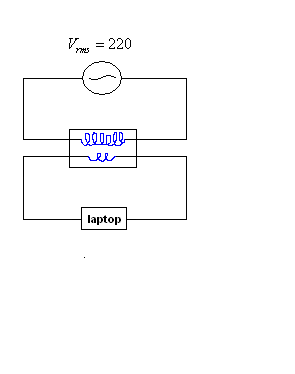
Transformer Problems

**Problem**

Consider you’re in France and you need a transformer to reduce the output voltage from 220V to 120V so that your laptop will not break. What should be the ratio of turns in the primary to the secondary?

**Solution**

The set up looks like this:



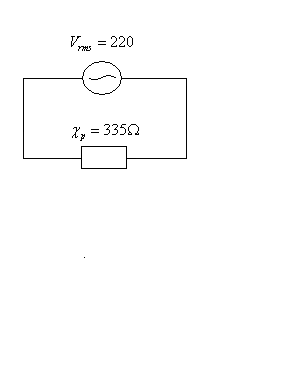
Since you want to lower the voltage, you want the number of turns in the secondary to be lower than in the primary. So it should look like above. And specifically,



Now, if the resistance of your laptop is 100Ω, what is the current in the primary and in the secondary? To find the current in the primary, we can determine the equivalent resistance of the transformer & laptop. We have,



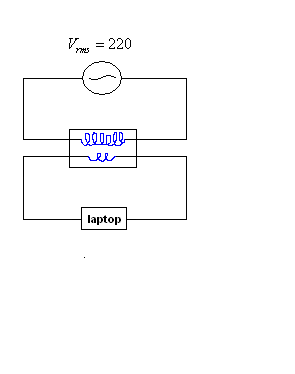
So then we can replace the transformer & Rlaptop with their equivalent resistance,



Therefore the current in the primary is:



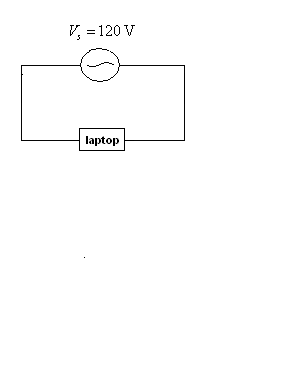
What is the current in the secondary? Well we can go back to:



and replace Vp = 220 with its equivalent in the secondary coil. The transformer steps the down the potential Vrms to:

,

and so we can represent the circuit as,

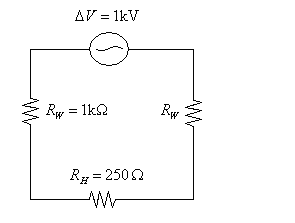


since we said the resistance of the laptop was 100Ω, the current will be:



**Problem**

The main use of transformers is actually for reducing power loss when transmitting electricity over long distances. Consider the following example. What is power supplied by battery? Power lost through wires?



**Solution**

OK, then what is the power supplied by the battery? This is:



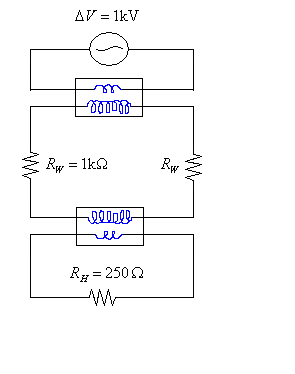
And what is the power lost through the wires?



So nearly all of the power that is supplied by the power station is lost by thermal dissipation. The fraction is 395/444 ≈ 89%.

**Problem**

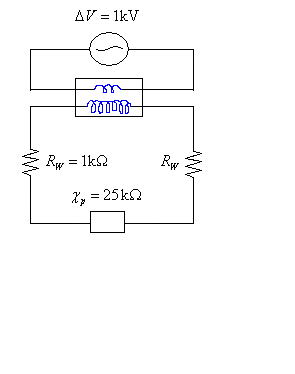
That is not good since it costs money to generate electricity. How can we solve this problem? Use a transformer to step up the voltage and thereby lower the current, minimizing power loss. Consider the following circuit.



With the first transformer we step up the voltage, and with the second we step it back down. Let’s suppose N2 = 100 and N1 = 10. Then what is the power loss in the lines? Well, the equivalent resistance of the transformer & RH is,



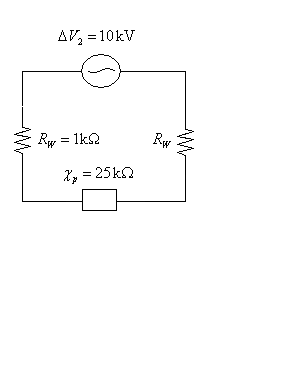
This makes our circuit,



Now the transformer steps up the potential difference across the primary into the secondary. Let’s determine the potential difference in the secondary,



So we can write this as:



Now what is the current in this circuit? We can use,



To say that



Therefore the current is:



The power supplied by the battery is equal to the *total* power lost.



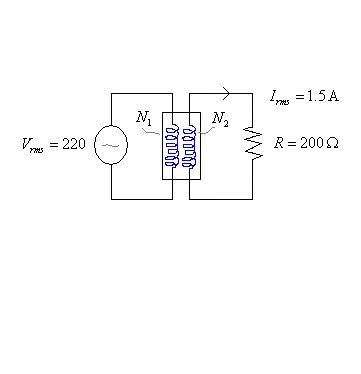
The power lost through the wire resistors is:



And so the fraction of power lost is 27/370 ≈ 7% - much lower than before.

**Problem**

If the rms current through the resistor must be 1.5A, and N1 = 50, what must N2 be? Note that even though N1 is pictured to equal N2 – they are not equal necessarily.



**Solution**

The transformer will step up the potential according to:



The current in the resistor is:



So,

