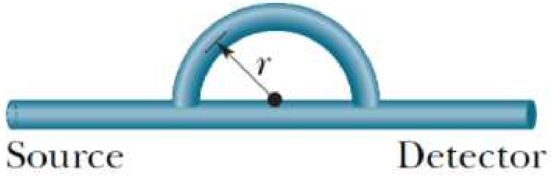
GPN1-QA6

Problem 1

In the figure, sound with a 40.0 cm wavelength travels rightward from a source and through a tube that consists of a straight portion and a half-circle. Part of the sound wave travels through the half-circle and then rejoins the rest of the wave, which goes directly through the straight portion. This rejoining results in interference. What is the smallest radius r that results in an intensity minimum at the detector? (01小題)



r_{min}=______ cm

01: **ANS:=17.5**

At the location of the detector, the phase difference between the wave which travel straight down the tube and the other one which took the semi-circular detour is

$$\Delta\phi = k\Delta d = \frac{2\pi}{\lambda}(\pi r - 2r).$$

For $r = r_{\min}$ we have $\Delta\phi = \pi$, which is the smallest phase difference for a destructi interference to occur. Thus,

$$r_{\min} = \frac{\lambda}{2(\pi - 2)} = \frac{40.0\,\text{cm}}{2(\pi - 2)} = 17.5\,\text{cm}.$$

Two identical piano wires have a fundamental frequency of 600 Hz when kept under the same tension. What fractional increase in the tension of one wire will lead to the occurrence of 6.0 beats/s when both wires oscillate simultaneously?兩根相同的鋼琴線在相同張力下的基頻為 600 Hz。 當兩根線同時振盪時，一根線的張力增加多少會導致 6.0 次/秒？ (01小題)

$\frac{\Delta\tau}{\tau}$=______

02: **ANS:=0.02**

$\lambda = 2L \quad f = v/\lambda = (1/2L)\sqrt{\tau/\mu}$,

$v = \sqrt{\tau/\mu}$ $\quad f_1 = 600$ Hz and $f_2 = 606$ Hz.

$f_1 = (1/2L)\sqrt{\tau/\mu} \quad f_2 = (1/2L)\sqrt{(\tau+\Delta\tau/\mu}$

$f_2/f_1 = \sqrt{(\tau+\Delta\tau)/\tau} = \sqrt{1+(\Delta\tau/\tau)}$.

$\Delta\tau/\tau = (f_2/f_1)^2 - 1$

$= [(606\,\text{Hz})/(600\,\text{Hz})]^2 - 1$

$= 0.020.$

Two sounds differ in sound level by 1.00 dB.What is the ratio of the greater intensity to the smaller intensity?兩種聲音的聲級相差 1.00 dB。強度較大與強度較小的比率是多少？ (01小題)

$\Delta\beta$=_____

03: **ANS:=1.26**

$$\Delta\beta = 10\log(\mathcal{R}) \Rightarrow \mathcal{R} = 10^{\Delta\beta/10} = 10^{0.1} = 1.26.$$

Problem 1

A 1.0 W point source emits sound waves isotropically. Assuming that the energy of the waves is conserved, find the intensity (a) 1.0 m from the source and (b) 2.5 m from the source.1.0 W 點源可各向同性地發射聲波。 假設波的能量是守恆的，求強度 (a) 距源 1.0 m 和 (b) 距源 2.5 m。 (02小題)

(a)I=____ W/m^2

04: **ANS:=0.08**

(b)I'=____ W/m^2

05: **ANS:=0.013**

(a) Since intensity is power divided by area, and for an isotropic source the area may be written $A = 4\pi r^2$ (the area of a sphere), then we have

$$I = \frac{P}{A} = \frac{1.0\,\text{W}}{4\pi(1.0\,\text{m})^2} = 0.080\,\text{W/m}^2.$$

(b) This calculation may be done exactly as shown in part (a) (but with $r = 2.5$ m instead of $r = 1.0$ m), or it may be done by setting up a ratio. We illustrate the latter approach. Thus,

$$\frac{I'}{I} = \frac{P/4\pi(r')^2}{P/4\pi r^2} = \left(\frac{r}{r'}\right)^2$$

leads to $I' = (0.080\text{ W/m}^2)(1.0/2.5)^2 = 0.013\text{ W/m}^2$.

A sound wave of frequency 300 Hz has an intensity of $1.00 \mu W/m^2$. What is the amplitude of the air oscillations caused by this wave? (01小題)

S_m=_____ m

06: **ANS:=3.68E-8**

$$I = \frac{1}{2}\rho v \omega^2 s_m^2.$$

The intensity is given by $I = \frac{1}{2}\rho v \omega^2 s_m^2$, where ρ is the density of air, v is the speed of sound in air, ω is the angular frequency, and s_m is the displacement amplitude for the sound wave. Replace ω with $2\pi f$ and solve for s_m:

$$s_m = \sqrt{\frac{I}{2\pi^2 \rho v f^2}} = \sqrt{\frac{1.00\times10^{-6}\ \text{W/m}^2}{2\pi^2(1.21\,\text{kg/m}^3)(343\,\text{m/s})(300\,\text{Hz})^2}} = 3.68\times10^{-8}\ \text{m}.$$

Earthquakes generate sound waves inside Earth. Unlike a gas, Earth can experience both transverse (S) and longitudinal (P) sound waves. Typically, the speed of S waves is about 4.5 km/s, and that of P waves 8.0 km/s. A seismograph records P and S waves from an earthquake. The first P waves arrive 3.0 min before the first S waves. If the waves travel in a straight line, how far away does the earthquake occur? (01小題)

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the distance=_____ m

07: **ANS:=<u>1.9E6</u>**

If d is the distance from the location of the earthquake to the seismograph and v_s is the speed of the S waves then the time for these waves to reach the seismograph is $t_S. = d/v_S$. Similarly, the time for P waves to reach the seismograph is $t_P = d/v_P$. The time delay is

$$\Delta t = (d/v_S) - (d/v_P) = d(v_P - v_S)/v_S v_P,$$

so

$$d = \frac{v_s v_p \Delta t}{(v_p - v_s)} = \frac{(4.5\ \text{km/s})(8.0\,\text{km/s})(3.0\,\text{min})(60\,\text{s/min})}{8.0\,\text{km/s} - 4.5\,\text{km/s}} = 1.9 \times 10^3\ \text{km}.$$

We note that values for the speeds were substituted as given, in km/s, but that the value for the time delay was converted from minutes to seconds.