Power

READ

In science, work is defined as the force needed to move an object a certain distance. The amount of work done per unit of time is called power.

EXAMPLE ▶

Suppose you and a friend are helping a neighbor to reshingle the roof of his home. You each carry 10.0 bundles of shingles weighing 300. newtons apiece up to the roof which is 7.00 meters from the ground. You are able to carry the shingles to the roof in 10.0 minutes but your friend needs 20.0 minutes.

Both of you did the same amount of work (force × distance) but you did the work in a shorter time.

$$W = F \times d$$

$$W = 10 \text{ bundles of shingles}(300 \text{ N/bundle}) \times 7.00 \text{ m} = 21,000 \text{ joules}$$

However, you had more power than your friend.

$$\text{Power (watts)} = \frac{\text{Work (joules)}}{\text{Time (seconds)}}$$

Let's do the math to see how this is possible.

Step one: Convert minutes to seconds.

$$10 \text{ minutes} \times \frac{60 \text{ seconds}}{\text{minute}} = 600 \text{ seconds (You)}$$

$$20 \text{ minutes} \times \frac{60 \text{ seconds}}{\text{minute}} = 1,200 \text{ seconds (Friend)}$$

Step two: Find power.

$$\frac{21,000 \text{ joules}}{600 \text{ seconds}} = 35 \text{ watts (You)}$$

$$\frac{21,000 \text{ joules}}{1,200 \text{ seconds}} = 17.5 \text{ watts (Friend)}$$

As you can see, the same amount of work that is done in less time produces more power. You are familiar with the word *watt* from a light bulb. Is it now clear to you why a 100-watt bulb is more powerful than a 40-watt bulb?

PRACTICE

1. A motor does 5,000 joules of work in 20 seconds. What is the power of the motor?

2. A machine does 1,500 joules of work in 30 seconds. What is the power of this machine?

3. A hair dryer uses 72,000 joules of energy in 60 seconds. What is the power of this hair dryer?

4. A toaster oven uses 67,500 joules of energy in 45 seconds to toast a piece of bread. What is the power of the oven?

5. A horse moves a sleigh 1.00 kilometer by applying a horizontal 2,000-newton force on its harness for 45 minutes. What is the power of the horse? (Hint: Convert time to seconds.)

6. A wagon is pulled at a speed of 0.40 meters/sec by a horse exerting an 1,800-newton horizontal force. What is the power of this horse?

7. Suppose a force of 100 newtons is used to push an object a distance of 5 meters in 15 seconds. Find the work done and the power for this situation.

8. Emily's vacuum cleaner has a power rating of 200 watts. If the vacuum cleaner does 360,000 joules of work, how long did Emily spend vacuuming?

9. Nicholas spends 20 minutes ironing shirts with his 1,800-watt iron. How many joules of energy were used by the iron? (Hint: convert time to seconds).

10. It take a clothes dryer 45 minutes to dry a load of towels. If the dryer uses 6,750,000 joules of energy to dr the towels, what is the power rating of the machine?

11. A 1000-watt microwave oven takes 90 seconds to heat a bowl of soup. How many joules of energy does it use?

12. A force of 100 newtons is used to move an object a distance of 15 meters with a power of 25 watts. Find the work done and the time it takes to do the work.

13. If a small machine does 2,500 joules of work on an object to move it a distance of 100 meters in 10 seconds, what is the force needed to do the work? What is the power of the machine doing the work?

14. A machine uses a force of 200 newtons to do 20,000 joules of work in 20 seconds. Find the distance the object moved and the power of the machine. (Hint: A joule is the same as a Newton-meter.)

15. A machine that uses 200 watts of power moves an object a distance of 15 meters in 25 seconds. Find the force needed and the work done by this machine.