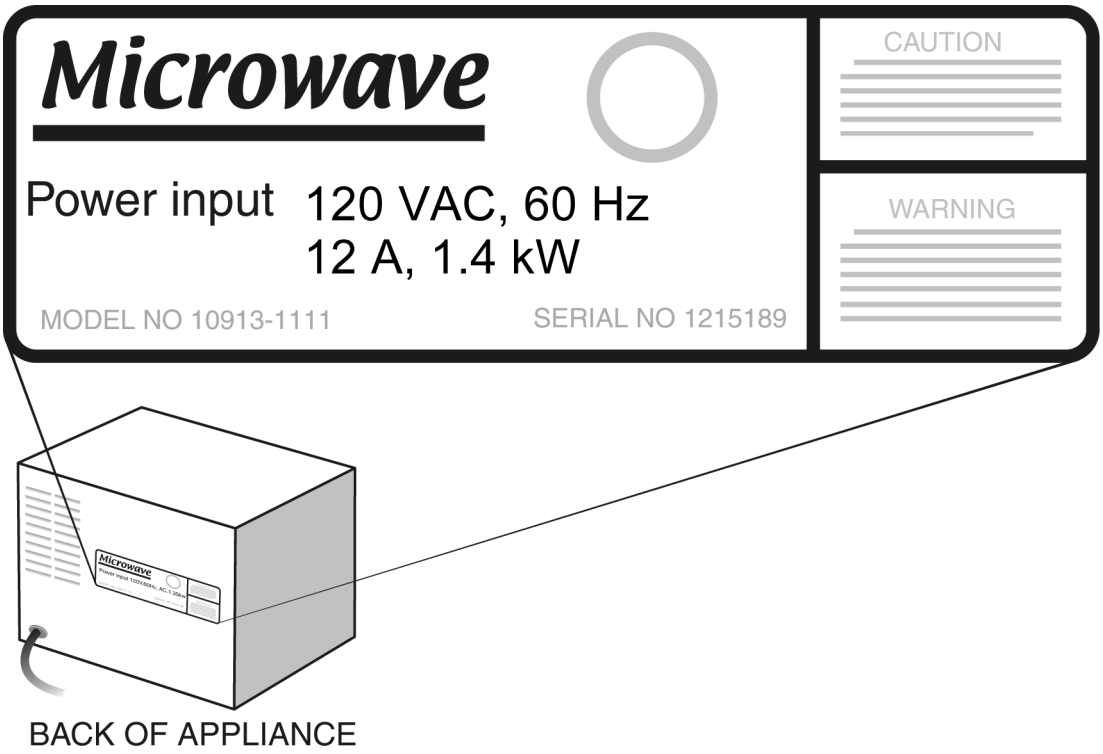
Name:

8.2 Work, Energy, and Power

Question: How much does it cost to use the electrical appliances in your home?

1 Find the power rating of home appliances

You will need to complete the first part of this Investigation at home. Your assignment is to find five electrical appliances that have a label with the device's power rating in watts or kilowatts. Some appliances you might investigate are a blender, coffee maker, toaster oven, microwave, television, hair dryer, space heater, room air conditioner, or an electric drill. The rating is often stamped on the back or the bottom of the appliance.



In the above example the power rating is 1.35 kW.

1. Fill out the first two columns of Table 1 as you find the power rating of each appliance. The second column should be in kilowatts.
2. Convert any power ratings listed in watts to kilowatts. To convert to kilowatts, divide the number of watts by 1,000. For example, 1500 watts is equal to 1500 ÷1000, or 1.5 kilowatts. Fill in the kilowatt column for each device.
3. Finally, estimate the number of hours the device is used each month. Assume that one month equals 30 days. If your coffee maker is used for a half hour each morning, you would calculate one-half hour times 30 days equals 15 hours per month. You may need to talk to other people in your home to get the most accurate estimate possible.
4. After you have filled in the estimated monthly use column, you are ready to complete the rest of the Investigation in class.

Table 1: Power rating, usage, and cost of household appliances

Appliance	Power rating in kilowatts	Estimated hours per month in use	Number kWh per month	Price per kWh	Total cost per month

2 Estimate the number of kilowatt-hours each appliance uses in a month

In order to determine how much your household spends each month to use some of your appliances, you must first calculate the number of kilowatt-hours expended per month.

To do so, simply multiply the power rating in kilowatts (from the second column) by the number of hours the appliance is used each month. If you use a 1-kilowatt toaster for five hours a month, you would multiply 1 times 5.

Write your answers in column 4 of Table 1, as shown in the sample below.

Appliance	Power rating in kilowatts	Estimated hours per month in use	Number kWh per month	Price per kWh	Total cost per month
Microwave	1.35 kW	22 hours	29.7		

3 Determine the monthly cost of using your appliances

Utility companies charge consumers for the number of kilowatt-hours of electricity they use each month. Many houses and apartments have a meter attached to the outside of the building. The meter uses a system of spinning disks to record how much electricity you use. Someone from the electric company reads the meters once each month.

Find out how much you pay per kilowatt-hour (or kWh). In some areas, one utility company provides all the electricity to an entire region, while in another places, several electric companies compete for customers.

a. Research your area and write the price per kilowatt-hour in column 5 of Table 1.

b. Calculate the amount of money your household spends to operate each appliance during one month. Multiply the kilowatt-hours per month by the price per kilowatt-hour in order to determine your cost.

4 Analyze your data

a. Compare your results with those of the other members of your group. List the three appliances from your group that had the highest power ratings in Table 2.

Table 2: Appliances with the highest power ratings

Appliance	Power rating in kilowatts

b. Think about the function of each appliance listed above. What kind of work is being done? In other words, electrical energy is converted into what other type(s) of energy?

c. Do you see any similarities in the kinds of work being done by the three appliances in Table 2? If so, what are they?

d. Suggest one practical way you or another group member could reduce your electricity bills.

e. Discuss the effect of climate on electricity use. What climate factors might influence which month has the peak electrical use in your area?

f. Name one other factor (not related to climate) that may influence which month has the highest electricity use in your area.

5 What do you buy from the electric utility company?

People often use the phrase "power plant" to refer to their local electric company. You may have heard people say that electric companies "sell power" to their customers, or that there was a "power shortage" in a particular area. Let's take a look at these phrases from a scientific perspective. What, exactly, do electric companies sell?

We know that electricity bills charge for the number of kilowatt-hours (or kWh) used per month.

Let's first change kilowatt-hours to the units of watts and seconds:

$$1 \text{ kilowatt} \cdot \text{hour} \times \frac{1000 \text{ watts}}{\text{kilowatt}} = 1000 \text{ watt} \cdot \text{hours}$$

$$1000 \text{ watt} \cdot \text{hour} \times \frac{3600 \text{ seconds}}{\text{hour}} = 3{,}600{,}000 \text{ watt} \cdot \text{seconds}$$

(You may remember from previous study of fractions that a term appearing in both the numerator and denominator will cancel when the fractions are multiplied.)

Power is equal to the amount of work done per unit of time, or the amount of energy transferred in a circuit per unit of time. In specific units, a watt is equal to joules per second. We substitute the fundamental units of joules per second for watts.

$$3{,}600{,}000 \left(\frac{\text{joules}}{\text{second}} \right) \cdot \text{seconds} = ?$$

a. Which terms in the last equation will cancel?

b. After canceling the terms that appear in both the numerator and denominator, what is the fundamental unit that remains?

c. Is the remaining unit a measure of energy, work, or power?

d. Do electric companies sell energy, work, or power?