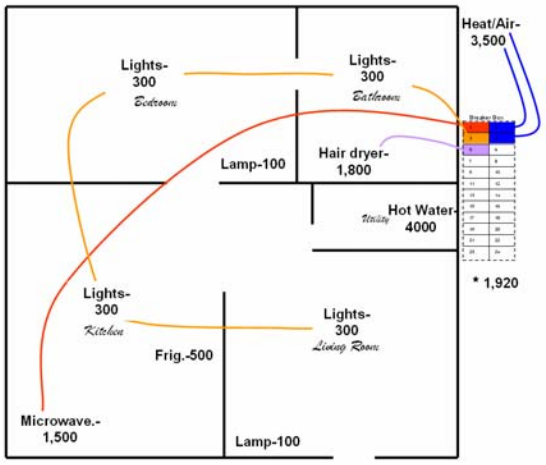
Teacher Notes- "Electricity- Watts, Wire, And Watt It Costs"

How well do you suppose your students understand Watts? Sure, some might have notice the Wattage labels on devices, but that by itself doesn't mean they understand the concept of Watts, or how it factors into an electric bill. That's what this lessons intends to clear up. In it, they will compare the Wattages of different devices, learn how to wire a home (on paper, at least), and then calculate the annual cost of several devices around their home.



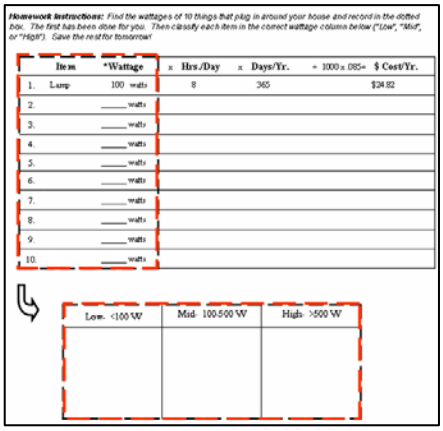
This lesson will create an awakening experience for every student. They've been told over and over to turn off the lights. But they don't care because they don't see the importance. In this activity it's their light, and their families' electricity bill we're now talking about, so it means something.

Materials per student:
Student Handout (see last page)
Colored pencils
Calculator

Additional Teacher Materials:
PowerPoint-Electricity (see p. 7)

Beforehand:

1. For homework the previous day, give students the handout with instructions to go home and find the Wattages of any 10 things that plug in and to write them on the handout. Use the PowerPoint "Homework Explanation-How To Find Wattages" to explain to them how to do this.



   The other part of the homework is to classify each device as being "Low" (<100 W), "Mid" (100-500 W), or "High" (<500 W). These sections are marked with dashed lines on the handout so students know exactly what to do and where to stop. They'll complete the rest in class the next day.

2. Put out colored pencils and calculators for students, if you're providing them.

3. This *can* be a one-day activity, but 1 ½ - 2 days will allow decent class discussion and give you plenty of time so you won't have to rush anything.

4. On your chalkboard write the 3 columns "Low", "Mid", and "High" in preparation for students putting their examples on the board (see step 2 below).

5. Print and cut enough copies of the list of appliances and Wattages (shown right) for each student to have 1.

Essentials
- Hot water heater- 4,000 W
- Heating/Air-3,500 W
- Lights-300 W /room
- Refrigerator-500 W
- 2 lamps-100 W (each)

Bathroom-choose at least 2
- Hair dryer-1,800 W
- Curling iron-1,200 W
- Straightener-200 W
- Shaver- 100 W
- Vanity light-300 W

Living Room-at least 6
- Telephone-1 W
- Computer/printer-150 W
- Printer-200 W
- Vacuum-1,300 W
- Stereo-100 W
- Aquarium-600 W
- Humidifier/Deh.-700 W
- Fan-150 W
- Clothes iron-1,000 W
- Television-300 W
- Heater (portable)-1,500 W
- Game system-50 W

Kitchen- at least 8
- Microwave oven-1,500 W
- Coffee maker-1,000 W
- Waffle iron-700 W
- Mixer-100 W
- Crock pot-150 W
- Toaster oven-1,500 W
- Popcorn popper-1,000 W
- Blender- 300 W
- Electric skillet- 1,500 W
- Toaster- 1,800 W
- Dishwasher-2,000 W
- Deep fryer- 1,800 W
- Garbage disposal-450 W
- Can opener-100 W
- Bread machine-600 W

Bedroom-at least 2
- Alarm clock-10 W
- Telephone-1 W
- Electric blanket-100 W
- Air freshener-10 W

Utility
- Clothes washer-1,000 W
- Clothes dryer-3,500 W

Procedure:

1. As students come into class you'll overhear them talking about their Wattages. Most students were already somewhat familiar with the term "Watts", but don't yet really understand what it measures. The homework has made them curious how it is an alarm clock can use 10 Watts while a toaster of similar size uses 1,000.

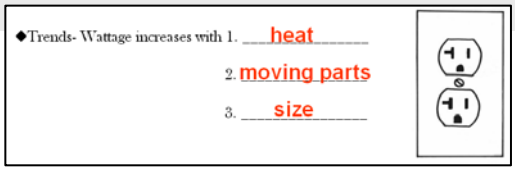
2. There are any numbers of ways to go over the Wattages students brought in,*[1] but the best, and most inclusive way, is to put examples on the chalkboard. Have 1/3 of class write an example of theirs in the "low" box, the next third put an example in the "medium", and the last third do the "high" group. What you'll be left with is a table that everyone in class created containing lots of good examples.

3. Spend a couple of minutes going over your examples on the board. Look at each column and notice how each "sounds", and any trends you might already notice.*[2] Compare with the next column and the next.*[3] There are a few examples on the PowerPoint that you can also mention (shown left). See if students notice the trends before you move into that section of the handout:

Low- <100 W	Mid- 100-500 W	High- >500 W
dvd player	television	toaster
telephone	mixer	vacuum
alarm clock	fan	microwave

"Look at these examples in the "high" group. They have their own feel. If I even took one (choose one) out and wrote it over here in the low, it just doesn't fit, does it? Now what do all these "highs" have in common? What do they do that makes them use so much electricity?

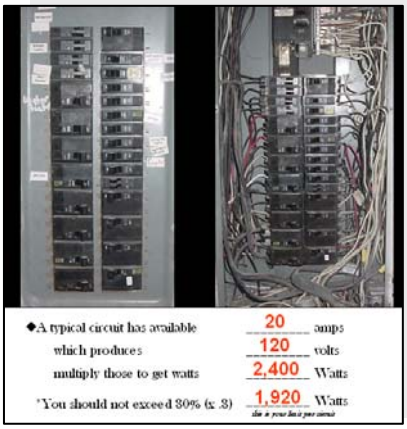
4. Click through the "Trends" answers on the PowerPoint showing why they need so much electricity- heat, moving parts, and size.



5. Now our attention shifts to circuits, which supplies the electricity for the appliances we've been talking about. PowerPoint slide #3 shows a picture of a breaker box. Show the first picture (the plain breaker box):

"How many of you have seen this somewhere in your home? (*hands raise*) This is called a breaker box, and it's full of breakers, or switches, that go to a different part of the house. Maybe you've had electrical work done on your house and someone had to turn off several breakers before they finally found the right one. You might remember that each time a breaker was turned off that lights or appliances in different rooms kept going off and then back on.

Now, attached to this breaker is a black wire (*show the second picture*), called the "hot". It carries electricity to a room through that wire.



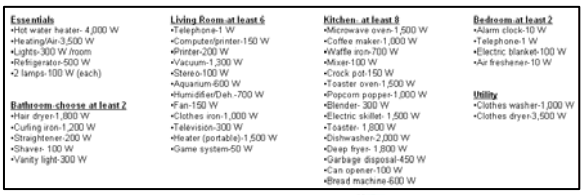
Let's say this breaker right here (*randomly pick one*) is for a bedroom on the other side of the house. That means this black wire leaves the breaker, goes up the wall cavity, runs across the attic all the way to the other side of the house, drops down a wall cavity down there, and then to the outlet. And that's just one breaker. Each one of these goes to a different part of the house. Altogether, there are hundreds of feet of wiring in your home!"

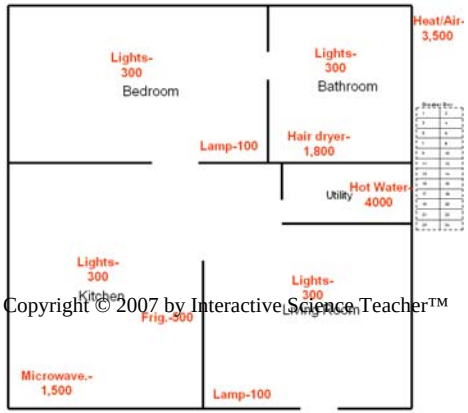
Caution students to NEVER try to remove their breaker box cover at home or play with circuit breakers.

6. On the back side of the student handout we need to establish how much current is available on each circuit. Lead students through this with the PowerPoint, but let them use their calculators to tell you the correct numbers first before showing them. The limit for this problem is 1,920 Watts.*[4]

◆A typical circuit has available	20	amps
which produces	120	volts
multiply those to get watts	2,400	Watts
*You should not exceed 80% (x .8)	1,920 (this is your limit per circuit)	Watts

7. In the next section all of this comes together. Introduce them to their home in 10 years (shown below) on their handout and give them the list of appliances to choose from for each room (left).





8. Help students furnish their homes with the list of Essentials first- hot water, heat/air conditioning, lights, a refrigerator, and 2 lamps. Hot water is already listed for them in the utility room. The PowerPoint shows the rest, one at a

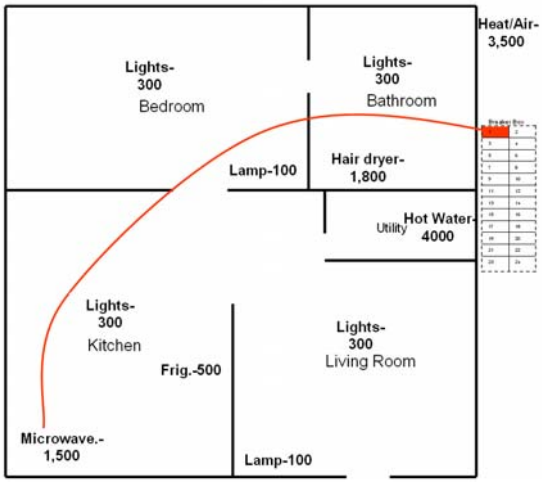
time, which students should also put on their handout. The heat/air is put outside because that's where those units usually are.

9. Notice that the rest of the rooms on the list of appliances have a certain number they have to include. The bathroom requires "at least 2" and the kitchen "at least 8". They can choose them all if they want, but they must have at least the minimum.

10. When clicking through the PowerPoint, stop when "Microwave" pops up (you'll notice a little stop sign appears in the lower-right corner- it tells you to stop because the next slide is where students begin wiring, and they still need about 5-10 more minutes before they're ready for that.)

11. Give students 5-10 minutes to furnish their homes by adding the things they want from the list.

12. After that it's time to wire homes. We'll begin with the microwave oven. Ask students how many Watts they can use per circuit (*2,400, but you shouldn't go past 1,920*).



"Now, that microwave oven uses 1,500 Watts. Hmm… we shouldn't go past 1,920. You know, there's not a lot of room left over. Especially when you remember it's in the kitchen, and most everything else in there uses at least a few hundred Watts also. Let's give one circuit completely to the microwave."*[5]

13. Have students choose a colored pencil and color in breaker #1 on their handout and then draw a line from it to the microwave using the same color. This represents the wire that goes from the breaker to the microwave.

14. Lights are next. Homes are typically wired with several rooms' lights on the same circuit, so that's what we'll do too. Color in breaker #3 (or any other; it really doesn't matter which one) and draw a line that loops from one set of lights to the next and next and next.

15. Let's do the heat/air next.

"How in the world we can provide it with 3,500 watts if there are only 2,400 Watts per circuit available.

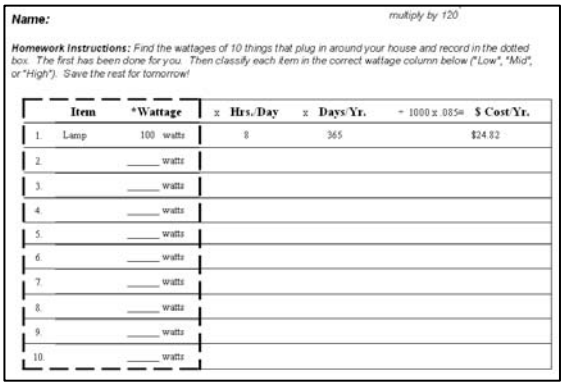
Can we use 2? Bingo! 2,400 + 2,400 = 4,800. That's exactly what we're going to do with the heat/air, and the hot water and clothes dryer. Have students color any 2 consecutive breakers*[6] (I chose #'s 2 and 4 on the PowerPoint) and draw those 2 lines to the heat/air."

16. Since we're already talking about high-demand devices, have students look around their home and see what else might concern them. They should notice the dishwasher and hair dryer. Let's run a dedicated line to them too. That way those will *always* run and won't interfere with anything else.

17. Before turning students loose to finish wiring their homes, do the living room together. Remember our spending analogy (Accessories #4)- fill a circuit until it's around 1,920 Watts. You'll actually want to stop well short of that if you have outlets on the same circuit because what if you want to plug in your 1,000 Watt vacuum?

18. If it's nearing the end of class, send it home with students to finish.

19. The last thing to do on the handout is back on the front side. It's a cost analysis table, and to many students this will be the most interesting part. Here they will calculate how much each device they scouted for homework costs their family per year. The first one (lamp) has been done for them as an example.



Name: *multiply by 120*

Homework Instructions: *Find the wattages of 10 things that plug in around your house and record in the dotted box. The first has been done for you. Then classify each item in the correct wattage column below ("Low", "Mid", or "High"). Save the rest for tomorrow!*

	Item	*Wattage	x Hrs./Day	x Days/Yr.	÷ 1000 x .085=	$ Cost/Yr.
1.	Lamp	100 watts	8	365		$24.82
2.		____ watts				
3.		____ watts				
4.		____ watts				
5.		____ watts				
6.		____ watts				
7.		____ watts				
8.		____ watts				
9.		____ watts				
10.		____ watts				

20. As you talk about how to calculate the cost, talk slowly and deliberately and use many examples. Students will catch on quickly if you do it this way. There are 3 columns:

- **<u>1. Hrs./Day</u>** This column is literally asking how many hours per day the device runs. It *doesn't* ask how many hours a day it's plugged in. Few objects run 24 hours a day. Put down a "ballpark" number. If it seems to run or be on about 1/3 of the time, that would 8 hours (as used in the example with the lamp).

    - For items that run less that one hour a day there are 2 things you can do: **1**. if it runs about 15, 30, or 45 minutes a day, that equals .25, .5, or .75 hrs.; **2.** any minute can be converted to hours by dividing by 60 (5 ÷ 60 = .08 hrs.).

  Another common mistake on this column is for students to assume that because toasters or a microwave oven or refrigerator or clothes washer is plugged in that it's using a thousand watts of electricity. Make sure they understand that for this column *we only need to know how many hours it actually runs per day.*

- **<u>2. Days/Yr.</u>** asks "about how days per year does this device run?" If it's used every single day, put down 365. If it seems like most days, then make it 300. And so on.

- **3a.** Divide that by 1,000 (to convert from Watts to Kilowatts).

- **3b**. Then multiply that by .085 (electricity costs about ¢8.5 a kilowatt where I live- Indiana) to get the final cost per year. Look at your last electric bill if you'd rather use your numbers.

21. A good follow-up activity to this one would be "Energy Consumption- Hi,Lo- Where Does It Go?". In it, students are given a list of appliances that they must classify as being "High", "Medium", or "Low" in terms of the Wattage each uses.

Accessories: Other sub-topics you can add for more length and depth.

- *[1] Suggestions:
  i. Start with a few students giving a few of their wattages.

  ii. Go room to room- "What about the kitchen? Let's hear some kitchen numbers. Did anyone check the microwave? 1,300 Watts. 1,500 Watts? WOW!"

  iii. Ask is anyone found anything interesting and see what you get. There's always a kid or two that found a welder or lava lamp.

- *[2] Take an item from the "low" group and write it in the "high" group and see if it fits: toaster, microwave, portable heater, vacuum, *vcr*….. (uh… that last one seems out of place).

  The first column can generally be described as small appliances around the house that have none or few moving parts. The "mid" group has moving parts. And the "high" group adds heat.

- *[3] Notice that a couple of hundred alarm clocks *still* don't use the same electricity as a toaster being used. Since we're pointing out large wattage appliances, this would also be a good time to ask if anyone has ever tripped a breaker. As they tell what happened, it will make a lot of sense what happened in this context. A circuit breaker is a safety device. When they trip, it may seem like a nuisance to have to reset them, but what they're preventing is you burning your house down. If they weren't there, you could draw unlimited current from an outlet, which would cause the wire in the wall to overheat and catch fire. A breaker that repeatedly trips is a sign that things need to be plugged in elsewhere or the home wiring needs to be upgraded.

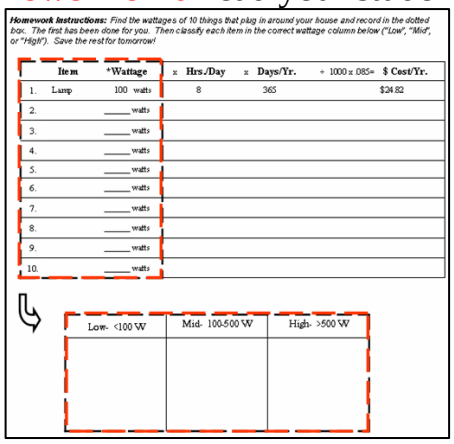
- *[4] Think of 1,920 Watts like a dollar limit. You've only got a certain amount you can "spend". You can spend them on several smaller things, or fewer larger things. Whatever you want. But you've only got that number to work with.

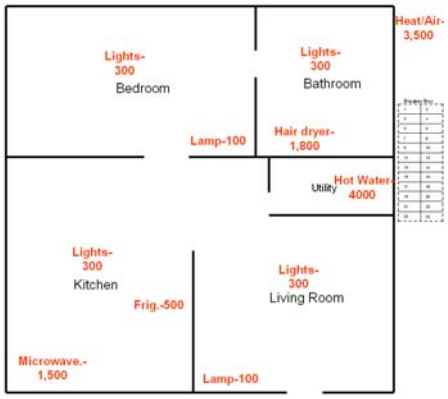
- *[5] This is how homes are wired today. A "dedicated circuit" is run for the microwave so that it will always run no matter what else is being used in the kitchen.

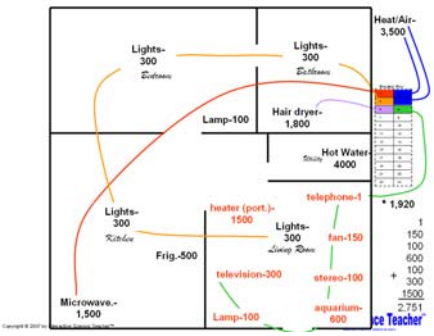
- *[6] "Do you remember that picture of the breaker box a few slides ago? Did you notice that several breakers were double-wide? Now you know why!"

Come back and visit InteractiveScienceTeacher.com to upgrade this lesson with:

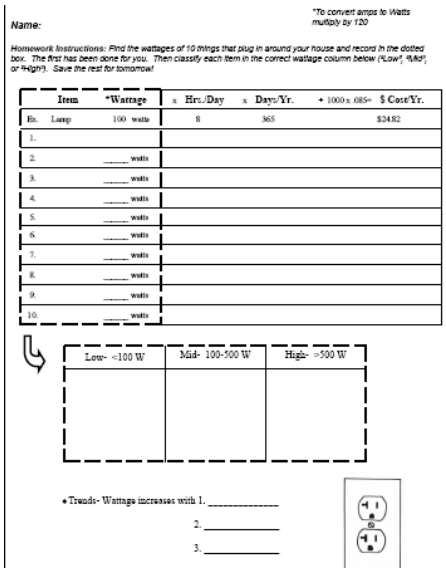
PowerPoint- lead your students through the lesson click-by-click

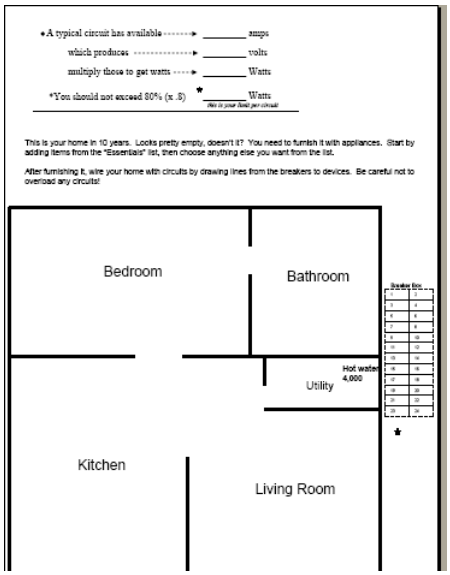






Student Handout





***Quick*Notes**

Teacher *Quick* Notes- "Electricity"

Material: per student:
Student Handout
Colored pencils
Calculator

Procedure:

1. Go over the Wattages students brought in for homework. Have them classify on the board inside a "low", "medium", and "high" box.
2. Click through the "Trends" answers on the PowerPoint showing why they need so much electricity- heat, moving parts, and size.
3. Move onto the back side of the student handout and work out how much current is available on each circuit.
4. Help students get started furnishing their homes- hot water, heat/air conditioning, lights, a refrigerator, and 2 lamps.
5. Give students 5-10 minutes to furnish their homes by adding the things they want from the list.
6. After that it's time to wire homes. Begin with the microwave oven.
7. Have students choose a colored pencil and color in breaker #1 on their handout and then draw a line from it to the microwave using the same color. This represents the wire that goes from the breaker to the microwave.
8. Lights are next. Homes are typically wired with several rooms' lights on the same circuit, so that's what we'll do too.
9. Do the heat/air next.
10. "Wire" the living room together and then let students finish on their own.
11. Go back to page 1 and help students begin figuring out how much it costs per year to run each appliance.