PH110, NCSSM, 1/14/02

Lab D02: *THE OSCILLOSCOPE*

Prelab: Read the class handout from Giancoli on thermionic emission and TWTW (pp. 262-263 1st edition; pp. 246-247 2nd edition) to learn how televisions and oscilloscopes work.

Equipment per station: oscilloscope, 2 alligator clip leads, battery holder with 4 D batteries

Goals: learn how to use an oscilloscope and to discover what an oscilloscope measures

First, some oscilloscope settings:

- Make sure that the two red dials (labeled "variable") are turned completely clockwise and clicked
- Set the VOLTS/DIV dial to 1
- The DC/AC button should be depressed
- The ground (GND) button should be depressed
- The oscilloscope probe (the long wire with red and black alligator clips at the end) should be attached to INPUT at the bottom left corner of the oscilloscope (if it's not attached, push the connecting piece in and turn clockwise)
- Set the TIME/DIV dial to H IN
- The two dials at the top left (under VERTICAL) and top right should be depressed in

1. Turn on the oscilloscope. You should see a blue-green dot. Are you actually seeing electrons? What are you seeing? Explain.

2. Connect the red and black alligator clips to each other. Then center the electron beam in the middle of the screen by using the dials at the top left and top right of the oscilloscope. Un-depress the push-button labeled "GND".

From this point on, do not use the very top left and right dials nor the GND button!

3. Attach the alligator clips to the 2 ends of a single battery, and to the oscilloscope probe by connecting the red (positive) end of the battery to the red alligator clip and the negative end of the battery to the black alligator clip. What happens to the electron beam? What apparently must the red alligator clip be connected to inside the oscilloscope? The black clip? Explain how you knew. Remember the sign of the electron charge!

4. Remember that you set the VOLTS/DIV dial to 1 volt/div. Notice that a "division" is one of the centimeter-sized marks on the screen. Predict what will happen when you turn the VOLTS/DIV dial to 2. Then try it. Repeat (predict and try) for 0.5 volt/div.

5. Predict what will happen when the battery holder connections are reversed (the red end of the battery holder to the black alligator clip, etc.). After predicting, try it.

6. Predict what will happen if you connect a 4 batteries to the oscilloscope. What do you have to do to get it back on the screen? (Remember that you can't use the very top left and right dials!)

7. Now replace the 4 batteries with the single battery. Now turn the TIME/DIV dial to 0.1 sec. What happens? How long does it take the electron beam to move across the entire screen (all 10 divisions)? Time it. Why is this dial labeled 0.1 sec? What inside the oscilloscope makes the beam move across the screen?--be specific

8. Experiment with the TIME/DIV dial. Describe what changing the setting does to the display. At what setting must the TIME/DIV be set so that the electron beam produces a constant line? Why does eye/brain perceive a line rather than a moving dot at that setting?

9. Draw a graph of the voltage difference between the horizontal deflection plates [i.e., $V_{left} - V_{right}$] as a function of time (for when TIME/DIV = 0.1 sec) in your lab book. Label axes appropriately. Get the shape of the graph correct first. Then add numbers to the axes where you can.

10. Disconnect the battery from the alligator clips. Hold one alligator clip with one hand and the other with your other hand. The electron beam should now trace an interesting pattern on the oscilloscope screen. (Sometimes you get a stronger signal if you hold the red and black plastic with your fingers. Sometimes, the signal is stronger if you touch the bare metal of the alligator clip. Experiment.) In order to best view the signal, use the lowest VOLTS/DIV setting so that the oscilloscope trace fills the screen. You should also experiment with the TIME/DIV dial. You may also want to increase the intensity of the electron beam. What shape is the oscilloscope trace?

11. Find the period (in seconds) of the waveform from step 10 using the TIME/DIV dial setting. Draw a large labeled diagram in your lab book showing what you measured. (Hint: measure the period in divisions first, and then convert to seconds.)

12. Determine the frequency of the waveform from step 11. Can you guess where this voltage signal comes from?

13. To summarize: what thing(s) do oscilloscopes measure?