

1cq1

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

- _____ 1. Bats can detect small objects such as insects that are of a size approximately that of one wavelength. If bats emit a chirp at a frequency of 60 kHz, and the speed of sound waves in air is 330 m/s, what is the smallest size insect they can detect?

- a. 1.5 mm
 b. 3.5 mm
 c. 5.5 mm
 d. 7.5 mm
 e. 9.5 mm

$$\lambda = \frac{v}{f} = \frac{330 \text{ m/s}}{60,000 \text{ Hz}} = 0.0055 \text{ m}$$

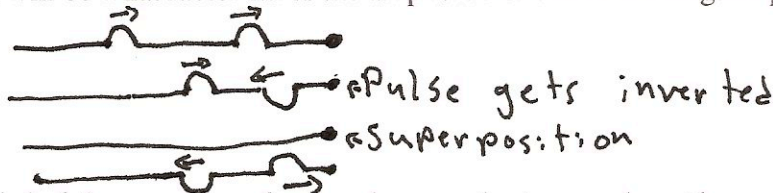
- _____ 2. A wave travels in a string at 60 m/s. A second string of 20% greater linear density has the same tension applied as in the first string. What will be the resulting wave speed in the second string?

- a. also 60 m/s
 b. 66 m/s
 c. 72 m/s
 d. 55 m/s
 e. 84 m/s

$$v_2 = \sqrt{\frac{T}{\mu_2}} = \sqrt{\frac{T}{\mu_1 \cdot 1.2}} = \sqrt{\frac{T}{\mu_1}} \cdot \sqrt{\frac{1}{1.2}} = 60 \text{ m/s} \cdot \sqrt{\frac{1}{1.2}} = 55 \text{ m/s}$$

- _____ 3. Consider two identical and symmetrical wave pulses on a string. Suppose the first pulse reaches the fixed end of the string and is reflected back and then meets the second pulse. When the two pulses overlap exactly, the superposition principle predicts that the amplitude of the resultant pulses, at that moment, will be what factor times the amplitude of one of the original pulses?

- a. 0
 b. 1
 c. 2
 d. 4
 e. 8



- _____ 4. If one-third of the members of a symphony orchestra are absent because of head colds, thus reducing the overall intensity of sound by 33%, what will be the reduction in the decibel level?

- a. 30 dB
 b. 3 dB
 c. 48 dB
 d. 1.7 dB
 e. 17 dB

$$\Delta I = 10 \log \left(\frac{I_0 - .33 I_0}{I_0} \right) = 10 \log (.67) = -1.74 \text{ dB}$$

- _____ 5. A very loud train whistle has an acoustic power output of 100 W. If the sound energy spreads out spherically, what is the intensity level in dB at a distance of 100 meters from the train? ($I_0 = 10^{-12} \text{ W/m}^2$)

- a. 78.3 dB
 b. 81.6 dB
 c. 89.0 dB
 d. 95.0 dB
 e. 112 dB

$$I = \frac{100 \text{ W}}{A} = \frac{100 \text{ W}}{4\pi \cdot (100 \text{ m})^2} = 7.96 \times 10^{-4} \frac{\text{W}}{\text{m}^2}$$

$$I \text{ dB} = 10 \log \left(\frac{7.96 \times 10^{-4} \text{ W/m}^2}{10^{-12} \text{ W/m}^2} \right) = 89.0 \text{ dB}$$

6. When I stand halfway between two speakers, with one on my left and one on my right, a musical note from the speakers gives me constructive interference. How far to my left should I move to obtain destructive interference?

- a. one-fourth of a wavelength
 b. half a wavelength
 c. one wavelength
 d. one and a half wavelengths
 e. two wavelengths

~~Constructive~~ destructive interference occurs when the right speaker is half a wavelength further away than the left. See picture below

7. The lower A on a piano has a frequency of 27.5 Hz. If the tension in the 2.0-m-long string is 304 N and one-half wavelength occupies the string, what is the mass of the string?

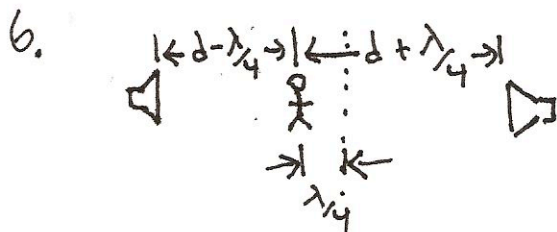
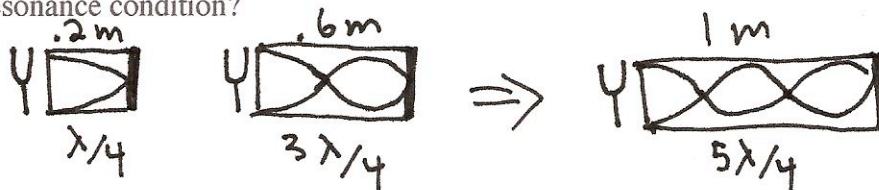
- a. 100 g
 b. 25 g
 c. 37 g
 d. 50 g
 e. 64 g

$$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}} \Rightarrow \mu = \frac{T}{(2Lf)^2}$$

$$m = \mu \cdot L = \frac{T}{4 \cdot L \cdot f^2} = \frac{304 \text{ N}}{4 \cdot 2 \text{ m} \cdot (27.5 \text{ Hz})^2} = 50 \text{ g}$$

8. A tuning fork is sounded above a resonating tube (one end closed), which resonates at a length of 0.20 m and again at 0.60 m. If the tube length were extended further, at what point will the tuning fork again create a resonance condition?

- a. 0.8 m
 b. 1.0 m
 c. 1.2 m
 d. 1.6 m
 e. 2.0 m



$$(d + \lambda/4) - (d - \lambda/4) = \lambda/2$$