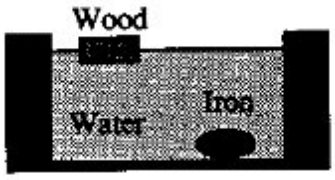
Test 3 Preparation Questions

A1. Which statement is true concerning an object executing simple harmonic motion?
(A) Its velocity is never zero.
(B) Its acceleration is never zero.
(C) Its velocity and acceleration can be zero simultaneously.
(D) Its velocity is zero when its acceleration is a maximum.
(E) Its maximum acceleration has the same magnitude as its maximum velocity.

A2. Two dams are identical with the exception that the water reservoir behind dam A extends twice the distance behind it as dam B. The depth of water is the same in both cases. Which of the following statements regarding these dams is correct?

(A) The force exerted by the water on dam A is greater than that on dam B.
(B) The force exerted by the water on dam B is greater than that on dam A.
(C) Dam A is more likely to collapse if the water level in both dams rises by 1 metre.
(D) Dam B is more likely to collapse if the water level in both dams rises by 1 metre.
(E) The horizontal distance of the water behind the dams does not determine the force on them.

A3. A piece of wood and an ingot of iron have equal volumes. They are both placed in a swimming pool filled with water. The wood floats on the surface and the iron sinks to the bottom. Which one of the following statements is correct concerning the buoyant forces acting on the two objects?



(A) The floating wood has a greater buoyant force on it since it is fully supported by the water.
(B) The submerged iron has a greater buoyant force on it.
(C) They both have the same buoyant force acting on them.
(D) They will have different buoyant forces acting on them but it is impossible to tell which is greater without knowing the actual weights of the two objects.
(E) The floating wood will have a greater buoyant force on it but only if its density is greater than that of water.

A4. A pipeline is replaced with one of equal length and twice the radius. If the same pressure differential is applied across the new pipeline, and the same liquid is transported, the new volume flow rate, Q_2, expressed in terms of the old volume flow rate, Q_1, is:
(A) $Q_2 = 2\ Q_1$
(B) $Q_2 = 4\ Q_1$
(C) $Q_2 = 6\ Q_1$
(D) $Q_2 = 8\ Q_1$
(E) $Q_2 = 16\ Q_1$

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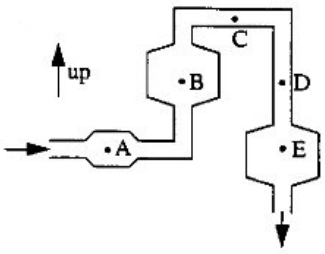
A5. What happens to a simple pendulum's frequency when both the pendulum's length and the mass of its bob are increased?
(A) It always increases.
(B) It always decreases.
(C) It always remains the same.
(D) If the ratio of mass over length increases then the frequency increases.
(E) If the ratio of mass over length decreases then the frequency increases.

A6. If you double your depth beneath the surface of a lake, the ***total*** pressure on you will be
(A) double its original value.
(B) more than double its original value.
(C) less than double its original value.
(D) four times its original value.
(E) more or less than double its original value, depending on the actual depths involved, and on the density of the water in the lake.

A7. Bernoulli's principle is a statement of
(A) hydrostatic equilibrium.
(B) thermal equilibrium for fluids.
(C) mechanical equilibrium for fluids.
(D) energy conservation in dynamic fluids.
(E) momentum conservation in dynamic fluids.

A8. A system of horizontal and vertical pipes that delivers a constant flow of water is constructed with pipe diameters as shown in the diagram. At which of the labelled points is the pressure in the system the greatest?



A9. In a water wave on the surface of a lake, the distance between a crest and an adjacent trough is
(A) one wavelength.
(B) one half the wavelength.
(C) two times the wavelength.
(D) the amplitude.
(E) one half the amplitude.

A10. How is the frequency of a simple pendulum affected when the mass *m* of its bob is increased and it is taken to a location where the value of *g*, the acceleration due to gravity, is greater?
(A) The frequency increases.
(B) The frequency decreases.
(C) The frequency remains the same.
(D) If the percentage change in *m* is greater that the percentage change in *g* then the frequency increases.
(E) If the percentage change in *m* is greater that the percentage change in *g* then the frequency decreases.

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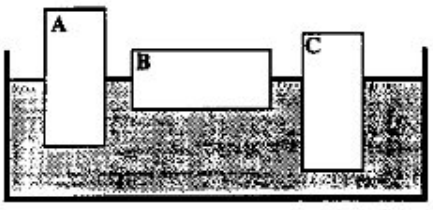
A11. Which one of the following statements concerning an object undergoing simple harmonic motion is true?

(A) It is at the equilibrium position when the acceleration is maximum in magnitude.
(B) It is at the equilibrium position when the velocity is zero.
(C) Its velocity and acceleration are simultaneously zero.
(D) Its velocity and acceleration are simultaneously maximum in magnitude.
(E) Its velocity is maximum in magnitude when its acceleration is zero.

A12. A solid cylinder has a radius *r* and a height *h*. The cylinder is composed of two different materials, mixed throughout the volume of the cylinder, with mass densities ρ_1 and ρ_2. If each of the two materials occupies an equal volume, what is the mass of the cylinder?

(A) $\frac{1}{2}\pi r^2 h(\rho_1 + \rho_2)$ (B) $\pi r^2 h\sqrt{\rho_1 \rho_2}$
(C) $\pi r h^2 \rho_1 + \pi r h^2 \rho_2$ (D) $2\pi r h(\rho_1 + \rho_2)$
(E) $\pi r h \rho_1 + \pi r h \rho_2$

A13. Three blocks labelled **A**, **B**, and **C** are floating in water as shown in the drawing. Blocks **A** and **B** have the same mass and volume. Block **C** has the same volume, but is submerged to a greater depth than block **A**. Which one of the following statements concerning this situation is **FALSE**?

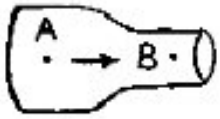


(A) The density of block **A** is less than that of block **C**.
(B) The buoyant force acting on block **A** is equal to that acting on block **B**.
(C) The volume of water displaced by block **C** is greater than that displaced by block **B**.
(D) The buoyant force acting on block **C** is greater than that acting on block **B**.
(E) The volume of water displaced by block **A** is greater than that displaced by block **B**.

A14. A curtain hangs straight down in front of an open window. A sudden gust of wind blows past the window, and the curtain is pulled out of the window. Which law, principle, or equation can be used to explain this movement of the curtain?

(A) Poiseuille's law (B) Bernoulli's equation (C) the continuity equation
(D) Archimedes' principle (E) Pascal's principle

A15. Water flows through a pipe as shown in the figure. The flow is steady and non-viscous. Which of the following statements is correct?



(A) The pressure at A is less than at B.
(B) The pressure at A is greater than at B.
(C) The pressure at A is the same as at B.
(D) The pressures are completely unrelated.
(E) The pressures are related, but without knowing the velocities it is impossible to tell which is larger.

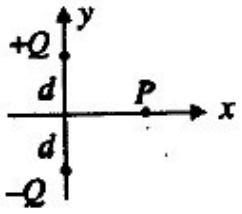
A16. A wave moves along a string at constant speed. Which of the following statements concerning the motion of individual particles in the string is correct?
(A) The particle speed is equal to the wave speed.
(B) The particle speed varies sinusoidally with time.
(C) The particle speed is independent of the amplitude of the periodic motion of the source.
(D) The particle speed is independent of the frequency of the periodic motion of the source.
(E) The particle speed at any instant is the same at all points on the string.

A17. The tension in a taut rope is increased by a factor of 9. How does the speed of wave pulses on the rope change?
(A) It is reduced by a factor of 9.
(B) It is reduced by a factor of 3.
(C) It remains the same.
(D) It is increased by a factor of 3.
(E) It is increased by a factor of 9.

A18. In a guitar string, where there is a standing wave of wavelength λ, the distance from one fixed end to the nearest node
(A) is λ.
(B) is $\frac{1}{2}\lambda$.
(C) is $\frac{3}{4}\lambda$.
(D) is 2λ.
(E) cannot be determined without knowing the harmonic at which the string is vibrating.

A19. A conducting ball, initially uncharged, is sitting on an uncharged insulating surface. A grounding wire is now connected to the ball. Which of the following statements best described the situation resulting when a positively-charged rod is brought near the ball?
(A) Negative charges flow from the ground onto the conducting ball.
(B) Positive charges flow from the ground onto the conducting ball.
(C) Negative charges flow from the ball to ground.
(D) Positive charges flow from the ball to ground.
(E) No charge flow occurs.

A20. Consider two charges, of opposite polarity and equal magnitude Q, arranged as shown. Which of the following statements is correct concerning the net electric field at point P?
(A) The electric field at P is 0.
(B) The electric field at P is in the positive x direction.
(C) The electric field at P is in the positive y direction.
(D) The electric field at P is in the negative x direction.
(E) The electric field at P is in the negative y direction.



A21. Which of the following changes will increase the propagation speed of a periodic transverse wave on a string?
(A) increasing the period
(B) decreasing the amplitude
(C) decreasing the frequency
(D) increasing the amplitude
(E) increasing the tension in the string

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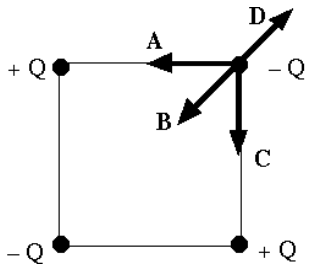
A22. Which of the following statements is FALSE?
(A) Sound waves in air are longitudinal pressure waves.
(B) Sound can travel through vacuum.
(C) Light travels much faster than sound.
(D) The transverse waves on a vibrating string are different from sound waves.
(E) Musical pitch and frequency refer to the same physical quantity.

A23. An observer is located between two speakers that are emitting sound waves of identical frequency and amplitude. If the amplitude of each individual sound wave is *A*, then the amplitude of the resultant wave heard by the observer
(A) is ½ *A* (B) is *A* (C) is 2 *A* (D) is 0
(E) depends on the location of the observer and is in the range of 0 to 2 *A*.

A24. A glass rod is rubbed with a piece of silk. During the process the glass rod acquires a positive charge and the silk
(A) also acquires a positive charge.
(B) acquires a negative charge.
(C) remains neutral.
(D) can acquire either a positive or a negative charge, depending on how hard the rod is rubbed.
(E) can acquire either a positive or a negative charge, depending on the length of time that the rod is rubbed.

A25. Four point charges, each of the same magnitude Q, are arranged at the corners of a square. If the charges have the polarities shown in the diagram, which of the arrows labelled A, B, C, or D gives the correct direction for the net electrostatic force that acts on the charge at the upper right corner?
(A) A
(B) B
(C) C
(D) D
(E) The net force on that charge is zero.



A26. Which of the following statements is true concerning the magnitude of the electric field at a point in space?
(A) It is the magnitude of the total charge at that point.
(B) If a charged object is placed at that point, it is the magnitude of the net electric force on that object.
(C) If a charged object is placed at that point, it is the ratio of the charge on that object to its mass.
(D) If a charged object is placed at that point, it is the magnitude of the net electric force per unit mass on that object.
(E) If a charged object is placed at that point, it is the magnitude of the net electric force per unit charge on that object.

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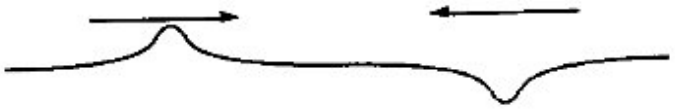
A27. A wave moves at constant speed along a string. Which one of the following statements concerning the simple harmonic motion of an individual particle in the string is true? The particle speed is
(A) equal to the wave speed.
(B) dependent on the tension in the string.
(C) dependent on the mass per unit length of the string.
(D) independent of the amplitude.
(E) not constant.

A28. A transverse, harmonic wave is described by the expression $y = \sin\left[2\pi\left(0.100\,t + \frac{x}{2.00}\right)\right]$, where y and x are in metres and t is in seconds. Which one of the following statements concerning this wave is true?
(A) The wave is travelling in the positive x direction.
(B) The amplitude of the wave is 2.00 m.
(C) The frequency of the wave is 10.0 Hz.
(D) The wavelength of the wave is 0.500 m.
(E) The wave speed is 0.200 m/s.

A29. The sound intensity level at a certain location in a kitchen is measured to be β (in dB) when one blender is in operation. If 10 identical blenders are operated simultaneously, what is the new sound intensity level at the same location? (Assume that all the blenders are at the same distance from the location and neglect any other sources of sound.)
(A) $10\,\beta$ (B) $\beta + 10$ dB (C) $100\,\beta$ (D) 100 dB $- \beta$
(E) The new sound intensity level cannot be determined.

A30. Two pulses of identical shape travel towards each other in opposite directions along a string as shown in the diagram. Which one of the following statements is true?



(A) The pulses will reflect from each other.
(B) The pulses will diffract from each other.
(C) The pulses will produce a standing wave.
(D) The pulses will produce beats.
(E) The pulses will interfere destructively.

A31. A standing wave of frequency 400 Hz is established on a string of length 1.50 m which is clamped at both ends. The speed of waves on the string is 300 m/s. How many antinodes are present in the standing wave pattern?
(A) 2 (B) 3 (C) 4 (D) 5 (E) 6

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A32. A violinist and an organist each play the note 'concert A' on their instruments. Which of the following statements **best** explains why it is possible to distinguish the sound of the violin from that of the organ?

(A) The violin produces a standing transverse wave in a string and the organ produces a standing longitudinal wave in a pipe.
(B) The relative amplitudes of the harmonics that the instruments produce are different.
(C) The speed of the wave on the violin string is different than the speed of sound in the organ pipe.
(D) The fundamental frequency produced by the violin is different from the fundamental frequency produced by the organ.
(E) The fundamental wavelength produced by the violin is different from the fundamental wavelength produced by the organ.

A33. Consider two conducting spheres *A* and *B*. Sphere *A* initially carries a net electric charge of +*Q*, and sphere *B*, the same size as *A*, is initially neutral. The spheres are brought into contact, then separated and placed on an insulating table with their centres separated by a distance *x*. Which one of the following statements describes the electrostatic force that now exists between the two spheres?

(A) The electrostatic force is attractive and has a magnitude of $k\frac{Q^2}{4x^2}$.
(B) The electrostatic force is attractive and has a magnitude of $k\frac{Q^2}{x^2}$.
(C) The electrostatic force is repulsive and has a magnitude of $k\frac{Q^2}{4x^2}$.
(D) The electrostatic force is repulsive and has a magnitude of $k\frac{Q^2}{x^2}$.
(E) There is no electrostatic force between them.

B1. The acceleration due to gravity at the floor of Death Valley is different from its value at sea level. A pendulum of length 1.00 m is taken to the floor of Death Valley, where its period is 1.95 s. What is the value of *g* in Death Valley?

B2. A watch is rated 'waterproof' for gauge pressures up to 1.52×10^5 Pa. According to this rating, calculate the depth in water to which the watch can be safely submerged. The density of water is 1000 kg/m^3.

B3. A child wants to pump up a bicycle tire so that the gauge pressure of the air inside the tire is 2.50×10^5 Pa. If the child uses a pump with a circular piston 0.0350 m in diameter, calculate the maximum force that the child must be able to exert.

B4. A wooden block, of volume 2.00×10^{-5} m^3, floats in water with exactly 2/3 of its volume submerged. The density of water is 1.00×10^3 kg/m^3. Calculate the mass of the wooden block.

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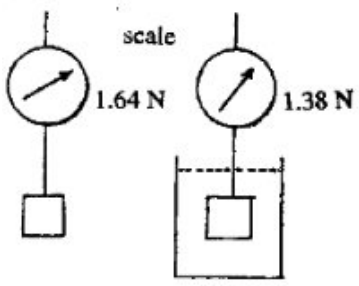
B5. A woman uses a hose to water her garden. The water enters the hose through a faucet with a diameter of 1.25 cm. The speed of the water at the faucet is 5.00 m/s. If the faucet and the nozzle are at the same height, and the water leaves the nozzle with a speed of 20.0 m/s, calculate the diameter of the nozzle.

B6. An object is undergoing simple harmonic motion of amplitude 0.100 m and frequency 35.0 Hz. If the object was at maximum displacement at time $t = 0$, calculate the speed of the object at time $t = 0.125$ s.

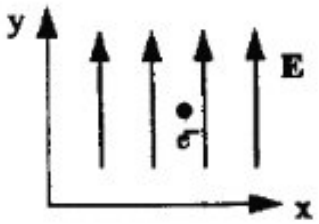
B7. A small object of weight 1.64 N has an apparent weight on the scale of 1.38 N when completely submerged in water. Calculate the volume of the object. Density of water: 1000 kg/m^3.



B8. A car is moving at 35.0 m/s and approaches a stationary whistle that is emitting a 220-Hz sound. If the speed of sound in air is 343 m/s, what is the frequency heard by the driver?

B9. An organ pipe of length 0.250 m is open at one end and closed at the other. Calculate the second-lowest resonant frequency. The speed of sound in air is 343 m/s.

B10. An electron is placed in a region of space where there is a uniform electric field which is in the +y direction as shown. The magnitude of the electric field is 51.0 V/m. Determine the magnitude and direction of the force on the electron.



B11. A transverse travelling wave is established on a stretched wire and is described by the expression:

$$y = (0.250\ \text{m})\sin[2\pi f t - (20.0\ \text{m}^{-1})\, x]$$

Given that the wave speed is 15.0 m/s, calculate the frequency.

B12. At a certain distance from a jackhammer the intensity level due to the jackhammer is 130 dB. Calculate the intensity level at this location if two jackhammers operate side by side.

B13. A loudspeaker is generating sound waves with power 2.61×10^{-3} W. Assume that the sound spreads uniformly in all directions, with no loss of power to the air. Calculate the intensity at a distance of 2.00 m from the loudspeaker.

B14. Calculate the wavelength of a travelling wave of frequency 165 Hz on a string of linear mass density 5.28×10^{-3} kg/m under a tension of 226 N.

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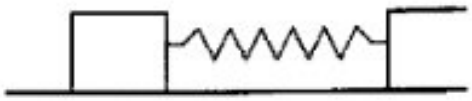
B15. Calculate the fundamental resonant frequency of an organ pipe, closed at one end and open at the other, of length 0.625 m. The speed of sound is 343 m/s.

B16. A proton is released from rest in a uniform electric field. It moves north with an acceleration of 125 m/s^2. Calculate the magnitude of this electric field.

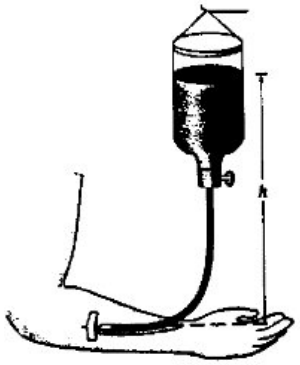
C1. A ball of mass 0.500 kg is attached to a vertical spring. It is initially supported so that the spring is neither stretched nor compressed, and is then released from rest. When the ball has fallen through a distance of 0.108 m, its instantaneous speed is 1.30 m/s. Air resistance is negligible.
(a) Using conservation of energy, calculate the spring constant of the spring.
(b) Calculate the oscillation period of the ball-spring system.

C2. A mass of 0.305 kg is attached to a spring on a horizontal frictionless surface as shown. The mass is pulled so that the spring is stretched by 0.130 m from its unstretched length, and then the mass is released from rest. The resulting oscillatory motion has a period of 0.444 s.



(a) Calculate the spring constant of the spring.
(b) Calculate the maximum speed of the mass.
(c) Calculate the total mechanical energy of the oscillating mass-spring system.

C3. A patient is to be given a blood transfusion. The blood is to flow from a raised bottle through a tube to a needle inserted in the vein, as shown in the diagram. The needle has a radius of 0.400 mm and a length of 4.00 cm. The required flow rate of blood is 6.67×10^{-8} m^3/s. Assume that the gauge pressure of blood in the vein is 2390 Pa.
Density of blood: 1.05×10^3 kg/m^3
Viscosity of blood: 4.00×10^{-3} Pa·s



(a) Calculate the gauge pressure at the 'upstream' end of the needle.

(b) Calculate the height at which the bottle must be placed to obtain the required flow rate. (*Hint*: The velocity of the blood flow through the tube is negligible.)

C4. At a distance of 10.0 m from a jackhammer, the sound intensity level is 120 dB. Assume that the sound radiates uniformly in all directions and that no energy is absorbed by the air.
(a) What is the sound intensity at that distance?
(b) How far away would you need to be for the sound intensity level to be 85.0 dB?

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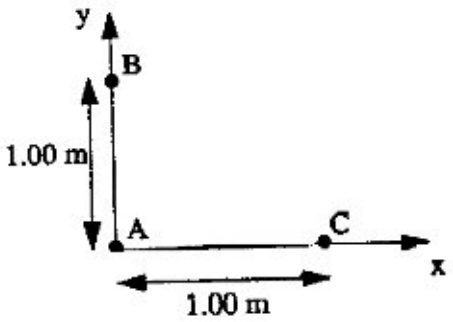
C5. Three particles, A, B, and C, are taken into space. Particle A has mass 1.00×10^{-5} kg and a charge of +36.0 μC, particle B has a charge of –20.0 μC and particle C has charge +60.0 μC. The particles are arranged as shown in the diagram. Particles B and C are held fixed while particle A is released. Determine the initial acceleration of particle A. (Specify the direction by the angle from the positive x-axis.)



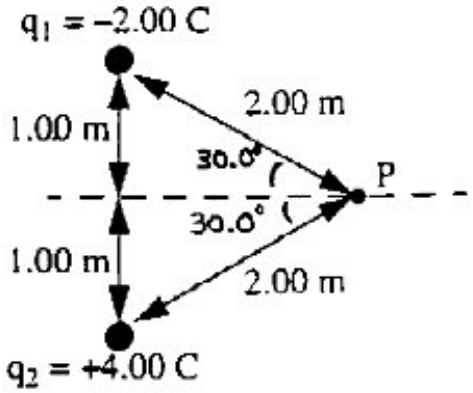
C6. Along a straight stretch of road, a stationary observer in a parked car is located **between** an ambulance and a police car, both of which are moving. The ambulance travels toward the observer with a speed of 25.0 m/s and emits sound waves from its siren with a frequency of 270.00 Hz. The police car moves away from the observer with a speed of 35.0 m/s and emits sound waves from its siren with a frequency of 315.00 Hz. The speed of sound in air is 343 m/s.

(a) Calculate the frequency of the ambulance's siren, as heard by the observer.

(b) Calculate the beat frequency of the total resultant sound wave heard by the observer.

C7. Calculate the length of an organ pipe that is open at one end and closed at the other if its fundamental frequency is four times that of another pipe that is 2.55 m long and open at both ends.

C8. Two charges (q_1 = –2.00 C and q_2 = +4.00 C) are fixed 2.00 m apart as shown in the diagram. Calculate the magnitude of the electric field at the point P shown.



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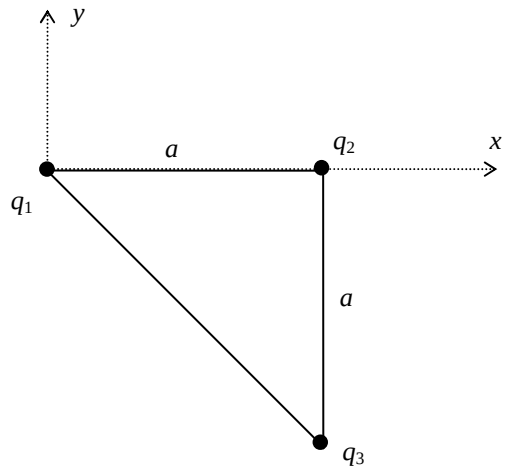
C9. Three point charges are placed at the corners of a triangle, as shown in the diagram. The side length, a, is 1.00 m. The values of the three charges are: q_1, –6.00 μC; q_2, +8.00 μC; and q_3, –6.00 μC. Calculate the magnitude and direction of the net electrostatic force acting on q_1 due to the other charges. (Express the direction as an angle with respect to the positive x axis.)



ANSWERS:

A1.	D	A18.	B	B1.	10.4 m/s^2	C1. (a)	18.3 N/m
A2.	E	A19.	A	B2.	15.5 m	(b)	1.04 s
A3.	B	A20.	E	B3.	241 N	C2. (a)	61.1 N/m
A4.	E	A21.	E	B4.	1.33×10^{-2} kg	(b)	1.84 m/s
A5.	B	A22.	B	B5.	0.625 cm	(c)	0.516 J
A6.	C	A23.	E	B6.	15.6 m/s	C3. (a)	3.45×10^3 Pa
A7.	D	A24.	B	B7.	2.65×10^{-5} m^3	(b)	0.335 m
A8.	E	A25.	B	B8.	242 Hz	C4. (a)	1.00 W/m^2
A9.	B	A26.	E	B9.	1.03×10^3 Hz	(b)	562 m
A10.	A	A27.	E	B10.	8.16×10^{-18} N, $-y$	C5.	2.05×10^6 m/s^2 @ 162°
A11.	E	A28.	E	B11.	47.7 Hz	C6. (a)	291 Hz
A12.	A	A29.	B	B12.	133 dB	(b)	5.40 Hz
A13.	E	A30.	E	B13.	5.19×10^{-5} W/m^2	C7.	0.319 m
A14.	B	A31.	C	B14.	1.25 m	C8.	7.80×10^9 N/C
A15.	B	A32.	B	B15.	137 Hz	C9.	0.337 N @ 19.9°
A16.	B	A33.	C	B16.	1.30×10^{-6} N/C		
A17.	D						