Name: Key

Chapter 16-17 Test - Waves and Sound 2015-2016

I. Matching (Select the correct SI unit for each wave parameter).

A 1. period

C 2. angular frequency

D 3. amplitude

B 4. wavelength x frequency

E 5. frequency

D 6. wavelength

B 7. speed of sound

A. seconds

B. meters per second

C. radians per second

D. meters

E. Hertz

II. Multiple Choice (Choose the one best answer for each question.)

8. Which sound has the fastest speed in air at 0.0 °C?
   A. 220 Hz tuning fork B. 440 Hz tuning [✓ C.] It is the same for both
   $V \neq V(f)$

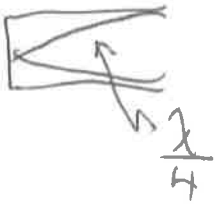
9. Which sound has the largest wavelength in air at 0.0 °C?
   [✓ A.] 220 Hz tuning fork B. 440 Hz tuning C. It is the same for both
   $\lambda = \frac{v}{f}$

10. Which sound has the largest frequency in air at 0.0 °C?
    A. 220 Hz tuning fork [✓ B.] 440 Hz tuning C. It is the same for both

11. As the temperature of the air decreases, the speed of sound
    A. increases [✓ B.] decreases C. stays the same
    $V = 331.3\sqrt{1+\frac{T}{273.15}}$

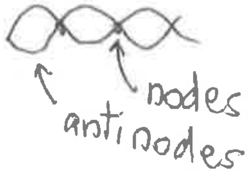
12. How many beats/sec are heard when two tuning forks of 512 Hz and 508 Hz are sounded simultaneously?
    A. 1 Hz B. 2 Hz [✓ C.] 4 Hz D. 510 Hz E. 1020 Hz
    $f_B = 512 - 508\,Hz$

13. How many wavelengths will fit inside a tube with one closed when you have resonance at the fundamental frequency?
    [✓ A.] 1/4 B. 1/2 C. 3/4 D. 1 E. 5/4

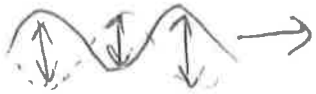


14. When shaking a string at one end that is attached to a post at the other end with just the right frequency to form a standing wave, the parts of the string that have maximum movement are called

A. fundamentals B. harmonics C. nodes [✓ D. antinodes]



15. Transverse waves have a disturbance that is
- A. in the same direction as the motion of the wave.
- [✓ B. perpendicular to the direction of motion of the wave.]
- C. counterclockwise to the direction of the wave.
- D. clockwise to the direction of the wave.



16. Sound waves are an example of a longitudinal wave.

[✓ A. True] B. False C. Unable to determine

17. Water waves are an example of a longitudinal wave.

A. True [✓ B. False] C. Unable to determine

18. When two waves are added together, you can get
- A. constructive interference.
- B. destructive interference.
- C. standing waves.
- D. resonance.
- [✓ E. All of the above.]

19. A sound source moving away from you (compared to the same sound source at rest) will have
- A. a higher pitch
- B. a lower speed of sound
- [✓ C. a lower frequency]
- D. a smaller wavelength
- E. the same frequency

20. As the frequency of a tone increases,
- A. the speed of sound increases.
- B. the speed of sound decreases.
- C. the frequency decreases.
- D. the wavelength increases.
- [✓ E. the wavelength decreases.]

III. Problems: Answers all of these problems on a separate sheet of paper. Your answers should flow from top to bottom. Do not skip around or place answers horizontally next to previous work. Show your work. Circle or box your answer. Answers must have the correct number of significant figures and the correct units.

5 points each:

Starting equation:	**1 point**
Work and correct answer:	**3.5 points**
Boxed answer:	**0.5 points**

==> NOTE: **The correct number of significant figures is required for full credit.** <==

1. At 35.0 °C, how much time will elapse between the firing of a gun and return of its echo from a cliff that is 2.60 km away?

2. Find the length of an organ pipe closed at one end that produces a fundamental frequency of 262 Hz (i.e. middle C) when the air temperature is 24.0°C.

3. A military sea mine is detonated at the surface of the water and the sound of the blast travels both through the air and the water. A Navy Seal swims right on the surface 1.60 km away from the blast. The sound travels through the sea water at 1540 m/s. The air temperature is 20.0 °C. How much sooner will the Navy Seal hear the blast through the water than he does through the air?

4. Calculate the speed of sound on a day when a 963 Hz frequency has a wavelength of 0.351 m.

5. What is the wavelength of a water wave that has a frequency of 0.200 Hz and a speed of 3.00 m/s?

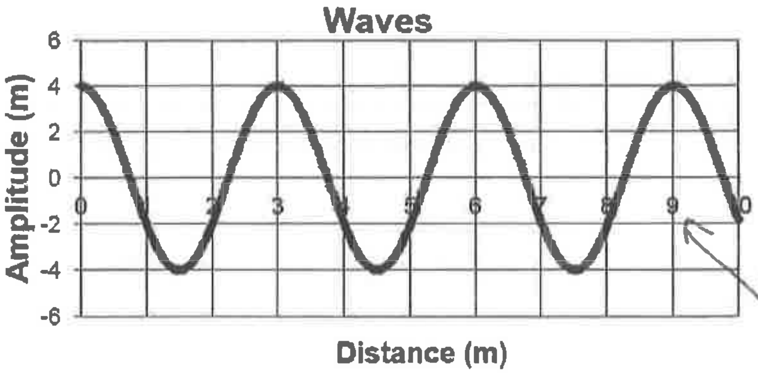
6. The human range for hearing is commonly given as 20 to 20,000 Hz (though there is considerable variation between individuals, especially at high frequencies). At 22.0 °C, what is the wavelength range for human hearing?

7. An ambulance approaches a pedestrian standing on the side of a hot desert road at 108 km/hr. If the ambulance's siren produces a steady tone of 675 Hz, what frequency will the observer hear? The air temperature is 42.0 °C.

(continued on the next page)

10 pts 8. Given v = 90.0 m/s, find

- A. λ
- B. f
- C. T
- D. A
- E. ω



Assume 3 sig figs

Bonus (2 pts each):

1. A sound meter records the exhaust frequency of a receding race car to be 4.92 x 10^2 Hz. The actual frequency is 5.60 x 10^2 Hz. If the air temperature is 24.0 °C, how fast is the car going?

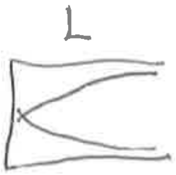
2. Three adjacent keys on a piano (F, F-sharp, and G) are struck simultaneously, producing frequencies of 349, 370, and 392 Hz. What beat frequencies are produced by this discordant combination?

Physics 200 Chapters 16-17
2015 - 2016

1. $$v=\frac{d}{t}\Rightarrow t=\frac{d}{v}=\frac{2\times 2.60\times 10^{3}\,m}{331.3\sqrt{1+\frac{35.0}{273.15}}\,\frac{m}{s}}=\boxed{14.8\,s}$$

$351.9\frac{m}{s}\rightarrow$

$\leftarrow 345.5\frac{m}{s}$

2. 

$$L=\frac{\lambda}{4}=\frac{v}{4f}=\frac{331.3\sqrt{1+\frac{24.0}{273.15}}\,\frac{m}{s}}{4(262\,Hz)}=\boxed{0.330\,m}$$

3. $$t_{air}=\frac{d}{v}=\frac{1.60\times 10^{3}\,m}{331.3\sqrt{1+\frac{20.0}{273.15}}\,\frac{m}{s}}=4.662\,s$$

$343.2\frac{m}{s}\rightarrow$

$$t_{water}=\frac{d}{v}=\frac{1.60\times 10^{3}\,m}{1540\,\frac{m}{s}}=\underline{1.039\,s}$$

$$\boxed{3.62\,s}$$

4. $$v=\lambda f=(0.351\,m)(963\,Hz)=\boxed{338\,\frac{m}{s}}$$

5. $$v=\lambda f\Rightarrow\lambda=\frac{v}{f}=\frac{3.00\,\frac{m}{s}}{0.200\,Hz}=\boxed{15.0\,m}$$

$344.4\frac{m}{s}\rightarrow$

6. $$\lambda_{20}=\frac{v}{20\,Hz}=\frac{331.3\sqrt{1+\frac{22}{273.15}}\,\frac{m}{s}}{20\,Hz}=$$

$$\lambda_{20{,}000}=\frac{v}{20{,}000\,Hz}=\frac{331.3\sqrt{1+\frac{22}{273.15}}\,\frac{m}{s}}{20{,}000\,Hz}=$$

$$\boxed{17.2\,m \text{ to } 1.72\times 10^{-2}\,m}$$

7. $f_o = f_s \frac{v \pm \overset{0}{\cancel{v_o}}}{v \pm v_s} = 675\,Hz \frac{331.3\sqrt{1+\frac{42.0}{273.15}}}{331.3\sqrt{1+\frac{42.0}{273.15}} - \underbrace{108\frac{km}{h}\left(\frac{1h}{3600s}\right)\left(\frac{1000m}{1km}\right)}_{30.0\frac{m}{s}}}$ ← $355.9\frac{m}{s}$

approaching

$= \boxed{737\,Hz}$

8. $v = 90.0\frac{m}{s}$

A. $\lambda = 3.00m$ (from graph

B. $f = \frac{v}{\lambda} = \frac{90.0\frac{m}{s}}{3.00m} = \boxed{30.0\,Hz}$

C. $T = \frac{1}{f} = \frac{1}{30.0Hz} = \boxed{3.33\times10^{-2}s}$

D. $A = \boxed{4.00m}$ (from graph)

E. $\omega = 2\pi f = 2\pi(3.33\times10^{-2}s) = \boxed{0.209\frac{rad}{s}}$

~~BONUS~~

~~1. $f_o = f_s \frac{v \pm \overset{0}{\cancel{v_o}}}{v \pm v_s} \Rightarrow f_o(v + v_s) = f_s v \Rightarrow v + v_s = \frac{f_s}{f_o}v$ receding~~

~~$\Rightarrow v_s = \frac{f_s}{f_o}v - v = v\left(\frac{f_s}{f_o} - 1\right) = 331.3\sqrt{1+\frac{24.0}{273.15}}\left(\frac{560}{492} - 1\right)$~~

~~$= \boxed{47.8\frac{m}{s}}$~~

~~2. $\begin{array}{r}392\\-349\\\hline\end{array}$ $\begin{array}{r}392\\-370\\\hline\end{array}$ $\begin{array}{r}370\\-349\\\hline\end{array}$ $f_B = f_2 - f_1$~~

~~$\boxed{43Hz}$ $\boxed{22Hz}$ $\boxed{21Hz}$~~

9. a) She plays B first, Then A

b) $V_{sound} \approx 331.4\,m/s + 0°(0.6) = 331.4\,m/s$

$V_{car} = V_{sound}\left(\frac{2^{\Delta P/12}-1}{2^{\Delta P/12}+1}\right)$

$$V_{car} = 331.4\,m/s\left(\frac{2^{8/12}-1}{2^{8/12}+1}\right)$$

$$\boxed{V_{car} = 75.2\,m/s}$$

~~Junction Rule:~~

~~$I_1 = I_2 + I_3$~~

~~Top Loop (CW)~~

~~$18V - 0.5I_2 - 6I_1 - 2.5I_2 = 0$~~

~~$18V - 3I_2 - 6I_1 = 0$~~

~~Bottom Loop (CCW)~~

~~$45V - 0.5I_3 - 1.5I_3 - 6I_1 = 0$~~

~~$45V - 2I_3 - 6I_1 = 0$~~

$15V - 3I_2$