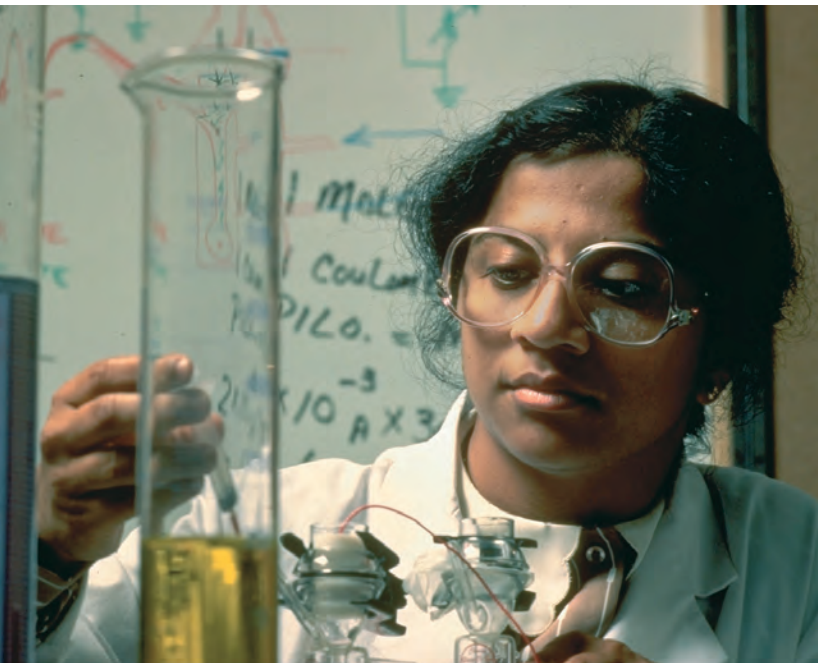
LESSON 9

The Mystery Object



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Careful laboratory work is an important part of science. In this lesson, you will test some of your lab skills.

INTRODUCTION

This lesson is the assessment for Part 1: Characteristic Properties of Matter. The assessment is in two sections. In Section A, you will work by yourself to investigate a mystery object. You will use your measurement skills, your knowledge of density, and a data table to determine the substance that makes up your mystery object. Section B consists of several multiple choice questions. Some of these will require you to use your knowledge and skills to interpret data tables, diagrams, graphs, and experiments. Your teacher will use the results of this assessment to evaluate how well you can apply the concepts, knowledge, and skills you learned in the first part of the module.

OBJECTIVES FOR THIS LESSON

Discover the identity of the matter that makes up your mystery object.

Use your knowledge and skills to solve problems related to the characteristic properties of matter.

Getting Started

1. Your teacher will assign you to one set of apparatus and tell you which balance to use.

2. Follow along as your teacher reviews the guidelines for the assessment:

A. Immediately check your apparatus against the materials list.

B. You will work individually and should not talk to other students.

C. Answer all of the questions.

D. Do the performance assessment (Inquiry 9.1) first.

E. As soon as you finish the performance assessment, begin the written assessment.

F. You have 15 minutes to do each section of the assessment and 5 minutes to check your answers.

G. Three or four minutes before the end of the lesson, hand in Student Sheet 9. Follow your teacher's instructions for cleaning up.

MATERIALS FOR LESSON 9

For you

1 copy of Student Sheet 9: Assessment
1 100-mL graduated cylinder
1 250-mL beaker
1 metric ruler
1 loupe (double-eye magnifier)
1 mystery object
Access to water
Access to an electronic balance

Inquiry 9.1
What Substance Makes Up My Mystery Object?

PROCEDURE

1. Use any of the apparatus, a balance, water, and Table 9.1 to identify the substance that makes up your mystery object. Your object is made from one of the substances in Table 9.1. You may not need to use all of the apparatus.

2. You may refer to your science notebook, student sheets, and Student Guide while working on Inquiry 9.1, but do not discuss your work with other students.

3. Write your name on Student Sheet 9.

4. Write the number of your object in the space provided on Student Sheet 9.

5. Begin Section A of the assessment. When you finish it, do Section B.

Table 9.1 Approximate Densities of Materials at Room Temperature

Name of Substance	Approximate Density (g/cm^3)
Polyvinyl chloride (PVC)	1.5
Titanium	4.1
Aluminum	2.7
Sulfur (rhombic)	2.1
Mercury	13.5
Steel	7.9
Lead	11.4
Copper	8.9
Nylon	1.2
Water	1.0

Choosing Materials for Pedal-Powered Flight

Daedalus made wings from wax and feathers to escape King Minos.

In Greek myth, Daedalus made wings out of wax and feathers. Daedalus used the wings to escape from the prison of King Minos on the Greek island of Crete. He flew more than 100 kilometers to safety.

In the mid-1980s, airplane engineer John Langford decided to do in real life what Daedalus had done in myth. However, Langford didn't use wax and feather wings. Instead, he put together a team that built an ultra-lightweight, pedal-powered airplane. He called the plane *Daedalus*, after the mythological Daedalus.

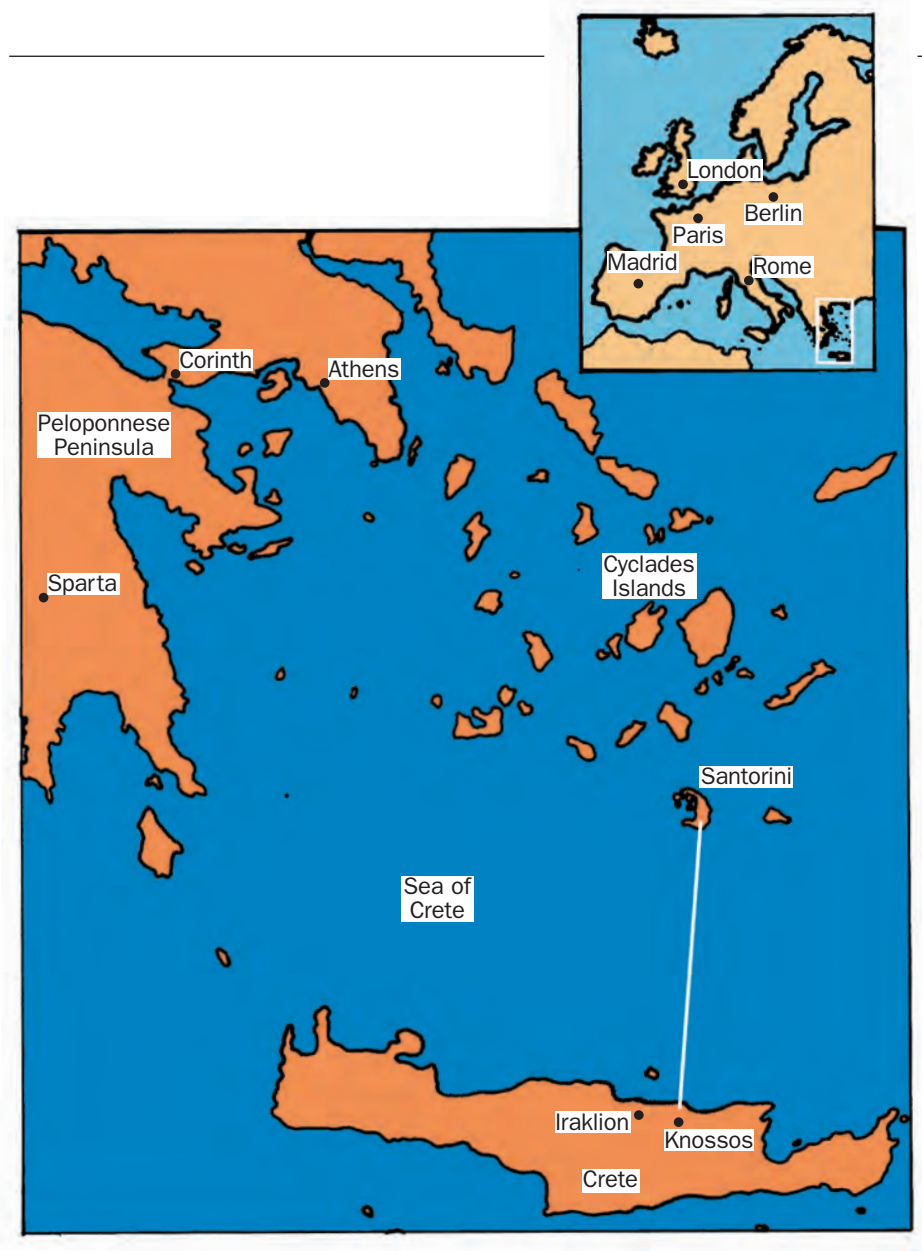
Kanellos Kanellopoulus, a Greek Olympic bicyclist, was the pilot. He flew the plane 115 kilometers from Crete to another Greek island, Santorini. As of 1998, the plane still held the distance record for human-powered flight.

It is easy to see where the myth of Daedalus came from. Almost everyone, at sometime or another, dreams of flying like a bird. Through the centuries, many would-be eagles have strapped on home-made wings and tried to fly using only their own muscles. They flew like bricks.

The problem, says Langford, is that people are not very good engines. To fly the *Daedalus* 115 kilometers would take several hours. For that length of time, even the best athletes can sustain only the same power output as a bright lightbulb. Because of this lack of power, the plane had to be very light. "Every gram mattered," says Langford.

When Langford and his team set out

The Daedalus *pedal-powered plane follows the route of the Daedalus of mythology.*



The Daedalus *was flown from Crete to Santorini in 4 hours—a feat of airborne cycling!*

to build *Daedalus*, they needed materials that were very strong and very light. Fortunately, new materials had been developed that fit the bill.

For the plane's frame, Langford chose tubes made of a carbon composite. This material is composed of thin, very strong carbon threads embedded in plastic. The wings were made of solid foam building insulation cut to the proper shape. The plane's skin was made of Mylar™, an extremely thin but sturdy sheet material that is also used in videotapes and shiny helium balloons.

These materials are said to be "lightweight." But one pound of the lightest carbon composite still weighs as much as one pound of steel. The materials used to build *Daedalus* were special because of their combination of *high strength* and *low density*. This combination allows these materials to pack a lot of strength into relatively little weight.

Even though they used the most advanced materials, the builders of the plane couldn't make it any stronger. To make it stronger, they would have had

to use denser materials, which would have made the plane too heavy to fly the distance. Despite a wing span of 34 meters—almost as wide as a passenger jet—the plane weighed only 31 kilograms. It was so fragile that the flight could only succeed on a completely windless day. But succeed it did.

At 7:00 A.M. on April 23, 1988, *Daedalus* took off from Crete and arrived at Santorini about 4 hours later. Once there, the plane's fragility caught up with it. While being maneuvered to land on the beach, it was hit by a gust of wind. The plane broke into pieces, and pilot Kanellopoulus cooled off with a short unscheduled swim.

Langford still dreams of having another try at human-powered flight. "It would be great fun to try to make a plane using only the materials the ancient Greeks had," says Langford. It would be a tough job, though. "I think I could make one that would fly, using thin silk for the skin and bamboo for the skeleton," he says. "But without modern lightweight materials, you could never go as far as *Daedalus*." □

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Many early attempts at human-powered flight, like that made in this ornithopter, failed because of poor design and the lack of strong, low-density materials.

QUESTIONS

1. What two properties did the designer of *Daedalus* look for in the materials he needed to build a human-powered airplane?
2. Imagine you have been asked to design each of the following items:

   A. A raincoat
   B. A bullet-proof vest
   C. A milk bottle
   D. A fishing weight (sinker)

   What three properties would you look for when selecting the materials to make each item? What materials would you use to make each item? Write a reason for using each material you choose.