2 Sound and Light

8/12:

1) Young and Freedman (2019): Problem 15.25.

A jet plane at takeoff can produce sound of intensity $10.0\,\mathrm{W/m^2}$ at 30.0 m away. But you prefer the tranquil sound of normal conversation, which is $1.0\,\mu\mathrm{W/m^2}$. Assume that the plane behaves like a point source of sound.

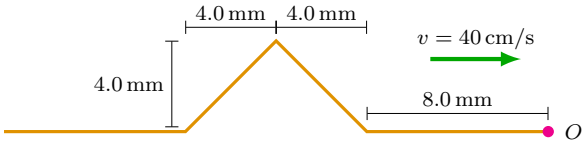
(a) What is the closest distance you should live from the airport runway to preserve your peace of mind?

(b) What intensity from the jet does your friend experience if she lives twice as far from the runway as you do?

(c) What power of sound does the jet produce at takeoff?

2) Young and Freedman (2019): Problem 15.28.

Reflection. A wave pulse on a string has the dimensions shown in the following figure at $t = 0$. The wave speed is 40 cm/s.



(a) If point O is a fixed end, draw the total wave on the string at $t = 15\,\mathrm{ms}$, 20 ms, 25 ms, 30 ms, 35 ms, 40 ms, and 45 ms.

(b) Repeat part (a) for the case in which point O is a free end.

3) Young and Freedman (2019): Problem 16.24.

The fundamental frequency of a pipe that is open at both ends is 524 Hz.

(a) How long is the pipe?

If one end is now closed, find the new fundamental's

(b) Wavelength;

(c) Frequency.

4) Young and Freedman (2019): Problem 16.35.

Two loudspeakers, A and B, are driven by the same amplifier and emit sinusoidal waves in phase. Speaker B is 12.0 m to the right of speaker A. The frequency of the waves emitted by each speaker is 688 Hz. You are standing between the speakers, along the line connecting them, and are at a point of constructive interference. How far must you walk toward speaker B to move to a point of destructive interference?

5) Young and Freedman (2019): Problem 16.50.

The siren of a fire engine that is driving northward at 30.0 m/s emits a sound of frequency 2 000 Hz. A truck in front of this fire engine is moving northward at 20.0 m/s.

(a) What is the frequency of the siren's sound that the fire engine driver hears reflected from the back of the truck?

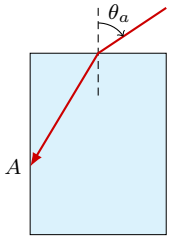
(b) What wavelength would this driver measure for these reflected sound waves?

6) Young and Freedman (2019): Problem 16.62.

A bat flies toward a wall, emitting a steady sound of frequency 1.70 kHz. This bat hears its own sound plus the sound reflected by the wall. How fast should the bat fly in order to hear a beat frequency of 8.00 Hz?

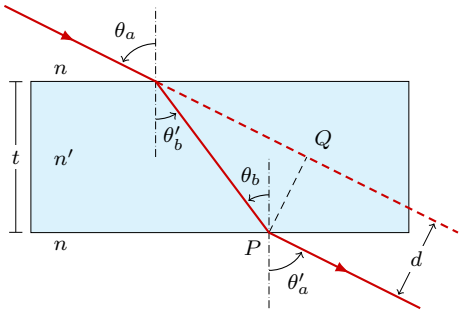
7) Young and Freedman (2019): Problem 33.39.

A ray of light is incident in air on a block of a transparent solid whose index of refraction is n. If $n = 1.38$, what is the *largest* angle of incidence θ_a for which total internal reflection will occur at the vertical face (point A in the below figure)?



8) Young and Freedman (2019): Problem 33.52.

Light is incident in air at an angle θ_a on the upper surface of a transparent plate, the surfaces of the plate being plane and parallel to each other.



(a) Prove that $\theta_a = \theta'_a$.

(b) Show that this is true for any number of different parallel plates.

(c) Prove that the lateral displacement d of the emergent beam is given by the relationship

$$d = t \cdot \frac{\sin(\theta_a - \theta'_b)}{\cos\theta'_b}$$

where t is the thickness of the plate.

(d) A ray of light is incident at an angle of 66.0° on one surface of a glass plate 2.40 cm thick with an index of refraction of 1.80. The medium on either side of the plate is air. Find the lateral displacement between the incident and emergent waves.

9) An airplane has a defective speedometer. In order to figure out how fast the plane is flying, the pilot (an aspiring opera singer) leans out the window and sings "middle C" (a note of frequency 262 Hz) at a mountain looming ahead. The echo off the mountain is heard by the pilot as "middle A" (frequency 440 Hz). How fast is the plane flying?