Name:

Make your work clear to the grader. Show formulas used. Give correct units and significant figures. Partial credit is available if your work is clear. Point values are given in parenthesis. Exact conversions: 1 inch = 2.54 cm, 1 ft = 12 in., 1 mile = 5280 ft. Prefixes: f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}, P=10^{15}. Use g=9.80 m/s^2, 1.0 atm=101.3 kPa, speed of sound in air at 20°C is 343 m/s.

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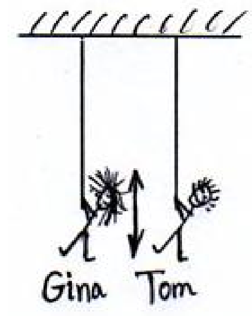
1. (8) Gina (58 kg) and Tom (92 kg) are hanging on identical bungee cords, bouncing up and down in simple harmonic motion with *equal amplitudes*.



a) (2) Whose motion has the larger period?

a. Gina b. Tom c. They have the same periods.

b) (2) Whose motion has the higher frequency?

a. Gina b. Tom c. They have the same frequencies.

c) (2) Whose motion has the greater oscillation energy? [Ignore gravity.]

a. Gina b. Tom c. They have the same oscillation energies.

d) (2) Who has the larger maximum speed?

a. Gina b. Tom c. They have the same maximum speed.

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2. (2) A mass connected to a spring has its maximum kinetic energy of oscillation when it is

a. at its maximum displacement. b. passing its equilibrium point. c. everywhere. Its KE is conserved.

3. (2) **T F** The intensity in a wave is proportional to its squared amplitude.

4. (2) **T F** In a given medium, higher frequency sinusoidal waves are associated with larger wavelengths.

5. (2) **T F** In a given medium, higher frequency sinusoidal waves travel faster than lower frequencies.

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6. (14) A car of mass 950 kg oscillates up and down at a frequency of 1.8 Hz with an amplitude of 2.5 cm when the driver gets out and there are no people in the car.

a) (4) What is the period of the oscillations, in seconds?

b) (4) How large is the effective spring constant associated with the oscillations, in N/m?

c) (4) How much energy is associated with the oscillations?

d) (2) If five people with a total mass of 350 kg get in the car, the oscillation frequency will be

a. 1.8 Hz. b. less than 1.8 Hz. c. greater than 1.8 Hz.

7. (12) A radio station emits 50.0 kW of 580 kHz radio waves, that travel at the speed of light ($v = 3.00 \times 10^8$ m/s).

a) (4) How far do the waves travel in one period?

b) (4) How many wave crests pass any chosen fixed point in space during one second?

c) (4) At a distance of 10.0 km from the radio station's antenna, about how large is the intensity of the waves?

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8. (2) A guitar string of length L is vibrating in a standing wave pattern with 4 loops. The wavelength is

a. L b. $L/2$ c. $L/4$ d. $2L$ e. $4L$.

9. (2) If λ is wavelength, the distance between adjacent nodes in any standing wave pattern is

a. λ b. $\lambda/2$ c. $\lambda/4$ d. 2λ e. 4λ.

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10. (6) An "A" guitar string should vibrate at 440.0 Hz in its fundamental standing wave. But with a tension of 98.00 N, its tone is "flat," vibrating at only 435.0 Hz. What should the tension be changed to so that the string really vibrates at 440.0 Hz?

Name:

1. (2) When the air temperature increases, the speed of sound in air

   a. does not change. b. increases. c. decreases.

2. (2) Which of these has the **highest fundamental resonant frequency**?

   a. a 1.0-m long pipe open at both ends. b. a 0.75-m long pipe open at both ends.
   c. a 1.0-m long pipe closed at one end. d. a 0.75-m long pipe closed at one end.

3. (2) Which type of musical sound source produces **only odd harmonics**?

   a. guitar string. b. piano string. c. organ pipe open at both ends. d. organ pipe closed at one end.

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4. (8) Sound in air at 20° C travels at 343 m/s, but light travels at $c = 3.00 \times 10^8$ m/s. One evening you see a lightning flash, and then hear the thunder it caused, starting 4.8 seconds later.

a) (4) How far from you is the closest point where the lightning struck?

b) (4) Why does the thunder from one lightning bolt sometimes go on and on and on? Explain.

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5. (14) A 38.0-cm long violin string is vibrating at 330.0 Hz ("E" note) in a resonance pattern with one loop. The mass of the 38.0-cm segment of string is 2.00 grams.

a) (4) What's the speed of the waves on the string?

b) (6) What tension is needed in the string?

c) (4) Where should the musician finger the string (push the string onto the neck of the violin) so that the note played becomes 492.0 Hz? [Give the resulting freely vibrating length of the string.]

6. (2) The "singing rods" demonstrated in lecture have anti-nodes

a. at one end only. b. at both ends. in the center. d. nowhere, they don't have anti-nodes.

7. (2) **T F** The wavelength of standing waves on a piano string is the same as the wavelength of the sound waves it producess in the air.

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8. (10) I saw a street musician playing saxaphone, generating 98 dB for my ears, 4.0 m from the saxaphone.

a) (4) How large was the sound intensity (W/m^2) at my ears?

b) (6) What average acoustic power was the saxaphone producing, in watts? Assume that the sound spreads isotropically from the saxaphone.

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9. (10) At a party, one person talking is producing an acoustic intensity of 45 $\mu W/m^2$ in my right ear.

a) (4) What's the sound level in decibels, in my right ear, due only to the one person talking.

b) (6) How much acoustic energy is incident on my right eardrum, of area 0.80 cm^2, while listening to the one person talk for 30.0 minutes?

Chapter 12 Equations

Sound:

In air, $v \approx (331 + 0.60\ T)$ m/s, T in °C, $v = 343$ m/s at 20°C, $d = vt$.

Sound Intensity, Level:

$I = P/A$, $I = P/4\pi r^2$, $\beta = (10 \text{ dB}) \log \frac{I}{I_0}$, $I = I_0 10^{\beta/(10 \text{ dB})}$, $I_0 = 10^{-12}$ W/m^2.

Chapter 11 Equations

Oscillators, frequency, period, etc.:

$F = -kx = ma$, $f = 1/T$, $\omega = 2\pi f = 2\pi/T$, $\omega = \sqrt{k/m}$, $\omega = \sqrt{g/L}$.

Oscillator energy, speed, etc.:

$E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kA^2 = \frac{1}{2}mv_{\text{max}}^2$, $v_{\text{max}} = \omega A$.

Waves:

$\lambda = vT$, $v = f\lambda$, $v = \sqrt{\frac{F_T}{m/L}}$, $I = P/A$, $I = P/4\pi r^2$.

Vectors

Written $\vec{V}$ or $\mathbf{V}$, described by magnitude=V, direction=θ or by components (V_x, V_y).

$V_x = V\cos\theta$, $V_y = V\sin\theta$,

$V = \sqrt{V_x^2 + V_y^2}$, $\tan\theta = \frac{V_y}{V_x}$. θ is the angle from $\vec{V}$ to $+x$-axis.

Addition: $\mathbf{A} + \mathbf{B}$, head to tail. Subtraction: $\mathbf{A} - \mathbf{B}$ is $\mathbf{A} + (-\mathbf{B})$, $-\mathbf{B}$ is $\mathbf{B}$ reversed.

Trig summary

$\sin\theta = \frac{(\text{opp})}{(\text{hyp})}$, $\cos\theta = \frac{(\text{adj})}{(\text{hyp})}$, $\tan\theta = \frac{(\text{opp})}{(\text{adj})}$, $(\text{hyp})^2 = (\text{opp})^2 + (\text{adj})^2$.