1) Which of the following quantities has units of a velocity? (There could be more than one correct choice.)
A) 40 km southwest
B) -120 m/s
C) 9.8 m/s^2 downward
D) 186,000 mi
E) 9.8 m/s downward

2) Suppose that a car traveling to the west begins to slow down as it approaches a traffic light. Which of the following statements about its acceleration is correct?
A) The acceleration is toward the east.
B) Since the car is slowing down, its acceleration must be negative.
C) The acceleration is zero.
D) The acceleration is toward the west.

3) When a ball is thrown straight up with no air resistance, the acceleration at its highest point
A) is upward
B) is downward
C) is zero
D) reverses from upward to downward
E) reverses from downward to upward

4) A ball is thrown downward in the absence of air resistance. After it has been released, which statement(s) concerning its acceleration is correct? (There could be more than one correct choice.)
A) Its acceleration is constantly increasing.
B) Its acceleration is constant.
C) Its acceleration is constantly decreasing.
D) Its acceleration is zero.

5) A 10-kg rock and a 20-kg rock are thrown upward with the same initial speed v_0 and experience no significant air resistance. If the 10-kg rock reaches a maximum height h, what maximum height will the 20-kg ball reach?
A) $h/4$
B) $h/2$
C) h
D) $2h$
E) $4h$

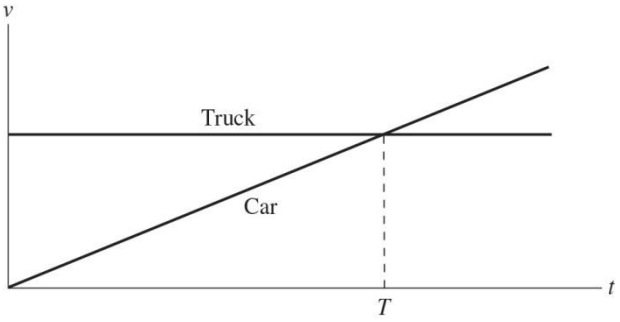
6) The slope of a position versus time graph gives
A) the distance traveled.
B) velocity.
C) acceleration.
D) displacement.

7) The slope of a velocity versus time graph gives
A) the distance traveled.
B) velocity.
C) acceleration.
D) displacement.

8) If the position versus time graph of an object is a horizontal line, the object is
A) moving with constant non-zero speed.
B) moving with constant non-zero acceleration.
C) at rest.
D) moving with increasing speed.

9) If the velocity versus time graph of an object is a horizontal line, the object is
A) moving with zero acceleration.
B) moving with constant non-zero acceleration.
C) at rest.
D) moving with increasing speed.

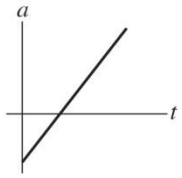
10) The motions of a car and a truck along a straight road are represented by the velocity-time graphs in the figure. The two vehicles are initially alongside each other at time $t = 0$.



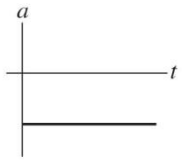
At time *T*, what is true of the *distances* traveled by the vehicles since time $t = 0$?
A) They will have traveled the same distance.
B) The truck will not have moved.
C) The car will have travelled further than the truck.
D) The truck will have travelled further than the car.

11) A child standing on a bridge throws a rock straight down. The rock leaves the child's hand at time $t = 0$ s. If we take upward as the positive direction, which of the graphs shown below best represents the acceleration of the stone as a function of time?

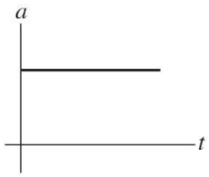
A)



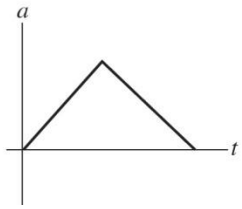
B)



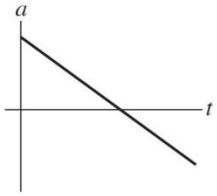
D)



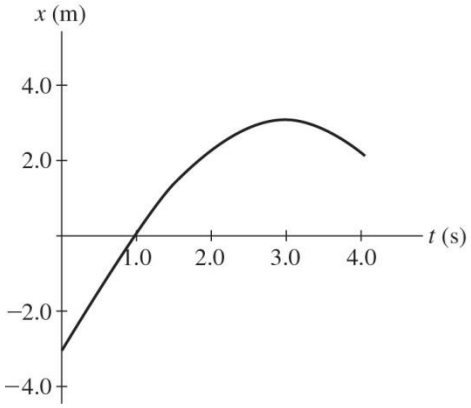
C)



E)



12) The graph in the figure shows the position of a particle as it travels along the *x*-axis.



At what value of *t* is the speed of the particle equal to 0 m/s?

A) 0 s
B) 1 s
C) 2 s
D) 3 s
E) 4 s

13) A car is traveling north at 17.7 m/s. After 12 s its velocity is 14.1 m/s in the same direction. Find the magnitude and direction of the car's average acceleration.
A) 0.30 m/s^2, south
B) 2.7 m/s^2, south
C) 0.30 m/s^2, north
D) 2.7 m/s^2, north

14) A racquetball strikes a wall with a speed of 30 m/s and rebounds in the opposite direction with a speed of 26 m/s. The collision takes 20 ms. What is the average acceleration of the ball during the collision with the wall?
A) 0 m/s^2
B) 200 m/s^2
C) 2800 m/s^2
D) 1500 m/s^2
E) 1300 m/s^2

15) A car initially traveling at 60 km/h accelerates at a constant rate of 2.0 m/s^2. How much time is required for the car to reach a speed of 90 km/h?
A) 15 s
B) 30 s
C) 45 s
D) 4.2 s

16) An airplane starts from rest and accelerates at a constant 10.8 m/s^2. What is its speed at the end of a 400 m-long runway?
A) 37.0 m/s
B) 93.0 m/s
C) 65.7 m/s
D) 4320 m/s
E) 186 m/s

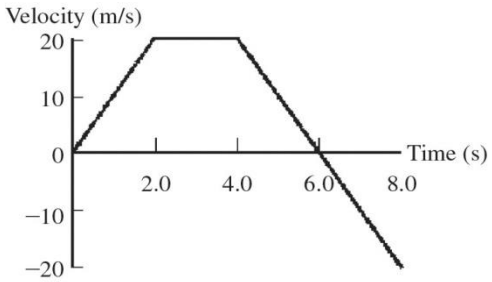
17) A ball is thrown upward at a velocity of 19.6 m/s. What is its velocity after 3.0 s, assuming negligible air resistance?
A) 9.8 m/s upward
B) 9.8 m/s downward
C) 0 m/s
D) 19.6 m/s downward

18) A bullet shot straight up returns to its starting point in 10 s. What is the initial speed of the bullet, assuming negligible air resistance?
A) 9.8 m/s
B) 25 m/s
C) 49 m/s
D) 98 m/s

19) A ball is thrown straight up with a speed of 36 m/s. How long does it take to return to its starting point, assuming negligible air resistance?
A) 3.7 s
B) 7.3 s
C) 11 s
D) 15 s

20) An object is thrown upwards with a speed of 16 m/s. How long does it take it to reach a height of 7.0 m on the way up? Neglect air resistance.
A) 0.52 s
B) 1.2 s
C) 2.4 s
D) 3.1 s
E) 4.2 s

21) The figure shows a graph of the velocity of an object as a function of time. What is the displacement of the object from 0 s to 6.0 s?



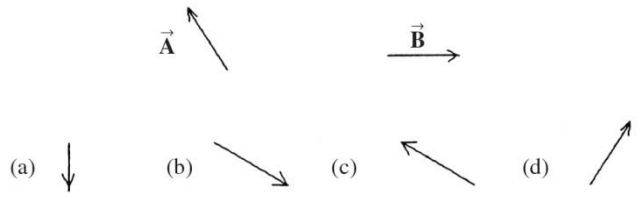
A) 20 m
B) 40 m
C) 60 m
D) 80 m
E) 100 m

22) A cart starts from rest and accelerates uniformly at 4.0 m/s^2 for 5.0 s. It next maintains the velocity it has reached for 10 s. Then it slows down at a steady rate of 2.0 m/s^2 for 4.0 s. What is the final speed of the car?
A) 20 m/s
B) 16 m/s
C) 12 m/s
D) 10 m/s

23) A car travels at 15 m/s for 10 s. It then speeds up with a constant acceleration of 2.0 m/s^2 for 15 s. At the end of this time, what is its velocity?
A) 15 m/s
B) 30 m/s
C) 45 m/s
D) 375 m/s

24) A cart with an initial velocity of 5.0 m/s to the right experiences a constant acceleration of 2.0 m/s^2 to the right. What is the cart's displacement during the first 6.0 s of this motion?
A) 10 m
B) 55 m
C) 66 m
D) 80 m

25) Consider two vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ shown in the figure. The difference $\vec{\mathbf{A}}$ - $\vec{\mathbf{B}}$ is best illustrated by



A) choice (a)
B) choice (b)
C) choice (c)
D) choice (d)

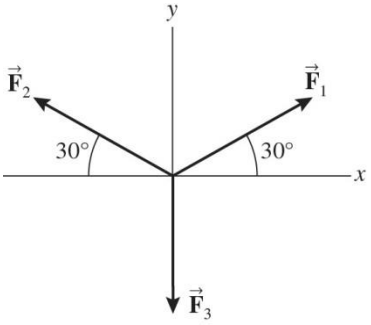
26) The *x* component of vector $\vec{\mathbf{A}}$ is 8.7 units, and its *y* component is -6.5 units. The magnitude of $\vec{\mathbf{A}}$ is closest to
A) 9.9 units
B) 7.9 units
C) 8.9 units
D) 11 units
E) 12 units

27) When Jeff ran up a hill at 7.0 m/s, the horizontal component of his velocity vector was 5.1 m/s. What was the vertical component of Jeff's velocity?
A) 4.8 m/s
B) 4.3 m/s
C) 3.8 m/s
D) 3.4 m/s

28) The *x* component of vector $\vec{\mathbf{A}}$ is 5.3 units, and its *y* component is -2.3 units. The angle that vector $\vec{\mathbf{A}}$ makes with the +*x*-axis is closest to
A) 340°
B) 160°
C) 250°
D) 110°
E) 23°

29) You walk $33\,\mathrm{m}$ to the north, then turn 60° to your right and walk another $45\,\mathrm{m}$. How far are you from where you originally started?
A) 68 m
B) 39 m
C) 75 m
D) 35 m
Answer: A
Var: 31

30) Three forces, $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$, each of magnitude 70 N, all act on an object as shown in the figure. The magnitude of the resultant force acting on the object is



A) 35 N.
B) 70 N.
C) 140 N.
D) 210 N.
E) 0 N.

31) A stone is thrown horizontally with an initial speed of 10 m/s from the edge of a cliff. A stopwatch measures the stone's trajectory time from the top of the cliff to the bottom to be 4.3 s. What is the height of the cliff if air resistance is negligibly small?
A) 22 m
B) 43 m
C) 77 m
D) 91 m

32) A boy throws a rock with an initial velocity of 3.13 m/s at 30.0° above the horizontal. How long does it take for the rock to reach the maximum height of its trajectory if air resistance is negligibly small and g = 9.80 m/s^2?
A) 0.160 s
B) 0.282 s
C) 0.313 s
D) 0.441 s

33) A boy throws a ball with an initial velocity of 25 m/s at an angle of 30° above the horizontal. If air resistance is negligible, how high above the projection point is the ball after 2.0 s?
A) 5.4 m
B) 13 m
C) 25 m
D) 43 m

E) 50 m

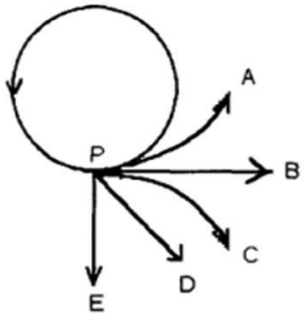
34) An athlete competing in the long jump leaves the ground with a speed of 9.14 m/s at an angle of 55° with the vertical. What is the length of the athlete's jump if air resistance is of no significance?
A) 0.88 m
B) 8.0 m
C) 12 m
D) 17 m
E) 4.0 m

35) An athlete competing in the long jump leaves the ground with a speed of 9.14 m/s at an angle of 35° above the horizontal. How long does the athlete stay in the air, assuming no significant air resistance?
A) 0.50 s
B) 0.88 s
C) 1.1 s
D) 2.5 s
E) 0.54 s

36) You are driving at 30.0 m/s on a freeway curve of radius 25.0 m. What is the magnitude of your acceleration?
A) 36.0 m/s^2
B) 1.20 m/s^2
C) 20.8 m/s^2
D) 0.833 m/s^2

37) A race car traveling at a constant speed of 50 m/s drives around a circular track that is 500 m in diameter. What is the magnitude of the acceleration of the car?
A) 0 m/s^2
B) 1.0 m/s^2
C) 10 m/s^2
D) 0.63 m/s^2
E) 2.2 m/s^2

38) A girl attaches a rock to a string, which she then swings counter-clockwise in a horizontal circle. The string breaks at point P in the figure, which shows a bird's-eye view (as seen from above). Which path (A-E) will the rock follow?



A) Path A
B) Path B
C) Path C
D) Path D
E) Path E

39) A satellite is in orbit around the earth. Which one feels the greater force?
A) the satellite because the earth is so much more massive
B) the earth because the satellite has so little mass
C) Earth and the satellite feel exactly the same force.
D) It depends on the distance of the satellite from Earth.

40) A bucket is being lowered by a very light rope with a constant downward velocity. The tension in the rope must be
A) equal to the weight of the bucket.
B) greater than the weight of the bucket.
C) less than the weight of the bucket.

41) What is the mass of an object that experiences a gravitational force of 685 N near Earth's surface where g = 9.80 m/s^2?
A) 69.9 kg
B) 68.5 kg
C) 71.3 kg
D) 72.7 kg

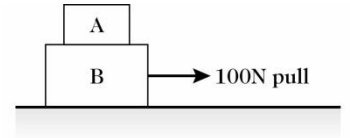
42) An astronaut weighs 99 N on the Moon, where the acceleration of gravity is 1.62 m/s^2. How much does she weigh on Earth?
A) 16 N
B) 61 N
C) 99 N
D) 600 N
E) 440 N

43) What magnitude net force is required to accelerate a 1200-kg car uniformly from 0 m/s to 27.0 m/s in 10.0 s?
A) 444 N
B) 1620 N
C) 3240 N
D) 4360 N
E) 11800 N

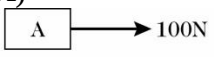
44) A 45.0-kg person steps on a scale in an elevator. The scale reads 460 N. What is the magnitude of the acceleration of the elevator?
A) 4.91 m/s^2
B) 9.81 m/s^2
C) 46.9 m/s^2
D) 0.206 m/s^2
E) 0.422 m/s^2

CHAP 5

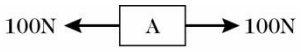
45) Two blocks, A and B, are being pulled to the right along a horizontal surface by a horizontal 100-N pull, as shown in the figure. Both of them are moving together at a constant velocity of 2.0 m/s to the right, and both weigh the same.



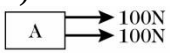
Which of the figures below shows a correct free-body diagram of the horizontal forces acting on the upper block, A?
A)



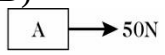
B)



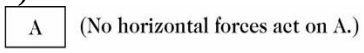
C)



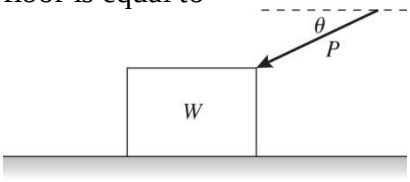
D)



E)

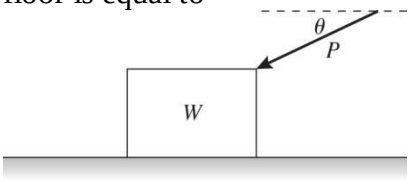


46) A push of magnitude *P* acts on a box of weight *W* as shown in the figure. The push is directed at an angle θ below the horizontal, and the box remains a rest. The box rests on a horizontal surface that has some friction with the box. The normal force on the box due to the floor is equal to



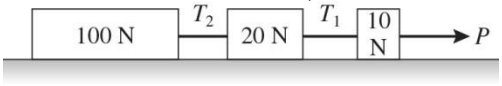
A) *W*.
B) *W* + *P*.
C) *W* + *P* cos θ.
D) W + P sin θ.
E) *W* - *P* sin θ.

47) A push of magnitude *P* acts on a box of weight *W* as shown in the figure. The push is directed at an angle θ below the horizontal, and the box remains a rest. The box rests on a horizontal surface that has some friction with the box. The friction force on the box due to the floor is equal to



A) *P* sin θ
B) *P* cos θ
C) 0
D) *P* cos θ + *W*
E) *P* + *W*

48) Three boxes are pulled along a horizontal frictionless floor by a constant horizontal pull *P*. The boxes are connected by very light horizontal strings having tensions T_1 and T_2 as shown in the figure. Which of the following statements about the tensions is correct? (There could be more than one correct choice.)



A) $T_1 = P$
B) $T_2 = P$
C) $T_1 + T_2 = P$
D) $T_2 > T_1$
E) $T_1 > T_2$

49) A 50-kg box is resting on a horizontal floor. A force of 250 N directed at an angle of 30.0° below the horizontal is applied to the box. The coefficient of static friction between the box and the surface is 0.40, and the coefficient of kinetic friction is 0.30. What is the force of friction on the box?
A) 32 N
B) 200 N
C) 220 N
D) 250 N
E) 620 N

50) A driver in a 1000-kg car traveling at $24\ \text{m/s}$ slams on the brakes and skids to a stop. If the coefficient of friction between the tires and the level road is 0.80, how long will the skid marks be?
A) 37 m
B) 30 m
C) 46 m
D) 34 m

51) A 6.0-kg box slides down an inclined plane that makes an angle of 39° with the horizontal. If the coefficient of kinetic friction is 0.40, at what rate does the box accelerate down the slope?
A) 3.1 m/s^2
B) 3.4 m/s^2
C) 3.7 m/s^2
D) 4.1 m/s^2

Chap 6

52) When a car goes around a circular curve on a horizontal road at constant speed, what force causes it to follow the circular path?
A) the normal force from the road
B) the friction force from the road
C) gravity
D) No force causes the car to do this because the car is traveling at constant speed and therefore has no acceleration.

53) Two small balls, A and B, attract each other gravitationally with a force of magnitude *F*. If we now double both masses and the separation of the balls, what will now be the magnitude of the attractive force on each one?
A) 16*F*
B) 8*F*
C) 4*F*
D) *F*
E) *F*/4

54) A hypothetical planet has a mass of one-half that of the earth and a radius of twice that of the earth. What is the acceleration due to gravity on the planet in terms of *g*, the acceleration due to gravity at the surface of the earth?
A) *g*
B) *g*/2
C) *g*/4
D) *g*/8
E) *g*/16

55) A 1000-kg car is moving at 30 m/s around a horizontal unbanked curve whose diameter is 0.20 km. What is the magnitude of the friction force required to keep the car from sliding?
A) 9000 N
B) 9800 N
C) 300 N
D) 900 N
E) 3000 N

56) A jet plane flying 600 m/s experiences an acceleration of 4.0 *g* when pulling out of a circular dive. What is the radius of curvature of the circular part of the path in which the plane is flying?
A) 640 m
B) 1200 m
C) 7100 m
D) 9200 m

57) What is the gravitational force acting on a 59-kg person due to another 59-kg person standing 2.0 m away? We can model each person as a small sphere. ($G = 6.67 \times 10^{-11}$ N · m^2/kg^2)
A) 5.8×10^{-8} N
B) 8.5×10^{3} N
C) 1.2×10^{-7} N
D) 9.8×10^{-10} N
E) 2.0×10^{-9} N

58) What would be the weight of a 59.1-kg astronaut on a planet twice as massive as Earth and having twice Earth's radius?
A) 580 N
B) 290 N
C) 1160 N
D) 118 N
E) 1200 N

Chap 9

59) A tiger is running in a straight line. If we double both the mass and speed of the tiger, the magnitude of its momentum will increase by what factor?
A) $\sqrt{2}$
B) 2
C) 4
D) 8
E) 16

60) Which of the following quantities are units of impulse? (There could be more than one correct choice.)
A) N · m
B) kg · s/m
C) kg · m/s
D) N · s
E) kg · m^2/s^2

61) A small car meshes with a large truck in a head-on collision. Which of the following statements concerning the momentum during the collision are correct? (There could be more than one correct choice.)
A) The momentum of the truck is conserved.
B) The momentum of the car is conserved.
C) The car and the truck must undergo the same change in speed.
D) The momentum of the car and the momentum of the truck are each conserved.
E) The momentum of the car-truck system is conserved, but the momentum of each one separately is not conserved.

62) A 0.140-kg baseball is dropped and reaches a speed of 1.20 m/s just before it hits the ground and bounces. It rebounds with an upward velocity of 1.00 m/s. What is the change of the ball's momentum during the bounce?
A) 0.0280 kg · m/s upwards
B) 0.0280 kg · m/s downwards
C) 0.308 kg · m/s upwards
D) 0.308 kg · m/s downwards
E) 0.000 kg · m/s

63) A 0.10-kg ball, traveling horizontally at 25 m/s, strikes a wall and rebounds at 19 m/s. What is the magnitude of the change in the momentum of the ball during the rebound?
A) 1.2 kg · m/s
B) 1.8 kg · m/s
C) 4.4 kg · m/s
D) 5.4 kg · m/s
E) 72 kg · m/s

64) A 1200-kg ore cart is rolling at 10.8 m/s across a flat friction-free surface. A crane suddenly drops $858\ \text{kg}$ of ore vertically into the cart. How fast does the cart move just after being loaded with the ore?
A) 6.30 m/s
B) 3.80 m/s
C) 4.20 m/s
D) 5.70 m/s

65) Two ice skaters suddenly push off against one another starting from a stationary position. The 45-kg skater acquires a speed of 0.375 m/s relative to the ice. What speed does the 60-kg skater acquire relative to the ice?
A) 0.50 m/s
B) 0.28 m/s
C) 0.38 m/s
D) 0.75 m/s
E) 0.00 m/s

66) A 1200-kg car moving at $15.6\ \text{m/s}$ suddenly collides with a stationary car of mass $1500\ \text{kg}$. If the two vehicles lock together, what is their combined velocity immediately after the collision?
A) 6.9 m/s
B) 8.6 m/s
C) 12.1 m/s
D) 5.5 m/s

1) Person X pushes twice as hard against a stationary brick wall as person Y. Which one of the following statements is correct?
A) Both do positive work, but person X does four times the work of person Y.
B) Both do positive work, but person X does twice the work of person Y.
C) Both do the same amount of positive work.
D) Both do zero work.
E) Both do positive work, but person X does one-half the work of person Y.

67) A 4.0 kg object is moving with speed 2.0 m/s. A 1.0 kg object is moving with speed 4.0 m/s. Both objects encounter the same constant braking force, and are brought to rest. Which object travels the greater distance before stopping?
A) the 4.0 kg object
B) the 1.0 kg object
C) Both objects travel the same distance.
D) It cannot be determined from the information given.

68) A stone is held at a height *h* above the ground. A second stone with four times the mass of the first one is held at the same height. The gravitational potential energy of the second stone compared to that of the first stone is
A) one-fourth as much.
B) one-half as much.
C) twice as much.
D) four times as much.
E) the same.

69) When you throw a pebble straight up with initial speed *V*, it reaches a maximum height *H* with no air resistance. At what speed should you throw it up vertically so it will go twice as high?
A) $16V$
B) $8V$
C) $4V$
D) $2V$
E) $\sqrt{2}V$

70) When you drop a pebble from height *H*, it reaches the ground with speed *V* if there is no air resistance. From what height should you drop it so it will reach the ground with twice speed?
A) $\sqrt{2}H$
B) $2H$
C) $4H$
D) $8H$
E) $16H$

71) Jill does twice as much work as Jack does and in half the time. Jill's power output is
A) the same as Jack's power output.
B) one-fourth as much as Jack's power output.
C) one-half as much as Jack's power output.
D) twice Jack's power output.
E) four times Jack's power output.
72) A force produces power *P* by doing work *W* in a time *T*. What power will be produced by a force that does six times as much work in half as much time?
A) $12P$
B) $6P$
C) P
D) $\frac{1}{6}P$
E) $\frac{1}{12}P$

73) An egg falls from a bird's nest in a tree and feels no effects due to the air. As it falls,
A) only its kinetic energy is conserved.
B) only its momentum is conserved.
C) both its kinetic energy and its momentum are conserved.
D) only its mechanical energy is conserved.
E) both its mechanical energy and its momentum are conserved.

74) A traveler pulls on a suitcase strap at an angle 36° above the horizontal. If 555 J of work are done by the strap while moving the suitcase a horizontal distance of 15 m, what is the tension in the strap?
A) 46 N
B) 37 N
C) 52 N
D) 56 N

75) Matthew pulls his little sister Sarah along the horizontal ground in a wagon. He exerts a force on the wagon of 60.0 N at an angle of 37.0° above the horizontal. If he pulls her a distance of 12.0 m, how much work does Matthew do?
A) 185 J
B) 433 J
C) 575 J
D) 720 J

76) An object hits a wall and bounces back with half of its original speed. What is the ratio of the final kinetic energy to the initial kinetic energy of the object?
A) 1/2
B) 1/4
C) 1/8
D) 1/16

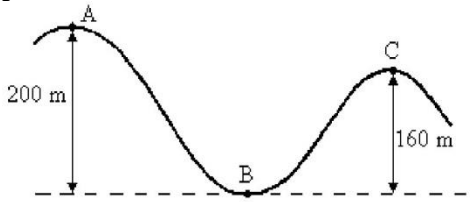
77) How much work must be done by frictional forces in slowing a 1000-kg car from 26.1 m/s to rest?
A) 3.41×10^5 J
B) 2.73×10^5 J
C) 4.09×10^5 J
D) 4.77×10^5 J

78) When a car of mass $1167\ \text{kg}$ accelerates from 10.0 m/s to some final speed, 4.00×10^5 J of work are done. Find this final speed.
A) 28.0 m/s
B) 22.4 m/s
C) 25.2 m/s
D) 30.8 m/s

79) An ideal spring has a spring constant (force constant) of 2500 N/m. is stretched 4.0 cm. How much work is required to stretch the spring by 4.0 cm?
A) 4.0 J
B) 0.00 J
C) 1.0 J
D) 3.0 J
E) 2.0 J

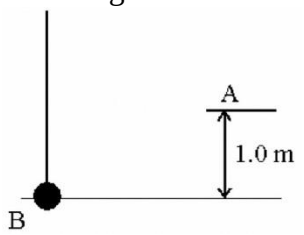
80) If 4.0 J of work are performed in stretching an ideal spring with a spring constant (force constant) of 2500 N/m, by what distance is the spring stretched?
A) 3.2 cm
B) 3.2 m
C) 0.3 cm
D) 5.7 m
E) 5.7 cm

81) A bead is moving with a speed of 20 m/s at position A on the track shown in the figure. This track is friction-free, and there is no appreciable air resistance. What is the speed of the bead at point C?



A) 0 m/s
B) 34 m/s
C) 69 m/s
D) 20 m/s
E) We cannot solve this problem without knowing the mass of the bead.

82) In the figure, a ball hangs by a very light string. What is the minimum speed of the ball at the bottom of its swing (point B) in order for it to reach point A, which is 1.0 m above the bottom of the swing?



A) 2.2 m/s
B) 3.1 m/s
C) 4.4 m/s
D) 4.9 m/s

83) A child pulls on a wagon with a force of $75\,\text{N}$. If the wagon moves a total of $42\,\text{m}$ in $3.1\,\text{min}$, what is the average power delivered by the child?
A) 17 W
B) 21 W
C) 22 W
D) 26 W