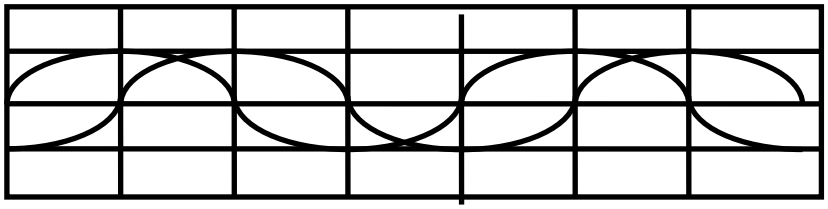
04 Oscillations and waves review questions

Part A: SHM:

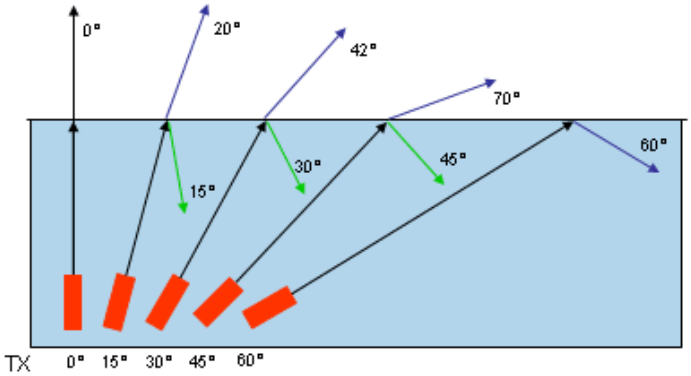
1. The condition for SHM can be simplified to this relationship:
   "Acceleration is proportional to negative displacement or a = -kx where k is constant"
   a. State the conditions necessary for SHM.
   b. Explain the significance of the minus in the above relationship.
2. A student connects a signal generator output to a cathode ray oscilloscope input. He gets the following traces on the oscilloscope using a time base of 5 ms per division and a voltage scale of 2 Volts per division.



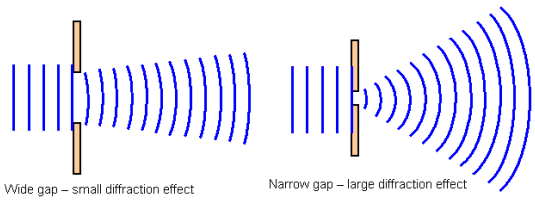
a. Calculate the period, frequency and amplitude of the signals.
b. What is the phase difference between the signals.

Part B: Wave characteristics and properties

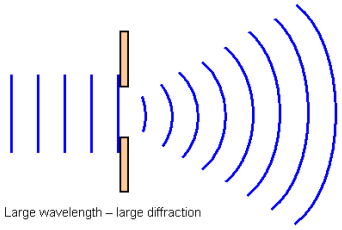
1. In an experiment lasers are used so that 5 light rays are travelling through a glass block as shown opposite.
   a. Redraw the 45° ray to include a normal line and label the angle of incidence, reflection and refraction.
   b. Calculate the refractive index of the glass block.
   c. Label the ray showing total internal reflection and calculate the critical angle for the block.



2. A light wave ($c=3.0\times10^{8}$ m/s, $f=1\times10^{15}$ Hz) travels into a glass block of refractive index n=1.4. The incident angle is 20°. Draw an accurate ray diagram of the refraction that occurs. State also the speed of light and the wavelength of the light in the glass.

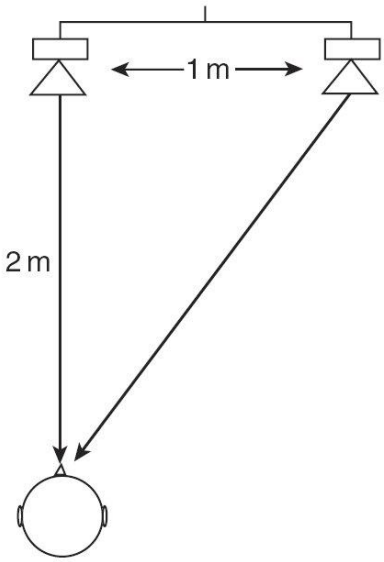


3. The wave front diagrams opposite show diffraction of a wave as it passes through a gap.
   a. Explain why the first picture shows a moderate amount of diffraction.
   b. Explain why the second two pictures show similar amounts of diffraction.



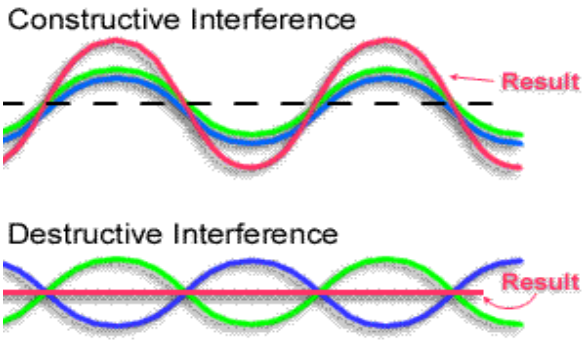
4. Two loudspeakers are positioned as shown on the next page. Pairs of identical notes are played through both loudspeakers simultaneously. The listener notes how loud the sound seems and then the frequency is changed. The listener notices that some notes are louder than others.
   a. Calculate the path difference for the listener from the two speakers.

b. State the value of the path difference in terms of wavelength that creates destructive interference.



c. Calculate the wavelength for the lowest pitch note that is quiet.

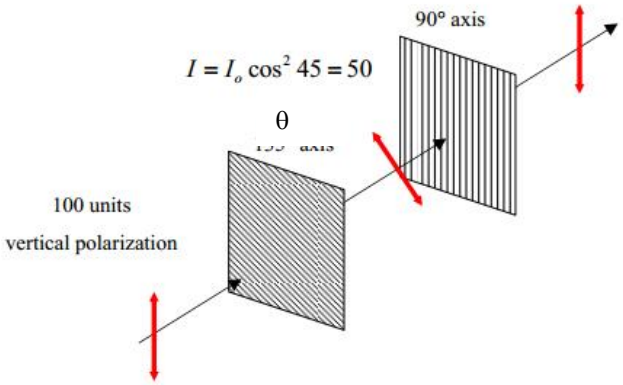
d. Using a speed of sound of 330 ms^{-1} calculate the frequency of this note.



5. A water wave approaches a wall. The water wave has a speed of 2m/s and a frequency of 1Hz.
   (a) What is its wavelength?
   (b) The wave direction is straight into the wall and the water wave reflects. Explain why there will be places in the water where the wave height will be large and places where it will be small.

Part C: Polarization and Intensity

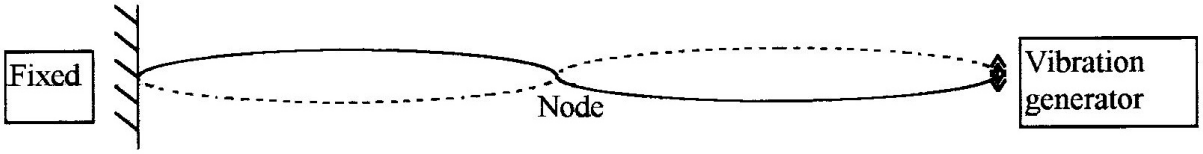
1. Light can be polarized by reflection off water. Use this fact to explain at what angle the plane of polarization of the sunglasses would be compared to the plane of polarization of the reflected light.
2. Consider the diagram opposite and calculate the intensity of radiation in units that would pass through the second filter.



3. A radio transmitter is in operation. 10km away the intensity of the radiation is $2x10^{-5}Wm^{-2}$.
   i) At a distance of 20km what will the intensity be?
   ii) By what factor will the amplitude of the signal have decreased?

Part D: Standing waves:

1. A string is connected to a vibration generator and the standing wave formed is shown below.



Sketch the wave that would form if:

(a) The string was doubled in length.

(b) The frequency of the vibration generator was increased by 50%.

(c) The string was put under a tension that doubled the speed of the wave along the string.

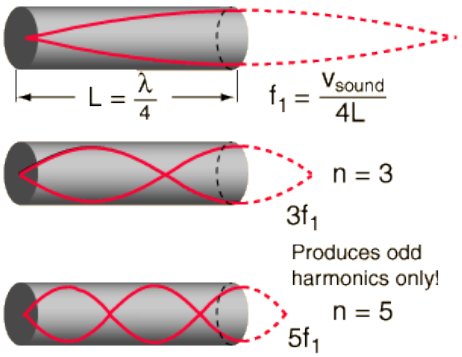
(d) The string was made heavier so that the speed of the wave along the string halved.

(e)In which of the situations above is the string vibrating at the fundamental frequency (first harmonic)

(f) What is happening to the wave at the fixed point?

2. Standing waves can be set up in open ended pipes. When the wave reached the end it reflects but in a different way to the reflection at a closed end or at the end of a string standing wave. A high pressure pulse reaching the end will cause a low pressure pulse to bounce back and vice-versa.

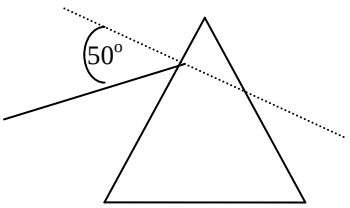
Which line of the table is correct:?



Type of end	Open	Closed
Behaviour of wave at end	Node	Node
	Node	Antinode
	Antinode	Node
	Antinode	Antinode

Extension question:

A white light ray is incident on an equilateral glass prism of refractive as shown in the diagram. The refractive index of the glass is 1.40 for red light and 1.42 for violet.



(a) At what angle will the red light leave the block?

(b) At what angle will the violet light leave the block?

(c) Over how many degrees is the visible spectrum dispersed?