Physics 53 Exam 4 Dr. Alward Monday, May 1, 2009 .

More difficult problems are marked with an asterisk (*).

1. A 0.25 kg block oscillates on the end of the spring with a spring constant of 200 N/m. If the oscillation is started by elongating the spring 0.15 m and giving the block a speed of 3.0 m/s, then the maximum speed of the block is:

(a) 0.13
(b) 0.18
(c) 3.7
(d) 5.2
(e) None of the above

2. A wave traveling in the positive x direction has the form, $y = 2 \sin (50x - \pi t/4)$, where x and y are in meters, t is in seconds, and the phase is in radians. What are the period, T, and wavelength, λ ?

(a) T = 0.02 s, $\lambda = \pi/5$ m
(b) T = 50 s, $\lambda = \pi/2$ m
(c) T = 8 s, $\lambda = \pi/25$ m
(d) T = 8 s, $\lambda = \pi/4$ m
(e) None of the above

3. The displacement of a string carrying a sinusoidal wave is given by $y(x,t) = A \sin (kx - \omega t - \varphi)$. At time t = 0 the point at x = 0 has a velocity v_0 and displacement y_0. The phase constant φ is given by tan φ =

(a) $v_0/\omega y_0$
(b) $\omega y_0/v_0$
(c) $\omega v_0/y_0$
(d) $y_0/\omega v_0$
(e) None of the above

4. Two sinusoidal waves have the same angular frequency, the same amplitude A, and travel in the same direction in the same medium. If they differ in phase by 50º, the amplitude of the resultant wave is given by

(a) 1.6 A
(b) 1.9 A
(c) 1.7 A
(d) 1.8 A
(e) None of the above

5. The speed of waves on a string of length L = 1.20 m under tension is 100 m/s. What must be the frequency (in hertz, Hz) at which one end of the string is vibrated in order to cause a standing wave with five anti-nodes?

(a) 312
(b) 208
(c) 246
(d) 346
(e) None of the above

6. A sound source atop a tall tower broadcasts its sound energy spherically symmetrically. The power output of the source is that of a typical radio, 10 watts. If reflections are ignored, and if other noises that might otherwise mask the sound are absent, about how far away (in miles) could the sound be heard by a human?

(a) 934
(b) 867
(c) 713
(d) 581
(e) None of the above

7. The sound intensity at a particular point is 3.0×10^{-4} W/m^2. If the "decibel level" at that point is increased by 12 dB, what would be the new sound intensity at that point, in W/m^2?

(a) 9.4×10^{-3}
(b) 7.5×10^{-3}
(c) 5.9×10^{-3}
(d) 4.8×10^{-3}
(e) None of the above

8. Two speakers are 2 meters apart, and each is broadcasting sound at a frequency of 200 Hz. What is the closest distance (in meters) one may stand from one speaker, between the speakers, in order to hear a minimum?

(a) 0.14
(b) 0.25
(c) 0.32
(d) 0.68
(e) None of the above

9. What is the *second*-lowest frequency (in Hz) of sound that will resonate in an open-closed tube of length L = 1.20 m?

(a) 243.86
(b) 256.74
(c) 285.83
(d) 312.76
(e) None of the above

*10. A listener moves to the left at speed 30 m/s, as a sound source to the right of the listener also moves to the left, at an unspecified speed. The frequency heard by the listener is 970 Hz. The frequency broadcast by the sound source is 1000 Hz. What is the speed of the sound source, in m/s?

(a) 20.32
(b) 34.56
(c) 45.12
(d) 26.56
(e) None of the above

11. The roof of a flat-top building is a rectangle, 10m x 15 m. The air pressure in the building is 101,000 Pa, while the air pressure outside is only 99,000 Pa. What upward force (in newtons) does the roof experience due to the pressure difference?

(a) 25,000
(b) 50,000
(c) 150,000
(d) 300,000
(e) None of the above

12. The lift piston of a hydraulic lift has a diameter of 30.0 cm. What must be the diameter (in cm) of the smaller push piston, to lift a 2000-lb object with only a 20-lb push?

(a) 1
(b) 6
(c) 10
(d) 0.3
(e) None of the above

13. Water flowing at 1.5 m/s exits a pipe whose radius is 0.10 m. How many seconds will it take to fill a 5000-liter container? Note: 1000 liters = 1 m^3.
(a) 89
(b) 67
(c) 99
(d) 106
(e) None of the above

14. Water is flowing through the pipe shown in the figure. The difference in heights is 3.1 m. The speed of the fluid in the lower pipe is 4.0 m/s, and speed in the upper pipe is 2.0 m/s. What is the magnitude of the difference in pressure at the two ends, in Pa?

(a) 22,860
(b) 24,380
(c) 18.680
(d) 16,400
(e) None of the above

*15. A solid cube of metal rests at the bottom of a tank of water. The density of the metal is 5000 kg/m^3. The length of each side of the cube is 0.80 m. What is the force exerted by the block on the bottom of the tank?

(a) 16,780
(b) 20,070
(c) 11,630
(d) 9,280
(e) None of the above

16. The equation of motion for an oscillating particle is given by $x(t) = 5 \cos (0.20t - 1.5)$, where x is in cm, t is in seconds, and the phase is in radians. At what time (in seconds) will x = 2 cm?

(a) 0.82
(b) 1.23
(c) 1.43
(d) 1.70
(e) None of the above

*17. An object of mass m = 5 kg is oscillating at the end of a spring whose spring constant is 180 N/m. Its equation of motion has the form, $x = A \cos(\omega t + \varphi)$. At time t = 4.0 seconds, the object is at x = -7.0 cm. When t = 5.0 seconds, the object is at x = -9.0 cm. What is the amplitude of the motion, in cm?

(a) 9.4
(b) 10.8
(c) 18.7
(d) 14.3
(e) None of the above

18. The total energy of a spring-mass system oscillating horizontally is 1600 J. What will be the kinetic energy (in joules) of the mass when its displacement is one-fourth of its amplitude?

(a) 400
(b) 800
(c) 1200
(d) 1500
(e) None of the above

19. A spring-mass system is undergoing simple harmonic motion according to the equation, $x = A \cos(\omega t + \varphi)$. Its period of motion is 0.05 seconds, and its amplitude is 0.002 m. What is the maximum speed of the mass, in m/s?

(a) 0.98
(b) 1.12
(c) 1.26
(d) 2.34
(e) None of the above

20. A spring-mass system is undergoing simple harmonic motion according to the equation, $x = 2 \cos(2.5t + 1.1)$, where x is in m, t is in seconds, and the phase is in radians. What is the acceleration (in m/s^2) of the mass when $t = 1.4$ s?

(a) -2.13
(b) 1.75
(c) -1.08
(d) -3.21
(e) None of the above