

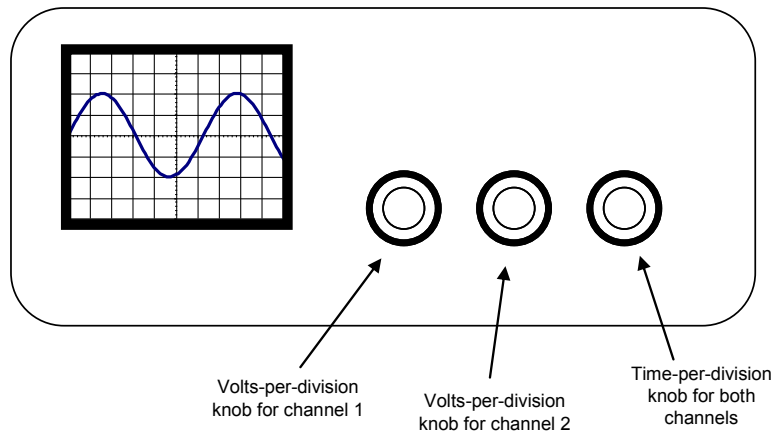
Physics 151
Faraday's and Ampere's Laws
Prelab Assignment

Name _____

In this week's lab you will use an instrument called an oscilloscope. When first encountered the oscilloscope is somewhat imposing. It has a little screen and lots of buttons and knobs. This prelab is to give you some familiarity with its most important features.

The screen can be thought of as a graph that has a vertical scale representing voltage and a horizontal scale representing time. You'll even see an 8-row by 10-column grid on the screen. The distance from one line to the next on the grid is called a *division*. So the screen is 10 divisions wide on the horizontal time axis and 8 divisions high on the vertical voltage axis.

The oscilloscope is used to observe how the potential drop between two points in a circuit changes with time. This time dependent voltage is often referred to as the *signal*, its graphical representation as the *waveform*, and the representation of the waveform on an oscilloscope is called the *oscilloscope trace*. It might so happen that the signal does not change with time. That's fine, the oscilloscope would display a flat line – not very exciting. More often it is used to observe a signal that does change with time. In this week's lab you will observe signals that change sinusoidally in time, like the signal shown in the diagram below.



The most important idea for a novice to learn is that the oscilloscope is a measuring device. It does not generate the signal being observed on the screen, and no combination of button-presses and knob-turns ever changes the signal. The *appearance* of the signal on the screen might change, but this is only because the vertical scale and/or horizontal scale or some other display setting has changed, not because the actual signal has changed.

With that said we can introduce the two most important knobs, knobs that affect how the signal appears on the screen. These are the *volts-per-division* knob and the *time-per-division* knob. (A photograph of the oscilloscopes you will use in lab can be found on the last page of the lab handout.) The volts-per-division knob sets the vertical scale. By turning it one way or the other the signal appears to stretch or shrink vertically. The time-per-division knob sets the horizontal scale. By turning it one way or the other the signal appears to stretch or shrink horizontally. These knobs are typically adjusted so that the signal nicely fills the screen. You don't want the waveform too tiny or you won't be able to make measurements with any precision, and you don't want it so big that it extends beyond the screen. You want it just the right size.

Once you have adjusted these knobs so the signal nicely fills the screen, you are ready to make measurements. For the sinusoidal signals you will work with there are two important measurements to make. First, you will measure the period of the waveform. The period is a time, the time it takes for the sinusoid to repeat, and is measured using the horizontal scale. Second, you will measure the vertical size of

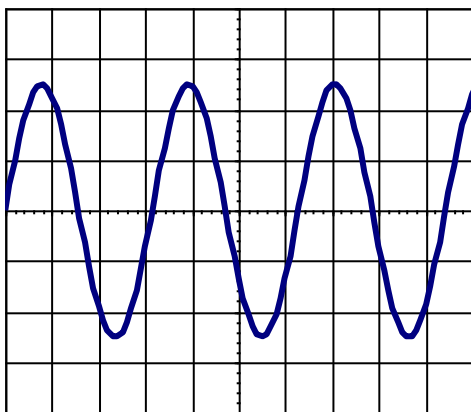
the sinusoid. The size is a voltage, and is measured using the vertical scale. The size you will measure in lab is called the *peak-to-peak voltage*. This is the vertical distance, in volts, from the very top of a positive peak to the very bottom of a negative peak.

As has already noted, the screen is segmented into divisions, 10 horizontal and 8 vertical. You will also notice minor tick marks on the central horizontal and vertical axes as a visual aid for your measurements. The spacing between minor tick marks is typically one-fifth of a division.

Period: To measure the period, count the number of horizontal divisions it takes for the waveform to repeat once. Don't limit yourself to an integer number of divisions. You should easily obtain a precision of one-fifth a division or even one-tenth a division. The number you record is the period, but it is not in units of seconds as desired, it is in units of "divisions". To complete the measurement you need a conversion factor between "divisions" and seconds. The conversion factor is right on the oscilloscope, these are the numbers you will see marking the various positions of the time-per-division knob. Find the number on the knob corresponding to its current setting. For example, it might be 2 ms, which means 2 ms per division. Or it might be 5 μ s, which means 5 μ s per division. To obtain the period multiply the period in "divisions" by this conversion factor. That's it.

Peak-to-Peak Voltage: To measure the peak-to-peak voltage, count the number of vertical divisions between the very top of a positive peak and the very bottom of a negative peak. Again, you should easily obtain a precision of one-fifth a division or even one-tenth a division. The number you record is the peak-to-peak voltage, but it is not in units of volts as desired, it is in units of "divisions". To complete the measurement you need a conversion factor between "divisions" and volts. The conversion factor is right on the oscilloscope, these are the numbers you will see marking the various positions of the volts-per-division knob. Find the number on the knob corresponding to its current setting. For example, it might be 2 V, which means 2 V per division. Or it might be 5 mV, which means 5 mV per division. To obtain the peak-to-peak voltage multiply its value in "divisions" by this conversion factor. That's it.

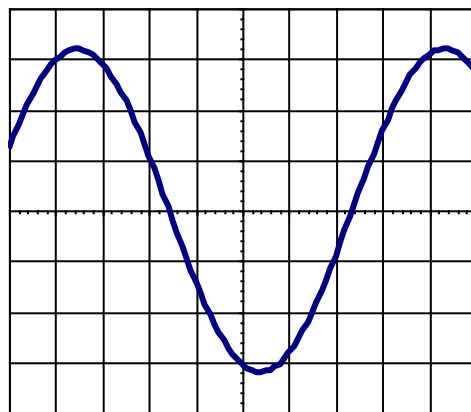
For the two oscilloscope traces shown below determine the period and peak-to-peak voltage with as much precision as possible. The two conversion factors, time-per-division and volts-per-division, are written beneath each trace. Show your work.



2 V per division
5 ms per division

T = _____

V_{p-p} = _____



50 mV per division
20 μ s per division

T = _____

V_{p-p} = _____