1. The wavelength of light visible to the human eye is on the order of $5 \times 10^{-7}$ m. If the speed of light in air is $3 \times 10^{8}$ m/s, find the frequency of the lightwave.
   a. $3 \times 10^{7}$ Hz
   b. $4 \times 10^{9}$ Hz
   c. $5 \times 10^{11}$ Hz
   d. $6 \times 10^{14}$ Hz
   e. $4 \times 10^{15}$ Hz

   ANS: D PTS: 2 DIF: Average

2. The speed of a 10-kHz sound wave in seawater is approximately 1 500 m/s. What is its wavelength in sea water?
   a. 5.0 cm
   b. 10 cm
   c. 15 cm
   d. 20 cm
   e. 29 cm

   ANS: C PTS: 2 DIF: Average

3. Bats can detect small objects such as insects that are of a size on the order of a wavelength. If bats emit a chirp at a frequency of 60 kHz and the speed of soundwaves in air is 330 m/s, what is the smallest size insect they can detect?
   a. 1.5 mm
   b. 3.5 mm
   c. 5.5 mm
   d. 7.5 mm
   e. 9.8 mm

   ANS: C PTS: 2 DIF: Average

4. Ocean waves with a wavelength of 120 m are coming in at a rate of 8 per minute. What is their speed?
   a. 8.0 m/s
   b. 16 m/s
   c. 24 m/s
   d. 30 m/s
   e. 4.0 m/s

   ANS: B PTS: 2 DIF: Average

6. A piano string of density 0.005 0 kg/m is under a tension of 1 350 N. Find the velocity with which a wave travels on the string.
   a. 260 m/s
   b. 520 m/s
   c. 1 040 m/s
   d. 2 080 m/s
   e. 4 160 m/s

   ANS: B PTS: 2 DIF: Average

11. If $y = 0.02 \sin (30x - 400t)$ (SI units), the wavelength of the wave is
   a. $\pi/15$ m

b. $15/\pi$ m
c. $60\pi$ m
d. 4.2 m
e. 30 m

ANS: A PTS: 2 DIF: Average

12. If $y = 0.02 \sin (30x - 400t)$ (SI units), the velocity of the wave is
a. 3/40 m/s
b. 40/3 m/s
c. $60\pi/400$ m/s
d. $400/60\pi$ m/s
e. 400 m/s

ANS: B PTS: 2 DIF: Average

13. If $y = 0.02 \sin (30x - 400t)$ (SI units), the angular frequency of the wave is
a. 30 rad/s
b. $30/2\pi$ rad/s
c. $400/2\pi$ rad/s
d. 400 rad/s
e. 40/3 rad/s

ANS: D PTS: 1 DIF: Easy

14. If $y = 0.02 \sin (30x - 400t)$ (SI units), the wave number is
a. 30 rad/m
b. $30/2\pi$ rad/m
c. $400/2\pi$ rad/m
d. 400 rad/m
e. $60\pi$ rad/m

ANS: A PTS: 1 DIF: Easy

15. If $y = 0.02 \sin (30x - 400t)$ (SI units) and if the mass density of the string on which the wave propagates is 0.005 kg/m, then the transmitted power is
a. 1.03 W
b. 2.13 W
c. 4.84 W
d. 5.54 W
e. 106 W

ANS: B PTS: 3 DIF: Challenging

16. Write the equation of a wave, traveling along the $+x$ axis with an amplitude of 0.02 m, a frequency of 440 Hz, and a speed of 330 m/sec.
a. $y = 0.02 \sin [880\pi(x/330 - t)]$
b. $y = 0.02 \cos [880\pi x/330 - 440t]$
c. $y = 0.02 \sin [880\pi(x/330 + t)]$
d. $y = 0.02 \sin [2\pi(x/330 + 440t)]$
e. $y = 0.02 \cos [2\pi(x/330 + 440t)]$

ANS: A PTS: 2 DIF: Average

17. For the wave described by $y = 0.15 \sin\left[\frac{\pi}{16}(2x - 64t)\right]$ (SI units), determine the first positive $x$ coordinate where $y$ is a maximum when $t = 0$.
a. 16 m
b. 8 m
c. 4 m
d. 2 m
e. 13 m

ANS: C PTS: 2 DIF: Average

18. For the wave described by $y = 0.15 \sin\left[\frac{\pi}{16}(2x - 64t)\right]$ (SI units), determine the $x$ coordinate of the second maximum when $t = 0$.
a. 20 m
b. 18 m
c. 24 m
d. 28 m
e. 16 m

ANS: A PTS: 2 DIF: Average

19. For the wave described by $y = 0.02 \sin(kx)$ at $t = 0$ s, the first maximum at a positive $x$ coordinate occurs where $x = 4$ m. Where on the positive $x$ axis does the second maximum occur?
a. 20 m
b. 18 m
c. 24 m
d. 28 m
e. 16 m

ANS: A PTS: 2 DIF: Average

20. For the transverse wave described by $y = 0.15 \sin\left[\frac{\pi}{16}(2x - 64t)\right]$ (SI units), determine the maximum transverse speed of the particles of the medium.
a. 0.192 m/s
b. $0.6\pi$ m/s
c. 9.6 m/s
d. 4 m/s
e. 2 m/s

ANS: B PTS: 2 DIF: Average

21. Which of the following is a solution to the wave equation, $\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}$?
a. $\frac{e^{-x}}{x}\sin x$
b. $(\cos kx)(\sin \omega t)$
c. $e^{-x}\sin \omega t$
d. $e^{-x}\sin(kx - \omega t)$
e. $e^{-x}\cos t$

ANS: B PTS: 2 DIF: Average

22. Find the period of a wave of 100-m wavelength in deep water where $v = \sqrt{g\lambda / 2\pi}$.
    a. 5.0 s
    b. 8.0 s
    c. 12.5 s
    d. 15 s
    e. 0.125 s

    ANS: B PTS: 2 DIF: Average

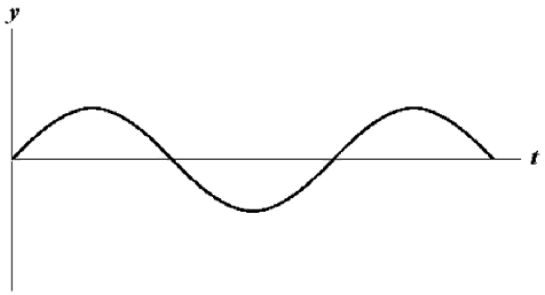
23. A piano wire of length 1.5 m vibrates so that one-half wavelength is contained on the string. If the frequency of vibration is 65 Hz, the amplitude of vibration is 3.0 mm, and the density is 15 g/m, how much energy is transmitted per second down the wire?
    a. 21 W
    b. 11 W
    c. 5.4 W
    d. 2.2 W
    e. 1.1 W

    ANS: D PTS: 2 DIF: Average

24. A student attaches a length of nylon fishing line to a fence post. She stretches it out and shakes the end of the rope in her hand back and forth to produce waves on the line. The most efficient way for her to increase the wavelength is to
    a. increase the tension on the hose and shake the end more times per second.
    b. decrease the tension on the hose and shake the end more times per second.
    c. increase the tension on the hose and shake the end fewer times per second.
    d. decrease the tension on the hose and shake the end fewer times per second.
    e. keep the tension and frequency the same but increase the length of the hose.

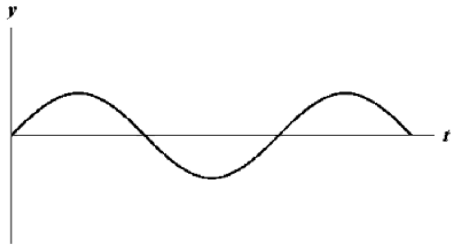
    ANS: C PTS: 1 DIF: Easy

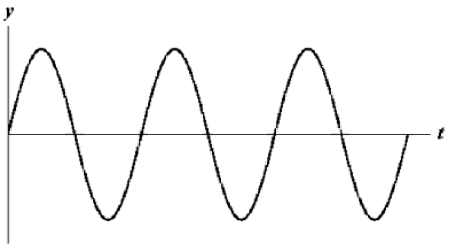
**Exhibit 16-1**
The figure below shows a sine wave at one point of a string as a function of time.

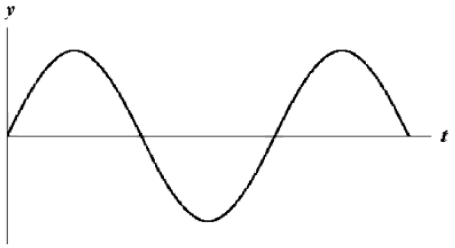


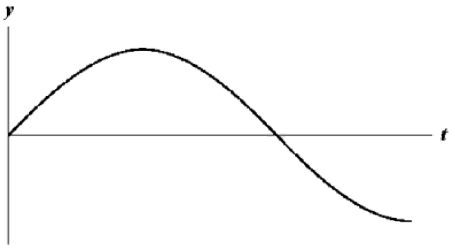

Use the exhibit to answer the following question(s).

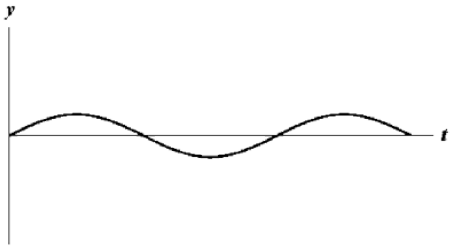
25. Refer to Exhibit 16-1. Which of the graphs below shows a wave where the amplitude and the frequency are doubled?

a. 


d. 

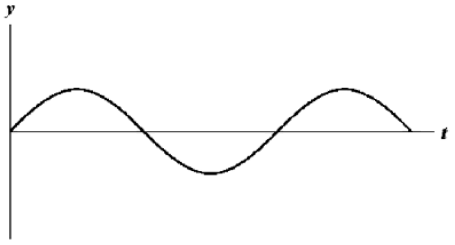

b. 

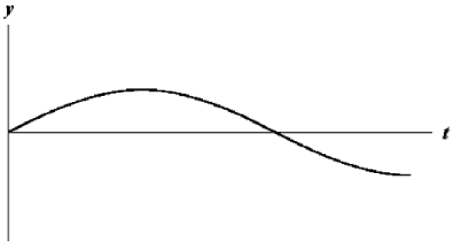

e. 

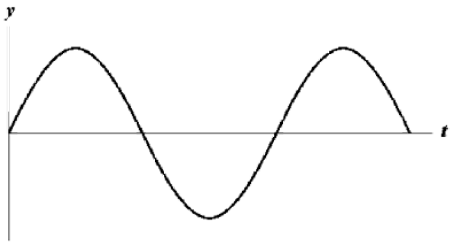

c. 

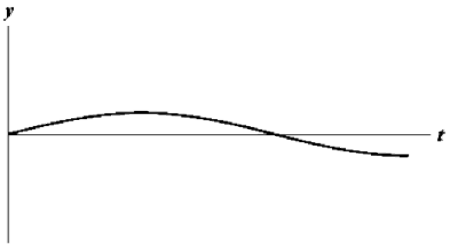

ANS: D PTS: 1 DIF: Easy

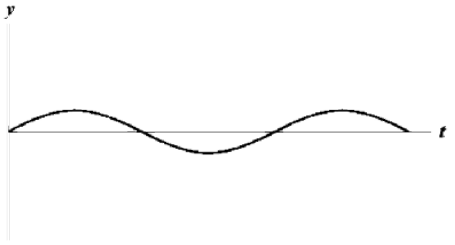
26. Refer to Exhibit 16-1. Which of the graphs below shows a wave where the amplitude and frequency are each reduced in half?

a. 


d. 

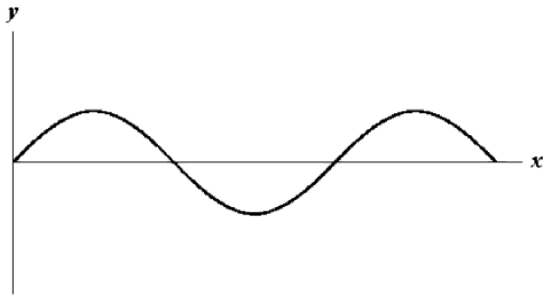

b. 


e. 


c. 

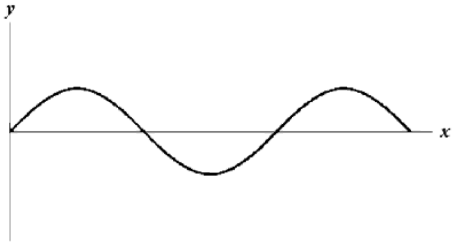

ANS: E PTS: 1 DIF: Easy

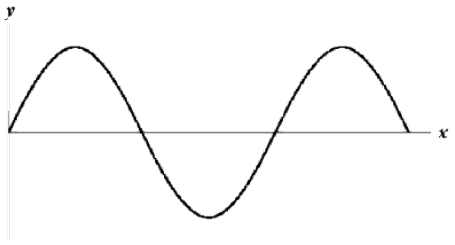
**Exhibit 16-2**
The figure below shows a sine wave on a string at one instant of time.

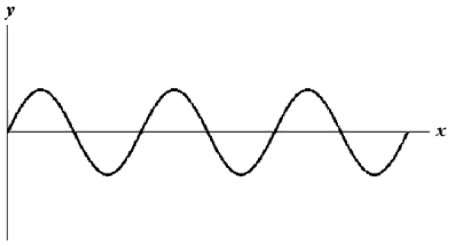


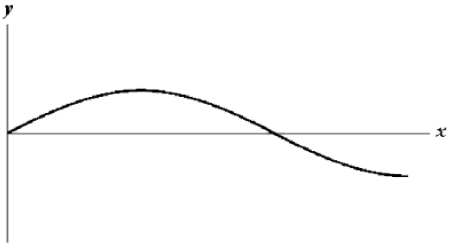

Use this exhibit to answer the following question(s).

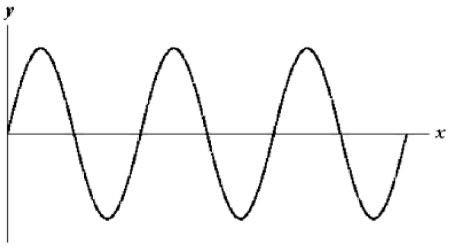
27. Refer to Exhibit 16-2. Which of the graphs below shows a wave where the frequency and wave velocity are both doubled?

a.



b.


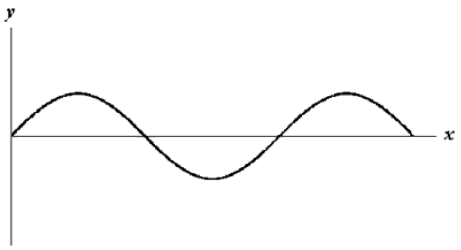

c.


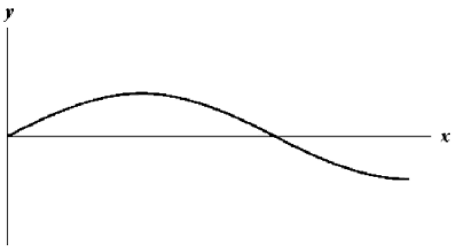

d.


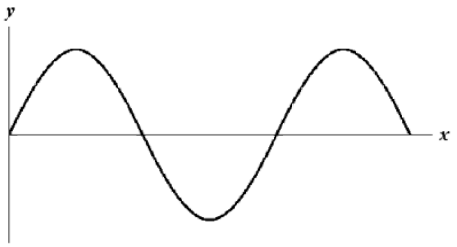

e.


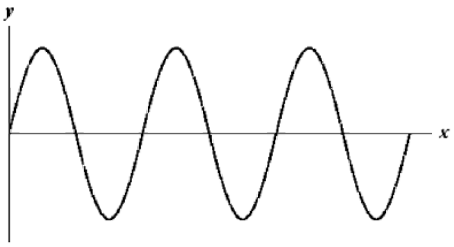

ANS: A PTS: 1 DIF: Easy

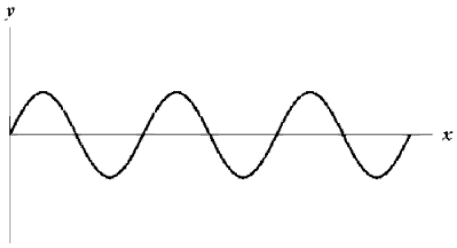
28. Refer to Exhibit 16-2. Which of the graphs below shows a wave where the wavelength is twice as large?

a.



d.


b. 


e. 


c. 


ANS: D PTS: 1 DIF: Easy

30. Ariel claims that a pulse is described by the equation

$$y(x,t) = \frac{2}{x^2 - 6.0xt + 9t^2 + 9}$$

where $x$ and $y$ are measured in cm and $t$ in s. Miranda says that it is not possible to represent a pulse with this function because a wave must be a function of $x + vt$ or $x - vt$. Which one, if either, is correct, and why?

a. Ariel, because $x^2 - 6.0xt + 9t^2 = (x - 3.0t)^2$.
b. Ariel, because a pulse is not an infinite wave.
c. Miranda, because $(x - 3.0t)^2$ is the same as $(3.0t - x)^2$.
d. Miranda, because a pulse is not an infinite wave.
e. Miranda, because $x^2 - 6.0xt + 9t^2 = x^2\left(1 - \frac{6.00t}{x} + \frac{9t^2}{x^2}\right)$ is infinite when $x = 0$.

ANS: A PTS: 1 DIF: Easy

33. The wave equation is written down in an exam as

$$\frac{d^2y}{dx^2} = v^2 \frac{d^2y}{dt^2}$$

From dimensional considerations we see that

a. $v^2$ should be replaced by $\frac{T}{\mu}$.
b. $v^2$ should be replaced by $\sqrt{\frac{T}{\mu}}$.
c. $v^2$ should be replaced by $v$.
d. $v^2$ should be replaced by $\frac{1}{v}$.
e. $v^2$ should be replaced by $\frac{1}{v^2}$.

ANS: E PTS: 1 DIF: Easy

42. The equation $y = A\sin(kx - \omega t + \frac{\pi}{2})$ is the same as

a. $y = -A\sin(kx - \omega t + \frac{\pi}{2})$

b. $y = A\cos(kx - \omega t)$

c. $y = -A\cos(kx - \omega t)$

d. $y = -A\sin(kx - \omega t - \frac{\pi}{2})$

e. $y = A\sin(kx - \omega t + \frac{3\pi}{2})$

ANS: B PTS: 2 DIF: Average

43. What is the expression for the transverse velocity of the wave in a string given by $y = A\sin(kx - \omega t)$?

a. $v = A\cos(kx - \omega t)$

b. $v = kA\cos(kx - \omega t)$

c. $v = -kA\cos(kx - \omega t)$

d. $v = -\omega A\cos(kx - \omega t)$

e. $v = \omega A\cos(kx - \omega t)$

ANS: D PTS: 1 DIF: Easy