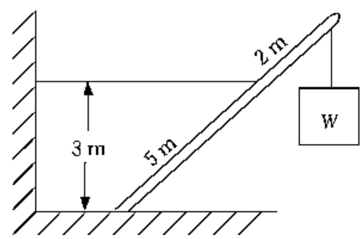
Exam 4 Review Questions
PHY 2425 - Exam 4

Section: 12–2 Topic: The Center of Gravity Type: Conceptual

8. After a shell explodes at the top of its trajectory, the center of gravity of the fragments has an acceleration, in the absence of air resistance,
   A) of less than g downward.
   B) equal to g and downward.
   C) greater than g and downward.
   D) of g downward plus a forward component.
   E) of g downward plus a backward component.
   Ans: B

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Numerical

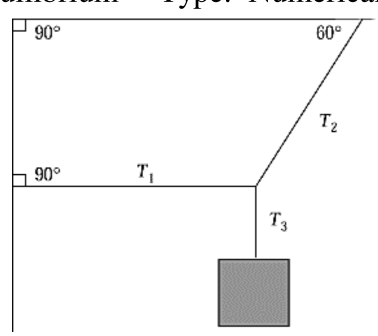
12. If you neglect the weight of the boom, what is the maximum weight W that can be suspended from the boom if the horizontal guy wire will break under a tension of 5.60 kN?



A) 4.00 kN B) 5.60 kN C) 6.70 kN D) 4.23 kN E) 3.00 kN
Ans: E

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Numerical

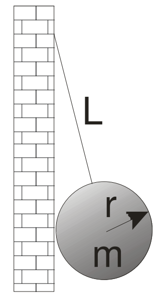
13. A heavy block is supported by three lines as shown. Which of the following statements is true in its entirety?



A) $T_1 > T_2$ and $T_2 > T_3$
B) $T_2 > T_1$ and $T_1 > T_3$
C) $T_2 > T_3$ and $T_3 > T_1$
D) $T_3 > T_1$ and $T_1 > T_2$
E) $T_1 > T_3$ and $T_2 > T_3$
Ans: C

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Numerical

18. A ball of radius r and mass m is hung using a light string of length L from a frictionless vertical wall. The normal force on the ball due to the wall is



A) mgr/L

B) $\frac{mgr}{\sqrt{L^2+2LR}}$

C) $\frac{mgL}{\sqrt{L^2+2LR}}$

D) mgL/r

E) None of these is correct.

Ans: B

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Conceptual

20. A 10-m long plank (of negligible mass) is supported at each end by vertical cables, also of negligible mass. A person of unknown weight sits on the plank between the cables. The tension in the left cable is 300 N, and in the right cable it is 200 N. The person's weight is

A) 100 N B) 300 N C) 400 N D) 500 N E) 700 N

Ans: D

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Conceptual

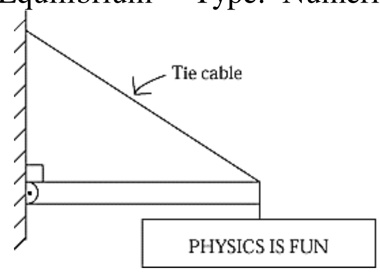
21. A 10-m long plank (of negligible mass) is supported at each end by vertical cables. A person of unknown weight sits on the plank between the cables. The tension in the left cable is 300 N, and in the right cable it is 200 N. How far is the person sitting from the left cable?

A) 2.0 m B) 3.0 m C) 4.0 m D) 6.0 m E) 7.0 m

Ans: C

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Numerical

22. The sign shown in the figure weighs 200 N. The boom is of uniform construction. If the force exerted by the hinge on the boom is 300 N and acts at an angle of 20º above the horizontal, the tension in the tie cable is



A) ~205 N
B) ~145 N
C) ~413 N
D) ~625 N
E) None of these is correct.

Ans: C

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Numerical

28. The horizontal boom supporting the sign is of uniform construction and weighs 50 N. If the sign weighs 150 N, the force exerted by the hinge on the boom is

A) ~350 N
B) ~304 N
C) ~25 N
D) ~550 N
E) None of these is correct.

Ans: B

Section: 12–3 Topic: Some Examples of Static Equilibrium Type: Numerical

31. A ladder is extended to a length of 8 m. It rests against a smooth frictionless vertical wall at an angle of 55 degrees to the horizontal. The ladder has a mass of 30 kg, and its center of mass is three-eighths of the way up the ladder from the floor. If the coefficient of static friction between the ladder and the floor is 0.2, calculate how far a man of 80 kg can stand along the ladder without it slipping away at the floor.

A) 3.7 m
B) 6.3 m
C) all the way to the top
D) 5.4 m
E) none of the above

Ans: D

Section: 12–7 Topic: Stress and Strain Type: Numerical

48. A wire 2.5-m long has a cross-sectional area of 2.5 mm^2. It is hung vertically, and a 4.5-kg mass is hung from it. By how much does the wire stretch if Young's modulus for that material is 2.0×10^{11} N/m^2?

A) 0.22 mm B) 2.2 mm C) 0.022 mm D) 0.72 mm E) 0.072 mm

Ans: A

Section: 12–7 Topic: Stress and Strain Type: Numerical

49. The bulk modulus of water is 2.0×10^9 N/m^2. By how much must the pressure be increased to reduce the volume of 1.0 kg of water from 1.00 to 0.998 L?

A) 2.0×10^6 N/m^2
B) 4.0×10^6 N/m^2
C) 20×10^6 N/m^2
D) 40×10^6 N/m^2
E) 8.0×10^6 N/m^2

Ans: B

Section: 12–7 Topic: Stress and Strain Type: Numerical

52. A wire of circular cross section of diameter d and length L is stretched an amount ΔL by a steady force F. An equal force would produce how much stretch in a similar wire of diameter $2d$ and length $2L$?

A) $\Delta L/8$ B) $\Delta L/4$ C) $\Delta L/2$ D) $2\Delta L$ E) $4\Delta L$

Ans: C

Section: 12–7 Topic: Stress and Strain Type: Numerical

59. An 800-kg mass is hung from a 2-m steel wire with a cross-sectional area of 0.25 cm^2. Young's modulus for steel is 2.0×10^{11} N/m^2. How much does the wire stretch?

A) 2.56 mm B) 2.97 mm C) 3.14 mm D) 3.86 mm E) 4.13 mm

Ans: C

Section: 12–7 Topic: Stress and Strain Type: Numerical

61. A wire has a diameter of 0.75 mm. It is stretched 0.2% of its original length when a mass of 5 kg is hung from it. What is the Young's modulus of the wire?

A) 1.4×10^{10} N/m^2
B) 5.6×10^{10} N/m^2
C) 1.7×10^{11} N/m^2
D) 5.6×10^8 N/m^2
E) 1.4×10^8 N/m^2

Ans: B

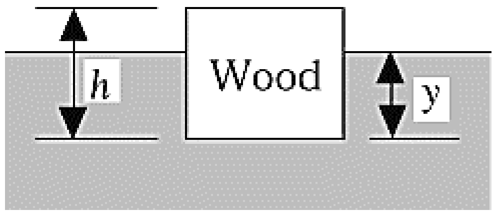
Section: 12–7 Topic: Stress and Strain Type: Numerical

63. Two wires, A and B, have the same initial length, but the radius of A is four times that of B, and the Young's modulus of A is a third that of B. If the same weight is attached to both wires, what is the ratio of the extension of A divided by the extension of B?

A) 0.19 B) 48 C) 5.3 D) 1.3 E) 0.75

Ans: C

Section: 13–1 Topic: Density Type: Numerical

3. 

A piece of wood is floating at the surface of some water as illustrated. The wood has a circular cross section and a height $h = 3.0$ cm. The density of the wood is 0.41 g/cm^3. The distance y from the surface of the water to the bottom of the wood is

A) impossible to determine because the area of the cross section is not given.
B) 0.81 cm
C) 3.2 cm
D) 1.2 cm
E) None of these is correct.
Ans: D

Section: 13–1 Topic: Density Type: Conceptual

5. A block of material has a density ρ. A second block of equal volume has three times the mass of the first. What is the density of the second block?

A) ρ B) 3ρ C) ρ/3 D) 9ρ E) ρ/9
Ans: B

Section: 13–1 Topic: Density Type: Numerical

7. A penny has a mass of 3.0 g, a diameter of 1.9 cm, and a thickness of 0.15 cm. What is the density of the metal of which it is made?

A) 1.8 g/cm^3 B) 3.4 g/cm^3 C) 3.5 g/cm^3 D) 7.1 g/cm^3 E) 4.5 g/cm^3
Ans: D

Section: 13–1 Topic: Density Type: Conceptual

8. If the atmosphere were compressed until it had the density of water, it would cover Earth to a depth of about

A) 0.81 km B) 4.6 m C) 1.6 km D) 76 cm E) 10 m
Ans: E

Section: 13–2 Topic: Pressure in a Fluid Type: Conceptual

9. A glass is filled with water. The gauge pressure at the top of the glass is zero and the gauge pressure at the bottom is P. A second glass with three times the height and twice the diameter is also filled with water. What is the pressure at the bottom of the second glass?

A) P B) $2P$ C) $3P$ D) $3P/2$ E) $3P/4$
Ans: C

Section: 13–2 Topic: Pressure in a Fluid Type: Numerical

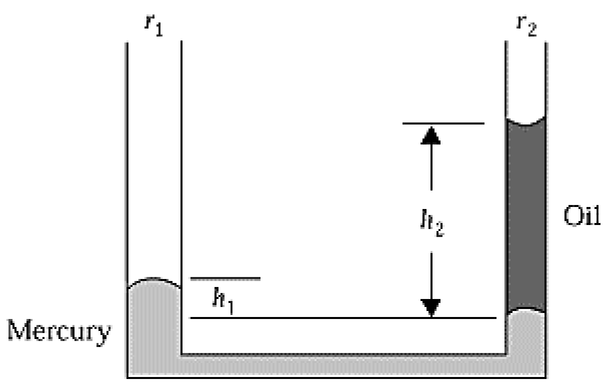
10. What is the gauge pressure at a depth of 6 cm in a glass filled with 4 cm of mercury and 4 cm of water? Water has a density of 1000 kg/m^3, and mercury has a density 13.6 times as great.
A) 3.1 kPa B) 5.6 kPa C) 5.8 kP D) 310 kPa E) 560 kPa
Ans: A

Section: 13–2 Topic: Pressure in a Fluid Type: Numerical

13. The atmospheric pressure deceases exponentially with height. At 5.5 km, the pressure is half that at sea level. At what height is the pressure one eighth that of sea level?
A) 7.5 km B) 11 km C) 16.5 km D) 22 km E) 27.5 km
Ans: C

Section: 13–2 Topic: Pressure in a Fluid Type: Numerical

16.



The left-hand side of an open U-tube has a radius r_1 = 0.82 cm, and the right-hand side has a radius r_2 = 0.41 cm. Mercury and oil are poured into the U-tube. The density of mercury is 13.6 g/cm^3. The heights shown in the diagram are h_1 = 3.50 cm and h_2 = 57.3 cm. The density of the oil is approximately
A) 0.83 g/cm^3 B) 110 g/cm^3 C) 7.9 g/cm^3 D) 6.9 g/cm^3 E) 1.82 g/cm^3
Ans: A

Section: 13–2 Topic: Pressure in a Fluid Type: Numerical

17. A tube with a radius of 4.2 cm is holding oil that has a density of 0.92 g/cm^3. The pressure in the oil at a depth of 64 cm from the top of the surface is
A) 5.8×10^2 Pa
B) 5.8×10^3 Pa
C) 1.0×10^2 Pa
D) 1.0×10^6 Pa
E) 1.7×10^3 Pa
Ans: B

Section: 13–2 Topic: Pressure in a Fluid Type: Numerical

18. A small sphere of wood with a density $\rho = 0.40$ g/cm^3 is held at rest well under the surface of a pool of water. The magnitude of the initial acceleration of the sphere when it is released is

A) 15 m/s^2 B) 9.8 m/s^2 C) 33 m/s^2 D) 23 m/s^2 E) 3.4 m/s^2

Ans: A

Section: 13–2 Topic: Pressure in a Fluid Type: Numerical

21. Two pistons of a hydraulic lift have radii of 2.67 cm and 20.0 cm. The downward force on the 2.67-cm piston that is required to lift a mass of 2000 kg supported by the 20-cm piston is

A) 350 N B) 270 N C) 36 N D) 1.5×10^3 N E) 2.6×10^3 N

Ans: A

Section: 13–2 Topic: Pressure in a Fluid Type: Numerical

26. If a column of liquid 52 cm high supports a column of mercury ($\rho = 13.6$ g/cm^3) 10 cm high, the density of the liquid is

A) 6.0 g/cm^3 B) 2.6 g/cm^3 C) 3.8 g/cm^3 D) 4.9 g/cm^3 E) 5.0 g/cm^3

Ans: B

Section: 13–2 Topic: Pressure in a Fluid Type: Conceptual

29. The force exerted by a stationary liquid on an inclined rectangular surface at rest in the liquid

A) acts normally to the surface.
B) is exerted equally at all points on the surface.
C) acts parallel to the surface.
D) is independent of the density of the liquid.
E) varies inversely as the depth.

Ans: A

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Numerical

31. A block of ice 30.5 cm thick floating in fresh water just supports a man weighing 801 N. If the specific gravity of ice is 0.917, the smallest area the block can have is

A) 3.25 m^2 B) 3.57 m^2 C) 2.88 m^2 D) 1.45 m^2 E) 0.269 m^2

Ans: A

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Numerical

32. A stone of volume 1.42×10^{-2} m^3 lies at the bottom of a freshwater lake. If the rock's specific gravity is 3.5, the work required to lift it 1 m through the water is approximately

A) 487 J B) 139 J C) 348 J D) 223 J E) 469 J

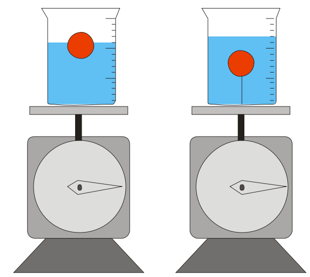
Ans: C

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Numerical

33. A solid wooden sphere of volume 0.0100 m^3 floats freely exactly one-half submerged in a liquid of density 800 kg/m^3. A lightweight cord is now tied to the sphere and is used to pull the sphere under the surface and hold it completely submerged. What is the tension in the cord?
A) zero B) 2.00 N C) 39.2 N D) 4.00 N E) 78.4 N
Ans: C

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Conceptual

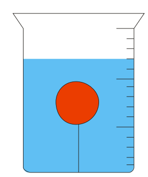
39. Two identical beakers are filled with the same amount of water. A ball of mass m is placed in the first beaker so that it floats on the surface while a second identical ball is placed in the second beaker but tied with a string of negligible mass so that the ball is completely submerged. Each beaker is then placed on a scale. Which scale has a higher reading?



A) (a) B) (b) C) the same D) depends on how far the ball is submerged in (b)
E) unable to tell
Ans: C

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Numerical

40. A beaker is filled with water. A ball of mass m and density $\rho < \rho_{water}$ is tied to a string. The other end of the string is then tied to the bottom of the beaker so that the ball is completely submerged. What is the tension in the string?



A) $mg\left(\frac{\rho_{water}}{\rho} - 1\right)$

B) $mg\frac{\rho_{water}}{\rho}$

C) mg

D) $mg\left(1 - \frac{\rho}{\rho_{water}}\right)$

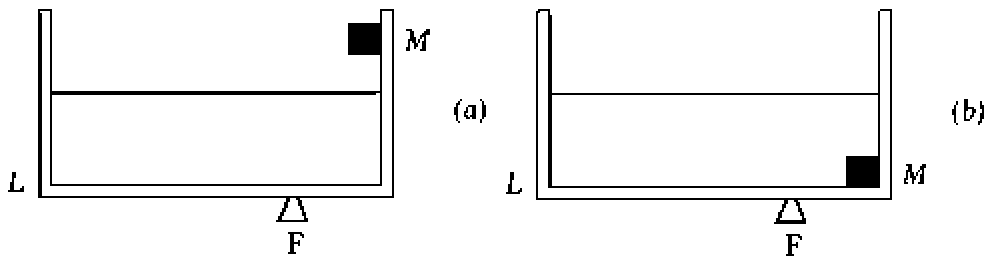
E) $mg\frac{\rho}{\rho_{water}}$

Ans: A

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Conceptual

41. A rock of mass *M* with a density twice that of water is sitting on the bottom of an aquarium tank filled with water. The normal force exerted on the rock by the bottom of the tank is
A) 2*Mg*
B) *Mg*
C) *Mg*/2
D) zero
E) impossible to determine from the information given.
Ans: C

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Conceptual

42.


A large tub is half full of water. A mass *M* = 25.0 kg, which has a specific gravity of 2.5, is attached to the right-hand side of the tub, out of the water. The entire apparatus balances perfectly horizontally on a fulcrum at F, as in *(a)*. The tub is clamped in place and *M* is lowered to the bottom, completely submerged, as in *(b)*. When the clamps are removed, the tub
A) remains balanced.
B) tips, with point *L* going down.
C) tips, with point *L* going up.
D) There is not enough information to solve the problem.
E) None of these is correct.
Ans: B

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Conceptual

43. You are floating in a boat in a swimming pool. There are some large stones, with a density of 2.5 g/cm^3, in the boat. You throw the stones out of the boat and they sink to the bottom of the pool. The water level *h*, measured vertically at the end of the pool __________ as the stones are thrown out.
A) decreases
B) increases
C) There is not enough information to solve the problem.
D) stays the same
E) None of these is correct.
Ans: A

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Numerical

44. A block of wood of length L = 21.0 cm, width w = 9.53 cm, and height h = 5.92 cm is just barely immersed in water by placing a mass m on the top of the block. The density of the wood is ρ = 0.390 g/cm^3. The value of m is

A) 0.72 kg B) 7.1 kg C) 1.2 kg D) 1.6 kg E) 0.36 kg

Ans: A

Section: 13–3 Topic: Buoyancy and Archimedes' Principle Type: Numerical

48. A metal block suspended from a spring balance is submerged in water. You observe that the block displaces 55 cm^3 of water and that the balance reads 4.3 N. What is the density of the block?

A) 7.0 g/cm^3 B) 8.0 g/cm^3 C) 9.0 g/cm^3 D) 1.1 g/cm^3 E) 1.2 g/cm^3

Ans: C

Section: 13–4 Topic: Fluids in Motion Type: Conceptual

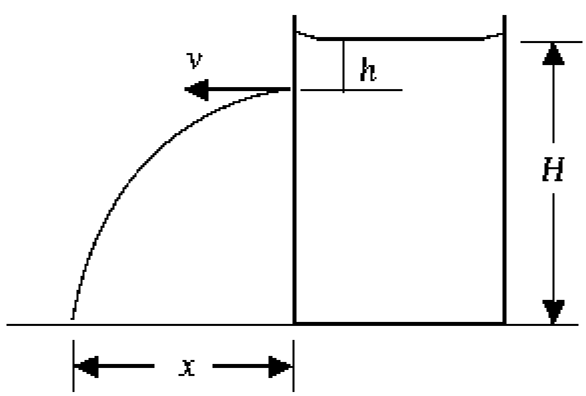
56. Water from a tap is flowing at a uniform rate of 24 cm^3/s into a cylindrical container. An exit tube is mounted on the side of the container at height h/2 from the base. The height h of the water remains constant. The volume flow at which the water leaves the container is

A) 12 cm^3/s B) 24 cm^3/s C) 36 cm^3/s D) 48 cm^3/s E) 72 cm^3/s

Ans: B

Section: 13–4 Topic: Fluids in Motion Type: Numerical

60.



A tank is filled with water to a height H. A small hole is punched in one of the walls at a depth h below the water's surface. The water leaves the hole in a horizontal direction. The stream of water strikes the floor at a distance x, as shown. Neglecting viscosity, you can calculate the value of x from

A) $x = H - h$

B) $x = [2h(H - h)]^{1/2}$

C) $x = h$

D) $x = 2[h(H - h)]^{1/2}$

E) None of these is correct.

Ans: D

Section: 13–4 Topic: Fluids in Motion Type: Conceptual

61. Water flows at speed v in a pipe of radius r. Neglecting viscosity, at what speed does the water flow through a constriction in which the radius of the pipe is $r/3$?
A) $v/9$ B) $v/3$ C) v D) $3v$ E) $9v$
Ans: E

Section: 13–4 Topic: Fluids in Motion Type: Numerical

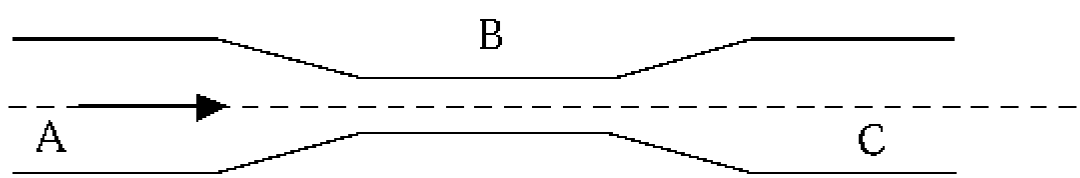
61. Cities across the U.S. supply fresh water to the residents at constant pressure by the use of water towers. If the diameter, d_2, of the pipe coming out of the tower is 25 cm, and the diameter, d_1, of the pipe at your home is 2.0 cm, what is the ratio of the velocity of the water at d_1 compared to d_2? Assume that all the taps are off except yours.
A) 12.5 B) 156 C) 0.0064 D) 0.08 E) 25
Ans: B

Section: 13–4 Topic: Fluids in Motion Type: Numerical

62. A pipe of 2.54 cm inside diameter has a constriction in which the inside diameter is 1.27 cm. If water is flowing through this pipe with a velocity of 1.22 m/s in the main section, the velocity in the constricted section is
A) 0.305 m/s B) 0.610 m/s C) 2.44 m/s D) 1.22 m/s E) 4.88 m/s
Ans: E

Section: 13–4 Topic: Fluids in Motion Type: Conceptual

77.



A liquid, such as water, with a low but not negligible viscosity is flowing from A to C with no turbulence through the horizontal tube, as shown in the figure. The cross-sectional area at A is equal to that at C. Which of the following is observed?
A) The pressure at A is the same as the pressure at C, and this pressure is smaller than the pressure at B.
B) The pressure at A is somewhat larger than that at C, and the pressures at both A and C are larger than the pressure at B.
C) The pressures at A and C are the same, and this pressure is larger than the pressure at B.
D) The pressure at A is larger than the pressure at B, which is larger than the pressure at C.
E) None of these is observed.
Ans: B

Section: 13–4 Topic: Fluids in Motion Type: Numerical

80. Using a motion sensor, Susana finds that the acceleration of a 4-kg rock that has been dropped from the roof of a building is 6 m/s^2. She concludes that the magnitude of force of air resistance acting on the rock is approximately

A) 39.2 N B) 24.0 N C) 15.2 N D) 9.81 N E) None of these is correct.

Ans: C

Section: 13–4 Topic: Fluids in Motion Type: Numerical

82. A horizontal pipe of 30 cm^2 cross-sectional area carries water at a speed of 2.5 m/s. This pipe feeds a smaller pipe of cross section 10 cm^2. Find the speed of water flow in the smaller pipe.

A) 3.5 m/s B) 0.8 m/s C) 2.5 m/s D) 7.5 m/s E) 23 m/s

Ans: D

Chapter 14

Section: 14–1 Topic: Simple Harmonic Motion Type: Factual

3. If F is the force, x the displacement, and k a particular constant, for simple harmonic motion we must have

A) $F = -k/x^2$
B) $F = k/x$
C) $F = (k/x^2)^{1/2}$
D) $F = -kx^2$
E) None of these is correct.

Ans: E

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

4. The frequency of a simple harmonic motion is 2.6×10^{-4} s^{-1}. The oscillation starts (t = 0) when the displacement has its maximum positive value of 6.5×10^{-3} cm. The earliest possible time at which the particle can be found at $x = -2.6 \times 10^{-3}$ cm is

A) 7.1×10^{-6} s
B) 1.2×10^{-5} s
C) 1.1×10^{-4} s
D) 1.1×10^{-3} s
E) 4.2×10^{-3} s

Ans: B

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

5. A particle moving with a simple harmonic motion has its maximum displacement of +18 cm at time t = 0. The frequency of the motion is 10 s^{-1}. At a time t = 0.65 s, the position of the particle is

A) +18 cm B) zero C) –13 cm D) –18 cm E) +7.3 cm

Ans: D

Section: 14–1 Topic: Simple Harmonic Motion Type: Conceptual

7. You want a mass that, when hung on the end of a spring, oscillates with a period of 1 s. If the spring has a spring constant of 10 N/m, the mass should be
   A) 10 kg
   B) $\sqrt{10}$ kg
   C) $4\pi^2(10)$ kg
   D) $10/(4\pi^2)$ kg
   E) None of these is correct.
   Ans: D

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

9. A particle moving in simple harmonic motion with a period $T = 1.5$ s passes through the equilibrium point at time $t_0 = 0$ with a velocity of 1.00 m/s to the right. A time t later, the particle is observed to move to the left with a velocity of 0.50 m/s. (Note the change in direction of the velocity.) The smallest possible value of the time t is
   A) 0.17 s B) 0.33 s C) 0.50 s D) 0.25 s E) 0.82 s
   Ans: C

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

10. A particle moving with simple harmonic motion has a maximum displacement of +12.0 cm. The particle moves from its maximum positive to its maximum negative displacement in 2.25 s. The motion starts when the displacement is $x = +12.0$ cm. The time for the particle to move to $x = -6.00$ cm is
    A) 1.70 s B) 0.750 s C) 1.50 s D) 2.20 s E) 0.983 s
    Ans: C

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

11. The force constant of a massless spring is 25.0 N/m. A mass of 0.45 kg is oscillating in simple harmonic motion at the end of the spring with an amplitude of 0.32 m. The maximum speed of the mass is
    A) 5.7 m/s B) 56 m/s C) 7.4 m/s D) 2.4 m/s E) 10 m/s
    Ans: D

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

12. The equation for the period T of a mass m oscillating with simple harmonic motion at the end of a spring with a force constant k is $T = 2\pi\sqrt{m/k}$. A mass m that is oscillating on a spring with a force constant of 0.52 N/m has a period of 2.1 s. On a second spring, the same mass has a period of 3.5 s. The force constant of the second spring is
    A) impossible to determine because the mass is not given.
    B) 0.19 N/m
    C) 1.4 N/m
    D) 0.31 N/m
    E) 0.75 N/m
    Ans: B

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

13. A particle with a mass of 65 g is moving with simple harmonic motion. At time $t = 0$, the particle is at its extreme positive displacement of 18.0 cm. The period of the motion is 0.600 s. At time $t = 1.35$ s, the velocity of the particle is
A) –1.9 m/s B) zero C) 0.84 m/s D) +1.9 m/s E) –0.84 m/s
Ans: A

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

14. A particle is oscillating with simple harmonic motion. The frequency of the motion is 10 Hz and the amplitude of the motion is 5.0 cm. As the particle passes its central equilibrium position, the acceleration of the particle is
A) 100 cm/s^2
B) 1.6×10^5 cm/s^2
C) 4×10^6 cm/s^2
D) zero
E) 3.2×10^6 cm/s^2
Ans: D

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

19. A body oscillates with simple harmonic motion according to the equation

$$x = 6.0 \cos(3t + \pi/3)$$

where the units are SI. The speed of the body when it has a displacement of 3 m is
A) $6\pi\sqrt{3}$ m/s B) 6π m/s C) 9π m/s D) $9\pi\sqrt{3}$ m/s E) 18π m/s
Ans: D

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

22. The equation of a body in simple harmonic motion is

$$y = 8.0 \cos(20t + \frac{1}{4}\pi)$$

where y is in centimeters and t is in seconds. The frequency of the oscillations is
A) $\pi/10$ Hz B) $\pi/4$ Hz C) $10/\pi$ Hz D) 8 Hz E) 20 Hz
Ans: C

Section: 14–1 Topic: Simple Harmonic Motion Type: Conceptual

23. A body of mass 0.50 kg moves in simple harmonic motion with a period of 1.5 s and an amplitude of 20 mm. Which of the following equations correctly represents this motion?
A) $x = 40 \cos(t/1.5)$ mm
B) $x = 40 \cos(2\pi t/1.5)$ mm
C) $x = 20 \sin(t/1.5)$ mm
D) $x = 20 \sin(1.5\pi t)$ mm
E) $x = 20 \sin(2\pi t/1.5)$ mm
Ans: E

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

26. A particle moves in one dimension with simple harmonic motion according to the equation

$$d^2x/dt^2 = -4\pi^2 x$$

where the units are SI. Its period is
A) $4\pi^2$ s B) 2π s C) 1 s D) $1/(2\pi)$ s E) $1/(4\pi^2)$ s
Ans: C

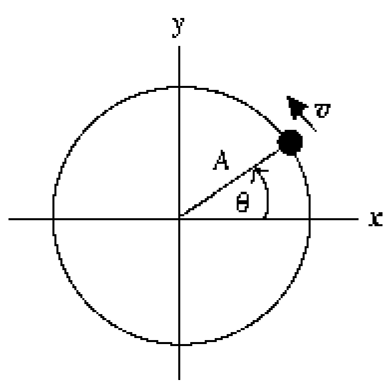
Section: 14–1 Topic: Simple Harmonic Motion Type: Conceptual

29. In the following equations, a is acceleration, r is a fixed distance, s is displacement, and m is mass. Which equation describes simple harmonic motion?
A) $a = -kr^2$ B) $a = \pi r^2$ C) $a = -ks^{-1}$ D) $a = 4\pi mr^2/3$ E) $a = -4\pi ms/3$
Ans: E

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

31. A particle moving in a circle of radius 15 cm makes 33.3 rev/min. If the particle starts on the positive x axis at time $t = 0$, what is the x component of the particle's velocity at time
$t = 1.2$ s?
A) 45 cm/s B) –3.8 cm/s C) 26 cm/s D) –45 cm/s E) 13 cm/s
Ans: A

Use the following to answer questions 32-34:



Section: 14–1 Topic: Simple Harmonic Motion Type: Conceptual

32. The object in the diagram is in circular motion. Its position at $t = 0$ was $(A, 0)$. Its frequency is f. The y component of its position is given by

A) $y = y_0 + v_{0y}t + \frac{1}{2}at^2$
B) $y = A \cos 2\pi ft$
C) $y = A \sin ft$
D) $y = A \sin 2\pi ft$
E) $y = A \cos ft$

Ans: D

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

36. A body of mass M is executing simple harmonic motion with an amplitude of 8.0 cm and a maximum acceleration of 100 cm/s^2. When the displacement of this body from the equilibrium position is 6.0 cm, the magnitude of the acceleration is approximately

A) 8.7 cm/s^2 B) 21 cm/s^2 C) 35 cm/s^2 D) 17 cm/s^2 E) 1.3 m/s^2

Ans: B

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

38. A light spring stretches 0.13 m when a 0.35 kg mass is hung from it. The mass is pulled down from this equilibrium position an additional 0.15 m and then released. Determine the maximum speed of the mass.

A) 1.10 m/s B) 2.75 m/s C) 11.4 m/s D) 1.25 m/s E) 0.02 m/s

Ans: D

Section: 14–1 Topic: Simple Harmonic Motion Type: Numerical

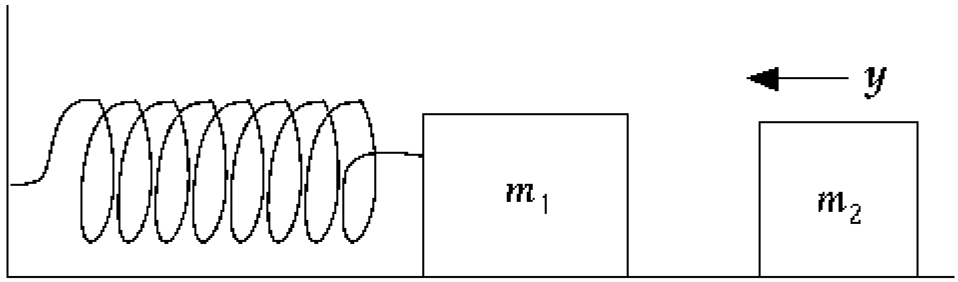
42. A particle is moving with SHM. If it has velocities of 6 cm/s and 2 cm/s when it is at positions 4 cm and 7 cm respectively from the equilibrium position, then calculate its period of oscillation.

A) 5.4 s B) 6.4 s C) 7.4 s D) 10.8 s E) none of the above

Ans: B

Section: 14–2 Topic: Energy in Simple Harmonic Motion Type: Numerical

48.



A mass of 0.50 kg is attached to a massless spring with a spring constant k = 600 N/m (see figure above). The system rests on a level, friction-free surface and is initially at rest. A second mass of 0.20 kg makes an elastic head-on collision with the mass attached to the spring; thereafter, the oscillating system vibrates with an amplitude of 0.25 m. What was the incident speed of the second mass?

A) 16 m/s B) 8.7 m/s C) 6.1 m/s D) 11 m/s E) 5.3 m/s

Ans: A

Section: 14–2 Topic: Energy in Simple Harmonic Motion Type: Conceptual

49. A mass attached to a spring has simple harmonic motion with an amplitude of 4.0 cm. When the mass is 2.0 cm from the equilibrium position, what fraction of its total energy is potential energy?

A) one-quarter B) one-third C) one-half D) two-thirds E) three-quarters

Ans: A

Section: 14–2 Topic: Energy in Simple Harmonic Motion Type: Numerical

52. A 2.5-kg object is attached to a spring of force constant k = 4.5 kN/m. The spring is stretched 10 cm from equilibrium and released. What is the kinetic energy of the mass–spring system when the mass is 5.0 cm from its equilibrium position?

A) 5.6 J B) 11 J C) 17 J D) 14 J E) 42 J

Ans: C

Section: 14–2 Topic: Energy in Simple Harmonic Motion Type: Numerical

56. A mass on a spring oscillates with an amplitude of 5.0 cm. What is the position of the mass when the kinetic and potential energies are equal?

A) There is not enough information provided to answer this question.
B) 1.2 cm
C) 2.5 cm
D) 3.5 cm
E) 3.8 cm

Ans: D

Section: 14–2 Topic: Energy in Simple Harmonic Motion Type: Numerical

67. A 10-kg block starts from rest at a vertical height of 1 m on a 30º frictionless inclined plane. If the block slides down the incline and then 20 m along a frictionless horizontal surface into a fixed spring with a force constant of 100 N/m, the spring is compressed approximately

A) 1.4 m B) 2.0 m C) 0.33 m D) 0.98 m E) 2.5 m

Ans: A

Section: 14–3 Topic: Some Oscillating Systems Type: Numerical

72. A rocket ship is propelled vertically up with an acceleration of g in a uniform gravitational field. A pendulum of length 1.0 m would have a period of

A) 0 B) 2.0 s C) 1.41 s D) 3.1 s E) the period is infinite

Ans: B

Section: 14–3 Topic: Some Oscillating Systems Type: Numerical

73. An 8.0-kg block is attached to a spring with a constant of 2.0 N/m. If the spring is stretched 3.0 m from its equilibrium position and released from rest, the maximum velocity attained by the mass is

A) 0.75 m/s B) 1.5 m/s C) 3.0 m/s D) 4.2 m/s E) 15 m/s

Ans: B

Section: 14–3 Topic: Some Oscillating Systems Type: Numerical

74. A 0.10-kg mass stretches a massless spring 0.20 m from its equilibrium position. If this same mass is set into vibration on this spring, the frequency is

A) 0.023 Hz B) 1.1 Hz C) 2.0 Hz D) 7.0 Hz E) 13 Hz

Ans: B

Section: 14–3 Topic: Some Oscillating Systems Type: Conceptual

80. Two clocks with basic timekeeping mechanisms consisting of (1) a mass on a spring and (2) a simple pendulum are taken to the top of a mountain. At the base of the mountain, they both keep perfect time. At the top of the mountain,

A) neither keeps correct time.
B) only the pendulum clock keeps correct time.
C) only the mass–spring clock keeps correct time.
D) both keep correct time.
E) Not enough information is given to answer this question.

Ans: C

Section: 14–3 Topic: Some Oscillating Systems Type: Conceptual

81. Both a mass–spring system and a simple pendulum have a period of 1 s. Both are taken to the moon in a lunar landing module. While they are inside the module on the surface of the moon,
A) the pendulum has a period longer than 1 s.
B) the mass–spring system has a period longer than 1 s.
C) both a and b are true.
D) the periods of both are unchanged.
E) one of them has a period shorter than 1 s.
Ans: A

Section: 14–3 Topic: Some Oscillating Systems Type: Conceptual

82. If the length of a simple pendulum with a period T is reduced to half of its original value, the new period T is approximately
A) $0.5T$ B) $0.7T$ C) T (unchanged) D) $1.4T$ E) $2T$
Ans: B

Section: 14–3 Topic: Some Oscillating Systems Type: Numerical

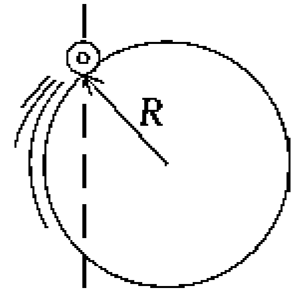
86. What must be the length of a simple pendulum with a period of 2.0 s if $g = 9.8\ m/s^2$?
A) 99 cm B) 97 m C) 6.2 cm D) 3.1 m E) 2.0 m
Ans: A

Section: 14–3 Topic: Some Oscillating Systems Type: Numerical

88. You have landed your spaceship on the moon and want to determine the acceleration due to gravity using a simple pendulum of length 1.0 m. If the period of this pendulum is
5.0 s, what is the value of g on the moon?
A) $1.3\ m/s^2$ B) $1.6\ m/s^2$ C) $0.80\ m/s^2$ D) $0.63\ m/s^2$ E) $2.4\ m/s^2$
Ans: B

Section: 14–3 Topic: Some Oscillating Systems Type: Numerical

92. A uniform disk ($I_{cm} = \frac{1}{2}MR^2$) of mass M and radius R is suspended from a point on its rim. If it oscillates as a physical pendulum its period is



A) $2\pi\sqrt{3R/2g}$
B) $2\pi\sqrt{3R/g}$
C) $2\pi\sqrt{g/R}$
D) $2\pi\sqrt{g/2R}$
E) $2\pi\sqrt{g/3R}$

Ans: A

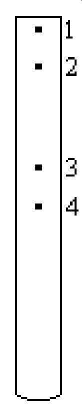
Section: 14–3 Topic: Some Oscillating Systems Type: Conceptual

94. Which of the following statements concerning the motion of a simple pendulum is incorrect?
A) The kinetic energy is a maximum when the displacement is a maximum.
B) The acceleration is a maximum when the displacement is a maximum.
C) The period is changed if the mass of the bob is doubled and the length of the pendulum is halved.
D) The time interval between conditions of maximum potential energy is one period.
E) The velocity is a maximum when the acceleration is a minimum.

Ans: D

Section: 14–3 Topic: Some Oscillating Systems Type: Conceptual

96. A long homogeneous rod can be pivoted as a physical pendulum at each of the points shown. Points at which the periods would be about the same are



A) 1 and 2 B) 3 and 4 C) 1 and 4 D) 2 and 3 E) 1, 2, 3, and 4

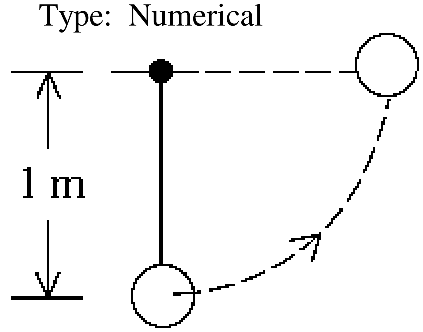
Ans: D

Section: 14–3 Topic: Some Oscillating Systems Type: Conceptual

97. A pendulum is oscillating with a total mechanical energy E_0. When the pendulum is at its maximum displacement, the kinetic energy K and the potential energy U are
    A) $K = \frac{1}{2}E_0;\ U = \frac{1}{2}E_0$
    B) $K = 0;\ U = E_0$
    C) $K = E_0;\ U = E_0$
    D) $K = E_0;\ U = 0$
    E) $K = E_0;\ U = \frac{1}{2}E_0$
    Ans: B

Section: 14–3 Topic: Some Oscillating Systems Type: Numerical

99. A simple pendulum has a mass of 10 kg. The length of the pendulum is 1.0 m. The work required to move the pendulum from its vertical position at rest to a horizontal position at rest is approximately



A) 0 B) 10 J C) 16 J D) 98 J E) 1.6 kJ
Ans: D

Section: 15–1 Topic: Simple Wave Motion Type: Conceptual

1. Which of the following statements is true?
    A) Waves transmit energy but not momentum.
    B) Waves transmit momentum but not energy.
    C) Waves transmit both energy and momentum.
    D) Waves transmit neither energy nor momentum.
    E) Waves can transmit either energy or momentum but not both.
    Ans: C

Section: 15–1 Topic: Simple Wave Motion Type: Factual

2. During the passage of a longitudinal wave, a particle of the medium
    A) remains in a fixed position.
    B) moves in a circle.
    C) moves at right angles to the direction of propagation.
    D) moves forward and backward along the line of propagation.
    E) moves forward with the velocity of the wave.
    Ans: D

Section: 15–1 Topic: Simple Wave Motion Type: Factual

3. A longitudinal wave is distinguished from a transverse wave by the fact that in longitudinal waves
   A) the particle vibration is parallel to the direction of propagation.
   B) the particle vibration is perpendicular to the direction of propagation.
   C) energy is transported from one point in space to another point.
   D) vibrations occur only in air or water.
   E) energy is not transported from one point in space to another point.
   Ans: A

Section: 15–1 Topic: Simple Wave Motion Type: Conceptual

4. Which of the following statements about longitudinal and transverse pressure waves is NOT true?
   A) Longitudinal pressure waves can travel through fluids.
   B) Transverse pressure waves can travel through fluids.
   C) Longitudinal pressure waves can travel through solids.
   D) Transverse pressure waves can travel through solids.
   E) Both longitudinal and transverse pressure waves transport energy.
   Ans: B

Section: 15–1 Topic: Simple Wave Motion Type: Conceptual

5. Both particles and waves transfer energy from one location to another. Which of the following statements is true?
   A) Both methods of energy transfer follow the conservation of energy principle.
   B) Energy transfer by particles follows the conservation of energy principle but waves do not.
   C) Energy transfer by waves follows the conservation of energy principle but particles do not.
   D) Whether the transfer of energy by a wave follows the conservation of energy principle depends on the speed of the wave.
   E) Whether the transfer of energy by a particle follows the conservation of energy principle depends on the speed of the particle.
   Ans: A

Section: 15–1 Topic: Simple Wave Motion Type: Factual

6. A particle is subject to a wave motion. Its distance from the equilibrium position at any particular time is called its
   A) amplitude B) displacement C) phase D) wavelength E) period
   Ans: B

Section: 15–1 Topic: Simple Wave Motion Type: Conceptual

8. A string under tension carries transverse waves traveling at speed *v*. If the same string is under four times the tension, what is the wave speed?
A) *v* B) 2*v* C) *v*/2 D) 4*v* E) *v*/4
Ans: B

Section: 15–1 Topic: Simple Wave Motion Type: Conceptual

9. A string under tension carries a transverse wave traveling at speed *v*. If the tension in the string is halved, what is the wave speed?
A) The wave speed is unchanged.
B) The wave speed is halved.
C) The wave speed is quadrupled.
D) The wave speed decreases to about 71% of *v*.
E) The wave speed increases by about 41%.
Ans: D

Section: 15–1 Topic: Simple Wave Motion Type: Numerical

14. A piano wire has a tension of 650 N and a mass per unit length of 0.060 g/cm. What is the speed of waves on this wire?
A) 1.0×10^2 m/s B) 3.3×10^2 m/s C) 1.0×10^3 m/s D) 33 m/s E) 52 m/s
Ans: B

Section: 15–1 Topic: Simple Wave Motion Type: Conceptual

15. A general rule for estimating the distance in kilometers between you and a lightning bolt is to count the number of seconds between the time you see the flash and the time you hear the thunder and then divide by
A) 2 B) 3 C) 4 D) 5 E) None of these is correct.
Ans: B

Section: 15–1 Topic: Simple Wave Motion Type: Conceptual

16. Sound travels at 340 m/s in air and 1500 m/s in water. A sound of 256 Hz is made under water. In the air,
A) the frequency remains the same but the wavelength is shorter.
B) the frequency is higher but the wavelength stays the same.
C) the frequency is lower but the wavelength is longer.
D) the frequency is lower and the wavelength is shorter.
E) both the frequency and the wavelength remain the same.
Ans: A

Section: 15–1 Topic: Simple Wave Motion Type: Numerical

21. A string exactly two meters long has a mass of 10.0 g and is under a tension of 12.5 N. The speed of a transverse wave in this string is
A) 1.58 m/s B) 15.8 m/s C) 25.0 m/s D) 44.7 m/s E) 50.0 m/s
Ans: E

Section: 15–1 Topic: Simple Wave Motion Type: Numerical

22. A string is stretched by a force of 4.0 N. The mass per unit length of the string is 4.0×10^{-4} kg/m. A transverse wave would travel along this string with a velocity of approximately

A) 0.80 cm/s B) 2.0 cm/s C) 8.0 cm/s D) 50 m/s E) 1.0×10^2 m/s

Ans: E

Section: 15–1 Topic: Simple Wave Motion Type: Numerical

23. A string of mass 2.4×10^{-3} kg and length 0.60 m vibrates transversely in such a way that its fundamental frequency is 100 Hz. The tension on this string must be approximately

A) 0.16 N B) 0.32 N C) 13 N D) 26 N E) 58 N

Ans: E

Section: 15–1 Topic: Simple Wave Motion Type: Numerical

24. The speed of sound in air at 0ºC is 331 m/s. What is the speed of sound in air at –40ºC?

A) 241 m/s B) 282 m/s C) 306 m/s D) 309 m/s E) 379 m/s

Ans: C

Section: 15–1 Topic: Simple Wave Motion Type: Numerical

26. Increasing the temperature, expressed in kelvins, in a gas by 125% will produce an increase in the speed of sound in the gas of approximately

A) 25% B) 18% C) 12% D) 9% E) 4%

Ans: C

Section: 15–1 Topic: Simple Wave Motion Type: Numerical

30. A stationary ship generates a sound signal at the bow and has a receiver system at the stern of the ship 100 m away. The difference in time between the signal arriving at the stern traveling directly through the air and the signal reflected from the sea bottom is 0.5 second. If the velocity of sound in air is 331 m/s and in water is 1435 m/s, calculate the depth of water below the ship.

A) 1150 m B) 574 m C) 359 m D) 396 m E) 450 m

Ans: B

Section: 15–2 Topic: Periodic Waves Type: Numerical

36. The tension of the rope at height y from the spring is

A) kA B) μgy C) $\mu gy + kA$ D) $\mu gy - kA$ E) $kA - \mu gy$

Ans: C

Section: 15–2 Topic: Periodic Waves Type: Numerical

38. The time it takes for a wave pulse to travel from the bottom of the rope to the ceiling is

A) $\sqrt{\frac{L}{g}}$ B) $\frac{2}{g}\left[\sqrt{gL+\frac{kA}{\mu}}-\sqrt{\frac{kA}{\mu}}\right]$ C) $\frac{2}{g}\left[\sqrt{\frac{kA}{\mu}}-\sqrt{gL+\frac{kA}{\mu}}\right]$ D) $\frac{2}{g}\sqrt{\frac{kA}{\mu}}$

E) $\frac{2}{g}\left[\sqrt{\frac{kA}{\mu}-gL}-\sqrt{\frac{kA}{\mu}}\right]$

Ans: B

Section: 15–2 Topic: Periodic Waves Type: Conceptual

41. A traveling wave passes a point of observation. At this point, the time between successive crests is 0.2 s. Which of the following statements can be justified?

A) The wavelength is 5 m.
B) The frequency is 5 Hz.
C) The velocity of propagation is 5 m/s.
D) The wavelength is 0.2 m.
E) There is not enough information to justify any of these statements.

Ans: B

Section: 15–2 Topic: Periodic Waves Type: Numerical

42. A set of waves has a speed of 4.2 m/s and a frequency of 2.0 Hz. The wavelength is

A) 8.4 m B) 2.1 m C) 0.48 m D) 0.84 m E) 3.2 m

Ans: B

Section: 15–2 Topic: Periodic Waves Type: Factual

45. In a sinusoidal traveling wave, the distance between two points that differ in phase by 2π radians is the

A) frequency. B) period. C) amplitude. D) phase constant. E) wavelength.

Ans: E

Section: 15–2 Topic: Periodic Waves Type: Numerical

47. The equation of a traveling wave is

$$y(x, t) = 0.02 \cos(0.25x - 500t)$$

where the units are SI. The velocity of the wave is

A) 4.0 m/s B) 10 m/s C) 0.13 km/s D) 0.50 km/s E) 2.0 km/s

Ans: E

Section: 15–2 Topic: Periodic Waves Type: Numerical

48. The equation of a transverse wave is

$$y(x, t) = 0.02 \cos(10\pi x - 400\pi t)$$

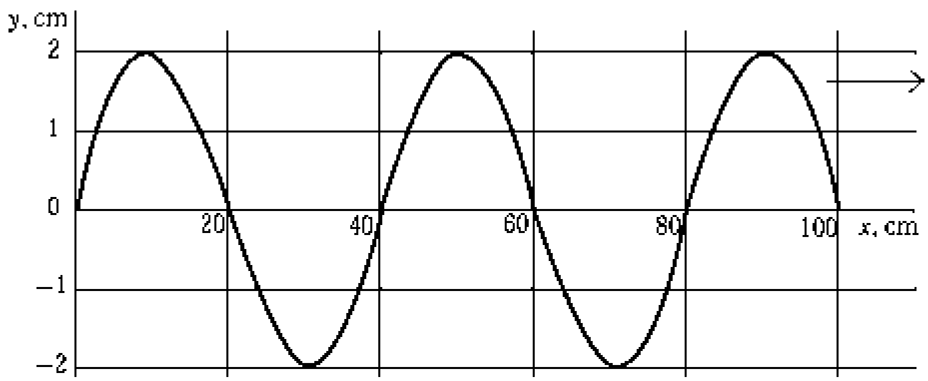
where the units are SI. The velocity of the wave is

A) 0.20π m/s B) 8π m/s C) 40 m/s D) 0.20 km/s E) 0.40π km/s

Ans: C

Section: 15–2 Topic: Periodic Waves Type: Numerical

49.



The graph shows a wave of frequency 3.0 Hz traveling to the right. The phase velocity of this wave is

A) 6 m/s B) 13 m/s C) 60 m/s D) 90 m/s E) 0.12 km/s

Ans: E

Section: 15–2 Topic: Periodic Waves Type: Numerical

50. A sinusoidal wave train is moving along a string. The equation giving the displacement y of a point at coordinate x has the form

$$y(x, t) = 0.15 \sin[10\pi(t - x/60)]$$

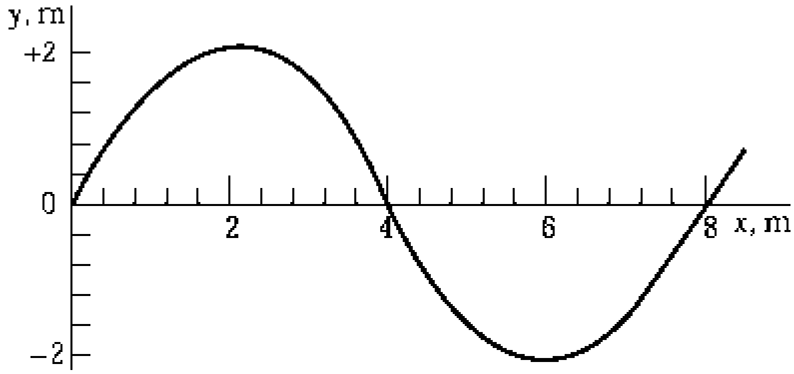
where the units are SI. The wavelength is

A) 8.0 cm B) 15 cm C) 6.0 m D) 12 m E) 60 m

Ans: D

Section: 15–2 Topic: Periodic Waves Type: Numerical

51\.



The graph shows a wave traveling to the right with a velocity of 4 m/s. The equation that best represents the wave is

A) $y(x, t) = 2 \sin(\pi x/4 - \pi t)$ m
B) $y(x, t) = 2 \sin(16\pi x - 8\pi t)$ m
C) $y(x, t) = 2 \sin(\pi x/4 + \pi t)$ m
D) $y(x, t) = 4 \sin(\pi x/4 - \pi t)$ m
E) $y(x, t) = 4 \sin(16\pi x - 8\pi t)$ m

Ans: A

Section: 15–2 Topic: Periodic Waves Type: Numerical

54\. The equation that gives the particle displacement of a medium in which there is a simple harmonic progressive wave is

$$y(x, t) = (2/\pi) \sin \pi(x - 4t),$$

where the units are SI. At $t = 2$ s, the velocity of a particle at $x = 10$ m is

A) 0 B) 2 m/s C) $4/\pi$ m/s D) 4 m/s E) 8 m/s

Ans: E

Section: 15–2 Topic: Periodic Waves Type: Numerical

55\. An equation that gives the particle displacement for a medium in which there is a simple harmonic traveling wave is

$$y(x, t) = (2/\pi) \sin \pi(3x + 2t),$$

where x and y are in centimeters and t is in seconds. At $t = 2$ s the speed of a particle at the location $x = 4$ cm is

A) 0 B) 2 cm/s C) 4 cm/s D) 6 cm/s E) 8 cm/s

Ans: C

Section: 15–2 Topic: Periodic Waves Type: Numerical

56. A sinusoidal wave train is moving along a string. The equation giving the displacement as a function of position and time is

$$y(x, t) = 0.12 \sin 8\pi(t - x/50),$$

where the units are SI. For a particle at $x = 5$ m when $t = 2.4$ s, the velocity of the particle is

A) 3.7 cm/s B) 27 cm/s C) 93 cm/s D) 1.6 m/s E) 3.0 m/s

Ans: C

Section: 15–2 Topic: Periodic Waves Type: Factual

57. The power transmitted by any harmonic wave varies directly as

A) the period.

B) the square root of the frequency.

C) the amplitude.

D) the amplitude squared.

E) None of these is correct.

Ans: D

Section: 15–2 Topic: Periodic Waves Type: Factual

59. The average rate at which energy is transmitted along a string depends on

A) the linear density of the string.

B) the square of the angular frequency of the source.

C) the square of the amplitude of the wave.

D) the speed of the wave.

E) all of these factors

Ans: E

Section: 15–2 Topic: Periodic Waves Type: Factual

60. To double the rate at which energy is transmitted along a string, you could

A) double the angular frequency of the source.

B) double the amplitude of the wave.

C) double the tension in the string.

D) quadruple the tension in the string.

E) halve the linear density of the string.

Ans: D

Section: 15–2 Topic: Periodic Waves Type: Numerical

62. If you were to double the amplitude of a wave on a string while keeping the speed and frequency of the wave constant, the energy delivered by the wave would
    A) double.
    B) quadruple.
    C) be reduced 50%.
    D) be reduced to 25% of its previous value.
    E) be unchanged.
    Ans: B

Section: 15–2 Topic: Periodic Waves Type: Numerical

63. If you were to reduce the amplitude of a wave on a string by half while keeping the speed and frequency of the wave constant, the energy delivered by the wave would
    A) double.
    B) quadruple.
    C) be reduced 50%.
    D) be reduced to 25% of its previous value.
    E) be unchanged.
    Ans: D

Section: 15–2 Topic: Periodic Waves Type: Numerical

64. If you were to double the frequency of a wave on a string while keeping the speed and amplitude of the wave constant, the energy delivered by the wave would
    A) double.
    B) quadruple.
    C) be reduced 50%.
    D) be reduced to 25% of its previous value.
    E) be unchanged.
    Ans: B

Section: 15–2 Topic: Periodic Waves Type: Numerical

65. If you were to reduce the frequency of a wave on a string by a factor of 2 while keeping the speed and amplitude of the wave constant, the rate at which energy is delivered by the wave would
    A) double.
    B) quadruple.
    C) be reduced 50%.
    D) be reduced to 25% of its previous value.
    E) be unchanged.
    Ans: D

Section: 15–2 Topic: Periodic Waves Type: Numerical

69. The human ear can be sensitive to sound frequencies up to 20 kHz. What wavelength does this correspond to at normal temperature and pressure?
A) 0.165 m B) 165 cm C) 16.5 mm D) 1650×10^{-4} m E) 1.65 mm
Ans: C

Section: 15–2 Topic: Periodic Waves Type: Numerical

70. Waves of amplitude 1.1 cm and wavelength 40 cm move along a 12-m long string that has a mass of 70 g and is under a tension of 15 N. Calculate the velocity of the wave.
A) 51 m/s B) 2570 m/s C) 16 m/s D) 15 m/s E) 331 m/s
Ans: A

Section: 15–2 Topic: Periodic Waves Type: Numerical

71. Waves of amplitude 1.3 cm move along a 14-m long string that has a mass of 90 g and is under a tension of 18 N. If the average total energy of the waves in the string is 5 J, calculate the frequency of the waves.
A) 21 Hz B) 811 Hz C) 129 Hz D) 92 Hz E) 256 Hz
Ans: C

Section: 15–2 Topic: Periodic Waves Type: Numerical

72. A wave of frequency f is transmitted on a string with tension T. If the tension is increased by a factor of 4 and the frequency and amplitude are unchanged, the power transmitted changed by
A) 1/2 B) 1/4 C) 2 D) 4 E) 1
Ans: C

Section: 15–2 Topic: Periodic Waves Type: Numerical

73. You have a rope that is 10 m long and has a mass of 0.2 kg. In addition, you have an oscillator that can generate a 5 Hz wave with an amplitude of 10 cm. What should the tension in the rope be if you need to transmit 10 W of power along the rope?
A) 102 N B) 205 N C) 320 N D) 51 N E) 250 N
Ans: B

Section: 15–3 Topic: Waves in Three Dimensions Type: Numerical

74. The intensity of a certain spherical wave is 8.0 W/m^2 at a distance of 1.0 m from the source. If the medium is isotropic and nonabsorbing, the intensity 100 m from the source is
A) 8.0 W/m^2
B) 6.4×10^{-4} W/m^2
C) 1.9×10^{-4} W/m^2
D) 8.0×10^{-4} W/m^2
E) 1.9×10^{-6} W/m^2
Ans: D

Section: 15–3 Topic: Waves in Three Dimensions Type: Conceptual

75. The intensity of a wave at a certain point is I. A second wave has twice the energy density and three times the speed of the first. What is the intensity of the second wave?
A) I B) $2I$ C) $3I$ D) $6I$ E) $2I/3$
Ans: D

Section: 15–3 Topic: Waves in Three Dimensions Type: Conceptual

76. The sound level of a dog's bark is 50 dB. The intensity of a rock concert is 10,000 times that of the dog's bark. What is the sound level of the rock concert?
A) 10,050 dB B) 500,000 dB C) 90 dB D) 2000 dB E) 54 dB
Ans: C

Section: 15–3 Topic: Waves in Three Dimensions Type: Numerical

77. A musical pitch is played at 60 dB. Another is played that sounds four times as loud. The sound intensity level of the second pitch is
A) 80 dB B) 100 dB C) 66 dB D) 64 dB E) 240 dB
Ans: C

Section: 15–3 Topic: Waves in Three Dimensions Type: Conceptual

78. Two sounds differ by 30 dB. The intensity of the louder sound I_L, compared with the softer I_S, is I_L/I_S. The value of the ratio is
A) 1000 B) 30 C) 9 D) 100 E) 300
Ans: A

Section: 15–3 Topic: Waves in Three Dimensions Type: Numerical

80. If a sound of intensity $I = 1.0 \times 10^{-6}$ W/m^2 falls on a detector of area $A = 7.0 \times 10^{-5}$ m^2 (about the size of your eardrum), how much power is received by the detector?
A) 6.2×10^{-14} W
B) 1.0×10^{-6} W
C) 7.0×10^{-11} W
D) 1.4×10^{-2} W
E) 70 W
Ans: C

Section: 15–3 Topic: Waves in Three Dimensions Type: Numerical

84. The sound intensity in front of a loudspeaker diaphragm vibrating at 2 kHz is 4.3 W/m^2, with an acoustic power output of 0.3 W. Calculate the diameter of the diaphragm.
A) 3 cm B) 9 cm C) 15 cm D) 30 cm E) 60 cm
Ans: D

Section: 15–4 Topic: Waves Encountering Barriers Type: Numerical

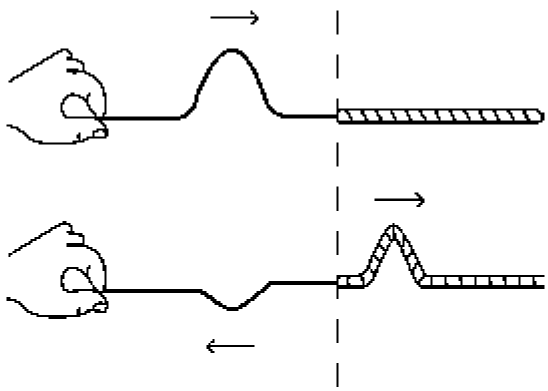
88. A wave given with amplitude A = 10 cm travels along a cord which has two sections, one with linear density 0.1 kg/m and the other with linear density 0.2 kg/m. The wave travels along the cord from the lighter density to the heavier. If the tension in the cord is 50 N, the amplitude of the reflected wave is

A) 0.65 cm
B) 1.5 cm
C) 5.9 cm
D) 7.4 cm
E) 8.3 cm

Ans: B

Section: 15–4 Topic: Waves Encountering Barriers Type: Conceptual

92.



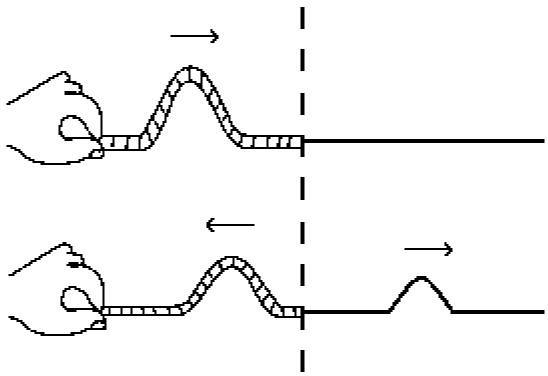
From the figure above, you can conclude that

A) the medium to the left of the boundary is denser than the medium to the right.
B) the medium to the right of the boundary is denser than the medium to the left.
C) the pulse is initially traveling from right to left.
D) the wave has lost energy as a result.
E) None of these is correct.

Ans: B

Section: 15–4 Topic: Waves Encountering Barriers Type: Conceptual

93.



From the figure above, you can conclude that

A) the medium to the left of the boundary is denser than the medium to the right.
B) the medium to the right of the boundary is denser than the medium to the left.
C) the pulse is initially traveling from right to left.
D) the wave has lost energy as a result.
E) None of these is correct.

Ans: A

Section: 15–5 Topic: The Doppler Effect Type: Conceptual

96. While you are standing on a corner, a police car with a 1-kHz siren drives past you at 30 m/s with its siren on. The speed of sound is 340 m/s. After the car has passed, the frequency you hear is about

A) 1.10 kHz B) 1.09 kHz C) 1.00 kHz D) 919 Hz E) 912 Hz

Ans: D

Section: 15–5 Topic: The Doppler Effect Type: Numerical

98. A blue line in the spectrum of the hydrogen atom has a wavelength λ = 486 nm. In the hydrogen-atom spectrum emitted by a distant galaxy, this line is observed on Earth at λ = 550 nm. With what speed is this galaxy receding from us? (The speed of light is 3.0×10^8 m/s.)

A) 1.31×10^7 m/s
B) 1.13×10^8 m/s
C) 2.65×10^8 m/s
D) 3.49×10^7 m/s
E) 3.95×10^7 m/s

Ans: D

Section: 15–5 Topic: The Doppler Effect Type: Conceptual

100. The frequency of a car horn is *f*. What frequency is observed if both the car and the observer are at rest, but a wind is blowing toward the observer?

A) *f*
B) greater than *f*
C) less than *f*
D) either greater or less than *f*
E) far greater than *f*, depending on how wind speed compares with the speed of sound

Ans: A

Section: 15–5 Topic: The Doppler Effect Type: Numerical

101. A siren of frequency 3.20 kHz moves away from a stationary observer with a speed of 30.5 m/s. If the speed of sound is 335 m/s, the frequency heard by the observer is

A) 2.66 kHz B) 2.93 kHz C) 3.49 kHz D) 3.52 kHz E) 3.84 kHz

Ans: B

Section: 15–5 Topic: The Doppler Effect Type: Numerical

114. A police car siren emits a sound at 600 Hz. If an observer moves toward the source at 50 km/hr, and the police car approaches the observer at 100 km/hr (all speeds relative to the road), calculate the siren frequency heard by the driver of the police car (assume the speed of sound in air = 343 m/s).

A) 626 Hz B) 600 Hz C) 679 Hz D) 577 Hz E) 970 Hz

Ans: B

Section: 15–5 Topic: The Doppler Effect Type: Conceptual

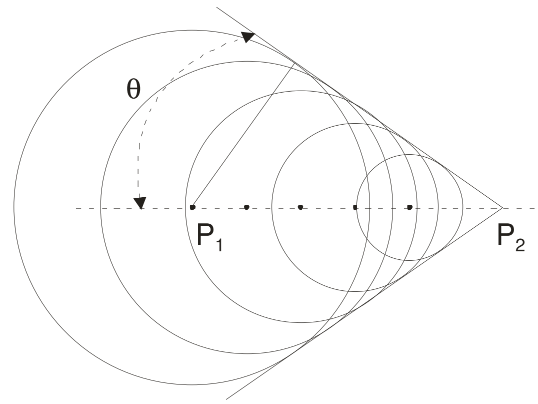
120. An oscillator tuned to a frequency of 1 kHz is dropped from a tall building. How does the frequency picked up by a stationary observer at the top of the building change with time?

A) The frequency will be lower than 1 kHz but does not change with time.
B) The frequency will be lower than 1 kHz and decreases further with time.
C) The frequency will be higher than 1 kHz but does not change with time.
D) The frequency will be higher than 1 kHz and decreases further with time.
E) The frequency stays at 1 kHz.

Ans: B

Section: 15–5 Topic: The Doppler Effect Type: Numerical

121. The picture on the right represents the wavefronts of a supersonic flight. The angle θ = 40°. If the speed of sound is 300 m/s, what is the speed of the plane?



A) 360 m/s
B) 330 m/s
C) 300 m/s
D) 390 m/s
E) 470 m/s

Ans: E

Section: 16–1 Topic: Superposition of Waves Type: Numerical

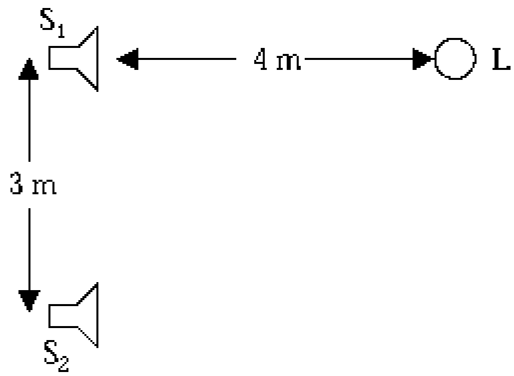
5. Tuning fork A has a frequency of 440 Hz. When A and a second tuning fork B are struck simultaneously, four beats per second are heard. When a small mass is added to one of the tines of B, the two forks struck simultaneously produce two beats per second. The original frequency of tuning fork B was
A) 448 Hz B) 444 Hz C) 438 Hz D) 436 Hz E) 432 Hz
Ans: B

Section: 16–1 Topic: Superposition of Waves Type: Numerical

6. The air columns in two identical pipes vibrate at frequencies of 150 Hz. The percentage of change needed in the length of one of the pipes to produce 3 beats per second is
A) 1% B) 2% C) 3% D) 4% E) 5%
Ans: B

Section: 16–1 Topic: Superposition of Waves Type: Numerical

7.



Two loudspeakers S_1 and S_2, 3.0 m apart, emit the same single-frequency tone in phase at the speakers. A listener L directly in front of speaker S_1 notices that the intensity is a minimum when she is 4.0 m from that speaker (see figure). What is the lowest frequency of the emitted tone? The speed of sound in air is 340 m/s.

A) 85 Hz B) 0.17 kHz C) 0.26 kHz D) 0.34 kHz E) 0.51 kHz

Ans: B

Section: 16–1 Topic: Superposition of Waves Type: Conceptual

8. If two identical waves with the same phase are added, the result is

A) a wave with the same frequency but twice the amplitude.
B) a wave with the same amplitude but twice the frequency.
C) a wave with zero amplitude.
D) a wave with zero frequency.
E) This problem cannot be solved without knowing the wavelengths of the two waves.

Ans: A

Section: 16–1 Topic: Superposition of Waves Type: Conceptual

10. If two identical waves with a phase difference of 6π are added, the result is

A) a wave with the same frequency but twice the amplitude.
B) a wave with the same amplitude but twice the frequency.
C) a wave with zero amplitude.
D) a wave with zero frequency.
E) This problem cannot be solved without knowing the wavelengths of the two waves.

Ans: A

Section: 16–1 Topic: Superposition of Waves Type: Conceptual

11. If two identical waves with a phase difference of 3π are added, the result is
    A) a wave with the same frequency but twice the amplitude.
    B) a wave with the same amplitude but twice the frequency.
    C) a wave with zero amplitude.
    D) a wave with an intensity equal to the sum of the intensities of the two waves.
    E) This problem cannot be solved without knowing the wavelengths of the two waves.
    Ans: C

Section: 16–1 Topic: Superposition of Waves Type: Numerical

13. A wave on a string has a frequency of 100 Hz and travels at a speed of 24 m/s. The minimum distance between two points with a phase difference of 60º is
    A) 0.040 m B) 0.12 m C) 0.14 m D) 0.24 m E) 25 m
    Ans: A

Section: 16–2 Topic: Standing Waves Type: Numerical

47. A string whose length is 1 m is fixed at both ends and vibrates according to the equation

$$y(x, t) = 0.04 \sin \pi x \cos 2\pi t$$

    where the units are SI. The total number of nodes exhibited by the string is
    A) 1 B) 2 C) 3 D) 4 E) 5
    Ans: B

Section: 16–2 Topic: Standing Waves Type: Conceptual

48. If the amplitude of a standing wave is doubled, the energy in the wave increases by a factor of
    A) $\frac{1}{4}$ B) $\frac{1}{2}$ C) 1 D) 2 E) 4
    Ans: E

Section: 16–2 Topic: Standing Waves Type: Numerical

49. If both the tension and the length of a vibrating string are doubled while the linear density remains constant, the fundamental frequency of the string is multiplied by
    A) 1 B) 2 C) $\sqrt{2}$ D) $\sqrt{2}/2$ E) $2\sqrt{2}$
    Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

50. The fundamental frequency of a vibrating string is f_1. If the tension in the string is doubled, the fundamental frequency becomes
    A) $f_1/2$ B) $f_1/\sqrt{2}$ C) f_1 D) $\sqrt{2}f_1$ E) $2f_1$
    Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

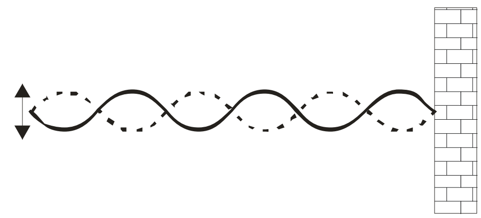
51. The fundamental frequency of a vibrating string is f_1. If the tension in the string is increased by 50% while the linear density is held constant, the fundamental frequency becomes

A) f_1 B) $1.2f_1$ C) $1.5f_1$ D) $1.7f_1$ E) $2f_1$

Ans: B

Section: 16–2 Topic: Standing Waves Type: Conceptual

56. A standing wave is shown in the figure on the right. If the period of the wave is T, the shortest time it takes for the wave to go from the solid curve to the dashed curve is

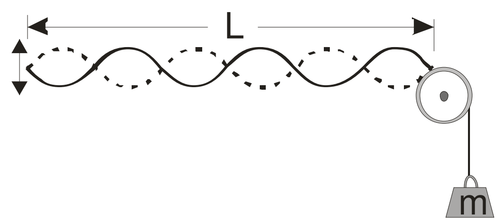


A) T/4 B) T/3 C) T/2 D) 3T/4 E) None of these is correct.

Ans: C

Section: 16–2 Topic: Standing Waves Type: Conceptual

57. A string of linear density μ and length L is under a constant tension T = mg. One end of the string is attached to a tunable harmonic oscillator. A resonant standing wave is observed



A) at any frequency.

B) when the frequency $f = \frac{n}{2L}\sqrt{\frac{mg}{\mu}}$ where n = 1, 2, 3, ...

C) when the frequency $f = \frac{n}{L}\sqrt{\frac{mg}{\mu}}$ where n = 1, 2, 3, ...

D) when the frequency $f = \frac{nv_s}{2L}$ where n = 1, 2, 3, ...and v_s is the speed of sound.

E) unable to tell

Ans: B

Section: 16–2 Topic: Standing Waves Type: Numerical

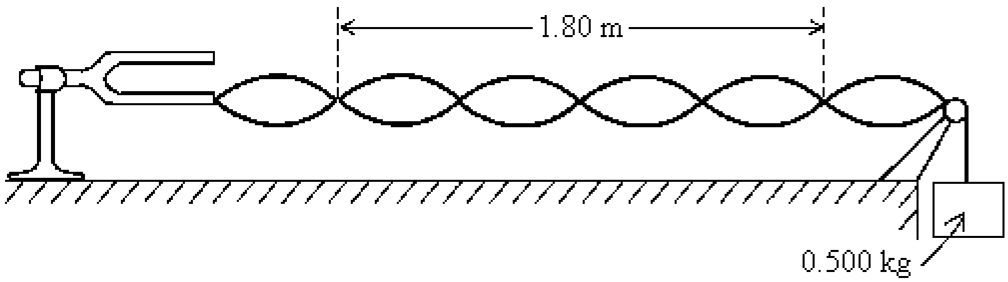
62. A string 2.0 m long has a mass of 2.4×10^{-2} kg. When fixed at both ends, it vibrates with a fundamental frequency of 150 Hz. The speed of a transverse wave in the string is

A) 3.6 m/s B) 75 m/s C) 0.30 km/s D) 0.60 km/s E) 0.63 km/s

Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

65.



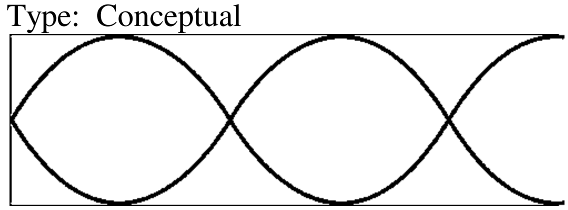
A string is connected to a tuning fork whose frequency is 80.0 Hz and is held under tension by 0.500 kg. The tuning fork causes the string to vibrate as shown. The mass per unit length for the string is

A) 9.45×10^{-4} kg/m
B) 6.80×10^{-3} kg/m
C) 4.34 kg/m
D) 6.00×10^{-3} kg/m
E) 3.85×10^{-2} kg/m

Ans: A

Section: 16–2 Topic: Standing Waves Type: Conceptual

69. The figure shows a standing wave in a pipe that is closed at one end. The frequency associated with this wave pattern is called the



A) first harmonic.
B) second harmonic.
C) third harmonic.
D) fourth harmonic.
E) fifth harmonic.

Ans: E

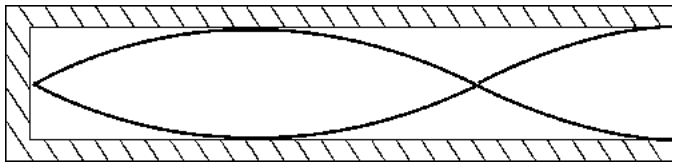
Section: 16–2 Topic: Standing Waves Type: Conceptual

72. When an organ pipe, which is closed at one end only, vibrates with a frequency that is three times its fundamental (first harmonic) frequency,

A) the sound produced travels at three times its former speed.
B) the sound produced is its fifth harmonic.
C) beats are produced.
D) the sound produced has one-third its former wavelength.
E) the closed end is a displacement antinode.

Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

73. 

The air in a closed organ pipe vibrates as shown. The length of the pipe is 3.0 m. The frequency of vibration is 80 Hz. The speed of sound in the pipe is approximately

A) 80 m/s B) 0.16 km/s C) 0.24 km/s D) 0.32 km/s E) 0.96 km/s

Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

74. A vibrating tuning fork of frequency 640 Hz is held above a tube filled with water. Assume the speed of sound to be 330 m/s. As the water level is lowered, consecutive maxima in intensity are observed at intervals of about

A) 12.9 cm B) 19.4 cm C) 25.8 cm D) 51.7 cm E) 194 cm

Ans: C

Section: 16–2 Topic: Standing Waves Type: Numerical

75. A vibrating tuning fork of frequency 1080 Hz is held above a tube filled with water. Assume the speed of sound to be 330 m/s. As the water level is lowered, consecutive maxima in intensity are observed at intervals of about

A) 7.65 cm B) 15.3 cm C) 23.0 cm D) 30.6 cm E) 53.6 cm

Ans: B

Section: 16–2 Topic: Standing Waves Type: Conceptual

77. A string fixed at both ends is vibrating in a standing wave. There are three nodes between the ends of the string, not including those on the ends. The string is vibrating at a frequency that is its

A) fundamental.
B) second harmonic.
C) third harmonic.
D) fourth harmonic.
E) fifth harmonic.

Ans: D

Section: 16–2 Topic: Standing Waves Type: Conceptual

78. On a standing-wave pattern, the distance between two consecutive nodes is d. The wavelength is

A) $d/2$ B) d C) $3d/2$ D) $2d$ E) $4d$

Ans: D

Section: 16–2 Topic: Standing Waves Type: Conceptual

80. In a pipe that is open at one end and closed at the other and that has a fundamental frequency of 256 Hz, which of the following frequencies cannot be produced?
A) 768 Hz
B) 1.28 kHz
C) 5.12 kHz
D) 19.7 kHz
E) all of these can be produced
Ans: C

Section: 16–2 Topic: Standing Waves Type: Conceptual

81. The fundamental frequency of a pipe that has one end closed is 256 Hz. When both ends of the same pipe are opened, the fundamental frequency is
A) 64.0 Hz B) 128 Hz C) 256 Hz D) 512 Hz E) 1.02 kHz
Ans: B

Section: 16–2 Topic: Standing Waves Type: Numerical

86. A 1.00 m string fixed at both ends vibrates in its fundamental mode at 440 Hz. What is the speed of the waves on this string?
A) 220 m/s B) 440 m/s C) 660 m/s D) 880 m/s E) 1.10 km/s
Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

88. For a tube of length 57.0 cm that is open at both ends, what is the frequency of the fundamental mode? (the speed of sound in air is 340 m/s)
A) 149 Hz B) 447 Hz C) 596 Hz D) 298 Hz E) 746 Hz
Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

91. Sound has a velocity of 335 m/s in air. For an air column that is closed at both ends to resonate to a frequency of 528 Hz, the length of the air column could be
A) 79.2 cm B) 55.5 cm C) 47.5 cm D) 31.7 cm E) 15.8 cm
Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

93. The third harmonic of a tube closed at one end is 735 Hz. If the speed of sound in air is 335 m/s, the length of the tube must be
A) 11.6 cm B) 22.9 cm C) 34.1 cm D) 45.7 cm E) 57.3 cm
Ans: C

Section: 16–2 Topic: Standing Waves Type: Numerical

94. The ratio of the fundamental frequency (first harmonic) of an open pipe to that of a closed pipe of the same length is
A) 2:1 B) 7:8 C) 4:5 D) 3:2 E) 1:2
Ans: A

Section: 16–2 Topic: Standing Waves Type: Numerical

99. A string with mass density equal to 0.0025 kg/m is fixed at both ends and at a tension of 290 N. Resonant frequencies are found at 558 Hz and the next one at 744 Hz. What is the fundamental frequency of the string?
A) 558 Hz B) 372 Hz C) 93 Hz D) 186 Hz E) none of the above
Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

100. A string with mass density equal to 0.0025 kg/m is fixed at both ends and at a tension of 290 N. Resonant frequencies are found at 558 Hz and the next one at 744 Hz. To what harmonic does the 558 Hz resonance correspond?
A) 1 B) 2 C) 3 D) 4 E) 5
Ans: C

Section: 16–2 Topic: Standing Waves Type: Numerical

102. A wire of mass 1.1 g is under a tension of 100 N. If its third overtone is at a frequency of 750 Hz, calculate the length of the wire.
A) 72 cm B) 101 cm C) 36 cm D) 65 cm E) None of the above
Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

108. A guitar string of length 105 cm is in resonance with a tuning fork of frequency *f*. Using the fret board the length of the string is shortened by 1.5 cm while keeping the tension in the string constant. Now a beat frequency of 10 Hz is heard between the string and the tuning fork. What is the frequency of the tuning fork?
A) 230 Hz B) 1380 Hz C) 345 Hz D) 690 Hz E) none of the above
Ans: D

Section: 16–2 Topic: Standing Waves Type: Numerical

109. Wire *A* is the same mass per unit length as wire *B*. However wire *A* is twice as long as wire *B* and has three times as much tension on it. Calculate the fundamental frequency of wire *A* divided by wire *B*.
A) 0.87 B) 0.66 C) 0.43 D) 0.75 E) 1.50
Ans: A

Section: 16–2 Topic: Standing Waves Type: Numerical

110. What is the third harmonic of an open-both-ends organ pipe of length 1.5 m? Assume the speed of sound to be 340 m/s.
A) 229 Hz B) 340 Hz C) 457 Hz D) 686 Hz E) none of the above
Ans: B

Section: 16–2 Topic: Standing Waves Type: Numerical

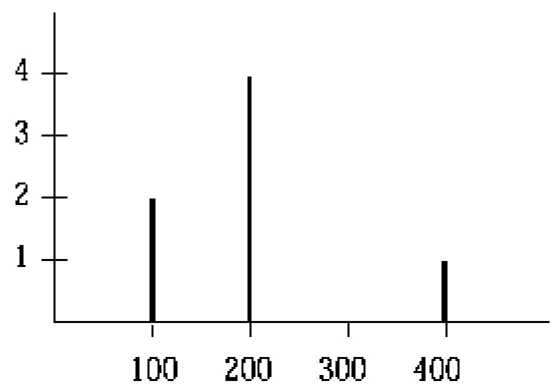
111. A piano tuner hears a beat every 0.33 seconds when he hits a note and compares it to his reference tone at 163 Hz. What is the lowest possible frequency of the piano note?
A) 44.9 Hz B) 166.0 Hz C) 162.7 Hz D) 163.3 Hz E) 160.0 Hz
Ans: E

Section: 16–2 Topic: Standing Waves Type: Numerical

112. Two identical loudspeakers are driven in phase by the same amplifier. The speakers are positioned a distance of 3.2 m apart. A person stands 4.1 m away from one speaker and 4.8 m away from the other. Calculate the second lowest frequency that results in destructive interference at the point where the person is standing. Assume the speed of sound to be 340 m/s.
A) 245 Hz B) 735 Hz C) 1225 Hz D) 490 Hz E) 1470 Hz
Ans: B

Section: 16–3 Topic: Additional Topics Type: Conceptual

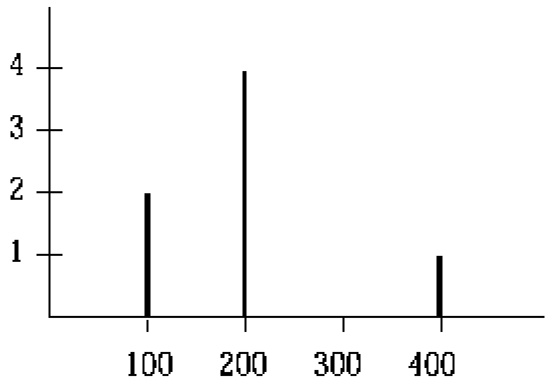
117.



The complex wave whose frequency spectrum is shown in the figure is made up of waves whose frequencies are
A) 1, 2, and 4.
B) 100, 200, and 400.
C) 100, 100, and 400.
D) 1 and 4.
E) 100 and 400.
Ans: B

Section: 16–3 Topic: Additional Topics Type: Conceptual

118.



The complex wave whose frequency spectrum is shown in the figure is made up of waves whose relative amplitudes are

A) 1, 2, and 4.
B) 100, 200, and 400.
C) 1 and 4.
D) 200 and 400.
E) 1 and 2.

Ans: A