PHY2010 Study Problems

Oscillations (B&S Chapter 1)

1. An oscillator has a frequency of 44.1 kHz. What is the period of oscillation? What is the angular frequency?
2. Describe how simple harmonic motion and uniform circular motion are related.
3. A damped oscillator has a Q value of 8. If the full with at half max Δf = 20 Hz, what is the frequency f_0?
4. A simple harmonic oscillator has m = 0.020 kg, and k = 10 N/m. What is the frequency (in Hertz) of the oscillation?
5. If an oscillation has a period of 15 ms, what is the frequency?
6. Draw a waveform for an oscillation with amplitude 5m and period 20 ms.
7. Two parts:
    a. What is the frequency in Hz of a simple harmonic oscillator with mass 5.0 g and spring constant 10 N/m?
    b. If you double the mass, by what factor does the frequency change?
8. A damped oscillator has a frequency of 20 Hz and a spring constant of k=0.5 N/m.
    a. What is the mass?
    b. If the bandwidth is Δf = 4 Hz, what is Q?

Waves, Properties & Behavior (B&S Chapter 2)

9. You & your friend use a string to make paper cup telephone, with physical values T=2N, mu =2g/m. L=6m.
    a. What is the time for signals to propagate along string?
    b. What is the wavelength for f=1kHz?
    c. If mu→ 4g/m, what is v_{new} / v_{old}?
10. Two speakers facing to the right, d=2m apart. For listener further to the right…
    a. what is lowest frequency for constructive interference?
    b. " …destructive…" ?
    c. Next highest f for destructive interference?
11. The speed of light is 3.0 x 10^8 m/s. What frequency of light corresponds to a wavelength of 400 x 10^{-9} m?
12. Waves on a steel cable are travelling at 5 m/s. If the mass per unit length is 4kg/m, what is the tension in the string?
13. Two mics are placed a distance 8 ft away from each other. If the speed of sound is 1140 ft/s, and a sound source is placed near the first mic, what is the frequency of a sound recorded at the second mic, which would be 180^0 out o phase with the signal recorded at the first mic?
14. How are the incident and reflected beams to and from a right-angle “corner shape” related?
15. Why is the sound louder to a distant listener if the wind is blowing, when the wind is travelling slower near the ground than it is higher up?
16. Why do ocean waves tend to arrive parallel to the beach, even if they initially come in at some other angle?
17. A sound has intensity 1 mW/m^2 at a distance of 3 ft from the source. What is the intensity 20 feet away from the source? (Hint: Use the Inverse Square Law)

Standing Waves (B&S Chapter 3)

18. The human ear canal may be regarded as a tube open at one end and closed at another, with a length of 1cm. The lowest frequency of a standing wave in the ear canal would then be what?
19. A wire is 5 m long, has a mass per unit length of 1 g/m, and a tension of 20 N. What is the frequency of the first overtone?
20. A pipe is 1.5 m long and is open at one end and closed on the other. If the temperature is 17°C, what is the period of the fundamental frequency?

Chapter 4

21. Two cylindrical Helmholtz resonators, with the same neck length and the same heights of the cylinders. One cavity has twice the radius of the other. What is the ratio of their frequencies, i.e. f_{Large} / f_{small}? Answer: 1/2.

Chapter 6

22. The SIL at 5m from a source is 90 dB.
    a. What intensity does this correspond to? Answer: .001 W/m^2
    b. If SPL=SIL, what pressure fluctuation does this correspond do? Answer: 0.63 Pa
    c. What is the SIL at 13 m from the source? Answer: 82 dB
    d. At what distance is the intensity 10^{-7} W/m^2? Answer: 500 m
2. At 1m from source, SIL is 120dB
    a. What is SIL at 25m? (92dB)
    b. At what distance is the SIL 70dB? (316m)

Room & Auditorium Acoustics (Chapter 8)

3. Describe "blend."

4. Room is 4' x 4' x 12'.
    a. Floor has a=0.5, walls have a=0.1, ceiling has a=0.01. What is RT60? (0.35s)
    b. Lowest 5 <u>unique</u> modal frequencies?
    c. What are the boundaries of the 4 frequency regions for this room?

Answers:

1. T = 1/f = 22.7 microseconds, $\omega = 2(3.14)(44100) = 2.77 \times 10^5$ rad/s
2. Uniform circular motion, when viewed from "the side", is identical to simple harmonic motion. The angle of rotation about the circle corresponds to the phase of the oscillation.
3. Q = $f_0 / \Delta f$ so $f_0 = Q \, \Delta f$ = (8)(20) = 160 Hz.
4. *f = sqrt(k/m)/(2*pi)* = 3.6 Hz
5. *f = 1/T = 1/(0.015s)* =67 Hz
6. draw something…
7. a) 7.1 Hz, b) goes down by sqrt(2)

8. a) 32 mg, b) 5
9. a) v = 31.6 m/s, so t = L/v = 0.19s, b) d) 1/sqrt(2)
10. a) 172.5Hz, b) half of (a), c) 3 times (b)
11. $f = v / \lambda =$ 7.5×10^{14} Hz
12. $v = sqrt(T/\mu) \rightarrow T = \mu v^2 = 4(25) =$ 100 N
13. $8' = \lambda/2$, so $\lambda = 16'$. $f = v/\lambda = 1140/16 =$ 71.25 Hz
14. They are always parallel.
15. The wind causes sound which would otherwise go upwards and away from the listener to be refracted downward and thus add to the sound going directly from the source to the listener.
16. The shallower water has a slower wave speed than the deeper water, giving rise to refraction which cases the waves to bend toward the beach.
17. $I_1 r_1^2 = I_2 r_2^2 \rightarrow I_2 = I_1 (r_1 / r_2)^2 = (0.001 W/m^2)*(3/20)^2 = 22.5\ \mu W/m^2$
18. $f = Nv / 4L = (345\ m/s) / 4 / 0.01m =$ 8625 Hz
19. Answer: 28 Hz.
20. Answer: v_s = 341.2 m/s, $\lambda = 4(1.5) = 6m$, f = 56.86 Hz, T = 18 ms.