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PART 1 Energy

LESSON 1

Circuit of Inquiries—A Preassessment

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Can you see a machine in this photo? Can you see motion? Can you see evidence of energy? You will explore these topics in this module.

INTRODUCTION

What do you know about energy, machines, and motion? In this lesson, you will complete eight short inquiries about the topics in this module. The inquiries are designed to get you thinking about physical forces, energy transformations, machines, and motion. The observations you make and the ideas you discuss in this lesson will prepare you for the inquiries ahead in *Energy, Machines, and Motion.*

OBJECTIVES FOR THIS LESSON

Perform a series of activities to investigate forces, energy transformations, and machines.

Observe, describe, and hypothesize about the physical phenomena you experiment with in the activities.

Relate your observations to personal experiences.

Getting Started

1. Your teacher will divide the class into pairs of students. You and your lab partner will work together on the eight short inquiries in this lesson.

2. Listen as your teacher reviews the directions for carrying out the inquiries. At your teacher's direction, go with your partner to your first inquiry station.

MATERIALS FOR LESSON 1

For you

1 copy of Student Sheet 1: What We Observe About Energy, Machines, and Motion

PROCEDURE

1. At each station, complete the activity described in the directions on the Inquiry Card. The directions are also included on pages 4–8 in your Student Guide. You may want to refer to them later.

2. For each activity, record your observations on your student sheet. Answer the questions in complete sentences.

3. When you finish each inquiry, put everything back the way you found it for the next pair of students.

4. When time is called, move quickly and quietly to the next station.

5. Repeat Steps 1, 2, and 3 for the other seven inquiries.

Inquiry 1.1
The Single Pulley

PROCEDURE

1. Pull on the string and observe what happens.

2. Describe what you observe. Write your description on Student Sheet 1.

3. On Student Sheet 1, describe a situation where you have seen a pulley or pulleys being used.

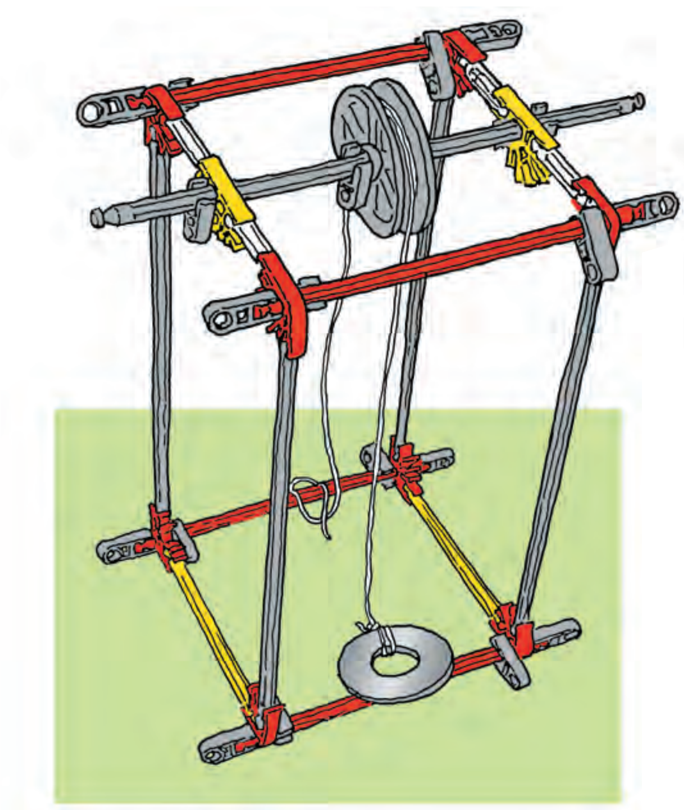


Figure 1.1 *K'NEX® assembly for the single pulley*

Inquiry 1.2
The Pegboard Lever

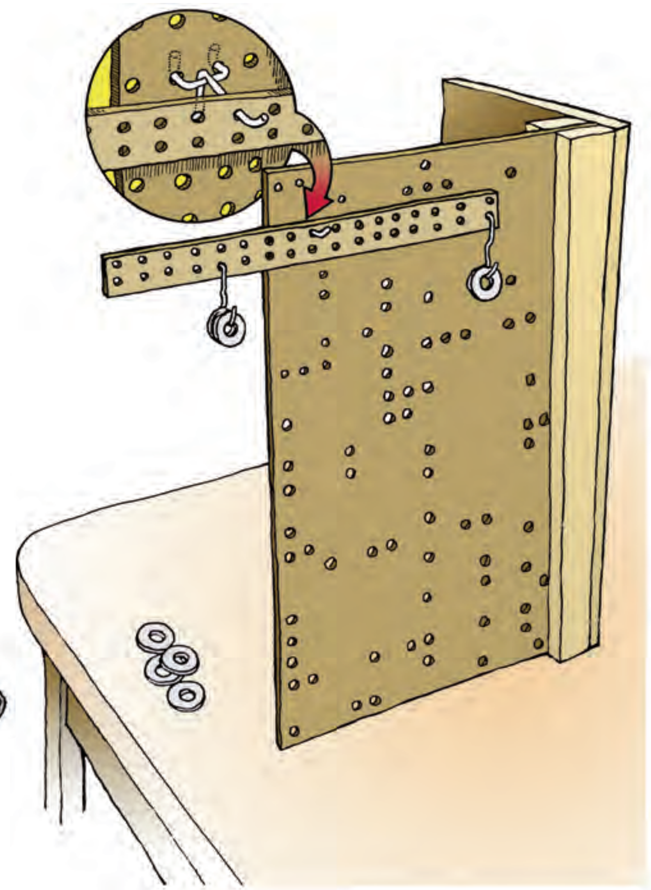


Figure 1.2 *The pegboard lever attached to the pegboard assembly*

PROCEDURE

1. Examine the lever. It should have one washer on the right arm and two on the left, and it should be balanced (see Figure 1.2). On your student sheet, draw a diagram showing the washers and the balanced lever.

2. Leave the washer on the right arm, but remove the paper clip and washers from the left arm. Use the paper clip to attach a different number of washers to the left arm, and try to balance the lever (or nearly balance it). Draw a diagram of your new arrangement.

3. In addition to the number of washers, what did you change to balance the lever?

4. On Student Sheet 1, describe something else you can balance.

Inquiry 1.3
The Hand Warmer

PROCEDURE

1. Put the digital thermometer's shaft between the palms of your hands for 1 minute. Observe the thermometer and record the temperature.

> **SAFETY TIP**
> When using a digital thermometer, be careful with the pointed end.

2. Leaving the thermometer between your hands, rub your hands together for a short time. Observe the thermometer as you do this. Stop rubbing your hands and describe what happens to the temperature.

3. Write down another example of how you can produce heat.

4. Each student should perform Steps 1 and 2 if there is time.

Inquiry 1.4
Constructing a Graph

PROCEDURE

1. A bowling ball was released, and the distance it rolled was measured at the end of 5, 10, and 15 seconds.

2. Draw a graph on your student sheet using the measurements recorded in Table 1.

Table 1 Distance the Bowling Ball Traveled Over Time

Time (seconds)	Distance (meters)
5	15
10	25
15	30

3. What does the graph show about the bowling ball's motion?

Inquiry 1.5
Transforming Energy

PROCEDURE

1. Rapidly move the shaft of the generator (motor) back and forth over the stretched rubber band on the books (see Figure 1.3). Watch the lightbulb and describe what you observe.

2. Describe the energy transformations that are taking place.

3. Give an example of another way to generate electricity.

Figure 1.3 *The setup for Inquiry 1.5*

Inquiry 1.6
The Puck Launcher

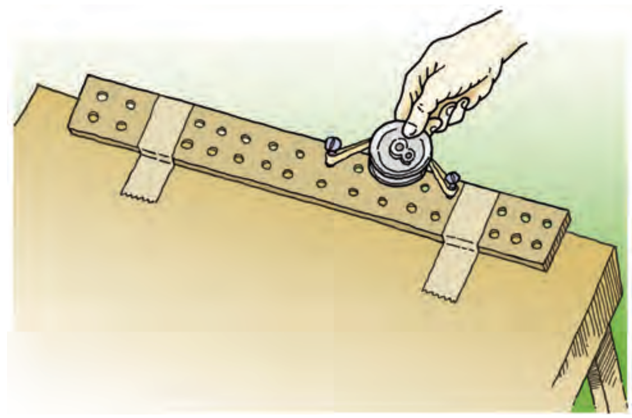


Figure 1.4 *The setup for the puck launcher*

PROCEDURE

1. Put the wheel against the rubber band (see Figure 1.4). Pull the band and puck back about 2 centimeters (cm) and release the puck. Describe the puck's motion.

2. Put the puck against the rubber band. Pull the band and puck back about 4 cm and release the puck. Describe the puck's motion.

3. What force acted on the puck each time it was released?

4. Describe how the puck's motion is different and how it is the same in the two trials.

5. Give an example of a force that acts on an object. What is the force's effect?

Inquiry 1.7
Up the Incline

PROCEDURE

1. Lift the 1.0-kilogram (kg) mass directly to the top of the ramp at the ramp's high end (see Figure 1.5). Describe the size of the force (for example, small, medium, or large) when you lift the mass directly onto the high end of the ramp.

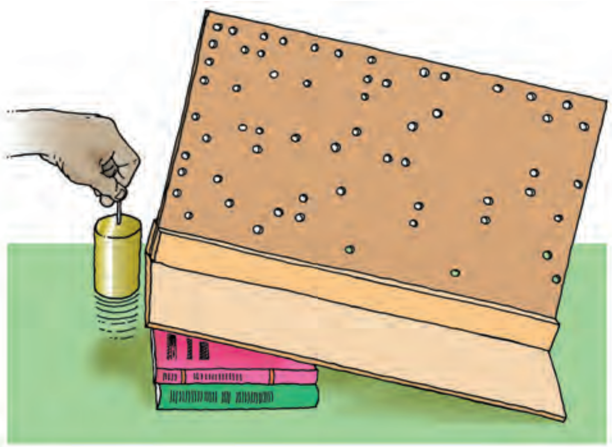


Figure 1.5 *Lifting a mass onto the inclined plane*

2. Put the same 1.0-kg mass on its side at the bottom of the inclined plane, and pull it with a steady force up the incline to the top (see Figure 1.6). Describe the size of the force you exerted or applied when you pulled the mass up the incline.

3. How do the forces—lifting the mass and pulling the mass—compare?

4. Describe another situation in which people use inclined planes.

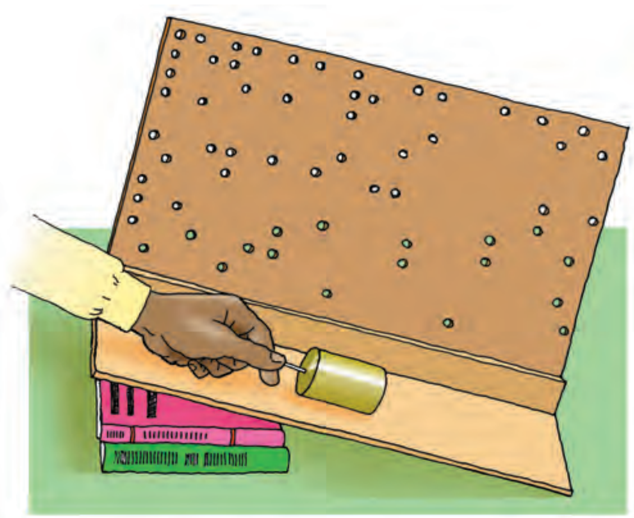


Figure 1.6 *Pulling a mass up the inclined plane*

Inquiry 1.8
Down the Ramp

PROCEDURE

1. Put the car on the ramp's high end (Position 1) and let it go.

2. Describe the car's motion.

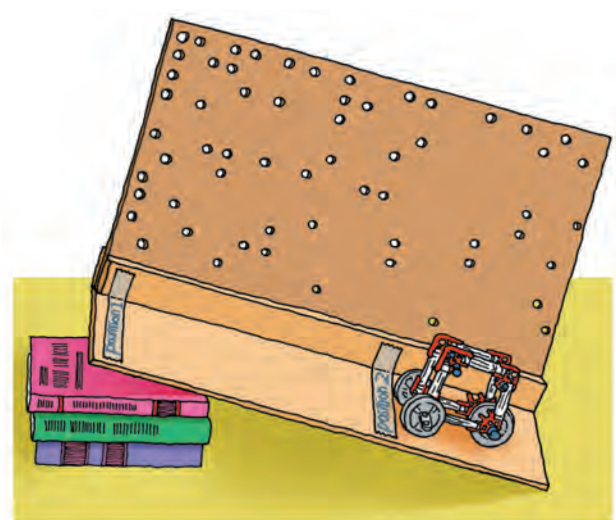


Figure 1.7 *The car and ramp*

3. Put the car farther down the ramp (Position 2) and let it go (see Figure 1.7).

4. Describe the motion you observe.

5. Compare the motions of the two cars and explain why they are different.

REFLECTING ON WHAT YOU'VE DONE

1. Discuss with your partner and then with the class what you have observed and your ideas about your observations.

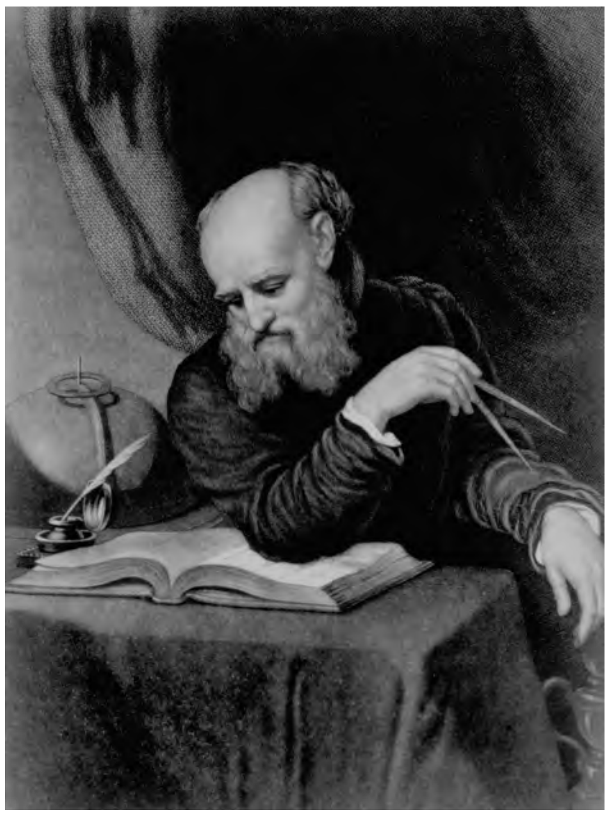
2. In class, summarize your observations and give examples of similar forces, energy transformations, and machines you have seen outside the classroom. Your teacher will record the ideas on a class list.

Galileo and Experimental Science

In Lesson 1, you made observations, took measurements, recorded and analyzed data, and discussed your findings with your classmates. This probably seems like the logical way to do science—but it hasn't always been the case.

In ancient times, scientists were curious about the world around them. These early scientists often relied too much on general observations and on what previous scientists had done. They were often reluctant to question authority.

About 400 years ago in Western Europe, things changed. A number of scientists began to explore the world around them with a fresh eye. Everything interested them. They looked at things in a new way. They did not just observe things and record information; they experimented to see if their ideas were correct. One of the most famous of these scientists was an Italian named Galileo Galilei.



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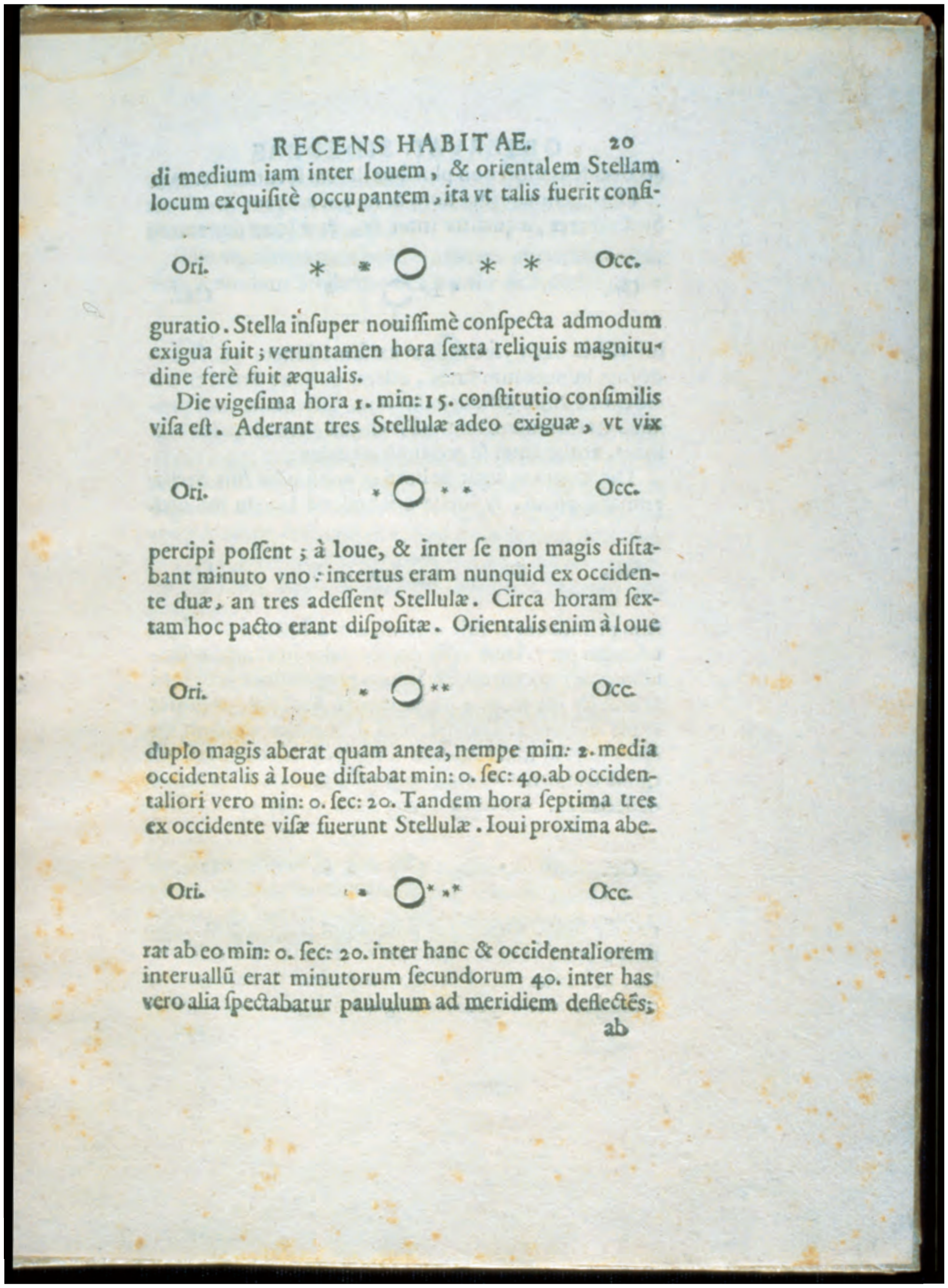
Galileo Galilei

Galileo was born in Pisa, Italy, in 1564. At the age of 17, he entered the University of Pisa. He planned to become a doctor, but he soon became sidetracked. Galileo began to observe things that were happening around him, and he found them much more interesting than what he heard in the lecture hall.

Even the simplest things could be fascinating. For example, Galileo sat in church and watched a lamp swing from the ceiling. He soon realized that its movements were regular. He could time them with his pulse beat. When Galileo watched different lamps, he discovered that there was a relationship between the time it took for a lamp to swing back and forth and the length of the chain from which it was suspended. He also discovered that a lamp swung back and forth in the same amount of time, regardless of how broad or narrow the swing.

Galileo did not find any immediate application for his observations of the swinging lamp. (That would come later, with the invention of a pendulum clock). But it didn't matter. The experience was important because he had identified and documented a mathematical relationship in a universal event—the swinging of a lamp.

As Galileo became more involved in science, he began to record his observations in notebooks. This was another important distinction between him and earlier scientists. These notebooks, in which he frequently made sketches, enabled Galileo to share his ideas with other



RECENS HABITAE. 20

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Ori. * * O * * Occ.

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Ori. * O * * Occ.

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Ori. * O ** Occ.

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Ori. * O * ** Occ.

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With his telescope, Galileo saw four moons orbiting Jupiter. He studied their motions from night to night and recorded the positions of the moons in his notebook.

people of his time. The notebooks, which still exist today, give us insight into his imaginative and creative mind.

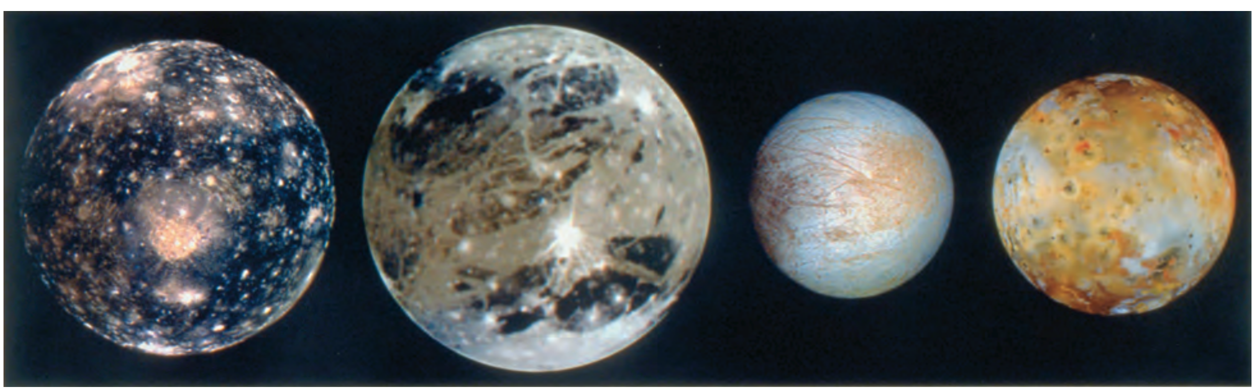
Galileo was a famous inventor. One of his most astounding devices was a military compass that could aim cannonballs at the enemy. He achieved his greatest fame as an astronomer, however. He built his own telescope. With it, he made observations that revolutionized our understanding of the universe. He saw craters on the moon and thousands of stars in the Milky Way galaxy.

He looked at the planet Jupiter and saw four small points of light circling it. At first, he thought they were distant stars. As he continued to observe and record what he saw, he finally concluded that those points of light were actually moons in orbit around the planet. Today, these moons are called the Galilean moons.

Galileo's ideas sometimes got him into trouble. For example, his observations convinced him that the planet Earth revolves around the sun. (For centuries, people had thought that Earth was the center of the solar system.) This idea was very controversial, especially to leaders of the Church, who put Galileo on trial for heresy and threatened him with torture. To keep Galileo quiet, the Church leaders put him under house arrest for the rest of his life. Galileo could no longer speak out in public, but he remained convinced that his beliefs about the solar system were correct (and, of course, they were).

The Galileo space probe, launched by the National Aeronautics and Space Administration (NASA) in 1989, honored this famous Italian scientist. Its mission is to observe Jupiter and send information back to Earth. The space probe also sends information about the four moons that Galileo first saw in 1609.

To Galileo, these moons were four tiny points of light. Take a look at the pictures from the space probe, below. Do you think Galileo would be pleased to see his moons in such detail? ☐



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Close-up photos of Jupiter's moons, taken by the Galileo space probe.