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THE AUSTRALIAN PHYSICIST, JULY, 1967 109
Electrons available from stock; evolution in cathodes
Condensed from a paper by Dr. P. Zalm

The development of electron tubes for higher frequencies and energy output creates an ever increasing demand for better cathodes. Today's magnetrons and other microwave tubes could never have been developed, had not the spectacular evolution of thermionic cathodes led to impressive possibilities. Of particular importance in this connection are the dispenser-type cathodes, on the subject of which we here set down a few stray thoughts.

It is to the credit of the late H. J. Lommens, of the Philips Research Laboratories, a creative investigator with exceptional intuition, that he proceeded from a fundamental separation of functions in cathodes. Whereas for a long time the functions of "heating" and "emission" in oxide-coated cathodes had been separated, he applied separation of the "electron-emission" and "barium-supply" functions as well. He thus indicated ways of solving the problem of the limited current density of oxide-coated cathodes. In the normal oxide-coated cathode the average current density must not exceed 0.5 to 1 A per cm², since otherwise, owing to the layer's resistance, so much heat would be generated in it that damage would occur. One of the factors determining the resistance in the layer and with which the life of the cathode is also linked, is its thickness (approx. 80 microns). If the layer is made very thin (say 5 to 20 microns), then, for the same current density the cathode's life will be short.

In the case of normal barium-strontium oxide cathodes the emitting layer consists of small (Ba, Sr)O crystals. These owe their low work function (and thus good emission at not too high temperatures) to the adsorption of barium. Barium evaporates, however, and has to be replenished. This occurs through reaction of the BaO with the reducing agent added to the nickel of the cathode: Al, Mg or Si etc. In L-cathodes (L for Lommens) and other dispenser-type cathodes the necessary barium is replenished not from the layer, but from a separate, small supply chamber shut off by a "lid" of porous tungsten; this results in a good separation of functions between emitting layer and barium supply. Hence the emitting surface consists of the porous tungsten on which a film of barium of atomic thickness has been adsorbed; the series resistance is then extremely low. A pleasing aspect of this development is that the sub-stratum (the metal "lid" on the supply chamber) can be varied at will. Frequent use is now made of this degree of freedom.

More recent developments in these cathodes disclosed an interesting paradox. When a study is made of the question as to how the work function of metals is influenced by adsorption of electropositive elements such as barium, it is found that at tungsten-barium interface a change in potential occurs, due to formation of a dipole layer as a result of polarization of barium atoms. This dipole layer reduces the work function. It is impossible to calculate that for a higher work function of the base material the number of barium atoms which can be adsorbed in such a state of polarization is greater. This increase is so sharp that the paradoxical effect is obtained that the higher work function of the base metal is more than compensated.

This calculation has been confirmed in practice. So we looked for the base material among metals with high work functions. These are to be found especially in the platinum group. For a number of applications osmium was chosen from this group. The Os-cathode, as every other normal dispenser-type cathode, can withstand temperatures of up to 1,000°C.

For professional purposes, particularly in communications engineering, it excels on account of high current densities (up to 10 A/cm²) and long life (10⁶ hours at 1 A/cm²).

Therefore it can truly be said that here many electrons are available from stock, and will be for a very long time.
P.S.S.C. Physics in Victorian Schools

L. D. Mackay
Lecturer in Education, Monash University.

In November 1966 it became public knowledge in Victoria that a report had been prepared in the Victorian Department of Education on the teaching of "science and mathematics" in Victorian State secondary schools. Despite parliamentary protests, the then Minister for Education, The Hon. John Bloomfield (now Sir John Bloomfield and not a member of the present Victorian State Cabinet), refused to make the document public but allowed it to be placed in the Library of Parliament.

The Victorian Branch of the A.I.P. wrote to the Minister requesting that the report be made public, so that the public might be fully acquainted with the crisis in the teaching of science and mathematics. Without such an awareness the taxpayer has been reluctant to increase his commitment on the education account. The Victorian Branch of the A.I.P. was joined in this matter by the Victorian Branch of the Royal Australian Chemical Institute and the Victorian Council Members of the Australian Mathematics Society.

In his reply the Minister refused to make the report public on the principal ground that it was an incomplete report and that it covered only about 90 per cent. of the teachers in mathematics, and that it was expected that the other 10 per cent. would have been substantially more highly qualified! Incidentally he also revealed that the report did really only refer to mathematics, although it seemed probable that some of the "mathematics" personnel were in fact science teachers.

It is fortunate that Mr. Lindsay Mackay, a lecturer in the Monash University Education Department, has been conducting an independent survey under the auspices of the Victorian Universities and Schools' Examination Board into the standards of Physics teaching in Victoria and the effectiveness of the P.S.S.C. inter alia, which he is publishing in "The Australian Physicist".

Mr. Mackay is a graduate in Science (B.Sc. majoring in Physics) and in Education (B.Ed.), and has had teaching experience at the secondary schools, Secondary Teachers' College, and University levels. His remarks on the P.S.S.C. course derive from the results of his survey and from his own experience in teaching the P.S.S.C. course to Leaving and Matriculation classes in Dandenong High School in 1966 and 1967, which he undertook to gain first-hand experience of the P.S.S.C. course in action. Mr. Mackay is currently working part-time towards a M.Sc. degree in Physics at Melbourne University.

C. Coogan

Introduction of P.S.S.C. Physics into Victorian Schools

The P.S.S.C. physics course has been introduced into secondary schools in Victoria as a 2-year course in the Leaving (Grade 11) year and the Matriculation (Grade 12) year. In Victorian secondary schools, Physics is usually studied concurrently with Chemistry in Grades 11 and 12, and occasionally concurrently with Biology. The students have studied a course in Science which includes some Physics, Chemistry, Biology, and Geology and Astronomy in Grades 7-10 in Victorian secondary schools before studying Physics at Grade 11. The P.S.S.C. course was introduced into Grade 11 in 1965, and into Grade 12 in 1966.

Examinations in Physics at the end of Grade 11 and Grade 12 in Victorian secondary schools are under the control of the Victorian Universities and Schools Examinations Board (V.U.S.E.B.). A number of secondary schools are accredited to conduct their own examinations in Physics at Grade 11, but about 60 per cent. of the Physics students in Victorian secondary schools present for the Leaving Physics examination conducted by the V.U.S.E.B. in November. All Grade 12 Physics students in Victorian Secondary schools present for the Matriculation Physics examination conducted by the V.U.S.E.B. in November of each year.

As a consequence of this system of examination, the V.U.S.E.B. Standing Committee for Physics,
which is comprised of University Physics teachers, school Physics teachers, and school inspectors, has the responsibility for determining the Physics syllabus for Grades 11 and 12 in Victorian Secondary schools. The way in which this committee has divided the P.S.S.C. Physics course to produce a two-year course is described in the detailed syllabi for Leaving Physics and Matriculation Physics in the V.U.S.E.B. Handbook. In preparing a two-year course, the committee has attempted to ensure that the first year of the course is in itself a suitable terminal course. The Leaving Physics course they have prepared contains sections from each of the four parts of the P.S.S.C. text. Part IV of the P.S.S.C. course has been revised by the introduction of M.K.S.A. units, and these revisions are available as a Supplement. With these modifications and other minor exclusions and additions, the Matriculation (Grade 12) Physics course includes the whole of the course outlined in the P.S.S.C. text.

Experimental kits for the P.S.S.C. course were produced by Australian firms and were issued to schools prior to the introduction of the P.S.S.C. course. Copies of the P.S.S.C. films were purchased by some schools, and were made available for loan to other schools through the State Film Centre.

Evaluation of the P.S.S.C. Physics Course in Victorian Schools

As with any other Physics course, the P.S.S.C. course was adopted for use in Victorian schools on the basis of the opinions of a relatively small number of people, with very little research evidence to guide them. The question that must now be asked is to what extent the P.S.S.C. Physics course in Victorian schools is achieving its expectations.

In an attempt to partly answer this question a number of projects are being undertaken by the author.

A teacher questionnaire survey has provided valuable information about teachers' opinions and comments on the course, the conditions under which the course is being taught in Victorian secondary schools, along with information on teaching practices being used in schools. Testing of a sample of Victorian students who had studied the P.S.S.C. course using an "objective" test used extensively with the previous Physics course and comparison of their performance with that of students of the previous Physics course has provided information about some of the areas in which gains and losses have occurred with change to the P.S.S.C. course. An analysis of the performance of candidates on the V.U.S.E.B. Leaving Physics and Matriculation Physics examinations has provided information on the abilities and content areas in which students experienced greatest difficulty, along with information on the abilities possessed by students at the end of their study of the P.S.S.C. Physics course.

With the assistance of a substantial grant from the Australian Research Grants Commission, tests are being developed in 1967 for use in a longitudinal study of a sample of Victorian Physics students during 1968 and 1969 in an attempt to map the changes which occur in students as they study the P.S.S.C. Physics course in Victorian schools. No one of the four studies outlined above will provide an answer to the question of whether P.S.S.C. is achieving its objectives, but each of these studies will make its own contribution to at least a partial answer to this question.

This article will be based on the results obtained from a survey using a teacher questionnaire which was mailed to all Victorian secondary schools in November 1966. A detailed report of this study will shortly be published.

Report of the Questionnaire Survey

Completed questionnaires were received from 246 Victorian schools teaching Leaving or Matriculation Physics in 1966, which represents just over 87 per cent. of all such schools in Victoria in 1966. The information obtained from teachers will be presented under 2 headings:

1. Teacher comments and opinions on the course.
2. Information on teachers and teaching conditions for Physics in Victorian secondary schools.

Teacher comments and opinions on the course

The information on teacher comments and opinions is based partly on replies to questions asked on the questionnaire, and partly on the spontaneous responses of teachers when they were invited to make any additional comments on the course under a number of headings. The following is a brief summary of some of the points which emerged from the analysis of the teachers' responses:

Opinions on the course

As a group, teachers did not consider that the two-year syllabus based on the P.S.S.C. course contained too much work that was difficult for the average student, nor did they consider that this course was too extensive. There was also general agreement that the first year syllabus did not con-

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3 Preliminary reports of these analyses were published in the S.T.A.V. journal "Lab-Talk" in April 1967 and May 1967. A full report should shortly be published by the V.U.S.E.B.
4 This report will be published by the Monash University Faculty of Education Publications Committee.
tain too much work that was difficult for the average student, but a slight majority of teachers indicated that the first year syllabus for the Leaving year was too extensive.

There was general agreement among teachers that the modification of the P.S.S.C. course by introducing M.K.S.A. units was desirable, but also general dissatisfaction with the Supplement as an effective means of modifying the course.

It appears, therefore, that teachers consider the P.S.S.C. course as modified for use in Victorian schools to be neither unduly extensive nor unduly difficult, and that they support, in principle, the major modification made to the course. An indication that teachers considered the course to be successful was that 18 per cent. of the teachers spontaneously commented that students of the P.S.S.C. course showed greater interest in Physics, or a better attitude towards Physics, than students of the previous Physics course.

Opinions on course materials

(i) P.S.S.C. Textbook

Teachers are encouraged to use a more rigorous mathematical approach than the text where they think it appropriate, and the responses indicated that a more rigorous approach was used by 87 per cent. of teachers at the Leaving level, and 93 per cent. of teachers at the Matriculation level. Fifty five per cent. of teachers spontaneously commented that they considered the textbook to be too verbose, and 17 per cent. of teachers indicated that they found an Australian edition of the textbook.

(ii) Laboratory kits and laboratory guide

Teachers indicated general dissatisfaction with the durability of the kits supplied for experimental work.

Seventeen per cent. of teachers spontaneously commented favourably on the P.S.S.C. laboratory guide, but 14 per cent. of teachers suggested that it should contain more detailed instructions.

Teachers are using laboratory exercises to establish understanding of the principles involved more frequently than to consolidate knowledge that has been previously taught, and in all but 10 per cent. of schools, students at least occasionally perform experiments at the appropriate stage recommended by the Teachers' Guide.

The average number of laboratory experiments performed by P.S.S.C. Physics students in Victorian schools is approximately 19 in each of the Leaving and Matriculation years. In over half the schools, students are performing experiments in addition to those in the laboratory guide.

(iii) P.S.S.C. Teachers' Guide

Thirty-eight per cent. of teachers spontaneously commented favourably on the quality and helpfulness of the Teachers' Guide.

The Teachers' Guide is being used extensively by teachers for a number of purposes. The purposes in order from most frequent use to least frequent use are:

(a) determining the appropriate times for use of films and experiments,
(b) selecting Home, Desk, and Laboratory (H.D.L.) problems of appropriate difficulty,
(c) selecting H.D.L. problems of appropriate importance,
(d) finding solutions to H.D.L. problems,
(e) planning lessons,
(f) preparing summaries to hand out to pupils.

Pupils have access to the Teachers' Guide for solutions to H.D.L. problems in 75 per cent. of schools.

(iv) Diagnostic Tests

Teachers indicated strong agreement with the proposition that their pupils appreciated the diagnostic tests prepared by the Australian Council for Educational Research, and also general satisfaction with the extent to which they sampled the course content. Teachers' satisfaction with the tests is further reflected in the fact that these tests were being used to determine areas of inadequate understanding in about 90 per cent. of schools.

(r) P.S.S.C. Films

P.S.S.C. films are being used extensively in schools, with classes of Leaving Physics seeing an average of 10 films during the year, and classes of Matriculation Physics seeing an average of 12 films in the year.

2. Information on Teachers and Teaching Conditions

As well as providing information on teachers' opinions to the P.S.S.C. Physics course, and on teaching practices in schools, the questionnaire survey supplied a great deal of valuable information on the qualifications and experience of teachers, and on the condition under which Physics is being taught in Victorian schools.

Qualifications and Experience of Physics Teachers

The information on the level of university physics qualifications of Physics teachers is summarized in the following table.

<table>
<thead>
<tr>
<th>University Physics Qualification</th>
<th>Percentage of physics teachers with this qualification or its equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics III or higher</td>
<td>37</td>
</tr>
<tr>
<td>Physics II</td>
<td>43</td>
</tr>
<tr>
<td>Physics I or lower</td>
<td>20</td>
</tr>
</tbody>
</table>

As Physics II or its equivalent has long been considered as the minimum desirable qualification for Physics teachers, it is of note that 20 per cent. of the teachers in the sample had qualifications of less than this.

How recently the Physics teachers in the sample
obtained their qualifications is set out in the following table:

<table>
<thead>
<tr>
<th>Period in which Physics qualifications obtained</th>
<th>Percentage of teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre-1950</td>
<td>24</td>
</tr>
<tr>
<td>1950–1959</td>
<td>36</td>
</tr>
<tr>
<td>1960–1965</td>
<td>40</td>
</tr>
</tbody>
</table>

In view of the fact that a quarter of the Physics teachers had obtained their Physics qualifications more than 15 years ago, it is of note that over one third of the Physics teachers expressed a desire to attend refresher courses in Physics.

The average Physics teaching experience of the Physics teachers was 6.8 years, but over half the Physics teachers had had less than 5 years Physics teaching experience. The information obtained on the Physics teaching experience of teachers is summarized in the following table:

<table>
<thead>
<tr>
<th>Number of years experience</th>
<th>Percentage of teachers with this experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>0—4</td>
<td>55</td>
</tr>
<tr>
<td>5—9</td>
<td>22</td>
</tr>
<tr>
<td>10—14</td>
<td>11</td>
</tr>
<tr>
<td>15—19</td>
<td>6</td>
</tr>
<tr>
<td>20—24</td>
<td>2</td>
</tr>
<tr>
<td>25—29</td>
<td>2</td>
</tr>
<tr>
<td>30+</td>
<td>2</td>
</tr>
</tbody>
</table>

Teaching Conditions in Victorian Secondary Schools

Responses to the questionnaire indicated that school conditions for teaching Physics in Victorian schools left a great deal to be desired. For example, among the findings in this section, teachers considered that:

(a) general facilities for experimental work in the Physics laboratory were unsatisfactory in 30 per cent. of schools.
(b) blackout provisions in the Physics laboratory were unsatisfactory in 50 per cent. of schools.
(c) film viewing conditions were unsatisfactory in 14 per cent. of schools.

Of particular concern is the fact that classes are above the maximum of 26 students recommended by the Physics Standing Committee in 30 per cent. of schools with Leaving Physics, and 15 per cent. of schools with Matriculation Physics. In one school, a Matriculation Physics class contained 48 students!

Conclusion

The value of this and similar studies is, I believe, that they provide information so that appropriate action can be taken to improve the standard of Physics teaching.

This article has only reported a small fraction of the findings of the teacher questionnaire survey. It has however indicated a number of areas in which teachers consider that there are deficiencies in the P.S.S.C. course or course materials. The findings of this survey have been considered in length by the V.U.S.E.B. Standing Committee for Physics, and, wherever possible, appropriate steps have been initiated in an attempt to rectify the deficiencies revealed or in some cases additional information has been sought from teachers.

PROFILE OF A PHYSICS DEPARTMENT
PHYSICS AT THE SOUTH AUSTRALIAN INSTITUTE OF TECHNOLOGY, ADELAIDE

Although the South Australian Institute of Technology celebrated its three-quarter centenary in 1964, the Physics Department of the Institute did not exist as a separate entity until the author arrived in January 1965. Prior to this date the teaching of physics was the responsibility of a joint department of mathematics and physics, which grew from a complement of one lecturer in mathematics in 1890 to an impressive collection of tutors, demonstrators, lecturers and senior lecturers in 1964.

To understand the growth of physics teaching in the Institute it is necessary to recall its early history as the School of Mines, which began Associateship and Fellowship Diploma Courses in Mining and Metallurgical Engineering in 1889. The subjects taught for these courses were Mechanical and Electrical Engineering, Metallurgy and Applied Mathematics. Since the school was on a site adjacent to Adelaide University, it was considered wise and expedient not to set up departments at the school in the science subjects such as physics, chemistry and geology, but to send diploma students to the University for the necessary teaching in these subjects. In 1903 the University initiated a Bachelor of Engineering course, which involved a reciprocal arrangement whereby B.E. students attended classes in Mechanical Engineering, Electrical Engineering and Metallurgy at the School of Mines. In point of fact, the early Fellowship Diploma and B.E. courses were exactly the same and matriculated students who took the common examination received both awards.

The School of Mines also assumed responsibility for pre-diploma teaching in 1903 when it inaugurated preparatory courses in mathematics, physics, chemistry and English for intending diploma students. Thus, physics teaching began at intermediate level for day and evening students. As time went on,
the preparatory courses became an important feature of the School of Mines and they were made the basis of a secondary-type technical school with a headmaster responsible for its activities. The preparatory school ultimately became the Adelaide Technical High School, which achieved the notable distinction of being the only high school in the State which was not administered by the Education Department. The school remained an integral part of the Institute of Technology until it was finally handed over to the Education Department and given new premises in 1963.

Apart from the pre-diploma teaching, no other courses in physics were offered at the School of Mines until 1947 when, with the advent of industrialization in South Australia, it became necessary to provide technician certificate classes in Physics. At this time the School of Mines was the only centre which was equipped for running tertiary courses in technological subjects. It was in these early post-war years that the responsibility for teaching X-Ray Physics to Radiography Technicians began. Immediately after the war, when expansion in education began to accelerate, the University decided to initiate its own B.E. courses and the School of Mines continued to offer its own diploma courses. The teaching in Physics I required for these diploma courses was still conducted by the University, but there was a growing awareness that all was not well with this arrangement; the failure rate of the School of Mines's students was far higher than that of the University Physics I students and murmurs of ill-preparedness began to be heard. Finally in 1954, it was decided, by mutual consent, that first year physics would be taught at the School of Mines. This decision heralded a new future for the joint department of mathematics and physics and gave both types of lecturer a more worthy aim.

Technological education in South Australia had a tremendous boost in 1957 when it was decided to initiate three-year Bachelor of Technology degree courses at the School of Mines. The school donned its new mantle of responsibility with a change of name to the South Australian Institute of Technology. The B.Tech. degree, which was to be awarded by the University of Adelaide, necessitated the creation of a unique university faculty, consisting of equal numbers of representatives from the University and the Institute. This new faculty not only administered the new B.Tech. courses in engineering, but also fostered several four-year courses in Applied Science for metallurgists and chemical technologists.

The initiation of the B.Tech. and B.App.Science degree courses at the Institute led to rapid developments in the teaching of physics. Second year physics courses were devised with particular emphasis on electron physics. In 1960, after much agitation on the part of various interested parties, a new B.Tech. degree course in Industrial Physics was approved by the University. This meant that physics teaching was required at third year level, which, with the continuation of certificate courses, involved an increasingly large joint department of maths and physics. The tiny workshop which had always coped with the maintenance of school-type experimental apparatus had to be expanded considerably in order to cope with the sudden demand for new equipment. Meanwhile the B.Tech. student population taking first year physics gradually rose until it reached 340 in 1965 and represented a major commitment for the new physics department when it was finally created in that year.

With the advent of the newly-constituted Wark Committee, the Institute now enters a new and exciting phase in its development. A large Federal grant has been given which will enable a new College of Advanced Education to be built on an open site of 180 acres at The Levels, which is 7 miles from the centre of Adelaide. Under the terms associated with this grant the Institute was required to initiate diploma courses at a professional standard. The new three-year diploma courses began in February 1967, and, since this was the date of introduction of revised B.Tech. and B.App.Sc. courses based on the new matriculation examination of Adelaide University, the expediency was adopted of making both diploma and degree courses identical in all respects. Thus, the new diploma course in Applied Physics is the same as the revised B.Tech. course in Industrial Physics, although the latter has now been accepted as a B.App.Sc. course in Applied Physics. The entrance requirement for the diploma course is Registration, which is defined as being matriculation equivalent. A novel points scheme has been devised, whereby students who possess a points equivalent to passes in any five matriculation subjects, may register. Students who are successful in their final examinations will receive a B.App.Sc. Degree from Adelaide University if they have fully matriculated, whilst those who have Registration only will receive a Diploma in Technology (Dip. Tech.) in Applied Physics of the Institute. Entrance to the B.App.Sc. course must cease after 1969, because the agreement between the Institute and the University will end in that year. This will bring to a close a very happy and fruitful partnership in tertiary technological education.

The present Physics Department staff consists of two senior lecturers, nine lecturers and three tutor/demonstrators, together with four laboratory technicians, three workshop technicians and a departmental secretary. The major teaching commitment is the first year course for degree/diploma students. The associated teaching problems include the opti-
mum size for a first-year laboratory class, marking of homework and the nature of tutorials, the usual problems, in fact, which most Australian Universities have had to grapple with in recent times. Time-tabling is extremely complex because of the nature of the student population, which includes part-time day release students and part-time evening students. It is not possible to experiment with novel solutions to teaching problems at this time and experience has led to lecturing first-year students in large classes.

For the new degree/diploma first-year course, all the experiments required throughout the year are set out to avoid duplication of apparatus. This necessitates tutorial preparation for the laboratory class and this precedes the actual class. The amount of report writing for these classes has been reduced to the minimum and involves the tabulation of results and the completion of problem type exercises on the practical work done. However, the importance of good report writing is not forgotten, but is taught in a separate subject known as General Studies. Although most of the laboratory work is conducted in normal laboratories, the group of nuclear experiments is carried out in a separate radiation laboratory. This small laboratory was set up in 1965 so that all first-year students, most of whom belong to Engineering and Chemical Technology disciplines, would have a basic knowledge of, and respect for radioisotopes and the associated Health Physics. This laboratory also caters for second and third-year Physics students and since the radioisotopes, such as cobalt 60, are used in millicurie quantities, the laboratory comes under the jurisdiction of the State Health Department. The Physics Department also houses a 2-curie caesium 137 source for radiographic purposes. A 5 millicurie radium-beryllium neutron source is also used to produce minute quantities of radioactive iodine and silver by thermal neutron activation.

Although fundamental physics must have a similar analytical content wherever it is taught, the teaching in this department has the essential aim of producing applied rather than philosophical physicists. Thus, in the second and third-year courses of the old B.Tech. degree in Industrial Physics and the new B.App.Sc./Diploma course in Applied Physics, the application of modern physics to technological problems is stressed rather than the advanced development of current theories. This does not imply that important theoretical topics such as special relativity, nuclear theory, fundamental particles, wave mechanics, statistical thermodynamics, etc., are ignored, but, rather, that they are presented with the minimum of fuss and without too much speculation about their validity. Solid state physics forms an important part of the courses and the second-year laboratory classes are biased in this direction. The third-year laboratory course departs from the old-style course of set experiments and consists of six or seven projects based on technological applications, such as X-ray diffraction, gamma and X-radiography, thin film techniques, the measurement of thermal diffusivity, spectral analysis, microwave physics, etc. Students are required to take ancillary subjects such as Basic Engineering Techniques, Electronics, Electrical Technology, Chemistry, Computer Programming, and Physical Metallurgy, as well as Mathematics, as part of their degree/diploma course. The department is proud of the fact that the old B.Tech. course is recognised by the Australian Institute of Physics as fulfilling the academic requirements for Graduate membership, and that the new B.App.Sc./Diploma course has recently been recognised for the same purpose.

Apart from the degree teaching, the department continues to conduct sub-professional courses in physics for certificates of the Institute in various branches of engineering and technology, and, in particular, is responsible for students taking the Conjoint Board examinations in Radiography and Radiotherapy. A recent introduction has been the certificate course in Photographic Science, which began in 1965. This four-year part-time course aims at providing photographic technicians for government research establishments and large industrial organizations.

The work of the department is not confined to teaching. Four members of the academic staff are currently working with various research groups in the University of Adelaide. This research work will lead to higher degrees of the University. Within the department itself, a small group, led by the author, has begun a separate research programme on the structural changes involved in the fast neutron bombardment of zirconium-aluminium alloys. A new Philips X-ray diffraction unit and a goniometer is being used for studying the radiation effects. Close cooperation with industry is also encouraged, and members of staff and senior students pay regular visits to the larger research and development laboratories.

C. G. Wilson
The International Union and the National Committee  
for Pure and Applied Physics

WALTER BOAS  
Chief, C.S.I.R.O. Division of Tribophysics, Melbourne

The February and March 1967 issues of the Australian Physicist contained a report on the 12th General Assembly of IUPAP held at Basle in September 1966 and the first News Bulletin published by the Union. It appears that most physicists in Australia would like to know something of the background and the history of the Union and the National Committee for Pure and Applied Physics and this article attempts to fill the gap and set out the relationship between the international and the Australian bodies.

1. The International Council of Scientific Unions  
(I.C.S.U.)

Before World War I, international co-operation in science took place through a heterogeneous collection of international associations, each of limited scope. Many of these had been under German auspices; at the end of the War they were defunct, and a new organization was clearly needed. To resume the international activities conferences were held in London, Paris, and Brussels late in 1918 and early in 1919 and an “International Research Council” was formed in 1919, mainly on the initiative of the Royal Society of London and the U.S. National Academy of Sciences. Owing to the bitter legacy of the War, the Central Powers were excluded but at the 4th General Assembly of the I.R.C in 1928 it was realized that it was undesirable to exclude for political reasons the participation of a country in international scientific activities. The Convention under which I.R.C. was constituted was due to lapse at the end of 1931, unless previously renewed. Accordingly much thought was given to a new constitution, which would not exclude any country which displayed evidence of scientific activity. Thus an international non-governmental organization, I.C.S.U., was born in 1931. By then eight Unions (including IUPAP) had been set up by I.R.C.

Under the current Statutes the objects of I.C.S.U. are, principally:

“(a) to facilitate and co-ordinate the activities of the International Scientific Unions in the field of the exact and the natural sciences; and

“(b) to act as the co-ordinating centre for the national organizations adhering to the Council,”

and secondarily:

“(a) to encourage international scientific activity;

“(b) to enter, through the intermediary of the national adhering organizations, into relations with the Governments of their respective countries in order to promote scientific research in these countries;

“(c) to maintain relations with the United Nations and its special and related agencies; and

“(d) to make such contacts and mutual arrangements as are deemed necessary with other International Councils, other Unions or other organizations, where common interests exist.”

In addition to the Unions, I.C.S.U. has set up a number of Scientific Committees, Joint Commissions, and Inter-Union Commissions to look after fields in which several Unions are interested. For instance, there are Scientific Committees on Oceanic Research, Antarctic Research, Space Research, and Water Research; Special Committees for the International Year of the Quiet Sun (following IGY); and for the International Biological Programme; the Committees on Data for Science and Technology, and on Science and Technology in Developing Countries; and the Inter-Union Commissions on Frequency Allocations for Radio Astronomy and Space Sciences, on Radio Meteorology, on Science Teaching, and on Solar Terrestrial Physics.

Before 1931 the I.R.C. had only one kind of member — an adhering national organization, usually the principal scientific society of the country concerned. Since 1931 I.C.S.U. is composed of two categories of members:

(a) National Members who adhere to the Council through their national scientific academies (under this or other title), and

(b) Scientific Unions who, in order to qualify for admission to the Council, must be international in character and interested in one or more branches of the exact or the natural sciences not already represented in the Council.

At present, the Council is composed of sixteen unions and fifty-nine countries. It may be of interest to note that the Federal Republic of Germany and the German Democratic Republic, the Democratic People’s Republic of Korea and the Republic of Korea, and the Viet Nam Democratic Republic and the Viet Nam Republic all adhere independently to I.C.S.U. Of China only the Republic (Taiwan) adheres.

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The Council is administered by:

a) the General Assembly which is held, as a rule, every two years, and

b) the Executive Committee consisting of the officers and representatives of the National Members and of the Scientific Unions. It meets at least once a year and directs the affairs of the Council between sessions of the General Assembly.

The Council obtains its funds from:

a) the dues of its Members,

b) subventions, donations etc. (e.g. from UNESCO),

c) revenue from capital investment.

Immediately on the formation of UNESCO in 1946, a formal agreement was concluded between I.C.S.U. and UNESCO and at its 60th Session in October/November 1961 the Executive Council of UNESCO admitted I.C.S.U. to Consultative and Associate status. UNESCO declared that it relied particularly on the assistance of I.C.S.U. in connection with the international co-ordination of the activities of non-governmental organizations working in the domain of science and hoped that the organizations affiliated to I.C.S.U. would participate in that work of UNESCO which lay within their competence. UNESCO also promised to give financial aid to I.C.S.U.

2. The International Union of Pure and Applied Physics

The creation of the International Union of Physics (U.I.P.) was decided in Brussels in July 1922, under the patronage of the International Research Council. The General Constitutive Assembly took place in Paris in December 1923 where 16 nations were represented.

The first President of the Union was Sir William Bragg (1922-1931). The first Secretary-General was Professor Henri Abraham until his death in a German concentration camp in 1943. Sir William Bragg was followed by R. A. Millikan (1931-1944) and M. Siegbahn (1944-1947). During the second World War the Union almost ceased to exist because of the isolation of the member countries and the occupation of the physicists in most countries with secret military work. The Union was revived at the fifth General Assembly, the first after the war, held in Paris in January 1947. At that Assembly the creation of two new International Unions, those of Pure (now Theoretical) and Applied Mechanics, and of Crystallography, was discussed. On the one hand, the separation of physics, mechanics, and crystallography was deplored and the creation of a framework within the Union of Physics thought possible whereby the importance of those disciplines could be done justice. However, the Secretary-General, Professor P. P. Ewald, pointed out that those disciplines also have strong bonds to other disciplines (e.g. mathematics, astronomy) and their activities could easily dominate the parent Union. It was further agreed that an international association of Optics would be constituted and this should be recognized as a member of the Union. Since that Assembly at Paris the National Committees and the Commissions of the Union have started to function again.

According to the Statutes of the Union which were adopted in 1924 and modified by the General Assemblies in 1931, 1948, 1954, and 1960, the aims of the Union are:

"(i) The stimulation and promotion of international co-operation in physics;

(ii) The co-ordination of the work of preparing and publishing abstracts of papers and tables of physical constants;

(iii) The promotion of international agreements on the use of symbols, units nomenclature, and standards.

(iv) The encouragement of interesting research. The Union may organize international meetings."

Individual nations adhere to the Union through their National Academies or National Research Councils.

"The body responsible for initiating its country's membership in the Union will set up a National Committee, which will maintain liaison with the Union.

The National Committees will, in their respective countries, encourage and co-ordinate study in various fields of Physics, with emphasis on international aspects. Every National Committee may, of itself or in collaboration with other National Committees, submit to the Union for discussion problems which are within its competence.

The National Committee elect their delegates to Union assemblies. They also elect a Delegation Head who votes on the delegate's behalf on questions of administration."

The work of the Union is directed by the General Assembly of delegates. A General Assembly of the Union is held every three years. It appoints the officers of the Union, the members of the Executive Committee, various special committees, and nominates representatives on various Inter-Union Committees. The officers are the President, the First Vice-President, the Secretary-General, and the Associate Secretary-General. The Executive Committee consists of the officers together with the Past President and eight Vice-Presidents. The First Vice-President will usually become President at the next General Assembly.

The Executive Committee usually meets once each year and conducts the affairs of the Union between General Assemblies.

The Union adheres to I.C.S.U. The funds which allow the Union to meet its administrative expenses and to support meetings and conferences

* General Information, JUPAP-10, May, 1964
come from the dues of the national members and from special grants from UNESCO through I.C.S.U.
In the period 1960-63 forty-one conferences were supported by IUPAP from this important source of
finance.

At present, 36 countries adhere to IUPAP.

The Union has fifteen specialized commissions. They are usually limited to six or seven members plus some corresponding members who are regarded as advisers. The commissions deal with the following topics: finance; symbols, units, and nomenclature (SUN); thermodynamics and statistical mechanics; cosmic rays; very low temperature; publications; acoustics; semi-conductors; magnetism; solid state; high-energy nuclear physics; low-energy physics; atomic masses; atomic and molecular physics, and spectroscopy; teaching of physics.

The International Commission for Optics which was founded in 1948 is affiliated with IUPAP. Seventeen countries are members of this commission which has organized numerous international meetings and a summer school.

3. Australia's Participation — The National Committee for Pure and Applied Physics

When the International Research Council was formed in 1919, Australia was one of the sixteen
countries invited to participate, on condition that it possessed, or else established, a National Academy (under that or other title) capable of representing it internationally. To this end the Australian National Research Council (A.N.R.C.) was created and this fulfilled the international functions of a National Academy until they were handed over to the Australian Academy of Science in 1954. The history of the A.N.R.C. has been described by Professor A. P. Elkin in an article in the Australian Journal of Science of June 1954 from which the following is quoted: "As there was no such representative scientific body for Australia, the senior Royal Society in Australia, that of New South Wales, was asked to take the initial steps. Two conferences were held in Sydney in 1919 of representatives of the several Royal Societies and of other scientific societies. Professor Sir Edgeworth David presided. It was decided to found a National Research Council, and a Provisional Council and Executive were appointed at once. The Australian National Research Council officially joined the International Research Council in 1920."

"The task of adopting the constitution and aims of the new body, as drawn up by the Provisional Council, of electing the members and executive of the permanent Research Council, and so of launching it as an independent body, was entrusted to the Australasian Association for the Advancement of Science, as the only existing Federal scientific association. This was done at its Melbourne meeting in January 1921." The A.A.A.S. was renamed ANZAAS in 1930.

"At first, the Council planned to present a report of its activities to each meeting of A.A.A.S., but already in 1922 this was considered unnecessary, and the A.N.R.C. was regarded as an independent body, free to conduct its own affairs subject to instructions from the International Research Council. This position continued until 1937, when the Council was reformed as a Committee of Fellows of ANZAAS." The formation of this new Council was the result of discussions which had been going on since 1930 when it was felt that the Council had not functioned "fully" as a National Academy. The new Council with a limited Fellowship was instituted by the General Council of ANZAAS at its meeting in New Zealand in January 1937. Fellows were elected on the recommendation of a Qualifications Committee and the new Council started on 3 December 1937 with 115 Fellows which later rose to about 225.

The financial resources of A.N.R.C. were very slender. They consisted of some initial grants: subscriptions of members (later, the Fellows of ANZAAS); special donations; and, from 1946 on, a yearly grant from the Commonwealth Government rising from £1000 to £3000 intended mainly to meet the international commitments. The Commonwealth Government made ad hoc grants for the conduct of Congresses in Australia. In 1954, the newly formed Australian Academy of Science took over, with adequate financial security and the goodwill of the A.N.R.C. from which most of the initial Fellows came.

For almost twenty years after the formation of the A.N.R.C., formal National Committees did not exist and matters relating to Australia's representation at IUPAP were dealt with by the physicists on the A.N.R.C. Executive. The General Meeting of A.N.R.C. held in Hobart on 11 January 1949 adopted a statement: "A.N.R.C. adheres to IUPAP and, therefore, a National Committee of Pure and Applied Physics should be set up in this country (as is the regular procedure in other countries that adhere to this Scientific Union) to provide an effective link with the Union. After consultation with the A.C.T. and State Divisions of A.N.R.C. the Executive Committee decided to invite 13 physicists to form the National Committee and Mr. N. A. Esserman, Chief of the Division of Metrology of C.S.I.R.O. to be Honorary Secretary and Convenor of the Committee. Most of the business of the Committee would be carried out by correspondence and the Chairman should be elected by those present at each meeting. On 7 June 1949, Professor E. O. Hércus, Joint Secretary A.N.R.C., advised Professor P. Fleury, Secretary-General of IUPAP, that a National Committee of Pure and Applied Physics had been formed.

In the middle of 1951. Mr. Esserman asked to be replaced because of pressure of work and suggested that the Secretary of the Australian Branch of the Institute of Physics become ex-officio the
Secretary of the National Committee. In August 1951 the Executive of A.N.R.C. adopted this suggestion with the remark: “In some ways it may be better for the National Committee to be identical with Committee of the local Branch of the Institute of Physics.” The Executive finally agreed to this as from the time when the headquarters of the Institute was transferred to Melbourne. This change occurred early in 1952 and on 20 March 1952 Dr R. N. Robertson, Hon. Sec. A.N.R.C., advised Professor Healey that Professor E. O. Hércus was now the Secretary of the National Committee, a position he held until 1954; he became Convener of the Committee in 1955. Dr J. S. Rogers was the Hon. Treasurer for many years, and the Presidents were Professor L. H. Martin (1952/53) and Professor M. L. Oliphant (1954).

On 1 March 1954, the Australian Academy of Science became the “Adhering Body” for Australia to IUPAP, and the National Committee became a Committee of the Academy with the existing Committee continuing to act for the time being. In 1955, Professor L. G. H. Huxley became the Chairman and Professor E. O. Hércus the Convener. From 1956 on the title Chairman lapsed and the Convener de facto became the Chairman and Secretary. Professor Huxley held this position until 1959 when Dr W. Boas became Convener. In 1966 the title Convener was changed to Chairman.

In August 1955, the National Committee recommended to the Academy Australia’s affiliation with the International Commission for Optics. In October Council did not approve this recommendation since the Academy already adhered to the parent body, and considered that subscribing to a Commission of the Union was not necessary. However, later the Academy Council agreed to adhere to the International Commission for Optics as from 1958, and subsequently formed an Optics sub-committee of the Australian National Committee for Pure and Applied Physics. This sub-committee became the National Committee for Optics in 1964.

The National Committee and its Chairman are appointed by Council of the Academy at three-yearly intervals. The Chairman is responsible for the conduct of its business. Standing Order VIII defines the functions of the Committee as follows:

“The chief function of a National Committee is to serve as an effective link between Australian scientists and overseas scientists in the same field. To this end it should:

a. ensure the maximum participation by Australian scientists in relevant activities of the International Union or other organization;

b. keep the International Union or other organization informed at appropriate times of Australian opinions, practices, and plans;”

c. advise the Council regarding Australian participation in the work and affairs of the related International Union or organization, including the appointment of delegates to assemblies of Unions or Commissions.

“A Committee may also advise the Council regarding the state of the appropriate science in Australia, where a standing committee with this function has not been appointed by Council.”

The Chairman may communicate directly with the International Union on scientific matters, but appointments of delegates to Union Assemblies and Commissions and matters of major policy and financial commitment have to be communicated through the Secretaries of the Academy.

Australian representation at General Assemblies of IUPAP and international conferences has always been difficult because of lack of funds for travelling, and usually a physicist already in the neighbourhood of the meeting place was asked to be the delegate. However, the advantages to Australia of being represented were often not recognized. In June 1948 the A.N.R.C. wrote to one prospective delegate that there was no real need for Australia to be represented as A.N.R.C. would receive full printed reports of the proceedings in due course! However, since 1954, the National Committee has endeavoured to find delegates to all major conferences of the Union.

The following is a list of official Australian delegates to General Assemblies and Conferences:

**General Assemblies**

January 1947, Paris: G. H. Briggs
July 1948, Amsterdam: C. E. Fddy
July 1951, Copenhagen: E. O. Hércus, E. G. Bowen
September 1960, Ottawa: C. K. Coogan
September 1963, Warsaw: J. F. Nicholas
September 1966, Basle: W. Boas, J. S. Dryden, N. H. Fletcher

**Conferences**

Physics of Metals, Amsterdam, July 1948: W. Boas
Teaching of Physics, Paris, July/August 1960: H. C. Webster.

Australians have also held office within the Union. For instance, Professor M. L. Oliphant was a Vice-President from 1951 to 1957, and Dr E. G. Bowen represented the Union at the Joint Commission on Radiometry and the Nature of Defects in Crystals (Melbourne,
August 1965) held under the joint auspices of the Academy and the International Union of Crystallography was supported by the Solid State Commission of IUPAP.

The present Chairman has tried to select the members of the Committee so as to have representation from each of the States and such physicists who are in touch with their colleagues in other countries so that they can easily distribute information from overseas and ascertain the views of the physics community. In these tasks the publication of the News Bulletins of the IUPAP in the Australian Physicist will be an invaluable help.

The compiling of this historical account would not have been possible without the discussions with Mr N. A. Esserman, Dr D. E. Martyn, and Dr J. S. Rogers and the help which Mr J. Doeble, Executive Secretary of the Academy, gave by enabling me to use the files of the Academy. To all of these I wish to express my sincere thanks.

The International Commission for Optics

W. H. Steel
C.S.I.R.O. National Standards Laboratory, Sydney

The statutes of the International Union of Pure and Applied Physics allow commissions of two types. The usual ones, such as those on Units and Nomenclature, or Solid State, are Special Commissions. Others, called Affiliated Commissions, are intended to cover more extensive fields of physics with some grants from sources outside the Union.

The International Commission for Optics, I.C.O., is such an Affiliated Commission and, at present, the only one. It has its own separate member countries, now numbering 17, each with its National Committee for Optics. These are formed in agreement with the country’s National Committee for Pure and Applied Physics and their relation with the Commission is the same as that of the latter committee to the parent Union. In Australia, the Council of the Academy appoints the National Committee for Optics, which until 1964 was called the Sub-Committee on Optics of the N.C.P.A.P.

International collaboration in optics was re-established in 1946 at the Réunion d’Opticiens in Paris. This meeting paved the way for the formation of the I.C.O. and, after a meeting in Prague the following year, the constituent assembly of the Commission was held in Delft in 1948 with T. Smith (Great Britain) as President. Subsequent meetings have been held at about three-yearly intervals in association with a Conference on a major field of optics. Between these Conferences, Colloquia have been organized, covering more restricted subjects.

Meetings of the Commission were held in London (1950) and Madrid (1953) with A. C. S. van Heel (Netherlands) as President for two terms. The 1956 meeting was held in Boston and I attended by special invitation. As a sequel to this, a Conference on Contemporary Optics, held in Sydney later that year under the auspices of the Australian Branch of the Institute, recommended to the Academy that Australia affiliate with the I.C.O. This took place in 1958 and the National Commit-
and nomenclature. In the last field it has recommended that name “optical transfer function” be adopted for a quantity that had, in the short space of ten years, collected almost ten different names. The ability of the Commission to undertake any activity naturally depends on some National Committee being keen enough on the project to undertake the work necessary.

In comparison with the larger Unions, the I.C.O. has been rather a small, intimate group, particularly at its earlier meetings. Huge increases in the attendance at the Japanese Conference and Paris meetings show, however, the great increase in interest in certain fields of optics. In Australia, the National Committee’s main functions are keeping physicists working in optics informed of the activities of the Commission, finding delegates for the Commission meetings, and presenting Australian views at these meetings or to Committees of the Commission. In the last field, Australia is represented on the Committee on Teaching of Optics by Mr. A. Aldersey. As Convener and later Chairman of the National Committee, I find the duties far from onerous.

Institute Affairs

NOTES FROM YOUR HONORARY REGISTRAR

J. F. NICHOLAS

The membership of the Institute consists of all those who have been elected as Honorary Fellows, Fellows, Associates, and Graduates and all such members have equal rights in the management of the Institute and in its scientific activities. The discussion below describes the qualifications required for election to Graduateship, i.e., the minimum qualifications demanded by the Institute for recognition as a professionally qualified physicist.

Formal requirements for admission

Article 9 of the Articles of Association reads:

9. Every candidate for admission to the grade of graduate shall
(a) have obtained the degrees of bachelor of science with physics as a major subject at a university recognised for the purpose of this article by the Council or a diploma recognised by the Council as providing an equivalent training in physics from a technical college or similar institution recognised for the purpose of this article by the Council, or shall have, in the opinion of the Council, attained an equivalent standard in his knowledge of physics and in his general education; and
(b) have had experience, for at least one year after obtaining that degree or attaining that standard, in the practice of physics or its applications or in the teaching of physics at such a standard as shall satisfy the Council.

The important points to note here are that:
(i) Graduateship of the Institute cannot be equated simply with graduation from a University, and
(ii) both parts of the Article require interpretation by the Council of the Institute and such interpretation is a continuing process.

Academic qualifications recognized at present

By resolutions of Council, the following qualifications are at present recognized as satisfying part (a) of Article 9:

(a) A pass B.Sc. degree in Physics from any Australian or New Zealand University.
(b) A degree in Physics from any university recognized by the British Institute of Physics and the Physical Society.
(c) Exemption from Part I of the British Institute and Society’s Graduateship examination, e.g., a Higher National Diploma in Physics.
(d) The B.Tech. degree in Industrial Physics or the B.App.Sc. degree in Applied Physics awarded by the University of Adelaide or work done at the South Australian Institute of Technology, or the Diploma in Technology in Applied Physics awarded by the South Australian Institute of Technology.
(e) The degree of B.Apk.Sc. from Melbourne University provided the degree includes Physics at the third level, Electronics, and Mathematics.
(f) The A.S.T.C. diploma in Physics, provided it was obtained prior to 1964, awarded by the Sydney Technical College.
(g) The Fellowship diploma in Applied Physics or Applied Physics (Meteorology) awarded by the Royal Melbourne Institute of Technology.
(h) The Associateship in Applied Physics awarded by the Western Australian Institute of Technology.

The significance of this list is that any applicant with one of these qualifications can be automatically regarded as satisfying the relevant part of Article 9. On the other hand, an applicant with other qualifications may still be adjudged under the final part to “have attained an equivalent standard in his knowledge of physics . . . .”. All such applications are treated as special cases and are very often referred by the Membership Committee for decision by the full Council. In this way, a certain amount of case-law is being built up and the number of cases that need to go to Council is being reduced.
As more tertiary institutes are formed in Australia, the list of acceptable qualifications may be expected to grow. In particular, it may be assumed that, at some stage, both the N.S.W. and the Queensland Institutes of Technology will approach the Institute for recognition. However, it is worth noting that Council has specifically refused recognition to the Associateship in Applied Science from the Perth Technical College and to the Associate Diploma in Applied Physics awarded by the Royal Melbourne Institute of Technology.

Acceptable experience

The second necessary qualification for Graduate-ship is one year's satisfactory experience in physics after attaining a formal qualification as described above. Again Council has laid down certain guide lines as to the standard required, some of which are:

(i) a further year's study in physics leading to an honours degree, whether this is taken out or not;

(ii) teaching of physics at higher levels, e.g., matriculation, in secondary schools;

(iii) acceptance as a Graduate of the Institute of Physics (London);

(iv) work as a Physicist or Experimental Officer or Scientific Services Officer in a government scientific establishment;

(v) any work equivalent to or more demanding than any of those listed.

The best summarizing description is that the applicant must have used his physics knowledge in a satisfactory fashion. One unacceptable form of experience could be study towards a further academic qualification where the physics knowledge is not essential, e.g., work for a degree in mathematics. However, all such cases have to be treated on their individual merits and I am here attempting to indicate the guide-lines that exist rather than be dogmatic about them.

Notes and News

Pawsey Memorial Lecture

The second Pawsey Memorial Lecture was given by Professor O. J. Eggen on Wednesday, 3 May, in the Bragg Lecture Theatre of Adelaide University. Professor Eggen, who is the Director of the Mount Stromlo Observatory, delighted his large audience with his lecture on "The Origins of the Galaxies" which was published earlier (June AP). In addition, however, he prefaced his published account with some authoritative comments about the proposed new telescope to be built at Siding Springs and this whetted the appetite of the audience considerably.

As a memento of this auspicious occasion, the President of the S.A. Branch of the Institute of Physics, Dr W. H. Schwietzke, presented Professor Eggen with an unusual paper weight made of local stone and incorporating a vein of opal.

Physics as a Career

The Department of Labour and National Service, in conjunction with the Education Department of South Australia and private schools, organizes annually separate Careers Weeks for boys and girls who are nearing the end of their school life, to provide them with an opportunity of visiting organizations to observe and discuss careers of interest. This year the boys' week extended from 12-22 May.

In 1967 the S.A. Branch of the A.I.P. was given the opportunity to assist the organizers during visits to establishments covering the field of physics. The Branch arranged first an introductory meeting for the boys at the S.A. Institute of Technology. The Chairman of the S.A. Branch, Dr W. G. H. Schwietzke, introduced each of the three guest speakers: Dr H. Blevin, Flinders University of South Australia, who spoke first about undergraduate courses at the Universities; Professor K. G. McCracken, University of Adelaide, who discussed the careers which followed from higher university degrees; and Mr C. G. Wilson, S.A. Institute of Technology, who spoke about the training of technologists, experimental officers, technical assistants, and technicians.

The large number of questions and the vast increase in the number of boys attending Careers Week (30 boys in 1966, 230 boys in 1967) show that students leaving school are vitally interested in physics. However, it is apparent that many boys have a very narrow view of physics as a career, probably due to the lack of information given to them by their teachers. How many physics masters have had the opportunity to visit establishments outside the university from which they graduated? Here is an important part of physics education that
may have been neglected, which the committee of the S.A. Branch is now considering.

On 18 and 19 May the boys visited laboratories at the Weapons Research Establishment, Salisbury. As the visits were limited to a morning, the boys were shown only three or four laboratories. This allowed time for them to talk to different classes of staff; technical assistants, experimental officers, and scientific officers. They visited both the Upper Atmosphere Division and the Applied Physics Division. In the former they were shown some aspects of rocketry and telemetry and the associated laboratory studies; in the latter Division they were shown the Optical and Mechanical Instrumentation Group, Electronics Techniques, and the main laboratory of the Division where they saw the Laser Research Laboratory and the Thin Film Microcircuit Research Laboratory.

The Committee of the S.A. Branch is most grateful to the Director of W.R.E. for allowing the boys to make this visit, to the Superintendent for the Applied Physics Division, Mr R. J. Dippy for his help, and to the Public Relations Officer for organizing the visit.

Astronomical Society of Australia

1. Conference on Solar Research and Observational Telescopes

This conference will be held under the joint auspices of the A.S.A. and the C.S.I.R.O. on 22-25 September. It will be held at Culgoora (near Narrabri, N.S.W.) following the official opening of the C.S.I.R.O. Solar Observatory and the commissioning of the Radiheliograph.

2. Annual General Meeting

The Annual General Meeting of the Society will be held in Canberra on 29-30 November and 1 December. Research papers in all branches of astronomy may be presented at this meeting.

**Book Reviews**


Reviewed by Mr. D. M. Sutherland, Advanced Devices Development Laboratory, Amalgamated Wireless (Australasia) Ltd., Sydney.

This book contains a rather fascinating collection of ideas for using physical effects (with an electronic flavour) in solving industrial control problems. Within the subject's specialty, it ranges very widely indeed and, although inevitably uneven, contains some very good brief discussions of basic control principles and devices. After an introduction, the succeeding chapters deal with solid-state, electrolytic, gaseous ion, capacitative, and magnetic induction sensors. There are final chapters on particular problems in sensing physical and chemical quantities.

The book should achieve its aims of stimulating and assisting workers in process control; but I do not think it can be given full status as a reference book until it has even more numerical information and further references more sharply directed towards design. In many cases the book will serve only as a starting point; but it will be effective enough in this role.

Future editions might contain some reference to the biological and medical field.

I must agree with the author's self-criticism that the list of manufacturers contains gaps. A more complete list of manufacturers would be useful; there is plenty of room, particularly if given in context, chapter by chapter.

Reviewed by Mr. A. M. Thompson, C.S.I.R.O. Division of Applied Physics, National Standards Laboratory, Sydney.

It would be difficult to give a more concise or more accurate description of the contents of this book than that set out in the author's preface. He says: "In this book the author's aim has been to present in a compact and logical way the basic principles involved in the design and analysis of linear a.c. circuits, with particular attention to the properties of the linear amplifier and its use in feedback systems. For the sake of brevity the author has not specifically discussed the characteristics of any active device other than the silicon transistor and has offered no explanation of mathematical techniques such as complex algebra, Fourier analysis, etc."

About half the book is given over to the essentials of circuit theory and the remainder to the principles of transistor amplifiers, negative feedback and noise in amplifying systems. The presentation is very clear and concise and is aided by the use of italics to emphasize new technical terms when they are first introduced into the text.

The publishers state that this book is intended for use in Departments of Physics rather than in Electrical Engineering and this is confirmed by the "bare bones" treatment and a complete absence of references to other literature. Although brief, it is very well suited for its intended use, as it covers most of the fundamentals of electrical circuits that would be of interest to experimental physicists. The clear presentation should also make the book a suitable starting point for those scientists, not necessarily physicists, who find they need some understanding of the fundamentals of modern electronic instrumentation.


Reviewed by Dr. G. J. Atchison, Department of Physics, Australian National University, Canberra.

Undergraduate textbooks on electricity and magnetism are legion; Scott has already gained sufficiently wide use to justify its appearing in paperback, and now extending to a second edition. It progresses from quite elementary field theory (which would present no great problems to a good Physics I student) to retarded potentials, antenna theory, wave guides, Laplace transforms, and (in this second edition) magnetohydrodynamics. Full chapters are devoted to D.C. and A.C. circuit theory.

The emphasis throughout is, as the title indicates, on the physics; the student using this book is not likely to lose sight of the physics behind the mathematics, nor of the relationship between field concepts and "practical" electricity.

Few major changes have been made in this second edition. There are many minor alterations, additions, and rearrangements, and some completely new sections. Among the more important of these are Section 6.5 (the Debye-Hückel Theory), 7.13 (Magnetic Mirrors, etc.), and 10.5 and 10.10 (Magnetohydrodynamics and MHD waves), and, by no means least, Appendix A.10 (Answers to selected problems). Gaussian units have been relegated to footnotes or small type, but have not disappeared entirely, and Appendix A.7 (Electrical Units), in which M.K.S. and Gaussian units are compared, has been retained. Vector notation is used from the outset, and a very readable 24-page appendix on Vectors is provided.

It is a little surprising to note that the "useful fiction" of magnetic pole strength is still introduced in Section 8.2 (Magnetic dipoles). There seems no reason (except perhaps to draw a parallelism between electrostatics and magnetostatics) why the author did not limit himself to the measurable quantity, magnetic moment.

Such changes as have been made in this second edition are improvements to an already acceptable book. Its use as an undergraduate text can be commended.


Reviewed by Professor J. C. Ward, F.R.S., Macquarie University.

It has become customary recently for controversial theoretical physics to be presented in the form of complete books, or even collected, or "selected" reprints, thereby presumably appealing to a wider jury of readers. The desire of book publishers to publish anything, now that there exists a guaranteed market, has greatly promoted this tendency.

Notwithstanding some of the heretical views, I found this book of Professor Heisenberg well worth reading. (Naturally the reviewer gets a free copy.) He has strong doubts about SU(3) as a basic symmetry, believes that the new Tamm-Dancoff method applied to a simple non-linear equation can predict masses and coupling constants, and exhibits some superficially impressive numerical results. I found this iconoclasm refreshing. The basic ideas, due of course originally to himself, of degenerate vacua, and the relation to symmetry problems and the Goldstone theorem are well presented.

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Chapter 4 is concerned with the description of polytypic structures and the notations which have been developed to describe them, while Chapter 5 deals with the physical and chemical properties (including methods of preparation and crystallographic data) of polytypic substances, in particular SiC. This chapter appears to be one of the most useful in the book, especially as it contains over 250 references.

Chapter 6 gives a detailed and well illustrated discussion of the structure determination of polytypes by X-ray methods.

One of the most successful theories of polytypism is the one based on F. C. Frank's screw dislocation theory of crystal growth. Dislocations and the spiral growth of crystals are, therefore, discussed in Chapter 7 in preparation for Chapter 8 which is devoted entirely to the various theories of polytypism. Although much of Chapter 7 is simply a repetition of material already available in a number of standard text books in dislocations, its inclusion can perhaps be justified on grounds of completeness. It also contains a large selection of Professor Verma's beautiful micrographs of spiral growth patterns.

The final chapter describes a number of more recent observations on polytypism and concludes with an assessment of the present theoretical position.

As the first of a series, this monograph augurs well for those to follow; but at SA12.75 it is an expensive book and one wonders if the lush production can be fully justified in view of the book's specialist nature. However, it can be confidently recommended to anyone concerned with polytypism or with polytypic substances.

THE MEASUREMENT OF TEMPERATURE.

Reviewed by Mr. W. R. G. Keurp, C.S.I.R.O., Division of Physics, National Standards Laboratory, Sydney.

Mr. Hall has just retired from the National Physical Laboratory where he was intimately concerned with all aspects of temperature measurement. He has also been a member for many years of the Consultative Committee of Thermometry of the International Committee on Weights and Measures. In fact, since his retirement from the N.P.L. he has been invited to retain his association with the International body. From such a background, Mr. Hall's book is an authoritative text with a strong leaning to the practical aspect of the subject.

Although the book is not meant as a manual, the chapter on "Expansion Thermometers" is probably the best account available on the use of mercury-in-glass thermometers. Similarly the instruments used for realising the International Practical Scale of Temperature are discussed in considerable detail.
Chapters on the calibration and use of temperature measuring instruments round out the practical aspect of the book.

As might be expected, Mr. Hall gives a very good account of the International Temperature Scale. Not only has he dealt in detail with the present scale, its definitions and method of realization but he has taken some care to point out its limitations and the possible changes that will be required to bring it closer to the thermodynamic scale.

The references are well chosen and sufficient for all but the expert. All in all, this is an excellent and concise account of the subject and is recommended to all who are or who may become involved in temperature measurement.


Reviewed by Professor C. N. Watson-Munro, School of Physics, University of Sydney.

It is very pleasing to see this book appear; it is written by an established authority in the subject and it is presented in a style which makes it obvious that the writer has encountered the problems of presenting the information to an advanced undergraduate class.

The book incorporates in an updated style much of the more useful basic data included in “Basic Data in Plasma Physics”, published by the same author in 1959.

In his presentation the author produces a pleasing balance of early history, the theory without the use of too heavy and too sophisticated mathematics, and the experimental results. These careful approaches combine together to provide the student with a sound physical comprehension of the behaviour of electrons, ions and neutrals in a plasma, and lay excellent foundations for subsequent more rigorous treatments of individual topics.

Topics covered include collisions, diffusion, ionization, radiation, surface phenomena, breakdown, glow, arc and microwave discharges, interaction with electromagnetic waves. It should be emphasized that in a book of this size there must be a concentration on the elementary principles of certain topics; as the title suggests, the concentration in this book tends to be in partly ionized gases and discharge physics. Other texts would be required for elementary courses in magnetohydrodynamics and fully ionized gases.

To summarize I find the book first class and I have no hesitation in recommending it as a text for a course in Gas Discharge Physics at about the IIIA level in an Australian University.

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**Monash University**

**Melbourne, Australia.**

**Chair Of Experimental Physics**

Applications are invited for appointment to a Chair of Experimental Physics which has been established with the intention of extending the range of research and post-graduate training into areas which may be adequately supported within the Australian University context. The new Chair is the third Chair of Physics to have been established by the University Council. Current research interests of the Department of Physics are in theoretical and experimental Solid State Physics.

Those who wish to make preliminary enquiries should write to the Chairman of the Department (Professor H. C. Bolton), Monash University, Clayton, Victoria, or to the foundation Professor of Physics, Professor R. Street, at present on leave at the Clarendon Laboratory, Oxford, who will be glad to supply details of present facilities and of the existing undergraduate and post-graduate programmes and to discuss future developments.

**Salary:** Not less than $A10,400 per annum. Superannuation on the F.S.S.U. basis.

Full information on application procedure, conditions of appointment, etc., is available from the Secretary-General, The Association of Commonwealth Universities, Appointments Section, Marlborough House, Pall Mall, London, S.W.1, or the Academic Registrar of the University, Clayton, Victoria, Australia.

Applications close with the Academic Registrar on 31st July, 1967.

The Council reserves the right to make no appointment or to appoint by invitation at any stage.

**J. D. BUTCHART,**

Academic Registrar.
As of July 1, Hewlett Packard Australia Pty. Ltd., the wholly owned subsidiary of Hewlett Packard, Palo Alto, California, now offers to the Australian INDUSTRIAL, MEDICAL & CHEMICAL markets direct distribution of all corporate products.

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