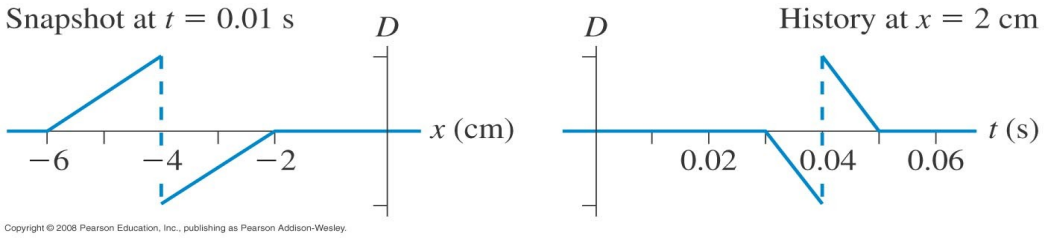
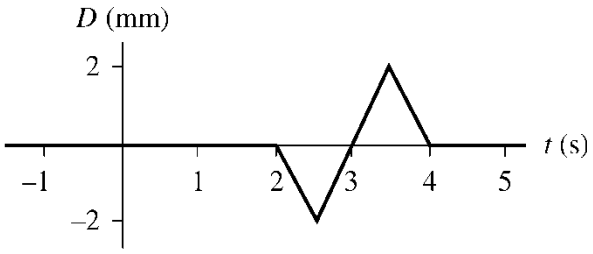
PHYC10007 Physics for Biomedicine
Tutorial Sheet 11 — *Waves and Optics*

Last updated: 24/12/2019

1. The figure below shows a snapshot graph and a history graph for a wave pulse on a stretched string. They describe the same wave.
   (a) In which direction is the wave travelling?
   (b) What is the speed of this wave?

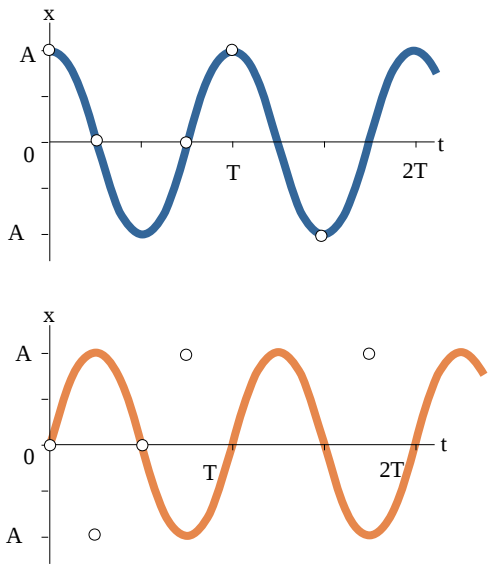


2. The figure below shows a wave travelling with positive velocity of 2 m/s. Plot the snapshot graph for this wave, at time $t = 0$ s.



History graph at $x = 8$ m

3. The position-time graphs for two identical simple harmonic oscillators are shown at right.
   (a) What is the difference in phase between the two?
   (b) What is the phase at each of the indicated points on the curves?



4. (a) Write an equation describing a sinusoidal transverse water wave travelling in the negative x direction with wavelength 10 cm, frequency 400 Hz and amplitude 2 cm.
   (b) What is the transverse speed of a water molecule at an instant when that molecule is displaced 1 cm from its rest position?

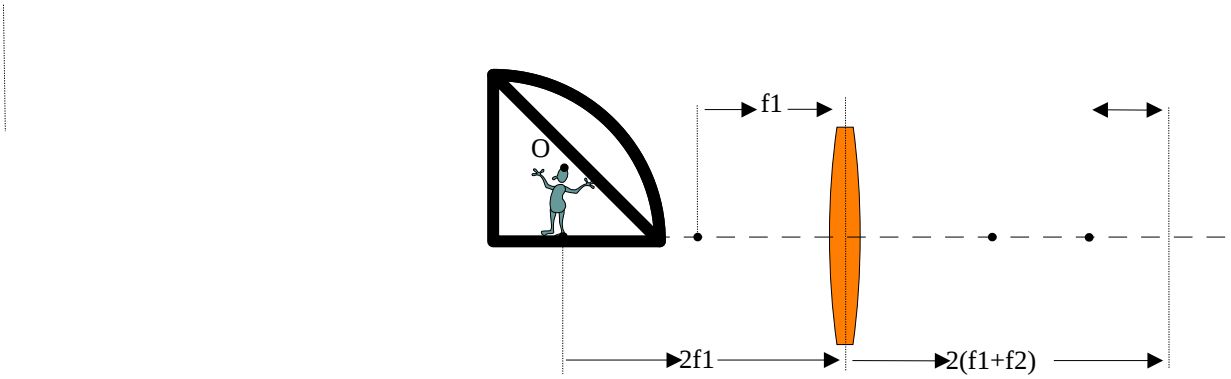
5. Red light, wavelength λ=612 nm in vacuum, travels 1.57μm in a medium of index 1.51. Find:
   (a) The wavelength in the medium.
   (b) The velocity of the light in the medium.

(c) The phase difference after passing through the medium, relative to travelling the same distance in vacuum.

6. Ocean waves, wavelength 100 m, have period 8.0 s. A motorboat heads into the waves at 9 m/s.

(a) What is the wave speed relative to (i) the land; (ii) the boat?

f2



(b) With what frequency do wave crests hit the front of the boat?

7. An upright object O is placed at a distance of twice the focal length in front of a converging lens (focal length f_1). On the other side of the lens is a converging mirror of focal length f_2 separated from the lens by a distance $2(f_1+f_2)$, similar to the figure (which is not to scale):

a) Find the location, nature (real or virtual), and relative size of the final image after passing completely through the optical system.
b) Draw the appropriate ray diagram.

8. The apparent depth of a swimming pool depends on the angle of viewing. Suppose that a coin is placed at the bottom of a swimming pool filled with water (n_{water} = 1.33) to a depth of 2.16m. Find the apparent depth of the coin below the surface when viewed

(a) At near normal incidence
(b) By rays that leave the coin making an angle of 35° with the normal to the bottom of the pool.

Answers:

1(a) to right; (b) 2m/s
3(a) $\pi/2$; (b) Upper, if $\cos(\phi)$ then $\phi = 0, \pi/2, 3\pi/2, 2\pi$, lower $\phi = \pi/2, \pi, 2\pi, 4\pi$
4(a) $y = 0.02\sin((\pi/0.05)x + 800\pi t + \phi_0)$; (b) 21.8m/s
5(a) 405nm; (b) $2\times10^8 m/s$; (c) 8.24 radians
6(a) 12.5m/s and 21.5m/s; (b) 0.215 Hz
8(a) 1.62m; (b) 1.27m.