



CHAPTER CONTENTS

Multi-Lab	
Predicting Motion	125
4.1 Inertia	126
4.2 Common Forces	130
Investigation 4-A	
Interactions of Objects	134

The forest of steel and cables shown here manipulates enormous amounts of mass by exerting huge forces with intricate precision. Rebuilding a city after a natural or political disaster requires hauling, lifting, and fastening millions of kilograms of concrete and steel. The technology that enables societies to build and rebuild structures at a breathtaking rate is rooted in an understanding of forces that dates back more than 400 years.

The inset photograph provides a close look at one of the hundreds of cranes used to build the high-rise buildings of a large city. The crane must be relatively easy to assemble and take apart. At the same time, it must be capable of lifting great masses and moving them to specific places within a new building's perimeter. The crane's slender arm belies its tremendous strength. By controlling the movement of a series of massive counterweights, the crane operator can guide the crane to every corner of the growing structure.

The ability to lift, balance, and move objects from feather-light sheet music to massive steel girders requires forces. Chapter 4 explores the development of the concept of force. You will consider the relationship between force and motion and then examine some common forces.

TARGET SKILLS

- Predicting
- Analyzing and interpreting
- Communicating results

Marbles

What will happen when you roll a marble horizontally across the floor? First, predict what will happen to the marble after it leaves your hand. Using a diagram, explain your prediction to your partner. Now, try the experiment.

**Analyze and Conclude**

1. Was your prediction correct?
2. Provide a reasonable explanation for the results.

Thinking about Space

Imagine that you are in a spaceship out in intergalactic space, very far away from any stars. You fire the ship's rockets for a while and then shut them down.

Analyze and Conclude

1. Describe the motion of your spacecraft after you turn the engines off.
2. Explain your answer to your partner using diagrams and a written explanation.
3. Discuss the possibilities with your partner and try to agree on a reasonable answer.

Tossing a Coin

Toss a coin vertically up into the air with a quick motion of your hand. Predict the motion of the coin from the moment it leaves your fingers. Draw a diagram that illustrates your prediction and explain it to your partner. If you and your partner do not agree, make separate predictions. Try the experiment and carefully observe the outcome.

**Analyze and Conclude**

1. Attempt to explain why the coin follows the path it does.
2. If you and your partner do not agree on an explanation, try to find a flaw in one of the explanations.

Air Table

What will happen if you tap on a puck that is lying on an air table or on a cart on an air track? Make a prediction then justify your answer to your partner using a diagram. Carry out the experiment.

**Analyze and Conclude**

1. Was your prediction correct?
2. Explain the results.