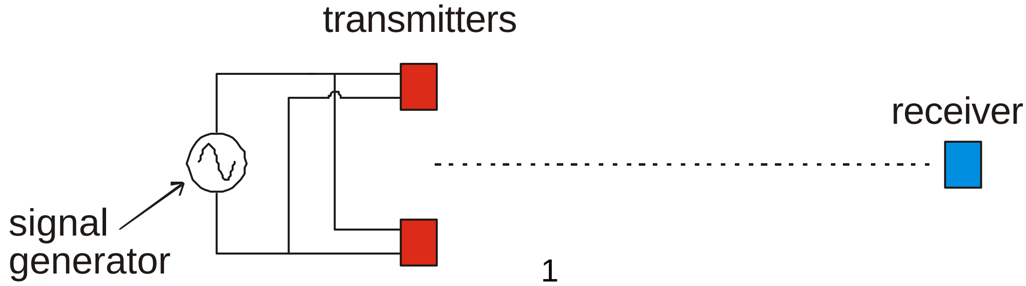
Experiments with Ultra-Sound

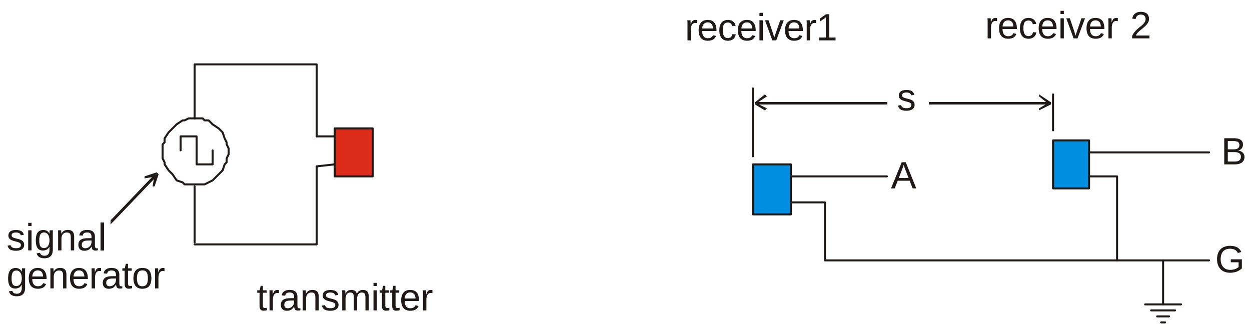
The term "ultra-sound" refers to longitudinal waves (usually in air) which have a frequency which is too high for them to be detected by the human ear. The u.s. transmitters used in these experiments have a frequency of 40 kHz (the highest frequency you can hear is certainly less than 20 kHz).

1. **Preparation:**
   a) You must know what we mean by: coherent sources, constructive and destructive interference, resonance, standing or stationary wave.
   b) Revise Young's "double-slit" experiment, especially the equation relating fringe separation to wavelength.
   c) Learn the relation between the frequency, wavelength and speed of propagation of a travelling wave.
   d) See parts 4 and 5.

2. You will do three experiments; two experiments to measure the wavelength of the u.s. waves and one to measure their speed of propagation.
   i) Connect one u.s. transmitter to a signal generator set to 40 kHz sine wave. Direct the waves towards a reflecting surface so as to produce a stationary wave by reflection. Connect one u.s. receiver to an oscilloscope and use it to detect the presence of the nodes and anti-nodes of the stationary wave. Move the screen slowly away from the transmitter. Find the distance between adjacent nodes of the stationary wave pattern and then use the fact that the distance between adjacent nodes is half of a wavelength.
   ii) Using two u.s. transmitters and one receiver, do an experiment similar (in some ways) to Young's "double-slit" experiment. Measure the "fringe separation" for fringes *near to the centre line* of the apparatus. See the diagram below. Signal generator set to 40 kHz sine wave output.



iii) Using ONE u.s. transmitter and TWO receivers, measure the speed of propagation of the waves as shown below.



Set the signal generator to “SQUARE WAVE” output at about 300 Hz

Use an oscilloscope to measure the time between waves arriving at receiver 1 and receiver 2, for a range of distances, s. Calculate the speed of propagation of the waves using the usual equation $v = s/t$.

Point A is connected to one input of the oscilloscope, point B to the other input and G to oscilloscope ground.

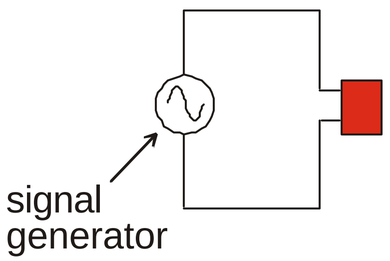
3. Use your results to verify the relation between the frequency, wavelength and speed of propagation of waves, assuming that the frequency is very close to 40 kHz.

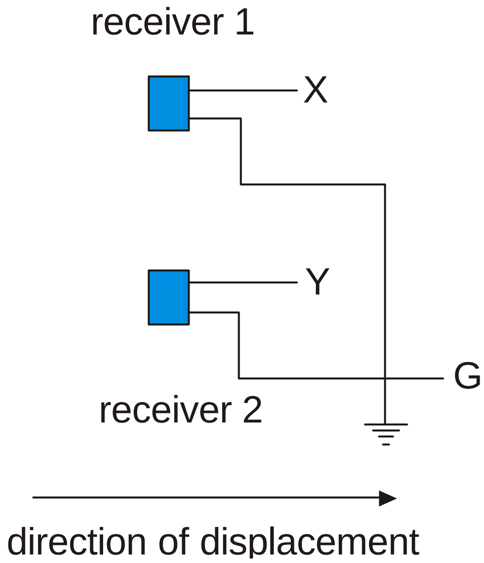
4. In the third experiment, you are advised to set the signal generator to give a “square wave” at about 300 Hz but the oscilloscope shows *damped sinusoidal oscillations of much higher frequency.* How can this be explained ?

5. Read about “Lissajou's figures”.

Alternative method of measuring wavelength.

Set signal generator to 40 kHz sine wave and oscilloscope to “X Y”.





Slowly displace one of the receivers in the direction shown in the diagram. Observe how the image on the oscilloscope screen changes as the receiver is being displaced. How can this be used to measure the wavelength of the u.s. ?