

# JOURNAL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

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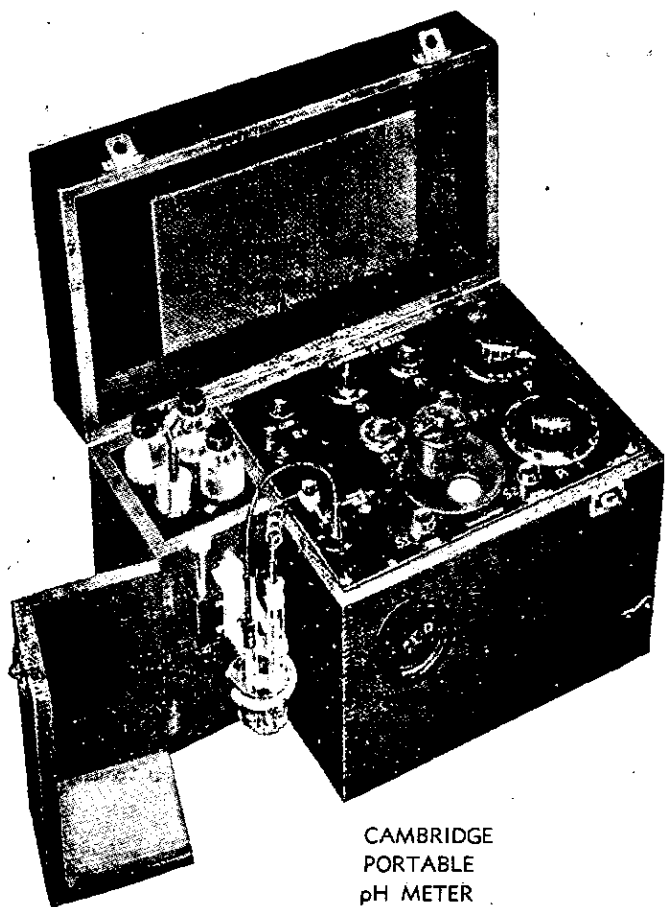
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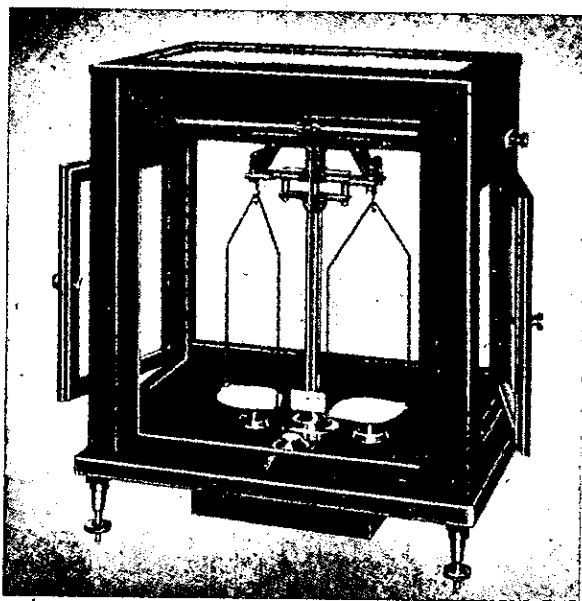
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## A.N.Z.A.A.S. CONFERENCE, BRISBANE, 1951.

The next Conference of the Australian and New Zealand Association for the Advancement of Science is to be held in Brisbane from May 23rd—May 30th, 1951, and the Chemistry (B) Section will meet in the Chemistry Department of the University of Queensland at St. Lucia.

Contributions in all branches of Chemistry, including Industrial Chemistry and Chemical Engineering, are invited for presentation to Section B. Titles and brief outlines (which will be treated as confidential) of proposed papers should be forwarded by the 30th September, to—

Maurice D. Sutherland,  
Secretary to the Chemistry (B) Section,  
Chemistry Department,  
University of Queensland.

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## STOP PRESS

### CONFERENCE BOOKLET.

Those members of the 1950 Conference who have paid their Conference fee will receive their receipts, together with the Conference booklet containing announcements, summaries of papers, programmes and lists of Conference members, through the post at least a week before the Conference commences.

Although 176 members have registered, only 110 have so far forwarded the Conference fee!

### HOW ABOUT YOUR £1?

Make it go further by sending it at once to the Conference Secretary, Box 1290, Christchurch, and please add exchange to cheques.



CONFERENCE COMMITTEE, CHRISTCHURCH, 1950.

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CONFERENCE, 1950.

Christchurch

August 22-August 25.

**PROGRAMME.**

The conference proper will be preceded by a meeting of the Council of the N.Z.I.C. on Monday, 21st August.

**TUESDAY, 22nd.**

Enrolments.

**MORNING.** 10.30 a.m.: Official Opening. Announcements.

**AFTERNOON.** 2.30 p.m.: Session—AGRICULTURAL CHEMISTRY.

Chairman—DR. M. M. BURNS.

Paper No. 1. The Properties and Use of South Island Agricultural Limestones.  
B. L. Elphick, Lincoln College, Christchurch.

" " 2. The Utilization of Applied Phosphate on Two Soil Types.

Dr. E. B. Davies and F. D. Dorofaeff, Galloway Laboratories,  
Hamilton.

" " 3. Liming and Trace Elements.

W. B. Healy, Soil Bureau, Wellington.

" " 4. Boron and other Minor Elements in Relation to Growth of  
Raspberries.

Dr. H. O. Askew, Cawthron Institute, Nelson.



This session will be run concurrently with—

**AFTERNOON, 2.30 p.m.:** Session—**PHYSICAL & STRUCTURAL CHEMISTRY**  
Chairman, DR. C. J. WILKINS.

- Paper No. 5. The Distribution of Ions between Miscible Solvents.  
Dr. H. N. Parton, Canterbury University College.
- " " 6. The Solubility of the Inert Gases.  
A. J. Beckwith, Canterbury University College.
- " " 7. A Test of the Modern Theory of Solids, applied to Graphite.  
M. T. Christensen, Canterbury University College.
- " " 8. The Physical Chemistry of the Flotation of Feldspar and Quartz.  
J. Rogers, School of Mines, Dunedin.

Times for both sessions—

Papers .....	2.30-3.40	Paper: 25 minutes.
Tea .....	3.40-4.05	Discussion 10 minutes per paper.
Papers .....	4.05-5.15.	

**EVENING, 8.00 p.m.:** PRESIDENTIAL ADDRESS (N.Z.I.C.)

DR. J. MELVILLE.  
SOME ASPECTS OF PHOTOSYNTHESIS.

**WEDNESDAY, 23rd.**

**MORNING, 9.30 a.m.:** Session—**AGRICULTURAL & BIOLOGICAL CHEMISTRY.**  
Chairman—PROF. I. E. COOP.

- Paper No. 9. Soil Moisture in its Relation to Pasture Growth.  
Dr. H. E. Annett, Department of Agriculture, Hamilton.
- " " 10. The Application of Bio-assay Methods to Soil Research.  
A. C. S. Wright, Soil Bureau, Wellington.
- " " 11. The Chemistry and Pharmacology of the Posterior Pituitary Gland. (With special reference to milk ejection activity.)  
W. G. Whittlestone, Ruakura Animal Research Station, Hamilton.
- " " 12. The Isolation of Photosensitizing Factors from *Panicum miliaceum* (Broom corn millet).  
D. S. Letham and N. T. Clare, Galloway Laboratories, Hamilton.

This session will be run concurrently with—

**MORNING, 9.30 a.m.:** Session—**INDUSTRIAL PROCESSES UTILIZING ORGANIC MATERIALS OF NEW ZEALAND ORIGIN.**

Chairman—P. R. PARR.

- Paper No. 13. By-products of the Dairy Industry.  
N. W. Vere-Jones, Dominion Laboratories, Wellington.
- " " 14. Furfural; Potential Uses and Possible Manufacture in New Zealand.  
H. A. L. Morris, Dominion Laboratory, Dunedin.
- " " 15. The Stearic Acid Industry in New Zealand.  
L. Hartman, Fats Research Laboratory, Wellington.
- " " 16. The Rheology and Microscopic Structure of Butter.  
Dr. R. M. Dolby, Dairy Research Institute, Palmerston North.

Times for both sessions—

Papers .....	9.30-10.40	Papers, 25 minutes.
Tea .....	10.40-11.05	Discussion 10 minutes per paper.
Papers .....	11.05-12.15	

**AFTERNOON EXCURSIONS.**

It is hoped to run excursions to—

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**EVENING: SOCIAL EVENING, 8.00 p.m.**

This notable function will be held in a setting unique in New Zealand, the famed "Sign of the Takaha." Accommodation is limited, so get your reservation in as soon as you arrive at the Conference.

**THURSDAY, 24th.****MORNING, 9.30 a.m.: Symposium—ISOTOPES.**

Chairman—Dr. A. J. Campbell.

Introduction.	Chairman	—	—	—	—	—	9.30-9.40 a.m.
Paper No. 17.	The Use of Isotopes in Biochemistry	—	—	—	—	—	9.40-10.25 a.m.
	Prof. N. L. Edson, Medical School, University of Otago.						
"	"	18.	The Control of Health Hazards from Radioactive Materials.	—	—	—	—
	H. Yeabsley, Dominion X-Ray and Radium Laboratory, Christchurch						
							10.25-10.55

**MORNING TEA, 10.55-11.15.**

"	"	19.	The Planning of a Radiochemical Laboratory	—	—	—	11.15-11.35
	T. Rafter, Dominion Laboratory, Wellington.						
"	"	20.	The Techniques of Radioactive Measurement	—	—	—	11.35-11.55
	G. J. Fergusson, Dominion Physical Laboratory, Wellington.						
"	"	21.	The Mass Spectrometer and its Uses in Chemistry	—	—	—	11.55-12.15
	G. Page, Dominion Physical Laboratory, Wellington.						

Discussion on all papers at 12.15.

**AFTERNOON: GENERAL MEETING** of 1. Royal Institute of Chemistry, 2.00 p.m.  
2. N.Z. Institute of Chemistry, 3.00 p.m.

**EVENING FREE.** (What a relief!) The Centennial Industries Fair will be open over the Conference period.

**FRIDAY, 25th.****MORNING, 9.30 a.m.: Session—ANALYTICAL CHEMISTRY.**

Chairman—N. T. Clare.

Paper No. 22.	The Determination of Radio-Phosphorus.	—	—	—	—	—	—
	F. D. Dorofaeff, Galloway Laboratories, Hamilton.						
"	"	23.	Some Observations on the Ellis, Matrone and Maynard Method of Estimating Lignin.	—	—	—	—
	Miss M. P. Bartrum, Galloway Laboratories, Hamilton.						
"	"	24.	Concentration Methods in Spectrochemical Analysis.	—	—	—	—
	H. P. Rothbaum, Dominion Laboratory, Wellington.						

**MORNING TEA: 11.00-11.20.**

Paper No. 25.	Hydroxyamidines as Chelating Reagents for Metals.	—	—	—	—	—	—
	Prof. L. H. Briggs, Auckland University College.						
"	"	26.	The Determination of Tin in Alloys by the Meta-stannic Acid Method.	—	—	—	—
	G. S. Lambert, Hayes' Metal Refineries, Auckland.						

**AFTERNOON, 2.30 p.m.:** PRESIDENTIAL ADDRESS. R.I.C.

DR. C. R. BARNICOAT.

THE BIOLOGICAL SIGNIFICANCE OF THE METALS.

This will be followed by afternoon tea and a brief closing ceremony.

## SOME ASPECTS OF THE ELECTRO-DEPOSITION OF METALS

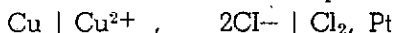
By H. BLOOM, Ph.D. (London), M.Sc. (Melb.), D.I.C., A.R.A.C.I., A.N.Z.I.C.,  
Chemistry Department, Auckland University College

It is proposed in this article to give a brief account of the theoretical principles underlying electrolysis and to illustrate these principles by considering two practical aspects:—

(a) electroplating, and

(b) electrolytic extraction of elements from their fused salts.

Under normal conditions of current density, decomposition of an electrolyte, whether it be an aqueous solution or a molten salt, will be governed by Faraday's laws. On increasing from zero the potential applied across two electrodes, e.g., of platinum dipping into an electrolyte, a characteristic curve of current against potential is always obtained. At zero applied potential no current flows but as the potential is increased a very small fairly constant current flows until a certain critical voltage known as the **decomposition potential** is reached. The current then rises steeply for a small increase of applied potential, current now being proportional to potential applied. In this region electrolytic conduction takes place; the metal of the electrolyte being deposited at the cathode and the non-metal at the anode, as the primary reactions. The decomposition potential is thus the lowest applied potential which will cause electrolysis. It varies for different electrolytes and may be calculated exactly for a particular solution (under ideal conditions). As an example we may take the electrolytic decomposition of copper chloride solution using platinum electrodes. As soon as electrolysis commences, the cathode begins to become covered with copper and the anode with chlorine. We therefore have a voltaic cell which can be represented as



This cell will have an e.m.f. in the opposite direction to the applied potential, hence the observed minimum critical voltage which must be exceeded in order that electrolysis may take place. In normal  $\text{CuCl}_2$  solution the e.m.f. of the above cell

is (neglecting polarization) 1.02 volt (the chlorine being positive). Thus it can be seen that no electrolysis will take place until the applied potential is at least equal to the e.m.f. of the cell composed of the decomposition products, i.e., 1.02 volt, which is the theoretical decomposition potential of the  $\text{CuCl}_2$  solution.

If the cell behaves ideally, it would be simple to calculate the minimum potential which must be applied in order that electrolysis may take place. The electrode potential  $\Pi_1$  of a metal in a solution of a salt of the metal is given by the equation

$$\Pi_1 = \Pi_1^\circ + \frac{RT}{z_1 F} \ln \alpha_1$$

where  $\Pi_1^\circ$  is the standard electrode potential i.e. the potential when the activity  $\alpha_1$  of the metal ion is unity.

$z_1$  is the valency of the metal

$F$  is the Faraday (96,500 coulombs)

$T$  is the absolute temperature

and  $R$  the gas constant (8.31 joules)

$\ln$  is as usual log to the base  $e$

=  $2.303 \log_{10}$

For a non-metal in a solution of one of its salts, the corresponding electrode potential  $\Pi_2$  is given by

$$\Pi_2 = \Pi_2^\circ - \frac{RT}{z_2 F} \ln \alpha_2$$

where  $\Pi_2^\circ$  is the standard potential of the non metal  
 $z_2$  its valency and  $\alpha_2$  the activity of its anion.

The e.m.f.,  $E$  of the cell formed will be

$$E = \Pi_2 - \Pi_1 = (\Pi_2^\circ - \Pi_1^\circ) - \frac{RT}{F} \ln (\alpha_1)^{1/z_1} (\alpha_2)^{1/z_2}$$

$$\therefore E = (\Pi_2^\circ - \Pi_1^\circ) - 0.05916 \log_{10} (\alpha_1)^{1/z_1} (\alpha_2)^{1/z_2}$$

as the value of  $2.303 RT$

$$\frac{RT}{F} = 0.05916 \text{ at } 25^\circ \text{ C.}$$

The values of the standard electrode potentials  $\Pi^\circ$  are known—hence it is possible to calculate the theoretical decomposition potential for any electrolyte at any activity required. In dilute solution concentration can be used instead of activity; otherwise the concentration must be multiplied by the activity coefficient (known for each electrolyte) to get the activity.

Calculation of decomposition potential on the above basis for, say, copper chloride gives in general a value lower than the potential actually necessary to decompose the electrolyte, because electrode polarization has taken place and to overcome it, the applied potential must be greater than the calculated opposite e.m.f. of the cell by a small amount known as the **overpotential**. The values of overpotential can be measured for various electrodes, different solutions and varying concentrations at different current densities. To get the true decomposition potential the appropriate value of the overpotential is added to the calculated e.m.f. of the cell.

In the practice of electroplating and the electrolytic extraction of elements it is customary to apply a potential sufficient to cause the required current to flow; e.g., if it is found empirically that a current density of 0.3 amp. per sq. dm. gives the best results in silver-plating, the applied potential is adjusted until this current density is maintained.

Some values of decomposition potentials are shown in tables I and II.

TABLE I

Decomposition potentials of electrolytes.  
Normal solutions—Platinum electrodes.

Electrolyte.	Decom. Pot. Volts.	Electrolyte.	Decom. Pot. Volts.
CdSO <sub>4</sub>	2.03	AgNO <sub>3</sub>	0.70
CaCl <sub>2</sub>	1.89	Na <sub>2</sub> SO <sub>4</sub>	0.71
CoCl <sub>2</sub>	1.78	NaCl	1.98
CuSO <sub>4</sub>	0.80	KOH	1.67
Pb(NO <sub>3</sub> ) <sub>2</sub>	1.52	NaOH	1.69
NiSO <sub>4</sub>	2.09	ZnSO <sub>4</sub>	2.55
K <sub>2</sub> CO <sub>3</sub>	1.74	H <sub>2</sub> SO <sub>4</sub>	1.67
KCl	1.96	CH <sub>3</sub> COOH	1.57

Table II

Decomposition potentials of molten electrolytes.

Electrolyte.	Temperature °C	Decomposition Potential Volts.
BaCl <sub>2</sub>	650	3.05
CaCl <sub>2</sub>	585	2.85
NaCl	800	2.65
LiCl	800	2.39
KCl	800	2.8
KOH	200	2.4
KOH	530	1.8

Overpotential is very important in industrial processes, e.g., the standard electrode potential\* of zinc in a solution of its ions (at unit activity) is  $-0.76$  volt; i.e., zinc will be deposited by electrolysis of its normal solution at a voltage of  $0.76$  more negative than the voltage required to deposit hydrogen from a normal solution of hydrogen ion. It would therefore appear that in an acidified zinc sulphate solution it would be impossible to deposit zinc at the cathode, as on making the cathode potential more negative hydrogen ion would be discharged first. However, the overpotential of hydrogen on zinc is quite considerable (about  $0.8$  volt), hence zinc plates out before hydrogen is liberated.

### **Electroplating.**

The practice of electroplating is complex and many of the factors have been found by empirical means. It will be possible in this article only to give a very brief resume of two electroplating processes.

Initially, the article to be plated must be thoroughly cleaned—usually by using organic solvents, alkaline solutions, detergents or electrolytically by making the article to be cleaned the cathode in a tank containing an alkaline solution. Scale due to metal oxides is removed by "pickling," or by electrolysis in a hot solution of sulphuric acid. In the actual electroplating step, the nature of the deposit is controlled by current density, temperature, concentration, agitation, pH and "addition agents" which are substances added to the bath in addition to the main constituents whose functions are understood. Addition agents are usually colloids or reducing agents; e.g., glue, glucose, peptone, carbon disulphide, sodium thiosulphate, sodium formate, etc. The control of pH is very important and the solutions are often buffered. Solutions may be acid or alkaline, according to the metal and deposit required.

In copper plating acid or alkaline baths can be used. An acid is, however, not suitable for plating directly on to iron or metals above iron in the electromotive series, as the metal will dissolve. An acid copper bath consists essentially of copper sulphate and sulphuric acid, the latter being added (a) to prevent hydrolysis of copper salts which would produce basic salts,

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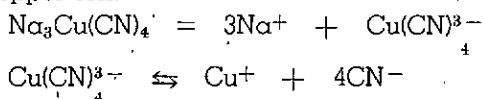
\* **Standard electrode potential** is defined as the potential of the electrode with the activity of the ion in solution equal to unity, against a hydrogen (bubbling over platinum) electrode at pressure of 1 atmosphere in a solution of hydrogen ions of unit activity; i.e. is the e.m.f. of the cell

$$M \mid M^+ (a = 1), H^+ (a = 1) \mid H_2 (1 \text{ atmos.}), Pt.$$

- (b) to increase the electrical conductivity of the bath, and  
 (c) to decrease the concentration (by the common ion effect) of copper ions without decreasing their potential supply.

Copper anodes are used, the temperature being ordinary room temperature and the current density 6-16 amps per sq. dm. In all electroplating operations it is preferable to have a low concentration of metal ions, as this will assist the production of fine-grained deposits, no one crystal being able to grow rapidly on account of the large number of ions ready to plate out on it. Small crystals produce bright deposits which are more coherent. In order to obtain low metal ion concentrations a complex salt with the metal in the anion is usually used. The solution is usually dilute, a rod of the metal being used as the anode to keep up the concentration of metal in solution.

In a complex salt, the metal in the anion is in equilibrium with a very small amount of free metal cation; e.g., in sodium cuprocyanide dissociation takes place to give sodium ions and cuprocyanide ions which are in equilibrium with a minute amount of copper ion.



The copper ions are removed by electroplating, but as fast as they disappear more are produced. In the alkaline copper plating solution there is present, in addition to sodium cuprocyanide, free sodium cyanide and sodium carbonate. Temperatures between 30° and 40°C and current densities from 0.3 to 0.5 amp per sq. dm. are used. One advantage of the alkaline copper bath is that it can be used for direct plating on to iron.

Other commonly plated metals are cadmium, gold, nickel, silver, tin, platinum, rhodium, zinc and chromium. The latter is plated from acid baths.

**Gold plating** can, by suitable adjustment of conditions, give a variety of colours and brightness. As gold is so low in the electromotive series, most other metals will displace it from solution and therefore gold plating may be carried out merely by dipping, say, a copper article into a solution containing sodium gold cyanide. The deposit is very thin but adheres well. The disadvantage of this method is that the deposit wears away quickly. To electroplate gold the complex cyanide solution is again used, the article to be plated being made the cathode while the anode consists of pure gold, graphite or stainless steel. The solution is kept alkaline by the addition

of sodium phosphate or carbonate. Varying colours may be obtained—white to red depending on composition of the bath, while green gold may be plated out if the anode is platinum or gold and silver with an electrolyte consisting of gold chloride, silver chloride and sodium cyanide.

### **Electrolytic Deposition of Elements from Fused Salts.**

Some metals are difficult or impossible to obtain by electrolysis of their aqueous solutions, as secondary reaction with the solvent, or preferential discharge of hydrogen, may take place. They are in many cases extracted by electrolysis of their fused salts. In this way it is possible to extract electrolytically Li, Na, K, Rb, Cs, Be, Mg, Ca, Sr, Ba, Ra, Al, Ce, Ti, Th, Ta, V and U. The metal is in most cases deposited as a liquid.

Fused electrolytes are essentially ionic conductors and the electrode products are usually the same as when the compound is electrolysed in aqueous solution, taking into account the fact that no water is available for secondary reactions. Proof of the ionic nature of molten salts (1, 2, 3, 4) is obtained by considering

- (a) The structure of the solid salts which are mostly ionic,
- (b) measurements of equivalent conductivities of melts and comparing them with equivalent conductivities of aqueous solutions; e.g., equivalent conductivity of NaCl solution at infinite dilution is 109 and for molten NaCl at 850°C approximately 150, and
- (c) the depression of the freezing point of molten salts by the addition of others.

All these considerations lead to the general conclusion that molten salts are completely dissociated into ions, but that strong inter-ionic attractions may occur.

The specific conductivities of ionic melts are much greater than those of the corresponding aqueous solutions (c.f. Specific conductivity of molar potassium chloride solution at 25°C is 0.11 mho and for molten potassium chloride at 800°C, 2.2 mho or 20 times as great), hence much larger currents can be used in the electrolysis of molten salts. This is a great advantage of electrolysis in the fused state over that of aqueous solutions, as it enables rapid production. The substance is kept molten by the electrical energy produced across the ohmic resistance of the melt and in practice the current density is limited to that which will just maintain a suitable temperature of the melt.

The specific conductivity  $H$  of molten salts varies with change of temperature according to the relation (1, 2, 3):



$$H = A e^{-C/RT}$$

where  $A$  is a constant for a particular substance

$C$  is the activation energy for ionic migration (also a constant for a particular substance)

$R$  is the gas constant

$T$  = absolute temperature

and  $e$  is, as usual, the base of natural logarithms.

From this relation it can be seen that the plot of  $\log H$  against  $1/T$  should be linear. This is found to be the case with most molten electrolytes. In certain instances two distinct straight lines of different slope are obtained indicating two different species of ion in the melt, one stable in the lower temperature range and the other stable in the higher temperature range.

The decomposition potentials of fused compounds always decrease with increase of temperature, as illustrated for  $KOH$  in Table II. Hence high temperatures are desirable for the electrolysis of fused compounds, but in practice any gain by using a higher temperature is more than offset by the extra wear on equipment, extra heat lost by radiation and decrease in current efficiency at higher temperatures. The optimum working temperature is near the melting point.

In the electrolysis of a single fused salt the decomposition potential is equal to the reversible e.m.f. of the cell set up by the decomposition products; e.g., in the electro-decomposition of molten lead chloride the decomposition potential would be equal to the e.m.f. of the cell  $Pb | PbCl_2 | Cl_2$ . The actual value depends on the nature of the electrodes, the electrolyte and the temperature. With mixtures of salts the e.m.f. depends on the concentration of the salt corresponding to the decomposition products at the electrodes, hence it is possible under suitable conditions to separate metals almost completely by electrolysis of mixtures of their molten salts.

### Conductivities of Mixtures of Fused Salts (1. 2. 3).

When certain salts are mixed in equimolecular proportions the conductivity of the melt is approximately equal to the arithmetic mean of the individual conductivities; i.e., there is an approximately linear relation between conductivity of the mixtures and mole fraction of each component in the melt. Examples of this behaviour, which we may term the **1st group** of mixtures, are  $AgCl - AgBr$ ,  $PbCl_2 - PbBr_2$ ,  $CdCl_2 - CdBr_2$ ,  $PbCl_2 - CdCl_2$ ,  $NaNO_3 - KNO_3$ ,  $NaCl - CaCl_2$ , and  $NaCl - BaCl_2$ . In all such cases the phase diagram of

450° C the melt of this composition would have a reasonable electrical conductivity and extraction of cadmium could proceed economically.

In the  $\text{PbCl}_2 - \text{KCl}$  system the complex ions have been shown to be  $[\text{PbCl}_3]^-$  and  $[\text{PbCl}_4]^{2-}$ , hence the same considerations can be applied to the electrolytic extraction of lead from its molten compounds.

The modern ideas of complex ion formation can be used to explain certain empirically found methods of improving the current efficiency in electrolysis of melts. Factors which have a direct bearing on current efficiency are:

(a) **Diffusion.** If the products of electrolysis dissolve in the melt they will diffuse to the other electrode and the subsequent secondary reactions will decrease the yield; e.g., sodium from the electrolysis of fused sodium hydroxide dissolves in the melt and reacts with water formed by the liberation of hydroxyl.

If the anode and cathode melts are kept separate by means of a porous partition, the current efficiency is found to approach 100%. If the anode and cathode melts are not separated by a porous partition the current efficiency will be lower and will decrease as temperature increases owing to increased rate of diffusion.

It has been found (5) that in the electrolysis of molten  $\text{PbCl}_2$  the yields of lead and chlorine are unequal, due to the absorption of chlorine by the melt. After continued operation, however, the electrolyte becomes saturated with chlorine and the yield rises to nearly that of lead. The most likely explanation of this absorption is that the chlorine goes to form  $[\text{PbCl}_3]^-$  and  $[\text{PbCl}_4]^{2-}$  complexes.

(b) There is another form of loss possible—the "metal fog" effect. In the electrolysis of molten compounds there is formed at the cathode a cloud or fog of very finely divided globules of the cathode metal. The fog is yellow or brown for lead chloride and black for silver compounds. The fog decreases the current yield very considerably although it is only present in concentrations less than 0.1%. The exact nature of the fog is not known, but such "solutions" of metals in molten salts which are known as "pyrosols" are thought to be colloidal. The addition of certain neutral salts reduces or suppresses fog formation, hence causes an increase in current efficiency during electrolysis. Such salts are  $\text{NaCl}$ ,  $\text{KCl}$ ,  $\text{BaCl}_2$  in the electrolysis of  $\text{PbCl}_2$ .  $\text{FeCl}_3$  has the opposite effect and reduces the current efficiency greatly. If the metal fog is assumed to be in equilibrium with  $\text{Pb}^{2+}$  ions the effect of adding

a salt such as KCl to the melt will be to remove  $Pb^{2+}$  ions to form the anionic complexes  $[PbCl_3]^-$  and  $[PbCl_6]^{4-}$  and hence equilibrium between lead fog and  $Pb^{2+}$  ions will necessitate the diminution of the lead fog. We would expect such a behaviour whenever a salt which can form such complexes is added to the melt.  $FeCl_3$  does not form anionic complexes containing lead and therefore does not cause removal of the lead fog. The loss of current efficiency in the presence of  $FeCl_3$  is due to continued reduction of  $FeCl_3$  to  $FeCl_2$  at the cathode and its reoxidisation at the anode.

**The anode effect** is another troublesome phenomenon occurring in the electrolytic extraction of elements from their molten compounds. During the course of electrolysis the voltage may suddenly and inexplicably increase markedly (with decrease of current) and the anode becomes covered with countless small luminous discharges. The molten electrolyte no longer wets the anode, which is now covered by a layer of gas that holds the electrolyte away. The cause of the anode effect is local overheating at the surface of the anode, by adhesion of an insoluble material or frozen electrolyte and the subsequent high electrical resistance produced.

In any practical case it is possible to apply the results of theoretical investigations to calculate the right conditions for electrolytic extraction. As an illustration a greatly over-simplified and abbreviated discussion will be given of some principles behind the extraction of aluminium. A suitable compound is the salt cryolite  $3NaF \cdot AlF_3$ . To get a lower melting point and a higher electrical conductivity pure  $Al_2O_3$  is added. The ions present are those of sodium, aluminium, oxygen (in a complex anion) and fluorine. The discharge potential of sodium ion is greater than that of aluminium ion and that of fluoride ion is greater than that of oxygen ions; hence the ions to be discharged will be aluminium and oxygen, the sodium and fluoride concentrations in the bath remaining constant. Aluminium is deposited at the cathode and  $CO_2$  is produced at the anode. When the  $Al_2O_3$  has been used up, the anode effect begins as the melting point will have increased and the solidified melt about the anode produces local overheating. More  $Al_2O_3$  is added and electrolysis proceeds. The exact composition of the melt is governed by the phase diagram between cryolyte and  $Al_2O_3$ . The composition should be close to the eutectic composition and the temperature should be sufficiently above the melting point so that the electrical conductivity of the melt will be high.

NEW ZEALAND INSTITUTE OF CHEMISTRY (INC.).

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st OCTOBER, 1949.

1948.		£	s.	d.	£	s.	d.
EXPENDITURE.							
167	To Institute Journal:	322	0	8			
10	Printing six issues	10	10	0			
21	Editor's Honorarium	20	18	2			
	Postages and Sundries				353	8	10
14	Chemists' Employment Committee				9	1	2
19	Examinations Committee				7	5	4
21	Honorarium—Secretary	26	5	0			
100	Salary—Registrar	125	0	0			
3	Audit Fee	3	3	0			
4	Branch Expense Allowances	4	0	0			
48	Typewriting and Duplicating	45	2	5			
53	Printing and Stationery	40	17	0			
28	Postages and Sundries	32	19	5			
54	Travelling Expenses	56	10	10			
15	Provision for Essay Prize	15	0	0			
9	Subscriptions Written Off				2	19	1
1	Depreciation						
	Conference:						
14	Transfer to R.I.C. (N.Z. Section)	4	5	0			
228	Excess of Income over Expenditure	98	8	1			
£809		£824	5	2			
1948.		£	s.	d.	£	s.	d.
INCOME.							
512	By Subscriptions:						
	Institute Journals:						
17	Subscriptions	24	14	0			
119	Advertising	187	12	6			
71	Refund Sales Tax						
	Chemists' Employment Committee:						
13	Subscriptions				212	6	6
15	Examinations Committee:						
	Entry Fees and Sundries				7	0	0
	Interest—Post Office Savings Bank:						
9	General Account				17	16	0
	Conference:						
50	Surplus of Receipts over Payments				21	4	9
3	Refund Food Parcels						
£809		£824	5	2			

TRUST FUND FOR THE YEAR ENDED 31st OCTOBER, 1949.

1948.		£	s.	d.	£	s.	d.
EXPENDITURE.							
167	To Institute Journal:	322	0	8			
10	Printing six issues	10	10	0			
21	Editor's Honorarium	20	18	2			
	Postages and Sundries				391	2	3
14	Chemists' Employment Committee						
19	Examinations Committee						
21	Honorarium—Secretary	26	5	0			
100	Salary—Registrar	125	0	0			
3	Audit Fee	3	3	0			
4	Branch Expense Allowances	4	0	0			
48	Typewriting and Duplicating	45	2	5			
53	Printing and Stationery	40	17	0			
28	Postages and Sundries	32	19	5			
54	Travelling Expenses	56	10	10			
15	Provision for Essay Prize	15	0	0			
9	Subscriptions Written Off				2	19	1
1	Depreciation						
	Conference:						
14	Transfer to R.I.C. (N.Z. Section)	4	5	0			
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3	Audit Fee	3	3	0			
4	Branch Expense Allowances	4	0	0			
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21	Editor's Honorarium	20	18	2			
	Postages and Sundries				391	2	3
14	Chemists' Employment Committee						
19	Examinations Committee						
21	Honorarium—Secretary	26	5	0			
100	Salary—						

THE NEW ZEALAND INSTITUTE OF CHEMISTRY (INC.).

BALANCE SHEET AS AT 31st OCTOBER, 1949.

1948.		£ s. d.		£ s. d.		ASSETS.		£ s. d.		£ s. d.		
LIABILITIES.		£ s. d.		£ s. d.				£ s. d.		£ s. d.		
61	Subscriptions Paid in Advance	67	15	10		10	Typewriter			9	0	0
4	Journal Subscriptions Paid in Advance	1	9	5			Addressograph Plates			15	0	0
33	Sundry Creditors	4	5	0		73	Subscriptions Overdue	80	8	0		
25	Provision for Essay Prize	40	0	0			Less Amount Reserved	20	0	0		
44	Travelling Expenses Reserve	43	17	5		23	Sundry Debtors			60	8	0
	Accumulated Fund:						Cash Balances:			69	15	0
	Balance at 31/10/48	711	9	9		371	Bank of New Zealand	129	0	7		
	Less Transfer to Trust Fund	50	0	0		398	Post Office Savings Bank	632	10	1		
		661	9	9		3	Petty Cash	1	11	1		
	Add Excess of Income over Expenditure for the Year	98	8	1			Trust Fund Investment:			763	1	9
711	Balance at 31/10/49					332	Post Office Savings Bank			391	2	3
332	Trust Fund											
		£1308	7	9		£1210				£1308	7	9

W. G. HUGHSON, Hon. Gen. Secretary-Treasurer.

AUDITORS' CERTIFICATE.

We have audited the books of the NEW ZEALAND INSTITUTE OF CHEMISTRY (INC.) for the year ended 31st October, 1949, and have compared them with the vouchers produced to us, and with the above Balance Sheet and accompanying statements. We have verified the various cash balances and certify that, in our opinion, the above Balance Sheet shows the true position of the Institute.

WELLINGTON, N.Z.,

12th December, 1949.

DYMOCK MacSHANE & SCLANDERS.

G. B. Macmoirran, F.P.A.N.Z.

## SALARY STATISTICS

Report by Dr. J. K. Dixon. 12/5/50.

Since the New Zealand Institute of Chemistry conducted a survey into 1948 salaries (1), two other Institutes have published statistics. The Royal Institute of Chemistry summarised figures as at August, 1947, (2) and recently the Australian Institute's data for 1949 have come to hand (3). While close comparisons cannot be made because of different exchange rates, costs of living and differing years for the collection of data, there are sufficient points in common to indicate the trends in salaries. The following table shows some simple comparisons.

Age Group.	Industry.			Government.		University.		R.I.C.(b)
	£N.N.	£A.(a)	£Stg.	£N.Z.(c)	£A.	£N.Z.	£A.	All members. £Stg.
21-25	515	610	468	460	605	525	545	450
26-30	571	730	594	515	685	604	640	569
31-35	721	875	778	652	800	779	805	745
36-40	850	1085	933	707	915	817	930	895
41-45	1110	1175	1138	856	970	908	1250	1069
46-50	844	1365	1307	928	1005	1370	1100	1217
51-55*	950	1500	1452	885	955	950	1135	1316
56-60		1205	1605		1265			1458
61-65					1040			1566

NOTES: (a) £125 A. = £100 N.Z. = £100 Stg.

(b) In the R.I.C. statistics only industry figures were taken out separately. The only other comparison possible is that of the total membership figures given in this column.

(c) Since February, 1948, N.Z. Government salaries have risen by £35 p.a. This has been incorporated in these figures.

(1) Jour. N.Z.I.C. 12 (1948), p. 32.

(2) Jour. R.I.C. (1948), Part 2, p. 101.

(3) Jour. R.A.C.I. 17 (1950), p. 46.

## ITEMS OF INTEREST

Professor L. H. Briggs, of Auckland, and Dr. F. B. Shorland, of Wellington, are so often in the news that they might be called, without disrespect, the "glamour boys" of New Zealand Chemistry. Last month we congratulated Dr. Shorland on the award of a D.Sc. degree by Liverpool University; he has now been awarded the I.C.I. prize of twenty-five guineas for the best contribution of published work by a member of the Institute in the past five years, an honour which is well-deserved. Last year it was won by Prof. Briggs as the first recipient, whom we now felicitate on being appointed President of Section B (chemistry) at the meeting of the Australian and New Zealand Association for the Advancement of Science to be held at Brisbane next May. This is not only an honour for Prof. Briggs, but for New Zealand chemists generally, and it is hoped that a number of them will be able to make the trip across the Tasman with the new President. Incidentally, a good deal of the organising work of Section B is being undertaken by Mr. Maurice Sutherland, a graduate of Auckland University College and a former Associate of this Institute, now lecturer in Chemistry at the University of Queensland. Some notable overseas visitors are expected, including Professor Pauling and Professor Huxley.

Among members of the executive committee of the Association of Universities of the British Commonwealth, which is holding a conference at Wairakei at the beginning of this month, is Dr. T. W. J. Taylor, C.B.E., M.A., D.Sc., now Principal of the University College of the West Indies, Jamaica, where Dr. C. H. Hassal, a graduate of Auckland University College and an Associate of this Institute, is Professor of Chemistry. Dr. Taylor was formerly lecturer in organic chemistry at the University of Oxford, and is the author of a number of works on the subject.

Mr. Leopold Hartman, Associate, has been appointed Wellington Branch Editor of the Journal. His address is care of the Fats Research Laboratory, Sydney Street.

The Royal Institute of Chemistry has made a number of changes in its journal, commencing with the February, 1950, issue. A larger page size is now used, and the changes appear to us to be all for the better. The Journal is available to non-members at 21/- per annum, post free.

A comprehensive congress on building research is to be held in London from September 11th to 20th, 1951, and will be the first of its kind ever held. It is sponsored by the British professional and learned societies interested in building science, by government departments and industrial federations in Great Britain. Papers are being invited and anyone interested should communicate with the Organising Secretary, Building Research Congress, 1951, Bucknalls Lane, Garston, Watford, Herts., England.

Mr. and Mrs. R. L. Taylor, Associates, are now enjoying life in Durban, where they are teaching at the Technical College.

A very interesting item of overseas news is that Imperial Chemical Industries of Great Britain is negotiating for the purchase of the well-established business of Arnold Hoffman and Co., of Providence, Rhode Island. There are many implications of this step which will doubtless occur to our readers, not the least being the British Government's proposal to nationalise the chemical industry.

The February issue of the "Journal and Proceedings of the Royal Australian Chemical Institute" contains a very fine address delivered by Dr. T. F. West, Director, Developmental Division, Drug Houses of Australia, entitled "Some Aspects of Research Administration." The following extract is well worth reprinting:

"Some of you will recall the story of the New York City plumber who wrote to the Bureau of Standards in Washington saying that he had found hydrochloric acid good for cleaning out clogged drains. The Bureau wrote him: 'The efficacy of hydrochloric acid is indisputable, but the corrosive residue is incompatible with metallic permanence.'

"The plumber replied that he was glad the Bureau agreed.

"The Bureau tried again with, 'We cannot assume responsibility for the production of toxic and noxious residue with hydrochloric acid, and suggest you use an alternative procedure. The plumber again said he was pleased the Bureau agreed with him.

"This time the Bureau wrote to the plumber: 'Don't use hydrochloric acid. It eats' hell out of the pipes.'

"I like this story because it is a classic example of 'pussyfooting'—to avoid a direct statement for fear of making an error."

## BOOKS RECEIVED

**ENCYCLOPAEDIA OF CHEMICAL TECHNOLOGY.** Edited by R. E. Kirk and D. F. Othmer. Vol. 2, Anthrone to Carbon Arc, 915 pages, 1948. Vol. 3, Carbon (continued) to Cinchophen, 955 pages, 1949. Vol. 4, Cineole to Dextrose, 969 pages, 1949. Published by Interscience Encyclopaedia Inc., New York. (Australasian agents: Angus and Robertson, Sydney.) \$20.00 per volume.

It is two years since we reviewed the first volume of this treatise and good progress has been made to issue a further three volumes, with Vol. 5 in the press. The high standard of production has been more than maintained, and in the main the articles are by well-known American authorities.

Most of the remarks made in our previous review (this Journal XII, 82 (1948)) now apply with even more point. The somewhat arbitrary arrangement makes the index more important and the publishers might well consider an interim index to make these volumes of more value until the set is complete. Though the relative amount of space given to American and non-American practice varies from one article to another, it is surprising in the article on Dairy Products to find that the only reference to New Zealand is in connection with the trade mark on butter and no reference to Denmark at all. With some of the statistics the reader can only infer that the figures refer to the United States alone and not to the world as a whole. The work is commendably free from errors but some of the physical data need verification, such as the boiling point of  $132^\circ$  for  $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ .

It is interesting to compare this work with Thorpe's well-known dictionary, the tenth volume of which is shortly to be published, and a further four expected to complete the set. Cineole to Dextrose, Vol. 4, 969 pages, in E.C.T., covers only 392 pages in volume 3 of Thorpe. It includes 94 major article in Thorpe but only 57 in E.C.T., and a rough calculation based on the number of pages and the number of words per page shows that E.C.T. has about 70 per cent. more reading matter in this same section than in Thorpe, and at this rate E.C.T. will require 21 volumes instead of the ten originally planned. (The statement on the dust-jacket of Vols. 1 and 2 that the work will be completed in ten volumes has now been deleted.) The volumes of Thorpe are £4 each, and at the current rate of exchange £7/3/- for each volume of E.C.T.

There is, however, room for the two works. Thorpe gives more space to theoretical concepts and omits such purely technical topics as Industrial Costings and Conveying, given 44 and 32 pages respectively in E.C.T. There is no doubt that the industrial chemist who can persuade his directors to secure these handsome volumes for his reference library is fortunate indeed and he should not be the only member of the staff to benefit by their acquisition.

**INDUSTRIAL CHEMISTRY.** By E. R. Riegel, University of Buffalo. 5th Edition, 1949. 1015 pages. Reinhold Publishing Co., New York: our copy from Technical Books, Wellington. Price in New Zealand, 70/-.

This work, first published in 1928, has won an important place as a one-volume treatise on industrial chemistry in all its aspects, and should be in every chemical library. Its basic form is not greatly altered, the same chapter headings being retained, but a good deal of new material has been introduced and the statistics brought up to date. It is interesting to note, for instance, that, since 1940 production of caustic soda in the United States by the electrolytic process has outstripped that by the lime-soda process, and in 1946 exceeded it by 35 per cent. Nevertheless the reviewer regards the grandiose claim in the preface that every line has been re-examined with some scepticism



since reading the statement on page 628 that "Sabatier and Senderens transformed oleic acid into solid stearic acid some twenty years ago." This information was incorrect when it appeared in the second edition (1933) as the research was actually conducted by Sabatier and Mailhe in 1909. It is now forty years ago rather than twenty. There are other signs that the author and his collaborators have not quite caught up with the progress in the industrial field or the basic research on the raw materials of the chemical industry.

Despite these defects, it is still a very useful work. For those unacquainted with it, there are 39 chapters dealing with the various chemical industries followed by chapters on the appliances and materials used by the chemical engineer, and on instrumentation. Each chapter has a list of references (many from English publications) and there are many problems for students. The printing and binding are good and the price reasonable.

**INDEX DES HUILES SULFONEES ET DETERGENTS MODERNES.** By J. P. Sisley, Directeur General de l'Institute Technique d'Etudes et de Recherches des Corps Gras (I.T.E.R.G.). 1949. 549 pages. Editions Teintex, 60, Rue Richelieu, Paris. 3000 francs

The usefulness of this work by an acknowledged French authority can be judged from the following outline of its contents:—

(1) Introduction. (2) List of firms manufacturing synthetic detergents. (3) Applications of synthetic detergents. (4) Properties of synthetic detergents. (5) Classification of detergents. This section of 120 pages gives a discussion of the various types of soaps, sulphonated oils and other detergents and includes details of preparation, application and examples. (6) A listing of detergents according to type, with the manufacturers' names. (7) An index of over 3000 products listed alphabetically under their trade names (310 pages). The monograph on each detergent gives its name, manufacturer, class, reaction, physical state, applications and the nearest substitute. Products from France, Germany, Britain, Japan, Austria, Hungary, Poland, U.S.A., Canada, Switzerland and Belgium are listed. The coverage seems good and the reviewer was unable to find any products in current production overlooked. This section would not be difficult to use by anyone with the poorest knowledge of French.

**OUTLINES OF BIOCHEMISTRY.** By the late Ross Aiken Gortner. 3rd Edition by R. A. Gortner, Jr., and W. A. Gortner. 1949. 1078 pages. John Wiley and Sons, New York; Chapman and Hall, London. \$7.50.

This book is almost unique in being a balanced account of biochemistry which is not limited to human physiological processes but discusses impartially the plant and animal kingdoms. While it is not sufficiently detailed in certain aspects for medical students, we feel there is great value in such a well-balanced approach which could be studied with profit by all advanced chemistry students. The revision by two sons of the original author is no mere sentimental gesture, for, with the aid of a dozen collaborators they have produced a very readable and up-to-date book. There are about 2500 literature references, of which more than a third are to papers published since the last edition in 1939. It is surprising to find no reference to antibiotics, but this will doubtless be remedied in the next edition. This book can be recommended to those who require a good one-volume treatment of biochemistry.

**TRAITE DE CHIMIE ORGANIQUE.** Published under the direction of Victor Grignard, G. Dupont, R. Loquin and Paul Baud. Vol. XVI, 1929. 1124 pages. 4100 fr. Vol. XVII (in two parts), 1949. 1879 pages. 7000 fr. Masson & Cie., Paris.

With the exception of Vol. VII, which is shortly to appear, this notable work on organic chemistry is now complete up to Vol. XIX. Four further volumes are in preparation and should appear by the end of 1951.

Vol. XVI deals with terpenes and camphors, essential oils and perfumes, natural and artificial resins, sterols and bile acids, vitamins D, sex hormones, corticosterone, cardiac glucosides and toad poisons. There are nearly 7000 references in the copious bibliographies, which in some cases go up to 1948, and as in the other volumes there is a partial author index. The section on synthetic resins is particularly full, while that on terpenes has many references to New Zealand work. It is natural, but a little unfortunate that the unfamiliar Grignard nomenclature should be used, and the volumes are also out of step with modern practice (and with most French usage) by employing superior figures for the number of atoms of each element in the various compounds. The fields covered by this volume made it a particularly useful one.

Vol. XVII deals with polycyclic aromatic hydrocarbons generally, as well as non-aromatic condensed hexagonal ring systems and spirans in which carbon or some other element is the spiro atom. A notable inclusion is a section of 34 pages on the photo-oxides of anthracene and related compounds. There are 11,000 references, but except in the later sections, they are almost entirely to work prior to 1940, so that there is a considerable time lag. The same general features as were noted in our review of Vol. XV (in our issue for October, 1949) are also in evidence in these volumes. The printing and binding are good, and the work is by authorities; there are valuable tables of compounds and their properties in the various sections, and the price is reasonable. These features demand a wider public for the treatise, but the large number of errors found is a bad feature which the publishers should strive to correct in later volumes.

Other books received include: **INTRODUCTION TO CHEMICAL ENGINEERING THERMODYNAMICS**, by I. W. Smith (McGraw-Hill, \$4.00), a well-organised and practical introduction to a subject of rapidly-growing importance; **GLASS-TO-METAL SEALS**, by J. H. Partridge, published by the Society of Glass Technology, Northumberland Road, Sheffield, 1949, at 35/-, a well-illustrated volume of 238 pages dealing exhaustively with all phases of the subject and written by a recognised authority; **THE CHEMISTRY OF ORGANIC MEDICINAL PRODUCTS**, by Jenkins and Hartung (John Wiley, \$7.50), a completely revised third edition of a well-known book and **ELECTRON MICROSCOPY**, by R. W. G. Wyckoff (Interscience, \$5.00), a well-illustrated account of the methods and applications of the subject in a small compass.

**THE CHEMICAL ELEMENTS AND THEIR COMPOUNDS**, by N. V. Sidgwick (Fellow of Lincoln College, formerly Professor of Chemistry in the University of Oxford). Volumes I and II, 1703 pages, 1949. Oxford University Press. Price 70/-.

A systematic treatment of the chemical and main physical properties of the elements and their compounds based on the structural theories of Pauling and Wells. The elements are dealt with in their periodic groups, the more uncommon compounds receiving the best treatment. Organic compounds which are not normally discussed in books of inorganic chemistry of comparable standard are treated here, this being perhaps the most useful feature.

The author treats critically the subject matter chosen and gives, as far as can be ascertained, the best available physical data. The structural side is well dealt with and leads to a better understanding of the compounds discussed.

The main point of criticism is in the inadequate use of certain physical properties such as electrode potential. The author seems sometimes carefully to avoid mentioning arguments which involve electrode potential in favour of a particular point, where other arguments can be used. An example of this is in dealing with the classical work of A. Ogg on the atomicity of the mercurous ion, where the main argument, based on electrode potential of mercury in mercurous nitrate solution, is not even mentioned.

Owing to the method of presentation, classes of compounds such as hydrides, nitrosyls, etc., have not been treated well, collectively, although the individual compounds are given in detail. The practice of discussing the less usual compounds has led virtually to the elimination of any mention of the alkali hydroxides and nitrates, whereas the alkali hydrocarbon derivatives have been given in great detail.

It appears to the reviewer that the author has been fairly successful in his aim "to discuss in detail the properties of the elements and their compounds in the light of modern theories of atomic and molecular structure." The book is an excellent compendium of inorganic data with emphasis on structure. Some physical properties, including melting and boiling points, colour, magnetic susceptibility and heats of formation have been given fully, the references are full (complete to the middle of 1948), the book is well printed on strong paper and it is completely indexed.

H.B.

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#### NEW ASSOCIATES

The following Associates were elected at the May meeting of the Council:

- BENNETT, Ian Barnes, M.Sc.** After completing his B.Sc. at Victoria University College, Mr. Bennett was employed for a short time in the Petroleum Section of the Dominion Laboratory before joining the British Petroleum Company of N.Z. Ltd. He graduated M.Sc. this year.
- CHILDS, William Edward, B.Sc.** Since completing his B.Sc. at Victoria University College in November, 1947, Mr. Childs has been with the British Australian Lead Manufacturers Ltd., Lower Hutt.
- CHRISTENSEN, Max Theodore, M.Sc.** Mr. Christensen graduated M.Sc. with 1st Class Honours in Chemistry in 1948 and has since carried out two years' Post-Graduate Research on an X-ray investigation of the structure of solid elements and compounds in the Physics Department, Canterbury University College, where he is now Junior Lecturer in Physical Chemistry.
- GERSON, Tomas, M.Sc.** Mr. Gerson graduated in 1949, and is employed in the Coal Research Section of the Dominion Laboratory, Wellington.
- GLADDING, Miss Alison Christina, B.Sc.** Miss Gladding, who graduated from the Auckland University College in 1949, has been employed in the Laboratory of Abels Ltd. for the past eight years.
- HEBDEN, William Herbert, B.Sc.** Before graduating in May, 1948, Mr. Hebden was with Lever Bros. (N.Z.) Ltd. for fifteen months. He then spent nine months as Technical Officer to Birdseye Frozen Foods Ltd., before being appointed to his present position in September, 1948, as Chief Chemist to Lever Bros. (N.Z.) Ltd.
- HIGGINS, Desmond James, B.Sc.** Mr. Higgins, who graduated in 1947, has been with Kempthorne, Prosser & Co. Ltd., Hornby, Christchurch, almost continuously since 1942.

- HODDER, Ivan George, B.Sc. Since completing his degree at Auckland in 1947, Mr. Hodder has been with N.Z. Forest Products Ltd. as Research Assistant in connection with hard-board construction and more recently with wood chemistry.
- JOHNSON, Ian Henderson, B.A., B.Sc., Dip. Ed. Mr. Johnson, who graduated B.Sc. in 1947, taught Science at Otago Boys' High School for twelve years before joining the Hawera Technical High School in 1947. He is now Senior Science Master and Head of the Department of Science.
- KENNERLEY, Rowland Alfred, B.Sc. After completing his degree at Victoria University College, Mr. Kennerley joined the staff of the Dominion Laboratory, where he has been engaged in analytical work on ceramic materials.
- LETHAM, David Stuart, M.Sc. Mr. Letham completed his M.Sc. degree in 1948 and has since held the position of Assistant Biochemist at the Ruakura Animal Research Station.
- MASLEN, Hugh Stafford, B.Sc. Mr. Maslen, who graduated in 1947, was for two years a Demonstrator at Auckland University College, and for the last eighteen months has been a Junior Lecturer.
- MONK, Robert Joseph, B.Sc. After completing his examinations at the University of Otago, Mr. Monk spent eighteen months as Works Chemist at the Benhar Pottery of McSkimming & Sons Ltd., before joining the Cawthron Institute as Research Chemist in the Biochemistry Department.
- PATERSON, Richard Maunsell Logan, M.Sc. Mr. Paterson, who graduated in 1948, has since been a Junior Lecturer in Chemistry at the Auckland University College.
- SAUNDERS, William Munro Hutchison, M.Sc. Mr. Saunders, who graduated in 1948, has been with the Soil Bureau, Wellington, for the past two years as Assistant Soil Chemist.
- THOMPSON, Robert Leslie, M.Sc. After completing his studies for M.Sc. at Canterbury University College, Mr. Thompson joined the Vacuum Oil Company Pty. Ltd., Christchurch, where he holds the position of Sales Chemist.
- VAUGHAN, John, M.Sc. (Wales), A.R.I.C. Mr. Vaughan, after graduating B.Sc. in 1941, joined the Ministry of Supply as a Research Chemist in the Armament Research Department. Following a period with the Crookes Laboratories, he was appointed Lecturer in Chemistry at the University College of Swansea, where he completed his M.Sc. He is now Lecturer in Organic Chemistry at Canterbury University College.





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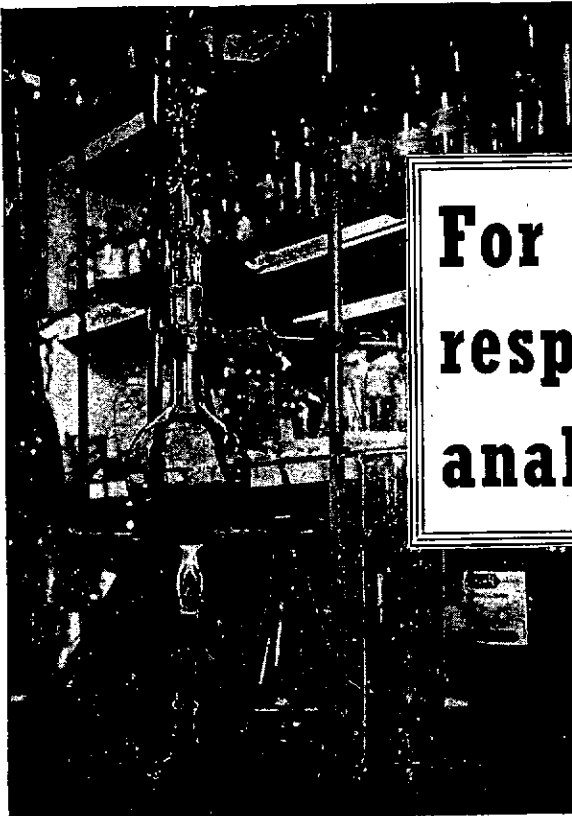
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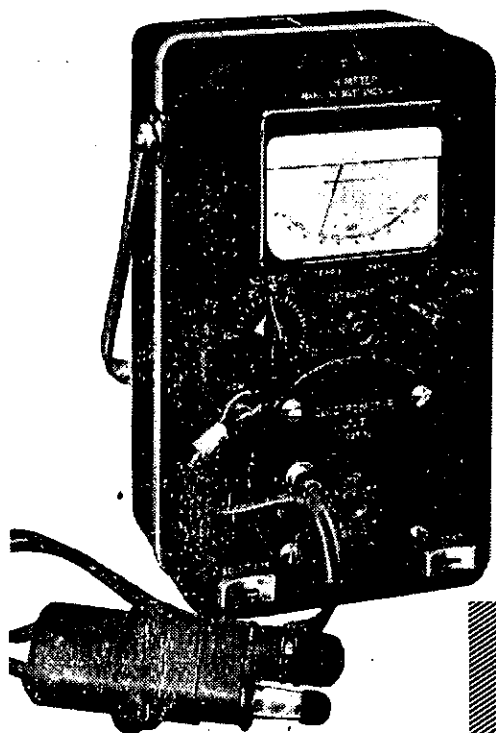
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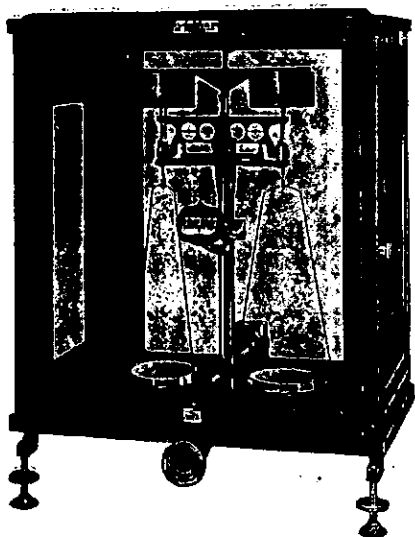
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