CHAPTER 1

Physics: The Science of Matter and Energy

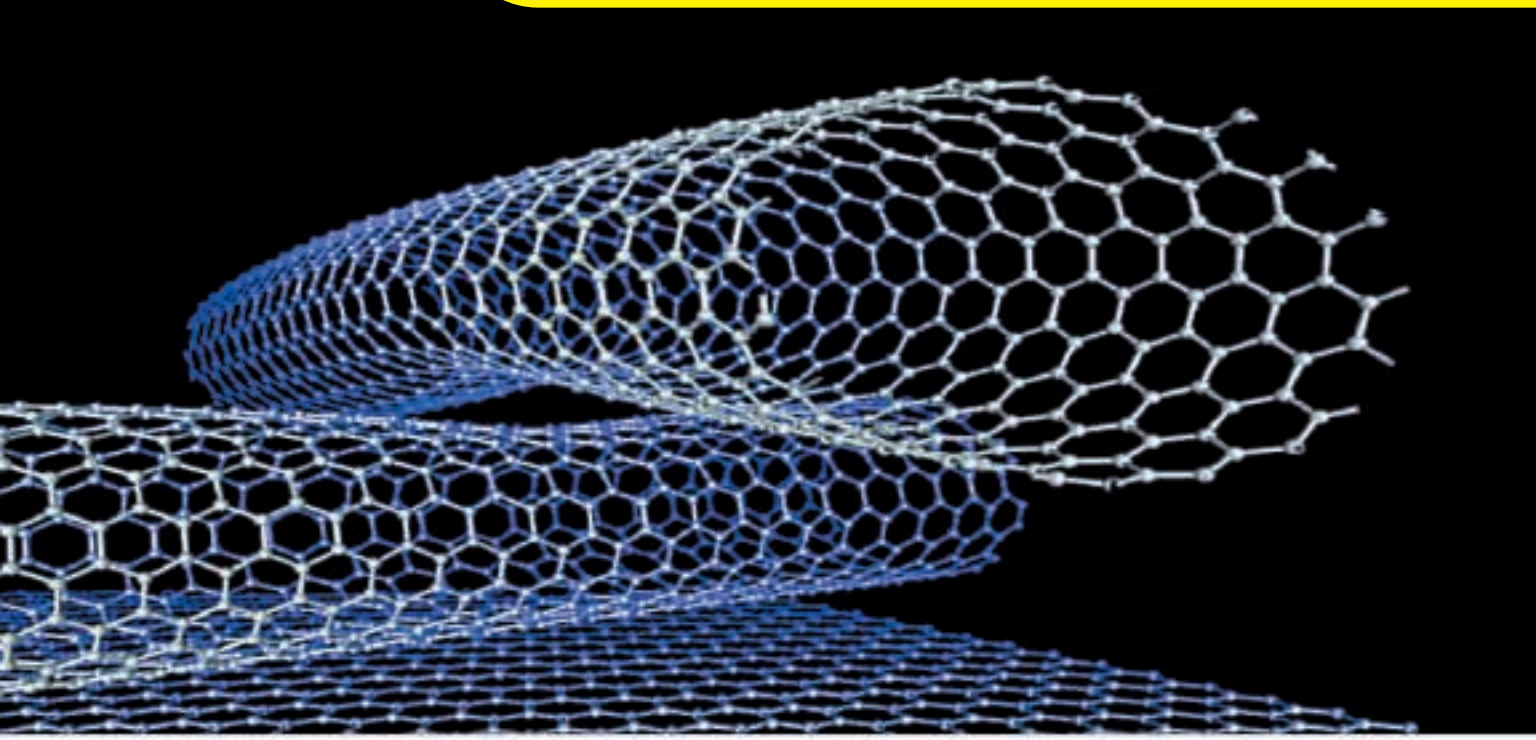

Image courtesy of IBM Research

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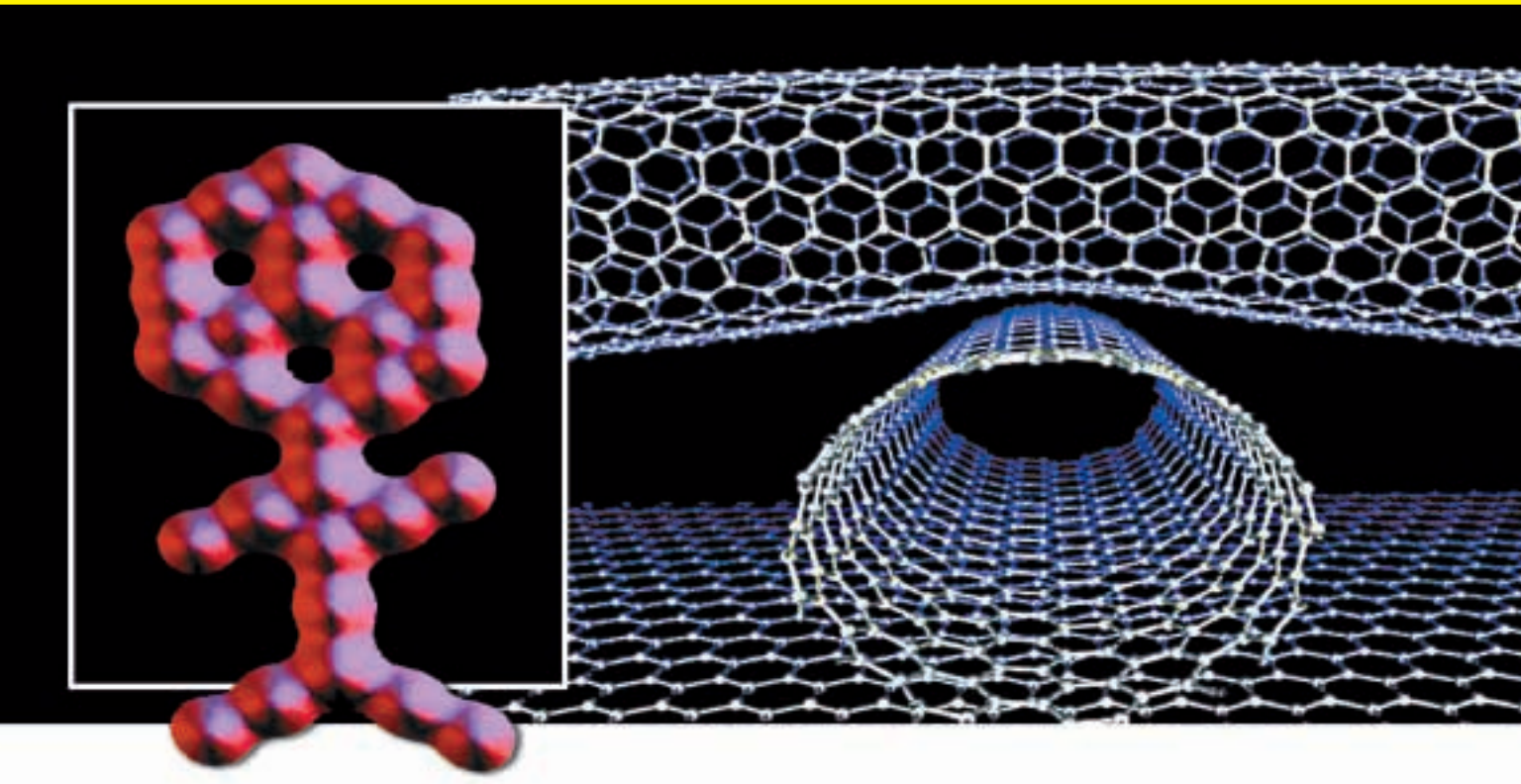
You are looking at two different views of a computer-generated model of a carbon nanotube — a straw on an atomic scale. Built one carbon atom at a time, this nanotube is a pioneering example of a new class of machines, so tiny they cannot be seen by the unaided eye, or even through most microscopes. Extraordinarily strong, yet only a few atoms in diameter, minuscule devices like this one may dramatically alter our lives in the years to come. In fact, some leading researchers believe the "nano age" has already begun. The inset "molecule man" made of 28 carbon monoxide molecules, and the "guitar" shown on page 10 are the results of researchers having fun with nanotechnology.

Nanotechnology, the emerging science and technology of building mechanical devices from single atoms, seeks to control energy and movement at an atomic level. Once perfected, nanotechnology would permit microscopic machines to perform complex tasks atom-by-atom, molecule-by-molecule. Imagine a tiny robotic device that could be programmed to produce specific products, like paper or steel, simply by extracting the required atoms from the atmosphere, in much the same way a potato plant absorbs nutrients from the soil, water, and air, and reorganizes them to create more potatoes.



Imagine if a machine could produce diamonds by rearranging atoms of coal or produce fresh water by coupling atoms of hydrogen and oxygen. What if such a machine could be programmed to clean the air by rearranging atoms in common pollutants, or heal the sick by repairing damaged cells? It is difficult even to begin to understand the impact such technology could have on our everyday lives, and on the countless chemical, biological, and physical relationships and processes that govern our world. However, one thing is certain: nanotechnology represents a new way of harnessing and transforming matter and energy, making it an important application of the science we call physics.

Throughout this course you will be involved in the processes of doing physics. You will be asking questions, forming hypotheses, designing and carrying out investigations, creating models and using theories to explain your findings, and solving problems related to physics. In short, you will be learning to think like a physicist. The activities in this course will be carried out at many levels of sophistication. In science, as well as in other disciplines, the simplest questions and investigations often reveal the most interesting and important answers.

Web Link

www.mcgrawhill.ca/atlphysics

To learn more about nanotechnology and view pictures of nanomachines, go to the above Internet site and click on **Web Links** to find out where to go next.

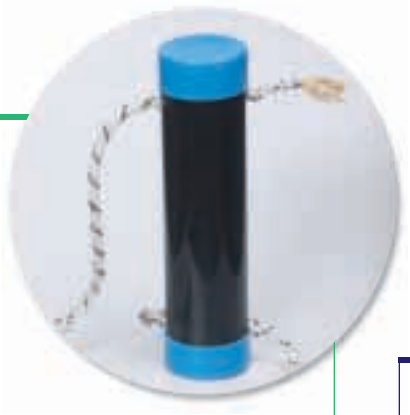
MULTI LAB

Think Physics!

TARGET SKILLS

- **Predicting**
- **Hypothesizing**
- **Performing and recording**
- **Modelling concepts**
- **Analyzing and interpreting**
- **Communicating results**

An important part of physics is creating models that allow us to develop explanations for phenomena. Models are helpful in making predictions based on observations. Try the following labs, creating your own models and making your own predictions based on what you already know. Keep these definitions in mind as you proceed.



Black Box

Pull the strings on the black box and observe what happens. Try several combinations, noting the motion and tension of the strings, any noises you hear, and anything else that strikes you. Record your observations.

1. Based on your observations, draw a model showing how you think the strings are connected inside the black box.
2. Test the accuracy of your prediction by once again pulling the strings on the black box.
3. How can this experiment be used to explain the process of scientific inquiry?

Beach Ball

With a partner, observe what happens to a beach ball when you throw it back and forth while applying various spins. Record your observations.

1. Describe the effects of each spin.
2. Draw a model representing what you observed.

Van de Graaff Generator

Place scraps of paper from a 3-hole punch onto the Van de Graaff generator as shown. Switch on the generator and observe what happens. Record your observations.

1. Based on your observations, draw a model showing what happened to the paper.

Super Ball

Drop a super ball from a specific height. Conduct several trials, changing variables like the initial velocity of the ball and its rate of spin. Record your observations. Then, develop rules that will allow you to predict whether the ball, based on its initial velocity and rate of spin, will bounce to a height above its starting point.

1. Test your predictions.
2. Describe the motion of the super ball using a model about the conservation of energy.

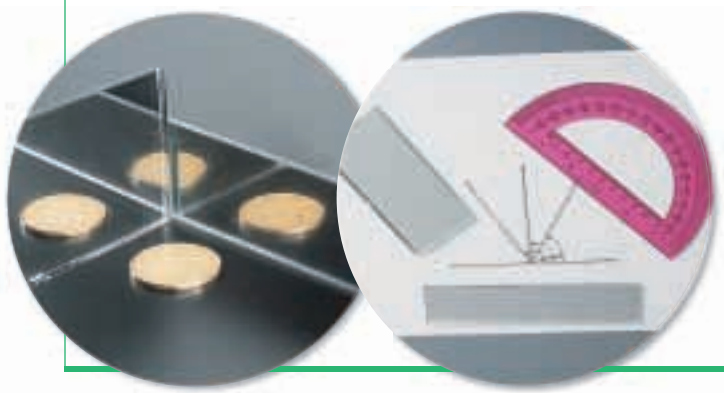
Radiometer

Shine a light on the radiometer and observe what happens. Repeat the process using a hair dryer on cool and hot settings. Record your observations.

1. What causes the vanes to spin? Formulate a hypothesis.
2. How was the energy transferred?
3. What similarities exist between heat and light?
4. Test your hypothesis.

Multiple Images with Two Plane Mirrors

Use a protractor to create a template similar to the one shown. Set up the mirrors and coin as shown. Then, create a table like this one. Count the number of images you see when the mirrors are set to specific angles. Record your observations.



Number of objects	Angle between mirrors	Number of images
1	180°	
1	120°	
1	90°	
1	60°	

1. Develop a mathematical equation that predicts the number of images that will appear when the angle between the plane mirrors is known. Hint: there are 360° in a circle.

Web Link

www.mcgrawhill.ca/links/atlphysics

Go to the above web site for other Quick Labs to help you get started.