Oscillations - Review

1. HR.p392. At $t = 0$ the displacement of the block in a linear oscillator is $-8.5\ cm$. At the same time the block velocity is $-0.92\ \frac{m}{s}$ and its acceleration is $47\ \frac{m}{s^2}$
a) What is the angular frequency of the system?
b) What are the phase constant and the amplitude?

Answer: $23.5\frac{rad}{s}$; $155°$; $0.094\ m$

2. BW.14.60. The motion of a block-spring system is described by $x = A\sin\omega t$. Find the angular frequency if the potential energy equals the kinetic energy at $t = 1s$.

Answer: $\frac{\pi}{4}\frac{rad}{s}$

Wave form, wave speed, and transverse speed

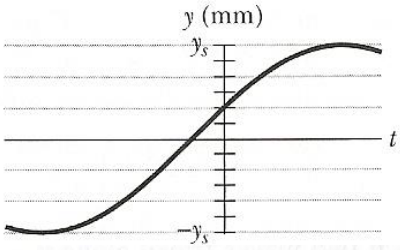
3. BW.15.19 The displacement from equilibrium caused by a wave on a string is given by $y(x,t) = -0.002\sin(40x - 800t)$, where all quantities are expressed in SI units. For this wave what are:
a) The amplitude
b) The number of complete cycles in $1s$.
c) The number of waves in $1m$.
d) What is the speed of the wave?
e) What is the displacement, velocity and acceleration of an element of string situated at $x = 10cm$ after $t = 1\ s$?

Answer: $2\ mm$; 127; 6.4; $20\frac{m}{s}$; $-1.85\ mm$; $-0.62\frac{m}{s}$; $1242\ m/s^2$

4. BW.15.23. A wave travels along a string in the positive x-direction at $30\ m/s$. The frequency of the wave is $50\ Hz$. At $x = 0$ and $t = 0$, the transverse velocity is $2.5\ m/s$ and the vertical displacement is $y = 4\ mm$. Write the function $y(x,t) = A\sin(kx - \omega t + \varphi)$ for this wave.

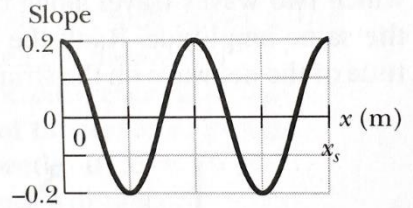
Answer: $8.91\sin(\frac{10\pi}{3}x - 100\pi\ t + 0.85\pi)$

5. HR.16.66. The figure shows the displacement y versus time t of the point on a string at $x = 0$, as the wave passes through that point. The scale is set by $y_s = 6\ mm$. The wave is given by $y(x,t) = A\sin(kx - \omega t + \varphi)$. What is φ ?



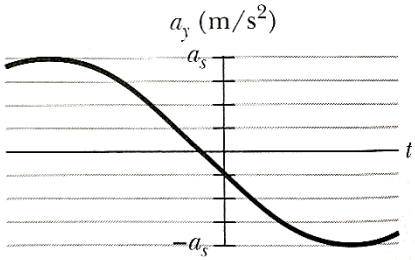
Answer: $0.9\pi\ rad$

6. HR.16.6. A sinusoidal wave travels along a string under tension. The graph shows the slopes along the string at t=0. The scale of the x axis is set by $x_s = 0.8\ m$. What is the amplitude of the wave?



Answer: $1.3\ cm$

7. HR.16.70. The figure shows the transverse acceleration versus time of a point on a string at $x = 0$, as the wave in the form $y(x,t) = A\sin(kx - \omega t + \varphi)$ passes through that point. The scale is set by $a_s = 400\ m/s^2$. What is φ ?



Answer: $0.92\pi\ rad$

8. BW.15.22. Show that the function $(x,t) = A\ln(x+vt)$, is a solution of the wave equation.

Energy, Power, Intensity

9. YF.15.27. By measurement you determine that sound waves are spreading out equally in all directions from a point source and that the intensity is $0.026\frac{W}{m^2}$ at a distance of $4.3\ m$ from the source.

a) What is the intensity at a distance of $3.1\ m$ from the source?

b) How much sound energy does the source emit in one hour if its power output remains constant?

Answer: $0.05\frac{W}{m^2}$; $2.2\ 10^4\ J$

Wave interference

10. HR.p428. Two identical sinusoidal waves, moving in the same direction along a stretched string, interfere with each other. The amplitude y_m of each wave is $9.8\ mm$ and the phase difference between them is $100°$.

a) What is the amplitude of the resultant wave due to the interference and what type is this interference?

b) What phase difference will give the resultant wave an amplitude of $4.9\ mm$?

Answer: $13\ mm$; $\pm 0.83\pi\ rad$

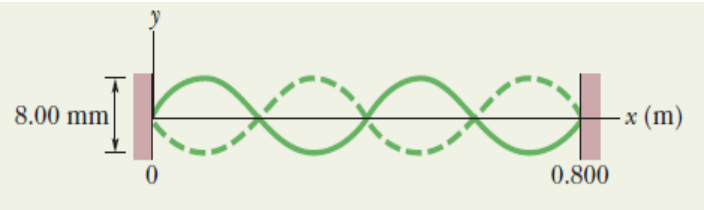
Standing waves

11. HR.p434. The figure shows the pattern of resonant oscillations of a string of mass $m = 2.5g$ and length $L = 0.8m$ and that is under tension $T = 325N$.

a) What is the wavelength of the transverse wave producing this pattern and what is the harmonic number?

b) What is the frequency of this wave?

c) What is the maximum magnitude of the transverse velocity of the element oscillating at coordinate $x = 0.18\ m$?



Answer: $0.4\ m$; 4; $806\ Hz$; $6.26\frac{m}{s}$

12. YF.15.82. Tuning an Instrument. A musician tunes the C-string of her instrument to a fundamental frequency of $65.4\ Hz$. The vibrating portion of the string is $0.6\ m$ long and has a mass of $14.4\ g$.

a) With what tension must the musician stretch it?

b) What percent increase in tension is needed to increase the frequency from $65.4\ Hz$ to $73.4\ Hz$, corresponding to a rise in pitch from C to D?

Answer: $186\ N$; 26%