Name: _____

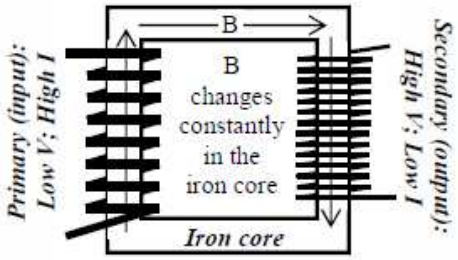
Period: _____

Transformers

7.4

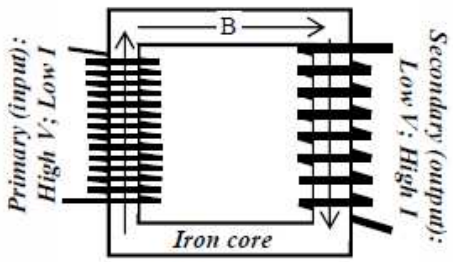
Transformers change AC (alternating current) voltage. **A transformer will not work with DC current.** Two sets of coils are set near each other. Usually a piece of iron is placed between them to increase efficiency. The coils can be interwoven or on different parts of the transformer. Voltage is put into the input coils, called the primary, and different voltage (and current) comes out of the output coils, called the secondary.

A Step-Up Transformer: steps UP voltage. More of coils of wire (N) = more voltage = less current.



The side with the most coils (N) has the most voltage (V) and the least current (I).

A Step-Down Transformer steps DOWN voltage. Less coils of wire (N) = less voltage = more current.



Notice that the side with fewer coils has thicker wires to handle more current and prevent melting.

How transformers work:

Transformers work because of magnetic induction. Changing I (current) makes a changing B (magnetic field). The change of B in the primary (Φ_p) is transferred to the secondary via the metal core, so that $\Delta B_p = \Delta B_s$. Since there must be a changing B and a changing I, **transformers only work with AC current**!

Transformer Equations:

Primary voltage (V_{in}) → $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ ← *# of coils on primary side*

Secondary voltage (V_{out}) → ← *# of coils on secondary side*

$$P_{in} = P_{out}$$

$$V_p I_p = V_s I_s$$

The power is equal on both sides, otherwise you are making energy for free (conservation of energy)

Example: The primary of a transformer has 12 coils; the secondary has 60 coils. If the input voltage is 6 VAC and 10 A, what is the transformer's secondary voltage and current?

Variables:

$N_p = 12$

$N_s = 60$

$V_p = 6\text{VAC}$

$V_s =$ _____

$I_p = 10\text{A}$

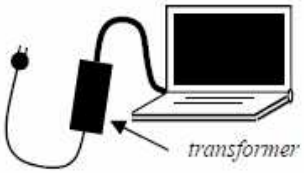
$I_s =$ _____

$\frac{V_p}{V_s} = \frac{N_p}{N_s}$ $\quad \frac{6}{V_s} = \frac{12}{60}$ $\quad 6(60) = 12V_s$ $\quad V_s = \frac{6(60)}{12} = 30\text{V}$

$V_p I_p = V_s I_s$ $\quad 6(10) = 30 I_s$ $\quad I_s = 2\text{A}$

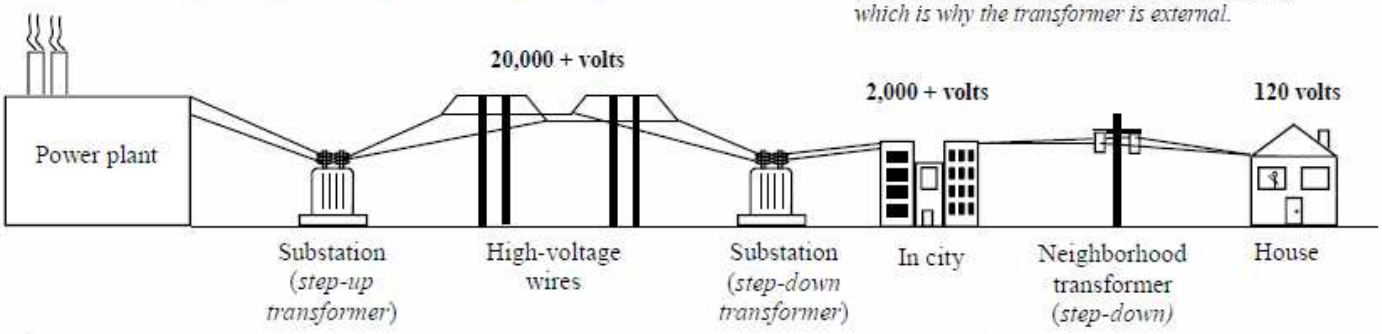
Use of Transformers

We use transformers all the time to change voltage. Most electronic devices have transformers in them (like TVs) or outside of them (the little black box in the power cord of a cell phone charger or laptop cord). This ability of transformers to easily change AC voltage is a major reason why we use AC and not DC current .



The box in the middle of a laptop cord is a step-down transformer, reducing the120VAC at the wall to less than 20VAC at the computer. Transformers produce a lot of heat, which could damage the computer, which is why the transformer is external.

The power company uses several transformers to get electricity to your house. The power company uses high voltage to reduces power loss, but you need low voltage at your house, which is safer.

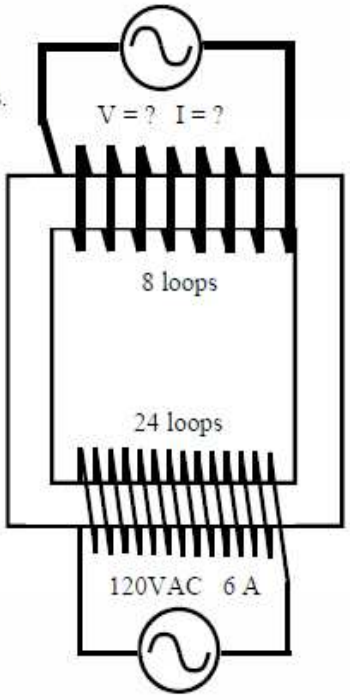


1. A. The side where the original voltage is input is called the: _____.

   B. The output side of the transformer is called the: _____.

2. Side with more or less coils?
   A. ____Has more voltage.
   B. ____Has more current.
   C. ____Has more power.
   D. ____Has thinner wires?

3. Step-up or Step-down transformer?
   A. ___ Produces less voltage.
   B. ___ Produces more current.
   C. ___ Uses DC current.
   D. ___ Works by changing magnetic fields.

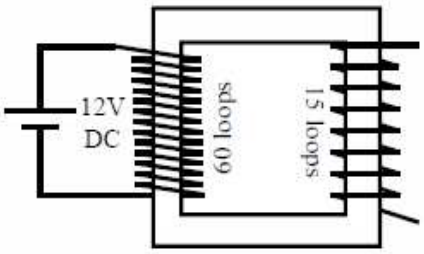


4. Top or bottom of the transformer at the right?
   A. ___ Is the primary for a step-down transformer.
   B. ___ Has more voltage.
   C. ___ Has the most changing magnetic field.
   D. ___ Has less power.
   E. ___ Is the secondary for a step-down transformer.
   F. ___ Has less current.
   G. ___ Is the primary if it is a step-up transformer.

5. 120 volts AC and 6 amps is put into the bottom of the transformer at the right.
   A) Calculate the secondary voltage.

   B) What is the output power?

   C) Calculate the output current.

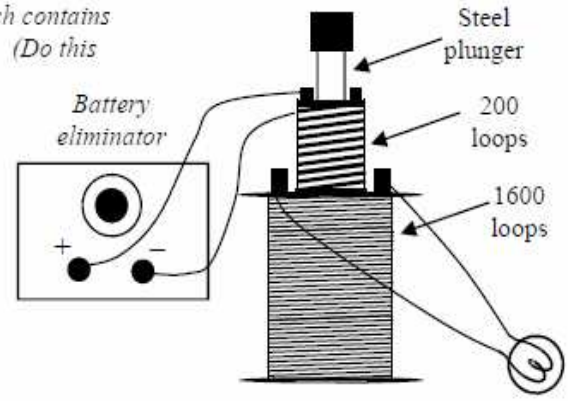


6. In the transformer at the left, current with 8 amps and 12V DC is applied into the left side.
   A. Calculate the input power.

   B. Calculate the output voltage.

   C. What is physically wrong with the diagram?

The picture at the right shows a vertical transformer. The plunger (which contains iron) fits inside the inner windings, which fits inside the outer windings. (Do this in the lab, if possible.)



7. A. Is there any wire's connecting the inside and out coils?
   B. Without the steel plunger, the inner coil is placed inside the outer coil. DC voltage is applied to the inner coil. What happens to the light?

   C. The plunger is then inserted. What happens?

   D. The plunger is removed and AC voltage is then applied to the inner coil. What happens to the light?

   E. The plunger is reinserted. What happens?

   F. Calculation: If 12VAC comes out of the battery eliminator, how much voltage is provided to the light bulb?