SCILINKS.
www.scilinks.org
Topic: Forces
Code: HF60604

FORCE DIAGRAMS

When you push a toy car, it accelerates. If you push the car harder, the acceleration will be greater. In other words, the acceleration of the car depends on the force's *magnitude*. The direction in which the car moves depends on the *direction* of the force. For example, if you push the toy car from the front, the car will move in a different direction than if you push it from behind.

Force is a vector

Because the effect of a force depends on both magnitude and direction, force is a vector quantity. Diagrams that show force vectors as arrows, such as **Figure 3(a),** are called *force diagrams.* In this book, the arrows used to represent forces are blue. The tail of an arrow is attached to the object on which the force is acting. A force vector points in the direction of the force, and its length is proportional to the magnitude of the force.

At this point, we will disregard the size and shape of objects and assume that all forces act at the center of an object. In force diagrams, all forces are drawn as if they act at that point, no matter where the force is applied.

A free-body diagram helps analyze a situation

After engineers analyzing a test-car crash have identified all of the forces involved, they isolate the car from the other objects in its environment. One of their goals is to determine which forces affect the car and its passengers. **Figure 3(b)** is a free-body diagram. This diagram represents the same collision that the force diagram **(a)** does but shows only the car and the forces acting on the car. The forces exerted *by* the car on other objects are not included in the free-body diagram because they do not affect the motion of the car.

A free-body diagram is used to analyze only the forces affecting the motion of a single object. Free-body diagrams are constructed and analyzed just like other vector diagrams. In Sample Problem A, you will learn to draw free-body diagrams for some situations described in this book. In Section 2, you will learn to use free-body diagrams to find component and resultant forces.

Quick Lab

Force and Changes in Motion

MATERIALS LIST

- **1 toy car**
- **1 book**

Use a toy car and a book to model a car colliding with a brick wall. Observe the motion of the car before and after the crash. Identify as many changes in its motion as you can, such as changes in speed or direction. Make a list of all of the changes, and try to identify the forces that caused them. Make a force diagram of the collision.

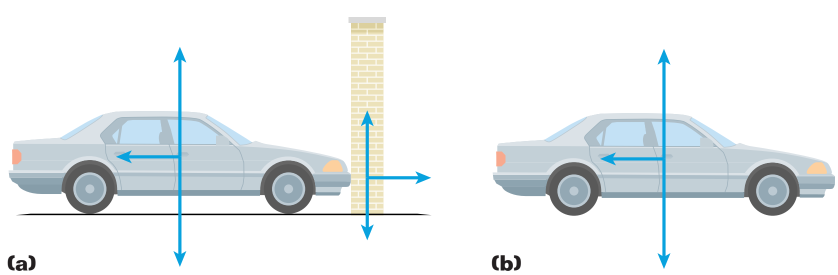

Figure 3
(a) In a force diagram, vector arrows represent all the forces acting in a situation. **(b)** A free-body diagram shows only the forces acting on the object of interest—in this case, the car.