Name _____ Class _____ Date _____

CHAPTER 12 Matter in Motion

SECTION 2

What Is a Force?

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is a force?
- How can a force be measured?
- How do balanced and unbalanced forces affect objects?

California Science Standards

8.2.a, 8.2.b, 8.2.c, 8.2.d, 8.2.e

What Is a Force?

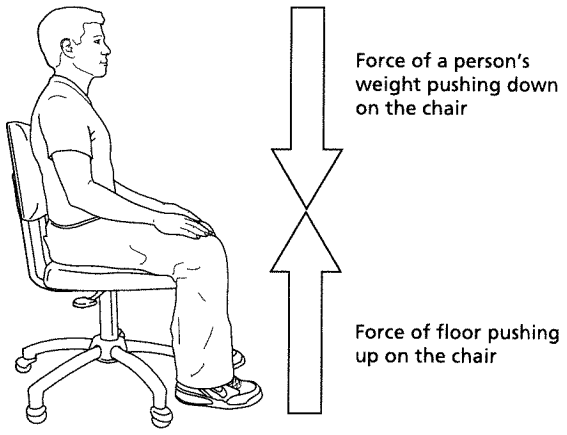
You probably hear people talk about force often. You may hear someone say, "That storm had a lot of force" or "Mrs. Larsen is the force behind the school dance." But what exactly is a force in science?

In science, a **force** is a push or a pull. All forces have two properties: direction and magnitude, or size. A **newton** (N) is the unit that describes the magnitude of a force.

Forces act on the objects around us in ways that we can see. If you kick a ball, the ball receives a push from you. If you drag your backpack across the floor, the backpack is pulled by you.

Forces also act on objects around us in ways that we cannot see. For example, in the figure below, a student is sitting on a chair. What are the forces acting on the chair?

The student is pushing down on the chair, but the chair does not move. Why? The floor is balancing the force by pushing up on the chair. When the forces on an object are balanced, the object does not move.



A person sitting on a chair

STUDY TIP

Brainstorm As you read, think about different objects, inside and outside. What forces are affecting them? How do the forces affect them?

CALIFORNIA STANDARDS CHECK

8.1.a Students know a force has both direction and magnitude.

1. List What two properties do all forces have?

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TAKE A LOOK

2. Explain When an object is not moving, what do you know about the forces acting on it?

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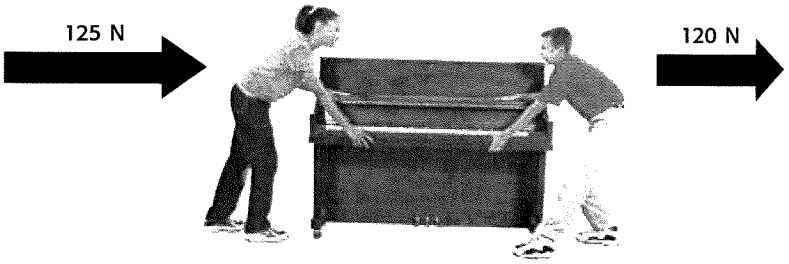
How Do Forces Combine?

As you saw in the example of the student sitting in the chair, often more than one force acts on an object. The result is the combined effect of the forces. This is called the **net force** on an object.

FORCES ACTING IN THE SAME DIRECTION



When forces act in the same direction, you add the forces to determine the net force. The net force will be in the same direction as the individual forces.

Suppose your music teacher asks you and a friend to move a piano, as shown in the figure above. You push the piano from one end and your friend pulls the piano from the other end. You and your friend are applying forces in the same direction. Adding the two forces gives you the size of the net force. The direction of the net force is the same as the direction of the forces.

$$125 \text{ N} + 120 \text{ N} = 245 \text{ N}$$

$$\textit{net force} = 245 \text{ N to the right}$$

FORCES ACTING IN OPPOSITE DIRECTIONS

When two forces act in opposite directions, you subtract the smaller force from the larger force to determine the net force.

Suppose two dogs are playing tug of war, as shown above. Each dog is exerting a force on the rope. In this case, the forces are in opposite directions. Which dog is winning the tug of war?

You can find the size of the net force by subtracting the smaller force from the bigger force. The direction of the net force is the same as that of the larger force:

$$120 \text{ N} - 80 \text{ N} = 40 \text{ N}$$

$$\textit{net force} = 40 \text{ N to the right}$$

TAKE A LOOK

3. Identify On the figure, draw an arrow showing the direction and magnitude of the net force on the piano. Make sure the length of the arrow represents the size of the force.

CALIFORNIA STANDARDS CHECK

8.2.b Students know when an object is subject to two or more forces at once, the result is the cumulative effect of all the forces.

4. Analyze In the example about moving the piano, what are the two forces that combine to form the net force?

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Critical Thinking

5. Predict What would happen if both dogs pulled the rope with a force of 85 N?

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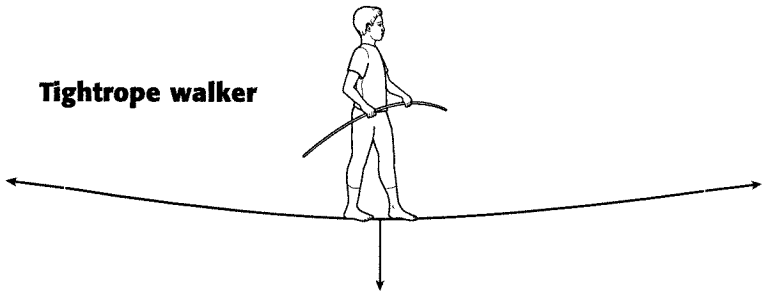
What Happens to an Object When Forces Are Balanced?

Objects that are not moving are said to be *static*. Balanced forces are acting on a static object. Because they are balanced, there is no change in the motion of the object. This means that the net force is 0 N. Remember, even when an object is static, forces are acting on it.

In many cases, the forces acting on static objects are tension or compression. *Tension* is a force that acts on an object when it is pulled or stretched. *Compression* is a force that is exerted when matter is pushed or squeezed.

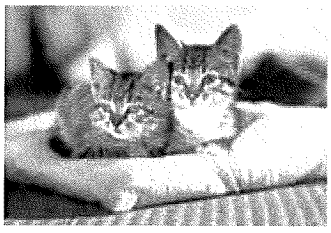
A rope bridge is a good example of an object that has both tension and compression acting on it. The figure below shows the compression and tension acting on a rope bridge.



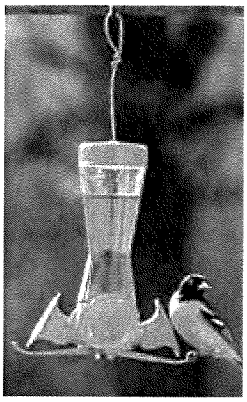
TAKE A LOOK

6. Identify Label each force arrow as "tension" or "compression."

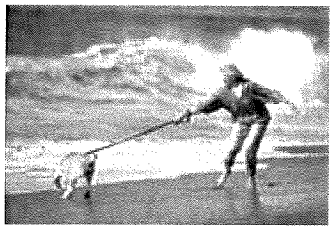
Static objects will not start moving when balanced forces are acting on them. The figure below shows other examples of balanced forces.



The kittens rest comfortably without moving. The downward force of their weight is balanced by the force of compression in the cushion pushing upward.



The bird feeder does not fall down because the weight of the bird and the bird feeder is balanced by the force of tension in the wire.



The dog cannot walk into the surf because the force that the dog is exerting is balanced by the tension in the leash held by the dog's owner.

CALIFORNIA STANDARDS CHECK

8.2.c Students know when the forces on an object are balanced, the motion of the object does not change.

7. Explain Look at the picture. Why doesn't the bird feeder fall to the ground?

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CALIFORNIA STANDARDS CHECK

8.2.e Students know that when the forces on an object are unbalanced, the object will change its velocity (that is, it will speed up, slow down, or change direction).

8. Identify Why does the velocity of an arrow change as it travels toward the target?

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What Happens to an Object When Forces Are Not Balanced?

If the forces acting on an object are not balanced, the forces are unbalanced. *Unbalanced forces* cause a change in the velocity of an object, which may be a change in speed, direction, or both. If unbalanced forces act on an object, the net force is not 0 N.

MOVING OBJECTS

Think about a soccer game for a moment. A soccer ball is kicked from player to player. When the soccer ball is kicked from one player to the next, the kick is an unbalanced force that sends the ball in a new direction with a new speed.

NONMOVING OBJECTS

Unbalanced forces cause nonmoving objects to start moving. A soccer ball that sits stationary in the middle of a soccer field is acted on by balanced forces. If you were to kick it, the ball would be acted on by unbalanced forces and would start moving. ☑

READING CHECK

9. Describe How can you make an unmoving object start moving?

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DIRECTION OF MOVEMENT

You have learned that forces have direction. You have also learned that unbalanced forces can cause a change in the direction of motion of an object.

Objects do not always move in the direction of an unbalanced force. When the space shuttle lands, it moves forward even though it has a parachute. The parachute exerts an unbalanced force pulling it backward. This force acts to slow the shuttle, not to change its direction.

TAKE A LOOK

10. Apply Concepts What do you know about the magnitude of the forces acting on the space shuttle during landing?

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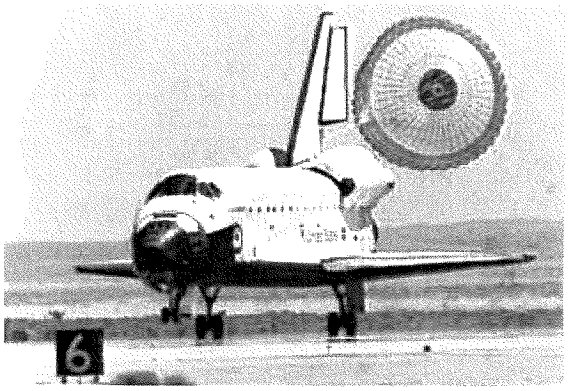

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Name _____ Class _____ Date _____

Section 2 Review

8.2.a, 8.2.b, 8.2.c, 8.2.d, 8.2.e

SECTION VOCABULARY

force a push or a pull exerted on an object in order to change the motion of the object; force has size and direction **net force** the combination of all the forces acting on an object	**newton** the SI unit for force (symbol, N)

1. Explain If there are many forces acting on an object, how can the net force be 0?

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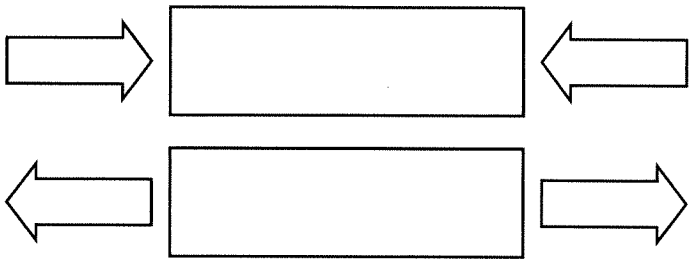
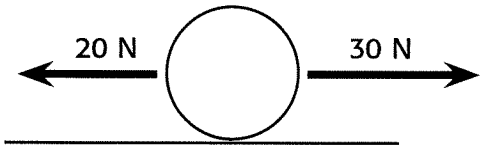
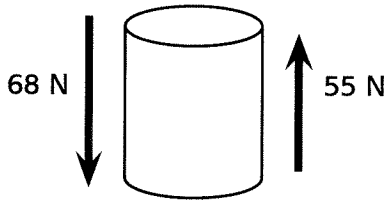
2. Complete Label the empty boxes with the type of force, tension or compression, shown by the direction of the arrows.



3. Calculate Determine the net force on each of the objects shown below. Don't forget to give the direction of the force.



net force = _____



net force = _____

4. Explain Describe how the objects shown above will be affected by the forces acting on them.

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5. Give Examples Give an example of an object that is under compression. In what way is the object under compression?

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