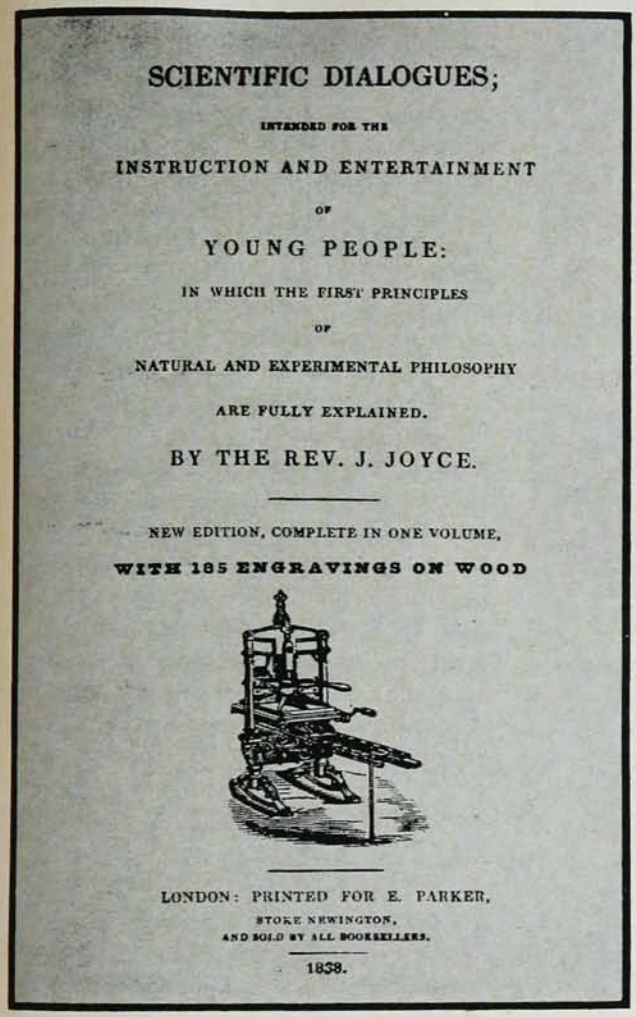

SCIENTIFIC DIALOGUES;

INTENDED FOR THE

INSTRUCTION AND ENTERTAINMENT

OF

YOUNG PEOPLE:

IN WHICH THE FIRST PRINCIPLES

OF

NATURAL AND EXPERIMENTAL PHILOSOPHY

ARE FULLY EXPLAINED.

BY THE REV. J. JOYCE.

NEW EDITION, COMPLETE IN ONE VOLUME,

WITH 185 ENGRAVINGS ON WOOD

LONDON: PRINTED FOR E. PARKER,
STOKE NEWINGTON,
AND SOLD BY ALL BOOKSELLERS.

1838.

Your Child's Physics Books

Although more than 2000 new titles for children are published each year, good reading in physics is not plentiful.

by Mae Freeman

The physician observes and guides his young son's intellectual development, hopefully watching for the first indication of a possible interest in medicine. The artist puts a brush in his child's hand, looking for signs of sensitivity to form and color that may portend a future Picasso. In the same spirit, the physicist answers his child's "how" and "why" questions with more purposeful intent than the average parent and is apt to give earnest thought to the selection of his youngster's science books.

Mae Freeman has written more than 30 books for young people, most of them on science subjects, some in coöperation with her husband, Ira Freeman. The books are translated into more than a dozen languages.

Statistics do not support the idea that early influences of this kind necessarily affect a young person's later choice of his life work, but one of the most notable exceptions is the case of the boy Michael Faraday. In *The Edge of Objectivity* (Princeton, University Press), C. C. Gillispie points out that it was a book for young people—*Conversations in Chemistry* by Jane Marcet—that drew Faraday toward science:

> "Do not suppose," wrote Faraday of his childhood, spent in poverty, "that I was a very deep thinker, or was marked as a precocious person. I was a very lively imaginative person, and could believe in the *Arabian Nights* as easily as in the *Encyclopaedia*. But facts were important to me, and saved me. I could trust a fact, and always cross-examined an assertion. So when I questioned Mrs Marcet's book by such little experiments as I could find means to perform, and found it true to the facts as I could understand them, I felt that I had got hold of an anchor in chemical knowledge, and clung fast to it. Thence my deep veneration for Mrs Marcet—first as one who conferred great personal good and pleasure on me and then as one able to convey the truth and principle of those boundless fields of

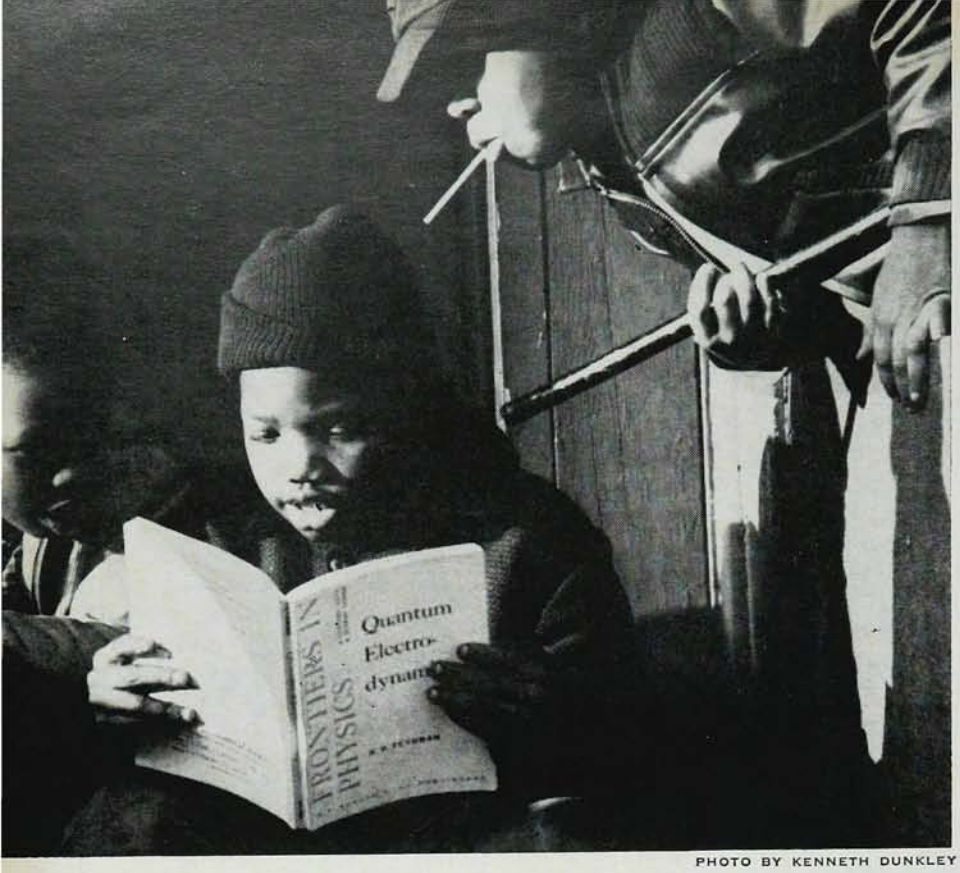


PHOTO BY KENNETH DUNKLEY

knowledge which concern natural things, to the young, untaught and inquiring mind."

Gillispie remarks that this should make present-day writers of science books for children reflect on their responsibility and opportunity.

Certainly, as far as the conscientious parent is concerned, he will make very careful choices for his child's library. *A Parent's Guide to Children's Reading* (Pocket Books), by Nancy Larrick, provides a reliable orientation in this area and specifically includes a section on science.

Early developments

Twenty-five years ago there were few books for younger children dealing explicitly with physics or any of its branches. There did exist a few titles on nature and animals, and about 1930 appeared *The Stars for Sam, The Earth for Sam* and *The Sea for Sam* (Harcourt Brace), in which Maxwell Reed "explained the wonders of the physical world to his nephew Sam." A pioneering effort in bringing science to young people, these books were welcomed and were never long left on the public-library shelves. They were revised and reissued a few years ago and are still used in spite of a rather stodgy presentation and textbookish format.

In the days before the proliferation of books on science for young people, I observed with admiration my physicist-husband's persistent efforts to provide some liaison between physicists and the adult public in order to combat the wary disinterest in a subject whose very mention often invited only a shudder. It seemed natural to me to extend such liaison efforts into the world of children, and the result was a book of simple experiments done with materials found in any home to illustrate some basic physics principles. A sympathetic and intrepid publisher—Random House—agreed to go along with the new idea, and this was the beginning of a long and productive relationship that resulted in numerous science books for every age from the beginning reader to the young adult.

When Albert Einstein began to endure the life of a celebrity, he expressed wonder at the frenetic enthusiasm with which the public greeted his accomplishments, especially since most people did not have even a superficial understanding of the nature of his work. When the atomic age opened, mass media initiated a general awareness of scientific and technological activity. The launching of Sputnik generated a nationwide wave of science consciousness, and now every television viewer talks confidently about a "500-mile apogee," "nuclear fission" and "exceeding Mach 2." Even young children are familiar with many physical terms but impart a vague, restricted meaning to them, gained from the context in which they were first heard. There remains the challenge of trying to get behind this surface familiarity into the fundamental concepts, which are as abstract as ever.

In his report, *The Process of Education* (Harvard University Press), covering the Woods Hole meeting of scientists and educators several years ago, Jerome S. Bruner suggests that it should be possible to teach any subject "in some intellectually honest form to any child at any stage of development." Perhaps the phrase "intellectually honest" is to be taken as a qualifying entity in this statement because Bruner goes on to explain that it is futile to attempt to present formal explanations based on logic that is distant from the child's manner of thinking and sterile in its implications for him.

Children can understand

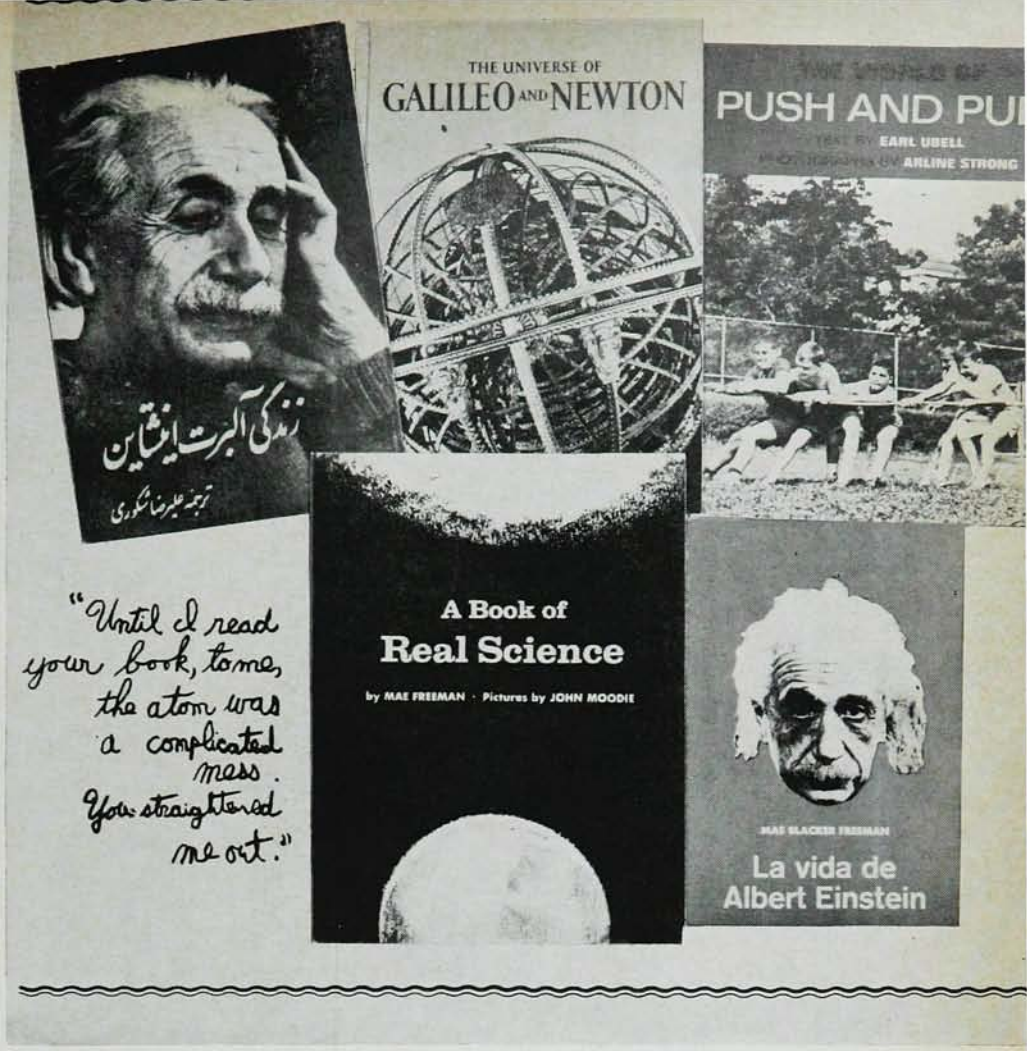
There is an appropriate version of any knowledge that may be imparted at whatever age one wishes to present it. If the books in which a child first reads about science are the right ones for him, he can experience some intellectual satisfaction that will draw him to other books that develop and expand his first understanding. This is a kind of self-reward sequence that is discussed in Bruner's recently-published *Toward A Theory of Instruction* (Harvard University Press). It can be demonstrated that fifth-grade children quickly grasp central ideas from the theory of functions, although they may not be able to ingest a formal explanation of what the theory is. Children can play games with rules modeled on advanced mathematics, even though a formal mathematical description of what they are doing is entirely beyond their understanding.

Comprehensibility is the key requirement in presenting fundamental physics concepts to children, and this must be accomplished with an understanding of the limitations of a child's

experience and with great respect for his reactions and manner of thinking. Piaget's work with Swiss children showed that intellectual development proceeds in stages from (a) establishing relationships between experience and action, to (b) receiving information and using it selectively, and to (c) projecting information to form new ideas. Piaget's coworker, Bärbel Inhelder, reports that basic ideas of physics are perfectly acceptable to 7–10-year-old children, provided that the ideas are divorced from mathematical expressions and presented through language and material that the child can handle.

There can be no vagueness about physics. It is a precise science, and that is where the pitfalls lie for the writer of children's books who has little or no scientific experience but grimly sets about "researching" for a science book. There is no way to glide along the top of physics and skim off information to present to children as fundamentals. From this kind of improvisation come such statements as "a battery makes electricity" and "nothing can go faster than light."

Although scientifically accurate presentations are to be expected from the occasional physicist who will stop for a figurative moment to write a book for children, there are pitfalls for him, too. He may find himself overlooking the fact that, to a child, "work" means simply what daddy does when he is away from home all day. "Mass" to many children can only denote a church ritual, and "force" is strength and might. Consider the statement: "The ball falls because of the earth's pull or gravity." The unsophisticated young reader cannot realize that the phrase "or gravity" is added simply to give a name to the earth's pull. He thinks the ball comes down for one of two reasons and takes his choice! Writing about science for children permits no ambiguity, either in semantics or syntax.



Photos courtesy of Scholastic Book Services (A BOOK OF REAL SCIENCE), Atheneum Publishers (THE WORLD OF PUSH AND PULL), American Heritage Publishing Co. (THE UNIVERSE OF GALILEO AND NEWTON) and Random House (THE STORY OF ALBERT EINSTEIN).

Importance of readability

When you are evaluating a physics book for your child, see that the language is within his present reading ability, and remember that he *understands* many words that he cannot yet *read*. A new concept may be lost to him simply because he skips over a key word that may be familiar to his ear but not to his eye. Certain "scientific" terms are indispensable, but they must be introduced in context comfortable to the child.

Basic science concepts can be explained to children simply and without sacrificing accuracy. This is a most demanding requirement, and it must be fulfilled in an interesting and inviting way—not in the manner of a stripped-down textbook. It can be done even for the child who has just acquired his first reading vocabulary. Writing for this level requires discipline and restraint, and the finished work often looks deceptively simple. *You Will Go to the Moon* (Random House), which I wrote in collaboration with my husband, is the story of a child who is a passenger on a flight to the moon. It is based on current technical ideas for the realization of such a journey, and as the adventure unfolds, such physical concepts as gravity and centripetal force become part of the story. This is done in a manner that can be handled by a bright youngster near the end of his first grade in school and by almost all second graders.

The books suggested below do not necessarily conform to all of the criteria discussed here, but they are written by experts with broad experience. The best way to make the final selection is to read the book yourself—you know your subject and your child's abilities and needs as well. Do not be impatient if your favorite areas seem slighted or if, to your professional eyes, certain ideas seem dispossessed of some of their supporting evidence. In undertaking expository writing for young children, an author needs courage and great determination to shear away tangential material in order to leave a basic concept crisp and clear. A well known and highly respected writer on science for young people once said that the text of a certain book "while clear, was emphatically not written down." His

implication that clarity is achieved in many cases only by the process of "writing down" is an indictment of much that passes for effective interpretation for the younger groups.

My discussion is not concerned with classical literature, or with the reading process per se. It simply includes a few guidelines concerning books on physics for the child who is just beginning to read and going as far as perhaps the 11- or 12-year-old. For readers above this age, many fine books are available both for those whose interest in physics is newly stirring and for those already somewhat knowledgeable. In one or two instances I have noted the name of an author whose work in presenting other fields of science to younger readers could well be included in your considerations.

Begin by giving simple, manageable books to your child and observe the results. If he is a budding scientist, he will read them eagerly and be stimulated to progress rapidly to the more advanced material that abounds for teenagers and young adults. But if yours is one of the very bright and beautiful children whose interests invite them elsewhere, he will at least have gained some familiarity with the world of science as he widens his horizon in the direction of his own specific talents.

Some books

Starting with suggestions for the earliest reader, the list proceeds in order of increasing sophistication. The age levels mentioned are purely a nominal guide and should not be followed rigidly; individual differences make such designations useful only in a very general way. Also, I have included a few books in other physical sciences that may be of interest. With the exception of one at the beginner level, books devoted primarily to home experiments have been omitted. They are readily available in all libraries, and their merit and suitability can be easily and quickly evaluated.

Air is All Around You (Thomas Y. Crowell) can serve admirably as one of the first information books at the beginner level. It was written by Franklyn M. Branley of the Hayden Planetarium in New York, who is the author of many books on science for children, all of them dependable and worth considering. In *Air is All Around You,* Branley develops the one simple concept that air is a substance. He wisely limits his presentation in this way and effectively reinforces the idea with examples close to a child's experience. It is a slim book with charming illustrations.

It is a considerable step from reading-and-knowing to reading-and-doing, and successfully accomplishing a task in response to written instructions is rewarding as well as stimulating. *Prove It!* (Harper & Row) provides this opportunity for the beginning reader, presenting simple physics experiments with water, air and sound that are reasonably achievable as well as entertaining. The authors are Rose Wyler and Gerald Ames, who have many excellent science books for young people to their credit. In *Prove It!* they display their usual skill in putting ideas in simple, lucid language for the very young reader, uncluttered by cozy "Guess what will happen!" and "Surprised?" phrases that some teacher-writers cannot resist. The book is visually uncrowded, charmingly illustrated, and a good one for that first attempt at independent investigation. Even so, an encouraging hand and word from you might be welcome.

For second and third graders, I recently wrote *A Book of Real Science* (Four Winds-Scholastic), which a child at this level can read and thus gain, through his own efforts, a simple introduction to the physical world. The phrase "Real Science" in the title is intended to indicate that basic principles are presented—to convey the idea that the word "science" is meant in a stricter sense rather than as the catch-all term common in many book titles. Such topics as atoms, electricity, heat, light, sound, etc., appear, one leading in a natural way to the next.

Rain, Hail, Sleet, and Snow, by Nancy Larrick (Garrard). Familiar weather phenomena explained in a simple, interesting manner.

Earl Ubell, a highly regarded science journalist who is now science editor of the Columbia Broadcasting System has, for the first time, turned his attention to the young reader in

Recognize the time-resolved spectrum of a pulsed argon ion laser?

You're looking at a single exposure, 100-nanosecond streak photograph . . . what you see is the axial mode beating in the 4579A band.

"Of all the measuring equipment we tried, the TRW Model 1D Image Converter Camera with a high-speed plug-in was the one instrument that gave us instantaneous data display, both quantitative and qualitative," Dr. Witte* told us. He said he got the information he needed with the Model 1D in no time, with no trouble.

If you're working with argon ion lasers, try measuring and recording results with a TRW Model 1D. We can send you a technical data bulletin showing what this instrument and all its related equipment can do in your laboratory. **Write or call us for your copy.**

TRW INSTRUMENTS

139 Illinois Street, El Segundo, California 90245 Telephone 213-679-9101

Developers and manufacturers of state of the art diagnostic instruments for basic and applied research.

* Dr. Robert S. Witte, Associate Manager of the Quantum Electronics Department, Quantum Physics Laboratory, TRW Systems, TRW Inc.

The World of Push and Pull (Atheneum). He gives the bright 9- or 10-year-old some general understanding of simple mechanics, although the liberal use of physics terms in somewhat anthropomorphic forms is disconcerting. It is a concentrated book; one rule follows on the heels of another; so stand by to give a reassuring lift here and there. Because the material (brightened by Arline Strong's lively photographs) is close to your child's experience, it will hold his attention.

By weaving some physics into a framework of geology, and adding a little meteorology, geography and history, topped off with a bit of prognostication, Jeanne Bendick tells about *The Shape of the Earth* (Rand-McNally) in an informative and interesting way.

An inquiring young mind will discover some interesting if somewhat disconnected facts in *Let's Find Out About Mars* (Franklin Watts) by David C. Knight, including a description of the flight of Mariner 4. The illustrations are commendable except for the literal representation of Martians that would better have been left to the child's imagination.

The aspects of luck, happy accident and sudden "Eureka!" successes of scientific discoveries are gently and clearly put into proper perspective in Bernice Kohn's *The Scientific Method* (Prentice-Hall). A simple description of scientific methodology in terms of a young person's problem with a puppy is reinforced by stories of the work of an outstanding scientist in each of several fields. Small and interesting sketches of the achievements of Galileo, William Harvey, Leeuwenhoek, Fermi and others point up the value of perceptiveness plus persistence. Because few books of this type are in existence, I would put this one in the library of any bright child up to the age of 12.

The Story of Numbers, by Patricia Lauber (Random House). This title means what it says, for it is a story —readable and inviting—of the development of the number concept. There is no look or feeling of the arithmetic workbook about this one, as there often is in books about numbers for youngsters.

Lightning and Thunder (Morrow), by Herbert S. Zim, gives a good description of the physical principles involved in these natural phenomena. Zim, who has written many trustworthy books for young people in the natural sciences, brings in such concepts as density, flotation, convection, electrostatic forces, etc. Amply illustrated. For ages 9 to 12.

Space Flight and How It Works, and *Jets and Rockets and How They Work*, by William P. Gottlieb (Doubleday). Text, photographs and drawings are admirably integrated in these accurate and very effective introductions to this field.

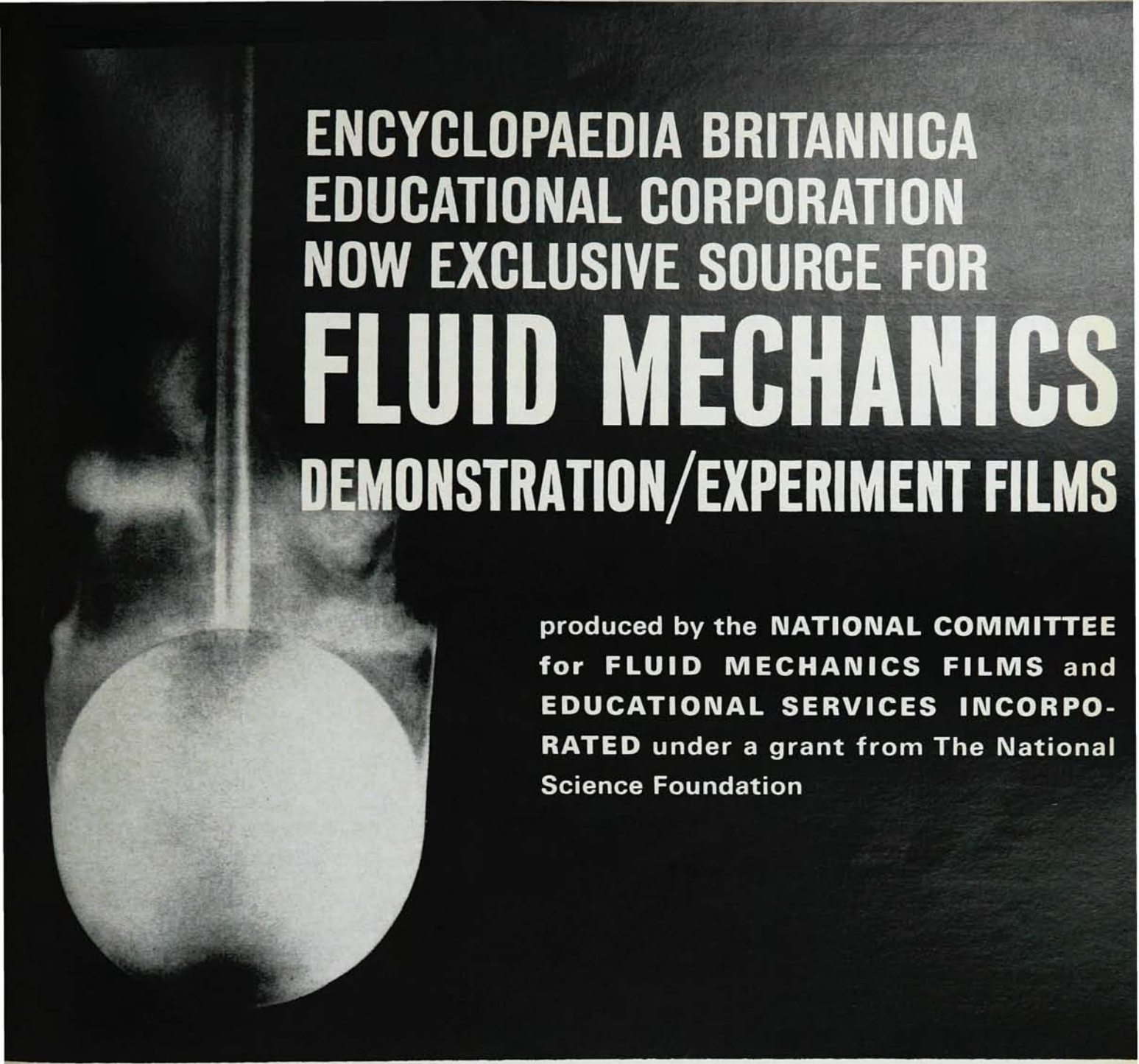
Prisms and Lenses (World), by Jerome S. Meyer. This shotgun presentation of a great many phenomena of optics goes beyond the limits suggested by the title, thus denying the possibility of including sufficient detail about any single topic. It could, however, stimulate the interest of a junior-high-school student in the subject as a whole.

All About Light and Radiation and *All About Sound and Ultrasonics*, by Ira M. Freeman, (Random House) explain the important principles involved in understanding these areas of physics, including recent developments.

If a 10- to 12-year old can worry his way through the isotope data and crystal-lattice diagrams in the first half of *Biography of an Atom* (Harper & Row), by J. Bronowski and Millicent Selsam, he will be rewarded for his efforts by the latter part of the book where the material develops within his own range of experience. Here the text becomes more descriptive, and the history of one carbon atom climaxes in the kind of attenuated series of coincidences and the huge numbers that fascinate and delight this age group. Mrs Selsam is a biologist with an impressive list of books in her own field. She is a master in communicating ideas to the youngest readers and any of her titles would be valuable adjuncts to a physics list.

The Wonders of Geology, by Henry Collins Jr (Putnam). A good, general introduction to this field.

How Much and How Manys: The Story of Weights and Measures (Whittlesey), by Jeanne Bendick.



ENCYCLOPAEDIA BRITANNICA EDUCATIONAL CORPORATION NOW EXCLUSIVE SOURCE FOR FLUID MECHANICS DEMONSTRATION/EXPERIMENT FILMS

produced by the **NATIONAL COMMITTEE for FLUID MECHANICS FILMS** and **EDUCATIONAL SERVICES INCORPORATED** under a grant from The National Science Foundation

NOW AVAILABLE . . . 13 16mm sound films and 61 8mm silent loops which afford distinct advantages over *live* demonstrations. Through close-ups, slow motion, time lapse photography, and animation, these films give each student the opportunity of viewing physical phenomena which could rarely be observed in the classroom. Equally important, the films can replace repetitive demonstrations in the laboratory, and help to free it for its proper job of developing each student's capacities for investigation.

16mm FILMS AVAILABLE (B/W unless noted)

Fluid Dynamics of Drag (4 Parts)—118½ min.—$475 ☐ Boundary Layer Control—25 min.—$95 ☐ Rheological Behavior of Fluids—22 min.—$85 ☐ Secondary Flow—30 min.—$115 ☐ Waves in Fluids—33 min.—$125 ☐ Surface Tension in Fluid Mechanics (Color)—29 min.—$225 ☐ Flow Visualization—31 min.—$115 ☐ Deformation of Continuous Media—38 min.—$145 ☐ Pressure Fields and Fluid Acceleration—30 min.—$115 ☐ Vorticity (2 Parts)—44 min.—$170 ☐ Channel Flow of a Compressible Fluid—29 min.—$110 (Scheduled for release Sept. 15) ☐ Low Reynolds Number Flows (Color)—32 min.—$250 (Scheduled for release Nov. 15) ☐ Magneto-hydrodynamics—27 min.—$105 (Scheduled for release Dec. 1)

WRITE DEPT. PT6-7A for descriptive notes on these films, for titles of 8mm loops, and for information on their many teaching applications in departments of engineering, of physics, mathematics, geophysics, meteorology, medicine, and astrophysics.

ENCYCLOPAEDIA BRITANNICA EDUCATIONAL CORPORATION

INCORPORATING ENCYCLOPAEDIA BRITANNICA FILMS/ENCYCLOPAEDIA BRITANNICA PRESS
THE EDUCATIONAL DIVISIONS OF ENCYCLOPAEDIA BRITANNICA AND F E. COMPTON

425 North Michigan Avenue • Chicago, Illinois 60611

While tracing the history and development of the art of measurement, this book brings out the importance of the quantitative aspect of science.

The competent twelve-year-old reader can extract a good deal of information from *Exploring the Moon*, by Roy A. Gallant (Garden City). The exposition is somewhat advanced but current interest in the subject on the part of children justifies having the book around for browsing.

An Adventure in Geometry (Viking) was written as well as illustrated by Anthony Ravielli. His exquisite drawings and expressive text give this work a deserved place on the reading list of any perceptive youngster. A description of basic geometric forms leads into a display of how they occur in nature and even touches whimsically on their psychological effects.

Archimedes and His Wonderful Discoveries (Prentice-Hall), by Arthur Jonas. An absorbing description of Archimedes' ingenious mechanical ideas and their applications.

The First Book of Color (Franklin Watts), by Herbert P. Paschel. The title had better not be taken too literally by the youngster who is trying to find out about light and color for the first time. On the second page he will encounter "radiant energy," "electromagnetic spectrum," "infrared," etc. The text continues in this blunt and compact manner all the way through, resulting in a superficial treatment of involved and abstract concepts. However, for those who have already been introduced more basically to the concepts of light, this could be a useful little book. The full-color illustrations contribute much.

For a well constructed and inviting introduction to crystallography, look at *The Curious World of Crystals* (Prentice Hall), by Lenore Sander. There are a few suggested experiments that point up the text. The illustrations are largely diagrammatic and will invite only the more serious reader. To be realistic, I would suggest leaning toward the top of the publisher's indicated age bracket of 9 to 12 years. This is a good book to precede the Science Study Series paperback *Crystals and Crystal Growing* (Doubleday), by Holden and Singer.

The New World of the Atom (Dodd-Mead), by David O. Woodbury, is predicated on the reader's having a fairly comprehensive familiarity with atomic physics. It is concerned more with applications, taking for granted some knowledge of the underlying principles. The glossary of the more important terms is helpful and so are the figures.

Of interest to the particularly precocious young person is *Relativity for the Million* (MacMillan), by Martin Gardner, a clearly written, nonmathematical introduction to the ideas of relativity, beautifully illustrated by Anthony Ravielli.

The Universe of Galileo and Newton (American Heritage), by William Bixby, is a very handsome book, strikingly illustrated in color with reproductions of paintings, drawings and documents. It is written for young adults, but an interested 10- or 12-year-old will be fascinated by the illustrations which will lead him to pick up what he can from the text. It is a book he will keep and enjoy looking at again and again—and so will his parents.

Really a textbook

HANDBOOK FOR THEORETICAL COMPUTATION OF LINE INTENSITIES IN ATOMIC SPECTRA. By I. B. Levinson, A. A. Nikitin Trans. from Russian. 242 pp. Daniel Davey, New York, 1965. $12.75

by Harold Mendlowitz

From a glance at the title, one might assume that the book contained a series of tables or graphs on line intensities in atomic spectra. However, the word, "Handbook" in the title is more in the German sense than in the American sense. This is primarily a textbook for workers in atomic physics and astrophysics. There are eleven chapters dealing with the basic theoretical background required for the calculations of the intensities. Some of the types of transitions treated in-