Unless otherwise stated, assume propagation in air, 1 atm, 20°C, c = 343 m/sec $\rho_0 c = 415$ Pa · sec/m

(1) A large plane circular piston with radius $a = 0.1$ meters radiates into air (1 atm, 20° C) at a frequency of 4 kHz.

   (a) How many _far field_ null angles are present between $\theta = 0°$ and 90° ? What are the angles?

   (b) Determine the extent of the _near field_ for this piston, based on the _near field_ pressure maxima (r_1) located the farthest from the piston.

(2) Two small spherical sources of sound ($ka\ll 1$) are radiating with frequency 250 Hz into air (1 atm, 20° C). The two sources are electrically driven in phase with each other. Assume that no reflections are present.

   Source #1 is located at (X, Y) coordinates (+10 meters, +10 meters)

   Source #2 is located at coordinates (-15 meters, -20 meters).

   A receiver is located at the origin (0 meters, 0 meters).

   The two sources and the receiver lie in the same plane (Z=0).

   When operating individually, each source can produce a pressure amplitude of 0.1 Pa when measured 1 meter away.

   (a) Determine the pressure amplitude received at the origin (0, 0) for:

      (i) Source #1 acting alone

      (ii) Source #2 acting alone

   (b) Taking into account the geometrical path length difference between the sources and the receiver, determine the total pressure amplitude at the origin due to the two sources acting simultaneously.

(3) An industrial worker sustains the following noise exposure:

   1.5 hours at 97 dBA   +   0.5 hour at 100 dBA   +   0.5 hour at 102 dBA

   Does this exposure exceed the OSHA industrial noise guidelines? Why or why not?

(4) A rectangular room has floor dimensions 10 meters by 20 meters, and a ceiling height of 5 meters. The floor absorption characteristic is "Floor, wooden", and the four walls are "Concrete block, no paint" (refer to Table 12.5.1 in the textbook).

  (a) If the ceiling material has absorptivity 0.2, determine the Sabine reverberation time (T_{60}) at 500 Hz.

  (b) If the ceiling absorptivity is increased to 0.999, what does the 500 Hz T_{60} become?