e.g., Smythe, "Static and Dynamic Electricity," p. 38).

Dr. Abbot's comparison of the electrical with the gravitational problem suggests an extension of Newton's purely geometrical proof for the latter to the electrical analogue. For a uniformly charged spherical electrical shell, Newton's proof, namely, to divide the surface of the shell by double cones with their vertex at the field-point obviously applies, *mutates mutandis,* since the law of force is in each case the same, namely, the inverse square and the effect of area is exactly cancelled by the effect of distance.

It is interesting to note, however, that in the case of a circular cylinder, if end-effects be ignored, the same method of proof is applicable when the aforesaid set of cones degenerate into a set of double planes cutting off long strips on the inner wall of the cylinder each of an area proportional to the distance from their line of intersection while the law of electric force now becomes that of the inverse distance, so that complete cancellation again results.

Newton's theorem that the force exerted by a gravitating shell or sphere at an external point acts as if the whole mass were concentrated at the center is also transferable to the electrical case and provable by the same simple geometrical construction, choosing now for the vertex of the cones or intersecting lines of the planes the point inverse to the external point.

I have not seen this method of proof applied to these simple problems.

A gravitational parallel to the more general electrical theorem which would correlate the density (per unit area) of fluid matter distributed over a shell of any form with the total curvature is a further obvious extension.

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SCIENTIFIC BOOKS

SURVEY TEXTS IN PHYSICAL SCIENCE

Man's Physical Universe. By ARTHUR TALBOT BAWDEN. xv + 832 pp. New York: The Macmillan Company. 1943. $4.00.

Physical Science. By WILLIAM F. EHRET, editor, LESLIE E. SPOCK, JR., WALTER A. SCHNEIDER, CAREL W. VAN DER MERWE and HOWARD E. WAHLERT. x + 639 pp. New York: The Macmillan Company. 1942. $3.90.

The Study of the Physical World. By NICHOLAS D. CHERONIS, JAMES B. PARSONS and CONRAD E. RONNEBERG. vii + 883 + xiv pp. Boston: Houghton Mifflin Company. 1942. $3.85.

SURVEY courses in the sciences began to appear in college curricula in the years before the war, and it is probable that their introduction is now being considered at many colleges where they were unknown before. For this reason, though none of the texts listed above is quite new, it still may not be too late for a review to be of interest.

In the well-established fields, in which texts have been written for a century or more, the author of a new one will hope to make useful innovations, but his opportunity will be somewhat circumscribed and the risk of going far astray will be similarly limited. The author of a text for a college survey course is guided by fewer landmarks, and this should be remembered in any criticism of his work. On the other hand, since his text may be expected itself to become a landmark in a field where there are not many, it is all the more important to suggest improvements where it appears they might be made.

These three texts cover, at somewhat different levels, the same subjects: astronomy, physics, chemistry, geology, meteorology and physical geography. The boundaries between these subjects are, by design, disregarded.

"Man's Physical Universe" is the most elementary of the three. Its author is the president of the Stockton Junior College in California, and the work was doubtless written for students in that and other junior colleges. It is entirely without mathematics and almost wholly descriptive rather than quantitative. This restriction is naturally a handicap in treating the more exact sciences. The clearest exposition, in my opinion, is that of geology and physical geography, and the least clear is that of physics.

Not all the difficulties result merely from the use of descriptive rather than mathematical terms. For example, the meaning of "centrifugal force" is changed twice in four successive paragraphs, from the d'Alembertian sense of mass times negative acceleration to the sense of Newtonian reaction and back again. (Is it not high time to discard this term, at least from beginners' books? Nothing in which authors can become so involved is likely to be of any help to students). In general, I should say that basic concepts, especially the more difficult ones of physics, are too often hurried over rather than given the patient explanation they need if they are to be understood. This may make things easier for the more superficial reader, but it must confuse the earnest student, especially if he has taken seriously the author's advice at the beginning of the book to insist on careful definitions.

The sequence of topics is, roughly speaking, that of the decreasing scale of phenomena, from astronomy to atomic and molecular structure. This is a generally logical development. Every sequence must have its drawbacks, and the disadvantage of this one is that

the conclusions in some of the subjects first treated depend on the principles or experimental methods of some of those following.

The book is crowded with scientific and technological facts. Most of them are interesting and many are presented with an appealing vividness. Those within the competence of this reviewer are remarkably accurate in view of the almost endless opportunity for error, though there are ambiguities here and there which could have been avoided by qualifying statements. Long before the reader comes to the end of the book, he will be struck with admiration for the industry and patience which must have been spent in gathering so much material. But by the time he completes 800 pages, I am afraid he will be appalled at the perseverance which would be needed to remember one half or one quarter of all these facts. He may wonder if a part of the author's labor would not better have been spent in weeding out some of them and making the rest more easily recollectible by connecting them with stronger threads of basic principle. To cite an extreme example, even in a book of 800 pages, is it worth so much as a line to say that there are seven longitudinal holes in a grain of smokeless gunpowder, especially when no mention is made of the sole possibly interesting fact that they are there to govern the rate of burning and the resulting development of pressure?

I raise this question because it seems to me to concern the central purpose of survey courses. It is claimed that they acquaint the student with the fundamentals of the sciences freed from the technicalities of the specialist. This ought not to mean skimping the enduring principles to make place for transient details of technology.

In spite of what seem to me its rather serious limitations as an introduction to science, the work has value as a handbook of useful information for young people coming of age in a highly technical culture, a sort of guide book, not to a country, but to a decade. They will learn something of their opportunities and responsibilities as farmers, householders, cooks, purchasers of consumer's goods, drivers of motor cars and airplanes, and generally as citizens of a much mechanized society. And this, clearly, as much as any other, was the author's purpose in writing the book. His method is didactic and the text is in places at least as much a tract as an exposition, but it is honest pamphleteering and its motives will commend themselves to most people of good will.

"Physical Science," by five of the faculty of scientific departments of New York University, is written for more mature students than the intended readers of "Man's Physical Universe." The treatment of the several sciences is at the introductory college level and is perhaps a little more difficult than that in some college texts, because it is somewhat more condensed. This book is shorter than the two others reviewed here by more than the number of pages show, since it has also fewer words to the page. Consequently many of the details found in "Man's Physical Universe" are missing from "Physical Science." This seems to me a clear gain, as I have already explained. "Physical Science" comes fairly close, I should suppose, to the ideal suggested some years ago by James Harvey Robinson, when he wrote:

> What a considerable and beneficent revolution would take place in teaching and writing if teacher and writer should confine himself, at least in addressing beginners or laymen, to telling only such facts as play so important a part in his own everyday thinking that he could recall them without looking them up! It is a good rule for a writer to assume that nothing in his favorite subject which fails to interest *him* vividly and persistently is likely to interest the outsider who reads his book.[1]

This omission of what will not be remembered is a negative virtue but a very desirable one and much too rare.

The emphasis of the book is on basic principles, and these are treated with little or no sacrifice in exactness as compared with most elementary texts in physics (to make the only reasonable comparison that I can make with any knowledge). The one serious exception, as it seems to me, was rendered inevitable by the sequence of topics chosen, some of the elements of electricity being introduced before the development of the mechanical concepts on which the electrical definitions depend. The advantage of having the electrical foundation of atomic and molecular theory available early, to facilitate the discussion of chemical reactions, is evident. There is doubtless some gain also in postponing mechanics, which is often a stumbling block to beginners. However, it would still seem to me preferable to have the student learn the fundamental concepts of mechanics before starting on electricity, which is difficult enough itself, even with the aid of a knowledge of mechanics.

As much of algebra and the rudiments of analytical geometry as the elementary treatment of physics demands is incorporated in the text itself. There is also a discussion of the relation of mathematics and formal logic to scientific reasoning, which is naturally elementary but is not superficial and is, in my opinion, one of the most successful pieces of exposition in the book.

I noted in reading a few minor historical corrections. Franklin introduced the terms "positive" and "negative" electricity, not, as stated, in accordance with the two-fluid theory but in opposing it with his own one-fluid theory. Ptolemy employed but did not invent the epicycle of ancient astronomy. Newton

[1] "The Humanizing of Knowledge," New York, 1924.

did not use the concept of energy nor, to split hairs, did Faraday "conclude" that the laws of electrolysis showed the atomic nature of electricity. (He saw the possibility of this conclusion but refrained from drawing it because of his doubts as to the reality of the atoms of matter). None of these mistakes is of any importance, but they are perhaps of some interest as showing how great reputations grow even greater by attracting to themselves some of the material of lesser ones.

"The Study of the Physical World," by three of the faculty of the Chicago City Colleges, will be discussed more briefly, not that it is less deserving of attention but that much can be said about it quickly in saying that in many respects it is intermediate between the two books just reviewed. Its use of mathematics is somewhat less than that in "Physical Science," and the treatment is more descriptive and hence, in the quantitative sciences, somewhat less exact. The economic and social consequences of discovery and invention are given more attention than in "Physical Science" without being stressed as strongly as in "Man's Physical Universe." In the relative emphasis given to general principles and illustrative facts, it is nearer to the former book, and the attempt is made throughout to have the facts really illustrate the principles. This purpose is aided by a clear and straightforward style of writing. Unfortunately in the attempt to make hard things easier, there are some over-simplifications and a good many errors, some of them rather serious. An example of over-simplification is in the treatment of atomic structure, in which the illustrations show the electronic orbits of the older quantum theory, and nothing in the text indicates that recent developments have required a different description. Probably the most serious errors are in the treatment of heat and kinetic theory. Here the energy of linear motion of the molecules of a gas is taken as the whole internal energy, which would mean that all gases have the same specific heats. A fallacious derivation of Carnot's theorem is based on the misconception that the second law of thermodynamics is a corollary of the first. The human body is described as an engine transforming heat to work, although it has no temperature difference which could maintain anything like its actual efficiency if this were true.

Although at first sight the sequence of topics in this book appears rather haphazard, reading through the text shows, on the contrary, that it is quite careful. There are few places in which reference needs to be made to anything ahead, an achievement which must have given the authors as much trouble as it saves the reader.

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ORGANIC CHEMISTRY

Textbook of Organic Chemistry. By E. WERTHEIM. Second edition. 867 pp., including 113 text figures, colored plates, portraits, industrial flow sheets, tables, etc. Philadelphia: The Blakiston Company. 1945. $4.00.

How well the first edition of this excellent text was received may be gathered from the fact that, since its appearance in May, 1939, eight reprintings have been necessary. This new edition, therefore, will be welcomed warmly by the many friends already won by its predecessor.

As the author states in his preface, the general plan of the book, its aims and objects, are essentially those set forth in the preface to the previous edition. Some rearrangement of subject-matter has been made, and new data and interpretations have been incorporated to bring the text up to date. These include new tables, charts, colored plates of molecular models, numerical problems and additional review questions.

Detailed descriptions of individual compounds have been replaced by group reactions, class properties, tables of all kinds, charts and summaries.

No more fitting frontispiece could have been selected for this work than the portrait of Emil Fischer which appears therein, for he was truly one of the outstanding builders of the science. The picture is an admirable likeness as the writer remembers him at the height of his career, when Fischer's great teacher, Adolf von Baeyer, used to say of him that he was a more brilliant organic chemist than the master under whom he had studied.

The book is heartily recommended, as a two-semester beginners' course, to meet the needs of students planning to major or specialize in organic chemistry, as well as for those who are taking chemical engineering, premedical or pharmaceutical courses.

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