

## Note-A-Rific: The Other Stuff

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This is the last section in the electricity unit.

- I have sort of a bunch of leftovers that I want to show you.
- These are examples of questions that you may need to know how to do. Some of them are my own, some are from old diplomas, some are just questions I've spotted over the years.
- All of them need you to bring together at least a couple of the concepts you've learned up till now.
- It's easiest to understand these questions if we work them out as examples together.

**Example 1:** A circuit with a single  $25.0\Omega$  resistor runs for  $5.00\text{s}$ . During this time  $15.0\text{C}$  pass through a point in the circuit.

- a) What is the power rating of this circuit?

First we will figure out the current...

$$I = q/t = (15.0\text{C}) / (5.00\text{s}) = 3.00\text{A}$$

Then we can figure out the power...

$$P = I^2R = (3.00\text{A})^2 (25.0\Omega) = \mathbf{225\text{W}}$$

- b) How much energy is used?

$$P = W / t$$

$$W = Pt = (225\text{W}) (5.00\text{s})$$

$$W = \mathbf{1.13 \times 10^3 \text{ J}}$$

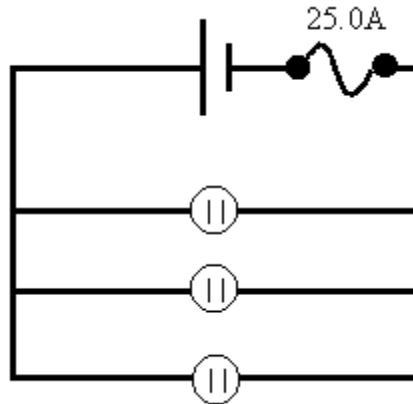
- c) Throw a  $5.0\text{kg}$  box straight up into the air using the same amount of energy. How high does it go?

$$E_p = mgh$$

$$h = E_p / mg = (1.13 \times 10^3 \text{ J}) / (5.0\text{kg})(9.81\text{m/s}^2)$$

$$h = \mathbf{23 \text{ m}}$$

**Example 2:** Most homes have their electrical wiring done in parallel. That way one part of the circuit can be turned off without affecting any other devices in the circuit. As more appliances are plugged in, the overall resistance of the circuit decreases. This means that the current in the circuit goes up, which could cause an electrical fire. Most homes have fuses or circuit breakers that break the circuit if the current goes too high. Here's a diagram of a household circuit.



This circuit has three outlets and a 25.0A fuse. If the current goes above 25.0A, the fuse will blow... notice that it will break the entire circuit in that position. If I plug in a stove (6000W), a microwave (600W), and a toaster (1000W), will the fuse blow out?

To solve this, we need to remember that household circuits run at 120V. We can figure out the resistance of each device based on this...

$$\text{Stove} \rightarrow P = V^2/R \rightarrow R = V^2/P = (120V)^2/(6000W) = 2.40\Omega$$

$$\text{Microwave} \rightarrow R = V^2/P = (120V)^2/(600W) = 24.0\Omega$$

$$\text{Toaster} \rightarrow R = V^2/P = (120V)^2/(1000W) = 14.4\Omega$$

We want to know how much current is flowing through the circuit before it branches.

- This is the spot where the current will be the highest, since it hasn't split up in the other branches yet.
- Since the current is at a maximum there is the greatest risk of the wire heating up enough to burn.
- Add the resistance up in parallel so we can figure out the current...

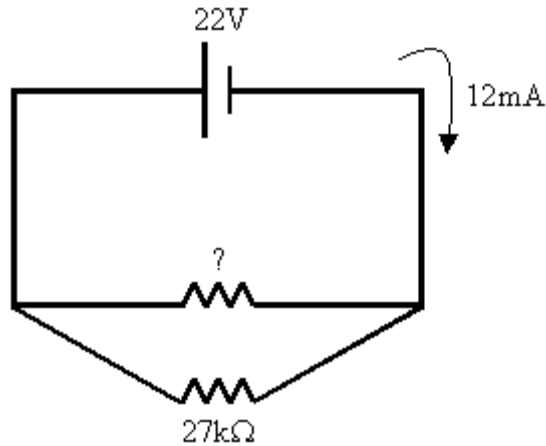
$$\begin{aligned} 1/R &= 1/R_1 + 1/R_2 + 1/R_3 \\ &= 1/(2.40\Omega) + 1/(24.0\Omega) + 1/(14.4\Omega) \\ R &= 1.89\Omega \end{aligned}$$

Finally we can figure out the current going through the circuit before it gets to any branches...

$$V = IR \rightarrow I = V/R = (120V)/(1.89\Omega) = 63A$$

Yep, the fuse blows!

**Example 3:** What is the missing resistor in this circuit?



Since the resistors are in parallel, the voltage across the two of them is the same. Let's treat the two resistors as if they were one and figure out the resistance of it.

$$V = IR$$

$$R = V/I = (22V) / (12 \times 10^{-3}A) = 1.8 \times 10^3\Omega$$

Now we can figure out the resistance of the missing resistor,  $R_2$ ...

$$1/R = 1/R_1 + 1/R_2$$

$$1/R_2 = 1/R - 1/R_1$$

$$= 1/(1.8 \times 10^3\Omega) - 1/(27 \times 10^3\Omega)$$

$$R_2 = 1.9 \times 10^3\Omega$$

**Example 4:** A 60W bulb is only about 5% efficient at changing electricity into light. How much energy is wasted in one hour?

95% is wasted, so we'll use that...

$$(0.95)(60W) = 57W \text{ wasted}$$

$$P = W/t$$

$$W = Pt = (57W)(3600s)$$

$$W = 2.1 \times 10^5J$$