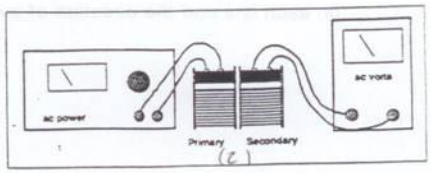
**Physics 221 – Lab 14**
**Transformers & Atomic Spectra**

**Transformers – An application of Inductance**

The point of a transformer is to increase or decrease the voltage. We will investigate a simple transformer consisting of two coils of wire and an iron core. In the diagram below the left coil is called the *primary* coil. It has $N_1$ turns of wire connected to an AC voltage of amplitude $V_1$. This AC voltage creates an alternating current. The alternating current creates a changing magnetic field. The right coil, *secondary coil,* has $N_2$ turns of wire. The changing magnetic field inside the secondary induces a current and voltage in the in the secondary coil. In an ideal transformer the relationship of the input voltage, V1 to the output voltage V2 is given by

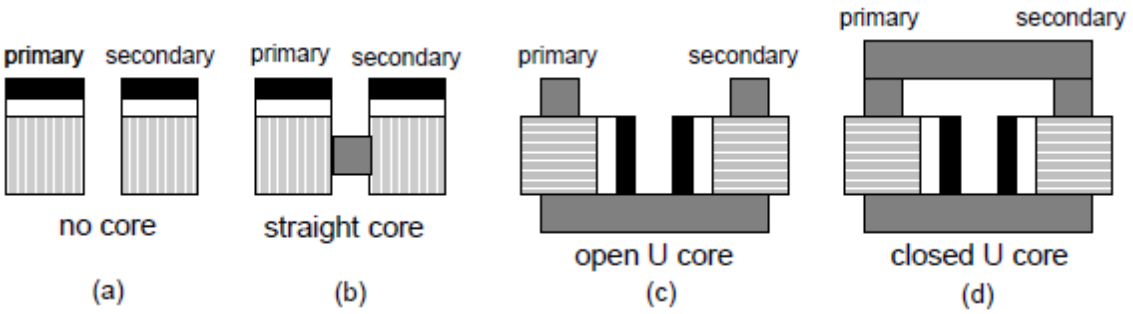
$$\boldsymbol{V_2 = \frac{N_2}{N_1} V_1}$$

Set up the coils as shown in the figure to the right. Use the digital multimeter to read the AC voltage and use the function generator as the AC power source. In the figure, the left coil is the primary and the right coil is the secondary. Note that an alternating current is input at the primary at one voltage level, and then the output voltage is read at the secondary.




a) With the 400 turn coil as the primary and the other 400 turn coil as the secondary, adjust the input voltage to 6 VAC. Check the input voltage with the multimeter and then use the same multimeter to read the output voltage. Record the results in Table 1.

b) Insert the straight cross-piece from the top of the U-shaped core as shown in (b) below. Record the output voltage Table 1.




c) Insert the open U core as shown in (c) above, measure the output voltage and record your results.

d) Finally, place the cross piece over the U-shaped core, measure your output voltage and record your results.

| Table 1 | | | | |
|---|---|---|---|---|
| **Number of Turns** | | | | |
| Primary Coil | Secondary Coil | **Input V** | **Output V** | **Core** |
| 400 | 400 | | | |
| | | | | |
| | | | | |
| | | | | |

e) Using the core configuration which gave the best output voltage, try all combinations of primary and secondary coils. Use a constant input voltage of 6 $V_{AC}$ as you did in a) – d) above. Record your data in Table 2.

| Table 2 | | | |
|---|---|---|---|
| **Number of Turns** | | **Core Configuration:** | |
| Primary Coil | Secondary Coil | Input V | Output V |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Questions**

1. In the description on page 1 for transformers, it is noted that the alternating current creates a changing magnetic field. Is this important for the function of the transformer? If so, why?

2. What do you think would happen if you input a DC (direct current) source into the primary and the coils sit still next to each other just like in the experiment? Meaning the current is steady and unchanging.

3. Create an analogous situation to 1. above using Faraday's Electromagnetic Lab. Describe what you did to create the situation and how the light bulb behaves under this circumstance.

4. Which core configuration gives the maximum transfer of electromagnetic effect to the second coil? Why is this is the case?

5. From your data in Table 2, for a primary having a constant number of turns, graph the resulting output voltage versus the number of turns in the secondary.
    a. What does the slope of this graph represent? Show your work to determine this.

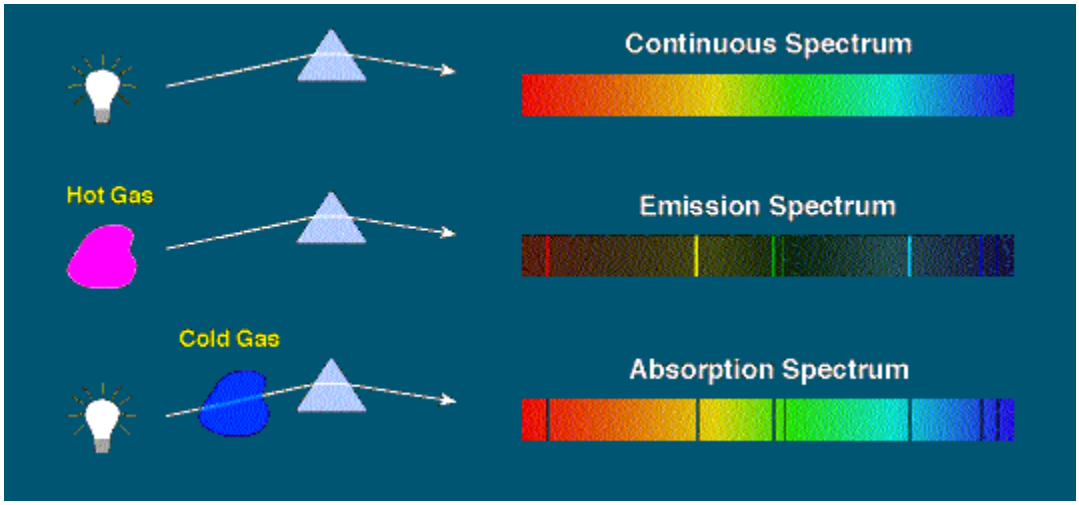
    b. Is your data ideal as defined on page 1?

**Atomic Spectra**

In this unrelated section of the lab you will explore the wavelengths of light that are emitted by various gases when heated. An ***emission spectrum*** is produced by thin gases at high temperatures. If hot enough, the collisions between atoms will excite their electrons to higher energy levels. Soon they return to lower energy levels, and every such downward transition results in a photon being emitted with a certain energy (or wavelength). Hot clouds of interstellar gas show such spectra. Each element has its own spectrum because each element has its own set of energy levels.

A ***continuous spectrum*** comes from high density objects. Such objects are called "blackbodies". There is emission at every wavelength. But there will be a wavelength where the emission peaks. That tells you the temperature of the object. The hotter it is, the more the emission peaks towards shorter wavelengths. Thus, if such an object appears blue, it is hotter than one that appears red. The colors of stars are an example of this. Their **color** tells you their **temperature**. This is called Wien's Law. For two objects of the same size, the hotter one will also be brighter.

An ***absorption spectrum*** occurs when light with a continuous spectrum passes through a cold, thin gas and atoms in the gas absorb only certain kinds of photons (only particular colors); this gives rise to dark lines (absence of light) in the spectrum. A star shows such lines superposed on its continuous spectrum.




1. Use your Spectrometer to observe sunlight (DO NOT POINT THE SPECTROMETER DIRECTLY AT THE SUN) by directing your spectrometer at clouds or a white piece of paper. Describe what you see below. Be specific about the colors you observe.

2. Observe fluorescent lights – this time point the spectrometer directly at the lights by aligning the right side in a straight line from your eye to a light. Describe what you observe and be specific about the colors.

3. Now observe these four gases: Helium, Neon, Mercury and water vapor. Create a table and describe each particular color you are able to see for each gas.

4. Do you think the sun emits an emission spectrum, a continuous spectrum or an absorption spectrum? Explain why think this using the information at the beginning of this section combined with your observation data.

5. Do you think the glass tubes emit an emission spectrum, a continuous spectrum, or an absorption spectrum? Explain why you think this using the information at the beginning of this section combined with your observation data.

6. Compare the spectrum from the mercury tube and the florescent lights. Why do you think there are similarities?

7. Calculate the energy of the brightest photons emitted by mercury if their wavelengths are 546 nm, 577 nm and 436 nm. (Show your work)