

Name: _____

Skill Sheet 8-B

Electrical Power



Which appliance in your kitchen uses the most power? The equation for electrical power is the tool you can use to answer this question. This skill sheet will help you sharpen your skills at calculating electrical power and analyzing the voltage, current, and power associated with electric circuits.

1. What is electrical power?

Power is the rate at which work is done or how much energy is being used per unit time. When you work with machines, power is calculated by dividing work by the amount of time it takes to perform the work. For electrical systems, the equation for power is:

$$\begin{aligned} \text{Current} \times \text{Voltage} &= \text{Power} \\ I \times V &= P \end{aligned}$$

This equation allows us to calculate the rate at which an appliance or other device is using energy or performing work.

The graphic below shows you why power is called a rate. The unit for voltage is joules per coulomb. The unit for current is coulombs per second. When you multiply voltage times current, the coulombs cancel so that the unit for power is joules per second.

$$\begin{array}{ccc} \text{Current} \times \text{Voltage} & = & \text{Power} \\ \downarrow & & \downarrow \\ \frac{\text{coulomb}}{\text{second}} \times \frac{\text{joules}}{\text{coulomb}} & = & \frac{\text{joules}}{\text{second}} \end{array}$$

2. The unit for electrical power

One joule per second is equal to one watt of power. The watt (W) is a familiar unit of power for most people. You can look at any appliance and see how many watts of power it uses. For example, the heating element on a coffee maker uses 1,050 watts of power. We can also say that the coffee maker has a power rating of 1,050 watts.

One watt of power represents one joule of energy being used per second of time.

$$\begin{aligned} \text{Power} &= \frac{\text{joules}}{\text{sec}} \\ 1 \text{ watt} &= \frac{1 \text{ joule}}{\text{sec}} \end{aligned}$$

The more watts of power a circuit or appliance has, the more energy it uses or the more work it can do per second of time. A 1,500-watt microwave oven can perform the same amount of work as a 900-W microwave; however, the rate at which the 1,500-watt microwave performs the work is faster. The 900-watt microwave takes more than one second to do the amount of work a 1,500-watt microwave can do in one second.

3. Practice problems

Complete the following problems. Be sure to show your work. The first problem has been done for you.

1. A toaster oven has a power rating of 750 W. If the oven heats a piece of pizza for 360 seconds, how many joules of energy have been used by the toaster oven?

$$\text{Power} = \frac{\text{joules of energy}}{\text{time}}$$

$$750 \text{ W} = \frac{\text{joules of energy}}{360 \text{ sec}}$$

$$750 \text{ W} \times 360 \text{ sec} = \text{joules of energy} = 270,000 \text{ joules}$$

2. The current flowing through an electric circuit is 9 amps. If the voltage in the same circuit is 120 V, what is the power of the circuit?

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3. A 7,200-watt electric clothes dryer operates with a current of 30 amps. What is the voltage associated with this circuit?

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4. A girl wants to build a radio that operates using a 9-volt battery. If the girl wishes the radio to function with 75 W of power, with what amount of current will she have to design her circuits?

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5. A CD player uses 85 joules of energy per second. If the voltage in the CD player is 170 V, what amount of current is required for the operation of player?

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6. You use your 60-watt DVD player to watch your favorite movie. If the player uses 324,000 joules of energy while playing the film, what is the running time of the movie?
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7. Your stereo has a power rating of 150 watts. Your friend buys a stereo with a power rating of 300 watts. If you both play your stereo for one hour, who will spend more money to listen to their music? Explain your answer.

8. The voltage supplied to household circuits is generally 120 V. However, individual circuits (circuits supplying the kitchen as opposed to the dining room, for example) differ in the amount of current they carry. What does that tell you about the amount of power operating in different household circuits? Why do you think household circuits are designed in this way?

4. Comparing electrical power and mechanical power

Power is a term that is used when you talk about machines that use electricity, like blenders, and mechanical machines, like pulleys. Look up the equation for mechanical power. Use this equation to answer the following questions.

1. Power can be calculated for electrical systems and mechanical systems. Write the equation for mechanical power. What are the units for mechanical power?

2. Compare the equations for electrical power and mechanical power. How are they alike and different?
