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THE UNIVERSITY OF ADELAIDE invites applications for appointment as LECTURER IN PHYSICS from experimental physicists with a Ph.D. or equivalent qualifications and some teaching experience in one of the following research areas: seismology, space physics, cosmic rays, radiophysics, upper atmosphere physics, solid state physics, vacuum ultraviolet physics. Duties will include lecturing to undergraduate classes and supervision of post-graduate students.

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COLLEGE PHYSICS

Physics in Australian Colleges of Advanced Education is an area of increasing importance for the training of physicists and as an avenue for their employment. Some of the patterns and problems of growth were evident at the conference held in Perth in August 1972—attended by 37 physics teachers representing all but two of the 18 colleges where physics is taught (see AP, December 1972).

The article and summary appearing in this issue arose from that conference and may help to provide physicists outside the colleges with a glimpse of the present status of physics in the CAE's.

The Australian Institute of Physics is also involved in the changing pattern of physics teaching. Since employers look to the Institute grades to define standards within the physics progression, the growth in number of colleges has been accompanied by a growth in the work of the AIP in accrediting courses. Many diploma and degree courses are now acceptable for Graduateship, including:

University of New South Wales—BSc in Textile Physics;

Sydney Technical College—ASTC Diploma in Physics (prior to 1964);

University of Melbourne—BAppSc, provided it includes physics at the third level, electronics and mathematics;

Royal Melbourne Institute of Technology—BAppSc (physics); Fellowship Diploma in Applied Physics or Applied Physics (Meteorology);

School of Mines and Industries, Ballarat—BAppSc (double major in physics); Diploma in Applied Physics;

Gordon Institute of Technology—Diploma of Applied Physics;

University of Adelaide—BTech (Industrial Physics); BAppSc in Applied Physics on work done at SAIT;

South Australian Institute of Technology—Diploma in Technology in Applied Physics;

Western Australian Institute of Technology—Associateship in Applied Physics;

Queensland Institute of Technology—Associate Diploma in Science (Physics); BAppSci (Physics);

Darling Downs Institute of Advanced Education—Associate Diploma in Science (Physics);

Capricornia Institute of Advanced Education—Associate Diploma in Science (Physics).

The accreditation process has involved detailed evaluations of applied physics or science courses at colleges, institutes and universities. On the other hand, a pass degree in physics from any Australian or New Zealand university (or any university recognized by the Institute of Physics, London) has, up to now, been accepted without question. With the trend towards courses with a large range of optional units—perhaps accreditation will become an even bigger task in the future. Meanwhile, a considerable amount of behind-the-scenes work goes into this AIP activity.

Branch Meetings

South Australia

“Electro-optics and Optic-electronics”

Dr Thonemann, WRE Salisbury

At the Levels campus, SAIT: 8 pm July 4.

Queensland

“Energy”

Prof. C. N. Watson-Munro, University of Sydney.

July 24.

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PHYSICS IN COLLEGES OF ADVANCED EDUCATION

G. J. Aitchison
School of Applied Science,
Canberra College of Advanced Education


The Nature of CAE's

There have been remarkable developments in the Colleges over the last few years. One has only to compare South Bentley with the old St George's Terrace, Perth, site, or the Levels with the SAIIT's overcrowded accommodation on North Terrace, or the Canberra CAE campus where four years ago sheep were grazing, to recognise something of the progress that has been made. CAE's across the country are in the process of either formation or reformation, and we certainly have not reached a 'Steady State' yet. In 1972 there were 54,000 students in CAE's; the Australian Commission on Advanced Education estimates 81,000 by 1975. A 50 per cent. increase in a triennium.

And what are the CAE's really, and how do they differ from the Universities? Are we really very clear as to just what the differences are? Today Mr Gorton's oft-quoted phrase: "equal to but different from" seems almost trite; but when he first uttered it, it must have sounded rather revolutionary. Many, I suspect, would have thought that 'inferior to and different from' would have been more appropriate. The real turning point was probably the tabling in the House of Representatives by Mr Fraser, on 17 September 1969, of the Wiltshire [1969] and Sweeney [1969] Reports. They respectively recommended Degrees (as well as Diplomas) for the Colleges and salary equality with Universities for specified staff.

The Commonwealth Advisory Committee on Advanced Education (CACA) itself seems to have faced up relatively early to the idea of equality. In its first report [CACA, 1966] it spelt out the differences between Universities and Colleges:

1. students with somewhat different types of interests;
2. a greater concentration upon part-time studies associated with employment, especially in scientific fields;
3. a more applied emphasis;
4. a more direct and intimate relationship with industry and other relevant organisations;
5. far less attention to postgraduate training and research;
6. a primary emphasis on teaching.

Differences of degree rather than of kind, and the distinctions none too sharply drawn.

But in stating that the Colleges were not to be inferior, the same report was much more definite:

"Colleges of advanced education should aim to provide a range of education of a standard of excellence and richness of content at least equal to that of any sector of tertiary education in this country, so that students and staff will be attracted to them on their merits for the special opportunities they offer. We hope that in due course some of the colleges will, in their own specialised fields, achieve international standing."

What then of a comparison between physics in universities and in CAE's? I find it particularly difficult to see any clearly defined differences when I look at the six criteria of the first CACA Report. Much university teaching in physics already has "an applied emphasis"; and in my experience, university physics is by no means completely out of touch with "industry and other relevant organisations".

But the task of physics within the CAE network, as I see it, is the education of students (there is a big difference between educating them and training them) in a manner appropriate to the needs of "industry"—using that word in the broadest possible context, to represent the whole outside world of employment. That is the task of the Colleges, whether or not others are likewise looking to the requirements of potential employers in planning their courses.

The Physics Profession and Employment Possibilities

Readers of this journal will suffer from no delusions about the present situation; any complacency of the sixties must have been rudely shattered with the release of the Argy [1970] Report. Perhaps the most frightening sentence in that report is the following:

"The Department (i.e. Labour and National Service) estimates that in the next decade the number of physicists available to enter the work force could be more than twice as great as in the last decade even with an appreciable decline in the proportion of students enrolling for physics."

That situation would certainly not be improved by a massive outpouring of physicists from the Colleges on to the labour market, at least if they are simply carbon copies of their counterparts from the universities. Not of course that the problems of employment for graduates are unique to physics, or to Australia. But we in this country are certainly making our contribution to the Graduation Explosion.

The Australian Physicist, June 1973
In 1957 the universities in Australia conferred just over 3,000 bachelor degrees. In 1971 the figure was 15,000—a fivefold increase in fourteen years. The number from the universities alone, excluding the CAE’s, is expected to rise to about 21,000 by 1975. It would seem that, as a broad generalisation, we are increasing the number of graduates from tertiary institutions much faster than we are increasing the number of jobs which the graduate is likely to regard as appropriate for a person of his education. Perhaps there is an element of truth in the assertion of a British appointments officer that a degree 'simply teaches you to do without the money it prevents you from ever being able to earn'.

The Role of Physics in the CAE’s

And so to the real question: What is the role of Physics in the CAE’s? One important role—let it not be despised—is its service function. For all of the Colleges, in terms of sheer student numbers, it is certainly the largest function; for nine of the eight College in which physics is taught, it is the only teaching function. SAIT, for example, has a first year Applied Physics class of 400, a third year Applied Physics class of 10. Footscray does not have a physics major, but has a first year (post-matriculation) physics class of 450.

It is impossible to know just how many physics majors are in the Colleges, because in some institutions first-year students need not have finally decided just what courses they intend following. However, Table 3 of Report No. 1 of the recent survey [Employment Survey, 1972] conducted by the NSW Branch of the AIP indicates a rapid rise in the estimated number of degrees and diplomas in physics, from 72 in 1972 to 220 in 1975.

But this is not intended as a plea for physicists in the Colleges to become solely service teachers, nor indeed to become solely teachers; indeed, my own conviction is that, if that is all that we do and are, then we will not be first-class even at that. I believe that to be a good tertiary teacher one must be associated with some form of activity that stretches one out intellectually. In my view, it need not be high-powered, esoteric, ultra-pure, and very expensive, research; one can even get the stimulus, for a limited time at least, by throwing all of one’s thought and ingenuity into the development and vivifying up of undergraduate courses. (At this stage of the Colleges’ development, many staff are finding that this is a most demanding task which leaves little time for much else). But we in the Colleges do have some opportunities for developing ‘applied research’ projects in close association with industry, at least if somebody else pays.

Happily, there are some signs that the official attitude to appropriate research work in the Colleges may be changing. The first Work Report [CACAIE, 1966] in the section headed: “Differences between universities and colleges of advanced education”, drew the contrast: “Within the universities, research and postgraduate training for research has steadily increased. In the Colleges there is little scope for research.” The second Report [CACAIE, 1969] stated: “While teaching is the primary function of colleges, appropriate members of staff should be encouraged to spend some time on investigational work for industry, not only for the reasons given in paragraph 1.19” (i.e. to establish links with industry) “but as a means of personal development. Because close links between industry and the colleges are vital, both in terms of the colleges’ function and in terms of staff and student development, we are prepared through the normal grants system to encourage colleges gradually to acquire facilities for research provided it is clearly related to industrial problems.”

Quite a change from the attitude of three years earlier. The Third Report [CACAIE, 1972] sets out the current attitude quite clearly: “To summarise, the Commission has endeavoured to identify seven ways in which research might be carried out in colleges of advanced education within the limitations set out in the preceding paragraphs:

1. Research on projects the majority of which would be concerned with practical problems; preferably related to problems within industry and to urgent social and economic questions within the community.
2. Research which would encompass training in investigational and research techniques as a part of the courses designed to provide higher degrees by formal study.
3. Research by members of staff to acquire qualifications of a post-graduate kind either within or out of the college and likely to lead to a higher degree either of a college or university.
4. Individual research either pure or applied, or a combination of both, stemming from individual interest and a strongly felt need for intellectual inquiry.
5. Research by individuals or groups supported by the Australian Research Grants Committee or other research fund organisations.
6. Research sponsored by agreement between industry and a college directed to specific ends.
7. Educational research supported by Australian Commission on Advanced Education funds.”

Physics Majors

To most readers of the Australian Scientist or the main, perhaps the sole, interest in physics in the Colleges is the physics majors—what sort, and how many. In the present state of the labour market, should the Colleges be producing them at all? My own personal view is that the Colleges will do the profession and the community a disservice if they flood that job market with physics graduates whose courses have been no different from those of their university counterparts. It is also my personal view that the Colleges have a real role to produce physicists with a difference, though what the difference is will vary from place to place, from College to College, according to the needs of the local situation. At this stage, when the Colleges are still working out their destinies, one’s thoughts are best expressed as questions:
Should the Colleges be producing 'super-technicians' and 'near-professionals'? The former Editor of this journal expounded on this need at ANZAAS in Adelaide in 1969, and said: "Our education system has not catered for such people though it may well be that we are seeing the beginnings of such training coming from the Colleges of Advanced Education" [Symonds, 1970].

Is there a need for people with a major in physics and their second major in something other than the traditional Maths? Another branch of science or something different—physics and computing, or physics and administration, or physics and...? Some of the Colleges have deliberately introduced a degree of flexibility into their course structures which make such combinations possible. There are some of us in the Colleges who have no doubt that there are real opportunities here for us to produce useful people, though there is some hard thinking to be done in deciding what, in any particular College, might be appropriately combined with physics to meet the local situation.

And there are other questions to be asked: Will the graduate in physics and... be as acceptable for the label of Physicist as the physics-maths graduate? Or for the label Grad.A.I.P.? And will the awarding of degrees by the colleges devalue lesser college awards?

Should the Colleges with Schools of Teacher Education be providing full majors in physics specifically designed for the needs of physics teachers? Should we offer units specifically in physics education?

And is there a role in the colleges for 'sandwich' courses in physics? If we tried to introduce them, would there be any real possibility of arrangements being made for appropriate sandwich-type employment in this country? Or does the fact that colleges cater to such a degree for part-time students lessen the need for sandwich courses? After all, many of our part-timers are currently taking ultra-thin sandwich courses—they oscillate between employment and college from day to day, sometimes from hour to hour.

These are the sorts of questions which the colleges are asking, and must ask; for, unlike the universities, the colleges must submit their courses to scrutiny by external moderators before they can be accredited for the award of degrees. And they are the sorts of questions which we must keep on asking; for the needs of 'industry' change so rapidly.

The summary which follows seeks to give snippets of information about physics in the individual colleges in Australia and Papua-New Guinea, in which the subject is taught. The information is gleaned from various letters and documents (some quite voluminous) which the Heads of the Physics Departments of the various colleges have supplied to me. I gratefully acknowledge their help, and accept the responsibility for any errors of fact or interpretation in the compilation of the summary from the material that they have supplied. I am grateful too to Mrs Sue Hogg of NSWIT for helpful comment on the draft of this paper.

**References**


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**SUMMARY OF PHYSICS ACTIVITIES IN CAE'S**

**Western Australia**

Western Australian Institute of Technology

The main campus of the Institute is at South Bentley, six miles south of Perth. Some Departments currently remain at the old city site on St. George's Terrace. The WA School of Mines at Kalgoorlie and the Muresk Agricultural College are parts of the Institute.

The Physics Department (including Geophysics) is one of seven departments in the Division of Applied Science. It offers a degree in Applied Physics, associateships in Applied Science (Physics), and Geophysics, and a post-graduate diploma in Applied Physics, Physics, Geophysics, and Experimental Methods are taught at third year. Two-year diplomas are offered in Diagnostic Radiography and Therapeutic Radiography. At Kalgoorlie, Physics is taught as a first year service unit only.

Academic staff: 20 (Head: Dr J. R. de Laeter); Support staff: 14.

There are Senior Lecturers in Chemical Physics, Experimental Methods, Geophysics, Materials Science, Nuclear Physics.

Student numbers (1972): Physics majors 195; Service units 763.

**South Australia**

South Australian Institute of Technology

SAIT developed in the early 1960's from the former SA School of Mines and Industries. It was unique among Australian Colleges in having effectively given degrees in the 1950's—the B.Tech. Degree, of the University of Adelaide, conferred by the University, was for work the bulk of which was taken in the School of Mines. (This arrangement was facilitated by the geographic proximity of the two institutions but is now almost phased out.) SAIT is currently moving from its city site to The Levels, in an outer Northern suburb, with physics currently split between the two sites. Physics,
Mathematics, and Electronic Engineering, combined in one School till about ten years ago, are now three separate Schools. The Institute operates a branch at Whyalla.

Physics offers Diplomas, Advanced Certificates, and Certificates, and hopes to add Degrees in the near future for some courses.

Physics staff: (Adelaide) 19 academic (Head: Dr G. L. Goodwin); 16 ancillary.
(Whyalla) 2 academic; 1 ancillary.

Student numbers: Professional Applied Physics: 1st year—400; 2nd year—70; 3rd year—10.
Sub-professional: Advanced certificates in Radiography and Radiotherapy—total approximately 60 students over two years. Photography certificate and Applied Physics certificate—each approximately 50 students over three years.

These last certificates are to be handed over to Education Department Technical Colleges over next four years. Most academic staff are involved from time to time in developmental work and advice for local industry, and some staff are engaged in research in the fields of semiconductors and thin films.

Victoria

School of Mines and Industries, Ballarat

The SMI, founded in 1870 and formerly financed by Victorian Education Department, now incorporates: Ballarat Institute of Advanced Education, Ballarat School of Industries, and Ballarat Technical School.
The Institute is currently moving to a new site of 340 acres, and Physics hopes to move by 1974.
The role of Physics was solely servicing until 1962, when a Diploma of Applied Physics (two year post-secondary) was introduced. This was increased to three years in 1965.
A Degree course as well as the Diploma course has been available since 1971. Students may take a double Physics major or Physics and Chemistry majors.
Academic staff: 8 (Head: Mr W. G. Durant).
Student numbers: 80 preliminary year; 106 first (post-matric); 15 second (i.e. Physics & Chemistry majors). (In 1972).

Bendigo Institute of Technology

The Institute developed from State Technical College approximately one century old. It offers Degree courses in Metallurgy and Civil Engineering and Diplomas in Applied Science, Engineering, General Studies, Mathematics, Business Studies; but no degree nor diploma in Physics—which has a purely servicing function. Preliminary submissions have been prepared for a diploma in Applied Physics and a multidisciplinary Degree course in Applied Science (Chemistry, Geology, and Physics departments).
Staff: Academic 5 (Head: Mr J. G. Roberts); Technical 2.

Caulfield Institute of Technology

The Institute was established in 1968 from the former Caulfield Technical College. The School of Applied Science includes: Chemistry, Computer Centre, E.D.P., Mathematics and Physics.

Physics was taught only to first year (post-matriculation) level till 1972, when the Degree in Applied Science (multidiscipline) and Diploma in Applied Science were introduced. Physics now offers two second year units and one third year unit.

Physics staff: 13 academic (Head: Mr R. F. Pugh); 2 technical.
Physics students: Preliminary 300; 1st year tertiary—300 (260 Engineering, 40 Applied Science).

Footscray Institute of Technology

The Institute was established in 1965 from the Technical College founded in 1916. It continues to provide training for Secondary, Trade, and Advanced technician students as well as tertiary, with a total enrolment of approximately 7000.

Physics has an essentially service function to Engineering and Chemistry, with teaching to second (post-matriculation) year.

A Laser-Radar research programme to study air pollution is being undertaken, with financial support from the Institute.

Academic staff: 10 (Head: Mr B. J. Thomson).

Gippsland Institute of Advanced Education (Churchill)

The Institute was formed two years ago from the Yallourn Technical College. It offers three Engineering Diplomas and a Diploma of Applied Chemistry inherited from the Technical College. Physics has a purely servicing role.

The School of Engineering and Applied Science has 25 academic staff, 2 technical, including Physics: 3 lecturers (Head: Mr K. G. Hamilton).

Physics students: 40 in preliminary year; 70 at first year tertiary; 24 second year level (all applied Chemists, including a few technical teachers). (In 1972).

Gordon Institute of Technology (Geelong)

This College was established as Gordon Technical College in 1887, and became the Gordon Institute of Technology in 1921. It has been a CAE within the Victorian Institute of Colleges since 1965. It is currently moving to 200 acre site at Waurn Ponds; Physics is on the new site. Till 1968, the function of Physics was wholly servicing to: Engineering (Civil, Electrical, Mechanical); Applied Chemistry: Textiles.

A Diploma of Applied Physics has been available since 1968, with a wide range of units, including Astrophysics and Astronomy.

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A multidisciplinary course of Physics, Mathematics and Computing, with a range of service subjects, has been submitted to Victoria Institute of Colleges.

Head of Applied Physics Department: Mr A. N. Pickering.

Student numbers: 15, Preliminary year; 168, first year tertiary; 43, second year; 6, third year. (in 1972).

**Preston Institute of Technology**

The Institute developed from Preston Technical College. The Technical College and the Institute of Technology are becoming separated (administratively and geographically) by the transfer of the Institute to a new site at Bundoora. Physics is at present still on the old site.

Physics is currently offering only service courses, up to second year post-matriculation. At present matriculation Physics is also included, but this will remain with the Technical College, and the Institute will be concerned solely with post-matriculation work. The courses serviced are: Engineering, Chemistry, Geology, Environmental Science.

Academic staff: 7 (Head: Mr D. Freeman).

Student numbers in tertiary years: 1st year 120; 2nd year 40. (in 1972).

**Royal Melbourne Institute of Technology**

Applied Physics is a Department within the Applied Science Division, which is one of five professional divisions. There are also five Industrial divisions.

The present Physics department arose from the amalgamation of several groups: Electronics, Instrumentation and Control; Paramedical (including Radiography, Radiotherapy, and Nucleography); Optics; and a group with expertise in Vacuum, Glass, Acoustics, Isotopes, and General Physics.

The department offers a degree in Applied Science (App. Physics); an Associateship Diploma of Applied Physics (Meteorology); and Associateship Diplomas in Medical Nucleography, Radiography, Radiotherapy.

It also conducts large evening programmes for both Degree/Diploma courses and for continuing education.

Staff: Academic 31 (Head: Dr R. E. Budwine); Technical, 12.

The staff carry on a ‘moderate’ programme of applied research and investigation as well as industrial consulting.

**Warrnambool Institute of Advanced Education**

The Institute developed from a Technical College, and affiliated with the Victoria Institute of Colleges in 1970.

Physics commenced in 1971, with a solely service function to Applied Chemistry; though there are hopes of introducing a multidisciplinary degree course in Applied Science.

Staff: Academic, 2 (Head: Dr R. G. Loch).

Students: 30 (preliminary, i.e. matriculation year); 50 (1st year tertiary); 10 (2nd year tertiary). (in 1972).

**Tasmania**

**Tasmanian College of Advanced Education**

The College is functioning on three campuses: Hobart, Launceston, Burnie.

Physics is within School of Engineering and Physical Sciences—a School of Applied Science is proposed, but it is not yet clear whether Physics will move into it.

Present function of Physics is solely servicing to:

Hobart—Engineers, surveyors, applied chemists, medical laboratory technicians (from own School) plus Teachers (from School of Education).

Launceston—Engineers, applied chemists, medical laboratory technicians.

Burnie—(Part-time students only)—Engineering, applied chemistry.

First year only is being taught, except for a few teachers wishing to specialise in Physics.

Senior Lecturer in Physics: Dr H. P. Avey.

Approximately 50 students. (in 1972).

**Australian Capital Territory**

**Canberra College of Advanced Education**

Physics is a discipline within School of Applied Science—one of five Schools. Three year full-time (or equivalent part-time) courses requiring a total of 21 semester units with at least four at third year level, have been submitted for degree status.

A diploma of 14 units, with at least two at third year level, is also available. The units of a diploma are a subset of those for a degree, so allowing part-time students to complete a diploma and then proceed to a degree. The course structure is very open; students may take up to half of their units outside the School of Applied Science. This makes possible double majors in Physics and almost anything else in the College, e.g. Computing, administration, other sciences, etc. In practice, the limitation on the number of other units that can be combined with a physics major is the mathematics requirement.

Academic Staff: School—25; Physics—5 (Fellow in Physics: Dr G. J. Aitchison).

**New South Wales**

**New South Wales Institute of Technology**

Institute established in present form by the amalgamation of the former NSW Institute of Technology (inaugurated in 1965, evolving from Sydney Technical College) and NSW Institute of Business Studies.

The College has strong emphasis on part-time and ‘sandwich’ courses.

Physics is one of four departments in the School of Physical Sciences: Physics, Chemistry, Geology, Materials. Most Physics courses are conducted at the central location at Broadway, though an increasing number of Science Servicing Physics courses are taken at Gore Hill, some 4 miles north along the Pacific Highway.
At present the heaviest commitments of Physics teaching is to the Servicing Courses, Engineering Sandwich students occupying a major role with Physics courses proceeding in the Electrical Engineering case to Stage III.

A small number of students are at present following through a Physics Major course, this having a high mathematical content. Early stages follow the basic stream of a general Science course and in Stages IV and V options are available.

Under the newly appointed Head of Physics and Associate Head of the School, Dr T. M. Sabine, two main projects are under way:

1. Proposals for a new 6-stage degree course (sandwich style similar to the Brunel University scheme of College-found employment periods spaced through the course). This course is designed to have two streams—Materials Physics and Engineering Materials.

2. Research by staff members into various problems in Materials Physics and Solid State Physics in conjunction with the Materials Science Group.

Academic Staff: 1 Associate Head of School; 1 Principal Lecturer; 4 Senior Lecturers; 10 Lecturers; 4 Tutor/Demonstrators.

Riverina College of Advanced Education

The CAE has taken over the former Wagga Wagga Teachers' College, with outposts at Albury and Griffith. The School of Applied Science has a staff of 13. Dr A. G. Robertson is currently the only physicist. The aim is to design programmes to meet established vocational needs—programmes in Applied Science may contain substantial elements of Business Studies and Liberal Studies.

Queensland

Capricornia Institute of Advanced Education—(Rockhampton)

A Diploma in Science (Physics) course is currently offered. Degree status is being sought.

All Diploma in Science students take common first year comprising Physics, Maths, Chemistry, Biology. In second year Physics students take Physics, Maths, Earth Science, Workshop Technology. The final year is entirely Physics, comprising: Electronics, Modern Physics, Electrodynamics, Materials Science, Vacuum Technology, Optical Instrumentation, Laser Technology; a project; and four electives chosen from: Acoustics, Astronomy, Applied Nuclear Physics, Crystallography, Digital Techniques and Data Transmission, Instrumentation and Control.

Staff: 5 Academic (Head: Mr R. L. Young); 3 Technical.

Student numbers: First year 46 (Total Diploma students in common first year); Second year 6; Third year 4. (in 1972).

Darling Downs Institute of Advanced Education (Toowoomba)

Courses in the School of Applied Science (with Departments of Chemistry, Geology, Mathematics, Biology and Physics) are 3-4 years. The Physics Department offers 3-year course for Associate Diploma as well as service functions.

For advanced years, local industry and research establishments are asked to provide projects for students —ranging from laboratory calibration of micrometeorological instruments to a small transmitter to indicate the temperature at the bottom of turtle nests.

Academic Staff: 5. (Head: Dr P. T. Dobney).

Queensland Institute of Technology

The Institute was established in 1965, initially with Physics in the Department of General Studies. From 1968, Physics has been one of five Departments in the School of Applied Science: Physics, Chemistry, Maths and Computer Science, Biology and Environmental Science, Paramedical.

The following courses in Physics are available:

3 year Associateship, recognised by AIP, and submitted for degree accreditation.

2 year service courses for Engineering.

1 year service courses for Industrial Chemistry, Medical Technology, Optometry.

Short courses in radioactivity waste disposal, biological use of radioisotopes.

Matriculation Physics for various technician courses.

A diploma course in Radiography, and a postgraduate course in Medical Physics and Bioengineering are being planned.

Staff: Academic 16 (Head: Dr O. J. Wordsworth); Technical 9.

Research is internally funded, and must therefore be integrated with third year student laboratory projects.

Papua-New Guinea

Papua-New Guinea Institute of Technology (Lae)

The Institute took its first students in 1967 at Port Moresby, but moved to Lae a year later. The total student population has risen from 31 in 1967, to 420 in 1972, with an estimated 620 in 1974. Because few students can proceed beyond Form IV at school, the Institute provides service courses to bring students up from this level.

The first year of physics is at essentially Matriculation level. Two more years follow, plus two short courses at 4th and 5th year levels for Electrical Engineers only. There are some facilities for research and testing work. The staff collaborate with the Micropulsation Research Group of University of Queensland in operating a field station, and with Bureau of Mineral Resources in operating a seismic station.

Staff: Academic, 5 (Head: Dr E. Balasubramian); Technical, 2.
THE TRAINING OF SCIENTISTS

I. W. Wark

Notes prepared for a Symposium of the Victorian Branch of the Australian Institute of Physics, held in the Physics Department at Monash University on Thursday, 15th March 1973, at 7.30 p.m.

Before I speak about the training of scientists it seems desirable to define what I mean by a scientist. To me a scientist is a person whose life is built around the study of the laws of nature and the attempt to extend them. Alternatively he is a person seeking to apply those laws in the solution of some of the problems of mankind. You will realize, therefore, that I make a distinction between pure and applied scientists. It is no sharp division and there will always be an overlap, with some scientists interested in both aspects and with others alternating between them. Despite this I should like you to consider whether different methods of training are needed for the two groups.

Within either category there is a great diversity of function and, moreover, the activities of individual scientists are constantly diverging from the original intentions. No two scientists have identical careers, and no true scientist follows the same pattern year after year. For adventure is at the heart of science, and there is no place in it for the stick-in-the-mud. Near-repetition research is not research at all.

If the lives of scientists are so varied, can a single scheme be satisfactory for the training of all scientists? I believe not: if one attempts to give a standard course there must be a sacrifice of the interests of one group to those of the other group. Under such a condition it would not be easy to decide which group should be less well catered for. It is my impression that in postgraduate studies the applied scientists have had the thin end of the wedge.

Despite these remarks I recognize that there is a great deal which must be common in the courses offered to all scientists, and (this should be a welcome remark in a gathering of physicists) most of the common base lies in mathematics and physics. The principles of science have been based on philosophical and practical studies of nature, on the analysis of the results of experiments, and the formulation of hypotheses which may become recognized as laws. These methods are the same for any branch of science. But the further one moves from mathematics and physics into chemistry, biochemistry, biology and the so-called social sciences, the less exact and less reliable become the formulations.
should be more strongly emphasized that life presents problems that in the present state of knowledge cannot be solved by science alone. I think the students' mentors should also emphasize that those who have to cope with such problems—industrialists, engineers and politicians—are in no way inferior to the academics. The 'elite complex' of the academics cannot be sustained. Nothing more infuriates the outside public than unwarranted claims and unqualified statements from university economists and social scientists, put forward forcefully as if all the answers were cut and dried.

For the training of professors and lecturers and research scientists I have little quarrel with traditional courses—except that Ph.D. studies have become far too protracted. Three years beyond a three-year undergraduate course was formerly regarded as sufficing, and should still suffice. That the course has extended to an average of six years in the USA is due mainly to bad choice of research projects in which a student, instead of a research assistant, is used to participate in the supervisor's own long-term research project.

On the other hand the very nature of the Ph.D. course, unless modified, makes it far from ideal for most applied scientists. They need less research on a highly specialized subject, more course work in science subjects, and much more on principles of management and on the many areas which will help them to understand human beings better. For in future they will be concerned with people more then with books. Admittedly the universities and the colleges do encourage the students to mix among themselves, and they even get an occasional glimpse of a professor. But for the potential man of industry external contacts would be more important than these internal ones.

Simultaneous training in industry and in academic circles comes closer to being ideal for the applied scientist. The sandwich course should be supported to a greater extent in Australia, not for the aspiring professors but for the majority of graduates who won't become dons. (Brunel University, for example, relies almost entirely on sandwich courses in certain disciplines: Strathclyde also.) Alternatively the student might spend a year or two in industry between undergraduate and postgraduate studies, as is customary in Russia for all except the academically most brilliant.

His mentors should implant in the mind of the student that to work on important industrial or community problems can be as rewarding as devotion to a discipline. You would be surprised how repeatedly I was rebuffed by men with Ph.D. degrees for proposing that they should undertake research on the prevention and control of bushfires: it was neither chemistry, nor physics, nor mechanical engineering, and no one would have anything to do with it. At last I did find an adventurous graduate willing to tackle the job: he made a success of it.

Rather than modify drastically the conventional university pattern of training for scientists, would it not be better to accept that a different type of institution should provide for those with industrial leanings? The colleges of advanced education have been supported with this function in mind, and they are accepting it. How-

ever there is some pressure within them from those who were trained in universities as potential professors, but who have not found careers within the universities, to convert the colleges into the type of institution in which they themselves were trained. It would be a disaster if they succeeded in doing so. The differences between colleges and universities must be maintained. I have suggested that funds should be made available to the colleges so that Ph.D.'s coming direct from the university should receive training in industry before starting to teach.

Perhaps the universities, as in Russia, should now concentrate on scholarship. Only ten per cent of Russia's tertiary-level students (the most gifted academically) attend universities; the rest are in institutes which correspond to our colleges.

The teaching staff should help to mould the student's attitude towards employment. He should be made to realize that his immediate past experience will probably be of no great significance to a prospective employer, that he may well have to change his major line of work several times during his career, and that each change will demand intensive study on his part. He must be prepared to replace allegiance to his subject by a willingness to solve his employer's problems, however far they may be removed from his former interests. For him any job with opportunities is better than no job: once within a company he has a chance to shape his own destiny. Initiative superimposed on training yields the personal dividend.

With respect to post-graduate training for the scientist, I would make certain pleas and comments.

1. It should be the aim of the universities to make the student, and particularly the post-graduate student, as independent as possible. Research students should not be spoon fed, as some have been by too-motherly supervisors.

I have been informed that an erstwhile director of the Royal Institution went around his laboratory up to three times a day. I cannot think of anything worse. My own professor in England saw me for detailed discussions perhaps once in two months, and advised students who could not progress under this system to quit.

2. Oliphant maintains that CSIRO should be used as a training ground for research students. I do not know whether the present Executive would agree, but there is evidence that the Organization is competent in this respect. Indeed twenty of my former colleagues in the Division of Industrial Chemistry, recruited at B.Sc. or M.Sc. level, have subsequently obtained D.Sc. degrees.

3. Without casting aspersions on any particular university, I feel that more care should be exercised in the award of Ph.D. degrees. There are men in Melbourne whose lives have been ruined by thinking, on the basis of an awarded Ph.D. degree, that they were competent researchers. It is all too rare for a faltering research student to be advised to abandon his course.
4. The choice of a student's research project is not an easy one. What is wanted is a problem that will develop ability to think and act, to assess results, and then to repeat these processes. A project in which the student is but a cog in a wheel is unsuitable; it will only show whether he is a good assistant. Helping to build cyclotrons is definitely out in my reckoning.

Many years ago a celebrated chemist in London had a group of students working on the syntheses by a common method of a series of related compounds: he needed the compounds to test a theory. I wouldn't have known whether any of those students was worth a Ph.D. degree, for they were not given the chance to show originality. About the same time another professor replied, when I enquired whether one of our scholarship men was showing initiative, "Dr Wark, my students do what they are told—I don't encourage originality." It was the same in a laboratory in Holland: one student didn't even know why he was given his problem until I pointed out how it fitted into the general pattern.

When I accepted this assignment I knew it to be a tough one. How could I, in a short space, make a worthwhile contribution to a subject which has occupied so much time for so many years in the minds of university and college staffs? However there may be some justification for my acceptance of this challenge in the fact that for thirty years I was on the receiving end of the graduate production line.

Throughout the fifty years since my formal studies ceased I have remained enormously grateful to those who guided me then. Nevertheless I do not think that I am being too precipitate in suggesting that some profound changes might now be warranted. In education it is to the future we must look—not to the past.

THE REGISTER
Changes in Membership from 11 December 1972 to 20 February 1973

Associateship
(a) New Elections
Cain, G. A.
Gibberd, R. W.
(b) Transfers
Booth, D. J.
Chamberlain, J. S.
East, R. R.
Henderson, T. L. E.
Phillips, D. M.
Plumb, I. C.
(c) Resignations
Langron, W. J. (NSW) Repacholi, M. H. (O/S)

Graduateship
(a) New Elections
Curidsik, J. I.
Hamilton, R. J.
Holmes, N. E.
O'Connor-Byrne, M. D.
Queen, J. M.
Ryan, G. J.
Savvides, N.
(b) Transfers
Ducker, C. H.
Gilbert, B. V.
Groves, M. R.
Jones, B. C.
Kotler, L. H.
Swann, R. B.
Ward, R. A.
Withers, R. J.
Wright, C. S.
Canberra Technical College, ACT
Education Department of Queensland
University of New England, NSW
Department of Education, NSW
Commonwealth Radiation Laboratories, Vic.
Department of Education, Vic. UK
Ionospheric Prediction Service, NSW

(c) Resigned

Students
New Elections
Cass, A. (Vic.) Malone, M. M. (Vic.)
Reen, E. D. M. (Vic.)

Subscribers
(a) New Election
Brett, J. H. (Vic.)
(b) Deceased
Dobbie, L. G. (NSW)

AUSTRALIAN INSTITUTE OF PHYSICS
Company Subscribers as at 19 April 1973

ACI Technical Centre
ANAC (Australia) Pty Ltd
APM Limited
Broken Hill Associated Smelters Pty Ltd
Broken Hill Proprietary Company Ltd
Broken Hill South Ltd

The Australian Physicist, June 1973 99
New Chiefs in CSIRO

Mr J. Warner has been appointed Chief of the Division of Cloud Physics, formerly the Cloud Physics Section of the Division of Radiophysics.

Dr G. B. Tucker, formerly Officer-in-Charge of the Commonwealth Meteorology Research Centre, has been appointed Chief of the Division of Atmospheric Physics.

Continuing Education Appointment

Dr J. A. McDonell, who is AP correspondent on Physics and Education, has been appointed Head of the Department of Continuing Education at Monash University.

News from University of WA

Dr P. Fisher from Purdue is visiting Perth until August, to lecture and work on soft X-ray spectroscopy at the University of WA and WAIT.

Dr J. I. Fernandes is visiting the University of WA until August to lecture on Feynman quantum mechanics.

Prof. A. F. Brown of City University, London, is at WAIT, working on ultrasonic techniques in solid state physics.

Dr B. M. Hartley has been appointed as Physicist, State X-ray laboratories, W.A. Prior to this he was a Lecturer in Physics at the James Cook University of North Queensland.

University Enrolments

Preliminary figures for 1973 enrolments at the University of Western Australia show a five per cent increase on 1972 but a two per cent. decrease in enrolments for science courses. The Vice-Chancellor, Professor Whelan, indicates that this is not specific to WA but reflects a national and world-wide phenomenon for which there is no ready explanation.

Open University

A committee under the chairmanship of Professor P. H. Karmel has been appointed by the Minister for Education to enquire into the desirability and means for expanding opportunities in Australia for extra-mural degree courses of University standard. The enquiry will include consideration of the position of persons unable to meet the normal entry requirements of universities.

Australian Academy of Science

New Fellows

Prof. R. Street (Monash University) was one of nine scientists elected to the Fellowship of the Academy at its Annual General Meeting on 26 April 1973. The election recognizes Professor Street's contributions to experimental and theoretical studies of magnetism.

Other new Fellows are A. L. J. Beckwith (Professor of Organic Chemistry, University of Adelaide), W. R. Levick (Professorial Fellow, Department of Physiology, ANU), J. H. Michael (Reader, Department of Pure Mathematics, University of Adelaide), A. F. Moodie (CSIRO Division of Chemical Physics—experimental and theoretical developments which have revolutionized the fields of electron diffraction and microscopy of crystals), J. P. Quirk (Head, Department of Soil Science and Plant Nutrition, University of WA), I. G. Ross (Professor of Chemistry, ANU), R. H. Wharton (CSIRO Division of Entomology), H. K. Worner (Conzinc Riotinto of Australia Ltd).

Awards

The Thomas Ranken Lyle Medal (given every two years for researches in mathematics and physics carried out in Australia) has been awarded to H. A. Buchdahl (Professor of Theoretical Physics at ANU).

Professor Buchdahl has published, in the years 1968-1972, two books and numerous papers dealing with the theories of optical aberration and tensors and spinors, as well as work on general relativity and related theories.

Of particular significance has been his work on aberration theory which is recognised as the best in the world. With his knowledge of practical optics he has made significant contributions to geometrical optical theory and his approach to higher order aberration theory has had a major impact on modern lens design with computers.

On general relativity his work has been extensive and wide ranging. He has shown exact solutions of field equations for the first time and has made valuable generalizations of significant results of general relativity.
The Penney Medal (given annually for distinguished research in physics by a scientist under 36 years of age) has been awarded to B. H. J. McKellar (Professor of Theoretical Physics, University of Melbourne) for his contribution to theoretical physics, particularly to nuclear theory.

His work covered the whole range of nuclear theory, from the nucleon-nucleon interaction through the theory of nuclear matter to the study of models of nuclear structure and reactions. It has extended beyond nuclear physics to the theory of strong and weak interactions when he found that such developments were necessary as a foundation for the nuclear theory.

The unifying theme of his recent work has been the understanding of nuclear interactions in terms of meson exchanges between nucleons. He was the first to apply the powerful ‘soft pion’ techniques developed in particle physics to problems of pion exchange forces between nucleons. His work on weak parity-violating forces between nucleons emphasised the possibility of obtaining fundamental information about the weak interaction from very precise experiments in nuclear physics. The importance of including two-body forces when calculating the effects of many-body forces was established in his work and is now generally accepted. Most recently he has calculated the two-pion exchange force between nucleons and demonstrated the existence of previously unsuspected limits to the concept of an energy-independent potential.

The Second Geoffrey Frew Fellowship has been awarded to A. J. Schawlow (Professor of Physics, Stanford University, USA).

International Scientific Unions

Representation in these unions include: J. S. Dryden (Pure and Applied Physics), W. H. Steel (President of International Commission on Optics), P. G. Law (Antarctic Research), J. H. Carver (Space Research).

Australian Journal of Physics

During 1972, 64 papers, 10 short communications and 5 supplements were published and 23 papers were rejected. The rejection rate has dropped from 17 per cent. in 1971 to 21 per cent. which is close to the average of 18 per cent. for all disciplines. This drop has been attributed to a decrease in overseas submissions.

On Walkabout

Professor K. D. Cole (Latrobe University) delivered an invited review on theories of irregularities in the upper ionosphere in equatorial regions, at the first Lloyd V. Berkner Symposium of the American Geophysical Union at the University of Texas, in May.

Professor E. Voigt (University of British Columbia) has been touring Australia under the auspices of the AIP Nuclear and Particle Physics Group. After visits to Sydney, Canberra, Adelaide and Melbourne he was the guest speaker at the Vacation School held at the University of Melbourne on 14-18 May.

Back Issues

The Circulation Editor is anxious to obtain copies of Volume 9, numbers 1 to 3 (January to March, 1972). Anyone wishing to dispose of their copies is asked to contact Mr E. G. Thwaites, National Standards Laboratory, Chippendale.

Agents

ANAC (AUSTRALIA) Pty Ltd announce their appointment as agents for the US based company, RECOGNITION SYSTEMS INC. RSI manufactures Diffraction Pattern sampling units, by means of a 64 element detector. The agreement authorises ANAC to act for RSI in Australia and New Zealand. RSI is a small, technologically oriented company, performing research, development and manufacturing in the electro-optical pattern recognition field. Present product line consists of the DPSU and a Recording Optical Spectrum Analyser, together with associated components which are used by other researchers in this field.

International Union of Pure and Applied Physics

Conferences Approved for 1973

The conferences have been designated A, B, or C according to the following categories.

(A) Large (500-2000) fully fledged meetings where all or most aspects of a Commission’s field are examined and reviewed. Most Commissions will only sponsor one such major meeting every three years.

(B) Medium (100-500) sized conferences at which a particular aspect of a Commission’s area of responsibility is examined in detail. A Commission might sponsor one such meeting a year.

(C) Small (40-100) sized meeting, often by invitation only, where specialists gather to assess progress in a very limited field. Such meetings might be satellite conferences, preceding or following a Category A meeting.

Commission on Thermodynamics and Statistical Mechanics

International Conference on Statistical Mechanics, (A) Amsterdam, Sept. Prof. N. Trappeniers, Van der Waals Laboratory, University of Amsterdam, Valckenaerstraat 67, Amsterdam, Netherlands.

Theoretical Physics and Biology, (C) Versailles, (date unknown). Prof. M. Marois, Institute de la Vie, 89 Bd St Michel, Paris 5e, France.

Commission on Cosmic Rays


Commission on Very Low Temperatures


Semiconductors Commission

5th Conference on Amorphous and Liquid Semi-
Conductors, B) Garmisch-Partenkirchen, BRD, Summer. Prof. M. H. Cohen, The James Franck Institute, University of Chicago, 5640 Ellis Avenue, Chicago, Illinois 60637, USA.

Physics of Semimetals, B) Cardiff, UK, Sept. 13-14. Dr J. E. Aubrey, Institute of Science and Technology, University of Wales, Cardiff CFI 3NU, UK.

Magnetism Commission
International Conference on Magnetism, (A) Moscow, USSR, Aug. 22-28. Dr A. A. Goussev, Vavilova St 44, Bldg 2, Moscow 117333, USSR.

Sagamore TV: Electron Charge, Spin and Momentum Density, (C) Minsk, USSR, Aug. 12-17. Prof. N. Sirota, The Institute of Physics, Byelorussian Academy of Sciences, Podlesnaya 17, Minsk, USSR.

6th International Colloquium on Magnetic Thin Films, (C) USSR, (date unknown). Prof. Telesninski, Department of General Physics, Faculty of Physics, Moscow State University, Moscow V-234, USSR.

Solid State Commission


Lattice Defects in Ionic Crystals, (B) Marseilles, France, July 2-7. Prof. M. Chenla, Laboratoire d’Electrochimie, Université de Paris VI, 9 quai Saint Bernard, 75-Paris Ve, France.

5th International Conference on Internal Friction and Ultrasonic Attenuation, (C) Aachen, BRD, Aug. 27-30. Prof. K. Lücke, Metallurgy and Metal Physics Division, Technische Hochschule, Aachen, BRD.

Commission on Particles and Fields
Vth International Conference on Photon and Electron Interactions at High Energy, (B) Bonn, BRD, Aug. 27-31. Dr K. H. Althoff, Physikalisches Institut der Universität Bonn, Nussallee 12, Bonn, BRD.

Nuclear Physics Commission
International Conference on Nuclear Physics, (A) Munich, BRD, Aug. 27-Sept. Prof. H. J. Mang, Physics Department, Technische Universität, 8046 Garching, BRD.

International Conference on Photonuclear Reactions and Applications, (B) Aislonar Conference Grounds, Pacific Grove, California, USA, Mar. 26-30. Dr Barry L. Berman, Physics Department, Lawrence Livermore Laboratory, University of California, Livermore, Calif. 94550, USA.

Reactions between Complex Nuclei, (B) Gatlinburg, Tennessee, USA, Oct. Dr Paul H. Stelson, Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA.

Atomic and Molecular Physics and Spectroscopy Commission
8th International Conference on the Physics of Electronic and Atomic Collisions (A), Belgrade, Yugoslavia, July 16-21. Dr Branka Cobic, Ion Physics Laboratory, Boris Kidric Institute, P.O. Box 522, Belgrade, Yugoslavia.

Plasma Physics Commission
Conference on Plasma Theory, (B) Kiev, USSR, Oct. Prof. L. A. Artsimovich, I.V. Kurchatov Institute for Atomic Energy, Moscow, USSR.

International Astronomical Union

PHYSICS AND EDUCATION
P. T. Dobney
Darling Downs Institute of Advanced Education

What are Keller-Plan Courses?
McDonell [1972], in a survey of some aspects of educational technology, has reported that no trials of ‘Keller-plan’ courses in Australian universities had come to his attention. What is a Keller-plan course? Briefly it is a personalized system of instruction via a reading course in which the subject matter is divided into little units. Each unit defines a certain area, either by clearly defined objectives, preferably behavioural, or by lists of specific questions. Each student works through a unit at a pace commensurate with his own ability until he considers that he fully understands the unit. He then presents himself to a tutor for a ‘readiness’ test, which is graded on the spot. If he passes the test he is congratulated and sent to work on the next unit. If he has made only a few errors, the tutor questions him as to his reasons for a wrong answer and attempts to clear up any misconceptions immediately. If he has made more than a few errors he is immediately sent back to study the unit for a while longer before being allowed to try another version of the test. The tutors are generally undergraduates who have been chosen for their knowledge of the subject, their maturity, and their understanding of the problems that confront beginners. The tutors are also available for consultation about problems which arise during the working of a unit. Laboratory exercises may be included in the units. Lectures and demonstrations are provided when a certain percentage of the class has reached a certain point in the class, but no examinations are based on them. The lectures are
generally not compulsory, and often only those students who have passed a certain number of units are allowed to attend them. All students are expected to take a final examination in which the entire course work is represented, but only ca 25 per cent. of the course mark is awarded for this examination.

Green [1971] lists nine reasons why a student likes such courses; he (1) works at his own rate, (2) works when he wants to, (3) knows what he is responsible for, (4) can get personal help, (5) is not rushed past the hard parts, (6) is not held back on material he already knows, (7) gets over being afraid of tests, (8) knows where he stands, and (9) enjoys being actively involved in learning instead of just listening to lectures.

Green points out that with such courses, the lecturer is no longer a verbal communicator of knowledge, or a performer and entertainer in front of a group of students. Instead he becomes the coordinator of a learning system who must tutor the tutees, prepare the study guides and tests, watch the rate at which students are working and help the students who are in difficulties.

The first Keller-plan course was taught in Brazil in 1962. In June, 1972, 190 Keller-plan courses were reported to be running in the U.S.A. Of these, 73 were in psychology (Keller’s own field of interest). Next came physics, with 38 reported courses. Teachers’ comments about these courses include “Absolutely wonderful”, “Highly successful”, “Physics no longer seems the most hated subject in the curriculum”. A few failures however have been reported. The failures have been attributed to such things as, “Undisciplined and average students” and “Lack of sustained student contact”. Austin and Gilbert [1973] have reported that in an electricity-magnetism course, Keller-plan students did substantially better than students in a conventional lecture-recitation course in the same subject area. They also reported an improved classroom atmosphere, better relationships with students and the opportunity to provide advantages for better students. The major problem encountered by these workers (and others) was student procrastination i.e. not completing units by a given deadline.

References:

Materials Available:
References to available manuals to assist in writing PSI courses, and a copy of Ben Green’s ‘Some Do’s and Don’ts for Success with PSI’ can be obtained by writing to the author of this article.

BOOK REVIEWS

Reviewed by W. A. Miller, School of General Studies, Sydney Technical College.

This popular English A level Physics text was first published in 1954 and has been reprinted every few years since then. The second edition “has been converted to SI units, and a number of sections—such as that on lasers have been enlarged to cover recent developments”. Actually there are very few changes, inches have been converted to centimetres, the section on lasers has been increased from half a page to one and a half pages, all quantities in the photometry section are now expressed in SI units, and some of the problems at the end of each chapter have been deleted and others added.

If you have a copy of the first edition the changes are too few to warrant buying this edition, though it is still a good book for first year university students.

Reviewed by D. G. Drummond, Electron Microscope Unit, University of Sydney.

It is disappointing that a book by a pioneer in this field should be so loosely written. It abounds in such statements as that on p. 78 that, ‘the . . . two quadrupoles . . . produce astigmatic components . . . at right angles to each other’—where in fact they are at 45°—or on pages 153-4, where mention is made of, ‘scattered electrons (leaving) the surface preferentially in the direction of incidence’—where clearly the direction of incidence leads deeper into the interior of the specimen. The meaning of such statements can usually be unravelled, but the paragraph on p. 183 and top of p. 184 has completely defeated the present reviewer.

Nevertheless, a physicist interested in the scanning electron microscope can get much from the book. The author has been personally concerned with every aspect of scanning electron microscopy, from the beginning of its development and, his discussions of the fundamental limitations of design, and of all the various components of the instrument are well worth having. The section on electron guns (of more crucial importance in the scanning than in the transmission electron microscope) is particularly useful.

This is not a book for the novice general user, but, as a collected summary of progress in concepts and design, it should be available in every scanning electron microscope laboratory.

Reviewed by E. G. Thoesti, National Standards Laboratory, Sydney.

There is not a lot of excuse for the title of this book. It is written with fluency but is more in the nature of a series of expanded notes on the major topics in an intro-
ductory course in mathematical statistics than a text adapted to the needs of physicists.

The coverage is selective and omits any direct discussion of analysis of variance, experimental design, or time-series analysis. The topics treated—probability theory, distributions, sampling, estimation, confidence intervals, and hypothesis testing—are those of fundamental importance.

The illustrative examples are mostly slight and do not relate to the situations of physics intimately or often enough. This is perhaps the most unsatisfactory thing about the book.

The notation is modern and the text generally accurate—an unfortunate mistake in the definition of 'intersection', 'A or B' instead of 'A and B', will cause confusion.

Important mathematical background is given in appendices—matrix algebra, classical theory of minima, orthogonal polynomials, and optimization of functions of several variables. The most used statistical tables are reproduced and there is an annotated bibliography.

If you are looking for a brief guide to the basic topics in mathematical statistics this book could serve your purpose.


Reviewed by G. A. Bell, National Standards Laboratory, Sydney.

This book, subtitled 'A History of Physics before 1900', is based on a series of lectures given to students of Birkbeck College on the history and nature of experimental physics. In it, frequently in a direct narrative style, we are taken down the well known road from the days of pre-science, the Greeks, Islamic Science, through Copernicus, Galileo, Newton, to Faraday and Maxwell.

This is not a definitive history of science, it is a most engaging and readable account of the mainstream of scientific activity which can be read with pleasure and profit by scientists and non-scientists alike.

The book opens with a chapter 'What is Physics?' in which Bernal discusses the human senses, social aspects of science, measurement, experiments and the building of theories.

The next four chapters cover pre-Copernican Physics and range over mechanics, philosophy, astronomy and mathematics as they developed in Europe, Asia and Africa.

The last half of the book is concerned with the development of classical physics as we know it today and with many applications of it.

The book is copiously illustrated with fine diagrams and reproductions of old drawings. It is enlivened by numerous anecdotes ranging from the wrong headed behaviour of a Chinese Emperor toward his most distinguished navigator to royal interest in lightning conductors and the entrepreneurial activities of a distinguished seventeenth century physicist.

It is a 'must' for any library connected with teaching science.


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

Since its discovery in 1960 laser technology has advanced on a wide front at an ever increasing rate; a new type of laser and a new application seem to occur every year; summaries produced in review articles, books, conferences, and workshops are useful but become rapidly out of date. The Proceedings of the Second Workshop, held by the Rensselaer Polytechnic Institute, in September 1971 are no exception. For instance, 30% of the book is devoted to the possibility of achieving nuclear fusion by inertial confinement of laser irradiated high density plasmas. While there is a very good account by Basov et al of the Russian experiments and proposals on the compression of deuterium pellets by multi-laser beams from different directions there is little mention of the American work at Livermore and this work suggests that the energy quoted in the discussion summary at Rensselaer for achieving fusion power could be reduced by a factor of 1000.

Apart from this kind of problem the Proceedings contain a very mixed bag of contributions with the following coverage:

Chapter I High Intensity Lasers (CO and I)
II Laser Induced Breakdown
III Plasma Diagnostics (some excellent articles)
IV Laser Produced Plasmas
V Theory of High Intensity Laser Interaction with Plasmas
VI Fusion Neutrons.

The book has sufficient and important useful information in it to justify a library rather than an individual copy.


Reviewed by J. R. Bird, AAEC Research Establishment.

Text books for undergraduate courses often develop a great similarity in content but this one is unusual. For each topic a first or early experiment is described and then an account of a more modern or precise experimental or theoretical treatment is given. For example, it is not common, these days, to read of the definitive work of Hopper and Laby on the charge of the electron—in addition to that of Millikan.

However, the title follows very much the terminology for 'Apple and Raspberry Jam'—all apple with a dash of raspberry for colour and flavour. This is a useful source-book for information relating to the important developments in atomic physics in the first half of this century.
CAREERS in

OBJECTIVE WOOL MEASUREMENT

In support of the increasing use of objective measurement techniques in the marketing of Australian wool, the Department of Primary Industry is setting up a small specialist team to monitor standards of commercial wool testing in Australia. This team will be primarily concerned with wool measurement and sampling techniques and standards.

To staff this Unit, the Department offers a variety of interesting positions in wool technology to persons qualified in this field from postgraduate and graduate levels through to technologists and wool samplers.

Applications are called for positions of:

WOOL TECHNOLOGISTS
(SYDNEY)

Salary will be paid within the range
99676-13325
depending on experience and qualifications.

A relevant degree or diploma is an essential qualification for these positions with postgraduate qualifications desirable at the higher level.

LABORATORY INSPECTOR
(SYDNEY)

$7081-7495

Approved technical qualifications and experience are required. However unqualified persons with a minimum of six years relevant experience will also be considered subject to passing a test of knowledge and competence in the field.

N.B. The occupant of this position will be required to travel interstate frequently.

WOOL SAMPLING INSPECTORS
(ALL MAINLAND CAPITALS)

Salary to be paid within the range
$4516-5282

It is expected that most appointees will commence on $4930 per annum.

Applicants should have knowledge and skill relating to wool processing including wool coring and sampling.

Conditions of Service:
- Appointments will be made as Chemist, Senior Technical Officer (Science) Grade 1, Clerical Assistant Grade 5 and Clerical Assistant Grade 4.
- Assistance may be given with fares and removal expenses.
- Long service, recreation and sick leave.

Applications should be forwarded to:
The Secretary,
Department of Primary Industry,
Canberra A.C.T. 2600.

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