Seed = 234. (If you are not the instructor, you can ignore the seed.) **** SOLUTION(S) ****

Practice Test 1, Physics 2010, (from Spring 2012), Dr. Hawley

You will have 50 minutes to complete this test. Name:_____
Turn OFF all cell phones. Use 345 m/s as the speed of sound.

Problem 1. (5 points) The speed of light is 3.0e+8 m/s. What frequency of light corresponds to a wavelength of 5.37e-07 m?
a) 2.795e+14 Hz b) 1.3975e+14 Hz c) 161.1 Hz d) 5.59e+14 Hz
The correct answer is d) 5.59e+14 Hz
Solution: $v = f\,\lambda$**, so** $f = v/\lambda = (3.0\mathrm{e}+8)/(5.37\mathrm{e}-07) = 5.59\mathrm{e}+14\,\mathrm{Hz}$.

Problem 2. (5 points) A CareBear of mass m = 125 g undergoes 17 oscillations per second when attached to a spring. What is the value of the spring constant k?
a) 13.4 N/m b) None of these c) 487 N/m d) 1430000 N/m e) 1430 N/m
The correct answer is e) 1430 N/m
Solution:

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}},$$

so

$$(2\pi f)^2 = \frac{k}{m}$$

and thus

$$k = m(2\pi f)^2 = 1.43\mathrm{e}+03\,\mathrm{N/m}.$$

Problem 3. (5 points) A damped oscillator has a Q value of 7.59. If the full width at half max Δf = 34.2 Hz, what is the frequency f_0?
a) 195 Hz b) 4.51 Hz c) 260 Hz d) 0.222 Hz e) 325 Hz
The correct answer is c) 260 Hz
Solution: $Q = f_0/\Delta f$**, so** $f = Q\Delta f = 260\,\mathrm{Hz}$.

Problem 4. (5 points) What is the fundemental frequency of an open tube of 3.98 meters?
a) 42 Hz b) 21.7 Hz c) 43.3 Hz d) 687 Hz
The correct answer is c) 43.3 Hz
Solution:

$$f = \frac{Nv}{2L} = \frac{(1)(345)}{2(3.98)} = 43.3\,\mathrm{Hz}.$$

Problem 5. (5 points) If a wave has a period of 24 ms, what is the frequency of the wave?
a) 0.024 Hz b) 0.0417 Hz c) 32.7 Hz d) None of these e) 41.7 Hz
The correct answer is e) 41.7 Hz
Solution: T **= 24 ms = 0.024 s.**

$$f = 1/T = 1/(0.024) = 41.7\,\mathrm{s}.$$

Problem 6. (5 points) The phenomenon in which waves bend when moving from one medium with one wave speed, to another medium with a different wave speed, is called...
a) infraction b) rarefaction c) None of these d) polarization e) diffraction
The correct answer is c) None of these
Solution: This phenomenon is called "refraction."

Problem 7. (5 points) Nikki Sixxxxxxx is playing a stringed instrument with a wire that is 2.38 m long, has a mass per unit length of 1.94 g/m, and a tension of 20.5 N. What is the frequency of the first overtone?
a) 4460 Hz b) 10.825 Hz c) 43.3 Hz d) 6.17 Hz e) 21.6 Hz
The correct answer is c) 43.3 Hz
Solution: The frequency for standing waves on a string is given by

$$f = \frac{N}{2L}\sqrt{\frac{T}{\mu}},$$

where "first overtone" means $N = 2$. Then canceling the 2's, the solution is

$$f = \frac{1}{2.38\,\mathrm{m}}\sqrt{\frac{20.5\,\mathrm{N}}{0.00194\,\mathrm{kg/m}}} = 43.3\,\mathrm{Hz}.$$

Problem 8. (5 points) You've convinced the members of Slipknot to come to church with you, but the music is bothersome because one of the (fretless) stringed instruments is out of tune. It should be playing a tone of $f_{good} = 204\,\mathrm{Hz}$, but instead it's playing $f_{bad} = 224\,\mathrm{Hz}$. You estimate (exactly) that the player in the worship band is fretting the string $L_{bad} = 38.5\,\mathrm{cm}$ from the bridge. By how many centimeters should the player move her hand to hit the proper note? (Hint: i.e., find the difference $|L_{good} - L_{bad}|$.)
a) None of these b) 3.8 cm c) 7.24 cm d) 42.3 cm e) 1.08 cm
The correct answer is b) 3.8 cm
Solution:
Since $f \propto 1/L$,

$$\frac{f_{good}}{f_{bad}} = \frac{1/L_{good}}{1/L_{bad}} = \frac{L_{bad}}{L_{good}}$$

or, flipping these over,

$$\frac{f_{bad}}{f_{good}} = \frac{L_{good}}{L_{bad}}.$$

Solving for L_{good},

$$L_{good} = L_{bad}\frac{f_{bad}}{f_{good}} = 38.5\left(\frac{224}{204}\right) = 42.3\,\mathrm{cm}.$$

Then,

$$|L_{good} - L_{bad}| = 42.3 - 38.5 = 3.8\,\mathrm{cm}.$$

Problem 9. (5 points) Reflection off a "rough" surface is known as _____ reflection.
a) inverted b) transverse c) diffuse d) specular
The correct answer is c) diffuse

Problem 10. (5 points) A sound with intensity $I_1 = 0.0213\ \mathrm{W/m^2}$ at distance $r_1 = 2.56$ m will have what intensity at $r_2 = 30.2$ m?
a) $0.000153\ \mathrm{W/m^2}$ b) $0.00181\ \mathrm{W/m^2}$ c) None of these d) $0.251\ \mathrm{W/m^2}$ e) $2.96\ \mathrm{W/m^2}$
The correct answer is a) 0.000153 W/m^2
Solution:

$$I_1 r_1^2 = I_2 r_2^2,$$

so

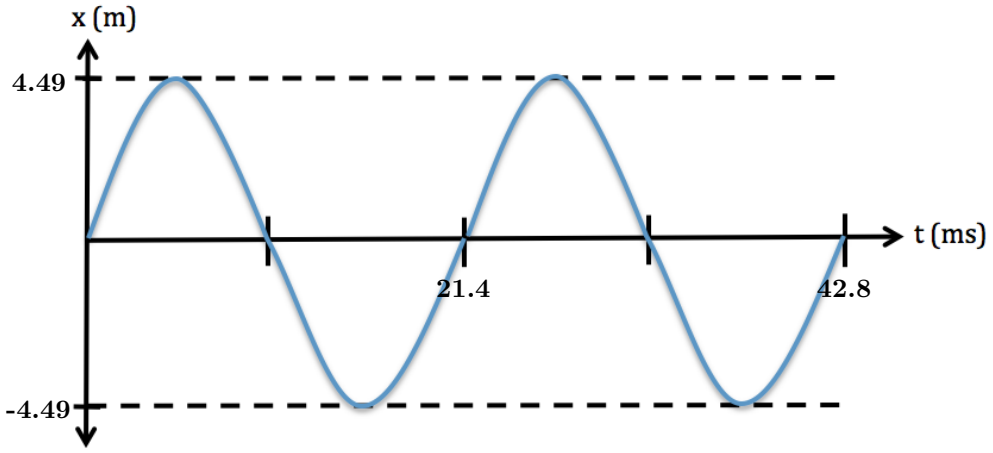
$$I_2 = I_1\left(\frac{r_1}{r_2}\right)^2 = 0.0213\left(\frac{2.56}{30.2}\right)^2 = 0.000153\,\mathrm{W/m^2}.$$

Part II: Short Answer. Show any work to receive nonzero credit. Explain your reasoning *in your own words.*

Problem 11. (10 points) a. What is a linear restoring force? b. How is SHM related to a linear restoring force?

a. A force which restores an object to equilibrium, and is linearly proportional to the displacement from equilibrium.
b. Simple Harmonic Motion describes the oscillations which occur in the presence of a linear restoring force.

Problem 12. (5 points) Draw a waveform for an oscillation with amplitude 4.49 m and period 21.4 ms.



Problem 13. (10 points) You're out with your friends at the sold-out Rebecca Black show, but you're way back beneath a balcony and the main PA speakers are mounted high up in the center of the auditorium. Describe what your perception of the mix will be altered by your location and why.

Your perception of the mix is likely to be bass-dominated, because the highs will get blocked by the balcony but the bass tones will diffract around it.

Problem 14. (10 points) The human ear canal can be regarded as a tube 1.84 cm long, open at one end and closed at the other. What is the fundamental resonant frequency of this column of air?

Solution: Since one end is open and once closed, the frequency is given by $f = Nv/4L$, and $N = 1$ because we're asked to find the fundamental. Thus

$$f = \frac{v}{4L} = \frac{345}{4(0.0184\text{m})} = 4.69\text{e}+03\,\text{Hz}.$$

Problem 15. (10 points) A given loudspeaker cone has an effective spring constant of 82.5 N/m. If the mass of the moving part of the speaker is 53.2 grams, what is the frequency f_0 of its natural oscillations?

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{82.5}{0.0532}}$$
$$= 6.27\,\text{Hz}.$$

Extra Credit:

Problem 16. (5 points) When Melinda Doolittle sings 4.32 times as loud as she normally does, she holds the microphone away from her mouth at a farther distance than she holds it for her normal volume, in order to keep the sound intensity at the microphone roughly the same. What is the ratio of the farther distance to the normal distance, i.e. x_{Loud} / x_{Normal}?

By the inverse square law, the ratio is $\sqrt{4.32} = 2.08$.