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Exploring physics can be an exciting adventure, just like exploring some mysterious ancient ruins. Physics, like other sciences, gives us a glimpse into the wonders of God’s creation.

**Don’t Be Afraid!**

The sciences in general have a reputation of being an almost out-of-reach specialty that is only for a few “special” people. Much of that reputation comes from the unfamiliar words, rules, tools, and procedures that define it. Although physics isn’t simple, we believe that it can be made easy to understand.

**Don’t Be Intimidated!**

We learn new and complicated things every day—from computer programs and games to new moves in a sport to a new song on a musical instrument. We are always learning. Physics is no different—it takes time and perseverance.

**Physics Can Be Fun and Exciting!**

Just like getting to know music, sports, or even a new board game, we will learn some terms and some rules. Each of our lessons develops a physics concept that will build confidence. Kids and parents can explore and develop a firm and lasting foundation for the future.
We hope you will be encouraged by these words from Proverbs: “Trust in the Lord with all your heart and lean not on your own understanding; in all your ways acknowledge him and he will make your paths straight.” (Proverbs 3:5-6)

Robert W. Ridlon, Jr.
Elizabeth J. Ridlon
This book contains 30 lessons. Each lesson is designed to be completed in one week. If you teach science twice weekly, allow for about 60 to 90 minutes each day. Some of the lessons may seem a little more challenging than others. Less-advanced students may have some difficulty with fully comprehending all the material in these few challenging lessons. Don’t worry! It is quite satisfactory if the student can learn just the foundational concepts that are represented by the Review It questions at the end of the lesson. Don’t rush! You may need to read the lesson slowly and more than once. If some words are too difficult, use a dictionary or other source to help clarify meanings. This work will pay off when it’s time for the upper-level classes or when other challenges come along that require perseverance.

Step by Step
Lesson Activities

The following are the activities for completing each lesson and unit:
Preparation

Each unit begins with a short introduction about the material covered in the unit lessons and provides a list of unit objectives, vocabulary words, and a list of materials needed for that unit. You may want to write the unit objectives on a piece of paper and keep it handy. Referring to the objectives will help give you confidence that the student is getting something from the material.

Teaching Time

Each lesson presents a topic that builds an understanding of some aspect of physics. The older or more advanced students themselves can read the lesson material. For very young or less-advanced students, it is a good idea to read the lesson in advance and then explain it at their level. The student should be on the lookout for the vocabulary words that are identified in the unit introduction. Also, encourage the student to take notes to help remember important ideas.

Review It

Do the review exercises. After the teaching time, each lesson has five Review It fill-in-the-blank exercises. The key to ensuring that the student is ready for the Hands-On Time activity and the next lesson is to have the student complete the fill-in-the-blank exercises. These are almost always exact quotes from the lesson and, therefore, the answers will be unambiguous. Once these are filled in, they should be an encouragement that some very important principles of physics have been learned. The answer key for these Review It questions is in an appendix.

Hands-On Time

This is the fun stuff. Each lesson ends with a Hands-On Time activity. These activities have a twofold purpose: (1) They reinforce some of the concepts from the lessons; and in many cases, (2) they will offer a chance for the student to experience being a physicist.
How to Use This Book

Coloring Pages
There is one coloring page per unit, and all of these, plus a coloring version of the cover illustration, are found after the glossary. These coloring pages may be photocopied. Children of all ages will enjoy these beautiful drawings.

Think About It
This is a critical thinking exercise regarding the results of the *Hands-On Time* activity. It isn’t absolutely necessary to do, but it offers students the opportunity to respond to questions that require some creative thought. This exercise might also be an alternative to the coloring page for the older student.

Unit Wrap-Up
At the end of each unit, there is an opportunity for the student to show what he or she has learned. The questions are in a multiple-choice format and are taken from the lesson review exercises. So, a great way to prepare is to go over each review exercise for the lessons in that unit. The answer key for these *Unit Wrap-Ups* is in an appendix.

What’s Important?

Building a Foundation
The important thing to keep in mind is that God is at the center of everything—including the study of physics. The more-advanced or older student may get more from the book than a younger or less-advanced student. It might be good to repeat this course every other year. Build a foundation. Things learned early will last a lifetime, so do your best. Have fun and learn!
Unit Six

Electricity and Magnetism

Both electricity and magnetism are things we probably take for granted. Just about everything we do involves some sort of electricity. The way electricity is made, the way it is delivered for our use, and the way it provides energy are all quite interesting from a physics point of view. Besides being able to stick to the refrigerator door, magnets also exhibit very interesting and mysterious behavior. In fact, we will see in this unit that magnets and electricity are partners. In Unit Six, we will explore the mystery of electricity, the way electric current moves, and how magnets work.
Upon completing Unit Six, the student should understand:

- The concept of electrons and charge
- Electric potential
- Electric current
- The concept of magnetism
- The earth’s magnetic field
- The compass

Unit Six Vocabulary Words

- amperage
- compass
- electrical conductor
- electrical insulator
- electric potential energy
- electric current
- electricity
- magnet
- magnetic field
- magnetism
- volt
- voltage

Materials Needed for This Unit

- pencil
- bar or horseshoe magnet
- small magnet
- sewing needle
- small amount of butter or margarine
- cereal-size bowl
Teaching Time:
Getting Attracted to Magnetism

Do you have any magnets on your refrigerator holding pictures or, maybe, some notes? Have you ever played with a magnet, picking up various objects? If you’ve ever thought about how magnets work, you might think it’s mysterious. In fact, magnets are sort of mysterious. In this lesson, we will explore a little about what magnets are and how they work.

What Is Magnetism?

Magnetism simply means the characteristics exhibited by certain materials to attract certain other materials and to create a special field, called a magnetic field, around them. An object that is a magnet will attract other magnets and also attract certain other types of matter. This is because the magnetic field around the magnet is a force field. There is a force exerted that pulls...
objects into this field. If you have ever played with a magnet, you also know that one end of a magnet will attract one end of another magnet. If you turn the magnet around, it actually pushes the other magnet away. The force of the magnetic field also pushes. If you remember Lesson 10 on force, you recall that that was the definition of force—it pushes or pulls. So, what are magnets and why do they have this kind of force available to them?

Magnets

There are two kinds of magnets: a temporary magnet and a permanent magnet. Temporary magnets act the same as permanent ones. The main difference is that electric current is used to create the magnetic field in a temporary magnet. A permanent magnet has magnetic properties because of the way its atomic particles behave.

A permanent magnet is made of some type of metal, usually iron. Iron is made of iron atoms. Inside these atoms are electrons that are always moving around the nucleus. Usually these electrons are moving in a random way—that is, with no particular direction. When something is a magnet or is magnetized, the majority of the electrons in the magnet move in one direction. This creates a magnetic force. Remember that when there are more electrons than protons, there is a negative electrical charge. However, in the case of magnets, the number of electrons doesn’t change—only the direction in which they are spinning. So, a field is created. There are two ends to every magnet. One end is called the north pole of the magnet. The other end is called the south pole of the magnet. Because of the way the electrons are spinning, the force fields of the north poles always attract those of the south poles. Also, the like poles always repel or push each other away (south poles repel south poles and north poles repel north poles; see the illustration on page 313). So, how do magnets pick up other objects?
Not every type of matter is a magnet. Normally the electrons in a particular material are not spinning in one direction. However, in some cases, these materials can still be attracted by a magnetic field. In other words, a magnet can pick them up. For example, a magnet can pick up a nail made of iron. When that happens, the iron nail becomes a weak magnet itself. There are only three types of matter that become a magnet. We have already mentioned iron. The other two are cobalt and nickel. Magnets actually occur in nature in the form of a type of iron called lodestone. Rubbing the iron nail with a magnet will cause the electrons in the iron nail to spin in one direction more permanently, thus creating another magnet.
Uses of Magnets

Besides being fun and useful for sticking things on the refrigerator, magnets have many other important uses. We mentioned one when we talked about electricity in the previous lesson. The magnetic field can be used to cause electrons to move in a wire, and that is how generators make electricity. Magnets are also used to guide the stream of electrons that are fired at the television screen to make the picture (see Lesson 21). Another use of magnetism is in computer disks. The information is stored by arranging small magnetic particles on the disks. The arrangement of the particles can be read back to retrieve the information. Very large magnets can also carry heavy weights and lift objects that are attracted by the magnetic force.
Review It

1. Magnetism simply means the characteristics exhibited by certain materials to attract certain other materials and to create a special field, called a ________________ field, around them.

2. A permanent magnet is made of some type of metal, usually iron, with the majority of its ________________ moving in one direction.

3. One end of a magnet is called the ________________ pole of the magnet and the other end is called the ________________ pole of the magnet.

4. The magnetic field can be used to cause electrons to move in a wire, and that is how generators make ________________.

5. ________________ are also used to guide the stream of electrons that are fired at a television screen to make the picture.
Hands-On Time:
What Can a Magnet Attract?

Generally, magnets are able to magnetize or attract only matter that has the ability to become a magnet itself. This includes iron or other material that contains iron. In this Hands-On Time, you will discover some of the types of matter that are attracted by magnetic force and some that are not.

Equipment Needed

- bar magnet or horseshoe magnet
- pencil

Activity

Using a magnet, test the materials listed in the Magnet Test Table on page 317 and decide whether or not the items can be attracted by magnetism.
### Magnet Test Table

<table>
<thead>
<tr>
<th>Material</th>
<th>Picked Up by Magnet or Not</th>
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<tr>
<td>Nail</td>
<td></td>
</tr>
<tr>
<td>Toothpick</td>
<td></td>
</tr>
<tr>
<td>Paper cup</td>
<td></td>
</tr>
<tr>
<td>Penny</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>Metal thumbtack</td>
<td></td>
</tr>
<tr>
<td>Potato chip</td>
<td></td>
</tr>
<tr>
<td>Paperclip</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

### Think About It

1. What do the objects that can be picked up with a magnet have in common?

2. What do the objects that cannot be picked up with a magnet have in common?

### Discovery Zone

The Greeks knew about the magnetic properties of naturally occurring lodestone as early as 500 B.C. They named it magnetis lithos (translated: the stone of Magnesia). Magnesia was a region in eastern Turkey where the stones were first found.
Teaching Time:
Don’t Forget Your Compass

Have you ever used a compass? If you have, you know that the compass points to the north part of Earth. Is there something in the north that makes the compass point that way? The answer to that will be discovered in this lesson.

The Compass

Explorers, hikers, and even airplane pilots use compasses to help them navigate from place to place. The compass is actually made of a magnetic needle mounted in a way that allows it to move in a complete circle. If there is any other magnetic force around, the needle will turn toward it. Like any other magnet, the compass needle has a north pole and a south pole. The north pole of a magnet will always be attracted to a magnetic south pole. If another magnet is brought close to a compass, it

Scripture

Whether a tree falls to the south or the north, the place where the tree falls, there it will lie. (Ecclesiastes 11:3b)

Name It!

compass
A device made of a magnetic needle mounted in a way that allows it to move in a complete circle. If there is any other magnetic force around, the compass needle will turn toward it. Used to determine direction because its needle orients toward the north pole of the earth.
will point its north pole toward the other magnet’s south pole. So, why does the compass point to the north, when no other magnets are around? Let’s find out.

**The Earth Is a Giant Magnet**

Earth itself is a giant magnet. Measurements of its magnetic field indicate that something inside the earth is acting as a giant bar magnet with a magnetic north pole and a magnetic south pole. However, scientists know that the inside of the earth is largely liquid metal. Just how the magnetic field is made is the subject of much research today. One theory is that there is an electric current flowing in the liquid metal that generates the magnetic field. One way or another, the magnetic field exists—just look at your compass.
The Compass and the Earth’s Magnetic Field

Now it’s time for a little confusion! The top part of the earth is called the north, and that is where the earth’s north pole is. Likewise, the south part of the earth is called the south, and that is where the earth’s south pole is. We know that with magnets, opposite poles attract (north is attracted to south). So, why does the north pole of the compass needle point to the north pole of the earth? The answer is that the north pole of the earth is where the magnetic south pole is located. The same is true of the earth’s south pole: that is where the magnetic north pole is. Now you know something that many others don’t know.
Review It

1. The __________________ is actually made of a magnetic needle mounted in a way that allows it to move in a complete circle; it has a north pole and a south pole.

2. The north pole of a __________________ will always be attracted to a magnetic south pole.

3. Earth itself is a giant __________________.

4. The top part of the __________________ is called the north, and that is where the earth’s north pole is.

   Likewise, the south part of the __________________ is called the south, and that is where the earth’s south pole is.

5. The north pole of the earth is where its __________________ South pole is located.
Hands-On Time:

Make a Compass

It’s easy to make a compass. Using a magnet, we can magnetize a sewing needle. A small amount of butter coating will enable the needle to float in a bowl of water. The needle will orient itself so that it is pointing exactly north.

Equipment Needed

- small magnet
- sewing needle
- small amount of butter or margarine
- cereal-size bowl
- water

Activity

1. Fill the cereal-size bowl with water.

2. Using the magnet, stroke the sewing needle in one direction (from one end to the other) three or four times, using only the north pole of the magnet.

3. Coat the needle with a little butter.

4. Gently place the needle lengthwise on the surface of the water (you may need to attempt this a couple of times until you can get it floating).
5. Watch the needle orient itself so that it points north.

6. You can verify the direction using another compass, if you like. Be sure the compasses are at least 2 feet apart.

**Think About It**

1. Did the activity work?

2. Which end of the sewing needle pointed north and which pointed south? How could you figure it out?

---

**Discovery Zone**

The first compass was made and used in China more than 2,000 years ago.
All books suitable for grades 3–8 unless otherwise noted.

**Physics Reference Books**


Appendix A: Book and Resource List


Lesson 26: Music

Unit Six — Electricity and Magnetism

Lesson 27: Electricity

Lesson 28: Electric Current

Lesson 29: Magnetism
Lesson 30: Earth’s Magnetic Field


**Important Physicists**

**General Biographies**


**Specific Physicists**

**Ampère, André**


**Archimedes**


**Aristotle**


Lesson 1

1. When we study science, we get to know more about God and appreciate His power and greatness.
2. When studying physics, we are learning about matter and energy.
3. Material things are those that we can see or touch. In physics, we call these material things matter.
4. Energy includes electricity, heat, light, and even sound and can be stored in matter and used to do work.
5. One special area of study in physics is the way matter and energy behave together. This behavior in physics is called mechanics.

Lesson 2

1. Speed is a measure of how fast an object is traveling from a starting point to an ending point.
2. When talking about measuring, dimensions include length, width, and height.
3. Distance is a measurement taken between two points, referred to as a starting point and a finishing point.
4. Temperature is a measure of how hot or cold something is.
5. Weight is a measure of how heavy (or light) something is.
Lesson 28

1. Conductors are types of matter in which the electrons move out of their atoms very easily. Examples are copper and aluminum.
2. Types of matter in which electrons do not move out of their atoms very easily are called insulators. Examples are wood, plastic, and glass.
3. To get electrons (electricity) flowing, there needs to be a continuous production of electric potential energy, which is done through a special machine called a generator.
4. The number of electrons that flow through a conductor is measured as the amperage.
5. Electricity generators create voltage, which is the electric potential energy.

Lesson 29

1. Magnetism simply means the characteristics exhibited by certain materials to attract certain other materials and to create a special field, called a magnetic field, around them.
2. A permanent magnet is made of some type of metal, usually iron, with the majority of its electrons moving in one direction.
3. One end of a magnet is called the north pole of the magnet and the other end is called the south pole of the magnet.
4. The magnetic field can be used to cause electrons to move in a wire, and that is how generators make electricity.
5. Magnets are also used to guide the stream of electrons that are fired at a television screen to make the picture.

Lesson 30

1. The compass is actually made of a magnetic needle mounted in a way that allows it to move in a complete circle; it has a north pole and a south pole.
2. The north pole of a magnet will always be attracted to a magnetic south pole.
3. Earth itself is a giant magnet.
4. The top part of the earth is called the north, and that is where the earth’s north pole is. Likewise, the south part of the earth is called the south, and that is where the earth’s south pole is.
5. The north pole of the earth is where its magnetic south pole is located.
Robert W. Ridlon, Jr., is a consultant for a systems development firm and an adjunct faculty member at Southwestern Illinois College, teaching courses in information systems theory. He earned a bachelor of arts degree in biological sciences from Indiana University and a master of science degree in information resource management from the Air Force Institute of Technology.

Elizabeth J. Ridlon is an adjunct faculty member at Southwestern Illinois College where she teaches biological sciences. She earned a bachelor of science degree in microbiology from Indiana University, a master of arts degree in biology from the University of Nebraska, and a secondary teaching certificate from Southern Illinois University.

The Ridlons are involved members of their church and committed to God’s message of Truth. They have one son, Robert (in graduate school); a daughter-in-law, Crystal; and two grandsons. The Ridlons have visited and explored 17 countries on four continents and have written two creation science books, as well as Christian Kids Explore Chemistry
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- Teacher’s Guide
- Student Reader

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