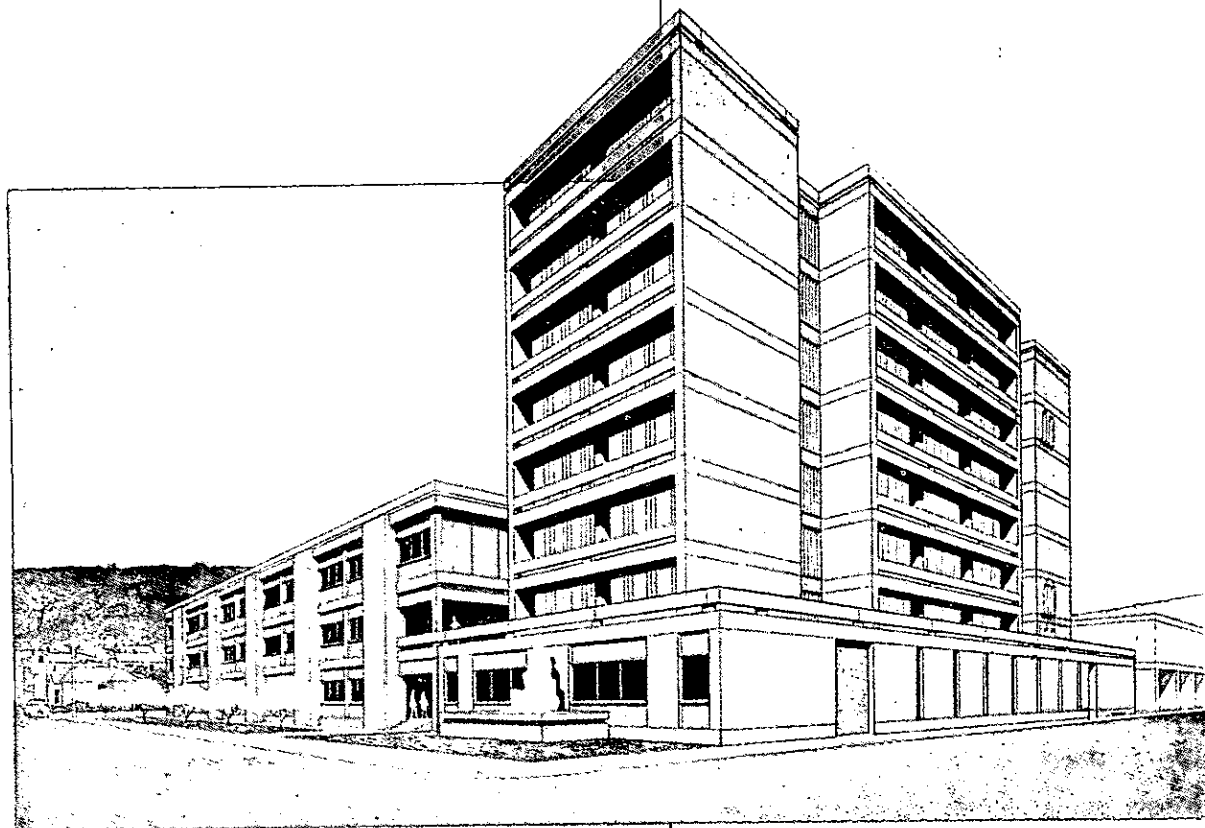


CHEMISTRY IN NEW ZEALAND

**JOURNAL OF
THE NEW ZEALAND
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Vol. 31, No. 6, December 1967



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JOURNAL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

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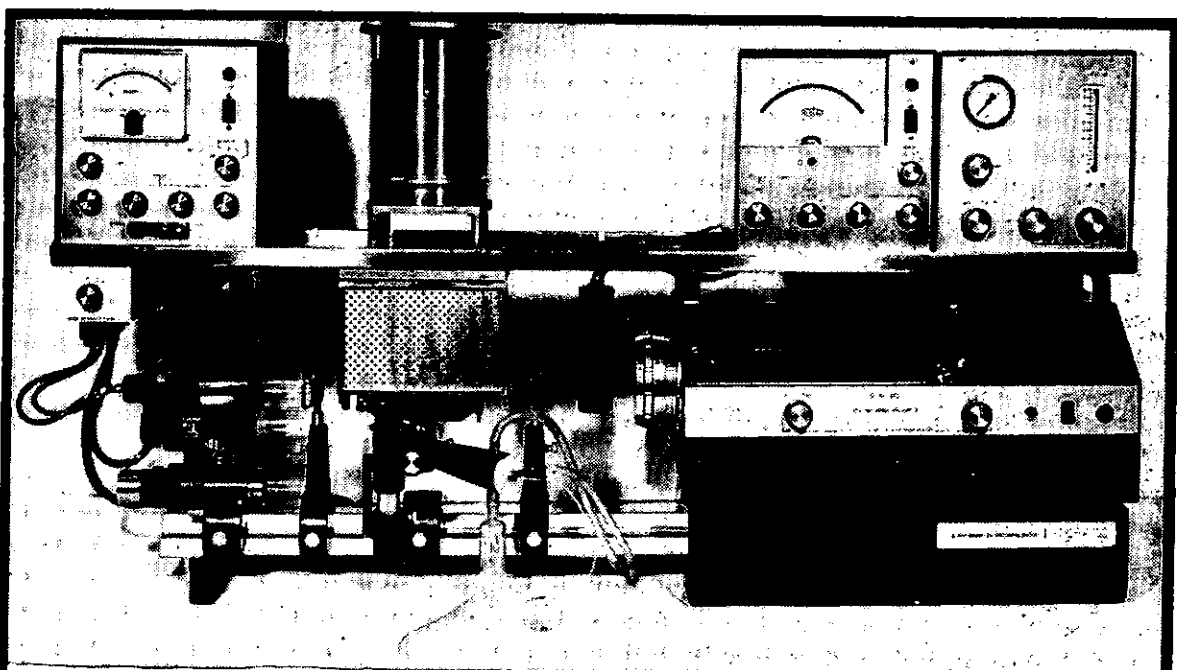
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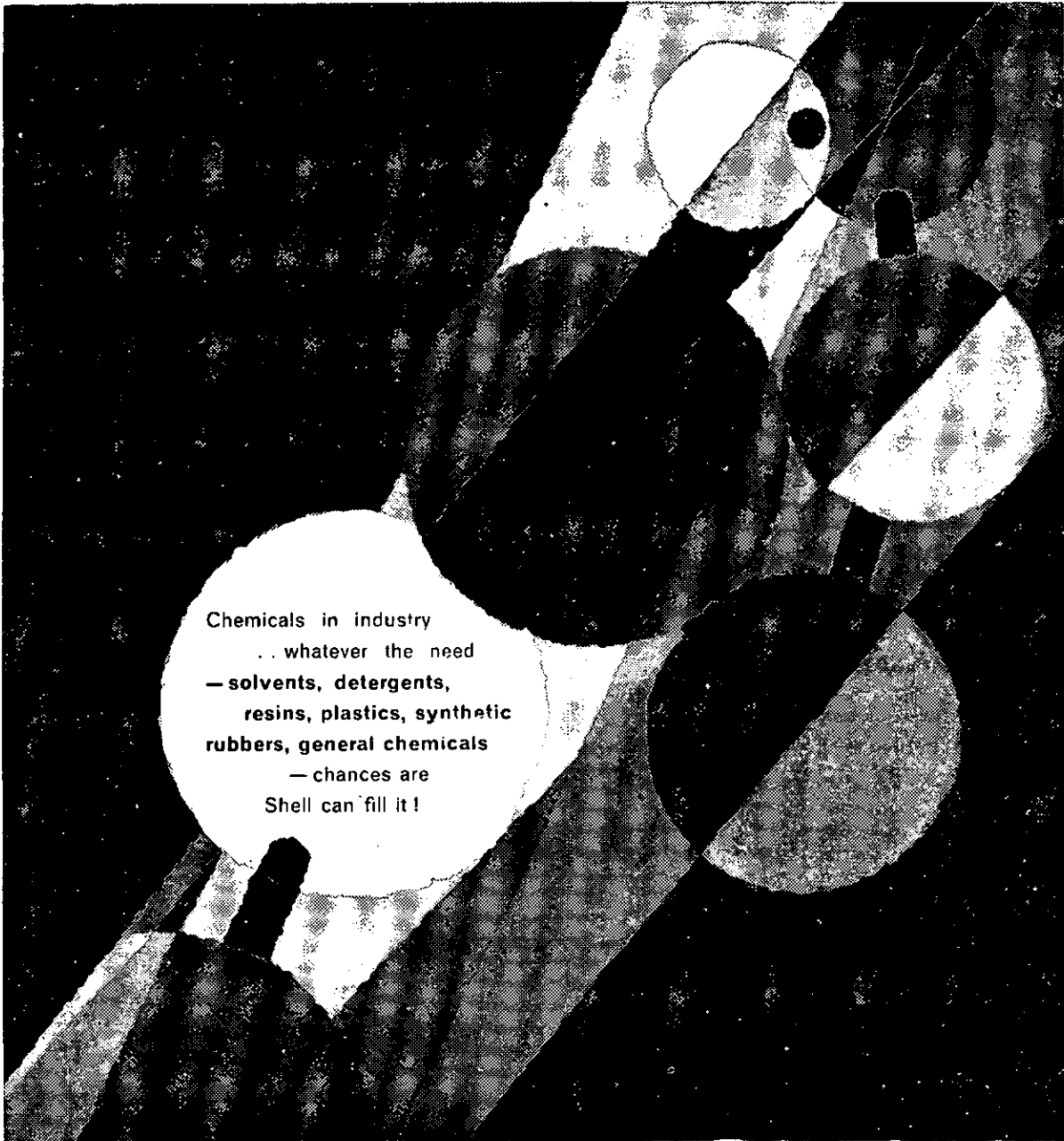
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EDITORIAL . . .

THE teaching of chemistry, how to teach it, what to teach, to whom and for what purpose has become a frequent subject for discussion and investigation. The recent visit of Professor Sir Ronald Nyholm has been the highlight of the year for those concerned with this aspect of chemistry.

Professor Nyholm is Chairman of the I.U.P.A.C. Committee on the Teaching of

Chemistry which recently published a report "The Effect of Examinations in Determining the Chemistry Curriculum up to the level of University Entrance." The comments on and criticisms of various types of questions and the probes into the purposes of examinations should give all those who set examinations plenty of food for thought when they draft their next questions.

EASTERFIELD AWARD 1967

The Easterfield Medal for 1967 will be awarded at the 1968 Conference of the New Zealand Institute of Chemistry and applications are now being sought from suitable candidates.

This will be the seventh occasion on which the Award has been made and it is intended to maintain the high standard already established by the previous applicants. The MEDAL, which will be supplemented by a cash grant of \$50.00, is considered to bring high honour to the successful applicant and should be particularly attractive to research workers in chemistry.

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and applicants are reminded that their age at 30th April, 1967, must be under 35 years. Applications close on 15 February, 1968.

STIMULATION OF THE SENSORY NERVES*

J. T. Davies, M.Sc.(N.Z.), M.A.(Cantab.), Ph.D., D.Sc.(London)

Professor of Chemical Engineering and Head of the Department, University of Birmingham

Formerly Beit Memorial Fellow for Medical Research

Consultant on Odour to International Flavours and Fragrances Inc.

Introduction

Almost exactly 2,000 years ago, Lucretius¹ tried to unify and explain the concepts of heat, light and odour by an atomic theory. He wrote "You cannot suppose that atoms of the same shape are entering our nostrils when stinking corpses are roasting as when the stage is freshly sprinkled with saffron of Cilicia and a nearby altar exhales the perfumes of the Orient . . . You may readily infer that such substances as agreeably titillate the senses are composed of smooth round atoms. Those that seem bitter and harsh are more tightly compacted of hooked particles and accordingly tear their way into our senses and rend our bodies by their inroads".

Thus over the centuries have investigators been puzzled by the extraordinary sensitivity of the sensory nerves of living creatures. The human sensory systems, for example, are sensitive to as little light as a few quanta (i.e., a total energy of about 10^{-11} erg), to sound waves of amplitude of the order of atomic dimensions and to quantities of odorous substances (called odorants) as low as 10^{-14} gram. The latter quantity, although it still contains a very large number of molecules, is far below the level of the best analytical balances. These astonishing sensitivities can never be understood until we know the detailed mechanisms by which the primary impulses (the quanta of light, the wavelike vibrations of the sound and the adsorption of the molecules of the odorant, etc.) are converted into the electrical impulses which

constitute the excitation of the nerve. A device for the conversion of light etc. into an electrical (or other) impulse is known as a transducer. These biological sensory transducers are characterised by their extremely sensitive built-in amplifiers which increase the energy of the input signal by a factor of several thousand times. This is rather like the firing of a powerful gun by the relatively small force on the trigger.

For many years it was believed that the chemical senses smell and taste were among the more complicated senses. True, their behaviour had long defied numerical analysis, while studies of light and sound were more readily amenable to quantitative investigations. However, it now seems possible that a mechanism which I first suggested in 1953 to explain how odorant molecules initiate nervous impulses^{2,3} may cast light on the more general problem of the transducer action in the detection of other stimuli. Let us return to this subject after a more detailed discussion of the proposed action of odorants on the olfactory (smell-detecting) nerves.

One of the most striking facts about the stimulation of the olfactory nerve fibres is the excessive sensitivity of the olfactory cells. Even in man, whose sense organs are not particularly sensitive, quantities of odorant (e.g., skatol) as small as 10^8 molecules are normally detected, while for moths the quantities are claimed to be much smaller. How is it, we may ask, that such minute, unweighable quantities, containing a calculated 10^{-14} gram, can affect the nerves? Direct experiments are urgently required yet the receptor sites on the ends of the olfactory nerves are too small to study directly. One way round this difficulty may lie in the study

*This paper was read before a joint meeting of the Royal Society of New Zealand and the N.Z. Institute of Chemistry at Christchurch on 31st October, 1966.

of model systems, simplified "artificial noses" whose physico-chemical properties are more amenable to close investigation.

Proposed Olfactory Mechanism

The minute quantities of odorant necessary for stimulation have been mentioned above. These figures apply only to the most powerful odorific substances such as musk, artificial musk (trinitro-tert-butyl-xylene) and skatol. The answer to the problems of the sensitivity of the detectors must lie partly in the structure of the molecules causing the nervous excitation. What do these three types of molecule have in common that makes them so peculiarly effective? They are, of course, all sufficiently volatile to reach the receptors. But, apart from that, their common property is that the molecules are all bulky and fairly strongly adsorbed at interfaces. This combination furnishes a key to the mechanism of stimulation.

During the excitation of a nerve it has been shown⁴ that the normal excess concentration of potassium ion inside the nerve is able to escape through the lipid plasma membrane which bounds the nerve cell. Simultaneously the deficiency of sodium ion within the nerve is made up locally by an intake of sodium from the higher concentration in the aqueous phase surrounding the cell. During its resting period the nerve cell somehow "pumps" sodium out of the cell and allows in excess potassium, both processes occurring against the concentration gradients.

This excess concentration of potassium ion inside the cells is rather like the excess air inside a balloon: energy is stored in the system by the inequality of concentrations and this energy is released upon "puncturing" the wall. Through the wall of the nerve cell, the potassium rushes out and the sodium rushes in; the concentrations inside and out are momentarily equalised and energy is released. Just as when a balloon is pricked with a pin the energy released breaks the wall farther along, so in some way the stimulation of one part of the nerve wall is able to transfer the breakdown of the fatty lipid layer to a

point farther along the fibre. This progressive breakdown of the cell wall constitutes the nerve impulse.

The lipid layer in most cells is not thick. Even bimolecular "sandwiches" of the type shown in Figure 1 would be enough to confer, under normal circumstances, the necessary impermeability to the cell wall and to maintain the concentration gradients. Such a layer preserves its continuity by being partly liquid: the hydrocarbon chains of the fatty molecules can move about with a certain degree of freedom, although this will be limited by the presence of rigid molecules such as cholesterol.

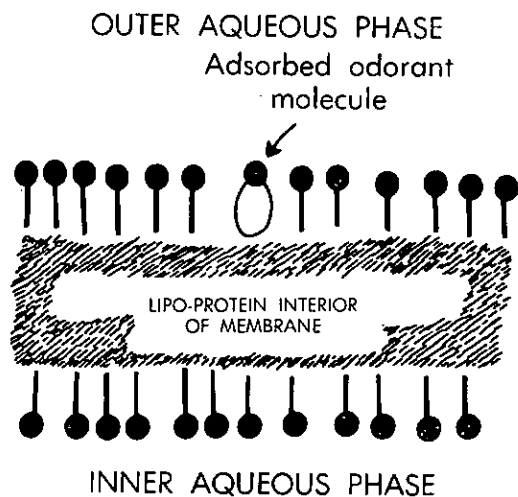


Fig. 1 Schematic representation of orientated lipid molecules constituting wall of olfactory nerve. These molecules are represented by a hydrocarbon tail and a polar headgroup.

Suppose that into this membrane there penetrates a bulky, awkward-shaped and rather rigid odorant molecule. This may either desorb out of the membrane or it may diffuse through (Figure 2). If the latter occurs, the hole left behind the diffusing odorant molecule may heal only relatively slowly, so that ions can pass through the hole. Once this leakage occurs, it initiates (as is generally accepted) the nervous impulse in the nerve. This puncturing process is the

modern counterpart of the atoms of Lucretius "tearing their way into our senses and rending our bodies by their inroads".

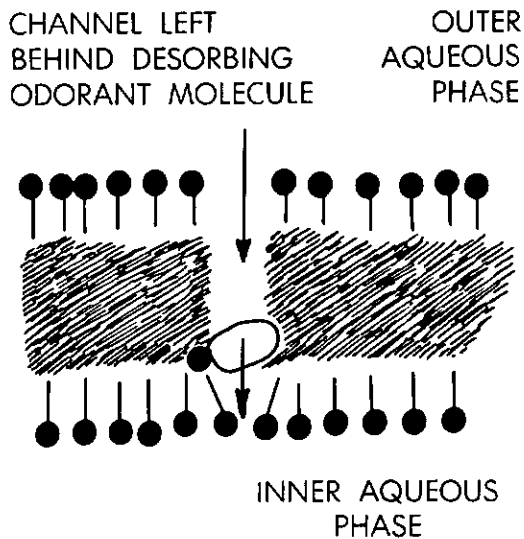


Fig. 2 Here the odorant molecule is penetrating through the lipid membrane of the cell, causing a "puncture". This will allow potassium ions to escape and sodium ions to enter, so initiating the nervous impulse.

If this mechanism^{2,3} is realistic, we should expect a correlation between the numbers of odorant molecules necessary for threshold stimulation and the number of cells lining the olfactory epithelium in the nose. The latter number about 2×10^7 in the human species, a figure in remarkable agreement with the value of 10^8 molecules for threshold stimulation by large molecules. This suggests that for these, the most effective of odorific substances, only a few (and perhaps only one) molecules of the odorant are sufficient to cause breakdown of certain cell walls.

For less powerful odorants such as ether or chlorophenol (whose molecules are smaller) it may be necessary for several of the odorant molecules to penetrate the cell wall side by side. This would explain the enormous differences in sensitivity to molecules only slightly different in solubility and chemical

properties; the shape, size and the rigidity are important. For example, if two molecules of odorant have to penetrate the cell wall at the same point before stimulation occurs, the concentration of odorant required must, by probability theory, be greater by several powers of 10 than if only one molecule were required. The known million-fold differences in sensitivity of the cell wall to phenol and synthetic musk are thus explicable, as is the experimental finding that the olfactory threshold (molecules of odorant per cubic centimetre of air required for the odour to be just detectable) of ethane is about 10^{11} times greater than the threshold for a strong odorant such as beta-ionone.

It is not necessary, of course, that all the olfactory nerves should be stimulated before an odour is perceived. It may happen, and this seems to be true for moths, that only a few fibres need stimulation before the smell is detected, whereas we need a large fraction of ours to be affected. Perhaps this explains the lower sensitivity of man's olfactory apparatus compared with that of dogs and insects. On this view, the difference between the species having different olfactory sensitivities would lie in the amplifying power of the appropriate part of the brain rather than in the olfactory organ itself.

"Artificial Noses"

Perhaps the most obvious type of model system to choose for the study of olfaction is a large living cell. It is generally agreed that the plasma membranes are somewhat similar from cell to cell, and so by choosing a cell sufficiently large for easy experiment, we may find a model awaiting us ready made. Several species of cells have been studied to elucidate the properties of the enclosing membranes. The red blood cell, for example, has been popular because when it is punctured (lysed) the red pigment haemoglobin rapidly escapes, thereby changing the colour of the whole solution. One of the most striking properties of red cells is that large, rigid, irregularly-shaped molecules such as saronin

are extremely effective in lysis. It has been found in the kinetics of haemolysis that simple kinetic equations of physical chemistry are not obeyed; the rate seems more like the speed at which a house falls when workmen start digging at the foundations! For a while nothing appears to happen, although the structure is certainly being weakened. Suddenly, however, comes the crash, corresponding to rupture of the cell wall, and lysis has occurred. These "all-or-nothing" reactions are much commoner in biological systems than in physical chemistry and this makes it difficult to find non-living models for the olfactory system.

In the concentration range studied, odorous substances act only as weak haemolytants. Dr. F. H. Taylor and I found,⁵ however, that all the odorants we tested acted as accelerators for haemolysis by saponin. Thus, the presence of only 0.002 percent of beta-ionone (a powerful odorant) in solution—or, more precisely, a 10^{-4} M solution—approximately doubles the rate of haemolysis by aqueous saponin solutions.

The accelerating power is a measure of the extent to which the cell wall is weakened by the penetration of the odorant. If the model is a good one, and if the odorant molecule is really adsorbed into and penetrates the olfactory cell wall, then we may expect a relation between the olfactory thresholds and the accelerating power for haemolysis. That this correlation does indeed exist is shown in Figure 3. Substances such as beta-ionone or skatol, which are powerful odorants (low olfactory thresholds), are also powerful accelerants; phenol and ethanol, having large olfactory thresholds (weakly odorant), are weak accelerators.

Mathematical Model

To place this "puncturing" theory of odour on a quantitative basis Dr. Taylor and I assumed⁶ that two factors control the puncturing of the nerve membranes. The first is the adsorption energy of the odorant mole-

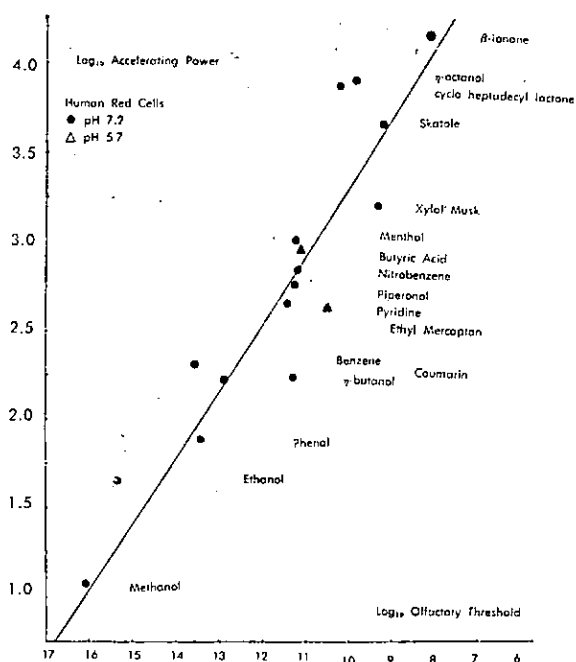


Fig. 3 Logarithm of the accelerating power of various odorants plotted against the logarithm of the olfactory threshold for humans (Davies and Taylor, see reference 5).

cules from the air to the lipid-water interface, constituted by the lipid-wall of the hairs which form the sensitive tips of the olfactory nerves and the thin layer of mucus in which they are bathed. This adsorption may be calculated from the free energies of the odorant molecules in passing first from air to water and secondly, being adsorbed from water at the lipid-water interface. Next, the adsorbed molecules must be effective in "puncturing" the olfactory nerve membrane at some point, either singly or with several smaller odorant molecules close together. From these considerations a mathematical equation can be derived predicting the olfactory threshold in terms of the molecular size and adsorption energy of the odorant molecule. The appropriate adsorption energy can be approximated from laboratory experiments so that olfactory thresholds can be predicted and compared with experiment.

Transducers for Various Senses

Various extensions of the "puncturing" theory of olfactory stimulation have recently been proposed for the stimulation of other sensory nerves. Again, the "puncturing" theory explains both the mechanism and the "triggering" of the release of more energy than is present in the input signal.

In the light receptors of the eye a substance called rhodopsin adsorbs light with a change in molecular shape of its chromophore (11-cis retinene) to a more linear molecule (cis-trans isomerisation). Since the transverse nerve membranes are constituted in a large part of visual pigment, it was suggested⁶ in 1962 that "the attack of the light on a molecule of visual pigment might in effect punch a unimolecular hole in such a membrane. That might permit a large flow of ions, resulting in a local depolarisation or loss of resistance sufficient to excite". An interesting analogy may also be drawn with the behaviour of monomolecular films; more linear molecules (trans configuration) fit together much more snugly and occupy less of the surface area.⁷ Consequently, holes could well be produced in the membrane by such a change of packing under the influence of light.

The transducer action by which sound vibrations are converted into electrical nerve impulses is also extremely efficient. Though amplitudes of as little as 10^{-11} cm. are reported⁸ to be detectable by the ear, this figure seems to be suspiciously low, as it is well below the size of a single atom. However, even if we take a figure of 10^{-7} cm. as reasonably well established, the problem still arises of how such a minute displacement can produce triggering of the nerve endings of the ear. Békésy's recent suggestion⁹ again envisages a puncturing process; "varying the free space between the molecules in a molecular layer may change the equilibrium of flow of some ions—mainly the sodium and potassium ions—across the molecular membrane, thus producing a change in the concentration potential across both sides of the membrane. . . . The energy of the potentials

would be obtained not from the mechanical energy of the vibrations but from an electrolytic pool". Again, there is a close analogy with the behaviour of certain monomolecular films—orientated, close-packed molecules of hexadecanol can set up a considerable barrier to the evaporation of water from a clean water surface into air.⁹ The magnitude of the barrier is, however, highly sensitive to the area occupied by each molecule in the film and a slight expansion of the film allows holes to form on a molecular scale sufficient to allow the water to pass through the film. The analogy with the biological membranes is obvious. Mechano-receptors, sensitive to mechanical pressure, may well work in the same way; the increase in permeability may result from a simple stretching of the receptor membrane.¹⁰

Temperature receptors in animals, it has been suggested,¹¹ may also operate through a change in the permeability of the nerve endings.

In olfaction, for which the "puncturing" mechanism of nervous stimulation was first put forward,^{2,3} monomolecular films again provide a close analogy. If in a hexadecanol film which would otherwise greatly inhibit the evaporation of water, there is a very small amount of benzene, this drastically reduces the barrier to the passage of water (La Mer⁹). Presumably, by rapid interchange between dissolved benzene below the film and benzene molecules in the gas above, holes are formed in the hexadecanol monolayer; and through these holes water can easily escape. Here the parallel with the escape of ions in the "puncturing" theory of nervous stimulation is again clear.

Conclusion

The recent interest in the fundamental mechanisms of biological transducer action has focussed attention on the permeability of the plasma membrane which surrounds the receptor nerve endings. The simple "penetration and puncturing" theory of olfaction, put forward in 1953 to explain the

physiological behaviour of odorants and for which there is the indirect evidence quoted above may perhaps be generally applicable to receptor mechanisms. If this is substantiated, it will be a refutation of the belief, still held in some quarters, that more precise measurements in terms of classical physics, e.g., of wavelengths and audio-frequencies can alone constitute a "scientific" study. Semi-intuitive approaches, particularly in the more complex fields of biology, interfacial phenomena and engineering science, may sometimes cast light where refinements of previous measurements are of little avail.

The "penetration and puncturing" theory is purely physical: no chemical process is observed. But, in spite of this further example of the "invasion" of chemistry by physics, the so-called chemical senses are still chemical in one respect. They are becoming better understood through the inventiveness of the organic chemist: he is synthesising many exciting new compounds (e.g. artificial musks¹²), using which the various theories of odour can be more sharply tested.

- ¹ Lucretius, T. C., "The Nature of the Universe", (47 B.C.); English translation by Latham, Penguin Books (1951).
- ² Davies, J. T., *Industr. Parfum.* 8, 74, (1953).
- ³ Davies, J. T., *Int. Parfum.* 3, 17, (1953).
- ⁴ Hodgkin, A. L. and Katz, B. J. *Physiol.* 108, 37, (1949).
- ⁵ This subject has been reviewed by Davies, J. T., *Symposia of the Society for Experimental Biology.* 16, 170, (1962).
- ⁶ Wald, P., Brown, P. K., and Gibbons, I. R., *Symposia of the Society for Experimental Biology.* 16, 32, (1962).
- ⁷ This subject has been reviewed by the present author in "Advances in Catalysis". 6, 1, (1954).
- ⁸ Békésy, G., *Symposia of the Society for Experimental Biology.* 16, 267, (1962).
- ⁹ This is reviewed in Davies, J. T., and Rideal, E. K., "Interfacial Phenomena" (Academic Press, 1963).
- ¹⁰ Inman, D. R., *Symposia of the Society for Experimental Biology.* 16, 317, (1962).
- ¹¹ Murray, R. W., *Symposia of the Society for Experimental Biology.* 16, 245, (1962).
- ¹² Theimer, E. T., and Davies, J. T., *J. Ag. and Food Chem.*, in press (1967).

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WHEN CHEMISTRY LEAVES THE CAMPUS

*R. H. Earle (Jnr.), M.Sc., Ph.D., of Hercules (Incorporated), Post-doctoral Fellow,
Chemistry Department, University of Canterbury*

If there is little room for basic research in the chemical industry today, we have no one to blame but ourselves. For too long we have been hiding behind the sacred cow of scientific objectivity—unwilling to dirty our hands in the practical realities of what happens when chemistry leaves the campus.

First, I will define what I mean by that much misused, catchall phrase "basic research". By "basic research" I mean experimental investigations designed to find out how and why things work; in chemistry how and why molecules react and interact. Such work is in contrast to "pot-and-paddle" chemistry through which, by trial and error, we devise new formulations or chemicals. It is also distinct from that kind of research devoted to grinding out data on physical or chemical properties without much concern for their consequences. In the latter area university as well as industrial work is too frequently bogged down under the misnomer of "basic research". This definition of basic research also distinguishes it from the necessary but limited work of control chemistry which is aimed at ensuring useful and uniform production or assaying for given properties by known methods.

The usual conclusion reached by chemists today is that there is little room for basic research in industry. Even in our universities, government and foundation grants are looked upon as tending to corrupt the true "basic" nature of research.

In this respect New Zealand is no different from the rest of the world. Many times I have heard chemists say, "My company isn't interested in research. The only thing you can spend money for is testing equipment". Or, "I don't want a research grant from

them, they'll just tell you what to do and you'll end up as nothing but a pair of hands". Very often these statements are only too true. The most amazing thing about this attitude is that we, the chemists, happily assume that the whole trouble lies in the lack of appreciation by the world of non-scientists of what we have to offer. We pompously assume that the rest of the world, whether it be a board of directors, a government grant committee, a group of shareholders, or a board of trustees should take our word for it that their money is well invested in our research.

Even more deplorable is our attitude that it is up to someone else to justify the money we spend, after it has been spent. Somewhere we have arrived at the happy state of mind in which we think that all we have to do to justify our existence and our expenditure of what, by anyone's measure, are huge amounts of money is to put in time in the laboratory and grind out results. We have no responsibility for the consequences of these results within the context of a real world. We often self-righteously pride ourselves on the "purity of our research" by the very fact that it has no visible application.

In reality, there are undoubtedly huge amounts of money being spent on ill-conceived and poorly executed investigations which are carried out with little, if any, idea as to why such work should be done. You have only to scan the current flood of journals to have strong doubts as to the present state of the quality (but certainly not the quantity) of research.

There is, at any given time in the world, only a finite amount of time, money and talent available. The same thing is true within the confines of any given company, busi-

ness or university. The decision as to what areas should have the use of these resources is a vital one in terms of the ultimate success of the industry, business, the university, or indeed, the society. Many of us feel, and probably quite rightly so, that there is a great need for more money to be spent in research if industry is to continue to grow and flourish. But we, as one of the groups responsible for such expenditures, must accept the concurrent responsibility of carrying this message beyond the walls of the campus and laboratory. What is even more important, we must accept the responsibility of seeing that these resources are well used.

This question is of major importance in shaping the future of the world. In my own country, vast amounts of money are being spent in a race to land a man on the moon within the next five or ten years. This same amount of money could be used to raise the yearly salary of all our university staff by several thousand dollars, or to make significant progress in wiping out blighted areas in our urban slums, or to provide possibly the cure for cancer or the common cold within the next decade. The possibilities are legion. But the resources are finite. Certainly research for the space race will provide information that can be the basis for all sorts of useful applications. But will this research accomplish as much as the same amount of money spent elsewhere? This is a justifiable question which we must answer.

In this same light, we as chemists must ask ourselves before we address our requests elsewhere, "What do I want to do? How do I plan to do it? What will I actually accomplish by doing it?" No sensible businessman should be expected to spend money on research without being convinced that this money will provide more ultimate benefits to his company than the same amount spent on machinery, advertising or a new company cafeteria. Likewise, a university has to think well before it spends £12,000 on an NMR when the same amount of money might handsomely equip a language laboratory

which would provide its graduates with a functional use of a foreign language so necessary in today's world of international business and trade, or to purchase many volumes for its library. We know the necessity of costly research equipment, but the world has the right to expect our explanation.

To date, I fear that most of us have failed badly in this whole area. We have blithely accepted, as our right, access to whatever amounts of money we feel necessary to do our work without accepting also the need to explain our plans and results to the non-scientific world or to see that optimum use is made of the products of our research beyond our laboratories. If we don't do this ourselves, we can't expect others to do it for us.

The problem starts right in our basic training ground, the university. The yearly catalogue overflows with courses on quantum mechanics, instrumental analysis, reaction theories, rate equations, yet nowhere is there anything about how to prepare a research proposal; how research can be used to approach industrial, medical, biological and related problems; where research money comes from. Never is a student confronted with the very real and vital problem of having to translate his ideas to people outside his very limited scientific world. At no point is much concern given to preparing the future scientist in the fine art of effective written or oral presentations, yet much of his effectiveness as a chemist will depend on how well he can measure up here. His results will be useful only if he can convey them beyond the four walls of his own laboratory. If he plans to teach, his effectiveness depends on how well he can communicate. You only have to sit through a few talks at scientific meetings or sit in on a few university lectures to find out how vital this need is.

But all this is secondary to the question of what a chemist can and should be expected to do with his scientific skill once he leaves the campus. First and foremost, he must appreciate and accept the fact that the future of chemistry—how much research is done,

how effective it is in helping industry, its continued growth in New Zealand—rests squarely with him. New Zealand is fortunate in being at the beginning of its industrial development. The character of this development and the place of research in it will depend on the effectiveness of the New Zealand chemist in convincing management and shareholders of the part that research can play in such growth. How is this accomplished?

First of all, we have to be willing to spend time in formulating and presenting our own ideas. What is more important, we have to be willing to translate these ideas into terms meaningful within the language of those responsible for spending the money. I've lost count of the number of times that chemists in my own company have complained of their inability to get management to let them work on a basic research approach to a problem. Of even more significance, I have yet to find one of these same people who has thought enough of his own ideas to sit down and write out a concrete proposal with details as to what he plans to do and how he plans to do it. If the chemist himself doesn't think enough of his own ideas to promote them, who, pray tell, will?

One of our young chemists was unhappy because of management's failure to continue the appropriation for his promising work in measuring surface phenomena. With much grumbling and dissatisfaction, the work came to a halt. In the course of a "bull session" on some of these ideas I have been discussing we decided it might be a good time to experiment and not to drop the programme without some semblance of a fight for it. We were convinced it was potentially of considerable use to the company. The first draft of the research proposal we prepared was scientifically sound but well disguised in phrases such as, "the electrostatic interaction at the boundary layer of a solid in aqueous media". It had as much chance of success as a snowman in Tahiti. After we had rephrased it in terms of "The properties of many of our company

products depend on how solids act when they are suspended in water", we were amazed at how easily the proposal got results. Before it was even approved for final typing the title had been changed from "A Research Proposal to "Current Research Program". We found that management was only too happy to spend money on research if they knew and appreciated what it was for.

Next we are faced with planning how we can approach a problem. The question as to whether or not basic research has a place depends on our own approach. The decision largely rests with us. Too often the easiest way to a quick answer is to modify a given formulation and see if it works better; or find out what happens if we hang a methyl group on instead of a hydrogen; or pick fifty other compounds off the shelf and try them to see if they work in the given application. Certainly such work can produce impressive compilations of data and often creates an improved product or process. It has less risk than a basic research approach because it will undoubtedly turn out some answers, albeit of limited utility, in a reasonable time. The more taxing job for the mind, imagination and chemical ability is to try to understand the how and why of the way something works. It may lead into many time-consuming and fruitless efforts.

Of the two approaches, the "trial-and-error" method is the easier and safer way for the chemist to remain secure in his laboratory and his job. Yet in the long run, the chance of finding a new, useful answer that will be of most significance, commercially and scientifically, lies not in the easy and obvious. Carothers' development of nylon, significant both in terms of polymer chemistry and commercial synthetic fibers, came from an understanding of the basic composition of silk and a logical attack of building the same type of chemical molecule.

When a sound scientific approach to a given situation has been made possible by careful planning and presentation of the ideas, when the necessary support has been

obtained and a stage in laboratory investigation successfully completed, the responsibility of the chemist does not end there. Just as the philosophers question whether you can talk of "sound" from a jungle waterfall where there is no one to hear it, so a non-scientist can question the utility of research that never gets beyond the laboratory. Too often the chemist is content to be satisfied with a report of his work, feeling: "Well, there it is. If they don't want to do anything about it, it's their business." If the work has been worth our time and effort in the first place, we should think enough of it to want it to find maximum use. In the long run, the only justification for research is its utility. It's easy to get carried away with impressive tables of data and nicely bound research reports. Only as the information is used, either as a step toward understanding the unknown, or solving a problem, or providing a needed product or process, is there justification for doing the work in the first place. If it is our work

we have the responsibility for assuring its utility.

When chemistry leaves the campus, the problems that face the chemist are inextricably bound up with worldly problems of economics, communication, human relations, psychology . . . many of them alien to the chemist. Yet his usefulness, not only to society but to himself, will depend in a large measure on how well he prepares himself to face these challenges and how well he utilizes them in his work. The place of research in society and its future contributions to mankind depend primarily on how well we as individuals relate our science to the rest of the world.

We are convinced that we, as chemists, can make a useful and necessary contribution to the overall efforts of men. If this conviction is to become a reality, we will have to use more than just chemistry to promote our work. We can't go fishing for whales with bent pins.

Obituary . . .

T. A. GLENDINNING, F.N.Z.I.C., F.R.I.C.

Mr Tom Aldrich Glendinning, the oldest member of the N.Z. Institute of Chemistry, and one of the oldest of the Royal Institute of Chemistry, died in Nelson on 18 August 1967, aged 95 years. Born in Scotland, he arrived in this country in 1915 and began teaching chemistry at Wellington Technical College, where he produced a series of text books which became widely known in Technical Schools.

Mr Glendinning was elected Associate of the Royal Institute of Chemistry in 1892, and Fellow in 1895. He was a foundation member of the N.Z. Institute of Chemistry, and elected Honorary Fellow in 1963. He was Institute Honorary Secretary-Treasurer from 1933 until 1940. He gained the degree of Master of Science not long after settling in New Zealand.

Mr Glendinning maintained his interest in the profession of Chemistry until his death. After his retirement, he continued teaching and coaching in Nelson for many years. He was well-known and esteemed in educational circles in this country. (C.R.B.)

THE NUFFIELD CHEMISTRY PROJECT

*W. G. Swan, M.Sc., Dip. Ed., Head of Science Department,
Papanui High School*

PROFESSOR Sir Ronald Nyholm F.R.C., Chairman of the Consultative Committee of the Nuffield Foundation Chemistry Project and Consultant on the Revision of Chemistry Syllabuses in Europe and the U.S.A., recently visited New Zealand. Secondary school teachers, members of the Department of Education and of University Chemistry Departments from all over the country attended a one-day symposium at the University of Canterbury during his visit.

Representatives of these groups outlined developments in the teaching of chemistry in New Zealand and Professor Nyholm spoke on developments in Britain. He was also a member of two discussion panels where he was able to draw from his wide experience to comment on questions concerning both Britain and New Zealand.

Rumblings of discontent about science teaching in Britain first came from teachers who thought their material required too much rote learning and too little understanding. We in New Zealand have been in a similar situation. Until recently our syllabuses have been influenced by those of England. Many of our texts have been English. Teaching this material results in cramming of a great mass of facts—a good memory exercise but it could hardly be called science.

In Britain the universities found that students entering their courses were out of date. They knew a vast number of preparations and properties with a minimum of theoretical background—often irrelevant and out-of-date. Such minds, capable only of absorbing and memorising facts, provide a totally inadequate background for dealing with a subject advancing at such a fantastic rate as is chemistry.

In the socio-political sphere the feeling began to arise that science and society were becoming divorced from one another and that children were not being satisfactorily prepared to understand the society in which they lived.

Finally came the realisation that fewer and fewer students were advancing in chemistry. With this came cries of dismay from the industrialists to whom the scientist on the spot had become more and more important.

Eventually in Britain, the Nuffield Foundation became interested and threw its considerable resources into helping solve the problem. To date a large sum of money, time and effort have been spent in the development of a Chemistry programme which includes experimental work, sample schemes, teaching aids and resource material. The O-level programme is now completed. This covers a 4 to 5 year course starting at 11 years and roughly parallels our New Zealand Forms I to V and School Certificate Examination. The A-level course is nearly completed. This is a 2 to 3 year course corresponding to a 6th form and first year university course in New Zealand.

It is important to realise that the Nuffield Foundation has not prepared a syllabus. Some educational authorities in Britain have 'gone Nuffield' but this was not the purpose. The Foundation has designed an approach to chemistry. Sample schemes have been prepared to help the teachers but if these schemes are modified, drastically changed or even rejected and replaced in the next few years this is unimportant. What is important is the hope that teachers will have changed their approach towards this essentially experi-

mental science. The Nuffield programme can be thought of as an enunciation of the principles upon which chemistry should be taught.

The important principles include the following:

First, if education is to be considered a process concerned with the development of the individual, the pupil-teacher relationship is most important. The course must therefore have the teacher as its central pivot. It must not be a strictly structured programme running to a particular pre-determined schedule but must be able to be adapted and orientated to suit particular pupils in their own situation.

Secondly, chemistry is first and foremost an experimental science and children are stimulated most by finding out things for themselves. The approach is not—"Today we are going to prove that . . ." but rather—"Today let us try to find out about . . ." This depends very much on the teacher's ability to adapt to his class, to unobtrusively direct their thinking, to use their ideas and encourage and maintain interest and the sense of wonder—incidentally a much more difficult and demanding approach to teaching than methods of earlier years.

Thirdly, emphasis is placed on understanding rather than just learning of facts. It is recognised that some facts are necessary but these should be essential ones.

Also, facts should be tied together by certain fundamental principles and should not exist in isolation. The depth to which any of these integrating principles should be taught will vary with the sophistication of the pupils—another point which underlines the importance of the teacher.

This raised the question—"To whom should chemistry be taught?" The answer is "To all". The programme is not only for the potential chemist or skilled technician but also for others whose future will not be remotely connected with the subject; this is

because the subject can help to develop an attitude of enquiry and stimulate imaginative minds, both of which are important in any field.

With this new emphasis on understanding, fundamental principles and discovery, it became obvious that changes were desirable in the examination system. New types of papers are envisaged broadly covering knowledge of facts, understanding and derivation of conclusions from given facts.

Finally, it was seen that a teacher should be able to develop a course suited to himself, his pupils and his area, within a broad general scheme. No longer should pupils in England learn about the manufacture of superphosphate in New Zealand but rather should they study their own local industries where these provide illustrations of fundamental principles or matters of chemical interest.

There is a similarity between the Nuffield programme and the new New Zealand syllabuses. At A-level there are three broad regions—Energetics, Structure and Properties, and the Unifying Pattern of the Periodic Table. Hitherto neglected and more difficult topics such as Thermodynamics are included, the principle adopted being "How will we teach?"—and not "Will we teach?"

Readers will be more familiar with recent developments in New Zealand. There has been much activity in the last few years and with the exception of School Certificate Full Chemistry we now have or are about to begin new courses in Chemistry in Forms I to V General Science and in University Entrance, Scholarship and Bursaries. There has been in all of these developments an unprecedented and most welcome degree of co-operation between those drafting the courses and practising teachers. Indications are that this will continue. Future revisions and modifications are likely to be more frequent and again influenced by suggestions from those in the 'front-line'.

A most important feature of our New Zealand system of education is that our syllabuses say what will be examined but the method by which this material is taught, the depth of treatment and the extension of work beyond the syllabus is very largely a matter for the individual teacher or school.

This freedom thus allows the New Zealand teacher the opportunity to develop his own methods and try various schemes which may suit him. In this situation then it is very likely that many will be exploring the work of the Nuffield Foundation. In doing this they will gain the greatest benefit if they remember some of the aims and principles of the Foundation as they develop this most interesting modern approach to Chemistry.

COURSE ON TEACHING UNIVERSITY ENTRANCE CHEMISTRY

Hutt Valley Memorial Technical College was host to a course on teaching of chemistry at university entrance level, from 19th-21st August, 1967. The course was attended by about forty secondary school teachers from as far afield as Christchurch and Opunake as well as members of the Victoria University of Wellington Chemistry Department. Professor J. F. Duncan (V.U.W.) chaired the course. With the help of some excellent demonstrations of practical teaching there was considerable discussion on both methods of teaching and the syllabus material.

A report on the course and the subject matter of the lectures is intended for future publication.

THE WELLINGTON EDUCATIONAL RESEARCH GROUP

THIS group consists of Professor J. F. Duncan (V.U.W.) (Chairman), Dr W. B. Elley (N.Z. Council for Educational Research), Mr J. Offenburger (Wellington Polytechnic), Mr R. Phillips (Curriculum Development Officer), and Dr Dora Suuring (Head of Science Department, Tawa College). Father McCan and Mr P. Jenkins have also been associated with the group, which has met regularly for over a year.

Its aim is to plan a chemical education which is suitable for this country. One of its first questions was, how could it find out what was wanted, by whom, and for what purpose. Is the present system adequate, and how can this be tested? To answer such questions more easily, a particular point in our education system, University Entrance, was chosen.

A questionnaire has been constructed, consisting of thirty questions each containing four options. Each of the questions is concerned with one of the following categories—philosophy of a chemistry course, knowledge of chemistry, understanding of chemistry, scientific method, attitudes (perseverance, thoroughness, honesty, etc.), skills (written and oral communication, manual dexterity), significance to society.

The questionnaire will be sent to various people such as teachers, employers of chemists, technicians, students and school pupils. The questions are designed to find out what various people think a U.E. level pupil should know of chemistry, what is most important, and what kind of person such a pupil should be, in their opinion.

Already it appears (from a small trial run) that what people really want is different from what was thought they wanted.

The results of the questionnaire will be evaluated by computer.

(Report from D. Suuring.)

A VISITOR'S VIEW

Some Impressions Gained as an Exchange Lecturer at V.U.W.

R. Bolton

SABBATICAL leave is virtually unknown in the universities in England; overseas experience is limited to post-doctoral research fellowships and visiting professorships, with a conspicuous vacuum between. As an Australian who has spent the last eight years in England, I was keenly interested in the chance of a year's temporary lectureship at Victoria University of Wellington. This opportunity was realised by the two universities concerned granting a year's leave of absence to the emigrant and a temporary post to the immigrant. While both universities were pleased with the scheme, financial assistance came only from V.U.W. (the maximum travel allowance available in London (£25) did not materially assist the exodus). The grant which Victoria provided (£300) met my own travelling expenses, but to gain the year's experience means a loss of about £700, the cost of transporting a wife and child as well. (It is obvious that to leave them in England and provide for their separate upkeep would be even more costly and would require some remarkable permissiveness of the Reserve Bank).

Although financially the exchange was not profitable, since the increase in salary equalled the excess travelling costs, educationally it was very profitable. Since much of my teaching experience has been with female undergraduates, it was salutary to return to teaching a preponderantly male class. To differentiate between London and New Zealand undergraduates is to expose the paucity of my experience, but some comparisons can be made which are not merely the result of the sex difference.

The best New Zealand student is on a par with the best English undergraduate and

may have a more mature outlook. The worst New Zealand student (past the first year) is probably rather worse than his English counterpart, a result of the different requirements for entry into University—in England it is a buyer's market. The tendency to over-specialisation of courses is unfortunately similar in both countries. The big distinction in favour of the New Zealand university can be (and is, in the case of V.U.W.) the lack of in-breeding in the department. In-breeding is renowned as a cause of hysteria, neuroses, and sterility; the effect is as evident in universities as it is in dynasties.

The absence of difficulties in promoting research was striking, despite the present New Zealand importing system which could constitute a stranglehold on research; this danger is generally averted by the superb "brinkmanship" of the universities, but a more fundamentally satisfactory way of keeping the balance of trade would be desirable. It was also a very pleasant surprise to find that the Chemistry Department at Victoria is as well equipped, if not better equipped, than many English departments. The concept of 'bush technology' with the associated ideas of sticking-plaster-and-string electronics and acute shortages of chemicals is simply not correct. The university grants scheme seems to operate for a different level in New Zealand, and it seems easier for a young member of staff, not yet of world renown, to find generous grants to set himself up in a new field of research.

One cannot select Wellington or London, weigh up each situation and say adamantly "This one is better"; personal factors, some of them trivial, tip the scales and they do so to different extents for different people. But

it would be a disservice not to record the facts (i) that we were pleasantly surprised at the diversity of research interests and the ease with which research could be carried out in New Zealand; (ii) that, despite the pessimism of New Zealand House, our cost of living has not changed with going from London to New Zealand; (iii) that we have enjoyed more spontaneous hospitality, both socially and at work, than we had ever dared hope

for; and (iv) that we would like to come again.

Finally, it is essential that credit should be given to the following people who made this exchange possible: Professor S. N. Slater and Dr M. D. Carr, of Victoria University, and Professor P. B. D. de la Mare, now at Auckland University. Without the help of these three gentlemen we would have missed making many good friends in New Zealand

40th ANZAAS CONGRESS

Christchurch — 24-31 January 1968

Outline of Programme for Section B (Chemistry)

Thursday, 25th:

- Symposium on Chemical Education: The teaching of thermodynamics—M. L. McGlashan, University of Exeter.
- The teaching of bonding theories—R. D. Brown, Monash University.
- The present and future balance of the undergraduate course—A. N. Hambly, Australian National University.
- Information retrieval in chemistry—J. F. Duncan, Victoria University of Wellington.

Joint Symposia:

- Chemistry and Physics of the Solid State (with Section A, Physics), Thursday, 25th to Tuesday, 30th.
- Chemistry and Physics of the Atmosphere (with Section A, Physics), Friday, 26th to Tuesday, 30th.
- Food Production—Chemistry, Processing, and Utilisation (with Section N, Biochemistry), Monday, 29th.
- Pollution of Natural Resources (with Section H, Engineering), Monday, 29th and Tuesday, 30th.

Presidential Address: New themes in theoretical chemistry—Professor D. P. Craig, Australian National University. (Evening, Monday 29th).

Liversidge Lecture: The chemistry underlying the phosphate problem in agriculture—Professor A. T. Wilson, Victoria University of Wellington. (Evening, Friday 26th).

An N.Z.I.C. Dinner will precede the Presidential Address on Monday, 29th.

All intending participants are urged to enrol without delay. Enrolment forms may be obtained from Mr C. M. Harris, ANZAAS Office, University of Canterbury.

Friday, 26th to Wednesday, 31st:

Mornings: Symposia.

1. Reaction Studies:
 - Rates and equilibria in solution—A. J. Parker, University of Western Australia.
 - Mechanism of octahedral base hydrolysis—S. C. Chan, University of Hong Kong.
 - Group replacement factors—J. Miller, Defence Standards, Victoria.
 - Intermediates in electrophilic aromatic substitutions—P. B. D. de la Mare, University of Auckland.
2. Structural Methods and Applications:
 - Diffraction Methods—A. McL. Mathieson, C.S.I.R.O.
 - Structural methods in biogenesis—A. J. Birch, Australian National University.
 - Computer applications—D. D. Perrin, Australian National University, and J. C. B. White, Monash University.
 - Optical rotatory dispersion—A. M. Sargeson, Australian National University.

Afternoons: Concurrent research sessions.

Friday, 26th:

1. (a) X-ray Studies; (b) Theoretical Studies.
2. Isotope and Radical Studies.
3. Reactions of Coordinated Ligands.

Monday, 29th:

1. Natural Products Chemistry.
2. Metal Complexes.
3. Organic Reaction Mechanisms.

Tuesday, 30th:

1. Spectroscopic Studies.
2. Reaction Mechanisms.
3. Physical Chemistry of Non-Reacting Systems.

Wednesday, 31st:

1. Applied Chemistry.
2. Spectroscopic Studies.
3. Physical Chemistry of Non-Reacting Systems.

CURRENT CHEMISTRY . . .**SORPTION OF WATER BY CLAY MINERALS**

A. Metcalfe, B.Sc.(Hons), Ph.D.

Chemistry Department, University of Canterbury

THE adhesion of adsorbed molecules to the surfaces of crystalline bodies has been attributed to a combination of classical chemical forces, dipole and ionic electrostatic interactions and electrodynamic dispersion forces. The extent to which each may contribute depends upon the prevailing temperature, the specific nature of the adsorbate and its concentration in the fluid phase, the physico-chemical properties of the solid phase and the crystallographic orientations of the faces presented by it.

Typical clay minerals possess layered structures of silica tetrahedra and alumina octahedra with fractional but stoichiometric substitution of hydroxyl groups in the common oxygen layer and total replacement in the basal alumina face. Hydrated silica-alumina sheets are stacked in the crystals with intersheet separations of about three Ångströms in some minerals; in others the separation may be larger and contain water molecules, apparently oriented with an ice-like structure. This occluded water is only loosely held and may be lost at moderate relative humidities even at ordinary temperatures, with consequent contraction of the intersheet separation.

Clay minerals crystalites are not, however, perfect crystalline specimens, being subject to mechanical faulting and dislocation and non-stoichiometry due to random replacement of a small proportion of lattice aluminium atoms by foreign atoms such as iron and titanium. Non-stoichiometry results frequently in an imbalance of electrical charge which must be satisfied by adsorption of ions

at exposed edges and basal planes. Ion sorption and the resulting ionic exchange capacity at basal planes, which form by far the greater proportion of the exposed surface in clay minerals, are predominantly due to lattice substitution and may result in the occupation of some two percent of crystal surfaces by ions. It is expected that the exchange capacity and the nature of adsorbed ions will have a pronounced effect upon the adsorption of water molecules, which are strongly polar, from the vapour phase.

Raw clay minerals are usually saturated with water at high humidities and all classes of adsorption are satisfied. However, outgassing of samples at 400°K and water vapour pressures of 10^{-8} torr should expose sites with interaction energies of 15 K.cal/mole and less. These sites are then available in subsequent adsorption investigations and may be expected to dominate the thermodynamic properties of the clay-water system.

Adsorption studies are not, however, limited to the derivation of thermodynamic data.

Transport of water between external and internal surfaces of crystal aggregates may be accomplished by gaseous and surface diffusion of adsorbed molecules. The temperature dependence of adsorption equilibria is used to distinguish relative importance of the two mechanisms.

At high humidities detailed analyses of adsorption isotherms reveal morphological features of clay mineral aggregates such as pore size distribution and pore shape. This

information, together with data on phase transitions of adsorbed water at lower temperatures enables estimates to be made of the exceedingly high hydrostatic pressures developed during the freezing of water in fine capillaries and interstices. The forces involved may be of sufficient magnitude to modify the morphology and possibly even the chemistry of clay minerals.

Studies have recently been initiated at the University of Canterbury, in co-operation with the New Zealand Pottery and Ceramic Research Association, into some aspects of the behaviour of clay-water systems at low humidities. It is expected that the work will

present problems which are academically stimulating and in addition will provide the understanding necessary for efficient utilisation of the materials studied.

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BRANCH NOTES

Auckland

The Annual General Meeting of the Branch took place on 3 October with about 30 members present compared with the average attendance of 47 for meetings through the year. The venue this year was the Berkeley Lounge, Mission Bay, where members and their wives enjoyed a buffet dinner following the business session.

Mr O. H. Keys recently attended the annual conference of the Australasian Corrosion Association at Brisbane.

Dr D. J. McLennan, a graduate of Victoria University at present at the University of California, Santa Cruz, has been appointed lecturer at the University of Auckland for the new B.E. course in Chemical and Materials Engineering.

Members of the staff of the University who will be on study leave next year are Professor L. H. Briggs (at the University of North Carolina), Dr G. A. Wright (at the Technical University of Denmark, Lyngby), Dr B. A. Grigor (at Clarkson College of Technology, Potsdam, New York), Dr C. E. F. Rickard and Dr D. J. Spedding (both at A.E.R.E., Harwell).

Manawatu

Dr E. L. Richards has been promoted to Reader in the Department of Chemistry and Biochemistry at Massey University.

Dr P. D. Buckley, a teaching fellow at the University of Leeds, has been appointed Lecturer in chemistry in the Department of Chemistry and Biochemistry at Massey University.

Dr I. G. Andrew, a microbial biochemist of the Plant Chemistry Division, D.S.I.R., has been appointed Lecturer in biochemistry in the Department of Chemistry and Biochemistry at Massey University.

Dr K. W. Jolley, who has an interest in N.M.R. spectrometry, will join the Department of Chemistry and Biochemistry at Massey University as a lecturer in chemistry.

Dr G. B. Petersen, a scientific officer of the Plant Chemistry Division, D.S.I.R., and the 1967 Chairman for the Manawatu branch of the Institute of Chemistry, has been appointed by the University of Otago to the Chair of Biochemistry. Dr Petersen has been at the Plant Chemistry Division since 1959 apart from two years (1962-63) when he held a teaching appointment at Oxford University as departmental demonstrator.

Wellington

The Branch was privileged to help host Professor Sir Ronald Nyholm during his stay in Wellington at the end of September. Sir Ronald delivered the 1967 Mellor Lecture to the Branch.

On 29 September a Symposium on Co-ordination Chemistry was held at Victoria University under the auspices of The Chemical Society. Professor Nyholm and Professor Duncan chaired the two sessions at which research papers were read by chemists from all parts of the country. Those who presented papers were: Professor Odell (A.U.), Dr Robinson (O.U), Dr Curtis (V.U.W.), Dr Golding (D.S.I.R.), Dr Waters (A.U.), and Professor Wilkins (C.U.).

Dr R. G. Burns, Senior Lecturer in Geochemistry at Victoria, leaves in December to take up an appointment as Lecturer in Geochemistry at the University of Oxford.

Professor J. F. Duncan is on a short visit to the U.K. in order to present a paper at a Discussion Meeting of the Faraday Society on the Mössbauer Effect. While overseas he will also discuss information retrieval at Nottingham University and at Columbus, Ohio, U.S.A.

Dr K. R. MacKenzie, who recently completed his Ph.D., leaves to do post-doctoral work at Sheffield University.

Dr P. C. Rankin has taken up a position on the Faculty of Washington University, Georgetown, U.S.A. Dr Rankin graduated Ph.D. at Victoria this year.

Dr D. Stewart has been appointed Post-doctoral Fellow at the University of Halifax, Nova Scotia.

Professor A. T. Wilson and Mr C. Hendy are spending the summer season in Antarctica where they plan to continue work initiated by Professor Wilson in previous visits.

Dr M. Coleman, a graduate of Auckland and Melbourne Universities, is working as a Post-doctoral Fellow with Professor Duncan on aspects of solid-state chemistry. His work will be relative to New Zealand industry.

Canterbury

Professor L. F. Phillips was recently appointed to the third chair in chemistry at the University of Canterbury. He previously held a personal chair. He was also recently elected one of the "three outstanding young men of the year". He will spend the next 15 months in the U.S.A. studying under a Harkness Fellowship. Twelve months of this will be spent at the Inorganic Materials Division, Lawrence Radiation Laboratory, University of California, Berkeley, and three months visiting research establishments in America.

Drs J. E. Fergusson and M. P. Hartshorn have been promoted to Readers in the chemistry department. Both will return shortly from sabbatical leave.

Dr A. Fischer has returned from a year's sabbatical leave at the University of Sussex.

Dr G. Rodley recently attended the tenth International Conference on Co-ordination Chemistry at Nikko and Tokyo, Japan. He said that the preparation of metal complexes with molecular nitrogen had been a main topic at the conference and that the recent discovery of these compounds was of particular interest because of the possible connections with the natural process of fixing nitrogen.

Dr W. S. Metcalf will spend 1968 on study leave at the Massachusetts General Hospital, Boston, where he will work with Dr Alexander Leaf on ion transport across membranes. His wife, Mrs M. G. Metcalf, has leave for 1968 from the Medical Unit, the Princess Margaret Hospital, Christchurch, and will be continuing her work on steroids with Dr Claude Villee at the Boston Lying-in hospital.

Mr C. G. Freeman, who is completing his Ph.D. at Canterbury University, has been awarded a Leverhulme Fellowship which he will take up next year under Professor Gowan Lock at Heriot-Watt University, Edinburgh. He will continue his work on gas-phase reactions.

Dr Graham Osborne has taken up a research fellowship at Lincoln College where he will be working on the synthesis of organo-phosphorous insecticides.

Mr A. H. Wooff, Head of the Science Department at Christchurch Boys' High School, has been awarded the Teaching Fellowship in the Chemistry Department, University of Canterbury for 1968.

Otago

Dr G. T. Laws of the Department of Pharmacology and Pharmacy left in October to take up a United States National Institute of Health Fellowship at Rice University, Houston, Texas, for one year. He will work on the transfer of drugs across membranes, and the development and synthesis of scolicidal drugs.

The cover picture of this issue of the Journal is an artist's impression of the new Chemistry Building for Otago University. The three-storey section contains all the undergraduate laboratories, advanced physical chemistry and applied chemistry on the ground floor, first year chemistry, radio chemistry and microanalytical chemistry on the middle floor, and advanced inorganic and advanced organic chemistry on the top floor. This section of the building for which working drawings have been completed was designed in the Dunedin office of the Ministry of Works. The University is waiting for permission from Government to call tenders for the construction of this block.

The eight-storey section of the building will contain research laboratories, staff accommodation and bulk storage and workshop facilities. Its design is in the hands of Mason and Wales of Dunedin.

BOOK REVIEWS . . .

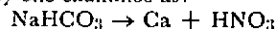
Mixtura Mirabilis. Second Edition 1965. Verlag Chemie Julius Beltz, GmbH, Weinhaven/Bergstr.

The items in this book were taken from the "Nachrichten aus Chemie und Technik" where they featured under the same title. There is a mixture of amusing errors from exams and newspapers, etc.; short poems, wisecracks, witticisms, extraordinary facts and technical peculiarities connected with chemistry. The book, mainly written in German, is attractively set out and contains many excellent illustrations by Jochen Bartsch. Its sub-title, "A lot of amusing, though sometimes naughty, but always true, facts and stories", describes the book exactly. It contains about 250 items. Here are some examples (translated) to give an idea of their range:

Science is not a sacred cow, but a horse. Don't adore it, feed it.

Men with base voices become tenors in a helium-oxygen atmosphere. This was found by Soviet scientists in experiments with outer atmosphere-simulating rooms. According to them, the change of voice is not a health hazard.

The equation for the preparation of nitric acid was given by one examinee as:



All the letters are there, but chemistry cannot yet use this new formula—more is the pity!

And lastly some good advice. Don't waste pure thinking on impure enzymes. First purify them, then think!

D. SURRENG.

Advances in Colloid and Interfacial Science. Edited by J. T. G. Overbeek, W. Prins, and A. C. Zettlemoyer. Elsevier Publishing Co. Amsterdam. Price \$15 per volume.

The preface of Part I, Volume I, of this new journal indicates that the intention of the editors is to publish review papers dealing with widely varied aspects of the vast subject range enveloped by the journal's title. The subject matter is presented in such a way as to provide an extremely useful collection of theory and techniques for students or scholars contemplating embarking on work in some segment of colloid or interfacial science, and particularly to workers in applied fields.

If the contents of future issues are of as high a quality as those by W. A. Steele on the Physical Adsorption of Gases on Solids and by A. Skoulios on the Structure of Concentrated Aqueous Solutions of Alkali soaps, then the journal will be, at the price of \$15 for a four-part volume, a worthwhile addition to any library.

B. L. JACKSON.

Alloying Behaviour and Effects in Concentrated Solid Solutions. Edited by T. B. Massalski. Published by Gordon and Breach, New York 1965, 445 pages, price \$22.50 (U.S.).

The articles collected in this volume review some of the recent advances made in a number of fields of research with a specific emphasis on alloys. Recent progress in the electronic theories for metals and alloys is discussed and a modification of the Bloch model is presented. This modification takes into account electronic interactions both within the valence and conduction bands and between valence and "core" electrons. In concentrated alloys disruption of the solvent lattice by the solute metal atoms causes major upsets in the basis of the Bloch model, the lattice periodicity.

Much progress has been made recently in relating theory to observation and new experimental data is becoming available relating directly to the band structure, the Fermi surface, and other electronic aspects of alloys. The roles of imperfections, stacking faults, volume and size factors, and long period superlattices are among some of the topics which are discussed in detail. 668 references are included in this volume which appears to be a comprehensive review of a few important aspects of alloy behaviour.

The book, which resulted from a metallurgy symposium held in 1963 in U.S.A., is obviously written for metallurgists. Metallurgy may be conveniently divided into three branches:

- (1) Extraction—chemistry of mining, beneficiation and reduction of ores to metals.
- (2) Physical—physics of the properties of metals and alloys.
- (3) Fabrication—engineering and physics of producing required shapes.

The content of this book definitely falls into the physical category. Most of the mathematical treatment, being entirely rigorous, uses methods, in many cases, which are largely foreign to most chemists. The rigorous method, by its very nature, often loses sight of the real physical model and, to many chemists, the complex mathematical result often fails to give an intelligible picture of the system under study. In order to circumvent such difficulties the chemist can usually find a less rigorous method more closely related to observation.

This book, therefore, appears to be an extremely useful review for the metallurgist who is interested in theory as well as practice but seems to be too specialised for the average chemist.

R. M. CARR.

The Chemistry of Rhenium and Technetium, by R. Colton. Interscience Publishers, a division of John Wiley and Sons Ltd., 1965, 185 pages, price 68/- (N.Z.).

Rhenium was discovered in 1925 and technetium was obtained artificially in 1937. In this short space of time no fewer than eight monographs or reviews on rhenium and four on technetium have been published. The book under review was published at almost the same time as another on the same topic.

It is unfortunate that this book was written during the early stages of a considerable attack on the chemistry of rhenium. In the last five years the discovery of "hidden" ligands (H^+ , N^3- , O^{2-}) in rhenium complexes, and di- and trinuclear rhenium clusters has completely altered the face of the chemistry of rhenium (II), (III) and (V). The chapters entitled "Complex Halides" (5) and "Complex Compounds" (6) would look quite different if written today. In the opinion of the reviewer if authors of monographs like the present one are to do justice to the material of recent research they must refer the reader to past publications as a source of early work rather than try to cover everything within 200 pages. The volume of published work on rhenium, for example, can be divided almost equally between 1925-1960 and 1960-1966.

The book has a number of typographical and referencing errors which are obvious to the reader; it is difficult to imagine how they were missed. It is to be hoped that at some later date they can be corrected.

There is a significant absence of reference to the work of Russian and Indian workers, a number of which have been active in the field of rhenium chemistry. This either reflects a disregard of their work or an omission to read it. In general, apart from the author's own research there is little information on work published since 1963.

When reference is made to structural work on rhenium and technetium compounds the author lists cell dimensions, but in very few cases does he give bond lengths and angles. This is unfortunate as it is this data that the chemist is interested in.

The book is at its best in discussing the chemistry of technetium and it is reasonably up to date, as very little work is being published on the chemistry of this element.

As a coverage of certain aspects of the chemistry of rhenium and technetium up to 1963 the book will be useful to the practising chemist. However, it is necessary to keep in mind that many of the aspects of di-, ter- and pentavalent rhenium have been reinterpreted.

J. E. FERGUSSON.

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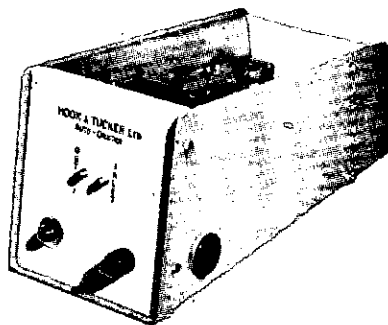
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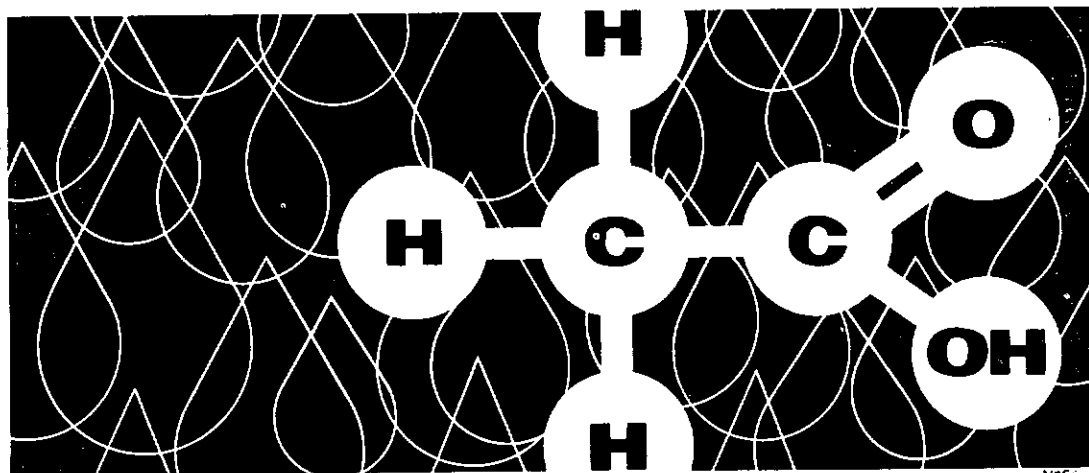
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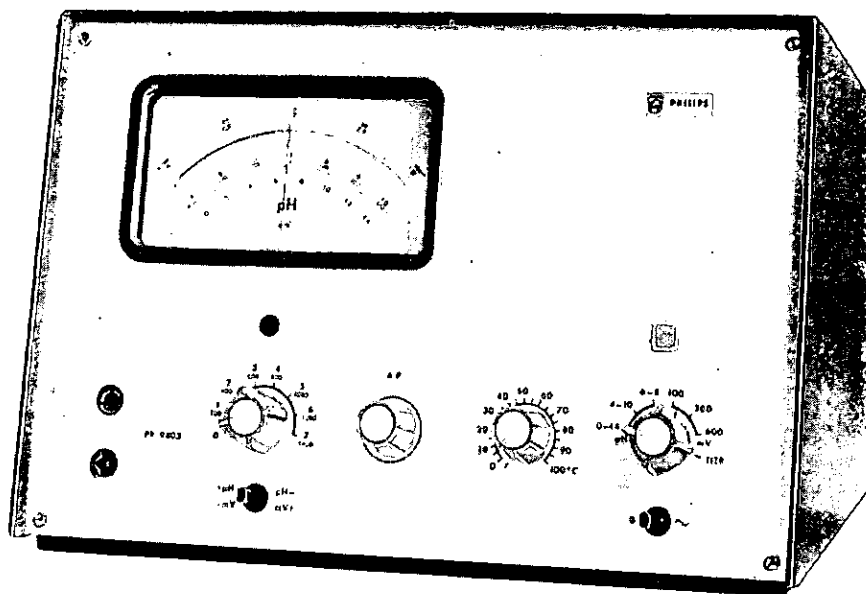
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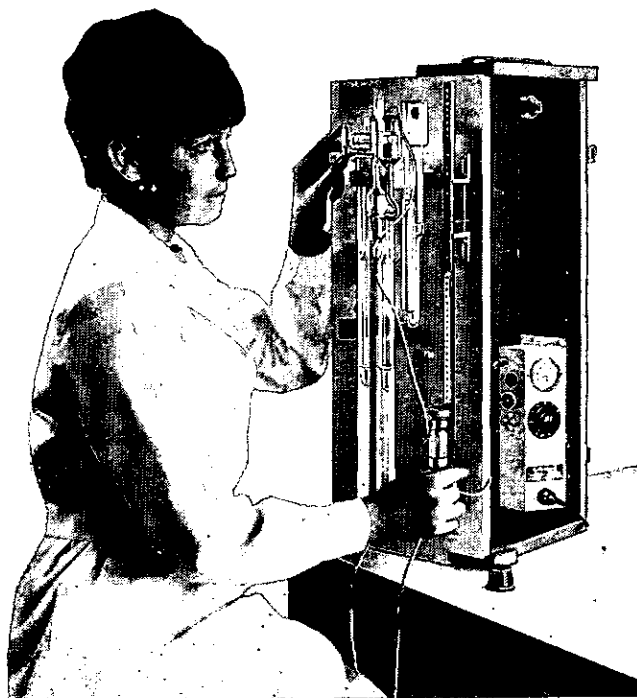
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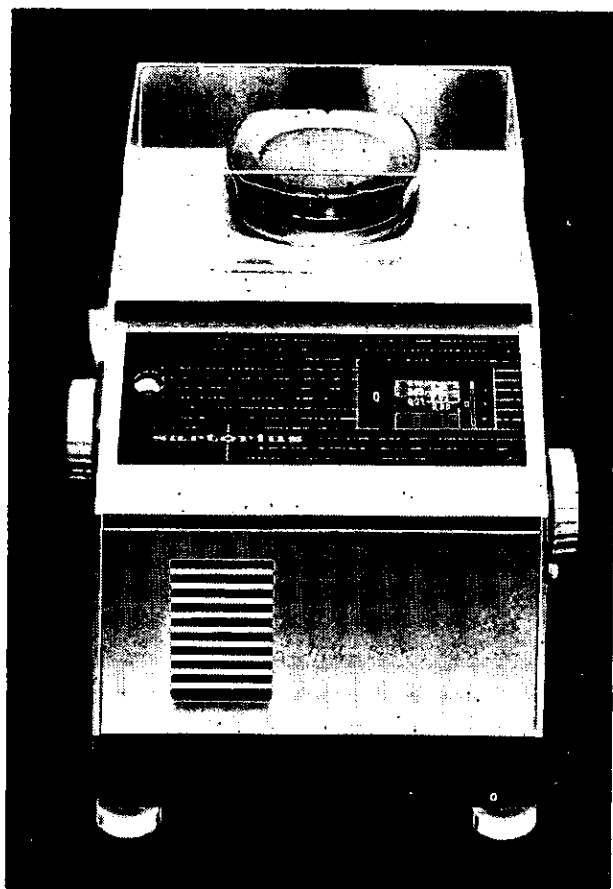
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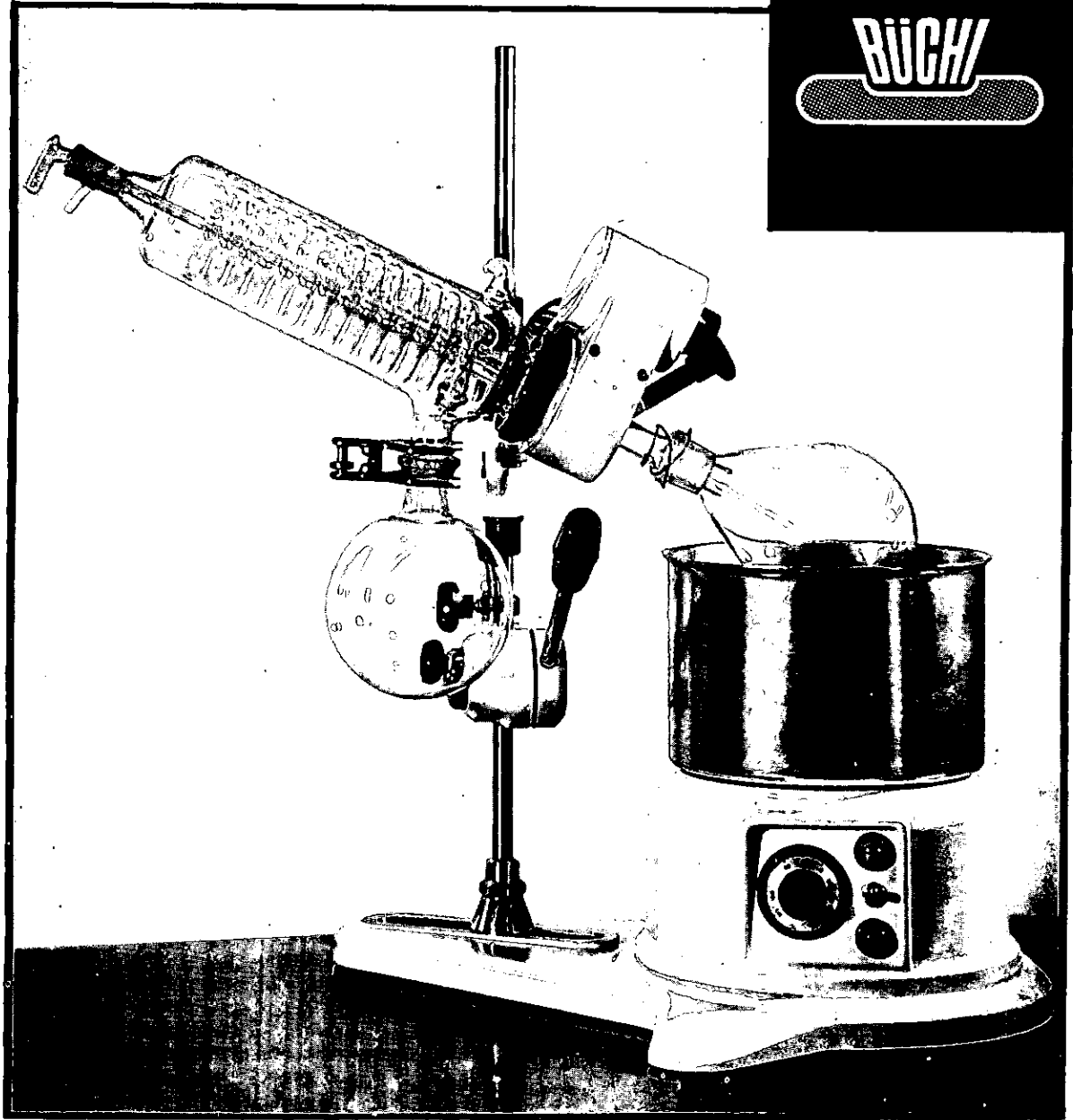
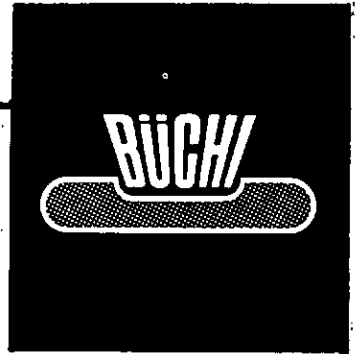
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