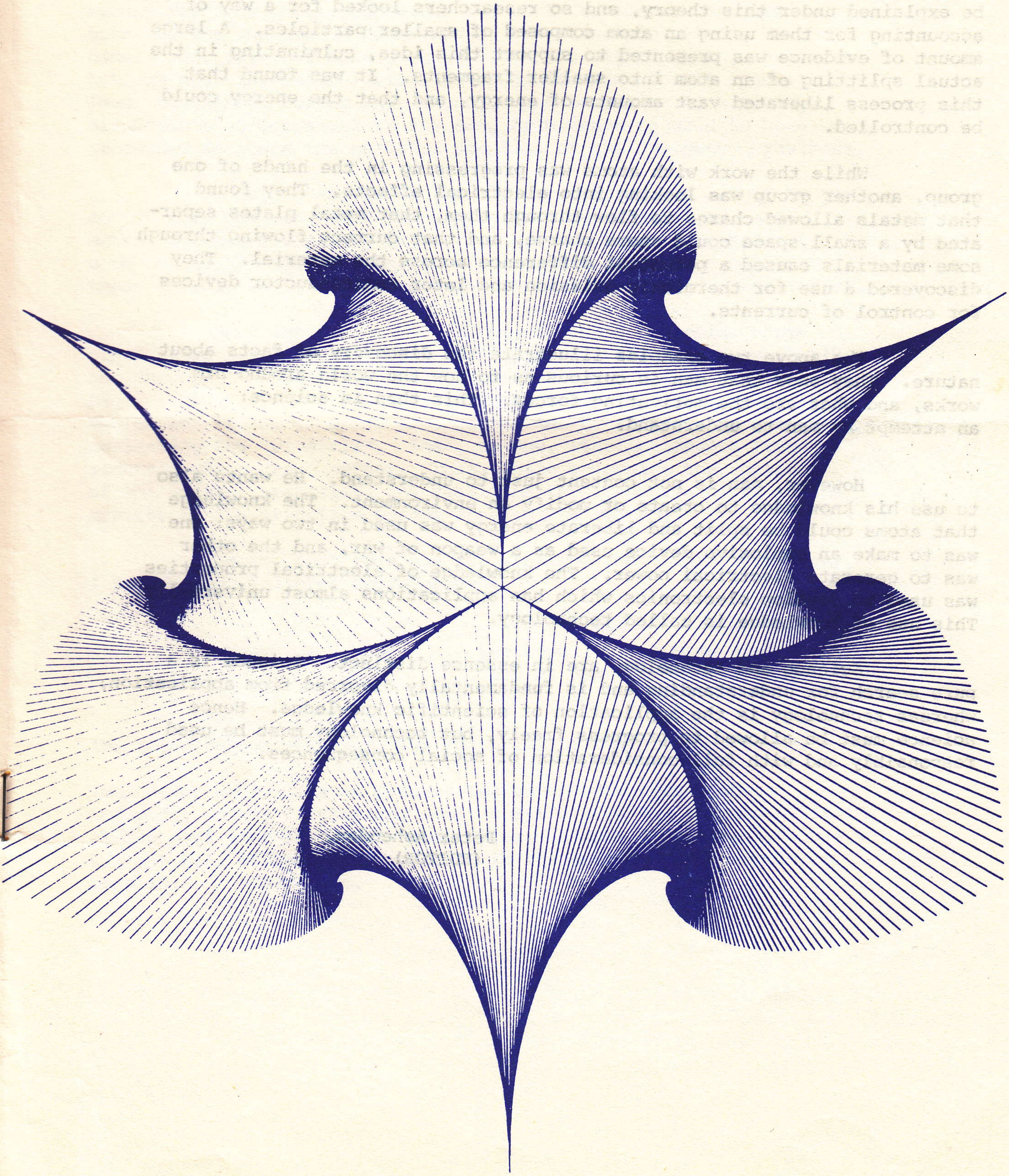
SCIENCE BULLETIN



EDITORIAL

For thousands of years, man has wondered about the fundamental constituents of the matter that forms the world around him. In ancient Greece, philosophers hypothesised that matter was composed of small indivisible particles which we now call atoms. They were, however, unable to satisfactorily prove or disprove their theory. In fact, it was not until comparitively recently that men discovered sufficient evidence to make atomic theory acceptable.

The idea that atoms were indivisible only lasted to the late nineteenth century. There were properties of matter that could not be explained under this theory, and so researchers looked for a way of accounting for them using an atom composed of smaller particles. A large amount of evidence was presented to support this idea, culminating in the actual splitting of an atom into smaller fragments. It was found that this process liberated vast amounts of energy, and that the energy could be controlled.

While the work with atoms was progressing in the hands of one group, another group was looking into electrical effects. They found that metals allowed charge to flow through them, that metal plates separated by a small space could store charge, and that current flowing through some materials caused a potential difference across the material. They discovered a use for thermionic emission and later semiconductor devices for control of currents.

The above two examples illustrate the discovery of facts about nature. They show that man is curious as to how the world around him works, and what are the motivating forces. This then is science: an attempt by man to understand.

However, man is not content just to understand. He wants also to use his knowledge to create or modify an environment. The knowledge that atoms could be split and liberate energy was used in two ways: one was to make an explosive device used as a weapon of war, and the other was to gererate electrical power. The knowledge of electrical properties was used to develop electronics which has applications almost universally. This use of knowledge is called technology.

Science and technology are in essence distinct. Science is a pure search for understanding and is fundamentally divorced from application, whereas technology is the application of scientific knowledge. Hence science must be allowed to progress freely, but technology must be used responsibly and with full consideration of social consequences.

Peter Ashenden.
(EDITOR)

Letters to the Editor

Dear Peter,

Once again the contents of your editorial require that I put pen to paper to respond to your writings. The opening paragraph of the editorial attributes to Isaac Newton the words: "Eureka! I've invented gravity!" It is on this point that I must take issue.

The word "Eureka" was uttered, in famous context, not by Newton, but by Archimedes shouting as he ran, naked, through the streets of ancient Greece. Authorities suggest that the reason for this unruly behaviour was that Archimedes had just observed the phenomenon described by the Principle bearing his name. That is, that upon stepping into his nightly bath, Archimedes noticed that the water level rose as he lowered himself into it. Thus, having discovered that a body, upon immersion in a fluid, displaces a volume equal to its own, Archimedes is said to have proceeded to shock the peaceful populace of the Parthenon Provinces.

This, to me, seems totally unrealistic. I put it to you, and to your readers, that the reason Archimedes acted so, was merely because either the bath water was too hot, or he had sat upon the plug! One needs no convincing that either, or both, of these stimuli would cause one to act in a like manner to Archimedes.

Now, let us turn to Newton, the only scientist whose birthday is a world wide holiday. The story that Newton was "walking through the orchard when an apple fell upon his head", is as big a pack of lies as one is ever likely to hear. More than likely Newton was trying to steal an apple or two by shaking the tree and collecting the "windfall". Then, as now, stealing apples from orchards was a grave matter. Thus, while observing the approach of the enraged orchadist, and realizing the impending dilemma, the gravity of the situation became apparent to Newton!

Hoping that this has set straight the record of history, I remain your faithful correspondant,

<u>Anon A. Mouse.</u>

(Because I'm not game enough to set my name to this piece.)

* * *

The above letter refers to the editorial of the previous issue.

The Editor would like to receive correspondance from readers and will, at his discretion, publish letters in the Science Bulletin. Please post your letters to The Editor, Science Bulletin, A.U.Sc.A., C/- S.A.U.A. office, or place them in the Bulletin pigeon hole in Room 56. Thank You.

WAVES IN THE MICROWORLD

By Kerry Hinton

Many people have watched the almost perfect circular ripples produced by a stone hitting the surface of a pond as it enters the water. The waves begin at the disturbance and propagate away at a steady rate.

The description of why waves propagate away in circular wave-fronts was first produced by a heuristic argument presented by a Dutch man named Huygens (Huygens' Principle).

His argument was far from mathematically rigourous or complete, but it did work and explained not just propagation of waves but also reflection and refraction.

With the first attempt to consider light as packets of energy rather than waves, Huygens' Principle was one of several experimental and theoretical reasons for dropping the "energy packet" idea. (It is an interesting side note that (Sir) Isaac Newton was one of the original proponents of the "wave packet" idea.)

However as the years passed, the Quantum theory of energy and fields was refined and developed. After undergoing several massive changes in interpretation and philosophy, the Quantum theory is now one of the accepted fundamental descriptions of nature.

Within this complicated and diverse theoty, Huygens has still maintained a foothold in certain areas of Quantum theory. One of the most interesting and physically realizable examples of this is an area called "Propagation Theory".

Consider the situation where we have a really huge billiard table. With this table we have a mechanism through which we can turn on and then turn off an electric field at any point on the table. Also we can vary the strength of the field.

Now we all know the laws of mechanics we were taught in matric (I hope). So if we have a ball at point $\underline{p}$ with velocity $\underline{v}$ on the table at a time t_o, at any time t_1 in the future, the ball, if allowed to move freely, will be at the point $\underline{p} + \underline{v}(t_1 - t_o)$. So with this type of rule, we know to where the ball will "propagate" just as with Huygens and his wave principle.

Let us try to generalise this. Say we have a type of ball which is electrically charged and are given its position $\underline{p}$ and momentum $\underline{m}$ at time t_o. (Note, not velocity, but momentum. This is due to a special quirk of Quantum theory which is beyond our present discussion.) We have a function $S(\underline{p}, \underline{m}, t_1 - t_o)$ which gives the position of the ball at time t_1.

Now say we start playing with the mechanism which produces electric fields at any given point on the table. Say we put a field at point $\overline{\underline{p}}$. Just as with Newton's law of gravity (i.e. $F = Gm_1m_2/r^2$) we can describe the effect of this potential on our charged ball if the ball goes through the point $\overline{\underline{p}}$. Say that we can describe the effect by a formula $E(\overline{\underline{p}})$. (We assume the field is the same for all time)

So we now look at what happens when our charged ball is aimed to go through $\overline{\underline{p}}$ and hence have its direction of motion affected by the electric field there, i.e. we see how it is deflected from its original path.

Waves in the Microworld (cont.)

We can describe the path in three parts. Before the ball reaches $\underline{p}$ we have its path described by $S(\underline{p}, \underline{m}, t_1-t_o)$. At $\underline{p}$ we have its path being affected by $E(\underline{p})$. Finally and most importantly, after the encounter, its path is now different and described by the same S as above, but we have a new momentum $\underline{m}'$ and new position and time dependence, i.e. $\underline{p}'$ and t_2, t'. We have t' and t_2 because t' is when this new function begins to describe the motion of the ball, and t_2 is any time after t'. (Later we shall represent $E(\underline{p})$ such that, rather than affect the ball at a given point on the table, which is in reality impossible, we let it act over a small length of the ball's path, $\Delta\underline{p}$.) For the present we have a description of the position of the ball at any time t, given by one of two formulae : $S(\underline{p}, \underline{m}, t_1-t_o)$ before time t' when the ball interacts with the field $E(\underline{p})$, and $S(\underline{p}', \underline{m}', t_2-t')$ after the interaction.

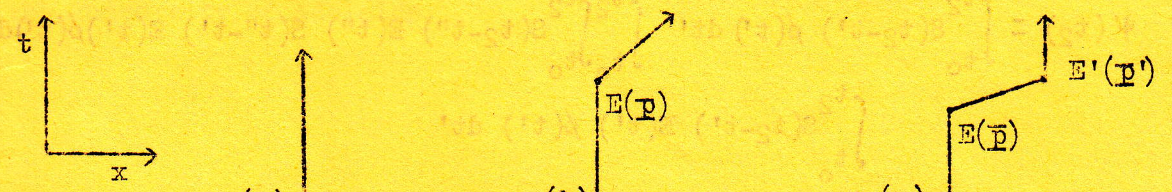
Before we go any further, it is useful to make several simplifying assumptions. Let us assume that all the balls originate from the same corner of the table. Also, let us assume that their position on the table is dependent only on time. So we have the position of the ball given by $S(t-t_o)$. (But the electric field $E(\underline{p})$ is still a function of position only.)

We can write down an equation to describe the ball at a time t_2 which is much later than when the electric field influenced the charged ball. When we interpret this equation, we do so from the point of view of a person who is a long way away from $E(\underline{p})$ and has a billiard ball detector, which tells when a billiard ball reaches it and records the trajectory of the ball.

Our equation for one ball is $S(\underline{p}', \underline{m}', t_2-t')\, E(\underline{p})\, S(\underline{p}, \underline{m}, t'-t_o)$ which may be written as $S(t_2-t')\, E(\underline{p})\, S(t'-t_o)$. This says that, starting at the corner from which our billiard ball originates at time t_o, it propagates to point $\underline{p}$ which it reaches at time t'. There $E(\underline{p})$ has its effect, and the ball then propagates to reach the detector at time t_2. We must remember that we are looking at the billiard ball at a time t_2 which is after the effect of the field. This is important in the next step.

Now let us see what happens if the bibliard ball path hits two points at which we have set up an electric field. We easily see that we will have for our detector $S(t_2-t'')\, E'(\underline{p}')\, S(t''-t')\, E(\underline{p})\, S(t'-t_o)$ where the term on the extreme right gives the path to the first interaction the ball has with the field, the next term is the interaction, the next term $S(t''-t')$ propagates the ball from the site of the first interaction to the site of the second, which is given by $E'(\underline{p}')$, and the left end term propagates the ball to the detector.

It is convenient to use some diagrams to interpret these equations.



(a) no interaction — (b) one interaction — (c) two interactions

In this diagram, we see that case (a) gives the ball going straight from the corner of origin to our detector. Case (b) gives one interaction with the field, and case (c) gives two interactions.

Waves in the Microworld (cont.)

If we could only use the billiard ball detector to look at the billiard ball, we would only be able to look at it at time t_2. If in addition to this we know the corner from which the ball came, we would then be able to measure only its initial trajectory and final trajectory. (The initial by the fact that we know the corner from which the ball started, and the final from our detector.)

So if we had a whole system of balls, and we looked at a typical ball, we would have to account for the various possibilities, i.e. a ball could have come straight from the corner it started from, or it could have interacted at $E(\underline{p})$ only, or it could have interacted at $E'(\underline{p}')$ only, or at both. We cover these possibilities by the equation

$$S(t_2-t_o) + S(t_2-t'')\ E'(\underline{p}')\ S(t''-t')\ E(\underline{p})\ S(t'-t_o) + S(t_2-t'')\ E'(\underline{p}')\ S(t''-t_o) + S(t_2-t')\ E(\underline{p})\ S(t'-t_o)$$

The next bit is the hard part. As I said above, we do not have any such thing as an electric field at a point. So how do we model a real field using this theory? The trick is to represent the field at each point, and then extend the result from that to a field which fills a region of space.

Again let us consider the single interaction, i.e. the case described by $S(t_2-t')\ E(\underline{p})\ S(t'-t_o)$. If we let the field be represented by a whole mass of values of E at different points, we can add up the possible interactions and get a sum (total) interaction. Before we do this, we must realize that it takes time to get from one point to another, so we replace the $\underline{p}$ in $E(\underline{p})$ by a t', as we said above that the interaction at $\underline{p}$ occurs at time t'. So now we have $S(t_2-t')\ E(t')\ S(t'-t_o)$. If we sum over all the possible single point interactions, we get

$$\sum_{t'} S(t2-t')\ E(t')\ S(t'-t_o),$$ where $\sum_{t'}$ denotes the sum over all t'.

If we now extend this to the two interaction situation as well, and include the no-scattering case, we get

$$S(t_2-to) \quad {}_{t''}\ {}_{t'}\ S(t_2-t'')\ E'(t'')\ S(t''-t')\ E(t')\ S(t'-t_o)$$
$$\qquad {}_{t'}\ S(t_2-t')\ E(t')\ S(t'-t_o),$$ where we interpret the parts as we did above.

I mentioned above that we can use the idea that a field will, in reality, extend over a small region $\Delta\underline{p}$, and corresponding to this region is a small time interval Δt during which the ball is in the region $\Delta\underline{p}$.

If we now apply this idea to the above equation, we get for the billiard ball detector description of the effect of the electric field on a whole bunch of balls emitted from the corner of the table,

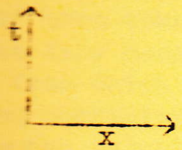
$$\Psi(t_2) = \int_{t_o}^{t_2} S(t_2-t')\ \phi(t')\ dt' \quad \int_{t_o}^{t_2}\int_{t_o}^{t_2} S(t_2-t'')\ E(t'')\ S(t''-t')\ E(t')\phi(t')dt''d'$$
$$\int_{t_o}^{t_2} S(t_2-t')\ E(t')\ \phi(t')\ dt'$$

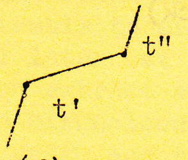
where $\Psi(t_2)$ denotes what the detector "sees" and $\phi(t')$ denotes what originally leaves the corner.

This equation is only accurate up to two interactions betwwen the field and the billiard ball; we could have triple, quadruple, etc. integrals. In fact, the series goes for ever. We use $\phi(t')$ to describe the situation as the balls (plural) leave the original corner, rather than $S(t'-t_o)$ because we are now looking at many balls and therefore are describing a whole collection of original trajectories, including statistical variations.

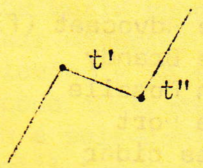
Waves in the Microworld (cont.)

The integrals in the last equation are over the times t' and t" between t_0 and t_2. This produces a surprising result, which is a strong part of the theory. We have two possibilities, either t' is less than t", i.e. we have diagram (d) below, which is quite normal. But we could also have t" less than t' which is diagram (e) below.





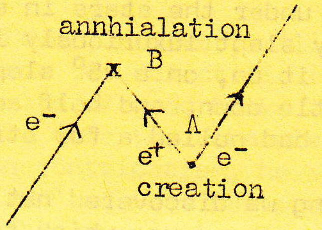
(d)



(e)

The second case gives rise to the situation of particles moving backward in time. A strange situation indeed. In fact, in the more rigourous theory, which is applied to electrons and other such sub-atomic particles, this situation is interpreted as an anti-particle, i.e. an anti-electron (or in our case, an anti-matter billiard ball). This interpretation then leads to the concept of pair creation and annhialation.

Let us look closely at (e). We can interpret it as shown below in figure (f). At A, (considering electrons) we have the production of an electron (e^-) and an anti-electron or positron (e^+). The original electron is coming in from the left. It encounters the positron, and being matter and anti-matter, they annhialate at B. The other electron produced at A then continues on its way "in place" of the original electron. One of the key reasons we can look at the situation this way is because we can not distinguish between electrons, i.e. we can not name them individually. So as far as the detector is concerned, the electron created at A is indistinguishable from the one annhialated at B.



(f)

Thus, with this brief insight into the microworld, we see how a concept which was dreamt up in the 1600's has application and interpretation in one of the most modern and dynamic theories of nature. To me, this is a truly remarkable fact, and goes further to demonstrate the beauty and simplicity of nature.

. . .

Editor's note - Kerry Hinton, a Science Association member well known to many students, is studying Honours Mathematical Physics at the University of Adelaide.

THE CONTINUING SAGA OF EXPERIMENT 69.

Male engineers vs. female science students.

Location: The Grampians

Aim: To prove female dominance over men.

Apperatus: 1 bottle Advocaat (fluffy duck)
1 bottle Brandy
1 flagon Moselle
1 bottle Port
4 bottles cider
3 nights
1 car
1 2-man tent (4 people)
2 sleeping bags (4 people)
Essentials?
1 tube toothpaste
3 socks (4 people)
Mishy Wishy & Leesy Bonce
Garry & Ron

Procedure: On reaching the Grampians we set out to prove our dominance by sleeping outside under the stars in subantarctic temperatures while Ronnie Pooh and Gary slept luxuriously in the tent. It took them half an hour to put it up, on a 45^{o} slope, half an hour to get inside, half an hour to settle down, and half an hour to crawl out, of the tent of course, after we had pulled a few strings, zips, and poles. Female dominance!

On awaking we discovered not only what appeared to be a fluffy duck in a tree above us, which turned out to be a pine cone, but after a previous night's roll we found ourselves at the bottom of the slope in the gutter. However, the males, still asleep, had no chance to observe this momentary decline (of dominance).

Lunch consisted of tuna sandwiches, fluffy ducks, and an audience of swooping crows and kookaburras who were uninvited guests on our plates. Gary and Ronnie Pooh's first and final attempt to ward off nashing beaks resulted in a spectacular display of black belt Taiquondo, and so-called male dominance, which, to their dismay, left us birds unimpressed.

Because we like to live dangerously we chose a camping site on a cliff with literally a 2000 ft. drop as a front doorstep. That night after consuming 1 flagon of moselle (x cm^3) and an unknown volume of fluffy duck, we observed, or rather didn't that our vision was impaired. Our hypothesis 1) The dense mist at such a high altitude
2) The reactivity of the mixture.

Bored with our company we attempted to demonstrate yet again our female dominance in testing our abilities for precision driving under treacherous conditions. Our feat was foiled not by an act of male dominance, but of male forgetfulness and a case of mislaid car keys.

At Mckenzie Falls, unable to resist a gamble and 4 mars bars each, we accepted the challenge of cracking the ice and fully immersing ourselves, clothes and all, which to their delight (or was it their intention) clung to our violently shivering bodies.

(Join us again next issue for the continuing saga of experiment 69).

SAYING WHAT ONE MEANS.

People write papers....in the honest conviction of publishing useful knowledge...(1)

Right. Most people who write papers are sure that the peck of wisdom they have gleaned is the peck for which the world hungers. Many of them take time and trouble to prepare their material and sort it into tiny heaps; they will later set it down lovingly in flowing prose from which they later on extract every pompous abstraction, hanging participle and turgid circumlocution with a self-control which approaches saintliness; they write and rewrite until the paper is a quarter its original length and says exactly what it means, in nouns and verbs, succinctly, elegantly and with charm. These people have done their homework; their prose is active and expressive, and their papers are published. Naturally they receive the recognition and advancement they deserve.

Alas, there are also the others. These people have messy minds and messier pens. If they are adept at anything it is at dressing up a sloppy bit of tomfoolery so that it resembles an experiment and then stretching their "results" over a dozen hypoxic exhalations.

Sometimes they get away with it. Fewer, however, will do so once Hugh Dudley's little book (2) has gone the scientific rounds. Professor Dudley is well aware of the wealth of good books available on the subject of communicating scientific data (he acknowledges these gracefully and even lists them). His own contribution, he says, is the result of a "confused empirical dossier" of what has proved useful and what has gone wrong in two busy academic surgical units full of people trying to publish their work. The wisdom thus accumulated is worth more than a passing glance.

He first disposes of the question of motive ("Have I since my last publication felt any trace of anxiety or envy...? Have I hurried ...to anticipate...someone else? Have I written this paper to bolster my promotion prospects?") devastatingly. He then passes on to the structure of a scientific paper, the conventions it must observe, the courtesies of presenting it, its referee-ability, the logic of its grammar and the elements of style.

However, the high point of the book is reached, we feel, in the section headed "Saying what one means and meaning what one says". Here are the clues which enable one to distinguish those authors of the second kind - those lily-livered, pudding-minded authors who sneak into journals dishonestly from time to time. Henceforth they will be recognized by everyone; Professor Dudley has cracked their code.

For example, when a paper begins in what seems an innocent way, "It has long been known...", what the author really means is "I haven't bothered to look up the original reference". When it continues, "It has not been possible to provide definite answers to these questions..." it is safe to substitute "The experiments didn't work out, but I figured I could at least get a publication out of it"; and "We believe this experience is worth recording" indicates that nothing of any significance was discovered. Solutions of "high purity", "very high purity" and "extremely high purity" are solutions whose composition is unknown except for the exaggerated claims of the suppliers. Something which was "accidently strained during mounting" was dropped on the floor; anything which was "handled with extreme care throughout the experiments" was not dropped on the floor. "It is clear that much additional work will be required before a complete understanding..." means "I don't understand it", and "It can be easily shown that" means "Some mathematician friend derived this relationship for me. I couldn't".

In the presentation of results, one should be on the lookout for "typical results are shown" - this indicates that only the best results are shown; "three of the samples were chosen for detailed study", which reveals that the results of the others didn't make sense and were ignored; and "the curve has been fitted by eye" - proof positive that a statistical technique would have failed to produce a fit. "It is of course impossible to translate results from animal to man" means "I am now going to do so"; "success rates of up to 80% have been achieved" is code for "usually we achieve 40%"; and "correct within an order of magnitude" can safely be translated as "wrong".

Work described as "fascinating" is work by a member of the author's own group, while work "of doubtful significance" has certainly been done by somebody else; "it is generally believed" indicates that "a couple of other guys think so too", and "the most reliable values are those of Jones" discloses that at some time in the past, "he was a student of mine".

We are indebted to Professor Dudley and strongly recommend his book. We also feel constrained to warn our contributors of the certain fate which awaits papers beginnig "It has long been known...".

(1) Silverman, G., "Lancet", 1976, 1: 364.
(2) Dudley, H., "The Presentation of Original Work in Medicine and Biology", Churchill Livingstone, London, Edinburgh; Penguin Books, Ringwood, Victoria, 1977.

* * *

Reprinted, by permission, from "The Medical Journal Of Australia", August 27, 1977.

* * *

Phantom Flooder Frozen Up?

Since the cold weather has set in, no reports of flooding within the university have been received. Perhaps the Phantom Flooder is frozen up and now finds that his plans to flood the university are "up the spout".

* * *

Talking down to people annoys them...
Talking over their heads puzzles them...
Talk to people in their own language; sincerely, honestly, convincingly.

NOTICES.

HAVE YOU GOT YOURS?

Fashionable ties displaying the Science Association motif are now available at a cost of $2.00 each. Also available are A.U.Sc.A. badges - $1.00 each (Limited supply).

This is your chance to purchase an item which will be a lasting memory of your years at university!

Contact Robin Marlin, Paul Moritz, or Simon Maddocks via the Science Association pigeon hole in the S.A.U.A. office, or by word of mouth.

HURRY WHILE STOCKS LAST!

* *

CAN YOU HELP?

If you are a student who has studied or is studying any science subject, you can.
The Science Association is planning to publish a magazine called "The Blue Dwarf" which will contain critiques of the different subjects in the Science and Maths Science Faculties, for distribution to enrolling students.
All we need from you is a summary of what you thought of your particular subjects, and what you think a student enrolling in these subjects should know about them.
Here is an example;

ORGANIC CHEM II.

This subject is very similar to the organic chem. section of Chem.I. There is, however, a lot more detail, with great emphasis placed on stereochemistry and mechanism. A student must learn to apply the mechanism taught in order to be able to formulate syntheses.

If you can do the tutorial problems, rejoice, because the exam questions are easier! Tutorials are taken in a group of about 9, with a staff member. The success of the tute depends heavily on the staff member.

The lecture material is much more interesting than that covered in 1st year.

Practicals are interesting, but do not relate to the lecture notes. You are left to organise yourself, and have an allotted amount of work to get through each term. There isn't very much work to do so there is no rush.

Text book; Morrison and Boyd - good for reference and closely followed by the lecturers.

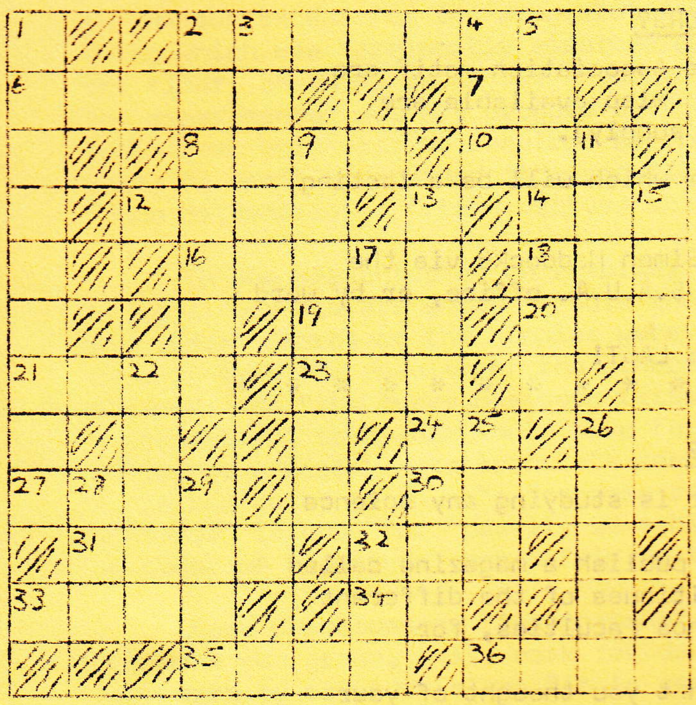
Critiques of the same subjects from different students will be merged and authors' names will not be published.
Please send contributions to The Editor, The Blue Dwarf, Science Association, C/- S.A.U.A. office, or place in the Bulletin pigeon hole in Room S6. Thank You.

* *

DON'T FORGET!

about the Reorientation camp to be held from June 22 - 24 at Loftia Park, leaving Uni. at the Friday night. $12 per head or free if you don't bring your head (so I'm told). Contact John Edwards or Kees Elferink (Elferinic,Elferinko).

SCIENCE CROSSWORD



Down

1. Adjective describing an object possessing energy.
2. Cellular division resulting in haploid daughters.
3. Joint in the human arm.
4. Mineral deposit.
5. Couch grass runner.
9. Transition metal.
11. Nine (prefix).
13. Study of heredity & populations.
15. Swelling of tissue due to an excess of fluid.
17. Woven, coarsely porous membrane.
22. Between.
25. The lowest prime.
26. Rare gas.
28. Blood group type.
29. Soothsayer.
32. Writing medium.

ACROSS.

2. Object which has changed its form.
6. Inventor of dynamite.
7. Variable factor in blood.
8. Term used to denote the same reference (Latin).
10. German one.
12. Those that will always be with us.
14. Collection of animals.
16. Pigs.
18. Uni.
19. Cave.
20. Insane.
21. Three (Latin prefix).
23. Suffix to stalact___ (geology)
24. Turn over.
26. Mode of radio transmission.
27. Small, furry creatures.
30. Within.
31. The discoverer of the Law of Optical Absorbance (also a beverage)
32. Crystalline Hydrogen oxide.
33. Opening in the skin.
34. Alignment of a compass needle.
35. Evil smelling.
36. Description of a stu id theory, or a bed.

SOLUTION TO LAST CROSSWORD.

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S P E C T R O S C O P Y
  I     E         O   R E
  N U L L         O P U S
M U   O L I V E       N
A S I D E     N   M U D
T   T E R R O R   I S
R   C     E   I   N   A
I N H A L E   C O D O N
X     R   F R O G     A
  R I G     U     F   L
    C O N C H O L O G Y
  F E N     R     G E T
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THE SCIENCE BULLETIN

The periodical of the Adelaide University Science Association.

22nd June, 1979

CONTENTS

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The Bulletin Standing Committee with sore feet:

Adrienne Day   Sandra Muirhead

Stephen Royce   Robert Trengove

Editor: Peter Ashenden

The Editor would like to thank

Mishy Wishy and Leesy Bonce
Paul Moritz
Kerry Hinton
and especially Sandra Muirhead.