Circle your lab day and time.

	Tue	Tue	Tue	Wed	Th	Th	Th	Fri
Your name:								
TA name:	10-12	12-2	2-4	12-2	10-12	12-2	2-4	12-2

Lab 6: AC Signals

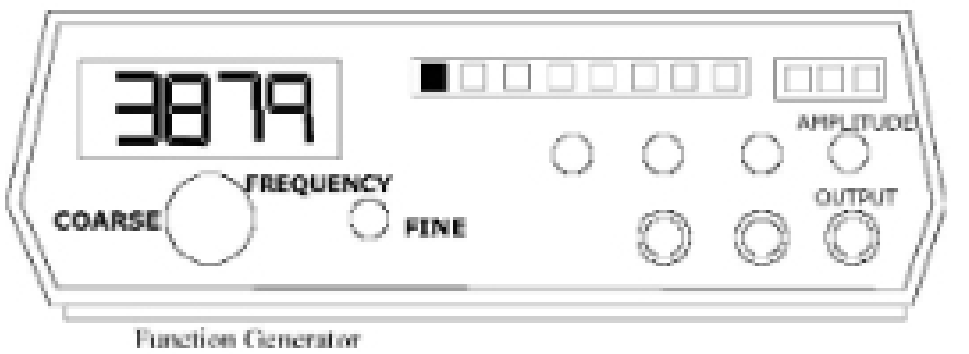
INTRODUCTION

In this experiment, you will use an oscilloscope to measure the time-varying (AC) voltages from two quite different sources: a signal generator and your heart.

Take a look at the appendix (now!) if you have never used an oscilloscope!

PART I: MEASURING THE FREQUENCY RANGE OF YOUR HEARING

At your table you should have a speaker, a signal generator, a microphone, and an oscilloscope. The speaker is driven by a signal generator which produces a sinusoidal voltage of adjustable frequency and amplitude. Note that there are both coarse and fine adjust knobs for the frequency, as well as "decade" buttons which can adjust the frequency by factors of 10.



Function Generator

Connect the signal generator directly to the oscilloscope and turn it on. Adjust the amplitude of the signal generator and the scales of the oscilloscope so that you see a couple of complete sine waves on your scope.

- Write down the frequency setting of the signal generator:

- From the oscilloscope trace, calculate the period of the alternating voltage signal.

- From this, calculate the frequency.

- Does your oscilloscope measurement match the setting on the signal generator? If not, why not?

Turn down the amplitude on the signal generator. Now connect the signal generator to the speaker, and connect the microphone to the oscilloscope. Turn the volts/div knob on the oscilloscope all the way up, to maximize its sensitivity. Place the microphone near the speaker and adjust the signal generator amplitude up until you can see a signal. Adjust the frequency and amplitude until you can hear a mid-range tone at a quiet but audible volume.

- Record the frequency setting on the signal generator:

- Calculate the period and frequency of the wave from the oscilloscope.

- Do they match? If not, why not?

Devise and carry out a simple method with this equipment to experimentally measure the frequency range of your own hearing (which means to identify the highest and lowest frequencies you can easily detect with your ears) and those of your partners. Record your results in the table below.

Lab Partner	Lowest Frequency	Highest Frequency

- Is this range the same for everyone in your group?

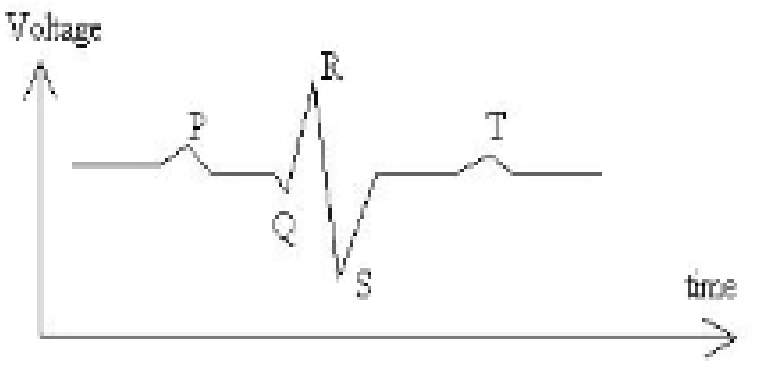
When you are done with this part, turn off the little switch on the microphone to save the batteries.

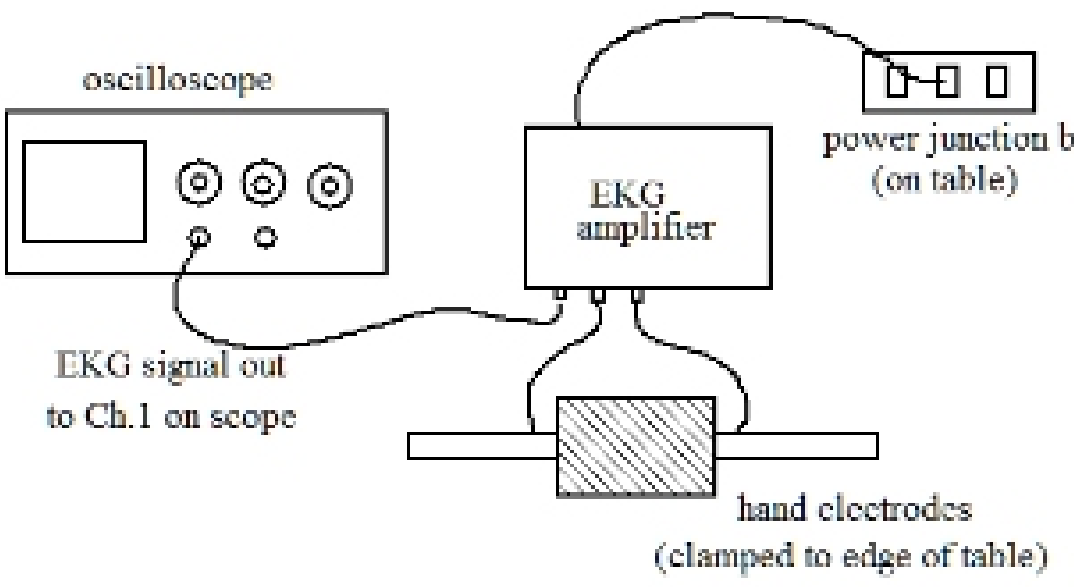
PART II: LOOKING AT YOUR HEARTBEAT

Every living person's heart produces electrical signals that can be measured on the surface of the skin. An EKG (electrocardiograph) is an instrument that can measure these signals and produce a visual image (and sometimes an audible sound, as in the "beep … beep … beep …" you hear in movies). Your goal for this experiment is to obtain an accurate recording of this voltage signal from one of your lab mates, and to determine what things affect this signal. Our makeshift electrocardiograph is an oscilloscope with two large copper terminals and an amplifier (some details are in your textbook, section 17-11).

Your heart is a complicated electrochemical machine that produces time-varying voltages as it beats. These heart voltages produce small voltage differences between points on your skin that can be measured and used to diagnose the condition of your heart. Usually nine electrodes, positioned at various points of the patient's body, are used when recording a full electrocardiogram. However, in this lab, we will only use two electrodes to measure ΔV between your right and left hands.

A typical plot of voltage difference between two points on the human body vs. time is shown in the figure to the right. The **P** deflection corresponds to the contraction of the atria at the start of the heart beat. The **QRS** group corresponds to the contraction of the ventricles. The **T** deflection corresponds to a recovery (or re-polarization) of the heart cells in preparation for the next beat. Every heart pattern is slightly different, and the interpretation of an EKG requires experience with many patients.





The EKG apparatus that you will use consists of two electrodes, an amplifier, and a storage oscilloscope. Signals travel from the hands, one placed on each electrode, to the EKG amplifier and then on to the oscilloscope. The voltage that is measured is the potential difference between the two electrodes. However, the voltage difference between your hands is inconveniently small to measure directly. To compensate for this, the signal from the electrodes is given a boost by the amplifier.

OSCILLOSCOPE SETUP

1. The oscilloscope needs to be switched from "AC" to "DC" (right above the BNC input).
2. The volts/division dial should be set at **0.1** and the time/division dial should be set at **0.1**.