

SAMPLE PROBLEM A

STRATEGY Drawing Free-Body Diagrams

PROBLEM

The photograph at right shows a person pulling a sled. Draw a free-body diagram for this sled. The magnitudes of the forces acting on the sled are 60 N by the string, 130 N by the Earth (gravitational force), and 90 N upward by the ground.



SOLUTION

1.

Identify the forces acting on the object and the directions of the forces.

- The string exerts 60 N on the sled in the direction that the string pulls.
- The Earth exerts a downward force of 130 N on the sled.
- The ground exerts an upward force of 90 N on the sled.

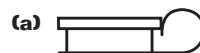


In a free-body diagram, only include forces acting on the object. Do not include forces that the object exerts on other objects. In this problem, the forces are given, but later in the chapter, you will need to identify the forces when drawing a free-body diagram.

2.

Draw a diagram to represent the isolated object.

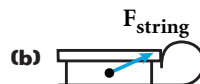
It is often helpful to draw a very simple shape with some distinguishing characteristics that will help you visualize the object, as shown in (a). Free-body diagrams are often drawn using simple squares, circles, or even points to represent the object.



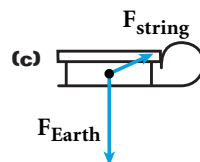
3.

Draw and label vector arrows for all external forces acting on the object.

A free-body diagram of the sled will show all the forces acting on the sled as if the forces are acting on the center of the sled. First, draw and label an arrow that represents the force exerted by the string attached to the sled. The arrow should point in the same direction as the force that the string exerts on the sled, as in (b).



When you draw an arrow representing a force, it is important to label the arrow with either the magnitude of the force or a name that will distinguish it from the other forces acting on the object. Also, be sure that the length of the arrow approximately represents the magnitude of the force.



Next, draw and label the gravitational force, which is directed toward the center of Earth, as shown in (c). Finally, draw and label the upward force exerted by the ground, as shown in (d). Diagram (d) is the completed free-body diagram of the sled being pulled.

