SOUND

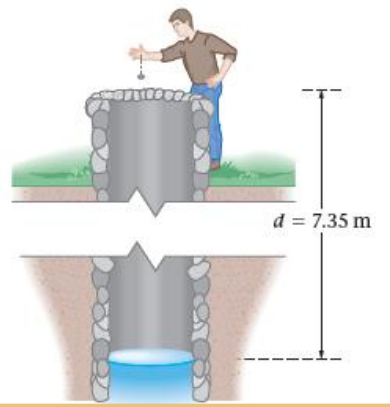
1 Calculate the speed of sound in air at STP. What will be the speed of sound at 37 ^{0}C (given that P = 1.01 x 10^5 N/m^2, taking γ = 1.40 and ρ = 1.29 kg/m^3). [

2 Find the speed of sound in air at the temperature of 27 ^{0}C .
[Given γ =1.42, R = 8.313 j/mol-K, molecular mass of air 28.8 x 10^{-3} Kg/ mol]
[350.66 m/s] [Ans V = 333.44 m/s , V_t = 355.31 m/s]

3 A sound wave of frequency 500Hz in air enters from a region of temperature 25 ℃ to a region of temperature 5 ℃. Calculate the percent fractional change in wavelength.

[3.414 %]

4 You drop a stone from rest into a well that is 7.35 m deep. How much time elapses before you hear the splash? [speed of sound in air is 343 m/s]



$$d = \frac{1}{2}gt_1^2$$

$$t_1 = \sqrt{\frac{2d}{g}} = \sqrt{\frac{2(7.35\ \text{m})}{9.81\ \text{m/s}^2}} = 1.22\ \text{s}$$

$$d = vt_2$$

$$t_2 = \frac{d}{v} = \frac{7.35\ \text{m}}{343\ \text{m/s}} = 0.0214\ \text{s}$$

$$t = t_1 + t_2 = 1.22\ \text{s} + 0.0214\ \text{s} = 1.24\ \text{s}$$

5 The speed of sound in air at 0°C is 332m/s. What will be its speed of 25°C?
[346.86m/s]

6 A 256 Hz tuning produces four beats per second when sounded, with another fork of unknown frequency. What are two possible values for the unknown frequency? [252 Hz, 256 Hz]

7 Calculate the speed of sound in air at atmospheric pressure P = 1.01 x 10^5 N/m^2, taking γ = 1.40 and ρ = 1.2 kg/m^3. [343.3 m/s]

8 Two sound waves of wavelengths 80cm and 81 cm produce 5 beats per second in air. Find the speed of sound.

[Hint $f_b = f_1 - f_2$, $f_b = \frac{V}{\lambda_1} - \frac{V}{\lambda_2}$ Ans V = 312 .5 m/s]

WAVES

1 A wave has a wavelength of 3.0 m. Calculate the frequency of the wave if it is (a) a sound wave and (b) a light wave. Take the speed of sound as 343 m/s and the speed of light as 3.0×10^8 m/s.

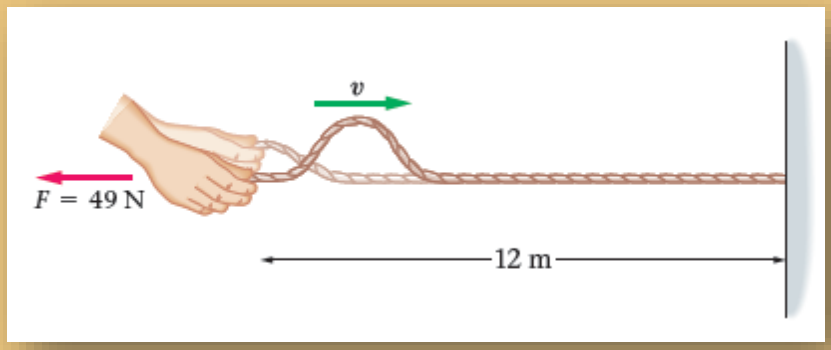
2 A typical guitar string has a mass per length of 0.401×10^{-3} kg/m and is tightened to a tension of 71.4 N. What is the speed of waves on the string? [422 m/s]

3 A piano string 1.10 m long has a mass of 9.00 g. (*a*) How much tension must the string be under if it is to vibrate at a fundamental frequency of 131 Hz? (*b*) What are the frequencies of the first four harmonics? [679 N , 262, 393, and 524 Hz]

4 A 12-m rope is pulled tight with a tension of 49 N. When one end is given a quick "flick," a wave is generated that takes 0.54 s to travel to the other end of the rope. What is the mass of the rope? [Hint v = d / t then find mass, Ans = 1.2 kg]

5 A standing wave is establish in a 2.4 m long string fixed at both ends. The string vibrates in four segments when driven at 200 Hz. Determine (i) the wavelength (ii) the fundamental frequency. [1.2 m , 50 Hz]

6 A string 2 meter long and mass 0.004 Kg is stretched horizontally by passing one of its ends over a pulley and the string is attached with one Kilogram mass to it vertically find the speed of the transverse wave on the string and the frequency of the fundamental and fifth harmonic at which the string vibrates
[70 m/s , 17.5 Hz , 35 Hz]



7 A particular harmonic wave is described by the following equation:

$$y = (0.12)\cos\left(\frac{\pi}{4}x - 8\pi t\right)$$

In this expression, *x* is measured in meters, and *t* is measured in seconds. What are the (a) amplitude, (b) wavelength, and (c) period for this wave?
[hint { $y = A\cos(kx - \omega t)$ } Ans : A = 0.12 m , λ = 8 m , T = 0.25 s]

8 The length of a stretched string is 0.4m and its mass is 1.0×10^{-4} kg. If the tension in The string is 10N, calculate (i) the velocity of the transverse wave in the string and (ii) the frequency of its fundamental node. [200 m/s, 250 Hz]

9 An open tube is 50 cm long. Find the wavelength and speed of the wave if it vibrates with a fundamental frequency of 170 vibrations/sec. [1m, 340 m/s]

10 A pipe is 2.46 m long. (a) Determine the frequencies of the first three harmonics if the pipe is open at both ends. Take 343 m/s as the speed of sound in air.
[69.7 Hz, 139 Hz, 209 Hz]

DOPPLER EFFECT

1 A car has a siren sounding a 2 kHz tone. What frequency will be detected by a stationary listener as the car is approaching him at 80 km/h? (speed of sound in air = 1200 km/h). [2.14 KHz]

2 The siren of an ambulance at rest is producing a frequency of 2000 hertz. What frequency will be heard by a listener moving towards the ambulance with a velocity of 100 km/hour? The velocity of sound in air = 1200 km/hour.
[2.166 KHz]

3 A car has its siren sounding at a 2 kHz tone. If the frequency heard by a stationary listener is 2143 Hz. Find the speed with which it approaches the stationary listener? (speed of sound 332 m/s) [22.15 m/s]

4 A source of sound and a listener are moving towards each other with velocities that are 0.5 times and 0.2 times the speed of sound, respectively. If the source is emitting a 2 kHz tone. Calculate the frequency heard by the listener. [2.4 KHz]

5 Two cars are moving straight toward each other from opposite directions at the same speed. The horn of one blowing with a frequency of 3000 Hz, and is heard by the people in the other car with a frequency of 3000 Hz; find the speed of the cars if the speed of sound in air is 340 m/s [21.25 m/s]

6 A note of frequency 650 Hz is emitted from an ambulance. What frequency will be detected by the listener if the ambulance moves (i) at the speed of 18 m/s towards the listener, (ii) at the speed of 15 m/s away from the listener[speed of sound = 340]
[Ans 665.66 Hz , 622.5 Hz]

7 A note of frequency 500 Hz is being emitted by an ambulance moving towards a listener standing on the bus stop. If the frequency heard by the listener is 526 Hz ; find the speed of the ambulance (speed of sound in air 340 m/s) [16.8 m/s]

8 A train moving at a speed of 40.0 m/s sounds its whistle, which has a frequency of 5.00 x10^2 Hz. Determine the frequency heard by a stationary observer as the train *approaches* the observer. The air temperature is 24.0 ^{0}C.
[Hint: first determine the speed of sound at 24.0 ^{0}C, then use Doppler formula]
[Ans 345 m/s 566 Hz]