L2 Physics: Problems on waves

The speed of sound is $340\,\mathrm{m\,s^{-1}}$ in air.

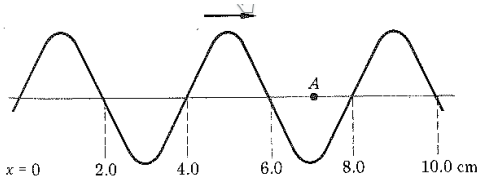
Sections 1.1-1.2

1. A radio station sends out radio waves with frequency 750 kHz. All radio waves travel with a speed of $3.0 \times 10^8\,\mathrm{m\,s^{-1}}$. How far apart are the crests of the wave sent out by the station?

2. A television station sends out radio waves with frequency 750 MHz. All radio waves travel with a speed of $3.0 \times 10^8\,\mathrm{m\,s^{-1}}$. How far apart are the crests of the wave sent out by the station?

3. A wave has wavelength 2 cm; at a given point, 25 wave crests per second are observed. Calculate (a) the frequency of the wave; (b) the speed of the wave; (c) the time between observed wave crests.

4. The wave shown below is travelling to the right with a speed of $2.00\,\mathrm{m\,s^{-1}}$. How long after the instant shown will the crest on the left have moved to the position of the crest on the right?

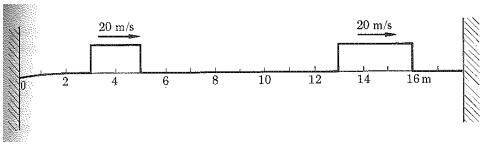


5. If the same wave is slowed so that it is moving at a speed of $100\,\mathrm{cm\,s^{-1}}$, how many crests per second will pass point A?

6. What frequency must a sound source have if the wavelength of its sound is to be 3.0 cm?

Sections 1.3-1.4

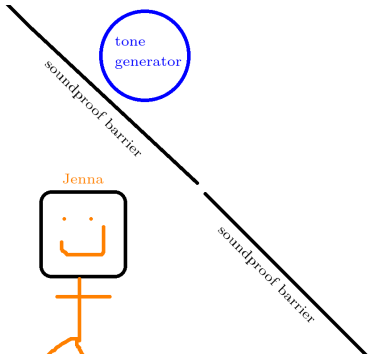
1. The two pulses in the igure are moving down the string at $2.0\,\mathrm{m\,s^{-1}}$ each. Sketch the position of the string (a) after 0.40 s; (b) after 0.20 s.



2. Two waves moving in opposite directions can interfere with each other in such a way that no net movement is seen; this is called an *standing wave*. Give a simple example of an experiment you could set up to show this.

3. Describe a water-wave experiment which illustrates the phenomenon of diffraction.

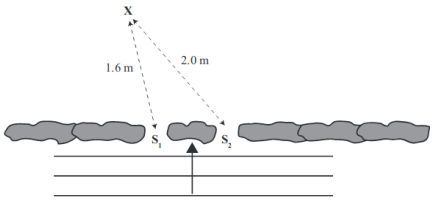
4. Jenna is conducting an experiment; she places a tone generator (a machine that generates a particular frequency of wave) on the other side of a narrow slit in a sound-proof barrier. She notices that, if the generator is placed around the corner as in the following diagram, the sound of the generator is much louder when it is set to a lower frequency. Explain this observation.



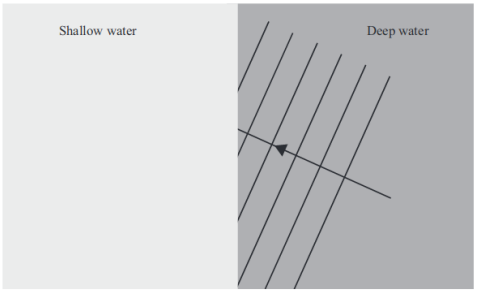
5. Two identical sound sources are at the coordinate origin and send 70 cm wavelength waves out. One source is now moved slowly to the left (to negative x–values). For an observer at point $x = 20\,\text{m}$ on the x–axis, what positions of the moving source give rise to (a) the loudest and (b) the quietest observed sound? (Assume the sources are in phase.)

6. Two identical sources with unknown wavelength are on the x–axis some distance apart. One of the sources is moved away from the observer (who is also on the x–axis, but some way away).
   (a) Draw a diagram and annotate it to explain why the observer hears alternating loud and weak sounds.
   (b) If the source moves 30 cm between observed loud sounds, what is the wavelength of the sound?

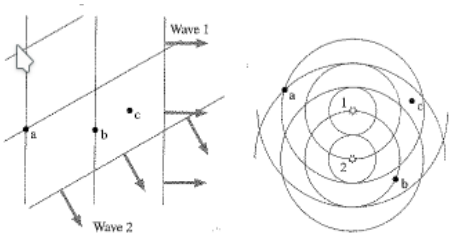
7. At a given place there are two gaps, labelled S_1 and S_2, in a line of rocks. A set of waves passes through the rocks, creating an interference pattern. The difference between the distance between points S_1 and X, and the distance between S_2 and X, is 0.40 m. The wave speed is $0.80\,\text{m}\,\text{s}^{-1}$, and one reaches the wall each second. Is X at a node or an antinode? Explain your answer.



8. Water waves travel from deep to shallow water. The wave-fronts of the wave hit the boundary between the depths at a shallow angle. Draw a diagram showing the relation of the wavefronts leaving the boundary to those reaching it. Which phenomenon does your diagram illustrate?



9. Consider the following systems of waves.



   (a) In the left-hand system, both waves have an amplitude of 2.0 mm and the same wavelength. What is the net displacement of the medium at points a, b, and c?
   (b) In the right-hand system, both circular waves are in phase. Are a, b, and c points of maximum constructive interference, points of maximum destructive interference, or in between?

10. Noise-cancelling headphones are an application of destructive interference. Each side of the headphones uses a microphone to pick up noise, delays it slightly, and then rebroadcasts it to your ear where it can interfere with the incoming sound wave of the noise. Suppose you are sitting 1.5 m from an annoying 120 Hz buzzing sound. What is the minimum headphone delay, in milliseconds, that will cancel this noise?