Tags
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In hot water!

In our last test, we measured the power in Watts of several hot water heaters.
We were also able to calculate power in Watts by multiplying Volts (electric potential energy) by Amperes (electric current, also known as "amps"):

Power (Watts) = Volts x Amps

This only works for devices that just create heat, like ovens, hot water heaters and non-induction stoves.
These are known as "ohmic loads", since they don't have any magnetic fields or other complexities, like motors or power supplies.

Another way to calculate power is by using an Ohmmeter, which measures resistance to electric current in Ohms (another dead dude, so we use capital letters)

Try this:
Use the ohmmeter (symbol looks like a horseshoe) to measure electrical resistance across your hands.
Try it with more than one person.
Questions: Why does it fluctuate? Why does it not hurt? How does this thing work? Why do they use this as a lie detector?

Back to the hot water tea maker:
Measure and record the resistance of the tea maker in Ohms .
Power can also be calculated by:
volts x volts/R where R is resistance in Ohms, or V^2/R

Connect your hot water tea maker through the little Kill-a-Watt meter we used before to measure power, current and voltage.
How close was your calculated value for power to the one measured?
What was the current you measured in Amps?

Another fun way to calculate power is this:

Power (Watts) = current x current x resistance, or i^2R
Calculate the predicted power of the tea maker using both of these formulas, and compare to the measured values on the little grey meter.
---------true power part----involves water----
Next, let's see how much power in Watts the hot water tea maker actually produces.

Measure out 1000 ml of cool water in each tea maker (you can see the amounts on the side of each unit).
This is one liter, and has a mass of 1000 grams.
To heat one gram of water one degree C, you would need one calorie (this is the definition of a calorie).

Measure the temperature of your cool water, and turn on the heater, recording the start and ending time, when the water boils. We can assume this happens at 100 °C.

The change in time is in seconds
The change in temperature is Δt and should be in °C

Calculate the amount of joules of electrical energy you added to the water like this:

Energy (joules) = Watts (joules/second) x seconds (use the values for Watts on the grey meter)

Now it takes 4.18 joules to equal one calorie, so convert your joule number into calories. This is your electrical energy number.
Record this:

From the hot water measurements, heat energy (calories) = mass (grams) x 1.00 (water number) x Δt (degrees C), or:

Q = mcΔt

(you may be seeing this in chem class this week)
Calculate how many heat calories your hot water heater delivered to the cool water.
m = mass (should be around 1000 grams for your test)
c = 1.00 (definition of water specific heat)

Δt = change in temperature, from starting temp (around 20 °C) to boiling (100 °C)
How many heat calories did the water absorb?

Divide the heat energy number by the electrical energy number. Is this greater than one? Why/why not? What does this number represent?

Now, take this to a bigger scale:
Your home hot water heater has a capacity of about 50 gallons, or 200 liters.
How many grams of water is this?
If the water comes in at 20°C and you want hot water at 70°C, how many degrees warmer is this?
How many calories is this?
How many joules is this?
If your hot water heater is 4500 W (this is 4500 joules/second), how long will this take? (divide the joules by 4500j/s)
How many kW is this?
How many kWh is this?
How much will it cost if HELLCO charges us $0.35/kWh?
How much per month is this, if it happens twice a day?

How could solar thermal panels change this?