PH 102 Quiz 2 SOLUTION

1. In order to maximize the percentage of the power that is delivered from a battery to a device, the internal resistance of the battery should be

- ⊗ As low as possible
- ◯ As high as possible
- ◯ The percentage does not depend on the internal resistance.

Power is delivered to the internal resistance of a battery, so decreasing the internal resistance will decrease this lost power and increase the percentage of the power delivered to the device.

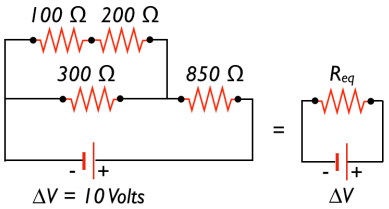
2. Two resistors connected in series are measured to have an equivalent resistance of 1000 Ω. The same two resistors in *parallel* are measured to have an equivalent resistance of 250 Ω. What are the values of the resistors?

- ◯ One of the measurements is in error, this can't be true.
- ◯ One is 750 Ω, the other is 250 Ω.
- ⊗ Both are 500 Ω.
- ◯ One is 200 Ω, the other is 50 Ω.

Call the two resistors R_1 and R_2. Connected in series, their equivalent resistance is $R_1 + R_2 = 1000\,\Omega$. Connected in parallel, their equivalent resistance is $1/R_1 + 1/R_2 = 250\,\Omega$.

$$R_1 + R_2 = 1000$$
$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{250}$$
$$\frac{1}{R_1} + \frac{1}{1000 - R_1} = \frac{1000}{(1000 - R_1)} = \frac{1}{250}$$
$$1000R_1 - R_1^2 = (250)\,(1000)$$
$$R_1^2 - 1000R_1 + 250000 = 0$$
$$\Rightarrow R_1 = 500\,\Omega = R_2$$

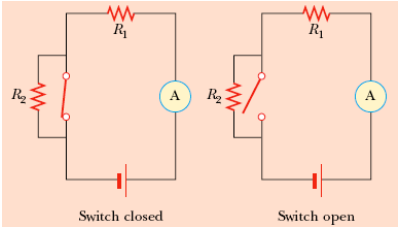
So there is a bit of math, but it works out in the end. Alternatively, a simpler way is to just look at the possible answers and try them out!



3. What is R_{eq} for the circuit at the left?

- ⊗ 1000 Ω
- ◯ 500 Ω
- ◯ 1400 Ω
- ◯ 1150 Ω

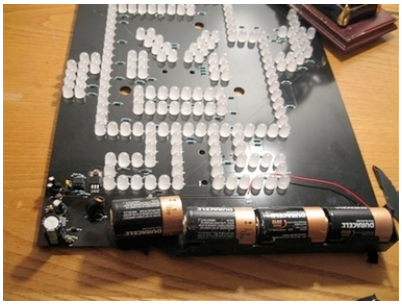
See the lecture notes. This is the same example circuit, which we also worked out in class.



4. With the switch in the circuit of the figure at left, there is no current in R_2, because the current has an alternate zero-resistance path through the switch. There is current in R_1 and this current is measured with the ammeter (a device for measuring current) at the right side of the circuit. If the switch is then opened, there is current in R_2 . What happens to the reading on the ammeter when the switch is opened?

- ◯ the reading goes up
- ⊗ the reading goes down
- ◯ the reading does not change

When the switch is opened, resistors R_1 and R_2 are in series, so that the total circuit resistance is larger than when the switch was closed. As a result, the current decreases, since the potential difference is fixed.



5. Consider the suspicious device at left. It takes approximately 135 light-emitting diodes (LEDs) to make up Err, second in command of the Mooninite Army. If each LED has a resistance of 200 Ω while lit, and all of the LEDs are in parallel, what is the equivalent resistance of Err?

- ◯ 27000 Ω
- ⊗ 1.5 Ω
- ◯ 12 Ω
- ◯ 200 Ω

We have 135 resistors in parallel R_1 through R_{135}, all of the same value. We know that the equivalent resistance must be:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_{135}} = 135\left(\frac{1}{R_1}\right) = \frac{135}{200} \tag{1}$$

So $R_{\text{eq}} = \frac{200}{135} \approx 1.5\,\Omega$.