- by To Chong, Sonja Scherer, and Chris Murray, 2002

Chapter 11

34. A fisherman notices that wave crests pass the bow of his anchored boat every 3.0 s. He measures the distance between two crests to be 8.5 m. How fast are the waves traveling?

The waves are traveling v = s/t = (8.5 m)/(3.0 s) = 2.8 m/s

Or if you prefer
$v = f\lambda$
$f = 1/T$
so $v = f\lambda = f/T$ = (8.5 m)/(3.0 s) = 2.8 m/s
(Table of contents)

35. A sound wave in air has a frequency of 262 Hz and travels with a speed of 330m/s. How far apart the wave crests (compressions)?

The distance between two successive wave crests is the wavelength:
$v = f\lambda$
Therefore, λ = v/f = 330/262 = 1.26 m
(Table of contents)

39. A cord of mass 0.55kg is stretched between two supports 30 m apart. If the tension in the cord is 150N, how long will it take a pulse to travel from one support to the other?

Now we will apply a special formula from the text book, which is: $v = (Ft/(m/l))^{1/2}$
or $v = \sqrt{T/\mu}$
Where μ = mass/length for the cord, and T is the tension in the cord.
have: T = 150N; m = 0.55kg; and l = 30m, so μ = (.55 kg)/(30 m) = 0.01833 kg/m
Therefore, $v = \sqrt{T/\mu} = \sqrt{(150 \text{ N}/(0.01833 \text{ kg/m}))}$ = 90.45m/s
The time will be: t = s/v = (30 m)/(90.45 m/s) = 0.33s
(Table of contents)

41. A sailor strikes the side of his ship just below the surface of the sea. He hears the echo of the wave reflected from the ocean floor directly below 3.0 s later. How deep is the ocean at this point?

The time that wave moves from the wave source to the ocean floor is half the total travel time: t = 3/2 = 1.5 s
The speed of sound in seawater is 1560 m/s (from table 12-1 on page 348). Therefore, s = vt = (1560 m/s)(1.5 s) = 2340 m = 2.3 km
(Table of contents)

42. S and P waves from an earthquake travel at different speeds, and this difference helps in the determination of the earthquake "epicenter" (where the disturbance took place). (a) Assuming typical speeds of 8.5 km/s and 5.5 km/s for P and S waves, respectively, how far away did the earthquake occur if a particular seismic station detects the arrival of these two typed of waves 2.0 min apart? (b) Is one seismic station sufficient to determine the position of the epicenter? Explain.

(a) Because two waves travel in the same distance, therefore, we will have:

$\Delta t = d/v_S - d/v_P$ Therefore, $d = \Delta t/(1/v_S - 1/v_P)$ = (2.0 min)(60 sec/min)/($^1/_{(5.5 \text{ km/s})} - {}^1/_{(8.5 \text{ km/s})}$) = 1.9×10^3 km

(b) Since the waves spread out in a circle, and we are not certain which direction the waves are traveling, we could not determine the exact location of the quake. We would need another station not in line with the other two.
(Table of contents)

51. If a violin string vibrates at 440 Hz as its fundamental frequency, what are the frequencies of the first four harmonics?

A violin is a both ends fixed, and so successive harmonics are simply multiples of the fundamental:
Therefore, f_1 = 440Hz (fundamental frequency)
$f_2 = 2f_1$ = 2 x 440 = 880 Hz
$f_3 = 3f_1$ = 3 x 440 = 1320 Hz
$f_4 = 4f_1$ = 4 x 440 = 1760 Hz
(Table of contents)

53. A particular string resonates in four loops at a frequency of 280 Hz. Name at least three other frequencies at which it will resonate.

Four loops means four anti-nodes, which means that we have the fourth harmonic, as the fundamental is one "loop" or anti-node. The fourth harmonic would be four times the fundamental, so therefore the fundamental is 280 Hz/4 = 70 Hz, and the next two would be 140 Hz, and 210 Hz. So

f_1 = 70Hz (fundamental frequency)
$f_2 = 2f_1$ = 2 x 70 = 140 Hz
$f_3 = 3f_1$ = 3 x 70 = 210 Hz
$f_4 = 4f_1$ = 4 x 70 = 280 Hz
(Table of contents)

55. The velocity of waves on a string is 92 m/s. If the frequency of standing waves is 475 Hz, how far apart are two adjacent nodes?

The distance between two adjacent nodes is the half of wavelength. Therefore:
λ = v/f = 92/475 = 0.2m
Therefore: d = λ/2 = 0.1 m
(Table of contents)

56. If two successive overtones of a vibrating string are 280 Hz and 350 Hz, what is the frequency of the fundamental?

If it is a vibrating string, we know that the harmonics are successive multiples of the fundamental, (f_1, $2f_1$, $3f_1$, $4f_1$, ...), and so the difference between successive harmonics or overtones is simply the fundamental. In this case, 350 Hz - 280 Hz = 70 Hz. (Note that these two are the fourth and fifth harmonics respectively)
(Table of contents)

57. A guitar string is 90 cm long, and has a mass of 3.6 g. From the bridge to the support post (=L) is 60 cm, and the string is under a tension of 520 N. What are the frequencies of the fundamental and the first two overtones?

Now we will apply a special formula from the data packet, which is: v = $\sqrt{T/\mu}$
Where μ = mass/length for the cord, and T is the tension in the cord.
have: T = 520N; m = 3.6 g = .0036 kg; and l = .90 m, so μ = (.0036 kg)/(.90 m) = .004 kg/m
Therefore, v = $\sqrt{T/\mu}$ = $\sqrt{(520 \text{ N}/(.004 \text{ kg/m}))}$ = 360.56 m/s

At the fundamental, the string has two nodes at the end, and one anti-node in the middle, so therefore the vibrating length of the string (.60 m) is equal to $^2/_4\lambda$, so λ = 1.2 m

Now we can get the fundamental by using v = $f\lambda$
f = v/λ = (360.56 m/s)/(1.2 m) = 300.5 Hz, and the next two harmonics are simply multiples of this fundamental:
f_1 = 300.5 Hz (fundamental frequency)
$f_2 = 2f_1$ = 2 x 300.5 Hz = 601 Hz
$f_3 = 3f_1$ = 3 x 300.5 Hz = 901 Hz
(Table of contents)

Chapter 12

1. A hiker determined the length of a lake by listening for the echo of her shout reflected by a cliff at the far end of the lake. She hears the echo 1.5 s after shouting. Estimate the length of the lake.

You hear the echo when the sound, traveling at 343 m/s, goes twice the length of the lake. (i.e. there and back again). It the sound travels for 1.5 s total, it went (343 m/s)(1.5 s) = 514.5 m total, and therefore the lake is half that in length, or 257.25 m long (about 260 m)
(Table of contents)

3. a) Calculate the wavelengths in air at 20^{o}C for sounds in the maximum range of human hearing, 20 Hz to 20,000 Hz. b) What is the wavelength of a 10-MHz ultrasonic wave?

The speed of sound at 1 atmosphere, at 20 ^{o}C is 343 m/s.
To find the wavelength use
v = $f\lambda$
so
λ = v/f
For 20 Hz,
λ = v/f = 17.15 m
For 20,000 Hz,
λ = v/f = 0.01715 m
For 10 MHz (10 x 10^6 Hz),
λ = v/f = 0.0000343 m = 3.43 x 10^{-5} m
(Table of contents)

5. A person sees a heavy stone strike the concrete pavement. A moment later two sounds are heard from the impact: one travels in the air, and the other in the concrete, and they are 1.4 s apart. How far away did the impact occur?

The speed of sound in air we will take to be 343 m/s, and that in concrete is 2950 m/s. (They figure it out using a chapter we skipped)
In general, the time for the sound to travel is t = s/v, so we have that we hear the concrete transmitted sound 1.4 seconds before the air transmitted sound

or,
s/v_a - s/v_c = 1.4 s where v_a and v_c are the speeds of sound in air and concrete. If we solve for s, we get:
s = (1.4 s)/($1/v_a$ - $1/v_c$) = 540 m
(Table of contents)

26. The A string on a violin has a fundamental frequency of 440Hz. The length of the vibrating portion is 32cm and has a mass of 0.35 g . Under what tension must the string be placed?

The fundamental frequency is: f_1 = 440Hz
At the fundamental, the string has two nodes at the end, and one anti-node in the middle, so therefore the vibrating length of the string (.32 m) is equal to $^2/_4\lambda$, so λ = .64 m
v = λf = (0.64 m)(440 Hz) = 281.6 m/s

Now we will apply the wave speed in a string relationship, which is: v = $\sqrt{}$T/μ
Where μ = mass/length for the cord, and T is the tension in the cord.
have: T = ??? N; m = .35 g = .00035 kg; and l = .32 m, so μ = (.00035 kg)/(.32 m) = .001094 kg/m
Therefore, v = $\sqrt{}$T/μ =, $\sqrt{}$(520 N/(.004 kg/m)) = 360.56 m/s
v^2 = T/μ
and
T = μv^2
T = 86.7 N
(Table of contents)

27. An unfingered guitar string is 0.7 m long and is tuned to play E above middle C (330Hz). How far from the end of the string must the finger be placed to to play A above middle C (440Hz)?

At the fundamental, the string has two nodes at the end, and one anti-node in the middle, so therefore the vibrating length of the string (.70 m) is equal to $^2/_4\lambda$, so λ = 1.4 m

The wave speed on the string must be
v = fλ = (330 Hz)(1.4 m) = 462 m/s

Now, at 440 Hz, the wavelength must be
λ = v/f = (462 m/s)/(440 Hz) = 1.05 m, and since at the fundamental, only half the wavelength fits on the string, then we get that the string must now be (1.05 m)/2 = .525 m long, which means the string must now be fingered .70 - .525 m = .175 m from the end.
(Table of contents)

28. Determine the length of an open organ pipe that emits middle C (262Hz) when the temperature is 21^0 C.

The speed of sound depending on temperature derives from the formula: v = 331 + 0.6T m/s
Thus, the speed of sound now is: v = 331 + 0.6*21 = 343.6 m/s
The wavelength of a 262 Hz sound at this temperature is: λ = v/f = 343.6/262 = 1.31m
Since a both ends open organ pipe has a node in the middle, and two anti-nodes at each end, the length of the pipe (L) is equal to $^2/_4\lambda$, or L = λ/2 = (1.31 m)/2 = 0.66m
(Table of contents)

29. (a) What resonant frequency would you expect from bowling across the top of an empty soda bottle that is 15 cm deep? (b) How would that change if it was one-third full of soda?

(a) The empty soda bottle is a closed pipe with the node is at the bottom of the bottle (fixed end) and the anti-node is at the top. Therefore the length of the bottle (L) is equal to only $^1/_4\lambda$, or λ = 4L = 4(.15 m) = 0.60 m
The resonant frequency must be: f = v/λ = (343 m/s)/(0.60 m) = 571.67Hz (Assuming the speed of sound is 343 m/s)

(b) The length of the pipe is now 2/3 of what is was or (2/3)(.015 m) = .40 m
The resonant frequency now is: f = v/λ = (343 m/s)/(0.40 m) = 857.5Hz
(Table of contents)

30. If you were to build a pipe organ with open tube pipes spanning the range of human hearing (20Hz to 20kHz), what would be the range of lengths of pipes required?

The speed of sound in air is 343m/s.
With f_1 = 20 Hz, the wavelength is: λ = v/f = (343 m/s)/(20 Hz) = 17.15 m. Since a both ends open organ pipe has a node in the middle, and two anti-nodes at each end, the length of the pipe (L) is equal to $^2/_4\lambda$, or L = λ/2 = (17.15 m)/2 = 8.575m (longest)
With f_1 = 20,000 Hz, the wavelength is: λ = v/f = (343 m/s)/(20,000 Hz) = .01715 m. Since a both ends open organ pipe has a node in the middle, and two anti-nodes at each end, the length of the pipe (L) is equal to $^2/_4\lambda$, or L = λ/2 = (.01715 m)/2 = .008575 m (smallest)
Therefore, the range of the length must be: 0.008575m =< L =< 8.575m
(Table of contents)

31. An organ pipe is 112 cm long. What are the fundamental and first three audible overtones if the pipe is (a) closed at one end, and (b) open at both ends?

If one end is closed, and one open, then you get a pattern of successive harmonics that goes
f_1, $3f_1$, $5f_1$, $7f_1$, $9f_1$ - that is, odd multiples of the fundamental, so let's find the fundamental:
With one end fixed, or a closed pipe, at the fundamental, the node is at the closed end (fixed end) and the anti-node is at the open end. Therefore the length of the pipe (L) is equal to only $^1/_4\lambda$, or $\lambda = 4L = 4(1.12 \text{ m}) = 4.48$ m, and the frequency you can get with $v = f\lambda$.

The resonant frequency now is: f = v/l = (343 m/s)/(4.48 m) = 75.6 Hz

And the next two can be found now:
f_1 = 75.6 Hz (fundamental frequency)
$f_2 = 3f_1$ = 3 x 75.6 Hz = 230 Hz
$f_3 = 5f_1$ = 5 x 75.6 Hz = 383 Hz
$f_3 = 7f_1$ = 7 x 75.6 Hz = 536 Hz

If both ends are open, then you get a pattern of successive harmonics that goes
f_1, $2f_1$, $3f_1$, $4f_1$, $5f_1$ - that is, multiples of the fundamental, so let's find the fundamental:
At the fundamental, a both ends open organ pipe has a node in the middle, and two anti-nodes at each end, the length of the pipe (L) is equal to $^2/_4\lambda$, or $L = \lambda/2$, or $\lambda = 2L = 2(1.12 \text{ m}) = 2.24$ m, and the frequency you can get with $v = f\lambda$.

The resonant frequency now is: f = v/l = (343 m/s)/(2.28 m) = 153.1 Hz

And the next two can be found now:
f_1 = 153.1 Hz (fundamental frequency)
$f_2 = 2f_1$ = 2 x 153.1 Hz = 306 Hz
$f_3 = 3f_1$ = 3 x 153.1 Hz = 459 Hz
$f_3 = 4f_1$ = 4 x 153.1 Hz = 612 Hz
(Table of contents)

33. A highway overpass was observed to resonate as one full loop when a small earthquake shook the ground vertically at 4.0 Hz. The highway department put a support at the center of the overpass, anchoring it to the ground as shown in Fig. 12 - 34. What resonant frequency would you now expect for the overpass? It is noted that earthquake rarely do significant shaking above 5 or 6 Hz. Did the modifications do any good?

With one support in the center, the second harmonic, or first overtone could still vibrate or resonate, as it has a node here. (So could the fourth, the 8th, all octaves (doublings) of the fundamental). The second harmonic would have twice the frequency, or vibrate at 8.0 Hz, and since apparently earthquake waves don't go this high in frequency, it would seem that this would work.
(Table of contents)

35. (a) At T = 15^{0}C, how long must a close organ pipe be if it is to have a fundamental frequency of 294 Hz? (b) If this pipe were filled with helium, what would its fundamental frequency be?

Well, since they give a temperature, we must calculate the new speed of sound:
v = 331 m/s + (.60 m/s/^{o}C)(15 ^{o}C) = 340 m/s.

The wavelength of a 294 Hz wave at this wave speed is λ = v/f = (340 m/s)/(294 Hz) = 1.1565 m
With one end fixed, or a closed pipe, at the fundamental, the node is at the closed end (fixed end) and the anti-node is at the open end. Therefore the length of the pipe (L) is equal to only $^1/_4\lambda$, so L = $^1/_4$(1.1565 m) = .289 m

The speed of sound in Helium is 1005 m/s (Look it up in your book - table 12-1 p 348)
The length of the pipe (L) is equal to only $^1/_4\lambda$, or $\lambda = 4L = 4(.289 \text{ m}) = 1.1565$ m, (we have figured this out before) and the frequency you can get with $v = f\lambda$.
The resonant frequency now is: f = v/l = (1005 m/s)/(1.1565 m) = 869 Hz
(Table of contents)

36. A particular organ pipe can resonate at 264Hz, 440Hz, and 616Hz. (a) Is this an open or closed pipe? (b) What is the fundamental frequency of this pipe?

A both ends open organ pipe would resonate at multiples of a fundamental, or f_1, $2f_1$, $3f_1$, $4f_1$, $5f_1$ - and if it had one end closed, it would resonate at f_1, $3f_1$, $5f_1$, $7f_1$, $9f_1$ - that is, odd multiples of the fundamental. So which is this??

Let's play with numbers:
616 - 440 = 176 Hz
440/176 = 2.5
so 176 Hz is not the fundamental. What about half of 176 Hz? 176 Hz/2 = 88 Hz
264/88 = 3
440/88 = 5
616/88 = 7

So I think they want us to say that it is a closed end pipe, and we are seeing the second (3x) third (5x) and fourth (7x) harmonics, but since they never said that these were successive harmonics (i.e. that there were no other resonant frequencies in between) then the pipe really could be a both ends open with a fundamental of say 44 Hz or 22 Hz or 11 Hz or even 2 H or 1 Hz (That is any thing that would go into (264, 440, 616) evenly - any factor of 88)
(Table of contents)

37. A uniform narrow tube 1.8m long is open at both ends. It resonates at two successive harmonics of frequency 275Hz and 330Hz. What is the speed of sound in the gas in the tube?

A both ends open organ pipe would resonate at multiples of a fundamental, or f_1, $2f_1$, $3f_1$, $4f_1$, $5f_1$ - so successive harmonics are separated in frequency by the fundamental frequency, 330 Hz - 275 Hz = 55 Hz in this case.
Since a both ends open organ pipe has a node in the middle, and two anti-nodes at each end, the length of the pipe (L) is equal to $^2/_4\lambda$, or L = λ/2, or λ = 2L = 2(1.8 m) = 3.60 m, and the velocity you can get with v = fλ.
v = (55 Hz)(3.60 m) = 198 m/s
(Table of contents)

38. A pipe in air at 20^{0}C is to be designed to produce two successive harmonics at 240Hz and 280Hz. How long must the pipe be, and is it open or closed?

A both ends open organ pipe would resonate at multiples of a fundamental, or f_1, $2f_1$, $3f_1$, $4f_1$, $5f_1$ - and if it had one end closed, it would resonate at f_1, $3f_1$, $5f_1$, $7f_1$, $9f_1$ - that is, odd multiples of the fundamental. So which is this??

Let's play with numbers:
280 - 240 = 40 Hz

280/40 = 7
240/40 = 6
Since these are successive harmonics (none in between) then this must be a both ends open pipe with a fundamental frequency of 40 Hz.

The velocity of sound at room temperature is 343 m/s, and at 40 Hz the wavelength is
= (343 m/s)/(40 Hz) = 8.575 m
At the fundamental, a both ends open organ pipe has a node in the middle, and two anti-nodes at each end, the length of the pipe (L) is equal to $^2/_4\lambda$, or L = λ/2, L = (8.575 m)/2 = 4.3 m
(Table of contents)

42. A piano turner hears one beat every 2.0s when trying to adjust two strings, one of which is sounding 440Hz, so that they sound the same tone. How far off in frequency is the other string?

If the beat period is 2.0 s, then the beat frequency is .50 Hz (f = 1/T)
We know that the beat frequency is just the difference in the two frequencies. So the other frequency is either 439.5 or 440 .5 Hz.
(Table of contents)

43. What will be the "beat frequency" if middle C (262Hz) and C# (277Hz) are played together? Will this be audible? What if each is played two octaves lower (each frequency reduced by a factor of 4)?

The beat frequency would just be the difference in the frequencies:
$f_{beat} = |f_1 - f_2|$
f_{beat} = |262 Hz - 277 Hz| = 15 Hz
And no, you would not be able hear that as beats, as the human ear can hear about 8 beats/sec
Two octaves lower, the frequencies would be:
262/4 = 65.5 Hz
and
277/4 = 69.25 Hz
Again, he beat frequency would just be the difference in the frequencies:
$f_{beat} = |f_1 - f_2|$
f_{beat} = |69.25 Hz- 65.5 Hz| = 3.75 Hz
And this would be audible as beats.
(Table of contents)

44. A certain dog whistle operates at 23.5hHz, while another (brand X) operates at an unknown frequency. If neither whistle can be heard by humans when played separately, but a thrill whine of frequency 5000Hz occurs when they are played simultaneously, estimate the operating frequency of brand X.

The mystery whistle has a frequency that is 5000 or 5 kHz from the other, which means is is at 23.5 + or - 5 kHz, which means the two options are 28.5 kHz (above human hearing) or 18.5 kHz which would be audible, and since it is not audible, then the other must be the higher frequency of 28.5 kHz.
(Table of contents)

45. A guitar string produces 4 beats/s when sounded with a 350Hz tuning fork and 9 beats when sounded with a 355Hz tuning fork. What is the vibrational frequency of the string? Explain your reasoning

At 350 Hz, and 4 beats/s, the other string could be 354 or 346 Hz, and at 355 Hz, and 9 beats/s, the other string could be 346 Hz, or 364 Hz. The only frequency that would work or course is 346 Hz.
(Table of contents)

48. Two loudspeakers are 2.5 m apart. A person stands 3.0 m from one speaker, and 3.5 m from the other. a) What is the lowest frequency at which destructive interference will occur at this point? b) calculate two other frequencies that also result in destructive interference at this point. (give the next two highest)

If destructive interference occurs at this point, then the difference in distance from one speaker to the next (.50 m in this case) must be have a half wavelength remainder. (i.e. the distance is $^1/_2\lambda$, $1\,^1/_2\lambda$, $2\,^1/_2\lambda$, $3\,^1/_2\lambda$ ...)
The lowest frequency would be the longest wavelength, so
the difference in dis
$.50\text{ m} = {}^1/_2\lambda$
$\lambda = 1.0$ m
Assuming that v for sound is 343 m/s, we can use
$v = f\lambda$
so f = 343 Hz

The next would be the next longest
$.50\text{ m} = 1\,^1/_2\lambda$
$\lambda = .3333$ m
Assuming again that v for sound is 343 m/s, we can use
$v = f\lambda$
so f = 1029 Hz

The last would be the next longest
$.50\text{ m} = 2\,^1/_2\lambda$
$\lambda = .2$ m
$v = f\lambda$
so f = 1715 Hz
(Table of contents)

49. A source emits sound of wavelengths 2.64 m and 2.76 m in air. (a) How many beats per second will be heard (assume T = 20^{0}C)? (b) How far apart in space are the regions of maximum intensity?

We can find the frequencies of the two waves by using
$v = f\lambda$
$f = v/\lambda = (343\text{ m/s})/(2.64\text{ m}) = 129.92$ Hz
$f = v/\lambda = (343\text{ m/s})/(2.76\text{ m}) = 124.28$ Hz

For the beat frequencies:
$f_{beat} = |f_1 - f_2|$
$f_{beat} = |129.92\text{ Hz} - 124.28\text{ Hz}| = 5.65$ Hz

The beat frequency itself would have a wavelength in air of
$\lambda = v/f = (343\text{ m/s})/(5.65\text{ Hz}) = 61$ m
(Table of contents)

Schaum's 23:

20. A wave along a string has the following equation (x in meters and t in seconds):
y = (0.02)sin(30t-4.0x)
Find the amplitude, frequency, speed, and wavelength?

The trick is to compare the equation with our template:
$y = A\sin(\omega t \pm kx)$ where $k = 2\pi/\lambda$ and $\omega = 2\pi f$
and
y = (0.02)sin(30t-4.0x)
so
A = .02 m
$\omega = 30\text{ rad/s} = 2\pi f$
$k = 4.0\text{ m}^{-1} = 2\pi/\lambda$
So the amplitude is simply A = .02 m
The frequency you can find with
$30\text{ rad/s} = 2\pi f$
f = 4.77 Hz
And the wavelength you can find with
$k = 4.0\text{ m}^{-1} = 2\pi/\lambda$
$\lambda = 1.57$ m, and finally the velocity you can find with

$v = f\lambda$
$v = (4.77\ Hz)(1.57\ m) = 7.5\ m/s$
(Table of contents)

21. For the wave y = 5sin30p [t-(x/240)], where x and y are in centimeters, and t is in seconds, find the a) displacement when t = 0, and x = 2 cm; b) wavelength; c) velocity of the wave, and d) frequency of the wave

The trick is to compare the equation with our template:
$y = A\sin(\omega t \pm kx)$ where $k = 2\pi/\lambda$ and $\omega = 2\pi f$
and
y = 5sin30p [t-(x/240)] = 5sin{30p t-(30p /240)x}
(I distributed the 30π so it would look like our formula)
so
A = 5 cm
$\omega = 30\pi$ rad/s $= 2\pi f$
$k = (30\pi/240)\ m^{-1} = 2\pi/\lambda$
So the displacement at t = 0, and x = 2 cm
$y = 5\sin 30\pi[0-(2/240)] = -3.53$ cm
The frequency you can find with
$\omega = 30\pi$ rad/s $= 2\pi f$
f = 15 Hz
And the wavelength you can find with
$(30\pi/240)\ m^{-1} = 2\pi/\lambda$
$\lambda = 16$ cm, and finally the velocity you can find with
$v = f\lambda$
v = (15 Hz)(16 c m) = 240 cm/s
(Table of contents)

23. For the wave shown in Fig 23-3, find its amplitude, frequency, and wavelength if its speed is 300 m/s. Write the equation for this wave as it travels out along the +x axis if its position at t = 0 is as shown

If you look at the drawing, exactly 2 1/2 wavelengths take 20 cm, and so the wavelength is
$2.5\lambda = 20$ cm
$\lambda = 8$ cm = .08 m
Since the velocity is 300 m/s, we can find the frequency with
$v = f\lambda$
f = 3750 Hz
You can read the amplitude right off the figure as .06 m, and now we are ready to use our fancy equation template to make our wave equation:
$y = A\sin(\omega t \pm kx)$ where $k = 2\pi/\lambda$ and $\omega = 2\pi f$
A = .06 m
$\omega = 2\pi f = 23600\ s^{-1}$
$k = 2\pi/\lambda = 78.5\ m^{-1}$
so
$y = A\sin(\omega t \pm kx) = (.06m)\sin((23600\ s^{-1})t \pm (78.5\ m^{-1})x)$
(Table of contents)