PHYSICS 570 – Master's of Science Teaching

"Electricity"
Lecture 11 – Applying Ohm's Law and power calculations to the world around us

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Big ideas

With a basic knowledge of electricity, you can understand a LOT that is both exciting and relevant.

What should the electric bill be?

What does it take to design an electric car?

What is the resistance of the filament of a light bulb?

Where we stopped last time …

An electric burner with 35 Ohms resistance consumes 1.5 kiloWatts. At what voltage does it operate?

(Homework 10-9) (You already did this one)

(A) 120 V
(B) 230 V
(C) 52,500 V
(D) 14,400 V
(E) 42.8 V

Power is the product of voltage and current (True for ALL devices)

$$P = I V$$

Ohm's law (resistors only)

$$V = I R$$

Resistor power dissipation

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

Resistance in terms of resistivity

$$R = \rho \frac{L}{A} = \frac{L}{\sigma A}$$

Find the resistance of a heating coil that draws 4.8 A when the voltage across it is 120 V. 5

(Homework 11-1)

What current flows when a 45 V potential difference is imposed across a 1.8 kOhm resistor.

(Homework 11-2)

What current does a 100 Watt light-bulb take?

(Homework 11-3a)

What is the resistance of the filament?

(Homework 11-3b)

What is the resistance of the filament in a 25 Watt lightbulb?

(Homework 11-3c)

Confusion between power and energy ...

What is a kilowatt-hour?

(A) A unit of power
(B) A unit of energy
(C) About $0.10
(D) B & C
(E) A & C

(Homework 11-4)

Saving money

Your parents are constantly telling you to turn off the TV, the lights, and the electric heater. They also are not keen when you leave the refrigerator door open while choosing a snack.

If you leave your TV on for 2 hours a day, an incandescent 100 Watt bulb on for 8 hours a day, a 2000 Watt electric heater on for 8 hours a day and you leave the refrigerator door open 15 minutes a day,
(A) How many joules do you use in a month?
(B) What is your contribution to the monthly power bill?

Saving money

If you leave your TV on for 2 hours a day, an incandescent 100 Watt bulb on for 8 hours a day, a 2000 Watt electric heater on for 8 hours a day and you leave the refrigerator door open 15 minutes a day,

(Homework 11-5)

(A) How many joules do you use in a month?
(B) What is your contribution to the monthly power bill?

TYPICAL WATTAGES OF VARIOUS APPLIANCES

Clock radio = 10
Clothes dryer = 1800–5000
Personal computer CPU - awake = 120
Refrigerator (frost-free, 16 cubic feet) = 725
Televisions -- Flat screen = 120

TV on for 2 hours a day (120 Watts)

Lightbulb 8 hours (100 Watts)

Heater 8 hours (2000 Watts)

Refrigerator 15 minutes (725 Watts)

(A) How many joules do you use in a month?

(B) What is your contribution to the monthly power bill?

Alternative Units for Energy and Power

Energy

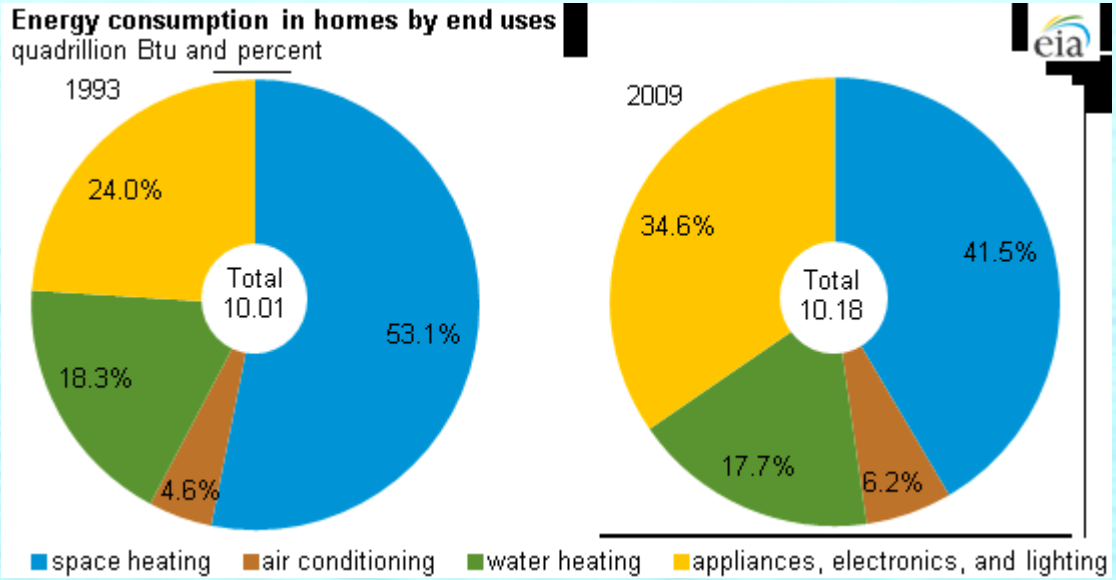
One BTU (British Thermal Unit). Amount of energy to raise one pound of water by one degree F. Turns out to be 1055 Joules.

Power

One Horsepower can lift 550 pounds one foot in one second.

This turns out to be the same as 745 Watts.

WWW.EIA.GOV
(US Energy Information Administration)



(Homework 11-6)

How many Joules are used every year to run appliances, electronics and lighting? What are people paying for this power?

1 BTU = 1055 Joules

Tesla Model S

Uses lithium batteries in series to give 375 Volts. Generates a maximum of 416 Horsepower.

(Homework 11-7)

What current does the system draw?

Tesla Model S

The wiring in a Tesla model S should not waste the energy being used to make the car go. If the wiring is allowed to waste 1% of the energy, what is the resistance of the wiring?

(Homework 11-8)

Tesla Model S

The wiring in a Tesla model S should not waste the energy being used to make the car go. If the wiring is allowed to waste 1% of the energy, what is the resistance of the wiring?