Name: _____ Date: _____ Skill and Practice

5E Free-Body Diagrams

Read:

One of the tools that we use to study forces is the free-body diagram. A free-body diagram shows all the force vectors acting on an object. This skill sheet will provide you with the opportunity to develop and interpret free-body diagrams. Refer to Table 5.1 in chapter 5 to learn the symbols you might need to use or interpret for the different forces you encounter.

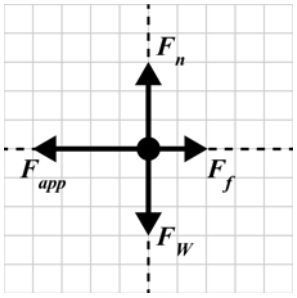
How to draw a free-body diagram:

1. Read the problem or scenario about an object.
2. Determine all the forces that act on the object. Table 5.1 in chapter 5 lists common forces.
3. Determine the direction of each force.
4. Draw the object as a point at the origin of a cartesian plane.
5. Draw each force as an arrow that starts at the origin and points in the correct direction.
6. Modify the length of each force arrow to correspond to its relative magnitude (strength).

Example:

1. You drag a heavy box to the left across a rough carpet. The box accelerates to the left. Draw a free-body diagram for the box.
   a. Determine all the forces that act on the box. The forces that act on the box are gravity (F_w), the normal force (F_n), frictional force (F_f), and the force you apply to drag the box (F_{app}).
   b. Determine the direction of each force. The force of gravity acts in the downward direction. The normal force acts in the upward direction. The force of friction acts against the motion of the box, so friction is directed to the right. The applied force accelerates the box to the left, so it acts in the leftward direction.
   c. Draw the object as a point at the origin of a cartesian plane. Draw each force as an arrow that starts at the origin, points in the correct direction, and has a length that corresponds to its relative strength. The box accelerates to the left, so the applied force is greater than the force of friction. There is no acceleration in the upward or downward directions, so the force of gravity and the normal force are equal in strength.

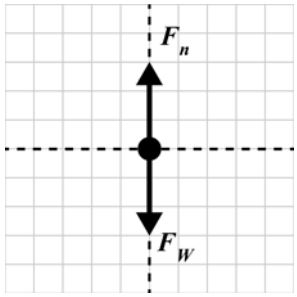
Solution:



Skill and Practice

Practice:

1. Below is a free-body diagram. Which scenario best matches it?

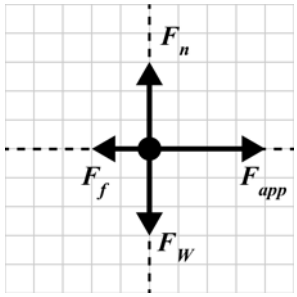


a. A rocket accelerating upwards into the sky.

b. A book at rest on a tabletop.

c. An acorn falling from an oak tree.

2. Below is a free-body diagram. Which scenario best matches it?



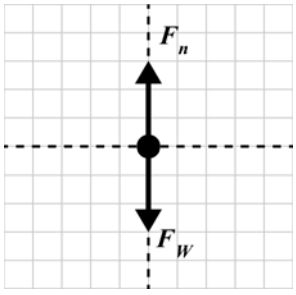
a. A football flies through the air towards its peak after being punted.

b. A skater coasts to a stop in the rightward direction.

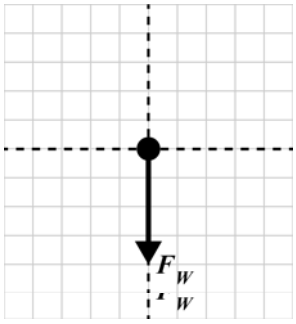
c. A book accelerates to the right while being pushed rightward across a rough desktop.

3. A rock is free-falling after being dropped from a cliff. Neglect air resistance. Which of the following shows what the free-body diagram should look like?

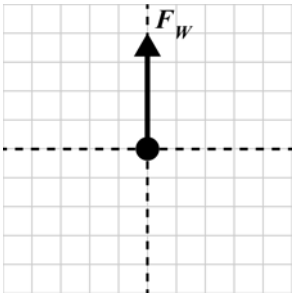
a.



b.

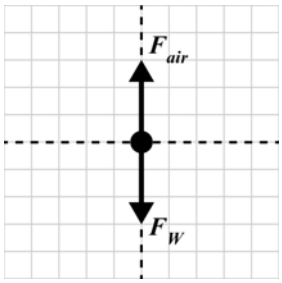


c.

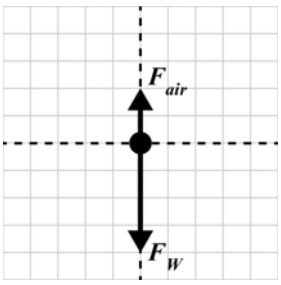


4. A sky diver is falling with a constant velocity. Considering air resistance, which of the following shows what the free-body diagram should look like?

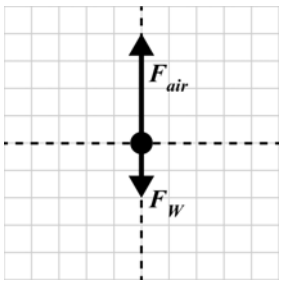
a.



b.

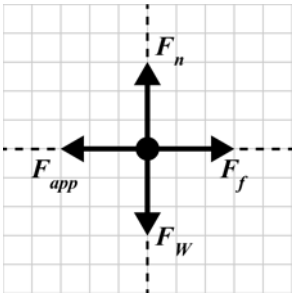


c.

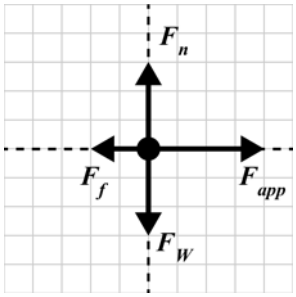


5. A force is applied to the right to drag a sled across loosely packed snow. The sled accelerates to the right. Which of the following shows what the free-body diagram should look like?

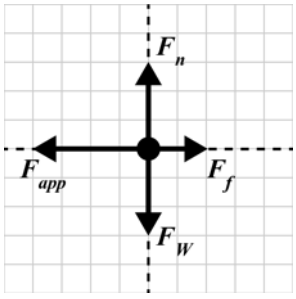
a.



b.

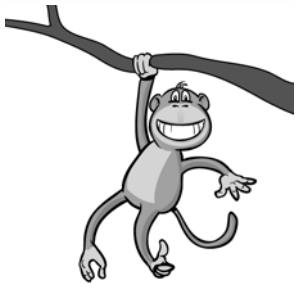


c.



a. b. c.

6. A monkey hangs motionless by one arm from a tree branch. Draw the free-body diagram.



7. A hockey puck glides to the left on the ice and slows down. Draw the free-body diagram.