

Name: _____

Skill Sheet 5-B

Power



In science, work is defined as the force needed to move an object a certain distance. Suppose that you and a friend needed to move two 500-newton piles of potting soil to a garden that was 100 meters away. You accomplished this task in 10 minutes while your friend took 30 minutes. Both of you did the same amount of work (force \times distance), but you did the work in a shorter amount of time. The amount of work done per unit of time is called power. In the example, you had more power than your friend. This skill sheet will give you practice with how to calculate power.

1. What is power?

Suppose you and a friend are helping a neighbor to re-shingle 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 \times 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?

2. Solving problems

Solve the following problems using the power and work equations. The first problem is done for you.

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

$$\text{power} = \frac{\text{work}}{\text{time}} = \frac{5000 \text{ joules}}{20 \text{ sec}} = \frac{250 \text{ joules}}{\text{sec}} = 250 \text{ watts}$$

2. A machine does 1,500 joules of work in 30 seconds. What is the power of this machine?
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3. A horse moves a sleigh 1.00 kilometer by applying a 2,000 newton force on its harness for 45 minutes. What is the power of the horse? (Hint: Convert minutes to seconds.)
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4. A wagon is pulled at a speed of 0.40 meters per second by a horse exerting a horizontal force of 1,800 N. What is the power of this horse?
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5. Suppose a force of 100 N is used to push an object a distance of 5.0 meters in 15 seconds. Find the work done and the power for this situation.
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6. A force of 100 N 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.
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7. 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?
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8. A machine uses a force of 200 N 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.)
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9. A machine that uses 200 watts of power moves an object a distance of 15.0 meters in 25.0 seconds. Find the force needed and the work done by this machine.
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