

THE SCIENCES

A READING BOOK FOR CHILDREN

ASTRONOMY · PHYSICS · HEAT · LIGHT · SOUND
ELECTRICITY · MAGNETISM · CHEMISTRY
PHYSIOGRAPHY · METEOROLOGY

BY

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REVISED EDITION

PREFACE

THE object of the present volume is to present chapters to be read in school or at home that shall materially widen the outlook of American school children in the domain of science, and of the applications of science to the arts and to daily life. It is in no sense a text-book, although the fundamental principles underlying the sciences treated are here laid down. Its main object is to help the child to understand the material world about him.

All natural phenomena are orderly; they are governed by law; they are not magical. They are comprehended by some one; why not by the child himself? It is not possible to explain every detail of a locomotive to a young pupil, but it is perfectly practicable to explain its principles so that this machine, like others, becomes a mere special case of certain well-understood general laws.

The general plan of the book is to waken the imagination; to convey useful knowledge; to open the doors towards wisdom. Its special aim is to stimulate observation and to excite a living and lasting interest in the world that lies about us. The sciences of astronomy, physics, chemistry, meteorology, and physiography are treated as fully and as deeply as the conditions permit; and the lessons that they teach are enforced by examples taken from familiar and important things. In astronomy, for example, emphasis is laid upon phenomena that the child himself can observe, and he is instructed how to go about it. The rising and setting of the stars, the phases of the moon, the uses of the telescope, are explained in simple words. The mystery of these and other matters is not magical,

as the child at first supposes. It is to deeper mysteries that his attention is here directed. Mere phenomena are treated as special cases of very general laws. The same process is followed in the exposition of the other sciences.

Familiar phenomena, like those of steam, of shadows, of reflected light, of musical instruments, of echoes, etc., are referred to their fundamental causes. Whenever it is desirable, simple experiments are described and fully illustrated, and all such experiments can very well be repeated in the schoolroom.

Finally, the book has been thrown into the form of a conversation between children. It is hoped that this has been accomplished without the pedantry of *Sandford and Merton* (although it must be frankly confessed that the principal interlocutor has his knowledge very well in hand for an undergraduate in vacation time) or the sentimentality of other more modern books which need not be named here. The volume is the result of a sincere belief that much can be done to aid young children to comprehend the material world in which they live and of a desire to have a part in a work so very well worth doing.

EDWARD S. HOLDEN

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THE SCIENCES

INTRODUCTORY CHAPTER

(To be read by the children who own this book)

LET me tell you how this book came to be written. Once upon a time, not so very long ago, a lot of children were spending the summer together in the country. Tom and Agnes were brother and sister and were together all the day long; bicycling or playing golf in the morning, reading or studying in the afternoon. The people who lived in the village used to call them the *inseparables* because they were always seen together during their whole vacation from June to September.

Their cousins Fred and Mary always spent a part of every summer with them; and when they came there were four *inseparables*, not two. The children liked the same games, liked to read the same books, to talk about the same kind of things, and so they got on very well together; though sometimes the two boys would go off by themselves for a hard day's tramp in the hills, or to shoot woodchucks, or for a very long bicycle ride, leaving their sisters at home to play in the garden with dolls, or to do fancywork and embroidery, or to play tennis, or to read a book together. Tom was thirteen years old then, and his sister Agnes was nine; cousin Fred was ten and his sister Mary was twelve.

When the summer afternoons began to get very warm, July, a rule was made that the children should spend them the house, or on the wide, shady porch, or else under the tree on the lawn, or in the garden. Golf, tennis, and wheeling had to be done in the morning; the afternoons were to be spent in something different. Tom's father used to say that the proverb

*All work and no play
Makes Jack a dull boy*

was only half a proverb. It was just as true, he said, that

*All play and no work
Makes Jack a sad shirk.*

And so a part of every summer afternoon was given up to reading some good book, or to study, or to work of some sort. The two boys had their guns and wheels to keep thoroughly bright and clean, and a dozen other things of the sort; the two girls had sewing to do; and all of them together agreed to keep the pretty garden free from weeds.

Almost any afternoon you might see the four inseparables tucked away in a corner of the broad piazza, each one busy about something, and all talking and laughing—except, of course, when one of them was reading, and the others paying good attention. Tom's big brother Jack was at home from college, and in the afternoons he was almost always on the porch reading, or else on the green lawn lying under the trees; and Tom's older sisters, Mabel and Eleanor, were there too, sewing, or embroidering, or reading, or talking together.

So there were two groups, the four children—the inseparables—and the three older ones. When the children came to something in their book that they did not quite understand, Tom would call out to his big brother Jack to explain it to

them, and Jack would usually get up and come over to where the children were and tell them what they wanted to know. Almost every day there were conversations of the sort, and explanations by some one of the older ones to the four children. All kinds of questions would come up, like these :



FIG. 1. THE PORCH

“Jack, tell us why a 'possum pretends to be dead when he is only frightened and wants to get away.”

“Jack, tell us why a rifle shoots so much straighter than a shot-gun or a musket.”

“Jack, what's the reason that a lobster has n't red blood?” or else :

“Eleanor, what is the difference between a fern and a tree?”

“Is that coral bead made by an animal or an insect?”

“What is amber, anyway?” and so on.

The children had no end of questions to ask, and Jack one of the older girls could generally answer them. When they could not give a complete answer the dictionary was brought out; and if that was not enough, a volume of the encyclopædia. Sometimes the questions were talked over at the dinner table and the whole family had something to say.



FIG. 2. A CELL OF DRY BATTERY

It is not expensive. The two wires are to be fastened to the two screw posts in the picture — one at the left-hand side, and one in the middle, of the top of the cell.

When the children were talking about electric bells, for instance, they actually strung a wire from one end of the long porch to the other, and put a real bell at one end of it and a push button and a battery at the other. In this book there is a picture showing exactly what they did; but, after all, you cannot understand an electric bell half so well by a picture as you can by the real bell and the real wire.¹ So when one of the children who is reading this book comes to an experiment he must read all that the book says about it, and understand it as well as he

¹Children should be careful to read the titles printed under each picture with attention. The titles explain what the picture means.

Tom's father had traveled a great deal and could almost always tell the children some real "true" story — something that had happened to himself personally, or that he had read.

The chapters in this book are conversations that the children had among themselves or with the older people. They are written down here in fewer words than those actually spoken, but the meaning is the same.

When the children were talking about electric bells, for instance, they actually strung a wire from one end of the long porch to the other, and put a real bell at one end of it and a push button and a battery at the other. In this book there is a picture showing exactly what they did; but, after all, you cannot understand

can. If he can get an electric battery, and a bell, and wire, and a push button, then the picture in this book will tell him exactly how to join them together; and when he has done this and actually tried the experiment — and made it succeed — he will know as much about electric bells as he needs to know.

If he cannot get the bell and the wire, and so forth, he can probably see a bell of the sort somewhere; and if he keeps his eyes open and thinks about what he has read, he can certainly understand how it works. Here is the battery always trying to send out a stream of electricity along any wires joined to the two screws at the top. Here is the wire, which is almost

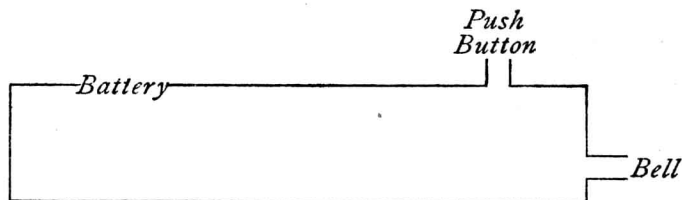


FIG. 3

a complete loop — almost but not quite. If the loop were continuous, — if the wire were all in one piece, — then the stream of electricity would flow along the wire from the battery and would ring the bell.

The use of the push button is to make the wire continuous — to join the two ends of it so that the stream of electricity can pass along it. When you have done this — when you have joined the ends of the loop of wire — the bell rings, and only then, which is just as it should be.

This book gives the pictures and the explanations. They can be understood by paying attention; and when they are once understood a great number of things will be clear that

all children ought to know, and that have to be learned sometime. Why not now? The sooner the better.

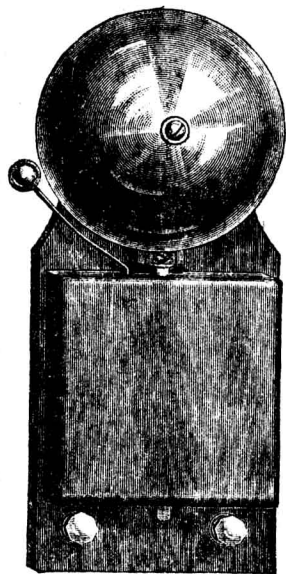


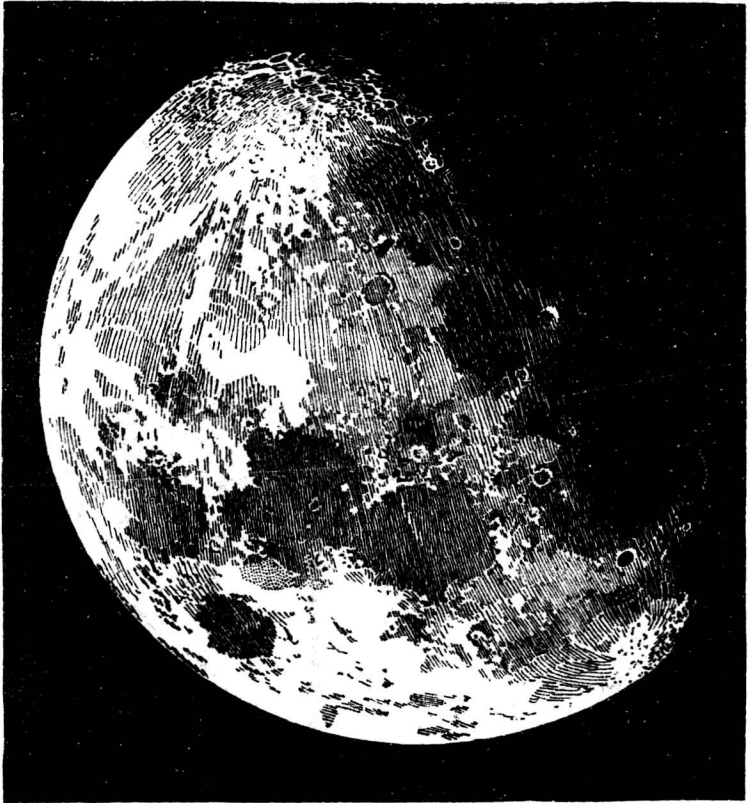
FIG. 4. AN ELECTRIC BELL
It is very moderately priced. The wires are fastened to the two screws at the bottom of the box.



FIG. 5. A PUSH BUTTON
It costs very little. The two wires are fastened to two screws inside the push button.

If you read what is written in the book and perfectly understand it, that is very well. If there is an experiment to be tried, and you can get the things to try it with, so much the better. If you have any trouble in understanding, ask some one — your father, your mother, your teacher — to explain to you. If you can find another book — a dictionary or an encyclopædia — that describes the same experiment, read that too. Perhaps it will tell you what you want to know, better, or more simply, or more fully, or in a different way. Then, finally, keep your eyes open to actually see in the world the things that are talked about in this book. When you see them try to understand them. Remember what you have read here, and you will find that you understand a good many things that you see about you every day. Somebody understands these things, — push buttons, electric lamps, telescopes, and so forth. Why should not you? You can if you pay attention enough. The world is, after all, your world. It belongs to

you as much as it belongs to any one. The things in it can all be explained and understood. It is everybody's business to try to understand them at any rate. All these things concern you. The more you know about them, the better citizen you can be — the more useful to your country, to your friends, and to yourself.



THE MOON

The moon, from a photograph taken with the great telescope of the Lick Observatory.

BOOK I

ASTRONOMY

THE SCIENCE OF THE SUN, MOON, AND STARS

The Earth as a Planet.—The children were looking at a map of the world one fine afternoon and studying the way the land and water are distributed, when Agnes said: "I never knew before how little land there was on the earth. Why, there is *very* much more water than land." "Oh, yes," said Tom, "there's very much more water on the surface; but it's all land at the bottom of the ocean. The sea is about three miles deep, you know, and then you come to the ocean bottom, and that is solid land again. The earth is nearly all rocks and soil; only a little of it is water, after all, but that little is on the surface, of course, and that is why it shows."

Agnes. So the earth is almost all land; if you dig down deep enough, you would come to rocks, even below the oceans?

Tom. Yes, and if you went up high enough, you would come to nothing. You would come to air first, and then by and by to no air, and then you would come to just nothing—to empty space.

Agnes. Well, it is n't quite empty, as you call it. There are other globes in space. There are other planets, and the sun and the moon, and there are simply thousands of stars. So space is n't empty; it is pretty full!



FIG. 6. AMERICA



FIG. 7. THE OLD WORLD