, *45*, 338 (1966).

[29] D. H. Eargle. EPR (Review of Analytical Chemistry Applications). Anal. Chem., *40*, 303R (1968).

[30] J. R. De Voe and J. J. Spijkerman. Mossbauer Spectrometry. (Review of Analytical Chemistry Applications). Anal. Chem., *40*, 472R (1968).

[31] P. S. Baker and M. Gerrard (Eds.). Proc. Second Symposium on Low Energy X- and Gamma Sources and Applications, Austin, Texas, Sept. 1967, ORNL-11C-10.

[32] J. S. Watt. Intern. Jour. Appl. Radiation Isotopes, *18*, 383 (1967); *ibid. 15*, 617 (1964).

[33] J. R. Rhodes. Radioisotope X-Ray Spectrometry (Review). Analyst, *91*, 683 (1966).

[34] W. J. Campbell and J. D. Brown. X-Ray Absorption and Emission. (Review of Analytical Chemistry Applications). Anal. Chem., *40*, 346R (1968).

[35] J. B. Birks. "The Theory and Practice of Scintillation Counting". (Pergamon, 1964).

[36] H. P. Yule. Anal. Chem. *38*, 603 (1966).

[37] A. R. Palmer. Studies in Computer Coupled Radiochemical Analysis.—Part 1. Peak Location and Peak Energy Measurement in Scintillation Spectrometry. Australian Atomic Energy Commission. Report TM437 (1968).

[38] S. G. Prussin, J. A. Harris and J. M. Hollander. Anal. Chem., *37*, 1127 (1965).

[39] T. S. Storrer. "Electronic Techniques in Gamma Ray Spectroscopy and Timing". Hewlett-Packard Journal, p. 2-10, March 1968.

[40] E. B. Owens. Appl. Spectry. *21*, 1 (1967).

[41] K. D. Schuy and J. Franzen. Z. Anal. Chem., *221*, 342 (1966).

[42] R. Thiesen. "Quantitative Electron Microprobe Analysis" (Springer-Verlag, New York, 1965).

[43] C. W. Oatley, W. C. Nixon and R. F. W. Pease. "Scanning Electron Microscopy". Advances Electronics and Electron Physics. Vol. 21. (Academic Press, 1965).

[44] R. F. Coleman and T. B. Pierce. Activation Analysis. A Review. Analyst *92*, 1 (1967).

[45] Sealed Tube Neutron Generator, Type A-710, Kaman Nuclear, Colorado Springs, Colorado, U.S.A.

[46] "Electrograph", National Instrument Laboratories Inc., Rockville, Maryland, U.S.A.

[47] H. Gomer. "Field Emission and Field Ionization". (Harvard Press, 1961).

[48] L. E. Smythe. "The Development and Influence of Autoanalysers and Data Processing in Analytical Chemistry". Talanta (A. A. Smales Honour Issue). *In press.* 1968.

[49] G. H. Morrison. Extraction. A Review. Anal. Chem., *36*, 94R (1964).

[50] H. Freiser. Extraction. A Review. Anal. Chem., *40*, 523R (1968).

[51] P. F. S. Cartwright, E. J. Newman and D. W. Wilson. Analyst, *92*, 663 (1967).

[52] D. H. Klein and J. A. Driy. Talanta, *13*, 289 (1966); *ibid., 14*, 937 (1967).

[53] H. B. Mark and co-workers. Anal. Chem., *39*, 685 (1967).

[54] C. N. Reilley and co-workers. J. Electroanal. Chem., *12*, 477 (1966); Rev. Pure Appl. Chem., *18*, 137 (1968).

[55] W. H. Reinmuth. Electrochemical Relaxation Techniques. A Review. Anal. Chem., *40*, 185R (1968).

[56] S. Barabas. Automation in Analytical Chemistry. Technicon Symposia 1966. Vols. I and II, p. 617 (Mediad Inc., New York, 1967).

[57] D. I. Packham. J. Chem. Soc., p. 2617 (1964).

[58] R. A. A. Muzzarelli and co-workers. Anal. Chem., *39*, 1762 (1967).

[59] R. L. Pescock and D. Saunders. Separ. Sci *1*, 613 (1966).

[60] J. Cazes. J. Chem. Ed. *43*, A567 (1966); *ibid.*, A625.

[61] D. Huys and L. H. Baetsle. J. Inorg. Nucl. Chem., *26*, 1329 (1964).

[62] Y. Inoue. J. Inorg. Nucl. Chem., *26*, 2241 (1964).

[63] J. Inczedy. "Analytical Application of Ion Exchangers". (Pergamon, 1966).

[64] C. B. Amphlett. "Inorganic Ion Exchangers". (Elsevier, N.Y. 1964).

[65] K. A. Kun. J. Polymer Sci. *A3*, 1833 (1965); *ibid., A4*, 847; 859 (1966).

[66] V. Kadlec and A. Brodsky. Chem. Listing *58*, 891 (1964).

[67] V. Djurkin, G. F. Kirkbright and T. S. West. Analyst, *91*, 89 (1966).

[68] H. Weisz. Mikrochim. Ichnoanal. Acta, *2*, 258 (1965); CA*63* : 2371f.

[69] I. M. Kolthoff. "The status of and trends in analytical chemistry". Talanta *11*, 75 (1964).

[70] L. S. Bark. "Analysis or Analytical chemistry—which to teach?" Jour. Royal Inst. Chem., *88*, 4 (1964).

[71] W. F. Pickering. "Analytical chemistry in Australian science degree courses". Proc. Royal Aust. Chem. Inst., *34*, 121 (1967) May.

[72] H. G. Laitinen. "The industrial-academic interface in analytical chemistry". (Editorial). Anal. Chem., *40*, 265 (1968).

[73] Many Authors. "New horizons in education in analytical chemistry". Anal. Chem., *38*, 35A-57A (1966) February.

[74] R. H. Muller. "Factors involved in choosing a career in analytical chemistry". Anal. Chem., *39*, 26A (1967) June.

[75] L. T. Hallett. Fisher Award Address on Analytical Chemistry. Anal. Chem., *39*, 27A-32A (1967) June.

[76] Many Authors. "Education in analytical chemistry—a view from industry". Anal. Chem., *38*, 29A-48A (1966) December.

[77] A. M. Weinberg. "The two faces of science". Jour. Chem. Education, *45*, 74 (1968) Feb. (See also comment on this article by H. G. Laitinen, Anal. Chem., *40*, 4 and 90-91A (1968) April.

[78] Remuneration Survey. Proc. Royal Aust. Chem. Inst., *33*, 369 (1966).

CONFERENCE 1969

Abstracts of papers to be given in the symposia to be held on Tuesday 26 August (Proteins), Wednesday 27 August (Fibres), Friday 29 August (Chemical based Industries).

Protein Symposium

Chairman: Dr. A. T. Johns

PROTEINS FROM THE MEAT INDUSTRY

R. H. Locker
Meat Industry Research Institute of New Zealand Inc.

THE meat industry is now our major source of overseas funds (42 percent). Over 70 percent of this comes from meat which reflects a low degree of by-product utilization. While the greatest immediate returns would no doubt come from changes in marketing and presentation of meat itself, there is no doubt that much more attention to by-products, particularly proteins, is essential to gain maximum returns and reduce vulnerability on world markets.

Collagen, while devaluing meat, is our most valuable by-product. Processing skins to leather offers far the biggest financial opportunity. Casings also are a valuable collagenous by-product, now suffering from competition by "synthetic" casings, due to insufficient attention to quality of the natural product. Research on improving and drying casings and also on the reconstitution of casings as "synthetic" collagen is now in progress in New Zealand.

In the field of edible proteins there should be a general up-grading of pet-food and stock meal materials to human food, and a promotion of fertilizer to stock meal, leaving only bone as fertilizer. A scheme is presented for doing this. One feature of the scheme is the drying of low fat offals to protein powders. Another is the solvent extraction of protein meals to convert them to human food.

The potential of glands as the basis of a national fine proteins industry is briefly discussed. It is suggested that for both fine proteins and edible proteins special research units are needed which might study utilization from a national rather than industry point of view.

Some of the present problems facing such diversification are briefly discussed, such as grossly inadequate research effort, lack of qualified personnel in works, finance, etc. In conclusion it is suggested that if it is to progress as its importance to the economy demands, the freezing industry should be passing from a phase of rearrangement to meet edicts from overseas, to one of anticipating problems in advance and building quality into both meat and by-products. Only in such a way can the industry avoid more costly rearrangements and hope to enjoy premium prices and stable demand.

DAIRY PROTEINS

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NATURAL selection through thousands of generations has ensured that milk is a particularly suitable foodstuff for mammals. In broad terms the composition of milk differs only slightly from species to species.

Cows' milk contains about 3.7 percent protein. The main types of milk protein are caseins (78 percent), lactalbumins (17 percent) and lactoglobulins (5 percent). From a nutritional point of view the aminoacid composition of the constituent proteins is particularly well balanced, making each a 'first-class' protein source. On a per pound protein basis dairy products such as casein and skim milk powder are less than a quarter the cost of meat proteins.

Casein normally exists as miscelles in which α_{s1}-casein and β-casein are enclosed in a sheath of κ-casein. The caseins may be separated from other milk proteins by acid precipitation or by coagulation with enzymes such as rennin. Either of these agencies normally give curd plus whey. Lactalbumin may be separated from other whey proteins by heat denaturation which leads to precipitation. These reactions form the basis of commercial methods of cheese, casein and lactalbumin manufacture.

The main dairy products rich in protein are casein, lactalbumin, skim milk powder, whole milk powder, cheese, condensed milk and whey, whey powder, buttermilk powder, and cultured products such as yoghurt and kefir.

Some 65,000 tons of 96 percent pure casein is manufactured in New Zealand each year. It is used for both edible and industrial purposes in a very large number of products ranging from sausages and salamis through cereal products, stock foods, adhesives and paper-coatings to plastics.

In a world chronically short of first-class protein it is a tragedy that the price which casein commands for industrial and edible purposes virtually precludes its use as a food for the poor. It is perhaps an even greater tragedy that most cheese and casein whey with its 0.8 percent of nutritionally very valuable protein is at present disposed of by discharge into rivers. Active attention is currently being devoted to methods of changing a whey disposal problem into high protein foodstuffs of which the dairy industry can be proud.

PLANT PROTEINS

J. W. Lyttleton
Plant Chemistry Division

THE population explosion that the world is experiencing has created a crisis in nutrition, not only in the absolute amount of food required, but more specifically in the protein available. It is probable that a large increase in protein supply will be possible only by developing resources which are at present little used, and plant protein is a major source which is capable of rapid expansion.

The study of plant proteins as a separate class goes back to around the turn of the century, and has been brought together in a classic work by Osborne, "The Vegetable Proteins". The major interest at that time was in the protein which could be extracted from seeds of various types, and these proteins were classified in terms of solubility in a system which is still widely used. More recent studies of the seed proteins, using modern physico-chemical techniques, have revealed a complexity beyond that which could be determined by solubility studies alone. In many cases the individual components undergo association—dissociation reactions, and the full range of constituents can only be separated in solvents such as 8M urea.

The seed proteins which have been most studied are those which are economically important—the cereals, legumes, and oilseeds. Cereal protein is seldom isolated as a foodstuff, but the level and composition of the protein of grain is of vital importance, as cereals constitute such a large part of the diet of the human race. Oil seeds are produced on a very large scale, but full utilization of protein from this source is far from being achieved.

The storage protein in the seed is without apparent biological activity, but the protein of growing tissue is of much greater interest to the biochemist. Many of the biochemical pathways found in plants are similar to those in animal and bacterial systems, with similar enzymes involved, while in addition there are found in green tissue all the proteins which are responsible for the enzyme reactions in photosynthesis.

From the point of view of food, although seeds contain protein in the highest concentration, the amount to be found in leaves is considerably greater. Extraction, however, is more difficult. None the less, if full use is to be made of the potential supply of protein from plants, methods of using leaf protein must be developed.

NEW ZEALAND'S CONTRIBUTION

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INCREASING public awareness of the problem of malnutrition which faces a large proportion of the world's rapidly expanding population is focusing attention on the better utilization of resources for food production and on distribution of existing food supplies. Already, with its highly-efficient, low-cost primary industries which have developed as a consequence of favourable climatic and other conditions and the effective application of agricultural and processing technologies, New Zealand is a major contributor to world food supplies. Obviously, since these products form the basis of our interantional trade they go predominantly to more affluent societies, but with increased productivity and changing patterns of world trade greater emphasis is being placed on the needs of developing areas.

Clearly, the products on which our traditional trade has developed may not necessarily suit the requirements of these new markets in which the emphasis will be on low cost and high nutritive value. New Zealand is in a position to diversify its production and indeed has done so to a quite considerable extent over recent years, but the establishment of a new market, or the introduction of a new product, poses difficulties—economic, social, climatic and technical.

Despite protein shortages there is generally a reluctance to accept a new and different food type, and even in areas of severe malnutrition success or failure of a food product depends more on acceptability by the population at large than on nutritive value or cost. There is in most areas a general, and understandable, reluctance to accept a foodstuff which may be regarded as a cheap substitute for the food which more affluent neighbours enjoy. Thus, many schemes to provide cheap foods have failed on the grounds of the novelty and the unacceptability of the product.

There is thus some evidence in aid programmes of a swing away from new food forms and a revaluation of the place of more traditional ones.

In addition, much of the thinking regarding traditional foods has been influenced by the high cost of production in Europe and other areas where farming is heavily subsidized. On this basis an alternative food may appear relatively cheap, but the situation is reversed when the comparison is made with traditional foods produced in low-cost, highly-efficient countries such as New Zealand, since although the basic raw materials for some of these new food products are relatively cheap, the processing required to get them into a reasonably acceptable form is generally expensive.

Work which has already been done in New Zealand on the production of food products more suited to developing countries and the further contribution which New Zealand can make to overcoming problems of protein deficiency will be discussed in this paper.

Fibres Symposium

Chairman: Mr. W. Olsen

INTRODUCTORY LECTURE

G. N. Malcolm
Massey University

"DURING the early days of his existence man depended upon animal skins and furs to keep him warm, but as the years passed his susceptibilities became more tender and his hide less coarse. A sheep-skin wrapped round the body may be better than nothing for keeping out the cold—but only just. Inevitably, man began to look around for something better."

So much for somebody's speculation about prehistory. Today we have textiles—warm, soft, glamorous, strong, and sufficiently supple to take up the contours of the human body.

The reason for these attractive properties is found in the structure of textile materials. Textiles are made by weaving yarns which themselves are made by twisting together (spinning) long, thin, flexible yet strong components called fibres. The fibres in their turn are made from macromolecules. The properties of the cloth will depend on the kind of yarn which is used and the way the yarn is woven. The properties of the yarn will depend on the kind of fibres from which it is made and the way in which the fibres are spun into yarn. The properties of the fibre will depend on the kind of macromolecules involved and the way in which they are associated to form the fibre.

A number of extremely good fibres, notably cotton, wool, jute, flax and silk, occur naturally. The main contribution of man to textile production for many centuries was in the craftsmanship of spinning and weaving these fibres. In the nineteenth century in England great progress was made by the application of inventive and engineering skill to the spinning and weaving processes. On this basis Britain's textile industry built itself to greatness in Victorian times.

Science, as distinct from engineering, was slow to reach the textile trade, and has played a significant role only in the last fifty years. The results of scientific study in this field have been spectacular, and highly profitable for those who invested heavily in fundamental research. The two major success stories of fibre science have been the production of fully synthetic fibres in which the fibre forming material is made from simpler substances, and the development of regenerated fibres from naturally occurring non-fibrous cellulose. In 1968 the fully synthetic fibres accounted for no less than one-fifth of the total world consumption of fibres and may account for one-third by 1975 (Nature, 1969, p. 328).

One of the disappointments of fibre science has been the failure so far to produce economically and technically satisfactory regenerated protein fibres from natural protein sources such as milk (casein), peanuts, maize and soya beans. Casein fibres are still in limited production, but manufacture of fibres from the other protein sources has been discontinued. At the present time the production of fibres from industrial waste protein in egg residues (from dried egg preparation) and in poultry feathers is being investigated. Advances in synthetic fibre science have had some unfortunate consequences also. A quality natural fibre, once the economic support and material comfort of a whole nation, has been threatened with relegation to the ignoble role of an ingredient of sponge cake!

Much of the incentive for the scientific study of fibres came from the commercial importance of textiles, but the results of this study have been of great significance in other fields where fibrous materials are involved. In biological systems in particular the understanding of the structure and function of collagen and muscle protein and of the blood-clotting action of fibrinogen has been aided by the general development of fibre science.

The properties which are important in a fibre include mechanical properties such as tensile strength, elongation, elastic recovery; physical properties such as density, and the effect of moisture, heat and sunlight; chemical properties such as reaction with acids, alkalis, organic solvents and dyes. The molecular characteristics on which these properties depend are the chain-like shape of the molecules, the chain length, the chain symmetry, the chain stiffness, the inter-chain attractive forces, and the conformation and arrangement of the chains within the fibre. Despite the tremendous increase in the scientific understanding of fibres which has occurred in the last fifty years it is still not possible to account for all the properties of fibres in terms of their molecular structure, and many matters are still controversial.

An attempt will be made to outline current ideas of the relation between general fibre properties and molecular structure without trespassing too severely on the territory of the special lectures on vegetable and synthetic fibres and on wool.

WOOL

A. J. Farnworth
Technical Director, Australian Wool Board

WOOL as an apparel fibre is undergoing a period of considerable challenge in end uses formerly its traditional and exclusive province. This challenge is occurring on almost every front associated with textile fibre utilization—that is,

(a) Production
(b) Presentation and Packaging
(c) Price
(d) Processing
(e) Promotion
(f) Properties and Performance.

The broad boundaries suggested by the organisers and the time factor necessitate confining the address to items (a), (c) and (f).

Production

World demand for textile fibres is increasing at a much greater rate than can possibly be met by natural fibres and the short-fall in fibre availability is being filled by synthetics.

Production statistics will be presented and reference will be made to the possibility of increasing the production of wool.

Price

There are two aspects of fibre price which greatly influence the attitude and profitability of textile manufacturers: the absolute figure in relation to alternative fibres and the stability of price over the long and short term.

Information will be presented in relation to past and present prices, and the Woolmark programme to identify and establish pure new wool products as quality articles worthy of a price premium.

Price stability of fibres, on the other hand, has an important bearing on the profitability of textile manufacturers and their competitive position in relation to others.

Properties and Performance

Of all textile fibres available, wool has by far the broadest spectrum of desirable properties which make it outstanding for use in apparel. Thus, it is outstandingly good in many aspects, shows moderate performance in others, and is deficient in relatively few properties.

The biggest challenges to wool from other fibres lie in the area of performance characteristics, particularly those related to easy-care, and a major portion of the wool textile research effort in Australia and elsewhere is directed towards imparting improved and new performance characteristics through fibre modification.

Reference will be made to the latest work in establishing the basic structure of the wool fibre and to a variety of chemical treatments for modifying the properties of wool to achieve such performance characteristics as mothproofness, machine washability, permanent creases, non-iron finishes, increased stability of dyes to light and washing, and prevention of yellowing in use.

WOOD FIBRES AND PROBLEMS AFFECTING THEIR WIDER USE AS A TECHNICAL RAW MATERIAL

D. J. Brash, M.Sc., Ph.D.
Chemistry Department, University of Otago

ALTHOUGH there is considerable industrial interest in New Zealand flax and kenaf, no vegetable fibres used in this country can approach those from wood in economic importance. Our forest industries, which include our two largest industrial enterprises, provide 41 percent of manufactured exports, employ 10 percent of the industrial labour force and have a present gross output value of over $270 million per annum. The aim of this paper is therefore to discuss some of the problems affecting the wider and more efficient use of wood as a technical raw material.

Wood fibres, while complex in organisation, are basically composed of the polysaccharide cellulose, and it is the high strength, inertness and insolubility of the cellulose fibres which give wood fibres their industrial (and biological) importance. These properties arise from the overall shape of the cellulose molecule because other glucose polymers are quite different. Infrared spectroscopy and X-ray diffraction have contributed to an understanding of this shape, but still the final conformation of the cellulose chain must be taken to be unknown.

Cellulose always occurs in vegetable fibres as aggregates of molecules called fibrils which in turn agglomerate into the fibre structures visible under the light microscope. In conifers such as *Pinus radiata* the fibres under consideration are the tracheids, thin walled cells which have a high length to diameter ratio. A great deal of published information is available on the nature of the external surface of the fibre and its role in the formation of interfibre bonding and paper quality. The properties of papermaking pulps are largely dependent on the morphology and chemical components of the fibres constituting the pulp.

Information on the porous inner structure of the wood cell is still fragmentary. Recent work suggests a multi-lamellar model in which the lamellae are separated by layers of water in a wet fibre, and coalesce into a solid wall when the fibre is dried. This theory, while oversimplified, explains many of the effects of both mechanical and chemical pulping, as well as beating and refining, on fibre properties.

Papermaking is essentially a process of water removal, and the cellulose-water relationship is basic to present theories of papermaking. Novel experimental techniques have clarified many points and reapportioned the emphasis to be attached to the various factors affecting papermaking.

Of the non-cellulosic constituents of plant fibres, the main structural features of the glucuronoxylans and glucomannans of wood are well known, but much of their detailed chemical structure has yet to be discovered. The important reactions which these polymers undergo in pulping are known only in general terms, but nevertheless this information has led to many improvements in pulping processes, for example the use of multistage pulping to produce pulps with increased polysaccharide retention.

What to do with by-products—turpentine, tall oil, bark and sawdust—has always been a problem of the forest-based industries. Any real programme for the wider and more efficient use of wood fibres in New Zealand should involve both bark and sawdust, the two outstanding sources of unused waste materials from our sawmills and pulpmills.

MAN-MADE FIBRES

A. F. Wilson
N.Z Forest Products Ltd., Kinleith

ONLY a small number of New Zealanders have had an opportunity of seeing a man-made fibre production operation. Those that have will have been impressed by the contrast between man's and nature's methods of making fibres. In a typical plant, molten polymer or a polymer solution is passed through hundreds of spinnerets to produce thousands of filaments at very high production rates. The fibre denier, or diameter, is accurately controlled by adjusting the rate of flow of polymer melt or solution to the spinneret and the extruded yarn take-up speed. Continuous filament yarns are produced with as many filaments in the yarn as there are holes in the spinneret. Staple fibres are produced by collecting the filaments from many spinnerets and cutting them to the required lengths.

For a New Zealand chemist the particular interest in man-made fibres is likely to be an understanding of the chemical composition of the important fibres and the factors that account for their different properties. How do man-made fibres differ in their composition and properties from such natural fibres as wool, cotton and silk? In what ways have studies of the composition and morphology of man-made fibres led to improved properties and distinctly different fibres?

There are two main classes of man-made fibres. Firstly, man has utilised naturally-occurring polymers, particularly cellulose, and converted them into extrudable forms to produce fibres. While nature has produced the polymer, it has been possible to change fibre properties appreciably by the addition of different side-chain groups to the main polymer chain or by establishing covalent bonds between chains. The properties of cellulose acetate fibres, for example, can be varied by changing the degree to which the hydroxyl side-chain groups on cellulose are acetylated.

In the late 1920's man learned to synthesize high molecular weight polymers from low molecular weight monomers and today many synthetic polymers are extruded to make commercial fibres.

In making synthetic fibres man is able to control not only the extrusion process but also the composition of the polymers being extruded. Dyesites can be built into the main chain by choosing small amounts of the appropriate monomer. The physical properties of a fibre are dependent on such factors as degree of crystallinity and orientation of polymer molecules and these in turn can be controlled by the choice of monomers and the degree to which the fibre is drawn or stretched after extrusion.

This paper will review the following:

- differences between natural and man-made fibres,
- chemical composition of the important man-made fibres,
- relationships between fibre chemical composition and morphology and properties,
- examples of how a knowledge of such relationships can be used to develop new fibres such as high temperature-resistant and elastomeric fibres,
- production of man-made fibres in New Zealand,
- versatility of man-made fibre extrusion processes in changing fibre properties,
- developments in the use of man-made fibres to make non-woven fibrous materials.

Chemical Based Industries

Chairman: Professor A. M. Kennedy

"THE ONLY SUBSTITUTE FOR PROFIT IS LOSS"

P. K. Foster
P.A.C.R.A.

IN a general description of the context within which industrial science operates the prime importance of profit in industry is first emphasised. The relationship between "technology" and "research" is discussed and it is argued that "technology" creates demands for "research" far more often than vice versa. Urgency in industry and the effect of delays in reducing profits ensure that technological advance proceeds largely independently of research. The change in emphasis in scientific effort as an industry develops is examined. The implicit differences between the "technological" chemist and the "research" chemist are then stated explicitly, and the reality of the difference illustrated by the attitudes of the two to scientific publications. Finally, the implications of the foregoing are discussed in relation to the Institute and to University research. The barriers to communication between Institute members are emphasised. It is shown that there are severe restrictions on the assistance that University research should be expected to provide for industry, and that the conditions under which post-graduate research operates unduly influence the best graduates away from a career in industry.

THE FERTILISER INDUSTRY

J. Rogers

Director, New Zealand Fertiliser Manufacturers' Research Association, Auckland

After Kempthorne Prosser and Co. built a superphosphate plant at Dunedin early in the 1880's the industry's growth was steady until between 1945 and 1966 when the annual use of fertiliser rose from half a million to almost two million tons (or from six to fifteen hundredweight per New Zealander) at a total cost on the farms of about sixty million dollars. Correspondingly, during the same period the f.o.b. value of pastoral exports grew more than five-fold—from 136 to 738 million dollars. Recently the National Development Conference set a target for pastoral exports of 910 out of 1215 million dollars for 1972-73 and 1100 out of 1585 million dollars for 1978-79. Although there are industries with greater percentage increases, agriculture's contribution is more than 2½ times the next biggest—manufacturing.

These figures show how gradually New Zealand's dependence on pastoral industry is likely to change, and consequently the continuing growth ahead of the fertiliser industry. In the five-year period 1962-67 our six fertiliser companies, all New Zealand owned, spent 15 million dollars on land, buildings and plant. Estimated expenditure in 1967-72 is eleven million. Despite a serious drop in fertiliser sales in 1967-68, the industry's spending on research doubled and currently it has been trebled.

Geography is one of several important factors bearing on the continuing dominance of superphosphate as the fertiliser for our major crop, grass. In New Zealand the sulphur and phosphorus in superphosphate are the catalysts for the annual fixation by clover-ryegrass pastures of nitrogen equivalent to five million tons of ammonium sulphate. This amount is a recent conservative estimate—it could be twice as much—and it could cost 250 million dollars a year.

Three minerals—sulphur, phosphate rock and potassium chloride—are the presently imported chief raw materials. The discovery of six million tons of sulphur near Lake Taupo is the latest of a series of recent developments affecting the fertiliser industry which embodies so much of the important findings of agricultural research. The prospects of future changes will be considered.

THE CHEMICAL FACETS OF ALUMINIUM PRODUCTION

J. R. Hunt

Comalco

With the major costs involved for processing and of power to break the strong bond between aluminium and oxygen to allow the production of the raw metal, it must be expected that reduction in costs will be unlikely; but the favourable properties of the metal and its alloys still allow a world increase in usage of over 10 percent per annum over the last ten years.

The electrochemical process of converting bauxite, the ore of aluminium, into ingot aluminium metal will be described.

BIOCHEMICAL INDUSTRIES

Professor R. L. Earle

Biotechnology Department, Massey University, Palmerston North

It is opportune, with the increasing necessity to add to overseas earnings, to look carefully into the possibilities of producing fine chemicals from biological sources in this country. New Zealand industries are in many cases very favourably situated with large quantities of fresh, raw materials. The most substantial source of raw materials is the meat industry where at present the only enzyme produced in quantity is rennin. There are many other enzymes, some in high demand overseas, such as pepsin, trypsin, gastrin; there are hormones; there is cholic acid as a possible source of steroids. Also, some of the major protein mixtures such as blood might be fractionated to yield commercial products. Plants are also possible sources of enzymes and pharmaceuticals, for example proteolytic enzymes from the chinese gooseberry and linoleic acid from flax seeds. We might also look towards further extension of the fermentation industries in this country, in the production again of enzymes and of fine chemicals such as citric acid.

LETTER TO THE EDITOR . . .

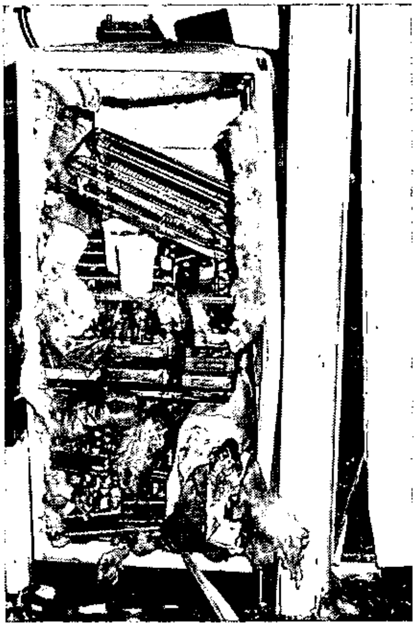
EXPLOSION IN FREEZER UNIT

Dear Madam,

The hazards of storing inflammable chemicals in domestic refrigerators do not seem to be well known, although reports have been published. A standard text⁽¹⁾ recommends that all electrical equipment be removed from the storage box while an article on Laboratory Safety⁽²⁾ draws attention to the spark hazards of thermostat controls in domestic refrigerators, and the disastrous explosions which have occurred. Whetstone⁽³⁾ reports an explosion where the refrigerator contained hydrogen peroxide, ether and a catalysed ethylene oxide condensation. In this case it was presumed that the condensation mixture heated spontaneously and produced an explosive ethylene oxide-air mixture which was ignited by live electric contacts within the cold compartment.

A recent explosion in the laboratory of a local hospital provides yet another reminder of these hazards. About 4 a.m. of 18 April a powerful explosion occurred in a 10 cubic foot upright home freezer unit, bulging out all faces of the unit (see photograph) and hurling the door across a corridor and through the wooden door of the room opposite. Fortunately none of the staff was involved but considerable secondary damage was caused by the dislodgement of chemicals and glassware from shelves in the vicinity.

The unit was about two-thirds full of pathological specimen bottles and jars, very few of which were actually broken by the explosion, and also contained some dead rats. The rats had been anaesthetized, killed and were being stored in the freezer pending collection for incineration; the method of anaesthetizing was by pouring a few millilitres of ether on a cotton wool pad in a jar. The dead rats, some with their cotton wool pads, had been wrapped in polythene and then in brown paper.



It is thought that, during the night, residual ether in the rats and their wrappings evaporated until the ether concentration in the limited volume of free air reached an explosive level. Calculation indicates that only about 5 grams of ether would be sufficient to reach this explosive level and it was considered that between 2 and 3 millilitres of ether were used for the anaesthesia of each rat. This explosive mixture was apparently ignited by the thermostat switch inside the control knob on the inside wall of the unit. The control knob was found loose in the unit and the live make-and-break contacts on a similar unit were found to produce sparks in normal operation.

It is felt that the danger of such an explosion in what is probably regarded in most laboratories as a perfectly safe piece of domestic equipment should be emphasised and where there is an unavoidable risk of explosive vapours in an enclosed space such as a refrigerator or oven, particular care should be taken to ensure that thermostat contacts are located outside any possible danger area. Yours faithfully,

D. Bradwell,

Chemistry Division, D.S.I.R., Auckland.

References

(1) Manufacturing Chemists Association, 1954: "Guide for Safety in the Chemical Laboratory" (Van Nostrand, New York) p. 21.
(2) Anon., J. Chem. Education *44*, A321-2 (1967).
(3) J. Whetstone, Chem. and Ind., *1960*, 686.

RETIREMENT OF MR. P. J. C. CLARKE, F.N.Z.I.C.

Deputy-Director and Dominion Analyst, Chemistry Division, D.S.I.R.

In April 1969 the Dominion Analyst, Mr. P. J. C. Clark, retired from the Chemistry Division of D.S.I.R. after 43 years of service in the laboratory. He joined the staff of Chemistry Division (then Dominion Laboratory) on 15 January 1926. This was at a time when few of the laboratories existing today had been founded.

When Mr. Clark began work as a chemist, the Chemical Research Laboratory at Teddington was only a year old, and Battelle Memorial Institute had been established only two years earlier. CSIRO in Australia had not then been established; it started in 1926, the same year as the New Zealand Department of Scientific & Industrial Research.

Laboratories like the United Kingdom Road Research Laboratory and the Forest Products Research Laboratory still lay in the future. Even some of the laboratories that we now think of as household words lay so far in the future that their existence could hardly have ben predicted; laboratories such as Euratom, Harwell, Brookhaven, Armour Research Foundation and the Central Research Laboratories of AEI.

Mr. Clark entered a laboratory that already had a proud tradition of accuracy in analysis and virtuosity in research. Only two years before he was appointed, the laboratory had examined the corrosion of brass sheathing of piles in the Hutt estuary, correctly identifying the cause as concentration cell corrosion caused by differential salinity, as the waters of the Hutt river passed over the top of the salt water in the harbour. Mr. Clark carried on both of these traditions.

When he joined Chemistry Division it had a staff of twenty-one. Over the 43 years the staff has increased up to ten times this figure. When Mr. Clark began work he received a salary of $160 a year, and during his service this has increased more than fortyfold!

Early in his career he recognised the chemical problems that lay in insecticides, he saw the problems that were going to arise, and he worked to see that formulations were developed that would have a maximum toxicity to pests and a minimum toxicity to humans. He realised that overseas agricultural research could not be simply translated to New Zealand conditions, owing to differences in agricultural practices and climate. He built up collaboration between Chemistry Division and the agricultural and biological divisions of DSIR, and the Department of Agriculture.

Mr. Clark established a sound reputation as a scientist in his chosen field of work, and he collaborated with others. Many of his published papers have been co-authored with someone from another laboratory. His first scientific publication was in 1933, on the particle size of lead arsenate sprays. This paper demonstrates his skill as a laboratory worker and shows a painstaking attention to detail to get the curve from which the particle size distribution could be calculated.

The other great enthusiasm of Mr. Clark has been forensic science. The New Zealand police have made an ever-increasing use of science in their work, and to a great degree this has been the result of contact with men like Mr. Clark, who demonstrated their ability to evaluate the significance of evidence, to explain their findings to the police, and to defend the findings under cross-examination in court.

Mr. Clark has given lectures at police training schools and to senior police officers to ensure that the force has an understanding of what science can do, and to build up a close liaison between the Police Force and DSIR.

One forensic issue in which Mr. Clark has been deeply involved is the drinking-driver problem. He played a significant part in providing the technical advice on which the present legislation is based.

His great strength as a forensic investigator is that he has never aligned himself with the police, nor considered that he should produce scientific evidence to support an official theory; he has always seen his job to be the scientific evaluation of evidence, no matter what conclusion it led to. This has been the administrative strength of maintaining a forensic laboratory independent of the police force.

In addition to his chemical interests Mr. Clark has had an extensive career outside of the laboratory, both as a local preacher for his church and as a local councillor. He was a key figure in the battle which Tawa waged to avoid amalgamation with the surrounding local bodies.

IAN K. WALKER, D.Sc. (N.Z.),
Director, Chemistry Division, DSIR.

BRANCH NOTES

WELLINGTON

Chemistry Division

Dr. A. J. Ellis was recently elected to the Fellowship of the Royal Society of New Zealand by its Annual General Meeting of Fellows.

The laboratory enjoyed a visit from Professor R. L. Scott, University of California, on 11 June. Professor Scott, at present on sabbatical leave at the University of Otago, delivered a lecture on recent work in the field of the heats of mixing of binary non-electrolyte solutions.

New equipment includes a Toshiba X-ray Generator which Dr. P. P. Williams has already put to use on single-crystal work, and a Northern Precision Flash Photolysis unit which is under the charge of Dr. G. J. Leary.

Mr. R. Norris, an M.Sc. graduate of Auckland University, has joined the Toxicology Section.

Institute of Nuclear Sciences

Professor A. Longinelli from the University of Pisa joined the Institute as a visiting scientist in January. His chief interest is in Isotopic Geology and he will attend a symposium on this subject in America on his way back to Italy in July.

Dr. G. B. Taylor returned to the staff of the Institute in June after four years' study overseas. His thesis for the degree of Dr. Rer. Nat. at Heidelburg University dealt with isotopic studies of water in the troposphere.

Soil Bureau

Mrs. M. R. Kampjes (née Thomson) is now doing a Ph.D. in the Applied Biochemistry Department at Nottingham University.

Victoria University

Dr. J. T. Craig will spend the period from August 1969 to April 1970 on sabbatical leave at the University of Melbourne, working with Dr. Q. N. Porter on the chemistry of some polynuclear heterocyclic compounds.

OVERSEAS

The President of the Institute of Paper Chemistry at Appleton, Wisconsin, announced in May 1969 that Dr. G. A. Nicholls had been promoted to Senior Research Associate, the Institute's highest rank, and would now hold a Professorship as a member of the Institute's faculty.

Professor R. D. Topsom, Dean of the School of Physical Sciences, La Trobe University, Melbourne, leaves in August on a year's sabbatical leave which he will spend at the University of California, Irvine, Victoria University, British Columbia, Cornell, Harvard and Connecticut. He will then spend several months at the University of East Anglia, Norwich, to have discussions on further developments of a programme of research work being jointly conducted with Professor A. R. Katritsky.

NOTICE OF MEETING

□

N.Z.I.C.

ANNUAL GENERAL MEETING

□

Thursday, August 28

11.00 a.m.

Dunedin

E. Harvey,
Secretary.

THE NEW ZEALAND INSTITUTE OF CHEMISTRY (INC.)

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 30th APRIL, 1969

1968 $	*EXPENDITURE*	$	$
	Administration Expenses		
975	Printing, Stationery, Postages, Tolls, etc.	1005.29	
625	Travelling Expenses	1007.95	
560	Salary, Registrar	627.50	
440	Branch Expense Allowances	440.00	
210	Honoraria (*Less* proportion charged to Journal)	200.00	
	Royal Society of New Zealand:		
—	Donation	100.00	
—	Membership Fee	20.00	
80	Audit Fees	127.00	
18	Depreciation	23.40	
—	Donation—S.A.N.Z.	50.00	
(2908)			3301.14
3159	Cost of Journal	3617.15	
1963	*Less* Revenue from Advertising ...	2367.26	
(1196)			1249.89
50	Prize—Conference Student	25.00	
—	"Careers in Chemistry" publication	1000.00	
—	"List of Members" publication ...	556.59	
—	Sundry publications	59.14	
			1640.73
2292	Excess of Income over Expenditure for year		152.65
$6446			$6644.41

1968 $	*INCOME*	$	$
6148	Subscriptions—Annual	6384.43	
11	Proportion Compound Subscriptions	4.44	
(6159)			6388.87
	Interest Received		
46	Bank of New Zealand	74.90	
181	Local Body Stock	180.64	
(227)			255.54
60	Surplus, Distribution of Publications		—
$6446			$6644.41

OVERSEAS VISITORS TRAVELLING FUND

$		$
100	Travelling Expenses paid during year	406.60
300	Balance, 30/4/69	—
$400		$406.60

$		$
—	Balance, 30/4/68	300.00
400	Received from General Fund	—
—	Conference Profit	73.24
—	Balance, 30/4/69	33.36
$400		$406.60

THE NEW ZEALAND INSTITUTE OF CHEMISTRY (INC.)

BALANCE SHEET AS AT 30th APRIL, 1969

1968			
$	*CURRENT LIABILITIES*	$	$
159	Sundry Creditors	105.00	
267	Subscriptions Received in Advance ...	362.70	
400	Royal Institute of Chemistry Funds held in Trust	400.00	
(826)	*Total Current Liabilities*		867.70
	SPECIAL FUNDS		
4	Compounded Subscriptions	—	
150	Education Fund	150.00	
300	Overseas Visitors Travelling Fund ...	33.36	
(454)			116.64
	TRUST FUND		
	Balance, 31/4/68	2582.57	
	Plus Interest Credited	2.67	
2583			2585.24
	ACCUMULATED FUNDS		
	Balance, 30/4/68	3822.54	
	Excess of Income over Expenditure for year	152.65	
3822			3975.19
$7685			$7544.77

1968				
$	*CURRENT ASSETS*		$	$
17	Petty Cash Funds		12.32	
2837	Bank of New Zealand		2731.57	
	Subscriptions in Arrears	809.90		
	Less Provisions for overdue Subscriptions	100.00		
517			709.90	
221	Sundry Debtors		279.32	
357	Publication on Hand		91.42	
80	Advance—Conference		40.00	
(4029)	*Total Current Assets*			3864.53
	TRUST FUND INVESTMENTS AT COST			
82	Post Office Savings Bank		85.24	
1000	Hutt County Council, Redemption Loan		1000.00	
1500	Lyttelton Harbour Board Stock ...		1500.00	
(2582)				2585.24
	GENERAL FUND INVESTMENT			
1000	North Canty. Hospital Board Stock			1000.00
	FIXED ASSETS AT COST			
	Office Equipment	241.90		
	Plus Office Cabinet ...	44.40		
		286.30		
	Less Depreciation	193.30		
72			93.00	
	Addressograph Plates ...	62.35		
	Less Depreciation	60.35		
2			2.00	
(74)	*Total Fixed Assets*			95.00
$7685				$7544.77

AUDITOR'S REPORT

We have audited the books of the New Zealand Institute of Chemistry (Inc.) for the year ended 30th April, 1969, and have received all the information and explanations we have required. In our opinion, according to the best of our information and the explanations given to us as shown by the books of account, the Balance Sheet, Income and Expenditure Account, and Trust Fund Account are properly drawn up so as to give a true and fair view of the state of the Institute's affairs as at 30th April, 1969.

SHANAHAN AND WINDER,
Public Accountants.
(Signed) M. P. WINDER, Auditor.

UNIVERSITY OF OTAGO DUNEDIN, NEW ZEALAND

LECTURER IN APPLIED CHEMISTRY

Applications are invited for a Lecturer in Applied Chemistry. Experience in industry and/or in chemical engineering is desirable.

Salary Scales: Under review. For 1969, the rates are as follows:
Lecturer: $3,100 x $200 — $4.700 x $100 — $4.800 per annum.
Senior Lecturer: $4,700 x $200 — $5,500 per annum; thereafter a range of salaries up to $6,600 per annum.

Further particulars are available from the undersigned. Applications close on **30 September, 1969.**

J. W. HAYWARD, Registrar.

UNIVERSITY OF OTAGO DUNEDIN, NEW ZEALAND

TECHNICAL CONSULTANT
DEPARTMENT OF MINERAL TECHNOLOGY

Applications are invited for the position of Technical Consultant in the Department of Mineral Technology, within the Faculty of Science.

Applicants should be qualified in the field of analytical inorganic chemistry, including X-ray and atomic absorption techniques and have a knowledge of minerals. An appreciation of the methods of mineral processing would be an advantage. The commencing salary will be in the range $4,000 to $5,000 per annum in accordance with qualifications and experience.

Further particulars are available from the undersigned. Applications close on **30 September, 1969.** J. W. HAYWARD, Registrar.

SCIENTIST

CHEMISTRY DIVISION, D.S.I.R., LOWER HUTT

Salary up to $5430 according to qualifications and experience. Further advancement on scientific merit. Appointee will undertake research into the chemistry of wines and fruit juices, and assist with the general work of the Food and Drugs Section.

Applications close on Monday, August 25, with the Secretary, State Services Commission, Box 8004, Wellington. Applicants should preferably use Form PS17A obtainable from Post Offices and should enclose copies only of testimonials and quote vacancy number 2951. Assistance towards expenses will be given to a married man required to move his household.

SHELL OIL NEW ZEALAND LIMITED

Staff appointments

At the end of this year Shell will be offering employment to men (or women) with degrees in Chemistry, Civil or Mechanical Engineering, Agricultural Science and Commerce. There may be also a few opportunities for graduates in other subjects, e.g. Economics, Law or Arts.

POSITIONS AVAILABLE

Most of the graduates will initially be stationed in Wellington. Each man is appointed as soon as possible to a position best suited to his qualifications, talents and interests and he is asked to follow a planned programme to enable him to use all his knowledge and ability at an early opportunity. The work is accepted as qualifying for corporate membership of professional Institutions or Societies.

Chemists will begin in the Central Laboratory on product development and testing, technical service, and the supervision of quality control, and may also be employed in chemicals marketing.

Engineers are responsible for design,development, construction and maintenance of oil storage facilities, processing plants, buildings, pipelines and road tankers.

Agricultural Science graduates are appointed to the Shell farm trade organisation, acting as specialist advisers on the marketing, development and application of chemicals for agricultural purposes.

Commerce graduates are employed primarily in finance, where the responsibilities include quarterly accounts, treasury, taxation, credit, investment, audit, payroll, costing, budgets and management accounting.

Data Processing with a Systems 360 60 IBM computer also offers a field for graduates with the necessary aptitudes for systems analysis, programming, operational research, etc.

ADVANCEMENT

As well as specialising initially in work for which he is qualified the graduate will be trained to take a comprehensive view of Shell activities generally.

The Shell group of companies, which is international in character, scope and shareholding, is engaged in New Zealand and throughout the world in two industries, petroleum and chemicals. Both are growing in volume and complexity and show ample prospect of development in the future.

Shell Oil New Zealand Limited is staffed by New Zealanders, of whom the most able may be eligible for promotion to senior positions overseas. With individual recognition, supervision and guidance each graduate is encouraged to progress towards the most senior position he is capable of filling. His own efforts towards self development may be aided in several ways, including overseas training for the most promising men.

SALARIES

Young graduates have a special salary scale and it is Shell's policy to offer salaries and conditions of employment (including retirement benefits) at least comparable to those offered by other large firms.

VACATION EMPLOYMENT

A few vacation jobs will also be available in Wellington next summer for students now in their second to last year of a degree course in Engineering, Commerce or Chemistry. No unusual obligations are imposed but preference will be given to men seriously interested in the eventual prospect of a Shell career.

ENQUIRIES

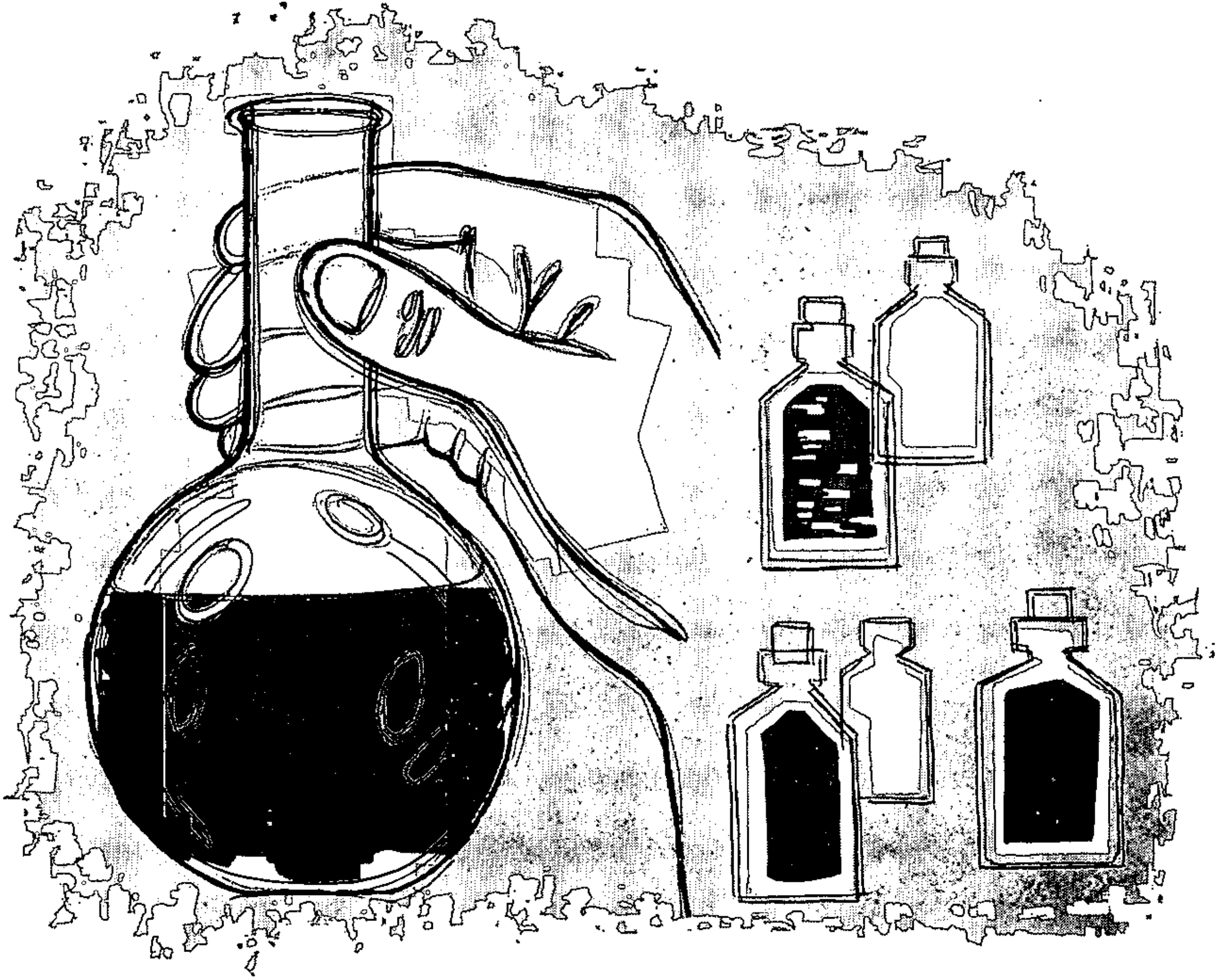
More detailed information is available in the booklet "A Guide to graduate employment with Shell Oil New Zealand Limited". Copies of this booklet are available from the University, or Shell Oil New Zealand Limited

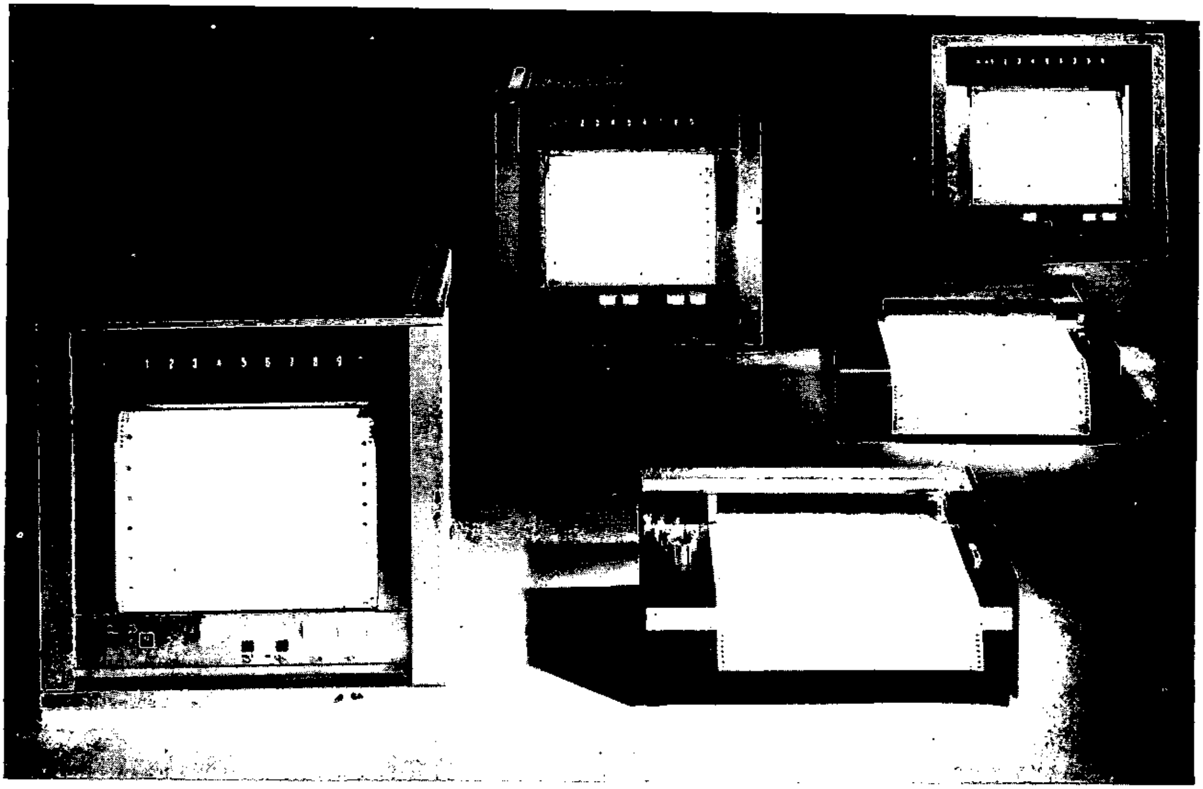
Interviews can be arranged to suit any students who may be interested.

Enquiries may be addressed to:
The Staff Manager, Shell Oil New Zealand Limited,
Shell House, The Terrace, PO Box 2091, Wellington. Telephone 45-060.

or Shell House, Albert Street, PO Box 1084, Auckland. Telephone 78-800

or St. Elmo Courts, Hereford Street, PO Box 2095. Christchurch. Telephone 62-939.





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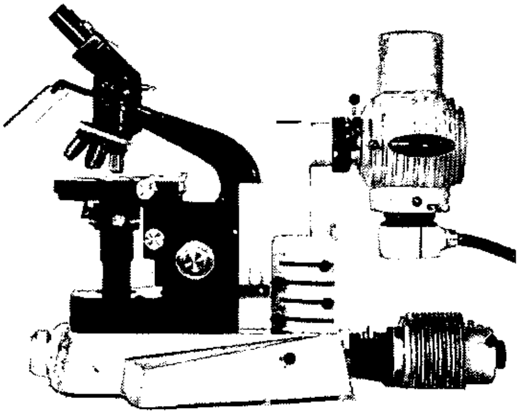

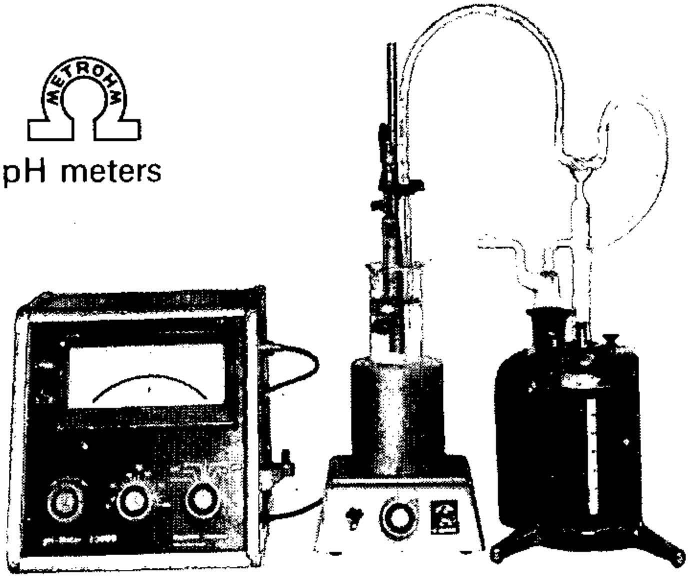

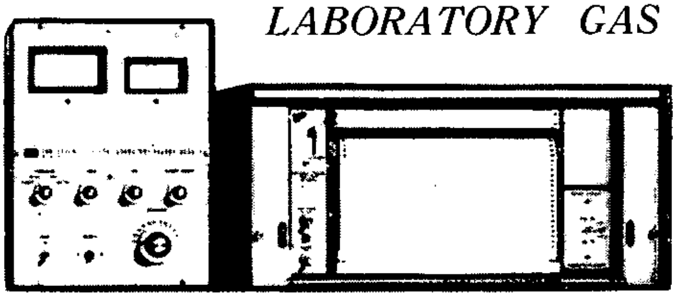

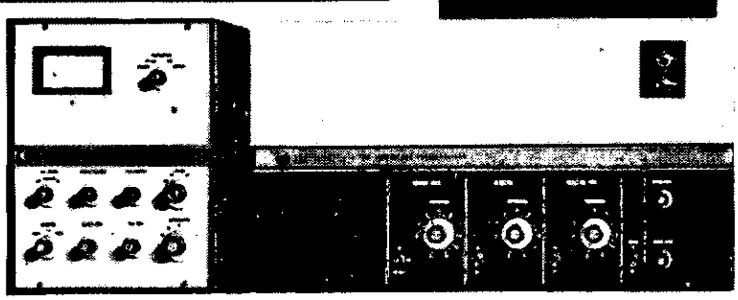


NEW
Gallenkamp
FLASK SHAKER

What difference does a balance error of 0.001 gram make?

Balance errors can be avoided today. Mettler guarantees the reproducibility of the measurement results and the accuracy of the weight indication on its balances. In the ultra micro range up to ± 2/10,000,000 g.

Until Mettler constructed the first single-pan substitution balance in 1946, people had to accept (or had been accepting) the inherent errors of the two-pan balance for 6,000 years. Even the first Mettler balance had an accuracy of ± 1/10,000 g.

Then the Mettler research department (120 men) battled against those errors which occur when weighing in the range of hundred thousandths and millionths of a gram.

In order to eliminate these insidiously tiny errors, a few dozen inventions were necessary. For example: we found a way to produce scales on which the scale divisions have an accuracy of position in fractions of 1/1000 mm. We invented the ring weights which are supported completely symmetrically and do not oscillate.
We developed an electrochemical treatment for the surfaces of the weights so that dust particles cannot settle on them. To our way of thinking, a few particles of dust weighing one millionth of a gram would be intolerable.

The Mettler researchers have also eliminated subjective weighing errors. The Mettler level-matic compensates automatically slight changes in balance level. The rapid and fine taring simplifies operation. The compact digital indicator makes reading errors almost impossible. For those who are scared of reading errors, the printer, which prints out the result to five decimal places, is available. Or they can combine a Mettler with a recording device or computer.

For a while, our researchers were somewhat disturbed because they had mastered errors in determining weight.

However, they are very satisfied again today because they have discovered many sources of error in the methods of thermal and volumetric measurement.

Almost as many as there were in 1946 with the old two-pan balance.

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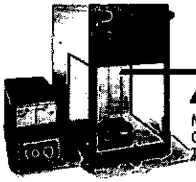

Mettler
Mettler Instrumente AG
CH-8606 Greifensee-Zürich, Switzerland
Tel. 051 87 63 11

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