JOURNAL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

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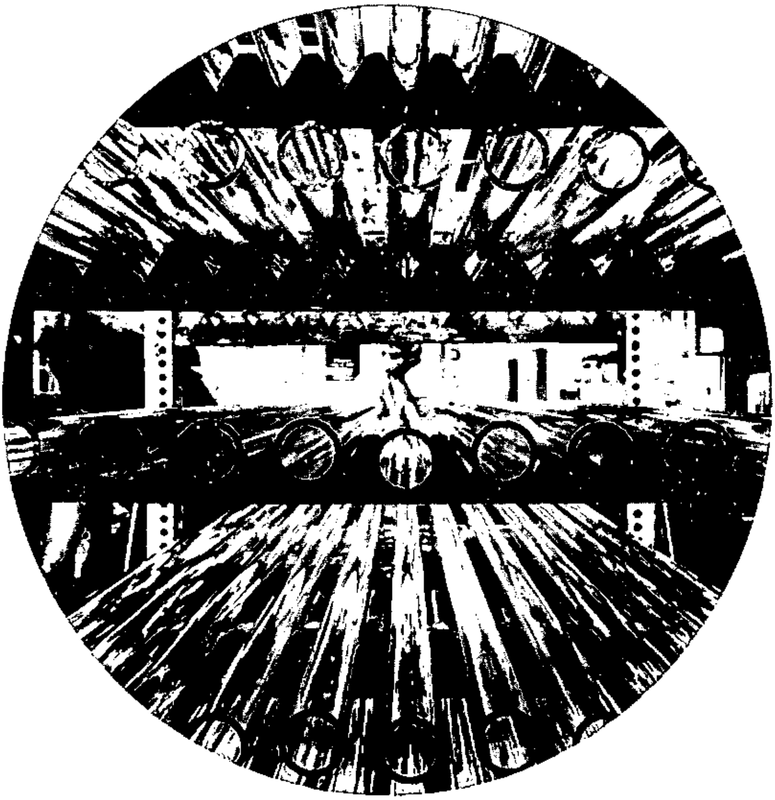

Chemistry Division,
GRACEFIELD

8 June 1966

New Zealand Institute of Chemistry
1966 Conference, Wellington,
August 16th - 19th.

GEOCHEMICAL SYMPOSIUM

An additional combined scientific and social function has been arranged by the N.Z. Geochemical Group for the evening of Tuesday, 16th August. A wine and cheese evening will be held at the Institute of Nuclear Sciences cafeteria (new building), when a symposium of geochemical papers will be presented. Tentatively the topic will be the "Origin of magmas of particular significance in New Zealand." Would those who intend to come along please make a note to this effect on the bottom of their enrolment forms.

Conference Committee (1966)

JOURNAL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

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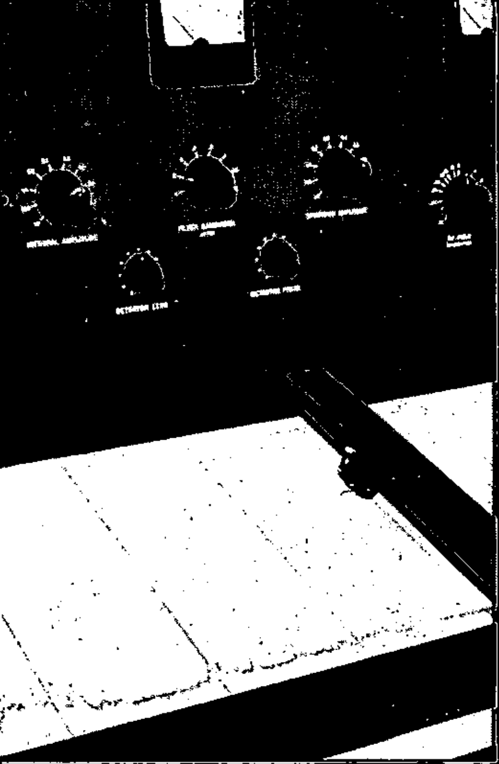

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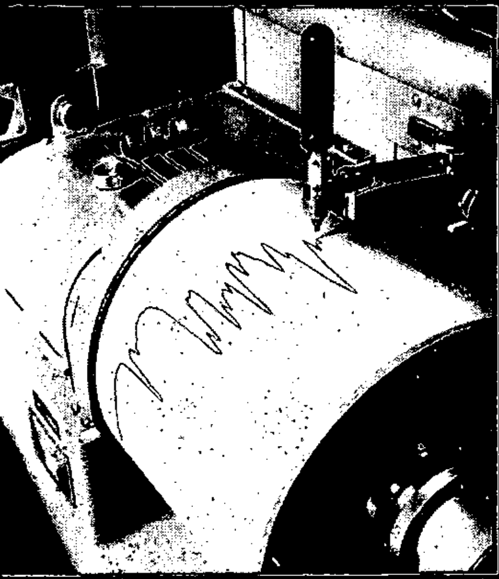

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JOURNAL OF THE NEW ZEALAND
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SODIUM AND POTASSIUM IN LIVING TISSUE

by

PHILIPPA M. WIGGINS

Department of Physiology, Medical School, University of Otago

Almost all living cells contain high concentrations of K ions, and low (often very low) concentrations of Na ions. In the body such cells are continuously bathed by an aqueous solution containing a much higher concentration of Na (0.145 N) than of K (0.005 N). We are accustomed to thinking of these two ions as practically interchangeable. There are, of course, differences in their properties, but these differences are slight, resulting chiefly from their difference in size. Na has the smaller crystal radius and the larger hydrated radius. In general, however, so similar are the properties of the two ions in aqueous solution that their separation is quite a problem to the chemist, but a problem that has been most dramatically solved by the living cell.

The ratio of the molal concentrations of K to Na ions in the solution outside cells is usually about 0.03, and the corresponding ratio inside cells lies in the range 1-30, according to the type of cell. This gives a molal selectivity coefficient, as defined for ion-exchange resins,

$$K^{K^+}_{Na^+} = \frac{mK^+/mNa^+\,(\text{inside})}{mK^+/mNa^+\,(\text{outside})} = 30 - 1{,}000$$

which for synthetic ion-exchange resins is not often greater than 2-3. This highly asymmetrical distribution of similar cations is somehow dependent upon the normal metabolism of the cell. If the cell dies, it swells, gaining water, Na and Cl ions and losing K ions.

The first mechanism proposed for this phenomenon was that the living cell membrane was impermeable to Na ions. The proteins and nucleic acids inside the cell carry more negative than positive charges at the physiological pH of 7.4, and require counter-cations to maintain electrical neutrality. Now if Na ions could not penetrate the cell membrane these fixed charges would all have to be neutralised by K ions, so that cells would contain high concentrations of potassium and little or no sodium. This theory involved difficulties and inconsistencies which however, are not worth considering here, since it has been shown more recently that both cations exchange freely across the membrane with their radioactive isotopes. In some cells the exchange is very rapid.

The "Sodium Pump"

It is now widely considered that Na ions are kept at a low concentration inside the cells by the action of the "sodium pump". This is thought to be a carrier-molecule on the membrane which combines with Na ions inside the cell, transports them across the membrane, and releases them on the other side. It thus constantly counteracts the spontaneous tendencies of the Na ions to come to an equilibrium distribution across the membrane, and maintains a steady-state, but not an equilibrium state of low intracellular Na ions. In order to do this it must do work and therefore expend energy, because the Na ions must be transported "uphill", against both a concentration and a potential gradient. This energy could be derived from metabolic reactions within the cell. This hypothesis is consistent with the observed behaviour of the cell when its normal metabolism is impaired. If energy were not being produced to work the pumps they would fail, Na ions would enter the cell freely down its electrochemical gradient and K ions would be lost.

An alternative approach to this problem is to assume that ions and water are at or near equilibrium across the living cell membrane, and that the observed distribution of ions is a function of the properties of the cell as a whole, and not exclusively of the membrane. Somehow the environment inside the cell favours K ions at the expense of Na ions, very much as a highly-selective ion-exchange resin might accumulate K ions from a solution containing both ions. It seems sensible to regard the cell as behaving in some respects as a polyelectrolyte gel or ion-exchange resin, because about 60 per cent of its weight is water and most of the rest of its weight is due to large molecules (chiefly proteins and nucleic acids) carrying many charged groups, most of which are negative. For the purpose of this argument then, a highly-simplified model of the living cell would be a polyelectrolyte gel with the following properties:

(1) It would have a finite, characteristic swelling volume which would depend upon the composition of the solution with which it was in equilibrium. This is a property of all polyelectrolyte gels. In addition the model of the cell would have two special properties:

(2) K ions would be preferentially associated with a large proportion of its fixed negative charges.

(3) Metabolic reactions would maintain in a steady state a highly ordered compact configuration of proteins. It would be this unique configuration that would have the low equilibrium swelling volume of the living cell and the property of preferential association of K ions.

Now a cell with these properties might be expected to exclude Na ions and to depend upon its normal metabolism for the maintenance of its asymmetrical distribution of cations.

(1) Consider the cell as a gel with a high resistance to swelling in equilibrium with a solution containing both Na and K ions. Such a cell could accommodate its counter-cations required to maintain electrical neutrality, and relatively few extra positive and negative ions. Now if most of the cell's negative charges were preferentially associated with K ions, very few Na ions would find room inside. If more from the relatively high concentration in the external solution were to fit into the cell they would be forced either to exchange with K ions or to enter the cell accompanied by anions to preserve electrical neutrality, and water molecules to maintain osmotic equilibrium. A cell that preferred K ions and resisted swelling would permit neither of these changes.

(2) Such a cell should swell, gain Na ions and lose K ions when its metabolism was impaired. If the unique configuration with the properties of low equilibrium swelling volume, and selective accumulation of K ions and exclusion of Na ions were maintained in its state of extremely low entropy by the expenditure of metabolic energy, then with impairment of metabolism it should lose these properties. It should become less compact and ordered, more randomly oriented and flexible. Moreover when a cell dies it releases enzymes which catalyse the hydrolysis of peptide bonds, so that the proteins themselves are broken down. The dying cell would swell, gaining both Na and Cl, the

most abundant ions in the external solution, and losing K ions which would no longer be stable inside the cell.

I have tried to distinguish experimentally between these two models by suppressing metabolism in cells, then following their loss of cations into an external solution of low electrolyte concentration. According to the "pump" hypothesis both sodium and potassium ions would be in free solution inside the living cell, not in equilibrium with the outside solution, but restrained from coming to equilibrium by the action of metabolic pumps. When metabolism was stopped, the pumps would stop and the ions would be free to come to an equilibrium distribution across the membrane. Cells should lose ions into a low-ion medium at rates limited by their rates of diffusion through the membrane.

On the other hand in the gel model of the living cell both Na and K ions would be at or near equilibrium with the external solution, and when metabolism was stopped K ions would be released from association at a rate controlled by the diverse chemical reactions which break down the highly ordered configuration of the living cytoplasm. Such a cell should lose Na ions at its rate of diffusion, but K ions at the rate of disruption of the cytoplasm and consequent release of associated K ions.

Experimental

For experimental tissue I use thin slices (0.1 mm. thick) of the outermost layers of the kidneys of rats. When these slices are stirred in an oxygenated, balanced saline medium of the approximate composition of the extracellular solution in vivo, they take up oxygen and continue most of their normal metabolic activities.

TABLE 1

The composition of the outermost slices of rats' kidneys respiring in a balanced saline at room temperature.

	Water (kg./kg. dry weight)	Na ions (m-equiv./kg. dry weight)	K ions (m-equiv./kg. dry weight)
Slice	2.8	294	230
Cells	1.8	150	220

After about twenty minutes of stirring at room temperature to remove fragments of cell broken in cutting, these slices have the fairly constant composition shown in Table 1. The composition of the cells has been derived from the directly-measured composition of the slice by subtracting estimates of the ions and water in between cells in the slice, where the ionic concentrations should be those in the medium (Na, 145 m-equiv./kg. water; K, 5 m-equiv./kg. water). Since there are uncertainties in the magnitude of this correction, the composition of the whole slice will be used as a starting point in this discussion. It must always be remembered however, that about half the Na ions in the slice are initially outside cells, but almost all the K ions inside cells.

About 40 slices of the composition of Table 1 were transferred rapidly into a low-ion medium saturated with nitrogen to suppress metabolism, and batches of slices removed for analysis at intervals, to follow the changes in composition with time. The low-ion medium was buffered at pH 7.4 with a phosphate buffer and contained Na 13.6 m-equiv./kg. water and K 0.4 m-equiv./kg. water. These concentrations were selected for the following reasons:

(1) They fitted in with the buffering requirements.

(2) The low concentration of K ions in the extracellular space of the slice would always be negligible, and all the K ions left in a slice after any time interval could be assumed to be intracellular.

(3) They preserved the physiological ratio mNa^+/mK^+ (outside) = 32.

Now slices put into a solution as dilute as this one would swell to contain more than double their initial water. To prevent this polyethylene glycol 6000 (PEG, 6000) was added to the low-ion medium. This is a longchain polyether of molecular weight about 6000 with a remarkably high affinity for water. It is taken up by slices of tissue, but stays outside the cells as it is too big to penetrate the cell membrane. Thus it lowers the activity of the extracellular water and prevents the cells from swelling. Suitable concentrations of PEG 6000 can be found by trial and error to control the water content of slices at a fairly constant level.

The composition of slices put into an anaerobic low-ion medium containing PEG 6000 at a concentration of 16 g./100 g. water at 38°C. changed as follows: The slices lost Na ions rapidly until a minimal level was reached after about ten minutes, and thereafter increased slowly. Some K ions were lost fairly rapidly in the first few minutes but the rest much more slowly. This is how one might expect the gel model to behave Na would diffuse rapidly out of the cells down its electrochemical gradient, but K would be lost much more slowly as the K-preferring structure was broken down by chemical reactions. As it was released it would diffuse out and be replaced by Na, the more abundant ion in the external solution.

Alternatively however, it could be said that the cells lost both ions at their rates of diffusion, but that the cell membrane was much more permeable to Na than to K.

In order, therefore, to get an independent measurement of the rate at which the two ions could diffuse between slice and medium, I charged slices with extra ions by putting them in a "recharging" solution containing equal and relatively high concentrations of Na and K. Slices transferred from an anaerobic low-ion medium to an anaerobic "recharging" solution took up both Na and K about equally rapidly. When replaced in the original low-ion medium they lost K much more rapidly than originally until its concentration had fallen to the level found in slices that had been left in the low-ion medium during the "recharging" period. The gradient then changed sharply and K was again lost at its initial slow rate. Similarly Na diffused rapidly out of the "recharged" slices until its concentration had fallen to that in slices left in the low-ion medium during the "recharging" period. It then increased slowly with that concentration. This too, seems what one might expect of the "gel" model. The rapid gain and loss of both Na and K ions would be controlled by their rates of diffusion into and out of the cells. The relatively slow loss of K and secondary gain of Na would be controlled by the rate of chemical reactions breaking down the specific K-preferring structure of the cytoplasm. The alternative interpretation (in terms of the "pump" hypothesis) is that the K initially present in the cells occupied a different cellular compartment from the one that was filled in the "recharging" experiments.

This problem was put on a semi-quantitative basis by deriving approximate first-order rate constants for efflux of ions from cells into the low-ion medium under the various conditions. From these calculations it seems probable that on "recharging" both Na and K ions went into the cellular compartment that was initially occupied by Na, because the specific rates of loss of initial Na and of "recharged" Na from the cells of the slice into the same low-ion medium were equal within the limits of experimental error, and the specific rate of loss of "recharged" K only slightly higher. There remains however, the possibility that the initial K, with a specific rate of loss only one-tenth as great, was in a different part of the cell, or in a different kind of cell.

One result of this should be that the specific rates of exchange of the two cations between cells and medium should be very different. Na should exchange ten times as quickly as K. Measurements of these exchange rates in other laboratories however, have shown that the rates of exchange of intracellular Na and K ions with their radioactive isotopes in the medium are of the same order. Burg and his co-workers in America, for example, have measured these rates using cells from the kidneys of rabbits at 25°C. The specific rate of exchange of K ions under these conditions was 0.069 or 0.117 min^{-1}, depending upon the method of analysis of their measurements. Fig. 1 shows the loss of initial K and of "recharged" K from the cells of very thin slices of the outermost layers of the kidneys of rabbits at 25°C. In these slices aerobic metabolism was suppressed by saturating the incubating medium with nitrogen, and anaerobic metabolism was suppressed by adding the inhibitor sodium iodocetate. Cells lost their initial K ions at the rate represented by the filled circles. Under the

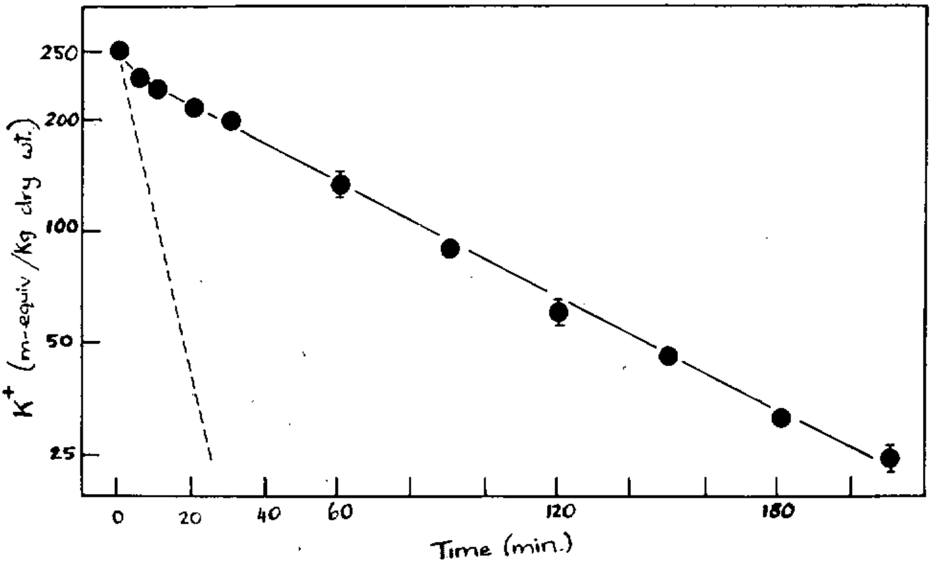

FIG. 1

Initial K ion loss from the outermost slices of rabbits' kidneys into an anaerobic low-ion medium (PEG 6000, 16 g./100 g. water) containing mM sodium iodoacetate at 25°C. The broken line represents the rate of diffusion of K ions from recharged cells of the same water content and under the same metabolic conditions.

same metabolic conditions the same amount of "recharged" K could have diffused out of the cells at the rate represented by the broken line, the gradient of which was 0.10 min^{-1}. Thus the specific rates of loss of "recharged" K into an anaerobic low-ion medium, and of exchange of K across the living cell membrane were of the same order, each being about ten times the specific rate of loss or loss of initial K ions when metabolism was suppressed. Two possible interpretations of Fig. 1 can be considered.

(1) The initial K occupied a cellular compartment that was not refilled in the "recharging" experiments and from which it could diffuse out into an anaerobic low-ion medium at only one-tenth of the rate at which it could diffuse into the medium when the cell was respiring. It is difficult to see however, how the changed conditions under which the diffusion was measured could drastically reduce the rate of K ion diffusion, and yet have little effect upon the rate of Na ion diffusion. Indeed, if Na were being pumped out of the cell during respiration, one would expect that when metabolism was suppressed its rate of efflux would decrease more than that of K.

(2) Initially K occupied the same cellular compartment as Na. On "recharging" both cations went into this same compartment, from which slices subsequently lost their "recharged" cations and their initial Na at their rates of diffusion, which were of the same order as their rates of exchange in respiring slices. So rapid is the dissociation of ion-pairs that the specific rate of exchange of K in the "gel" model of the cell should be determined by its rate of diffusion. The K which was lost at one-tenth of this rate remained in the slice, not because it had not had time to diffuse out, but because it was still stable inside the cells, which retained diminishing remnants of their K-preferring structure.

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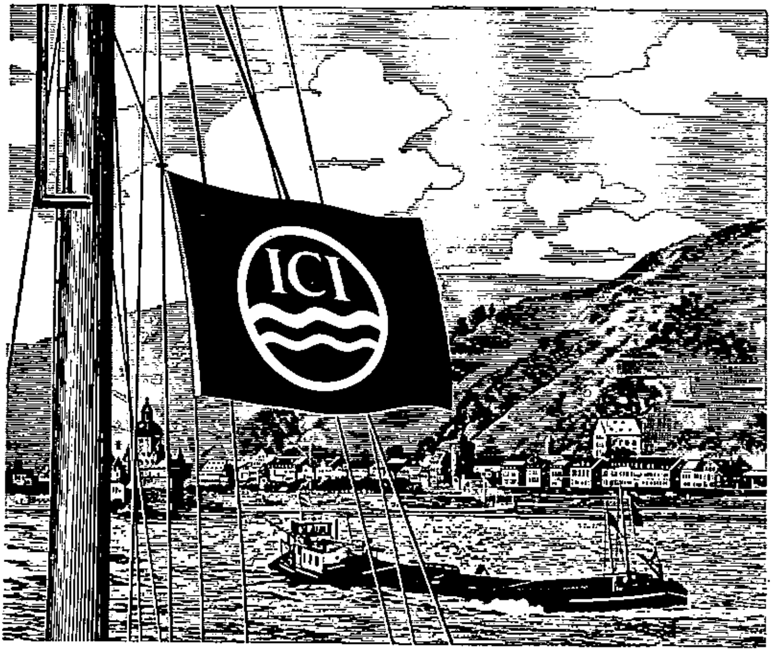
Volume 28, No. 6, 1964.

Volume 29, Nos. 1, 2, 3, 4, 5, 1965.

English cargoes on the Rhine



Up and down the Rhine goes the inland shipping of half Europe, as it has for centuries, fetching and carrying a hundred different kinds of cargo between Basle and the open sea. Swelling this familiar traffic is a growing new element—tankers carrying petrochemicals. These are the exciting new materials out of which ingenious chemical engineers will produce polyester fibres for glamorous clothes, hard-wearing synthetic rubbers for shoe-soles, supple plastics for car upholstery.

Here and there among the flags at the mastheads is one bearing a symbol that is becoming more and more familiar to European industry—the ICI trade mark. And from ICI's petrochemical plants in Britain—the largest in Europe—cargoes are now finding their way right across the world: to Australia and New Zealand, the Far East, U.S.A., South America. In the petrochemicals sphere, as in so many others, from colour chemistry to crop-protection, the name ICI has come to mean quality, service, experience.

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THINGS IN THE WITNESS BOX

by

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

This is based on an *N.Z.I.C. Lecture for Secondary School Pupils,* given in June 1965.

Only people commit crimes but they invariably do so through the medium of things. In investigating crimes the policeman questions *people* to find out what information they can give him so that he can discover whether or how a crime was committed, and determine who did it. The forensic scientist questions the *things,* that is he studies things that are used in a crime, or the things that are present at the time of a crime, and endeavours to find out and to understand what they have to say. These things which bear an apparently mute witness against a criminal can actually give very important and useful evidence. They do not forget. They are not confused by the excitement of the moment. They are not absent because human witnesses are. Their main limitations are human failure to find them or human failure to interpret their story.

What are these things? What may they tell us? Let us take some representatives and see what they have to say.

Hairs and Fibres

Consider the variety of fibres which make up clothing. There might be cotton, wool, synthetics such as rayon, nylon or terylene, used either alone or in a mixture. There is also a variety of fibre thicknesses and colours. If, during the investigation of a crime, fibres from the clothing of the suspect person are found on the clothing of the victim, or at the scene of the crime, they may assist in throwing light on the crime. But can we be certain that the fibres came from the particular suspect?

In a particular crime which involved safe-blowing the criminal broke in through a sky-light and left green woollen fluff on the sky-light. This fluff was indistinguishable from an identical green fluff—probably from green woollen gloves—found in his coat pocket. When I gave evidence in this case I was asked whether I could say beyond reasonable doubt that this fluff must have come from that particular accused person and from no other. My answer was no. Although this fluff indicated probability, it did not indicate certainty.

Consider a hypothetical case. Suppose that after a meeting some damage is found in the meeting room and dark blue fibres are found where the damage occurred. We would immediately think of those present who wore blue. The things indicate this possibility. But a suit which appears to be very dark grey, usually contains some medium blue fibres, so a person wearing grey could be suspect too.

One fibre may not be very strong on its own but many fibres can form a very strong rope. At the scene of a stabbing a coat button was found. This button and the coat of the suspect were brought into the laboratory to see if there was any connection. On the button and on the coat were brown cotton thread, green cotton thread, yellow acetate rayon fibre and a fragment of cotton lining material which had thin black cotton threads in one direction, and thick black cotton threads in the other direction. In this case the combination of these fibres pointed beyond reasonable doubt to the fact that this button came from that coat.

Instead of a combination of several different types and colours of fibres, the evidential rope may be built up from fibres of the same kind. At the scene of a shopbreak there was found a button to which were attached two scraps of nylon material. The police brought in a nylon shirt worn by a suspect. A button had been torn from the shirt, taking with it two scraps of material with the same number of rows, same number of stitches in each row, same type of weave, same type of fibre and same weight of fibre as that found on the button at the burgled shop. It was clear that the button at the shop had come from the suspect's shirt.

Some years ago there were a large number of rabbits in New Zealand and their skins were of considerable value. This was before the days of the policy which caused the rabbit to become devalued. The hide store of a stock and station agency was broken into, and a large number of rabbit skins was stolen. During investigations the police examined a suspect car and in it found many hairs which looked like rabbit hairs. The owner of the car explained that these might be dog hair, pig hair, deer hair—he claimed to be a keen pig and deer hunter—he asserted that the hairs could not be rabbit hairs. Most hair has a circular or oval cross-section, but rabbit hair is most unusual in that the cross-section is dumb-bell shaped.. When these hairs were examined in the laboratory they were found to have the characteristic, rabbit, dumb-bell shaped cross-section and hence were rabbit hairs. This evidence aided in the conviction of the owner of the car and his partner.

A woman on her own in an isolated house was attacked at night by a masked intruder. After she had successfully fought him off he ran away leaving behind a knitted balaclava hat. During police investigations, they held a suspect and took possession of his jersey. Dark brown hairs from the balaclava agreed very closely with dark brown hairs from the jersey. In addition, blond hair found on the jersey agreed very closely with the bleached blond hair of the complainant. Although these hairs did not prove conclusively that the accused man was responsible for the assault, they indicated this with a high degree of probability and formed an important part of the prosecution evidence.

Glass

Fragments of glass may be excellent witnesses. If the shattered glass in a broken window remains in the window frame, the damage may be seen to have been in the form of a star crack, i.e., from the centre of the impact lines of fracture radiate out in all directions. At the point of impact the glass has been stretched and split, and the first series of cracks have been the radial fractures. If the breaking force has been continued a second series of cracks, known as concentric fractures, would have appeared. If there are two lots of damage to the one pane we can find out which occurred first, and we can find out whether the window was broken from the inside or the outside.

As the crack spreads through the glass, curved markings known as rib markings are left on the broken edge. These indicate the surface at which the crack originated and the direction in which the crack spread. The surface to which the rib marking is perpendicular is the surface at which the crack originated. The direction of travel of the crack is from the concave to the convex side of the rib markings. On one occasion a lady alleged that a burglar had broken into her home by breaking the glass in the back door and turning the Yale lock. Examination of the rib markings of the broken glass however, indicated that this glass must have been broken by a blow from the inside.

On another occasion, where a factory had been broken into, glass was found in a heap on the outside of the building and it appeared that this alleged break might have been an inside job. Study of the broken glass, however, indicated that the window had in fact been broken from the outside, probably by tapping with a tool. Then the shattered glass had been levered outwards so that the police found it in a heap outside.

When glass is broken in a burglary it may be taken away on the burglar's clothing. In a hit-and-run motor accident broken glass from the headlamps or the windscreen of the car may be left at the scene of the accident, or may be left in the clothing of the victim. In such cases the glass on the burglar's clothing is compared with the glass from the broken window, or the glass from the scene of the accident with the glass from the suspect car. The most conclusive proof of source with fragments of broken glass is a jigsaw puzzle. The jigsaw may be the matching of broken pieces along their edge in common. However, this requires larger pieces than are generally available. The type of jigsaw puzzle usually achieved is when a flake is fitted into a hollow on the parent glass. We have succeeded in matching flakes as small as one-eighth of an inch across.

In the majority of cases jigsaws are unsuccessful or impracable so the pieces of glass are compared by means of physical properties, particularly density and refractive index. Densities are compared by floating fragments of the glass in a liquid of high density such as a mixture of bromoform and xylene. Refractive index is measured by immersion in liquids of known refractive index and by studying the Becke line. Both of these properties can be measured on minute fragments of sample.

Suppose the glass on the burglar's clothing is indistinguishable by these methods from the glass in the broken window. What does this mean? Without further information it can be said that the glass on his clothing could have come from that window, but this is not very strong evidence. To take the matter further considerable background information is needed about the density and refractive index of that *type* of glass. If, for example, the densities of the two samples of glass agree within one unit in the fourth decimal place and it is known that this type of glass varies in density from 2.45 to 2.55 (one in the first decimal place), then the range within which the samples fall is one-thousandth of the range over which random samples may vary. This is an over-simplification because allowance should be made for the distribution of density values within the observed range, and to interpret the observations fully we should also know whether the density and refractive index are inter-dependent. These physical properties frequently indicate with a considerable degree of probability that two samples have come from the same source. That is, that the burglar got glass on his clothing from a particular broken window, or that the glass at the scene of an accident came from a particular motor car.

Poisons

There is a time honoured expression "Dead men tell no tales". Like many other proverbs this is fortunately not true, because a dead body frequently has a lot of very useful information for the policeman, the pathologist and the scientist.

Toxicology may be defined as the science of poisoning, but the function of the scientist, at least in our case, is the isolation and identification of poisons, not their administration. People may die from poisoning by accident, by suicide or by murder. Only too frequently the victims of poisoning are children. It is worth pointing out that the average home has numerous poison hazards in the way of drugs, liniments, fruit sprays, solvents and so on. The barbiturates or sleeping tablets are popular poisons for suicide.

The main problem in detecting poisons is that there is a small amount of poison in a large amount of tissue. The barbiturates may be present as 4 milligrams of drug per 100 grams of liver, i.e. 1 part in 25,000. The problem is to remove the 24,999 parts that are not wanted leaving one part, the one in which we are interested, in a pure enough condition to measure and identify.

Murders are occasionally perpetrated with poison. Trials for murder and attempted murder where arsenic has been the poison have occurred recently. In one of these, arsenic was found in a body which had been buried for twelve and a half years.

Not every poison leads to the death of the victim. Alcohol is a poison and many people regularly use it to poison themselves, without usually experiencing fatal results. This is a private matter for the person himself to decide, unless however he is driving a motor vehicle on the public roads. If we are discussing drinking drivers it is necessary to define what we mean by drunk. One definition is expressed in rhyme.

He is not drunk who from the floor
Can rise again and drink once more
But he is drunk who prostrate lies
And can neither drink nor rise.

This definition is obviously not applicable to drinking drivers. The term "impaired" rather than "drunk" should be used because it is the level of alcohol in the blood which causes loss of inhibitions and impairment of co-ordination, thus making a driver unsafe. At the present time in New Zealand the Legislature and the Courts have not fixed a blood alcohol level at which a driver is deemed "impaired". At present, alcohol analyses of body fluids are merely used to corroborate other evidence of a driver's condition. However, the analyses of blood or urine can give evidence against a drinking driver and can also indicate the minimum amount of liquor which he has drunk.

Under the heading of poisons we may also consider illicit drugs. One of these is marijuana, or Indian Hemp. If a person has hand-rolled cigarettes in his possession and the ends of these cigarettes are twisted and turned in, a policeman might suspect that they are marijuana cigarettes, or reefers. The person concerned may well assert that this is the way in which he rolls ordinary cigarettes. If an analysis of the contents discloses that they consist of marijuana, these things can give their evidence against the accused person.

Another person may have small white tablets in his possession and assert that they are aspirin or saccharin. In such a case the policeman may well bring these tablets in to the laboratory where we question the tablets as to their identity, i.e. we analyse them. According to the results of our examination the police know what action to take.

Fires

In cases of arson, the perpetrators or criminals sometimes believe that the fire will destroy all evidence. Is this so? Can dead ashes tell us anything useful?

When a fire is examined, we can frequently find the seat or source of the fire because the line of burning may be followed by the depth to which combustible materials have been burnt. We can frequently tell the direction in which the flames have travelled. For example, beams may be charred more deeply on one side than on the other.

The chance of a fire occurring at any time on a premises is very small. The chance of there being two separate sources of fire at one time is extremely small. Hence when more than one source of fire is found, arson is suspected. Sometimes, however, two apparently separate sources of fire are found to be related on further investigation. In one case a number of separate fires was found in a long building where dressed timber was stacked. At first sight these separate fires indicated arson but further investigation showed that the initial fire had melted a number of plastic skylights which, falling on the timber, had started separate secondary fires.

Mr. L. C. Nickolls, former director of Scotland Yard Laboratory, states "The layman has many erroneous ideas concerning the behaviour of inflammable materials in fires. Since offenders are usually laymen their ideas are also erroneous". Sometimes the fires do not go as planned by the offenders. Sometimes the things at the fire give evidence that there has been planning, and hence the police look for the planners. Sometimes the things give evidence which contradict statements made by the offenders.

The layman imagines that petrol just burns when ignited. In fact, petrol always explodes when a light or a spark is applied to it. After the lower boiling fractions have been removed in this way, the residue will burn very vigorously, but the initial effect is an explosion. This explosion has spoiled many a fire which would otherwise have been quite satisfactory to the raiser.

Contrary to popular belief, a cigarette end will not ignite petrol, nor any other inflammable liquid likely to be found in the possession of members of the public. Many statements of suspects have been challenged successfully because of this mistaken idea.

Kerosene as a fluid cannot be ignited by a flame or a spark because its flashpoint is too high. It needs some material like a wick by which it can be heated locally above its flashpoint. Nickolls quotes a case where two men who owned a garage stocked it with derelict, worn-out cars which they insured for a comparatively large sum of money. In due course the garage was burned to the ground. In a statement made to the police these men said that they were working on a lorry. One of them was loosening nuts with a blowlamp, when the other banged into him, knocking the blowlamp out of his hand. The blowlamp fell into a vessel of kerosene which blew up and fired the garage. In evidence it was stated by the expert that this could not be true. In these circumstances the blowlamp would be extinguished and, contrary to popular belief, would not ignite the kerosene.

Where inflammable materials such as petrols or kerosene have been used to start fires traces frequently remain. Even after a severe fire they can seep into wood, soil, carpet and so on, and be detected afterwards. By means of gas chromatography minute traces may be identified and compared with liquids from known sources. These minute traces give evidence that they have been used to start the fire, and frequently also give evidence of their origin.

Marks

I do not know whether marks should be regarded as "things" or evidence of damage to things, but they can provide very useful information.

In tool marks there are two general types, impressed marks and cutting marks. The tool producing an impressed mark resembles a rubber stamp in that the features of the tool impress themselves each time that it is used. If a hammer has a groove across its face, each time it strikes soft material such as wood or lead, that groove will be left impressed in reverse in the hammer mark. If a screwdriver or a jemmy is used to lever a door or a window marks and dents on the face of the tool may be impressed into the wood. We can study these marks directly and make similar marks with the suspected tool for comparison, or alternatively, we can make a cast of the mark (with room temperature vulcanising silicone rubber) and then compare this cast with the tool itself. In a recent robbery the metal strap on the complainant's watch was broken. Links of watch strap in the possession of the accused were found to have been stamped with the same die in the same state of deterioration.

The other type of tool mark is demonstrated where there is scratching or cutting. For example, if a piece of wood is cut with a notched knife the cut surface will have a ridge across it. If the cutting iron of a plane is notched it will leave a groove across the work.

In England a policeman was investigating a theft of cabbages. He successfully matched the marks on the cut cabbages with the marks on the cut stumps in the field from which the cabbages were stolen.

A criminal broke into a draper's shop and stole £100 worth of clothing. Although the clothing found in his possession was identical with that stolen, the draper could not be certain that these clothes were the goods actually removed from his shop. Amongst the recovered clothing was a 1/3 coathanger from which the name of the firm had been scratched so that traces only remained. It was found that the curved part of the coathanger had been shaped on a machine in which the cutter was badly chipped and worn. The degree of chipping and wearing was identical with that in the cutter used for shaping another coathanger at the draper's shop. Both coathangers had been made on the same machine at about the same time, hence the coathanger among the clothes had been stolen from the draper.

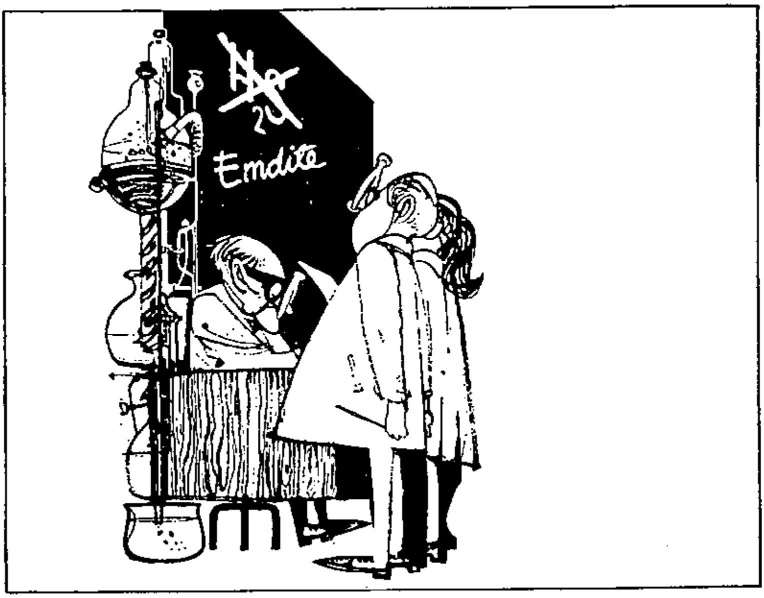
Comparison of bullets comes under this heading. Imperfections in a rifle barrel cause bullets fired from that barrel to carry a series of longitudinal scratches. These scratches are largely reproduced in successive bullets fired from that particular barrel. The markings on fired bullets or cartridge cases may sometimes be used to classify the weapon used. If the class of weapons indicated is small, such information can be very useful during police enquiries or in court. In the rifling process helical grooves are cut in the bore of the weapon so that raised helical portions, or lands, are left. In different types of weapons, these may vary in number, direction of twist, width and pitch. A bullet fired through a rifle barrel will usually reveal these four pieces of information, as well as its calibre.

In self-loading weapons, especially auto-pistols, the fired cartridge case is drawn from the barrel by a hook known as the extractor, and is then knocked against a projection, known as the ejector, which throws it from the weapon. The nature and relative positions of extractor and ejector markings, as well as other characteristic markings, vary from brand to brand of self-loading weapons.

Conclusion

These things which have been discussed, hairs and fibres, glass, fires, poisons and markings, are merely a few representatives of the many things which may occur as evidence. The emphasis has been on the evidence which these things may give in the witness box. There has been only cursory mention of the procedures which may be used to interrogate these potential witnesses, i.e. to examine the things, to analyse the samples. Techniques include inspection by unaided vision, microscopy, chemical analysis, ultraviolet or infrared spectrophotometry, gas chromatography—in fact any chemical or instrumental technique which is available. Often we wish that more were available, such as neutron activation analysis.

This is a branch of science which has many interesting research problems in the gathering of background information, the applying of new techniques and the interpreting of observations so that the things may give their evidence in the witness box.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Dr. J. Rogers

NEW APPOINTMENT

The New Zealand Fertilizer Manufacturers Research Association (Inc.) has appointed Dr. John Rogers as Director of the Otara Research Station, Auckland.

Dr. Rogers is a Canterbury graduate. In 1941 he went to Australia as a foundation member of the Physical Chemistry Section of the Division of Industrial Chemistry, C.S.I.R.O. (now the Chemical Research Laboratories). Returning to New Zealand in 1946, after a year at the Soil Bureau, he went to the University of Otago to establish the Mineral Engineering Department in the School of Mines and Metallurgy. In 1949 he visited Canada and the United States as a Nuffield Post Graduate Scholar, and the U.S. Educational Foundation in New Zealand awarded him one of the first Fulbright travel grants. In 1954 he received the first Easterfield Medal awarded by the New Zealand Section of the Royal Institute of Chemistry.

Research in the Department of Colloid Science, Cambridge University, which won him a Ph.D. in 1957 was followed by two years as a Research Scientist with the International Nickel Company of Canada at Copper Cliff, Ontario. In 1959 the New Zealand Geological Survey and the Chemistry Department of the University of Otago established a joint laboratory for high pressure-high temperature studies in geochemistry. Dr. Rogers has been responsible for the Geological Survey's work in this laboratory.

BRANCH NEWS

Waikato

Dr. W. M. H. Saunders recently of Soil Bureau, has joined the staff of the Ruakura Agricultural Research Centre, and will be stationed in the Soil Research Section. He replaces Dr. E. B. Davies who has retired, and will be in charge of the Soil Chemistry Research team of the Ruakura Centre.

Mr. C. I. Denmead has transferred to the Meat Industry Research Institute from Auckland. He is to study pollution problems relating to the Freezing Industries.

Dr. R. H. Locker has returned from seven months' study leave abroad, where he spent five months at the John Hopkins University.

Dr. E. B. Davies, who is well known for his work on trace elements, will leave shortly for a world tour. Dr. Davies is a Foundation Member of the Waikato Branch, a Fellow of the Institute, and through the years has been very active in the Institute.

Mr. D. F. Waters, another Foundation Member of the Waikato Branch, has also retired. He has been largely responsible for the building up of the highly efficient Soil Analytical Service for the Department of Agriculture.

Mr. K. J. McNaught leaves in May for 5 months overseas. He plans to return in October.

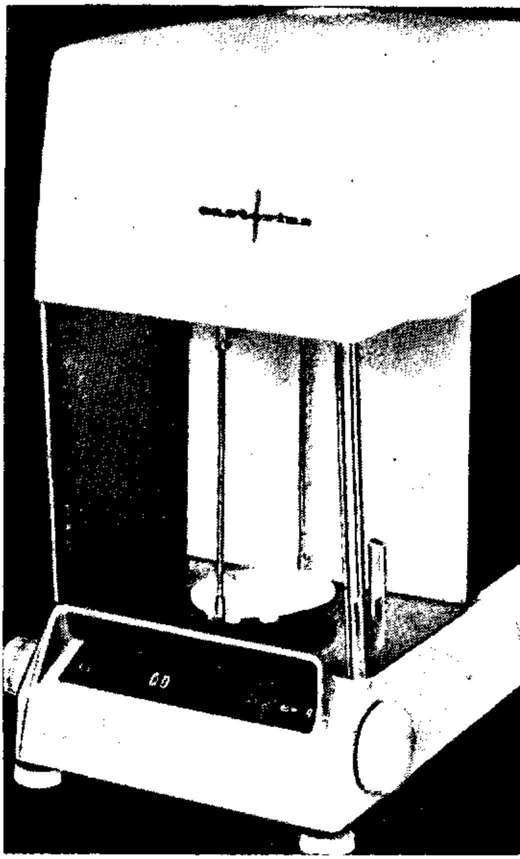
Recent additions to the N.Z. Co-operative Dairy Laboratory in London Street have been completed, and should facilitate work in Dairy Chemistry.

Canterbury

Mr. J. A. Grigor has transferred to the Waikato Branch. He is to be Head of the Science Department at Otumoetai College, Tauranga.

Dr. K. R. Richards, who has been appointed as a lecturer in chemistry at the University of Canterbury, is expected to arrive in June. He completed a first-class honours degree at the University of Exeter, spent some time in industry, then gained his Ph.D. at the University of Keele.

Dr. M. M. Sutton has arrived from the University of Leeds to take up a post-doctoral fellowship in physical chemistry at the University of Canterbury. At Leeds he carried out research on flames in the Houldsworth School of Applied Science. At Canter-



bury he will be using a mass spectrometer to study fast reactions in the gas phase.

Dr. K. H. Khoo, formerly of Otago University, has been appointed a lecturer in the Department of Chemistry, University of Malaya, Kuala Lumpur.

Otago

Dr. J. Rogers of the Geological Survey, Dunedin, has been appointed Research Director of the New Zealand Fertilizer Manufacturers Research Association (Inc.) and will take up his position at Otara, Auckland, in September.

Dr. W. C. Somerville has returned from six months' leave during which he visited numerous universities in Australia, India, North America and Britain in order to investigate the Residential Hall systems operating in these places.

Dr. A. G. Williamson has returned from a year's leave spent at the University of Exeter, and U.C.L.A.

INTERNATIONAL CONFERENCE ON ELECTRON-NUCLEAR HYPERFINE INTERACTIONS IN SPECTROSCOPY

17th - 21st OCTOBER, 1966, IN WELLINGTON

PROVISIONAL PROGRAMME

Persons marked with an asterisk are those who will be attending the conference. Further papers and attendances are expected.

Review paper on theory.

Pseudo-interactions in atomic and nuclear shells—model calculations of spectroscopic properties.
** B. G. Wybourne, Christchurch, New Zealand.*

Electron nuclear interactions in some iron (III) complexes.
** R. M. Golding, Wellington, New Zealand.*

Predictions of isomer shifts from atomic vibrations.
** M. Anderson and *J. F. Duncan, Wellington, New Zealand.*

Review paper N.M.R.-spectroscopy of heavy nuclei.
** E. Fluck, Heidelberg, Germany.*

Ionic contributions to the ground state splitting of S-state ions of the rare earths and the actinides.
** B. G. Wybourne, Christchurch, New Zealand.*

Spin-spin coupling in aqueous solutions of fluoroborates.
*J. W. Akitt, *N. N. Greenwood and J. Walker, Newcastle, Britain.*

Nuclear hyperfine couplings of the $NH_3{}^+CHCOO^-$ radical at 77°K.
** M. A. Collins, Wellington, New Zealand.*

Review paper on Mössbauer spectroscopy in Physics.
** H. Frauenfelder, Illinois, U.S.A.*

Carbon-13 N.M.R. of paramagnetic iron group cyanides.
** R. J. Kurland and D. J. Davis, Pittsburgh, U.S.A.*

Far infra-red spectra (10—500 cm^{-1}) of compounds containing heavy atoms.
** N. N. Greenwood and B. P. Straughan, Newcastle, Britain.*

g and hyperfine interaction tensors for small molecules.
** J. Bailey and *R. M. Golding, Wellington, New Zealand.*

Review paper on Impurity Spectra.
** D. P. Craig, London, Britain.*

General papers

Instrumentation for routine and high precision Mössbauer spectroscopy.
** J. J. Spijkerman and F. C. Ruegg, Washington, U.S.A.*

Relaxation effects in Mössbauer spectroscopy.
** A. J. F. Boyle, Perth, Western Australia.*

Magnetic hyperfine spectra of the 6.2 keV γ-ray of Ta^{181}.
** R. D. Taylor, W. A. Steyert and E. K. Storms, Los Alamos, U.S.A.*

Review paper on Mössbauer spectroscopy in chemistry.
** V. I. Goldanskii, Moscow, U.S.S.R.*

A new tin Mössbauer source.
** J. J. Spijkerman and D. K. Snediker, Washington, U.S.A.*

Mössbauer effect in metallic cesium.
**G. J. Perlow, Argonne, U.S.A., and A. J. F. Boyle, Perth, Australia.*

Mössbauer effect of some rare earth-tin alloys.
** C. R. Kanekar, R. P. M. Rao and V. U. W. Rao, Bombay, India.*

Mössbauer studies on ferroelectric materials.
Bookshpan and Pelah, Rehovoth, Israel.

Chemical effect of nuclear transformations on a fast time scale.
** R. H. Herber, New Brunswick, U.S.A.*

Applications of Mössbauer effect as an analyser in tracer method.
** V. I. Goldanskii, R. A. Stukan and E. F. Makarov, Moscow, U.S.S.R.*

Magnetic study of spinel phases.
** J. F. Duncan and *H. Whitfield, Wellington, New Zealand.*

Further Mössbauer data in the Ky^{83} clathrates.
*Grenshpan and *P. Hillman, Rehovoth, Israel.*

A study of the role of cations in two solid state reactions.
** J. F. Duncan, *K. McKenzie and *D. J. Stewart, Wellington, New Zealand.*

A Mössbauer study of iron phosphides.
** R. E. Bailey, Wellington, New Zealand.*

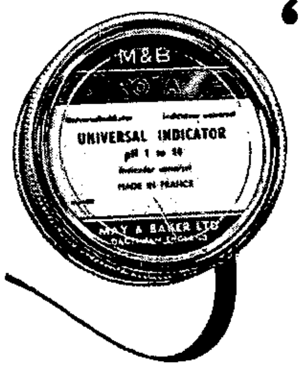
A study of iron co-ordination chemistry by Mössbauer spectroscopy.
** J. J. Spijkerman and L. May, Washington, U.S.A.*

Mössbauer spectroscopy of some iron-containing substances of biological importance.
*Vu. S. Moshkovskii, *V. I. Goldanskii and E. F. Makarov and R. A. Stukan, Moscow, U.S.S.R.*

Molecular structure studies of organometallic compounds by Mössbauer spectroscopy.
** R. H. Herber, New Brunswick, U.S.A.*

Mössbauer studies on hearing.
*Gilad, *Hillman, Rubinstein and Eviatar, Rehovoth, Israel.*

Mössbauer studies of ^{57}Fe in layered LiOH-type crystals.
*Simpoulos, Pelah and *P. Hillman, Rehovoth, Israel.*
Technical investigations of iron sands by Mössbauer spectroscopy.
** M. Avrahami and *R. M. Golding, Wellington, New Zealand.*
Applications of Mössbauer effect in mineralogy.
** G. M. Bancroft and *G. R. Burns, Cambridge, Britain.*
Mössbauer spectra of substituted Fe^{III} acetylacentonates.
** G. M. Bancroft, A. G. Maddock, W. K. Ong and R. H. Prince, Cambridge, Britain.*
Mössbauer studies of commensurate and incommensurate spin density waves in chromium and chromium alloys.
** R. Street and B. Window, Clayton, Victoria, Australia.*
A Mössbauer Study of ferrous ions in spinel crystal.
** K. Ono, L. Chandler and A. Ito, Illinois, U.S.A., and Tokyo, Japan.*
Mössbauer study of ferrous ions in $FeCl_2$, FeI_2, $NiCl_2$ and $CoCl_2$.
*A. Ito, T. Fujita and *K. Ono, Tokyo, Japan.*
Electron Spin Resonance Spectroscopy.
** J. Wertz, Minnesota, U.S.A.*



BOOK REVIEWS

Crystal Chemistry of Tetrahedral Structures, by Erwin Parthé. Publisched by Gordon and Breach, New York, London. Price $9.50.

This book sets out to describe a semi-empirical rule which applies to tetrahedral crystal structures, and correlates structure and valence electron concentration. Such semi-empirical rules are of very doubtful theoretical value, but until we are able to solve explicitly the proper Schrodinger equations for the energies of complex crystal structures, the rules do at least serve the purpose of systematising the available knowledge, and, to a limited extent, permit extrapolation of that knowledge to unknown compounds. If it is in fact true (as the author states) that "what sets this rule apart from other rules of crystal chemistry is the fact that exceptions do not seem to exist", then Dr. Parthé has made a considerable contribution to correlating a vast amount of information about an industrially very important group of compounds. However, time alone will demonstrate the truth of that statement.

The book starts with a fair introduction to tetrahedral structures, dealing first with "normal" structures in which every atom is surrounded tetrahedrally by four other atoms. A hasty treatment of sp^3 hybridisation (adequate for 1944, but disappointing in 1964) is followed by an excellent description of Grimm-Sommerfeld structures. An interesting appendix describes and relates the seven existing systems for defining the SiC homeotect structures. The remainder of the book is a valuable collection and discussion of "normal" and "defect" (perhaps an unfortunate word for an ordered structure with vacant sites) tetrahedral structures. It is for this collection of information, originally scattered through the metallurgical ceramic, geological, physical and chemical literature that the book is most likely to prove to be of value.

Although an occasional expression betrays the author's European origins, the book is well written, and extremely well produced with excellent diagrams, tables and indices, and very few misprints. The price for 176 pages is not low, but nevertheless the book may well find its way into the libraries of a number of solid state chemists.

P. P. Williams

Approach to Chemistry 1963, edited by E. S. Swinbourne and F. S. Symes; The University of New South Wales, Sydney, Australia, 1964.

This volume contains the proceedings of the fourth Summer School for secondary-school chemistry teachers held at the University of New South Wales in January, 1963. It is noteworthy as much for the evidence it provides of the enterprise of those connected with chemical education in Australia as for the interest of the 15 lecture texts and five workshop reports it contains. The lectures range from the specifically didactic (e.g. magnetic phenomena; nuclear chemistry; oxidation mechanisms; hydrogen bonds) to the broadly educational. Apart from a sprinkling of trivia ("the chalk board can be a powerful aid in the hands of the teacher skilled in its use") and occasional sermonising ("chemical substances . . . are mysteries which can be partly understood because the human mind is made in the image of the Mind which created them") there is very little in the volume which is unworthy of the attention of school teachers.

It is significant that the preface acknowledges the generous financial assistance of 24 industrial concerns which sponsored the Summer School. The University of New South Wales provided substantial funds for publishing the proceedings in the form of this well-bound volume. Would not chemical education in New Zealand benefit from a similar pooling of the resources of Industry and the University?

W. E. DASENT

Laboratory and Workshop Notes, 1962-1964, compiled and edited by Ruth Lang. Published by Edward Arnold (Publishers) Ltd., London, 1965. 278 pages. Price 60/- in U.K.

This is the seventh of a highly successful series and is a compilation of reprints culled from the *Journal of Scientific Instruments* by the skilful editorship of Dr. Ruth Lang. The book is arbitarily divided into seven sections and includes laboratory and workshop devices, optical devices, thermal devices and techniques, devices for low temperature work, vacuum and pressure techniques, as well as a section on electronic bits and pieces. All the articles reprinted in this volume have previously passed scrutiny by the editor and referees of the parent journal, so there is no doubt of their merit. It would be wrong to try to single out articles for special citation since such a selection is so dependent upon personal interests. Nevertheless, the book's one hundred and forty-eight articles have something for everyone who is interested in laboratory technique and instrumentation. It can be wholeheartedly recommended to those gadget-minded enthusiasts who like to be something more than mere users of ready-made "black-boxes". Finally it should be said that the price is reasonable, whilst the printing and presentation are excellent.

J. R. L. WALKER

Electrical Phenomena in Gases, by R. Papoular. First published in France in 1963 under the title *Les Phénomènes Electriques dans les Gas.* English edition by London Iliffe Books Limited, 1965. 198 pages. Price 45s.

On the dustcover of this book one reads that the subject matter ranges from first principles to the forefront of present day research. This may be true, but it must not be imagined that the book contains sufficient information to enable the uninitiated reader to make such a transition. A further claim made for this volume is that it is "very up-to-date". This claim was not true when the book was first published in the French edition in 1963 and is certainly not true now. No book published in such a rapidly developing field can be expected to remain up-to-date for two years.

Upon reading the book one soon realises that the writer's intention was to present in a concise form most of the more important topics which need to be discussed in any consideration of electrical phenomena in gases. Principal concepts and equations are introduced without much indication of their theoretical background. Such a treatment may convey to the reader the impression that the subject is a large collection of empirical facts. However, within the space of 198 pages there is very little scope to broaden the theoretical background in the book.

Necessarily the topics treated are extensive and include a discussion of atomic spectra and energy levels, elastic and inelastic collisions, surface phenomena, transport phenomena, diffusion and mobility. After the reader has been acquainted with the elements of each of these topics, the concepts involved are then employed in a discussion of some of the several forms of electrical discharges.

As a concise collection of fundamental facts and principles this book gives a competent introductory approach to the general area of collision phenomena in excited gases. However, since this is a somewhat specialised area, it is unlikely that anyone wishing to be acquainted with the field would be satisfied with this level of treatment. The enquiring reader will be disturbed to find that, apart from a list of a few standard texts, the book is without references. A book as concise as this one should be supplemented in the body of the text with sufficient relevant references. At the end of various chapters the author makes comments and draws conclusions, but the reader is not directed to the pertinent literature in order that he may evaluate for himself the relevant experimental and theoretical work.

Even after allowing for the limitations on the depth of coverage imposed by the size of the book there are a number of rather curious statements to be found. For example on page 13 ". . . charged particles are influenced by forces which have no effect on molecules or neutral atoms: i.e., forces of electric and magnetic origin". Quite apart from the fact that the author has thus denied the existence of phenomena resulting from the interaction of electromagnetic radiation with atoms and molecules, the reality of the Stern-Gerlach experiments, and the existence of dielectric phenomena, he has also implicitly denied the existence of ion-molecule reactions. These latter reactions, which result from the setting up of an ion induced dipole and the subsequent interaction of the ion-molecule pair, might be expected to be important in discharge reactions. Recent experiments using probes to analyse the composition of discharges clearly support this viewpoint.

On pages 58 and 59 we find a rather glaring misinterpretation of the Massey criterion for non-resonant charge transfer.

Papoular gives the condition for maximum charge transfer cross section as

$$v = \frac{a\,E_s}{h}$$

where v is the ionic velocity, E_s is the energy defect of the reaction, and a is a constant of atomic dimensions. Use of the equation in this form allows a satisfactory treatment of endothermic reactions. However the form suggested by Massey is

$$v = \frac{a\,|E_s|}{h}$$

Using this form of the equation it can be appreciated at once why the shape of the cross section curve as a function of ion velocity could be similar for both endothermic and exothermic reactions. This expectation is well supported by experiment. Consequently the statement on page 59, that when $E_s < O$ the maximum cross section appears at zero velocity, is simply not true and could not be expected to be true if the Massey equation was applicable and if it were correctly interpreted.

The discussion of recombination reactions reveals the obsolescent nature of the book. In the conclusion of this section it is stated that very little is known about the process of recombination. In actual fact over the last ten years or so a great deal of information has been gathered on this subject mainly by the use of elegant microwave probe techniques.

For those interested in reading about electrical phenomena in gases there are a number of eminently more suitable works available. These include books by G. Francis (1960), J. B. Hasted (1964) and A. von Engel (1965).

K.R.R.

Diels-Alder Reactions, by A. Wassermann. Published by Elsevier Publishing Company, 1965. 114 pages. Price 30/-.

This book is the first summarising monograph published dealing exclusively with Diels-Alder reactions with particular reference to the theoretical aspects. The first chapter consists of an introductory discussion of the organic background, and deals with the various kinds of dienes which can take part in the reaction. Particular stress is laid on the difference in reactivity between dienes with the cisoid, and with the transoid conformations. The discussion of dienophiles is largely restricted to maleic anhydride, although there is a brief discussion of the reactions of cyclopropene, cyclooctyne, and benzyne with dienes.

The remaining chapters of the book deal with the more theoretical aspects of the Diels-Alder reaction. Chapter two discusses the stereoisomeric products which can be formed, and includes a description of the stereochemistry of polymers formed by this reaction. Chapters three, four and five deal with equilibria, kinetics, and reaction mechanisms, and require a fair background knowledge of physical chemistry, as no derivations are given for the fundamental formulae which are frequently mentioned.

The author states that the book is intended mainly for chemists interested in research into correlations between structure and mechanism, and it can be recommended to such workers with confidence. It will also be of value as a reference book for those interested in the synthetic applications of the Diels-Alder reaction.

J. T. Craig

Science of Materials, T. J. Lewis and P. E. Secker. Published by Harrap, London, 1965. 256 pages, price 27/-.

The authors' "aim is to provide a largely descriptive but detailed account of the nature of atoms and molecules and the manner in which they interact to form everyday materials".

This book is attractive reading. It is an excellent *description* of the theory usually contained in a modern advanced chemistry course. The logical development of, and the evidence for this theory is rarely described, so that after eleven chapters of it, the final chapter on real materials is welcome. These real materials are metals, organic materials (polymers only), ceramics, and fuels. Semiconductors are not discussed.

A list of introductory and advanced texts and popular articles is given, but it is not referred to in the text.

This book raises in an acute form the controversy as to whether a descriptive account of advanced theory gives a student a more useful background than does a rigorous treatment of more elementary matters of fundamental importance. I find a systematic descriptive account of the facts acceptable, but have never been able to use any theory which I have been unable to examine critically to my own satisfaction. On the other hand the authors must believe that engineers will use materials more effectively if they read this book.

The diagrams, layout and printing are very clear and the excellent paper has no shine. The cover is drab. The book is good value for money, good bedside reading and a useful source of material for popular lectures. Engineers should read it, but I would hesitate to recommend it as a serious study text.

W. S. METCALF.

Industrial Heat Transfer, by ALFRED SCHACK. Chapman and Hall. 1962. Sixth Edition. Translated from the German. Price £5 (U.K.).

Although several excellent books on engineering heat transfer have been published during recent years, Professor Schak's book is by no means redundant amongst them. The book's main strength lies in its presentation of heat transfer coefficients, in easily understood form, which cover most of the circumstances met with in practice. One unusual feature is that the heat transfer coefficients in convection are presented alone, and not hidden in their associated dimensionless number. This feature certainly aids quick reference. A small section of the book is devoted to numerical examples of calculations typical of the various topics discussed. This, together with a reasonably complete collection of basic heat transfer data which is also included, helps to maintain the book's practical approach.

Throughout the book the general approach is first to describe briefly the major equations involved and then to discuss, often in great detail, their derivation. After this, summaries of experimental confirmation from the literature are presented.

Conduction heat transfer is very fully discussed as far as the more elementary aspects are concerned, and unsteady state problems are presented in a direct and easily understood manner. Mention is made of experiments to measure conduction through porous walls through which gas is also flowing. However, there is little account given of numerical methods of solving unsteady state problems, and relaxation is not even mentioned.

The section on convection starts with a clear exposition of the principles of similarity and dimensional analysis. Fairly detailed accounts are given of the historical developments of most of the traditional dimensionless groups, whilst the limitations of the various approaches are discussed. The whole section covers about one-third of the entire book and abounds with summaries of accounts of experimental determinations of heat transfer coefficients taken from the literature. These include liquid metal transfer and coefficients encountered in staggered brickwork regenerators.

The basic ideas of radiation heat transfer are only sketchily covered, particularly those concerned with enclosures with walls at different temperatures, and the very useful concept of the resistance analogy in radiation is not mentioned. The radiation section does, however, cover radiation from, and through, gases very fully and this is obviously a subject of great interest to Professor Schack The collection of data presented is probably one of the fullest available in a general heat transfer textbook.

A section is devoted to heat exchangers and regenerators and fairly detailed descriptions of the general equations defining effectiveness are given including the case where the heat transfer coefficient is a function of position, in the exchanger. Costs are also dealt with to a limited extent. The treatment of regenerators is very full.

In presentation the book appears to be rather crowded, for instance the section on convection starts on the same page as the end of conduction, and is preceded by a minor heading only.

Diagrams are not numerous, but graphs and tables are adequate and well presented. The English is rather stilted, probably as a result of translation, and in a few places is a little difficult to follow. There appear to be occasional misprints, variables being printed as subscripts in two cases. However, these errors are of a minor nature and detract little from the value of the book which can be recommended with confidence to those faced with heat transfer problems of a type encountered in industry.

J. B. STOTT.

Annual Surveys of Organometallic Chemistry. Volume 1. Covering the Year 1964, by DIETMAR SEYFERTH and R. BRUCE KING. Published by Elsevier Publishing Company, Amsterdam, London and New York. 1965. 130 pages. Price 110/-.

One should begin a review of what is essentially an edited summary of one year's published work in the field of organometallic chemistry by considering the prior need for such a book. In the opinion of the reviewer the enormous growth in the number of papers written on the chemistry of organometallic compounds and the range of journals in which they appear is sufficient justification for the annual publication of a book primarily designed to alleviate some of the organometallic chemists' burden.

For the purposes of the survey the editors define an organometallic compound as one "which contains at least one metal-to-carbon bond and we include metal carbonyls in this definition". There is a division into main group (non-transition) metal (D. Seyferth) and transition metal (R. B. King) organometallic compounds, with a subdivision according to the periodic groups. Each editor provides a brief synopsis of the highlights in his sphere of interest and these include such topics as the structure of the Grignard reagent in ether solvents, the details of Sommer's work with optically active organosilicon compounds, the generation and reactions of silenes and germenes and the increasing use of Mössbauer spectroscopy in the study of organometallic compounds containing iron. A list of contemporary review articles and books is given. The editors then endeavour to give a critical coverage of the various groups in a style similar to that of Annual Reports of the Chemical Society.

This first volume has been competently prepared and the coverage is of sufficient depth to warrant recommending the book to the uninitiated as well as to the practising organometallic chemist. This volume, and one hopes all subsequent volumes, could serve as a useful stepping-off place to a more detailed treatise on the subject.

G.R.B.

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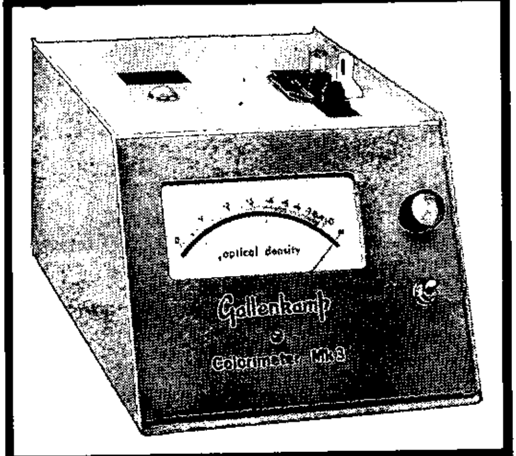
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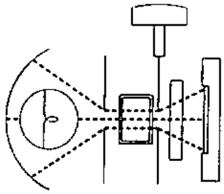

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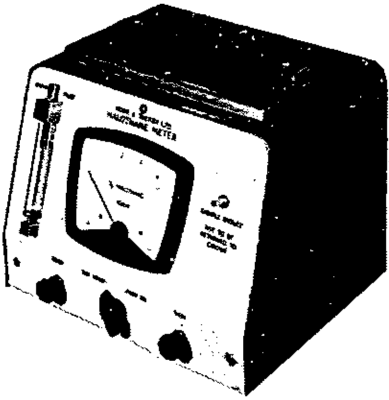

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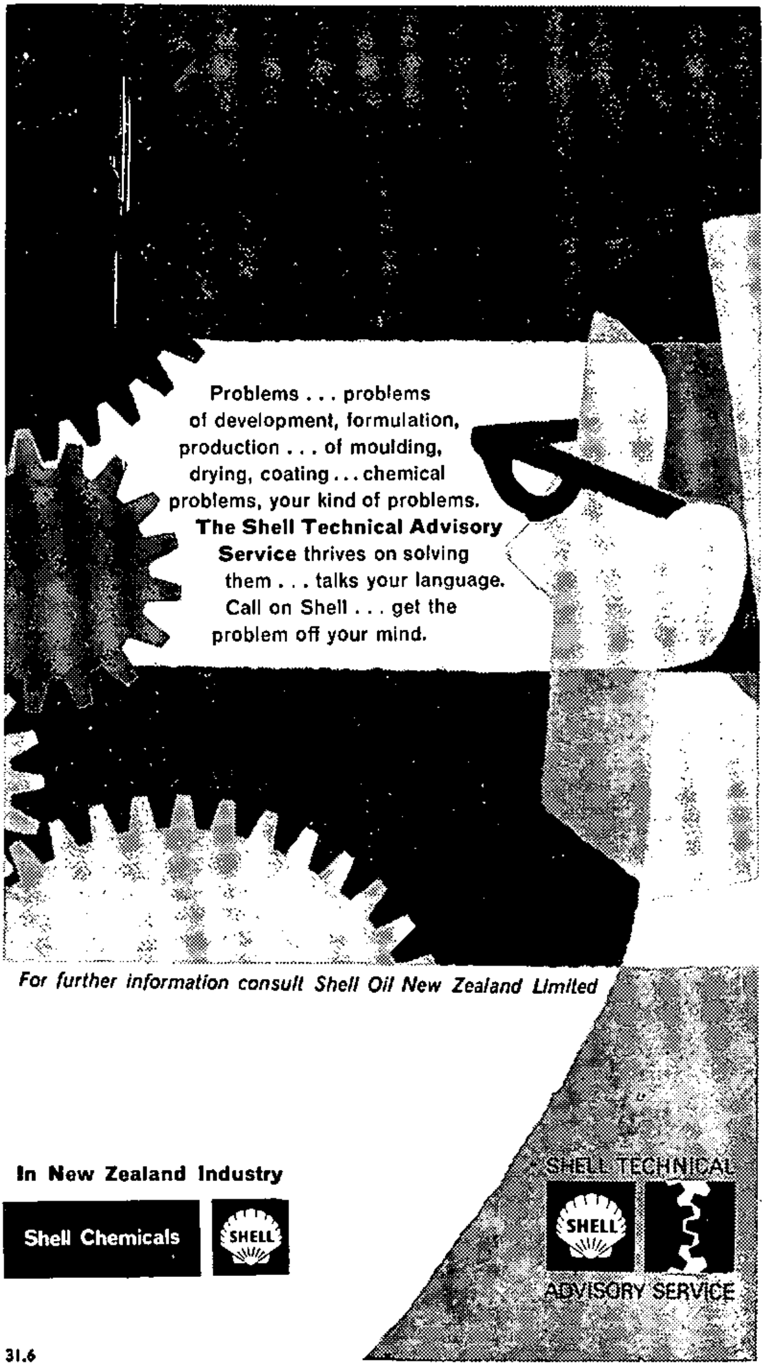

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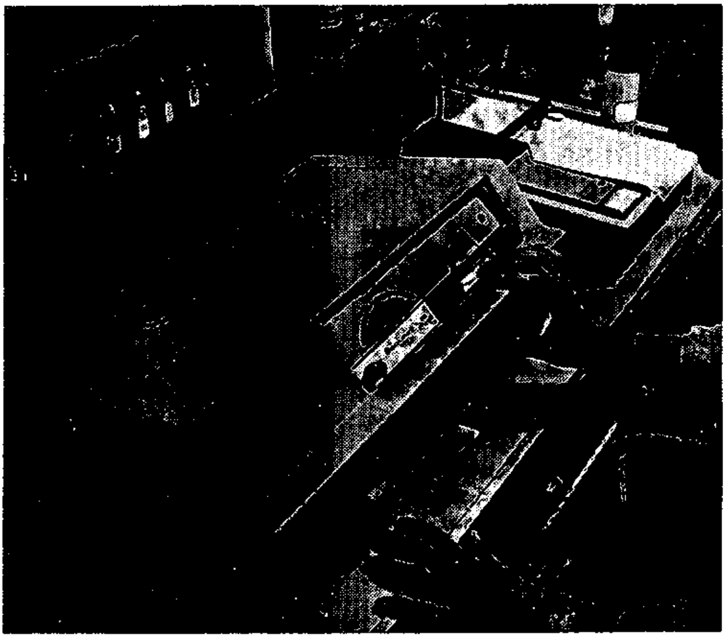

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