Fall 2001: PSC2121 Homework Assignments
Solutions due Oct 9, Ch. 9 and 10

Ch. 9:

7. The velocity of sound depends on the temperature T in °C:

Using equation (9-5): $v_T = v_o + 2.00\ T$ where $v_o = 1087$ ft/s, T = 30°C

$v_T = 1087$ ft/s + 2.00*30 ft/s = 1147 ft/s

Once we know the velocity, s = vt = (1147 ft/s)(6.0 s) = **6882 ft**

Using the equation in the notes (same as 9-4): v_T = 331 m/s + 0.6*T

gives v_T = 349 m/s, so s = vt = (349 m/s)(6.0 s) = 2094 m

and we need to convert m to ft: (2094 m)(100 cm/m)(1 in/2.54 cm)(1 ft/12 in) = 6870 ft

Often the problem is easier if you read the book.

9. Again we need the velocity of sound in ft/s at 20.0°C.

Using equation (9-5): $v_T = v_o + 2.00\ T$ = 1087 ft/s + 2.00*T ft/s = 1127 ft/s.

We then use the wave equation: $v = \lambda f$ or $\lambda = v/f$ to find λ.

(a) λ at 16 Hz = (1127 ft/s)/(16 Hz) = **70.44 ft** (the 74 in the book is wrong!)

λ at 20,000 Hz = (1127 ft/s)/(20,000 Hz) = **0.056 ft**

(b) For water at 20°C we use table 9-2: v = 4794 ft/s

λ at 16 Hz = (4974 ft/s)/(16 Hz) = **300 ft**

λ at 20,000 Hz = (4974 ft/s)/(20,000 Hz) = **0.24 ft**

11. The question is asking for the number of waves in 1 second.

This is the frequency. From the wave equation $v = \lambda f$, so

$f = v/\lambda$ = (16.3 m/s)/(100 m) = 0.163 Hz = **0.163 waves/s**

13. Back to the wave equation: $v = \lambda f$, using light $v = c = 3\times10^8$ m/s

(a) $f = c/\lambda = (3\times10^8$ m/s)(100 cm/m)/(6.06×10^{-5}) = **4.95×10^{14} Hz**

(b) period, $T = 1/f = 1/(4.95\times10^{14})$ = **2.02×10^{-15} s**

14. Again: $v = \lambda f$, using light $v = c = 3\times10^8$ m/s

$\lambda = c/f = (3\times10^8$ m/s)/(10^6 Hz) = **300 m**

23. For an open pipe (see Figure 9-40):

$L = \lambda/2$, so fundamental wavelength $\lambda = 2L = 2(0.5\text{ m}) = 1.0$ m

we get fundamental frequency from λ and wave equation $v = \lambda f$

$f = v/\lambda$ = (340 m/s)/(1 m) = **340 Hz**

For a closed pipe (see Figure 9-39):

$L = \lambda/4$, so fundamental wavelength $\lambda = 4L = 4(0.5\text{ m}) = 2.0$ m

$f = v/\lambda$ = (340 m/s)/(2 m) = **170 Hz**

30. For the first 3 standing wave modes in a string see Figure 9-37:

$L = \lambda_0/2$, so $\lambda_0 = 2L = 2(2\text{ m})$ = **4 m**

$L = \lambda_1$, so $\lambda_1 = L$ = **2 m**

$L = 3\lambda_2/2$, so $\lambda_2 = 2L/3 =$ **1.33 m**

40. A. (c) B. (b) C. (a) D. (d) E. (a) F. (b) G. (b) H. (c) I. (b)

Ch. 10:

2. (a) $s = ct = (299{,}792\ \text{km/s})(1\ \text{yr})(365\ \text{day/yr})(24\ \text{hr/day})(60\ \text{min/hr})(60\ \text{s/min}) =$ **9.45×10^{12} km**
(b) $s = (9.45\times10^{12}\ \text{km})\ (1\ \text{mi}/1.6\ \text{km}) =$ **$5.90 \text{ x } 10^{12}$ miles**

3. (a) $s = (40\ \text{ly})\ (9.45\times10^{12}\ \text{km/ly}) =$ **3.78×10^{14} km**
(b) $s = (40\ \text{ly})\ (5.90\times10^{12}\ \text{mi/ly}) =$ **2.36×10^{14} mi**

4. For a reflection the pulse travels twice the distance 2s.
$c = (2s)/t$, so $s = ct/2 = (3\times10^8\ \text{m/s})(93.0\times10^{-6})/2 = 13950\ \text{m} =$ **13.95 km**

5. Wave equation $v = c = \lambda f$, with $\lambda = (5890\ \text{Å})(1\ \text{Å}/10^{-10}\ \text{m}) = 5.89\times10^{-7}\ \text{m}$
$f = c/\lambda = (3\times10^8\ \text{m/s})/(5.89\times10^{-7}\ \text{m}) =$ **5.09×10^{14} Hz**

7. $t = s/c = (5\times10^3\ \text{km})(10^3\ \text{m/km})/(3\times10^8\ \text{m/s}) =$ **1.67×10^{-2} s**

14. Violet. See Figure 10-49.

15. X-rays have the shorter wavelength and the higher frequency. See Figure 10-19.

16. $n = c/v = (3\times10^8\ \text{m/s})/(1.5\times10^8\ \text{m/s}) =$ **2.0**

18. Wave equation $v = c = \lambda f$, so $\lambda = c/f$
for $f = 900\ \text{Mhz} = (900\ \text{Mhz})(10^6\ \text{Hz/ Mhz}) = 9\times10^8\ \text{Hz}$
$\lambda = c/f = (3\times10^8\ \text{m/s})/(9.0\times10^8\ \text{Hz}) =$ **0.333 m**
for $f = 2560\ \text{Mhz} = (2560\ \text{Mhz})(10^6\ \text{Hz/ Mhz}) = 2.56\times10^9\ \text{Hz}$
$\lambda = c/f = (3\times10^8\ \text{m/s})/(2.56\times10^9\ \text{Hz}) =$ **0.117 m**

23. See Figure 10-47.
(a) the complement of blue is **yellow**
(b) the complement of yellow is **blue**
(c) the complement of magenta is **green**

24. The index of refraction $n = c/v$. Since the velocity of light in matter $v < c$, $n > 1$.

27. See Figure 9-23. When light passes from low n (air) to high n (water) it is bent toward the normal. From water to air it is bent away from normal.
Use Table 10-1 for index of refraction values:
(a) lower n (air $n = 1.00$) to higher n (glass $n = 1.52$), **toward normal**
(b) lower n (water $n = 1.33$) to higher n (glass $n = 1.52$), **toward normal**

30. A. (c) B. (a) C. (b) D. (c) E. (d) F. (b) G. (b) H. (c) I. (b) J. (c)