Physics 1520, Spring 2011
Quiz 1, Form: A

Name: Key

Date: _____

Unless otherwise stated, the $+x$ axis is defined to the right and the $+y$ axis is defined upward.

Section 1. Exercises

1. A person's heart beat is 45 beats per minute. What is the period of her heart beat, in seconds?

   (a) 0.022 s
   (b) 0.75 s
   (c) 1.0 s
   (d) 1.33 s

   $f = 45 \frac{\text{beats}}{\text{min}}$. $T = \frac{1}{f} = \frac{1\text{ min}}{45\text{ beats}} = (0.022\text{ min})\left(\frac{60\text{ s}}{1\text{ min}}\right)$

   $= 1.33$ s

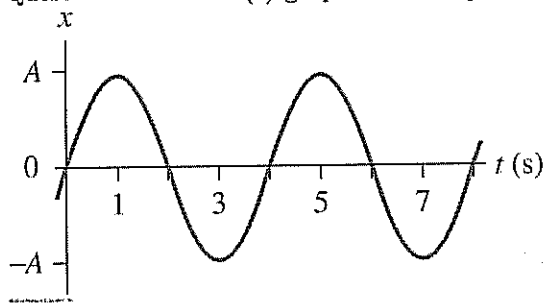
2. A mass on a spring oscillates with an angular frequency of 3 rad/s. What is its frequency in Hz?

   (a) 0.48 Hz
   (b) 0.95 Hz
   (c) 1.05 Hz
   (d) 2.1 Hz
   (e) 3 Hz

   $\omega = 3 \frac{\text{rad}}{\text{s}}$ $\omega = 2\pi f$

   $f = \frac{\omega}{2\pi} = \frac{3 \frac{\text{rad}}{\text{s}}}{2\pi} = 0.48$ Hz

Questions 3–4: An x(t) graph for an object oscillating on a spring is shown below.



3. What is the first clock reading when the object is momentarily at rest?

   (a) 1 s
   (b) 2 s
   (c) 3 s
   (d) 4 s
   (e) none of the above

   at max and min, the slope is zero and $v = 0$.

4. What is the first clock reading when the object has a maximum speed and is moving to the right?

   (a) 1 s
   (b) 2 s
   (c) 3 s
   (d) 4 s
   (e) none of the above

   at equil. with pos. slope.

5. If you double the amplitude of oscillation, the energy of the oscillator changes by a factor:

(a) $\sqrt{2}$
(b) 2
(c) 4
(d) 8
(e) None of the above; it stays the same.

$E = \frac{1}{2}kA^2$

So $E \propto A^2$

$(2A)^2 = 4A^2$

6. The frequency of a harmonic oscillator is 2 Hz. If you double the amplitude of the oscillation, the frequency will be

(a) 1 Hz.
(b) the same, 2 Hz.
(c) 2.8 Hz.
(d) 4 Hz.
(e) 8 Hz.

$\omega = \sqrt{\frac{k}{m}}$ and $\omega = 2\pi f$

So $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

f is independent of amplitude

7. You do a curve fit to a x(t) graph for a mass on a spring and find that the best-fit curve is $x(t) = (1.5\text{ cm})\cos(6t)$. What is the period?

(a) 0.95 s
(b) 6.0 s
(c) 1.5 s
(d) 3.0 s
(e) 1.05 s

$\omega = 6 \frac{rad}{s}$

$\omega = \frac{2\pi}{T}$ $\quad T = \frac{2\pi}{\omega} = 1.05\text{ s}$

8. In which material is the speed of sound greater, water ice or liquid water? (Think about what influences the speed of sound. You do not need to know the values for the speed sound in these substances.)

(a) water ice
(b) liquid water
(c) Neither; the speed of sound in the two materials will be the same.

It is a "stiffer" material.

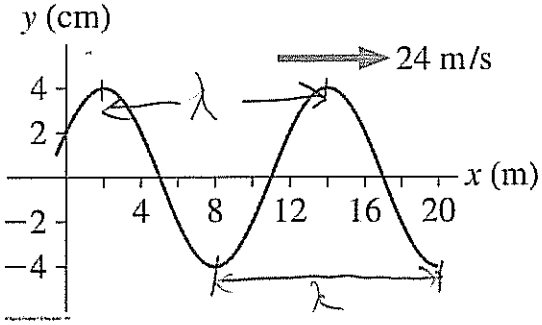
9. The speed of sound in air at 0°C is approximately 330 m/s. If I produce a sinusoidal sound wave in air of this temperature with a speaker oscillating with a frequency of 400 Hz, what is the wavelength of the sound wave?

(a) 1.2 m
(b) 0.0025 m
(c) 132,000 m
(d) 400 m
(e) 0.83 m

$v = \lambda f$

$\lambda = \frac{v}{f} = \frac{330\frac{m}{s}}{400\text{ Hz}} = 0.825\text{ m}$

10. A snapshot graph (i.e. picture) of a wave traveling on a string at $t = 0$ is shown below.



What is the wavelength of the wave?

distance between crests is $\lambda = 14m - 2m = 12m$

distance between troughs is $\lambda = 20m - 8m = 12m$

(a) 4 cm
(b) 2.4 m
(c) 10 m
(d) 3 m
(e) 13 m

12 m

11. A source of sinusoidal sound of frequency 1000 Hz is coming toward you with a velocity of 20 m/s. You are at rest. The speed of sound in air is about 343 m/s. What frequency will you hear?

(a) exactly the same as the source, 1000 Hz
(b) 942 Hz
(c) 945 Hz
(d) 1058 Hz
(e) 1062 Hz

$V = 343 \frac{m}{s}$ $f_s = 1000 Hz$ $V_s = 20 \frac{m}{s}$ $V_d = 0$ source moving toward listener

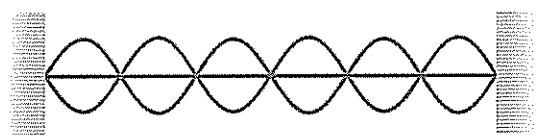
$f_d = \left(\frac{V \mp V_d}{V \pm V_s}\right) f_s$

$f_d = \left(\frac{343 + 0}{343 - 20}\right)(1000) = 1062\ Hz$

12. If a listener is moving away from a stationary sound source, the listener will hear

(a) the same frequency as the source.
(b) a high frequency than the source.
(c) a lower frequency than the source.

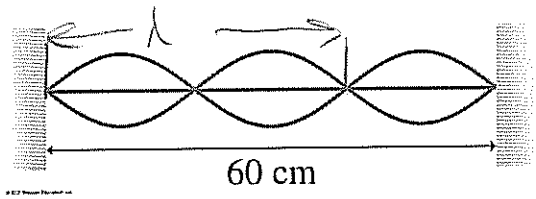
13. What is the mode (m) (i.e. harmonic) of the standing wave on a string shown below?



M = # antinodes in this case.

(a) 3
(b) 5
(c) 6
(d) 7
(e) 15

14. A standing wave on the string shown below is the 3rd harmonic. What is the wavelength of the standing wave?



$\lambda = \frac{2L}{m}$

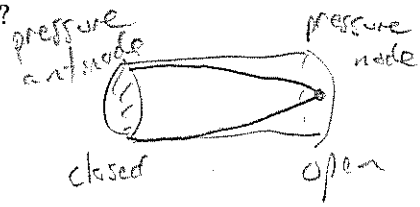
$= \frac{2(60\text{cm})}{3} = 40\text{ cm}$

(a) 60 cm
(b) 90 cm
(c) 20 cm
(d) 40 cm

15. The low E string on a guitar ("top" string) is thicker than a B string (2nd from the "bottom"). Suppose that both the low E string and B string have the same tension and both oscillate in the fundamental mode when played. Which string will oscillate with a higher frequency?

(a) low E string
(b) B string
(c) Neither; because they will have the same wavelength standing wave.

16. What is the longest possible wavelength for a standing sound wave in a 1-m long tube that is closed on one end and open on the other end?



(a) 4 m
(b) 2 m
(c) 1 m
(d) 0.5 m

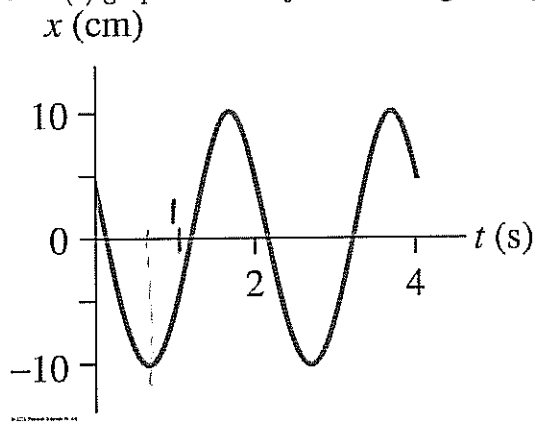
$\lambda = 4L$

$= 4(1\text{m})$

$= 4\text{m}$

Section 2. Critical Thinking

17. An x(t) graph for an object oscillating on a spring is shown below.



What is the first clock reading when the force on the object acts in the $+x$ direction and is largest?

(a) 0.25 s
(b) 0.75 s
(c) 1.25 s
(d) 2.25 s
(e) All times between 1.25 and 2.25 s

$F = -kx$ Hooke's law

When x is most negative, F is most positive.

18. You do a curve fit to a x(t) graph for a 0.25 kg mass on a spring and find that the best-fit curve is $x(t) = (1.5\text{ cm})\cos(6t)$. What is the spring stiffness, k?

(a) 13.5 N/m
(b) 0.23 N/m
(c) 6.0 N/m
(d) 9.0 N/m

$\omega = \sqrt{\frac{k}{m}}$

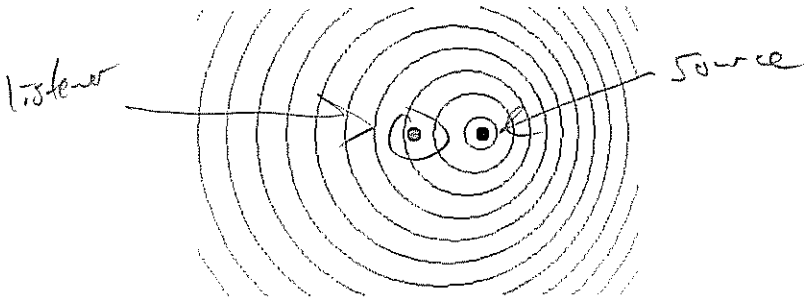
$\omega = 6\ \frac{rad}{s}$

$m = 0.25\ kg$

$k = \omega^2 m$

$= (6)^2(0.25\ kg) = 9\ \frac{N}{m}$

19. The picture below shows the wavecrests due to a sound wave emitted by a moving source. The source is the dot on the right and the listener is the dot on the left.



When moving away from listener, the f is lower. So wavelength is longer. Since wavecrests are spread further apart at the listener, the source is moving away from the listener.

Is the source moving away from the listener or toward the listener?

(a) The source is moving away from the listener.
(b) The source is moving toward the listener.
(c) Neither; the source is at rest.

20. A violin string has a standard length of 32.8 cm. It sounds the musical note A (440 Hz) when played without fingering and when oscillating in the fundamental mode. If its linear density is 5×10^{-4} kg/m, what is the tension on the string?

(a) 10 N
(b) 167 N
(c) 94 N
(d) 0.072 N
(e) 42 N

$v = \sqrt{\frac{T}{\mu}}$

fundamental so $\lambda = 2L = 65.6\text{ cm} = 0.656\text{ m}$

$v = \lambda f = (0.656\text{m})(440\text{Hz}) = 289\ \frac{m}{s}$

$v^2\mu = T$

$T = \left(289\ \frac{m}{s}\right)^2\left(5\times10^{-4}\ \frac{kg}{m}\right) = \boxed{41.8\ N}$