Short questions

Mechanics BMETE11AP59

1. True or False: Dimensional analysis can give you the numerical value of constants of proportionality that may appear in an algebraic expression.

2. Under which of the following conditions is the magnitude of the average velocity of a particle moving in one dimension smaller than the average speed over some time interval?

   (a) A particle moves in the $+x$ direction without reversing.
   (b) A particle moves in the $-x$ direction without reversing.
   (c) A particle moves in the $+x$ direction and then reverses the direction of its motion.
   (d) There are no conditions for which this is true.

3. If a car is traveling eastward and slowing down, what is the direction of the force on the car that causes it to slow down?

   (a) eastward
   (b) westward
   (c) neither eastward nor westward.

4. Which one of the following statements is true?

   (a) If a car is traveling eastward, its acceleration must be eastward.
   (b) If a car is slowing down, its acceleration must be negative.
   (c) A particle with constant acceleration can never stop and stay stopped.

5. Consider the following choices: (a) increases, (b) decreases, (c) increases and then decreases, (d) decreases and then increases, (e) remains the same. From these choices, select what happens to (i) the acceleration and (ii) the speed of a ball after it is thrown upward into the air.

6. Which of the following are vector quantities and which are scalar quantities?

   (a) your IQ
   (b) acceleration
   (c) velocity
   (d) speed
   (e) mass.

7. Consider the following controls in an automobile in motion: gas pedal, brake, steering wheel. What are the controls in this list that cause an acceleration of the car?

   (a) all three controls
   (b) the gas pedal and the brake
   (c) only the brake
   (d) only the gas pedal
   (e) only the steering wheel.

8. As a projectile thrown at an upward angle moves in a parabolic path.
   (i) At what point along its path are the velocity and acceleration vectors for the projectile perpendicular to each other?

   (a) nowhere (b) the highest point (c) the launch point

   (ii) At what point are the velocity and acceleration vectors for the projectile parallel to each other?

   (a) nowhere (b) the highest point (c) the launch point

9. A particle moves in a circular path of radius r with speed v. It then increases its speed to $2v$ while traveling along the same circular path.

   (i) What is the factor by which the centripetal acceleration of the particle has changed?
   (ii) What is the factor by which the period of the particle has changed?

10. A particle moves along a path, and its speed increases with time. In which of the following cases are its acceleration and velocity vectors parallel?

    (a) when the path is circular
    (b) when the path is straight
    (c) when the path is a parabola
    (d) never

    From the same choices, in which case are its acceleration and velocity vectors perpendicular everywhere along the path?

11. Which of the following statements is correct?

    (a) It is possible for an object to have motion in the absence of forces on the object.
    (b) It is possible to have forces on an object in the absence of motion of the object.
    (c) Neither statement (a) nor statement (b) is correct.
    (d) Both statements (a) and (b) are correct.

12. An object experiences no acceleration. Which of the following cannot be true for the object?

    (a) A single force acts on the object.
    (b) No forces act on the object.
    (c) Forces act on the object, but the forces cancel.

13. You push an object, initially at rest, across a frictionless floor with a constant force for a time interval Δt, resulting in a final speed of v for the object. You then repeat the experiment, but with a force that is twice as large. What time interval is now required to reach the same final speed v?

    (a) $4\Delta t$ (b) $2\Delta t$ (c) Δt (d) $\Delta t/2$ (e) $\Delta t/4$

14. What is weight? Give an example of how it differs from the gravitational force.

15. Suppose you are talking by interplanetary telephone to a friend who lives on the Moon. He tells you that he has just won a newton of gold in a contest. Excitedly, you tell him that you entered the Earth version of the same contest and also won a newton of gold! Who is richer?

    (a) You are. (b) Your friend is. (c) You are equally rich.

16. A fly collides with the windshield of a fast-moving bus. Which experiences an impact force with a larger magnitude?

    (a) The fly.
    (b) The bus.
    (c) The same force is experienced by both.

    Which experiences the greater acceleration?

    (a) The fly.
    (b) The bus.
    (c) The same acceleration is experienced by both.

17. A large man and a small boy stand facing each other on frictionless ice. They put their hands together and push against each other so that they move apart.

    (A) Who moves away with the higher speed?
    (B) Who moves farther while their hands are in contact?

18. You press your physics textbook flat against a vertical wall with your hand. What is the direction of the friction force exerted by the wall on the book?
    (a) downward (b) upward (c) out from the wall (d) into the wall.

19. A basketball and a 2-inch-diameter steel ball, having the same mass, are dropped through air from rest such that their bottoms are initially at the same height above the ground, on the order of 1 m or more. Which one strikes the ground first? (a) The steel ball strikes the ground first. (b) The basketball strikes the ground first. (c) Both strike the ground at the same time.

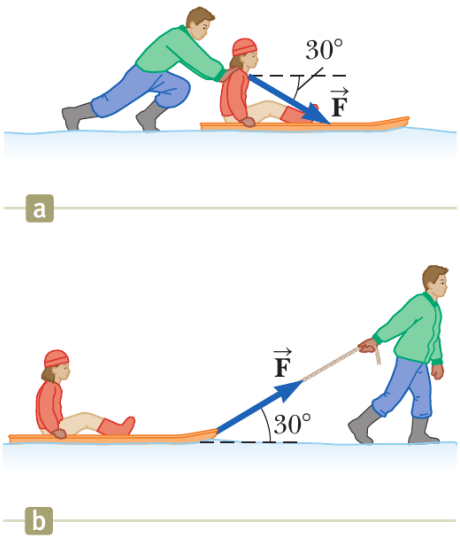
20. What is the terminal velocity of a falling object? Give a short derivation.

21. What is the relation between the magnitudes of static and kinetic frictions?

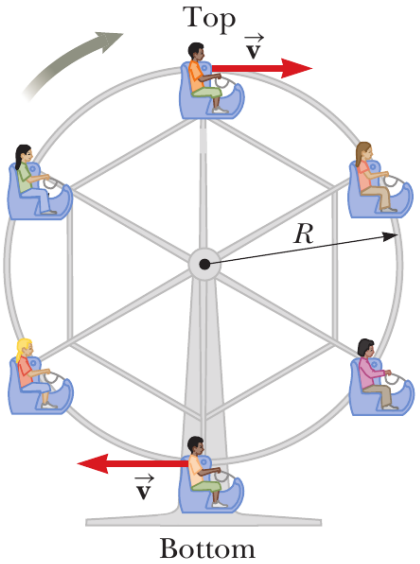
22. Charlie is playing with his daughter Torrey in the snow. She sits on a sled and asks him to slide her across a flat, horizontal field. As shown in the figure, Charlie has a choice of

(a) pushing her from behind with a downward force on her shoulders at 30° below the horizontal or
(b) attaching a rope to the front of the sled and pulling with a force at 30° above the horizontal.

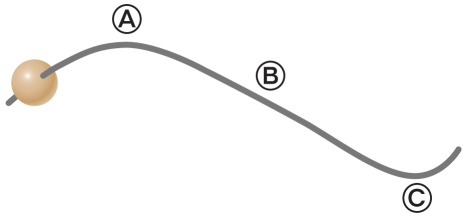
Which would be easier for him and why?



23. You are riding on a Ferris wheel that is rotating with constant speed as shown in the figure. The car in which you are riding always maintains its correct upward orientation; it does not invert. (i) What is the direction of the normal force on you from the seat when you are at the top of the wheel? (a) upward (b) downward (c) impossible to determine (ii) From the same choices, what is the direction of the net force on you when you are at the top of the wheel?



24. A bead slides at constant speed along a curved wire lying on a horizontal surface as shown in the figure below.
(a) Draw the vectors representing the force exerted by the wire on the bead at points A, B, and C.
(b) Suppose now that the bead speeds up with constant tangential acceleration as it moves toward the right. Draw the vectors representing the forces on the bead at points A, B, and C.

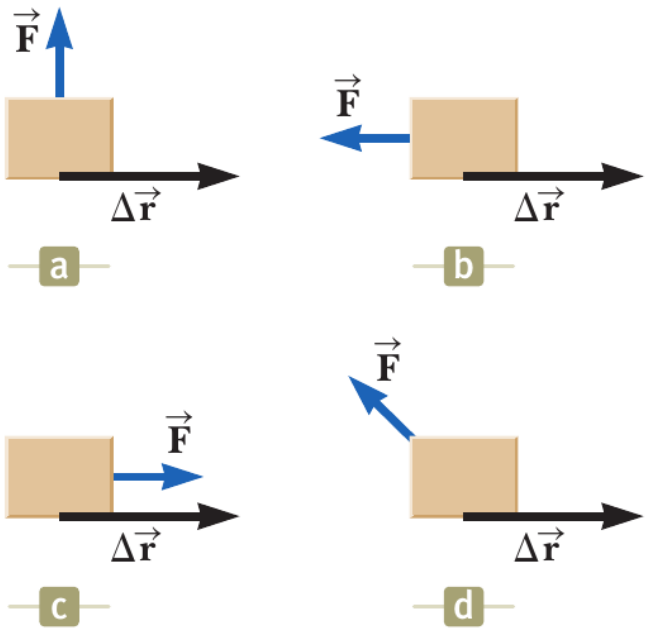


25. Which of the following forces are nonconservative?
(a) spring elastic force (b) kinetic friction (c) gravitational force (d) air resistance force

26. A basketball and a 5-cm-diameter steel ball, having the same mass, are dropped through air from rest such that their bottoms are initially at the same height above the ground, on the order of 1 m or more. Which one strikes the ground first? (a) The steel ball strikes the ground first. (b) The basketball strikes the ground first. (c) Both strike the ground at the same time.

27. The gravitational force exerted by the Sun on the Earth holds the Earth in an orbit around the Sun. Let us assume that the orbit is perfectly circular. The work done by this gravitational force during a short time interval in which the Earth moves through a displacement in its orbital path is (a) zero (b) positive (c) negative (d) impossible to determine.

28. The figure shows four situations in which a force is applied to an object. In all four cases, the force has the same magnitude, and the displacement of the object is to the right and of the same magnitude. Rank the situations in order of the work done by the force on the object, from most positive to most negative.



29. A dart is inserted into a spring-loaded dart gun by pushing the spring in by a distance x. For the next loading, the spring is compressed a distance 2x. How much work is required to load the second dart compared with that required to load the first? (a) four times as much (b) two times as much (c) the same (d) half as much (e) one-fourth as much.

30. What does the slope of a graph of potential energy $U(x)$ versus position x represent?

    (a) the magnitude of the force on the object
    (b) the negative of the magnitude of the force on the object
    (c) the x component of the force on the object
    (d) the negative of the x component of the force on the object.

31. Choose the correct answer. The gravitational potential energy of an object
    (a) is always positive
    (b) is always negative
    (c) can be negative or positive

32. Consider a block sliding over a horizontal surface with friction. Ignore any sound the sliding might make.

    (i) If the system is the block, this system is
    (a) isolated (b) nonisolated (c) impossible to determine

    (ii) If the system is the surface, this system is
    (a) isolated (b) nonisolated (c) impossible to determine

    (iii) If the system is the block and the surface, this system is
    (a) isolated (b) nonisolated (c) impossible to determine

33. A rock of mass m is dropped to the ground from a height h. A second rock, with mass 2m, is dropped from the same height. When the second rock strikes the ground, what is its kinetic energy?

    (a) twice that of the first rock
    (b) four times that of the first rock
    (c) the same as that of the first rock
    (d) half as much as that of the first rock
    (e) impossible to determine

34. Three identical balls are thrown from the top of a building, all with the same initial speed. The first is thrown horizontally, the second at some angle above the horizontal, and the third at some angle below the horizontal. Neglecting air resistance, rank the speeds of the balls at the instant each hits the ground.

35. Two objects have equal kinetic energies. How do the magnitudes of their momenta compare?

    (a) $p_1 = p_2$ (b) $p_1 < p_2$ (c) $p_1 > p_2$ (d) not enough information to tell.

36. Considering a fully elastic collision in two dimensions, is the outcome fully determined by energy and momentum conservation? Why?

37. Your physical education teacher throws a baseball to you at a certain speed and you catch it. The teacher is next going to throw you a medicine ball whose mass is ten times the mass of the baseball. You are given the following choices: You can have the medicine ball thrown with (a) the same speed as the baseball, (b) the same momentum, or (c) the same kinetic energy. Rank these choices from easiest to hardest to catch.

38. Two objects are at rest on a frictionless surface. Object 1 has a greater mass than object 2.

    (i) The two objects are accelerated by the same force through the same distance d in a straight line. Which statements are true for their momenta p_1, p_2 and kinetic energies K_1, K_2?

    (a) $p_1 < p_2$ (b) $p_1 = p_2$ (c) $p_1 > p_2$ (d) $K_1 < K_2$ (e) $K_1 = K_2$ (f) $K_1 > K_2$

    (ii) The two objects are accelerated by the same force for the same time interval Δt in a straight line. Which statements are true for their momenta p_1, p_2 and kinetic energies K_1, K_2?

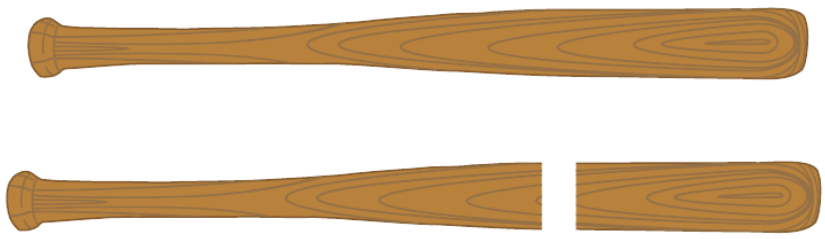
    (a) $p_1 < p_2$ (b) $p_1 = p_2$ (c) $p_1 > p_2$ (d) $K_1 < K_2$ (e) $K_1 = K_2$ (f) $K_1 > K_2$

39. In a perfectly inelastic one-dimensional collision between two moving objects, what condition alone is necessary so that the final kinetic energy of the system is zero after the collision?

    (a) The objects must have initial momenta with the same magnitude but opposite directions.
    (b) The objects must have the same mass.
    (c) The objects must have the same initial velocity.
    (d) The objects must have the same initial speed, with velocity vectors in opposite directions.

40. A table-tennis ball is thrown at a stationary bowling ball. The table-tennis ball makes a one-dimensional elastic collision and bounces back along the same line. Compared with the bowling ball after the collision, does the table-tennis ball have
    (a) a larger magnitude of momentum and more kinetic energy,
    (b) a smaller magnitude of momentum and more kinetic energy,
    (c) a larger magnitude of momentum and less kinetic energy,
    (d) a smaller magnitude of momentum and less kinetic energy, or
    (e) the same magnitude of momentum and the same kinetic energy?

41. A baseball bat of uniform density is cut at the location of its center of mass as shown in the figure. Which piece has the smaller mass?
    (a) the piece on the right (b) the piece on the left (c) both pieces have the same mass (d) impossible to determine



42. A cruise ship is moving at constant speed through the water. The vacationers on the ship are eager to arrive at their next destination. They decide to try to speed up the cruise ship by gathering at the bow (the front) and running together toward the stern (the back) of the ship.
(i) While they are running toward the stern, is the speed of the ship
(a) higher than it was before,
(b) unchanged,
(c) lower than it was before, or
(d) impossible to determine?
(ii) The vacationers stop running when they reach the stern of the ship. After they have all stopped running, is the speed of the ship
(a) higher than it was before they started running,
(b) unchanged from what it was before they started running,
(c) lower than it was before they started running, or
(d) impossible to determine?

43. Ethan and Rebecca are riding on a merry-go-round. Ethan rides on a horse at the outer rim of the circular platform, twice as far from the center of the circular platform as Rebecca, who rides on an inner horse.

(a) When the merry-go-round is rotating at a constant angular speed, what is Ethan's angular speed?
(i) twice Rebecca's
(ii) the same as Rebecca's
(iii) half of Rebecca's
(iv) impossible to determine

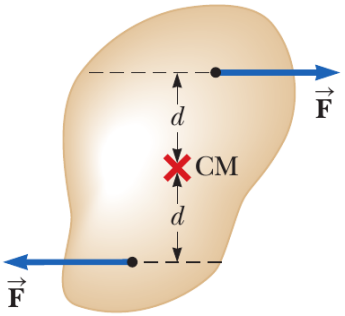
(b) When the merry-go-round is rotating at a constant angular speed, what is Ethan's tangential speed?
(i) twice Rebecca's
(ii) the same as Rebecca's
(iii) half of Rebecca's
(iv) impossible to determine

44. If you are trying to loosen a stubborn screw from a piece of wood with a screwdriver and fail, should you find a screwdriver for which the handle is
(a) longer or
(b) fatter?

45. You turn off your electric drill and find that the time interval for the rotating bit to come to rest due to frictional torque in the drill is Δt. You replace the bit with a larger one that results in a doubling of the moment of inertia of the drill's entire rotating mechanism. When this larger bit is rotated at the same angular speed as the first and the drill is turned off, the frictional torque remains the same as that for the previous situation. What is the time interval for this second bit to come to rest?
(a) $4\Delta t$ (b) $2\Delta t$ (c) Δt (d) $\Delta t/2$ (e) $\Delta t/4$ (f) impossible to determine

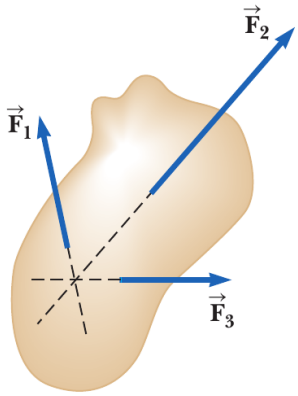
46. Consider the object subject to the two forces of equal magnitude in the figure. Choose the correct statement with regard to this situation.

(a) The object is in force equilibrium but not torque equilibrium.
(b) The object is in torque equilibrium but not force equilibrium.
(c) The object is in both force equilibrium and torque equilibrium.
(d) The object is in neither force equilibrium nor torque equilibrium.



47. Consider the object subject to the three forces of in the figure. Choose the correct statement with regard to this situation.

(a) The object is in force equilibrium but not torque equilibrium.
(b) The object is in torque equilibrium but not force equilibrium.
(c) The object is in both force equilibrium and torque equilibrium.
(d) The object is in neither force equilibrium nor torque equilibrium.



48. A meterstick of uniform density is hung from a string tied at the 25-cm mark. A 0.50-kg object is hung from the zero end of the meterstick, and the meterstick is balanced horizontally. What is the mass of the meterstick?

(a) 0.25 kg (b) 0.50 kg (c) 0.75 kg (d) 1.0 kg (e) 2.0 kg (f) impossible to determine

49. A section of hollow pipe and a solid cylinder have the same radius, mass, and length. They both rotate about their long central axes with the same angular speed. Which object has the higher rotational kinetic energy?

    (a) The hollow pipe does.
    (b) The solid cylinder does.
    (c) They have the same rotational kinetic energy.
    (d) It is impossible to determine.

50. A solid sphere and a hollow sphere have the same mass and radius. They are rotating with the same angular speed. Which one has the higher angular momentum?

    (a) the solid sphere
    (b) the hollow sphere
    (c) both have the same angular momentum
    (d) impossible to determine

51. An ice skater starts a slow spin (pirouette) and then pulls in her arms to speed it up. What happens to her rotational kinetic energy?

    (a) It increases.
    (b) It decreases.
    (c) It stays the same.
    (d) It is impossible to determine.

52. You turn off your electric drill and find that the time interval for the rotating bit to come to rest due to frictional torque in the drill is Δt. You replace the bit with a larger one that results in a doubling of the moment of inertia of the drill's entire rotating mechanism. When this larger bit is rotated at the same angular speed as the first and the drill is turned off, the frictional torque remains the same as that for the previous situation. What is the time interval for this second bit to come to rest?

    (a) $4\Delta t$ (b) $2\Delta t$ (c) Δt (d) $\Delta t/2$ (e) $\Delta t/4$ (f) impossible to determine

53. A ball rolls without slipping down incline A, starting from rest. At the same time, a box starts from rest and slides down incline B, which is identical to incline A except that it is frictionless. Which arrives at the bottom first?

    (a) The ball arrives first.
    (b) The box arrives first.
    (c) Both arrive at the same time.
    (d) It is impossible to determine.

54. A meterstick of uniform density is hung from a string tied at the 25-cm mark. A 0.50-kg object is hung from the zero end of the meterstick, and the meterstick is balanced horizontally. What is the mass of the meterstick?
    (a) 0.25 kg (b) 0.50 kg (c) 0.75 kg (d) 1.0 kg (e) 2.0 kg (f) impossible to determine

55. True or False: the centrifugal force is the reaction force to the centripetal force? Explain.

56. Why does the measured gravitational acceleration depend on the latitude? Where does it take the lowest and highest values?

57. Consider an object moving along a latitude circle westward vs. eastwards. How does its weight change?

58. Cyclons are formed by winds blowing toward a low pressure area at their center. Why do cyclons on the Northern hemisphere rotate and in which direction? What happens in the Southern hemisphere?

59. Superman stands on top of a very tall mountain and throws a baseball horizontally with a speed such that the baseball goes into a circular orbit around the Earth. While the baseball is in orbit, what is the magnitude of the acceleration of the ball?

    (a) It depends on how fast the baseball is thrown.
    (b) It is zero because the ball does not fall to the ground.
    (c) It is slightly less than 9.80 m/s^2.
    (d) It is equal to 9.80 m/s^2.

60. An asteroid is in a highly eccentric elliptical orbit around the Sun. The period of the asteroid's orbit is 90 days. Which of the following statements is true about the possibility of a collision between this asteroid and the Earth?

    (a) There is no possible danger of a collision.
    (b) There is a possibility of a collision.
    (c) There is not enough information to determine whether there is danger of a collision.

61. A comet moves in an elliptical orbit around the Sun. Which point in its orbit (perihelion or aphelion) represents the highest value of

    (a) the speed of the comet,
    (b) the potential energy of the comet–Sun system,
    (c) the kinetic energy of the comet, and
    (d) the total energy of the comet–Sun system?

62. What is the escape velocity for a spherical object with mass M and radius R?

63. The orbit of Mars has a radius of 1.524 times those of the Earth. Estimate the time it takes to travel to Mars on a Hohmann transfer orbit.

64. You are shipwrecked and floating in the middle of the ocean on a raft. Your cargo on the raft includes a treasure chest full of gold that you found before your ship sank, and the raft is just barely afloat. To keep you floating as high as possible in the water, should you

    (a) leave the treasure chest on top of the raft,
    (b) secure the treasure chest to the underside of the raft, or
    (c) hang the treasure chest in the water with a rope attached to the raft?

    (Assume throwing the treasure chest overboard is not an option you wish to consider.)

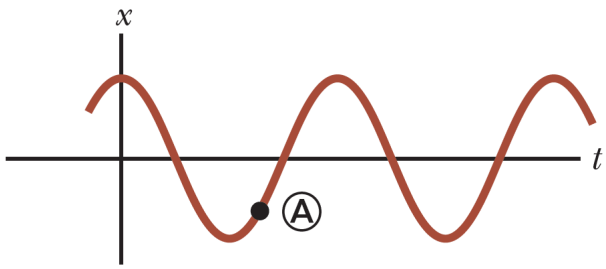
65. Two soap bubbles are connected by a tube. What happens? Explain.

66. You observe two helium balloons floating next to each other at the ends of strings secured to a table. The facing surfaces of the balloons are separated by 1–2 cm. You blow through the small space between the balloons. What happens to the balloons?

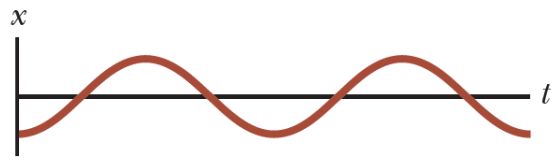
(a) They move toward each other.
(b) They move away from each other.
(c) They are unaffected.

67. How does the laminar flow of a viscuous fluid depend in a pipe on the pressure difference?

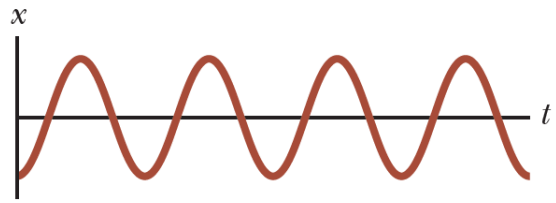
68. Consider the graphical representation of simple harmonic motion below. When the particle is at point A on the graph, what can you say about its position and velocity?
(a) The position and velocity are both positive.
(b) The position and velocity are both negative.
(c) The position is positive, and the velocity is zero.
(d) The position is negative, and the velocity is zero.
(e) The position is positive, and the velocity is negative.
(f) The position is negative, and the velocity is positive.



69. The figure below shows two curves representing particles undergoing simple harmonic motion. The correct description of these two motions is that the simple harmonic motion of particle B is
(a) of larger angular frequency and larger amplitude than that of particle A,
(b) of larger angular frequency and smaller amplitude than that of particle A,
(c) of smaller angular frequency and larger amplitude than that of particle A, or
(d) of smaller angular frequency and smaller amplitude than that of particle A.



Particle A



Particle B

70. An object of mass m is hung from a spring and set into oscillation. The period of the oscillation is measured and recorded as T. The object of mass m is removed and replaced with an object of mass 2m. When this object is set into oscillation, what is the period of the motion?
(a) $2T$(b) $\sqrt{2}T$ (c) T (d) $T/\sqrt{2}$ (e) $T/2$

71. Grandfather clocks use the period of a pendulum to keep correct time.

(a) Suppose the clock is calibrated correctly and then a mischievous child slides the bob of the pendulum downward on the oscillating rod. Does the grandfather clock run
(i) slow, (ii) fast, or (iii) correctly?

(b) Suppose a grandfather clock is calibrated correctly at sea level and is then taken to the top of a very tall mountain. Does the grandfather clock now run
(i) slow, (ii) fast, or (iii) correctly?

72. How is the quality factor related to the resonance curve?

73. A sinusoidal wave of frequency f is traveling along a stretched string. The string is brought to rest, and a second traveling wave of frequency $2f$ is established on the string.

(a) What is the wave speed of the second wave?
(i) twice that of the first wave
(ii) half that of the first wave
(iii) the same as that of the first wave
(iv) impossible to determine

(b) What is the wavelength of the second wave?
(i) twice that of the first wave
(ii) half that of the first wave
(iii) the same as that of the first wave
(iv) impossible to determine

(c) What is the amplitude of the second wave?
(i) twice that of the first wave
(ii) half that of the first wave
(iii) the same as that of the first wave
(iv) impossible to determine

74. The amplitude of a sinusoidal wave along a stretched string is doubled, with no other changes made to the wave. As a result of this doubling, which of the following statements is correct?

(a) The speed of the wave changes.
(b) The frequency of the wave changes.
(c) The maximum transverse speed of an element of the medium changes.
(d) Statements (a) through (c) are all true.
(e) None of statements (a) through (c) is true.

75. Which of the following, taken by itself, would be most effective in increasing the rate at which energy is transferred by a wave traveling along a string?

(a) reducing the linear mass density of the string by one-half
(b) doubling the wavelength of the wave
(c) doubling the tension in the string
(d) doubling the amplitude of the wave

76. If you blow across the top of an empty soft-drink bottle, a pulse of sound travels down through the air in the bottle. At the moment the pulse reaches the bottom of the bottle, what is the correct description of the displacement of elements of air from their equilibrium positions and the pressure of the air at this point?

(a) The displacement and pressure are both at a maximum.
(b) The displacement and pressure are both at a minimum.
(c) The displacement is zero, and the pressure is a maximum.
(d) The displacement is zero, and the pressure is a minimum.

77. Increasing the intensity of a sound by a factor of 100 causes the sound level to increase by what amount?

(a) 100 dB (b) 20 dB (c) 10 dB (d) 2 dB

78. You stand on a platform at a train station and listen to a train approaching the station at a constant velocity. While the train approaches, but before it arrives, what do you hear?

(a) the intensity and the frequency of the sound both increasing
(b) the intensity and the frequency of the sound both decreasing
(c) the intensity increasing and the frequency decreasing
(d) the intensity decreasing and the frequency increasing
(e) the intensity increasing and the frequency remaining the same
(f) the intensity decreasing and the frequency remaining the same

79. How does a pulse traveling down a string reflect at (a) a fixed end (b) a free end?

80. Two pulses move in opposite directions on a string and are identical in shape and size except that one has positive displacements of the elements of the string and the other has negative displacements. At the moment the two pulses completely overlap on the string, what happens?

(a) The energy associated with the pulses has disappeared.
(b) The string is not moving.
(c) The string forms a straight line.
(d) The pulses have vanished and will not reappear.

81. When a standing wave is set up on a string fixed at both ends, which of the following statements is true?

(a) The number of nodes is equal to the number of antinodes.
(b) The wavelength is equal to the length of the string divided by an integer.
(c) The frequency is equal to the number of nodes times the fundamental frequency.
(d) The shape of the string at any instant shows a symmetry about the midpoint of the string.

82. A pipe open at both ends resonates at a fundamental frequency f_{open}. When one end is covered and the pipe is again made to res- onate, the fundamental frequency is f_{closed}. Which of the following expres- sions describes how these two resonant frequencies compare?

(a) $f_{\text{closed}} = f_{\text{open}}$ (b) $f_{\text{closed}} = f_{\text{open}}/2$ (c) $f_{\text{closed}} = 2f_{\text{open}}$ (d) $f_{\text{closed}} = 3f_{\text{open}}/2$