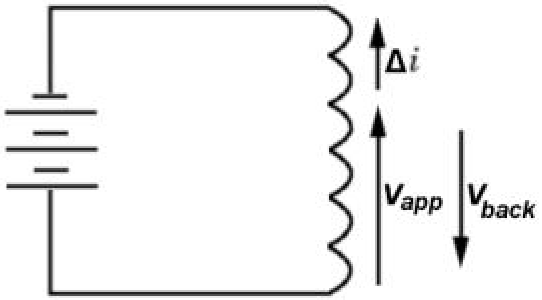
Transformers

more than meets the eye…

When you turn on a circuit with just a resistor in it the current reaches its steady state almost instantly.

This is not true when we have a coil in a circuit (Inductor - L).



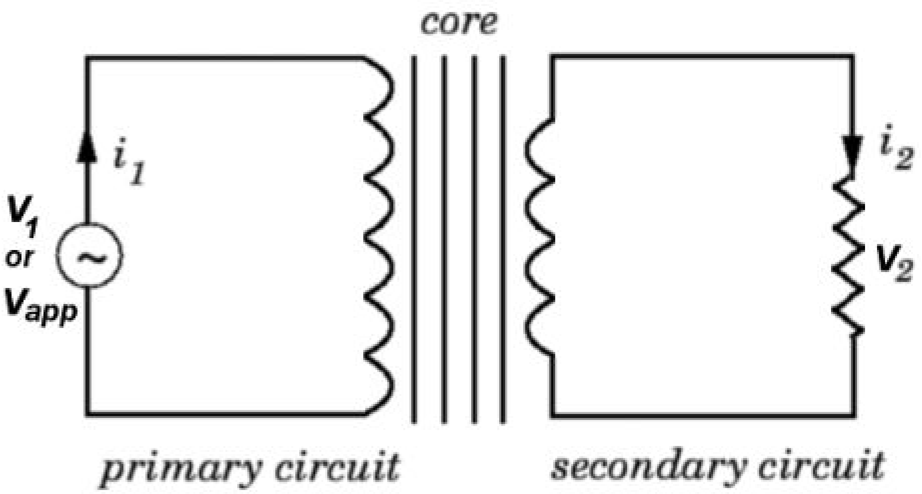
Changing current and back EMF in a coil*

$$V_{net} = V_{applied} - V_{back}$$

This is because the current that you send through the wire creates a $\vec{B}$ of its own. This opposes the current in the wire and has the wire 'fights' that field. As long as the current is changing the $\vec{B}$ will work against it. Eventually there comes an equilibrium and the inductor works as a short circuit.

Once the circuit is turned off, the opposite is true. The current will decrease (this is a change in $\vec{B}$) and the $\vec{B}$ will oppose the lack of current and it will continue for a time afterwards.

The above picture is ½ a transformer. We take this concept and double it…



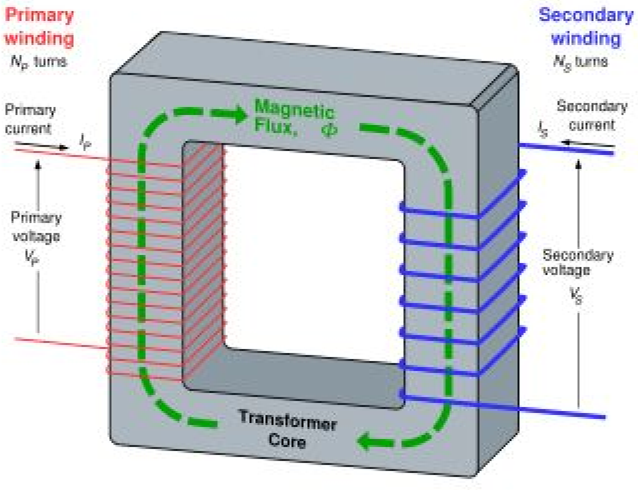
Closed 2ndary circuit

In this case we send a current through the left circuit and it creates a $\vec{B}$. This has an effect on the secondary circuit and creates a current there. Wireless electricity! I've seen this done in a lab and we got a light bulb to light a meter away without connection to anything. Pretty sweet.

Now, we use this concept to build our transformer.

The primary coil has more turns than the secondary coil. This is called a step down transformer. The voltage in the secondary coil is lower than that of the primary.

A step up transformer simply has the coils in the opposite orientation.



Let's build the equation:

$\varepsilon_p = -N_p \dfrac{\Delta\Phi_p}{\Delta t}$ also, $\varepsilon_s = -N_s \dfrac{\Delta\Phi_s}{\Delta t}$. We are interested in the ratio of voltage in the primary and the secondary so we need to divide $\dfrac{\varepsilon_p}{\varepsilon_s}$. This gives us our step up / down equation:

$$\frac{\varepsilon_p}{\varepsilon_s} = \frac{N_s}{N_k} = \text{constant} \ = \ k$$

The astute among you may have wondered how we get this ΔV for nothing. The law of conservation of energy still applies. Input still must equal output. The tradeoff is in current.

$$P_p = P_s$$
$$I_p V_P = I_s V_s$$
$$\therefore \frac{V_p}{V_s} = \frac{I_s}{I_p}$$

Transformers are used to

a) Increase AC
b) Decrease AC
c) Both A & B
d) Keep AC constant

Transformers are an application of

a) Induction
b) Mutual induction
c) Electrostatics
d) Mutual Charges

If the secondary voltage is higher than the primary voltage the transformer is called a

a) Step up transformer
b) Step down transformer
c) Inductor
d) Resistor

An ideal transformer dissipates

a) Unit power
b) Infinite power
c) Zero Power
d) Limited Power

If an AC source is 240V and a transformer supplies 12V to a model train which draws current of .8A, then the primary current is

a) .4A
b) .04A
c) 1A
d) 2A

Hint: C B A C B