Physics 100A – Fall 2009
Chapter 14

Solutions are provided only for problems from your textbook. The other problems already have so much guidance and notes that you should be able to understand where you have gone wrong.

Problems

14.2) **Picture the Problem:** A surfer measures the frequency and length of the waves that pass her. From this information we wish to calculate the wave speed.

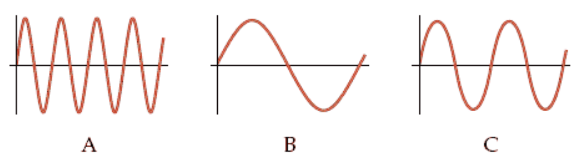
Strategy: Equation 14-1 relates the wave speed to the wavelength and frequency.

Solution: Apply equation 14-1:

$$v = \lambda f = (34\text{ m})(14\text{ /min})\left(\frac{1\text{ min}}{60\text{ sec}}\right) = 7.9\text{ m/s}$$

Insight: The wave speed can increase by either an increase in wavelength or an increase in frequency.

14.12) **Picture the Problem:** The three waves, A, B, and C, shown in the figure at right propagate on strings with equal tensions and equal mass per length.



Strategy: Use $v = \lambda f$ (equation 14-1) and the principles of wave propagation to determine the requested rankings.

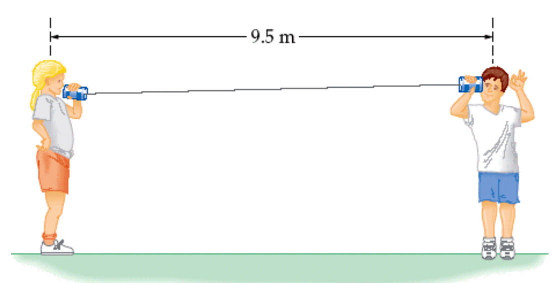
Solution: (a) With equal tensions and equal mass per length, it follows from equation 14-2 that waves on the three strings have the same speed. Since $v = \lambda f$, the wave with the longest wavelength therefore has the lowest frequency. The ranking for frequency is B < C < A.

(b) Wavelength is simply the distance from crest to crest. Therefore the ranking for wavelength is A < C < B.

(c) As stated in part (a) the wave speeds are the same. Therefore the ranking for speed is A = B = C.

Insight: If these were sound waves, the ranking for sound pitch would be the same as for frequency: B < C < A.

14.14) **Picture the Problem:** The image shows two people talking on a tin can telephone. The cans are connected by a 9.5-meter-long string weighing 32 grams.



Strategy: Set the time equal to the distance divided by the velocity, where the velocity is given by equation 14-2. The linear mass density is the total mass divided by the length.

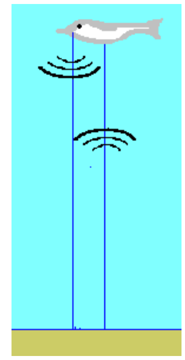
Solution: Set the time equal to the distance divided by velocity: $t = \frac{d}{v} = d\sqrt{\frac{\mu}{F}}$

Now substitute $\mu = m/d$ and insert numerical values:

$$t = d\sqrt{\frac{m/d}{F}} = \sqrt{\frac{md}{F}} = \sqrt{\frac{(0.032 \text{ kg})(9.5 \text{ m})}{8.6 \text{ N}}} = \boxed{0.19 \text{ s}}$$

Insight: The message travels the same distance in the air in 0.028 seconds, about 7 times faster.

14.27) **Picture the Problem:** The dolphin sends a signal to the ocean floor and hears its echo.



Strategy: The sound wave of the click must travel to the ocean floor and back before it is heard. So the distance traveled is twice the distance to the floor. Divide this distance by the speed of sound in water to calculate the time. Calculate the wavelength from equation 14-1.

Solution: (a) Divide the distance by the speed of sound in water:

$$t = \frac{2d}{v} = \frac{2(75 \text{ m})}{1530 \text{ m/s}} = 0.098 \text{ s}$$

(b) Solve equation 14-1 for the wavelength:

$$\lambda = \frac{v}{f} = \frac{1530 \text{ m/s}}{55 \text{ kHz}} = 28\times10^{-3} \text{ m} = 28 \text{ mm}$$

Insight: In air the wavelength would be 6.2 mm. The wavelength is longer in the water because the wave travels faster in water, while the frequency is the same.

14.38) **Picture the Problem:** We are given the sound intensity of one hog caller and are asked to calculate how many hog callers are needed to increase the intensity level by 10 dB.

Strategy: Multiply the intensity in equation 14-8 by *N* callers, setting the intensity level to 120 dB and solve for *N*.

Solution: Write the intensity level for *N* callers:

$$\beta = 10\log\left(\frac{NI}{I_0}\right) = 10\log(N) + 10\log\left(\frac{I}{I_0}\right)$$

Insert the intensity levels and solve for *N*:

$$120 = 10\log(N) + 110$$
$$10 = 10\log(N)$$
$$N = 10^{10/10} = 10 \text{ callers}$$

Insight: Increasing the intensity level by 10 dB increases the intensity by a factor of 10. Therefore 10 callers, each with intensity level 110 dB, would produce a net intensity level of 120 db. 100 callers (10 × 10 callers) would be needed to produce an intensity level of 130 dB (120 dB + 10 dB).