Investigate the Possibilities

Elementary Physics

ENERGY

Its Forms, Changes, & Functions

Teacher's Guide

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Introduction

The overall goal for each book is to include three components: good science, creation apologetics, and Bible references. This goal underlines the rationale for the design of the workbooks.

Science is a great area to teach, because children have a natural curiosity about the world. They want to know why and how things work, what things are made of, and where they came from. The trick is to tap into their curiosity so they want to find answers.

Many elementary-level science lessons begin with definitions and scientific explanations, followed by an activity. A more effective method is to reverse this order and begin with an activity whenever possible. The lessons found in these workbooks begin with an investigation, followed by scientific explanations and opportunities to apply the knowledge to other situations.

In addition to the investigations, there are sections on creation apologetics, written mostly in narrative forms; connections to Bible references; on-your-own challenges; pause and think questions; projects and contests; and historical stories about scientists and engineers. These sections encourage students to think more critically, to put scientific ideas into perspective, to learn more about how science works, to gain some expertise in a few areas, and to become more grounded in their faith in the Bible.

It is not expected that students will do everything suggested in the workbooks. The variety provides students with choices, both in selection of topics and in learning styles. Some students prefer hands-on activities and building things, while others prefer such things as writing, speaking, drama, or artistic expressions. Once some foundational ideas are in place, having choices is a highly motivating incentive for further learning.

Every effort has been made to provide a resource for good science that is accurate and engaging to young people. Most of the investigations were selected from lessons that have been tested and used in our Discovery classrooms. The science content meets and exceeds the recommendations of the National Science Education Standards.

Format for Individual Lessons:

1. Think about This

The purpose of this section is to introduce something that will spark an interest in the upcoming investigation. Lesson beginnings are a good time to let students make observations on their own; for a demonstration by the teacher; or to include any other kind of engaging introduction that causes the students to want to get answers. Teachers should wait until after students have had an opportunity to do the investigation before answering too many questions. Ideally, lesson beginnings should stimulate the students' curiosity and make them want to know more. Lesson beginnings are also a good time for students to recall what they already know about the lesson topic. Making a connection to prior knowledge makes learning new ideas easier.

2. The Investigative Problem

This section brings a focus to the activity students are about to investigate and states the objectives of the lesson. Students should be encouraged throughout the investigation to ask questions about the things they want to know. It is the students' questions that connect with the students' natural curiosity and makes them want to learn more. Teachers should stress to students at the start of each lesson that the goal is to find possible solutions for the investigative problem.

3. Gather These Materials

All the supplies and materials that are needed for the investigation are listed. The teacher's book may contain additional information about substituting more inexpensive or easier to find materials.

4. Procedures and Observations

Instructions are given about how to do the investigation. The teacher's book may contain more specifics about the investigations. Students will write their observations as they perform the activity.

5. The Science Stuff

It is much easier for students to add new ideas to a topic in which they already have some knowledge or experience than it is to start from scratch on a topic they know nothing about. This section builds on the experience of the investigation.

6. Making Connections

Lessons learned become more permanent when they are related to other situations and ideas in the world. This section reminds students of concepts and ideas they likely already know. The scientific explanation for what the students observed should be more meaningful if it can be connected to other experiences and/or prior knowledge. The more connections that are made, the greater the students' level of understanding will become.

7. Dig Deeper

This section provides ideas for additional things to do or look up at home. Students will often want to learn more than what was in the lesson. This will give them some choices for further study. Students who show an interest in their own unanswered questions should be allowed to pursue their interests, provided the teacher approves of an alternative project. Students should aim to do at least one project per week from Dig Deeper or other project choices. The minimum requirements from this section should correspond to each student's grade level. Students may want to do more than one project from a lesson and none from other lessons. Remember, this is an opportunity for students to choose topics that they find interesting.

8. What Did You Learn?

This section contains a brief assessment of the content of the lesson in the form of mostly short-answer questions.

9. The Stumpers Corner

The students may write two things they would like to learn more about or they may write two "stumper" questions (with answers) pertaining to the lesson. Stumper questions are short-answer questions to ask to family or classmates, but they should be hard enough to be a challenge.

Note to the Teacher

The books in this series are designed to be applicable mainly for grades 3–8. The National Science Education Standards for levels 5–8 were the basis for much of the content. Recommendations for K–4 were also considered, because basic content builds from one level to another. Many of the objectives listed with each lesson are taken from the National Science Education Standards

However, the built-in flexibility allows younger students to do many of the investigations, provided they have good reading and math skills. Middle school students will be presented the basic concepts for their level, but will benefit from doing more of the optional research and activities

We feel it is best to leave grading up to the discretion of the teacher. However, for those who are not sure what would be a fair way to assess student work, the following is a suggestion.

1. Completion of 20 activities with write-up of observations — ⅓
2. Completion of What Did You Learn Questions + paper and pencil quizzes — ⅓
3. Projects, Contests, and Dig Deeper — ⅓

The teacher must set the standards for the amount of work to be completed. The basic lessons will provide a solid foundation for each unit, but additional research and activities are a part of the learning strategy. The number of required projects should depend on the age, maturity, and grade level of the students. All students should choose and complete at least one project each week or 20 per semester. 5th and 6th graders should complete 25 projects per semester. A minimum guide for 7th and 8th graders would be 30 projects. The projects can be chosen from "Dig Deeper" ideas or from any of the other projects and features. Additional projects would give extra credits. By all means, allow students to pursue their own interests and design their own research projects, as long as you approve first. Encourage older students to do the more difficult projects.

As students complete each investigation and other work, they should record what they did and the date completed in the student journal. You may or may not wish to assign a grade for total points. But a fair evaluation would be three levels, such as: minimum points, more than required, and super work. Remember, the teacher sets the standards for evaluating the work.

Ideally, if students miss one of the investigations, they should find time to make it up. When this is not practical, make sure they understand the questions at the end of the lesson and have them do one of the "Dig Deeper" projects or another project.

You should be able to complete most of the 20 activities in a semester. Suppose you are on an 18-week time frame with science labs held once a week for two or three hours. Most investigations can be completed in an hour or less. Some of the shorter activities can be done on the same day or you may choose to do a teacher demonstration of a couple of the labs.

It is suggested that at least five hours a week be allotted to the investigations, contests, sharing of student projects, discussion of "What Have You Learned" questions, and research time. More time may be needed for some of the research and projects. Count projects, contests, and Dig Deeper activities equally. There are over 70 possible activities from which students may choose.

Any time chemicals are used that might irritate eyes, safety glasses should be required. This is also a requirement for being around flames and other devices used for heating water or other chemicals. They are as important as safety belts are for children in a moving vehicle. Some activities should be done only as demonstrations led by an adult, but a student helper can assist if the student is wearing safety glasses and covering to protect clothes.

Refer students to textbooks or other references to help them answer questions, but also encourage them to think of their own explanations. It is not too early to help students understand that science is mostly about finding explanations for things they have observed and about finding patterns in nature. When controlled experiments are done, help them identify the controls and the variable.

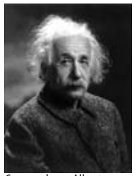
Most of the supplies and equipment can be obtained locally. However, these may also be ordered for convenience.

INVESTIGATION #1

Where Exactly Does Energy Go?

Think about This

Ella understands that light is a form of energy, but she is having trouble with the idea that light energy cannot be created or destroyed.



German-born Albert Einstein was awarded the 1921 Nobel Prize in physics. His studies of light transformation helped to base his discovery of the photoelectric effect.

"Look," she told her aunt, who is a science teacher."When I flip the switch and turn off the lights, I cause all the lights in the room to go away." She demonstrated and made the room very dark.

"Now look what happens when I turn the light switch back on. The room fills with light again. Didn't I just create and destroy the light in the room?" she asked.

"No, you certainly did not," her aunt said. "All you did was demonstrate how energy can change from one form into another."

Let's look at some examples of how energy changes from one form to another in this lesson.

The Investigative Problems

What are examples of energy?
Can one form of energy change into another form of energy?

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Procedure & Observations

1. Electric energy to light and heat energy: Take a 1.5-volt dry cell, a five-inch wire, and a light bulb. Test different combinations until you get the light bulb to come on. Show your teacher when you are successful. Make a drawing to show how you connected everything.

   Feel the light bulb. Can you tell if it has gotten any warmer? (Note: This is a small amount of heat and it may not be easy to detect.)

2. Mechanical energy to heat energy: Rub a piece of sandpaper quickly over a board several times. Feel the sandpaper and the board. What kind of energy is produced?

3. Mechanical energy to sound energy: Remove the cover from a sturdy box and cut three grooves on opposite edges of the box. Now choose three rubber bands of equal length, but each with a different thickness. Stretch the rubber bands around the box, fitting each into one of the grooves. Pluck each rubber band. Observe that it is vibrating. Listen for a sound. Repeat for each rubber band. Compare the pitch made by the different rubber bands. Record your observations.

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OBJECTIVES

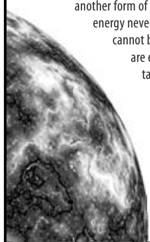
Energy cannot be created or destroyed, but it can change from one form into another. Heat energy can be produced in many ways. Energy is associated with heat, light, electricity, mechanical motion, sound, the nature of a chemical, and other things. Energy is transferred in many ways.

NOTE

The idea that one form of energy can change into another form of energy may be a difficult concept for some students. Even if the definitions and concepts are not clear, providing many examples will help them achieve a good level of understanding.

After the students complete their investigations, light a candle. Ask the students if they can figure out where the energy is coming from that is producing light and heat. Explain that there is stored chemical energy in a candle. This chemical energy is changed into heat and light energy. Explain that cars provide another example of using chemical energy. The gasoline contains chemical energy, which changes into heat energy inside the engine. The heat energy is changed into mechanical energy, which eventually makes the car move. Ask the students if they can think of other examples of one form of energy changing into another form of energy.

The Science Stuff



Energy is what enables matter to move or to change. Energy is found in many different forms, such as heat, light, electricity, mechanical (the energy in moving things), sound, nuclear, and chemical. One form of energy can be changed into another form of energy. Still, the total amount of energy never changes. This means that energy cannot be created or destroyed. These ideas are expressed in one of the most important laws in all of science — the law of conservation of energy.

These activities illustrate some of the main forms of energy. Each activity shows one form of energy being changed into another form of energy. Electrical energy changed into light and heat, mechanical energy changed into heat, and mechanical energy changed into sound.

In the first activity, when the equipment was wired together correctly, an electric circuit was completed. An electric current then moved through the dry cell, wires, and light bulb. As the electric current moved through the light bulb, electric energy changed into light energy and heat energy.

This activity illustrates another important concept about energy. It shows that energy can be transferred from one place to another. Much of the earth's energy is transferred from the sun to the earth.

Remember the conversation between Ella and her aunt? When Ella flipped the light switch, the electric current began to move through the wires and the light bulb. Inside the light bulb, electric energy changed into light and heat energy, which is the same thing that happened in your activity with electricity. When she turned the lights off, the objects in the room absorbed the heat and light energy. (This is a small amount of energy, and you probably couldn't detect it without some sophisticated equipment.)

When you rubbed a board with sandpaper, your motion produced mechanical energy. This motion produced friction between the sandpaper and the wood, causing the molecules to move faster. As a result, both the sandpaper and the wood became hotter. Thus, the mechanical energy of the moving sandpaper changed into heat energy.

You were also the source of motion when you plucked the tight rubber bands, causing them to vibrate. Sound is produced when a force causes something to vibrate and produce sound waves. Sound energy is carried in waves.

Making Connections

Another way in which mechanical energy can produce sound waves is by tapping on a table. Tapping on the table causes the table to vibrate in the same way plucking on the rubber bands caused them to vibrate. Sound waves actually travel faster through the table than through the air. You can put your ear next to the table and hear the tapping sounds clearly. You can also raise your head and hear the sounds as the sound waves pass through the table and then through the air.

When electrical energy passes through a light bulb, it is changed into light energy and heat energy. Even though the heat energy is unwanted, it is still part of the electric bill. Engineers try to design light bulbs that increase the amount of light and decrease the amount of heat produced. Some progress has been made, but light bulbs continue to produce unwanted heat.

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Dig Deeper

Start with the energy being given off from a TV or a radio in your home. Try to figure out where this energy comes from. See how far back you can trace the energy changes. This gets a little complicated, so get a good reference book to help you.

What is the difference between an electric motor and an electric generator? They basically contain the same parts and are built the same way. However, an electric motor changes electric energy into mechanical energy, and an electric generator changes mechanical energy into electric energy.

In 1905, Albert Einstein proposed a theory that altered the law of conservation of energy. He said that matter can be changed into energy, and energy can be changed into matter, but the total amount of matter and energy in the universe remains the same. How was Einstein's theory shown to be true?

What Did You Learn?

1. Give two examples of how one form of energy can change into heat energy. Give another example of an energy change.
2. List two ways in which energy does work for us.
3. The following list contains examples of forces, properties of matter, and forms of energy. Underline all the examples of forms of energy: inertia, light, heat, density, buoyancy, electricity, lift, weight, chemical, push, and nuclear.
4. Define mechanical energy and give an example.
5. What kind of energy can be quickly provided by a battery?
6. What is the law of conservation of energy?
7. Give an example of when an unwanted form of energy is produced in a device.
8. What happens to a roomful of light on a dark night when the lights are turned off?
9. Was energy transferred from the battery to the light bulb when an electric circuit was completed?

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What Did You Learn?

1. **Give two examples of how one form of energy can change into heat energy. Give another example of an energy change.** *Mechanical (moving) energy can change into heat energy, electrical energy can change into heat energy, and the chemical energy in a candle can change into heat energy. Other examples of energy changes are the chemical energy in a battery can change into electrical energy and electrical energy can change into light energy.*

2. **List two ways in which energy does work for us.** *Two examples in which energy does work for us include using energy to make objects move and using energy to change things. (There are other examples.)*

3. **The following list contains examples of forces, properties of matter, and forms of energy. Underline all the examples of forms of energy: inertia, light, heat, density, buoyancy, electricity, lift, weight, chemical, push, nuclear.** *The examples of forms of energy are light, heat, electricity, chemical, and nuclear. (Inertia and density are properties of matter; buoyancy, lift, weight, and push are examples of forces.)*

4. **Define mechanical energy and give an example.** *Mechanical energy is energy of motion. An example is rubbing a piece of sandpaper over a board.*

5. **What kind of energy can be quickly provided by a battery?** *Electrical energy*

6. **What is the law of conservation of energy?** *It says that energy cannot be created or destroyed.*

7. **Give an example of when an unwanted form of energy is produced in a device.** *Heat energy is produced in an electric lightbulb. This doesn't make the light brighter or last longer.*

8. **What happens to a roomful of light on a dark night when the lights are turned off?** *The light energy is absorbed by substances in the room and changed into heat energy.*

9. **Was energy transferred from the battery to the lightbulb when an electric circuit was completed?** *Yes*