Family edition

Light Show Lab: Watts, Plugs and the Bill

Ages 10-13 · about 45 minutes, in one sitting

Your child works out what it costs to keep a house full of holiday lights on, in LED and in old glass bulbs, and finds out why too many old strings trip a breaker. It is real arithmetic with a real bill at the end.

What you need

- A computer or Chromebook with a current browser.
- The link: mytekdev.com/try/lightshowlab?lesson=watts-plugs-and-the-bill&ref=fam-lightshowlab-2. No account, no email and nothing to install.
- A calculator, and your own electric bill if you have one handy.

Before you start: try it once yourself

Open mytekdev.com/try/lightshowlab?lesson=watts-plugs-and-the-bill&ref=fam-lightshowlab-2. A short guide opens over the app. The house has 1,488 bulbs up, and a line under it reads "208 watts on 1 plug. One circuit carries it."

1. **The list.** Open `List`. In LED: 208 watts, $6.75 for a season. In old bulbs: 1,394 watts, $45 for a season. Under them: "1,488 bulbs in 32 sets, on 1 plug and 1 circuit." A table lists each part of the house with its feet, sets and watts.
2. **Old bulbs.** Press `Old bulbs`. The line under the house becomes a warning: "13 plugs, and this house has 2 outdoor outlets." Click it for the reason: only a few old sets can plug end to end before the limit on the tag, 210 watts.
3. **The season.** Three boxes set the season: 6 hours a night, 30 nights, 18 cents a kilowatt-hour. Change the hours to 3 and both costs halve, to $3.38 and $23.
4. **All out.** Open `Lights` and press `All out`: lights go on everything, 1,969 bulbs in 42 sets. In LED that is 279 watts on 2 plugs, $9.04 a season. In old bulbs it is 1,948 watts on 17 plugs, $63 a season, and the line under the house reads "1,948 watts is too much for one circuit. This needs 2."

> The app rounds what it shows and calculates with the tenths. 208 watts is 208.4, so a child who uses 208 gets $6.74 and the app says $6.75. Accept either. Costs of ten dollars or more are shown to the whole dollar.

The ideas, in plain words

A watt measures how fast energy is used. The electric company bills for energy, in kilowatt-hours: 1,000 watts for one hour. So the chain is watts, divided by 1,000, times hours, times nights, times the price. The app uses 18 cents, close to the United States average, and children can change it.

An old glass bulb makes light by heating a wire, and most of its energy leaves as heat. An LED makes the same light with far less. For this house the old bulbs draw about 6.7 times the watts of the LED ones, so they cost about 6.7 times as much to run.

The limits are real ones. A common household circuit is 15 amps at 120 volts, which is 1,800 watts, and electricians keep a load that stays on for hours under 80 percent of that, 1,440 watts. A thin-wire light string carries a tag with its own limit, 210 watts here, which is why old sets cannot all plug end to end. The numbers for sets and bulbs are typical ones: the tag on a real box is the authority.

Common mistakes: multiplying watts by the price without converting to kilowatts; thinking more bulbs always means more plugs (in LED, 32 sets run from one); thinking a breaker trips because of the number of plugs and not the watts.

Do it together

1. Open mytekdev.com/try/lightshowlab?lesson=watts-plugs-and-the-bill&ref=fam-lightshowlab-2 together and ask for a guess: what does a month of evenings cost for this house? Then open `List`.

   > **You'll know it worked when:** Two big numbers: 208 watts in LED and 1,394 watts in old bulbs.

2. Work the LED cost on paper: 0.208 kilowatts × 6 hours × 30 nights × $0.18.

   > **If you get stuck:** Divide the watts by 1,000 first. The price is for a kilowatt-hour, not a watt.
   >
   > **You'll know it worked when:** About $6.74. The app says $6.75 because it keeps the tenths of a watt.

3. Do the same for the old bulbs, then press `Old bulbs` and click the warning under the house.

   > **You'll know it worked when:** About $45, and 13 plugs for a house with 2 outdoor outlets.

4. Change `hours a night` from 6 to 3. Predict both costs first.

   > **You'll know it worked when:** Both halve: $3.38 and $23.

5. Put the hours back to 6. Open `Lights`, press `All out`, and go back to `List`.

   > **You'll know it worked when:** In old bulbs it reads 1,948 watts, too much for one circuit. In LED it is 279 watts.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- Why do you divide the watts by 1,000?
- If the lights run 3 hours a night and not 6, what happens to the bill? Why?
- About how many times more do the old bulbs cost? Where did that number come from?
- With lights on everything, which limit do the old bulbs break?
- What does one night cost in LED?

> One night in LED is $6.75 ÷ 30, about 23 cents. In old bulbs it is about $1.50. A child who can get from the season to one night has the unit rate.

For younger and older kids

Younger: For a younger child, skip the multiplying: compare the two watt numbers and the two costs, and count the plugs.

Older: For an older child, find the price per kilowatt-hour on your own bill, type it into `cents a kilowatt-hour`, and work the season again.

Keep going

- In List, change the price to what your family or your state pays for a kilowatt-hour and work the season again.
- Press Print the list and read the plug plan. Why are some plugs carrying 175 watts and others only 61?
- The front peak needs 28 feet of big bulbs and the sets are 25 feet long. How many sets, and how much is left over?

Bring it into other subjects

- Science: hold a hand near an old glass bulb and near an LED bulb, with an adult. Where did the extra energy go?
- Social studies: find the price of a kilowatt-hour in three states. Where would this house cost the most to light?
- Writing: write a note to a neighbor explaining, with numbers, whether new LED lights are worth buying.
- Careers: find out what an electrician checks before adding outdoor outlets to a house.

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	Light Show Lab: Watts, Plugs and the Bill
SUBJECTS	Math, Engineering
TIME	45 minutes
WHAT WE DID	Calculated the seasonal cost of a lighting display from watts, hours, nights and a unit price, compared LED and incandescent bulbs, and checked two designs against a circuit limit.

SKILLS PRACTICED	Unit rates; Multiplying decimals; Design constraints

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/lightshowlab?lesson=watts-plugs-and-the-bill

Essential question: What does it cost to keep a house full of lights on, and what limits how many you can plug in?

Warm-up: This house has 1,488 bulbs. My guess for a month of evenings: $_____

1. **Vocabulary.** Watt, kilowatt-hour, unit rate, circuit, constraint: write each in your own words.

2. **The first house.** LED: _____ watts. Old bulbs: _____ watts. Work each cost: watts ÷ 1,000 × 6 hours × 30 nights × $0.18. LED: $_____. Old bulbs: $_____. The app says: $_____ and $_____.

3. **Half the hours.** At 3 hours a night I predict: LED $_____, old bulbs $_____. The app says: $_____ and $_____.

4. **All out.** LED: _____ watts on _____ plugs. Old bulbs: _____ watts on _____ plugs and _____ circuits.

1. A circuit should stay under 1,440 watts for lights left on all evening, and this house has 2 outdoor outlets. With lights on everything, which design meets both limits? Give the numbers.

2. What does one night cost for the first house in LED? In old bulbs? Show your division.

Quick check

Name: _____

1. Lights that draw 500 watts run for 4 hours. How many kilowatt-hours is that? (A) 2 (B) 125 (C) 2,000

2. A house draws 1,948 watts in old bulbs. One circuit carries 1,800. What does it need? (A) fewer outlets (B) a second circuit, or LED bulbs (C) longer cords

3. Write one sentence, with a number in it, comparing what LED and old bulbs cost to run.

Answers

QUESTION	ANSWER	WHY
1	A	500 watts is 0.5 kilowatts, and 0.5 × 4 hours = 2 kilowatt-hours.
2	B	1,948 is more than 1,800, so the breaker would trip. Splitting the load or using bulbs that draw less both fix it.
3	Open answer	A full answer gives a number: the old bulbs draw about 6.7 times the watts, or $45 against $6.75 for the season.

If your state or umbrella school asks, this lesson covers Common Core Math 6.RP.A.3b, Common Core Math 7.RP.A.2c, Common Core Math 4.OA.A.3, NGSS MS-ETS1-1, NGSS MS-ETS1-2.

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The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

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