SCIENCE GIANTS
PHYSICAL SCIENCE

27 Activities Exploring the World's Greatest Scientific Discoveries

ALAN TICOTSKY

Aligns to National Science Education Standards

A GOOD YEAR BOOK™
Good Year Books
Culver City, California

Dedication

To Davida and Rob,
great friends and colleagues who
teach and encourage me.

Science Giants: Physical Science contains lessons and activities that reinforce and develop skills defined in the National Science Education Standards developed by the National Research Council as appropriate for students in grades 5 to 8. These include motions and forces, properties and changes in properties of matter, transfer of energy, and understanding about science and technology. In addition, the following areas of the standards are central to the approach of *Science Giants:* unifying concepts and processes, science as inquiry, and the history and nature of science. See www.goodyearbooks.com for information on how specific lessons correlate to specific standards.

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A GOOD YEAR BOOK™

Contents

Introduction for Teachers

Some ideas people believed in the past appear foolish to us while other ideas seem to be inevitable but erroneous conclusions reached using limited resources and information. One may assume with reasonable certainty that some of today's prevailing knowledge will be overturned by new discoveries in the future. Science can describe reality to the limit of our tools and our ability to conceptualize that which we cannot measure or observe. New ideas constantly challenge old assumptions. Revolutions occur when an idea is discarded in favor of a better one.

The Structure of This Book

Science Giants: Physical Science arranges important scientific discoveries in major disciplines into a historical context. Activities and simulations provide hands-on experiences for students using readily available classroom supplies. Activities are followed by student reading pages summarizing the history of scientific discovery and explaining the theories.

The book is divided into chapters based on major areas of science inquiry. Each chapter contains teacher instructions for active student investigations paired with student reading pages. You can use chapters individually, or you can follow the sequence of the book to provide an overview of the history of physical science.

Activities are designed for teams of students and follow a simple format—a list of materials needed per team (mostly common, inexpensive items), followed by instructions and teacher background information. Teamwork among students provides valuable rewards in the classroom. Working in teams:

- encourages dialogue among students, creating better thinking and more discovery.
- improves communication skills.
- increases motivation.
- promotes peer teaching and learning.
- builds social competency.

After doing an activity, hand out the student reading pages to enhance students' knowledge of the history behind each discovery. Student reading pages include vocabulary words, which are shown in bold type and defined at the end of each reading, and offer suggestions for further study. Time lines at the beginning of each chapter provide reference points and springboards for studying biography, an important and interesting aspect of the history of science. There's a bibliography for teachers at the end of the book.

The book focuses on ideas rather than personalities. Some famous legends are covered because scientific and historical literacy would be incomplete without them. The circumstances of discovery often illustrate the truth of Louis Pasteur's observation, ". . . chance favors the prepared mind." Using *Science Giants* should help prepare the minds of students for future discoveries.

Gender Equity

Why is there a predominance of men in the history of science? Margaret Cavendish was the first woman to attend a meeting of the prestigious Royal Society in 1667; the next woman to attend was admitted in 1945. Examples of women scientists are necessary and important for students—and so is a discussion about why such a high percentage of great scientists mentioned in the history books are men.

As you and your students follow modern scientific developments in newspapers, magazines, and other media, note how both women and men contribute to the advances in all fields. Make it an assumption in your class: scientists come in all genders and colors and from all countries—in short, every variety of human being. Resources abound to help you if you choose to devote a section of study exclusively to women's contributions to science.

Generating Enthusiasm

Start each section with students' questions and ideas. What do they know? What do they want to know? Then go on and survey the history of each field you choose. The activities will emphasize science process skills and most will need little introduction—get the kids started and stay out of the way. Through the experimenting, students will be controlling variables, making predictions, recording and interpreting data, drawing conclusions, and *doing* science.

Connecting the main ideas in an historical and social context should enrich their overall understanding and make them eager to discover where science is heading today. Studying today's news should be a major goal for all of us who teach and especially those who teach science—helping students become scientifically literate and able to understand current issues and ideas.

A goal of writing and using this book is to excite the scientists of tomorrow about all there is to know now and all there is for them to discover in the future. There's a lot you can see from the shoulders of giants.

Introduction for Students

Science as Historical Process

What do we know and how do we know it? These two questions can lead you on a very rewarding journey. Thanks to thousands or even more years of questioning, observing, and experimenting, we know a mind-boggling amount about the world and universe around us. The average ten-year-old school child knows more science than anyone knew just a few hundred years ago. How did all that knowledge get here?

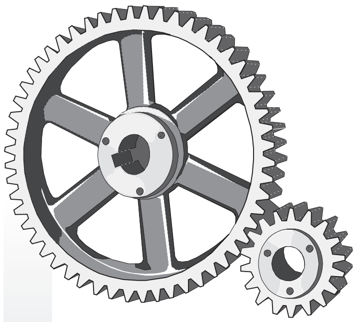
Isaac Newton (1642–1727) was born in the same year in which another famous scientist, Galileo Galilei (1564–1642), died. Responding to a question about how he could know so much, Newton is reported to have said, “If I have seen further, it is by standing on the shoulders of giants.” Galileo was a giant pair of shoulders for Newton, and Newton grew giant shoulders for others himself. Every generation starts from the current knowledge and builds further.

Look outside your classroom window. The sun comes up on one side of the building, rises and travels across the sky, then heads down to set on another side. Throughout the year, the sun’s path changes as it appears lower in the winter and higher in the summer. Doesn’t it seem reasonable to describe the sun as traveling around the Earth?

In fact, not so long ago, most people thought the Earth was the center of the universe. Other ideas that have changed include the following:

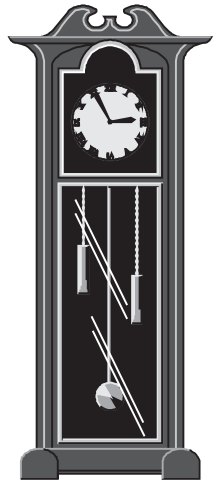
- Scientists believe the Earth was formed about five billion years ago. In 1650, Bishop Ussher set the date at 4004 B.C.
- Things burn when they combine with oxygen, not because they contain a substance called phlogiston.
- Matter consists of tiny atoms that are themselves made of smaller substances. Earlier people believed all matter was made from four elements: earth, fire, water, and air.
- Plants make their own food mostly out of the carbon in the air, not from the soil or water.

Who knows what ideas of today will be changed in the future? Enjoy these activities and ideas that teach about how science has grown and changed, and maybe you will see something new on the shoulders of giants.



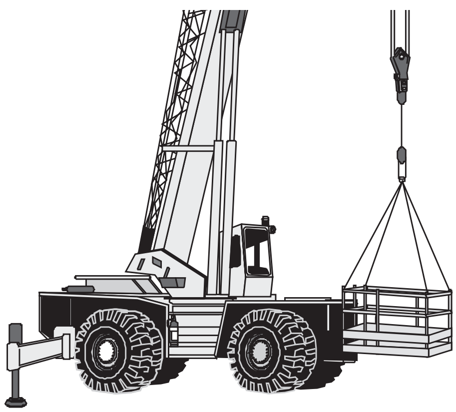
CHAPTER 1

Physics



TIME LINE

Year	Notable Event
250 B.C.	Archimedes experimented with displacement, leverage, simple machines, buoyancy, and other physical principles.
1581	Galileo Galilei formulated his law of pendulums.
1589	Galileo experimented with spheres and ramps.
1687	Isaac Newton published a book known as the *Principia* that contained his three laws of motion.
1738	Daniel Bernouilli published his discoveries about fluids.
1827	Robert Brown observed tiny particles moving in a liquid, a process later named Brownian motion.
1846	Michael Faraday described light as electromagnetic waves.
1864	James Clerk Maxwell published equations explaining electromagnetic fields.
1900	Max Planck explained some energy as occurring in specific amounts, the basis of the quantum theory.
1905	Albert Einstein proposed his first theories of relativity, described light as a particle called the photon, and also explained Brownian motion.
1915	Albert Einstein formulated his general theory of relativity.



Materials per Team

- variety of spheres (tennis balls, baseballs, golf balls, etc.)
- thin book or magazine
- paper

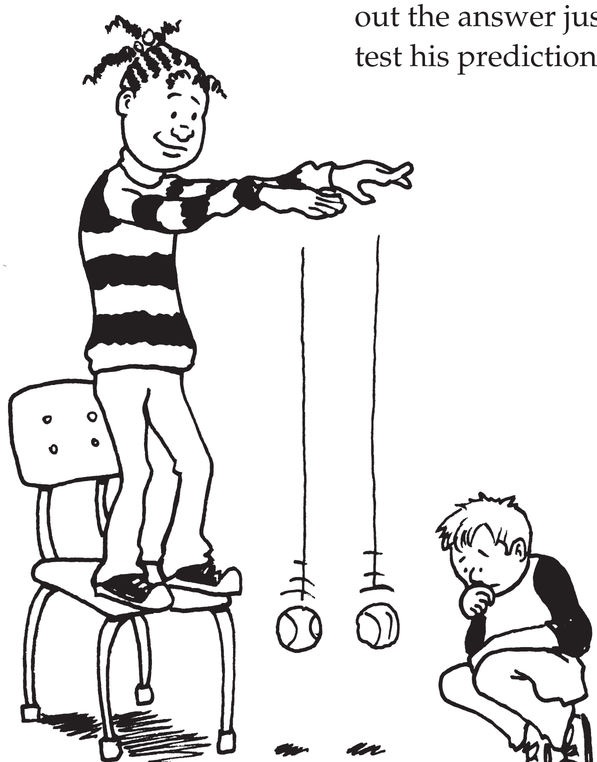
Gravity

Falling Spheres

Galileo Galilei is one of the most famous scientists of all time. He helped move science away from myth and toward a data-driven foundation. As part of their scientific literacy, students should understand the significance of the legend of Galileo's experiment at the Tower of Pisa.

Activity

To begin this activity, ask students what they think happens when two objects that have the same shape but different mass (or weight) fall? Will the heavier or lighter object hit the Earth first, or do they fall at the same rate? Legend says Galileo climbed the Tower of Pisa to answer this question. Instead of trying to figure out the answer just by thinking, Galileo designed an experiment to test his prediction.



Encourage predictions. Does the heavier one hit the ground first? Does the lighter one? Or do they hit at the same time? Let's find out. Making a prediction increases the level of curiosity in the outcome and sharpens critical thinking skills. Predictions may be private, but emphasize that students should form a hypothesis about any experiment before trying it.

Now have students practice dropping identical spheres. Group members should take turns standing on a chair and dropping two tennis balls while a teammate observes carefully. Because students can't calibrate their hands to release the balls exactly at the same time, some repeating and practice is necessary until the results are close enough to assume that the balls hit simultaneously.